WUNNA EDUCATIONAL SERVICES

A-LEVEL PHYSICS PAPER 1 & 2 REVISION QUESTIONS

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PHYSICS P510/1 REVISION QUESTIONS

List of physical constants to be used

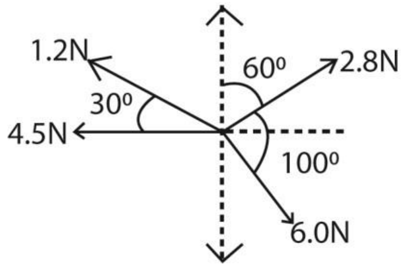
Acceleration due to gravity, g	$9.81ms^{-2}$
Electron charge, e	$1.6 x10^{-19}C$
Electron mass	$9.11 \times 10^{-31}kg$
Mass of the earth	$5.97 \times 10^{24}kg$
Plank's constant, h	$6.6 \times 10^{-34}Js$
Stefan's-Boltzmann's constant, σ	$5.67 \times 10^{-8}Wm^{-2}K^{-1}$
Radius of the earth	6.4 x 106m
Radius of the sun	$7 \times 10^{8}m$
Radius of the earth's orbit about the sun	$1.5 \times 10^{11}m$
Speed of light in the vacuum, c	$3.0 \times 108ms^{-1}$
Thermal conductivity of copper	390Wm-1K-1
Thermal conductivity of aluminium	210Wm-1K-1
Specific heat capacity of water	$4.200Jkg^{-1}K^{-1}$
Universal gravitational constant	$6.67 \times 10^{-11}Nm^{2}Kg^{-2}$
Avogadro's number, N_A	$6.02 \times 10^{23}mol^{-1}$
Surface tension of water	$7.0 \times 10^{-2}Nm^{-1}$
Density of water	$1000kgm^{-3}$
Gas constant, R	$8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	$1.8 \times 10^{11}Ckg^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_0}$	$9.0 \times 10^{9}F^{-1}m$
Faraday's constant, F	$9.65 \times 10^{4}Cmol^{-1}$
Thermal conductivity of Iron	75Wm-1K-1
Specific latent heat of fusion of Ice =	$3.3 \times 10^{5}Jkg^{-1}$
Permittivity of free space, μ0	$4.0\pi \times 10^{-7}Hm^{-1}$
Permittivity of free space, ε0	$8.85 \times 10^{-12}Fm^{-1}$
One electron volt	$1.6 \times 10^{-19}J$
Resistivity of Nichrome wire at 250C	$1.2 \times 10^{-6}\Omega m$
Specific heat capacity of copper	$400Jkg^{-1}K^{-1}$

SECTION A (MECHANICS)

1. (a) (i) Distinguish between scalar and vector quantity. (01 mark)

(ii) Give two examples of each type of quantity. (02marks)

(b) A body of mass 0.2kg at rest is acted on by four forces of 2.8N, 6.0N, 4.5N and 1.2N as shown in the figure below.



Calculate

(i) Resultant force on the body (04marks) (ii) Distance moved in 4s (02marks)

(c) State Newton's law of motion and use them to derive the law of conservation of momentum. (06marks)

(d) A body of mass 800kg moving at $30ms^{-1}$ collides with another of mass 400kg moving in the same direction at $25ms^{-1}$. The two bodies stick together after collision. Calculate the

(i) common velocity just after collision (02marks)

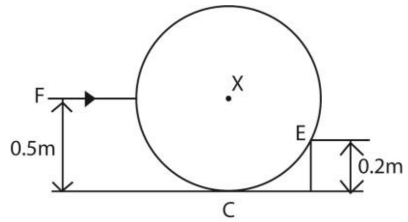
(ii) kinetic energy lost during collision (03marks)

2. (a) Define moment of force and give its SI unit. (02marks)

(b) Explain briefly how to locate the centre of gravity of an irregular sheet of cardboard. (04marks)

(c) State the conditions necessary for equilibrium of a rigid body under action of a system of forces. (02marks)

(d) A wheel of radius 0.5m rests on a level surface at point C and makes contact with edge E of a block height 0.2m as shown in the figure below.



A force F is applied horizontally through the axle of the wheel at X to just move the wheel over the block. If the weight of the wheel is 180N, find the

(i) Force exerted at point E (02marks) (ii) Force F (04marks)

(e) State the laws of friction and explain each of them (06marks)

3. (a) Define the following as applied to circular motion:

(i) Centripetal acceleration (01mark) (ii) Period (01mark)

(b) (i) Explain why a cyclist bends inward while going round a curved path. (03marks)

(ii) Show that if θ is the angle of inclination of the cyclist to the vertical and μ is the coefficient of limiting friction between the ground and the bicycle tyres, then for safe riding $\tan \theta \leq \mu$. (04marks)

(iii)A body of mass 1.5kg moves once round a circular path to cover 44.0cm in 5s. Calculate the centripetal force acting on the body. (04marks)

(c) Define simple harmonic motion (01mark)

(d) A body executes simple harmonic motion with amplitude A and angular velocity, ω.

(i) Write down the equation for velocity of the body at a displacement x from the mean position (01mark)

(ii) Sketch the velocity-displacement graph for the body in (d)(i) for $\omega < 1$. (02marks)

(iii)If the body moves with amplitude 14.142 cm, at what distance from the mean position will be kinetic energy equal to potential energy? (03marks)

4. (a) State and illustrate Archimedes' principle. (05marks)

(b)(i) State the law of flotation (01 marks)

(ii) Describe an experiment to verify the law in (b)(i). (05marks)

(c)(i) Write Bernoulli's equation and define each term in the equation. (02marks)

(ii) Explain the origin of lift force on the wings of a plane. (03marks)

(iii) Air flows over the upper surfaces of the wings of an aeroplane at a speed of $120ms^{-1}$, and past the lower surface of the wings at $110ms^{-1}$.Calclate the lift force on the aeroplane if it has a total wing area of $20m^2$. Density of air = $1.29kgm^{-3}$)

5. (a) What is meant by relative velocity? (01mark)

(b) A ship is heading due to north at a speed of $30ms^{-1}$. Water in the lake is moving in the north-east direction at an average speed of 5kmh-1. Calculate

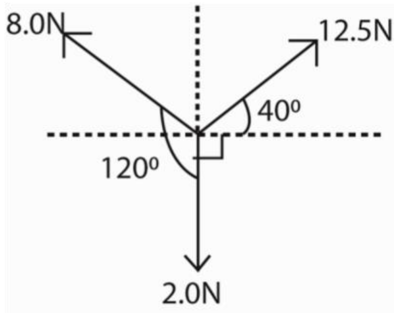
(i) Relative velocity of the ship (04 marks)

(ii) Distance off course the ship will be after 40 minutes. (02marks)

(c) (i) Explain why a passenger in a car jerks forward when the brakes are suddenly applied. (03marks)

(ii) Use Newton's second law to define the Newton. (04marks)

(d) Three forces of 8.0N, 12.5N and 2.0Nact on a body of mass 0.7kg as shown below



Calculate the acceleration of the body

6. (a) What is meant by the centre of the mass? (01mark)

(b) Explain why a long spanner is preferred to a short on n undoing a tight bolt. (03marks)

(c) A uniform ladder of length 10m and weight 400N, leans against a smooth wall and its foot rests on rough ground. The ladder makes an angle of 60^0 with the horizontal. If the ladder just slips when a person of weight 800N climbs 6m up the ladder, calculate the

(i) Reaction on the wall and the ground (05marks)

(ii) Distance another person of weight 600N can climb up the ladder so that the same reaction are exerted as in (c)(i). (02marks)

(d) (i) State the principle of conservation of energy. (01mark)

(ii) How does the principle in (d)(i) apply to a child sliding down an incline? (02marks)

(e) A pump with power output of 147.1W can raise 2kg of water per second through a height of 5m and delver it into a tank. Calculate the speed with which the water is delivered into the tank. (03marks)

(f) Explain the effect of a **couple** on a rigid body. (03marks)

7. (a) What is meant by a

(i) Brittle material (01mark)

(ii) Ductile material (01marks)

(b) Give one example of each of the materials in (a) (01mark)

(c) Explain why bicycle frame are hollow (02mark)

(d) (i) Sketch a labelled graph of stress against strain for a ductile material (02marks)

(ii) Explain the main features of the graph in (d)(i) (04marks)

(e) Derive the expression for the energy stored per unit volume in a rod of length, L, Young's Modulus, Y, when stretched through distance, e. (04marks)

(f) A load of 5kg is placed on top of a vertical brass rod of radius 10mm and length 50cm. if

(i) Decrease in length (03marks) (ii) energy stored in the rod. (02marks)

8. (a) Define the following:

(i) Angular velocity

(ii) Period

(b) An object moves in a circular path of radius, r, with a constant velocity, V. Derive an expression for its acceleration. (04marks)

(c) (i) State two factors on which the rate of flow of a fluid through a tube depends. (02marks)

(ii) Describe an experiment to measure the coefficient of viscosity of a liquid using Poiseulle's formula

(d) Find the time take for an oil drop of diameter 6.0×10^{-3}mm to fall through a distance of 4.0 cm in air of coefficient of viscosity 1.8×10^{-5}Pa.

[The density of oil and air are $8.0 \times 10^{3}kgm^{-3}$ and $1kgm^{-3}$ respectively]

9. (a) (i) State Newton's laws of motion. (03marks)

(ii) A molecule of a gas contained in a cube of side L strikes the wall of the cube repeatedly with a velocity u. Show that the average force F on the wall is given by

$F = \frac{mu^2}{L}$; where m is the mass of the molecule (04marks)

(b) (i) Define linear momentum and state the law of conservation of linear momentum. (02marks)

(ii) A body of mass m1 moving with velocity u, collides with another body of mass m2 at rest. If they stick together after collision, find the common velocity with which they move (04marks)

(c) A bullet of mass 10g is fired horizontally with a velocity of $300ms^{-1}$ into a block of wood of mass 290g which rests on a rough horizontal floor. After impact, the block and the bullet move together and come to rest when the block has travelled a distance of 15m. Calculate the coefficient of sliding friction between the block and the floor. (07marks)

10. (a) State Kepler's laws of planetary motion. (03marks)

(b) Use Newton's law of gravity to derive the dimension of the universal gravitational constant (03marks)

(c) A satellite is resolving at a height, h, above the surface of the earth with period T.

(i) Show that the acceleration due to gravity, g, on the earth's surface is given by

$g = \frac{4\pi^2(r_e+h)^3}{T^2 r_e^2}$, where r_e is the radius of the earth. (06marks)

(ii) What is meant by parking orbit? (02marks)

(d) A satellite revolves in a circular orbit at a height of 600kmabove the earth's surface. Calculate the

(i) Speed of the satellite. (03marks)

(ii) Period of the satellite. (03marks)

11. (a)(i) Define Simple harmonic motion. (01mark)

(ii) Sketch a displacement-time graph for a body performing simple harmonic motion. (01mark)

(b) A uniform cylindrical rod of length 16cm and density 920kgm^{-3} floats vertically in a liquid of density 1000kgm^{-3}. The rod is depressed through a distance of 7mm and then released.

(i) Show that the rod performs simple harmonic motion (06marks)

(ii) Find the frequency of the resultant oscillations. (04marks)

(iii) Find the velocity of the rod when is at a distance of 5mm above the equilibrium position (03marks)

(c) What is meant by potential energy? (01mark)

(d) Describe the energy changes which occur when a;

(i) ball thrown upwards in air (03marks)

(ii) loud speaker vibrating (01mark)

12. (a)(i) Define elastic deformation and plastic deformation (02marks)

(ii) Explain what is meant by work hardening. (02marks)

(b) (i) Sketch using the same axes, stress-strain curves for ductile material and for rubber. (03marks)

(ii) Explain the features of the curve for rubber. (03marks)

(c) A capillary tube is held in a vertical position with one end dipping in a liquid of surface tension γ and density ρ. If the liquid rises to a height, h, derive an expression for h in terms of γ, ρ and radius r of the tube assuming the angle of contact is zero. (04marks)

(d) A mercury drop of radius 2mm falls vertically and on hitting the ground, it splits into two drops each of radius 0.5mm. Calculate the change in surface energy given that the surface tension of mercury is 0.52Nm^{-1}. (05marks)

(e) State the effect of temperature on surface tension of a liquid. (01mark)

13. (a) (i) Define dimensions of a physical quantity. (01mark)

(ii) In the gas equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

Where P = pressure, V= volume, T= absolute temperature and R= gas constant, what are the dimensions of the constants a and b? (04mark)

(b) A particle is projected from a point on horizontal plane with a velocity, u, at an angle, θ, above the horizontal. Show that the maximum horizontal range R_{max} is given by,

$R_{max} = \frac{u^2}{g}$ where, g, is the acceleration due to gravity. (04marks)

(c) (i) Define elastic limit of a material. (01marks)

(ii) Describe an experiment to determine Young's Modulus of a steel wire. (06marks)

(d) Explain why tyres of a vehicle travelling on a hard surfaced road may burst. (04marks)

14. (a) (i) What is meant by efficiency of a machine? (01mark)

(ii) A car of mass1.2 x 10^{3}kgmovesup an incline at a steady velocity of 15ms^{-1} against a frictional force of 6.0 x 10^{3}N. The incline is such that the car rises 1.0m for every 10m along the incline. Calculate the output power of the car engine. (04marks)

(b) (i) Define the impulse and momentum. (02marks)

(ii) An engine pumps water such that the velocity of the water leaving the nozzle is $15ms^{-1}$. If the water jet is directed perpendicularly on a wall and comes to a stop at the wall, calculate the pressure exerted on the wall. (03marks)

(c) (i) Define inertia. (01mark)

(ii) Explain why a body placed on a rough plane will slide when the angle of inclination is increased. (04marks)

(d) (i) State the conditions for a body to be in equilibrium under action of coplanar forces. (02marks)

(ii) Briefly explain the three states of equilibrium (03marks)

15. (a) (i) What is meant by conservative forces? (01mark)

(ii) Give two examples of conservative forces (02marks)

(b) Explain the following

(i) damped oscillations (02marks)

(ii) Forced oscillations (02marks)

(c) (i) State Newton's law of gravitation (01mark)

(ii) Show that Newton's law of gravitation is consistent with Kepler's third law. (05marks)

(d) If the earth takes 365 days to make one revolution around the sun, calculate the mass of the sun (04marks)

(e) Explain briefly how satellites are used in world-wide radio or television communication. (04marks)

16. (a) (i) What is meant by fluid element and flow line as applied to fluid flow? (02mark)

(ii) Explain why some fluids flow more easily than others (03marks)

(b) (i) State Bernoulli's Principle. (01mark)

(ii) Explain how a Pilot-static tube works (04marks)

(c) Air flowing over the upper surface of an air craft's wing causes a lift force of 6.4×10^5N. The air flows under the wing at a speed of $120ms^{-1}$ over an area of $28m^2$. Find the seed of air flow over an equal area of the upper surface of the air craft's wings. (Assume density of air = $1.2kgm^{-3}$) (04marks)

(d) (i) What is meant by surface tension and angle of contact of a liquid? (02marks)

(ii) A water drop of radius 0.5cm is broken up into other drops of water each of radius 1mm. assuming isothermal conditions, find the total work done to break up the water drop. (04marks)

17. (a) (i) what is meant by conservative force? (01mark)

(ii) Give two examples of conservative forces. (01mark)

(b) (i) State the law of conservation of mechanical energy. (01mark)

(ii) A body of mass, m, is projected vertically upwards with speed, u. show that the low of conservation of mechanical energy is obeyed throughout its motion. (05marks)

(iii) Sketch a graph showing variation of kinetic energy by the body with time. (01 mark)

(c) (i) Describe an experiment to measure the coefficient of static friction. (04marks)

(ii) State two disadvantages of friction. (01mark)

(d) A bullet of mass 20g moving horizontally strikes and get embedded in a wooden block of mass 500g resting on a horizontal table. The block slides through a distance of 2.3m before coming to rest. If the coefficient of kinetic friction between the block and table is 0.3, calculate;

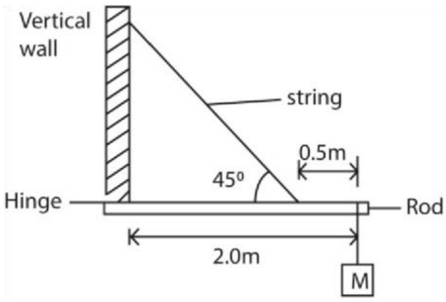
(i) Friction force between the block and the table. (02marks)

(ii) Velocity of the bullet just before it strikes the block. (04marks)

18. (a) (i) State the principle of moments. (01mark)

(ii) Define the terms centre of gravity and uniform body. (02marks)

(b) Figure below shows a body, M of mass 20kg supported by a rod of negligible mass horizontally hinged to a vertical wall and supported by a string fixed at 0.5m from the other end of the rod.



Calculate the

(i) Tension in the string (03marks)

(ii) Reaction of the hinge (03marks)

(iii) Maximum additional mass which can be added to the mass of 20kg before the string can break given that the string cannot support a tension of more than 500N. (02marks)

(c) (i) Define Young's modulus. (01marks)

(ii) Explain the precautions taken in determinations of Young's modulus of a wire. (06marks)

(iii) Explain why a piece of rubber stretches much more than a metal wire of the same length and cross section (02marks)

19. (a) State Kepler's laws of planetary motion (03marks)

(b) (i) What is a parking orbit? (01mark)

(ii) Derive an expression for the period, T, of a satellite in a circular orbit of radius, r, above the earth in terms of mass of earth, m, gravitational constant, G and r. (04marks)

(c) (i) A satellite of mass 200kg is launched in a circular orbit at a height of 3.59×10^7m above the earth's surface. Find the mechanical energy of the satellite. (03marks)

(ii) Explain what will happen to the satellite if its mechanical energy was reduced. (03marks)

(d) Describe laboratory method of determining the universal gravitational constant, G. (06marks)

20. (a) (i) Distinguish between surface tension and surface energy (01mark)

(ii) Show the surface energy and surface tension are numerically equal. (03marks)

(iii) Explain why water dripping out of a tap does so in spherical shapes. (03marks)

(b) Two soap bubbles of radius 2.0cm and 4.0cm respectively coalesce under isothermal conditions. If the surface tension of the soap solution is $2.5\text{x } 10^{-2}Nm^{-1}$, calculate the excess pressure inside the resulting soap bubble. (04marks)

(c) (i) State Bernoulli's principle (0marks)

(ii) Explain how wind at a high speed over the roof of a building can cause the roof to be ripped off the building. (03marks)

(iii)An aeroplane has a mass of 8,000kg and wing area of $8.0m^2$. When moving through still air, the ratio of its velocity to that of the air above its wings is 0.25. At what velocity will the aeroplane be able to just lift off the ground? (Density of air = $1.3kgm^{-3}$)

21. (a)(i) What is projectile motion? (01 marks)

(ii) A bomb is dropped from an aeroplane when it is directly above a target at a height of 1402.5m. The aeroplane is moving horizontally with a speed 0f $500kmh^{-1}$. Determine whether the bomb will hit the target. (05marks)

(b) (i) Define angular velocity. (01mark)

(ii) A satellite is revolving around the earth in a circular orbit at an altitude of $6 \text{ x } 10^5$ m where the acceleration due to gravity is 9.4 ms^{-2}. Assuming that the earth is spherical, calculate the period of the satellite. (03marks)

(c) (i) State Newton's laws of motion (03marks)

(ii) Explain how a rocket is kept in motion. (04marks)

(iv)Explain why passengers in a bus are thrown backwards when the bus suddenly start moving (03marks)

22. (a) (i) What is meant by Young's modulus? (03marks)

(ii) State Hooke's law (01mark)

(iii)Derive an expression for energy released in a unit volume a stretched wire in terms of stress and strain. (04marks)

(b) A steel wire of length 0.6m and cross-section area $1.5 \text{ x } 10^{-6}m^2$ is attached at B to a copper wire BC of length 0.39m and cross section area $3.0 \text{ x } 10^{-6}m^2$. The combination is suspended vertically from a fixed point at A and supports a weight of 250N at C. find the extension in each of the wires, given that Young's Modulus for steel is $2.0 \text{ x } 10^{11}Nm^{-2}$ and that of copper is $1.3 \text{ x } 10^{11}Nm^{-2}$. (05marks)

(c) With the aid of a labelled diagram, describe an experiment to determine the Young's Modulus of a steel wire (07marks)

(d) Explain the term plastic deformation in metals (02marks)

23. (a) Define work and energy (02marks)

(b) Explain whether a person carrying a bucket of water does any work on the bucket while walking on a levelled road. (03marks)

(c) A pump discharges water through a nozzle of diameter 4.5cm with speed of $62ms^{-1}$ into a tank 16m above the intake.

(i) Calculate the work done per second by the pump in raising the water if the pump is ideal. (04marks)

(ii) Find the power wasted if the efficiency of the pump is 73% (02marks)

(iii)Account for the power loss in (c)(ii) (02marks)

(d) (i) State work-energy theorem. (01mark)

(ii) Prove the work-energy theorem for a body moving with constant acceleration. (03marks)

(e) Explain briefly what is meant by internal energy of a substance. (03marks)

24. (a) Define coefficient of viscosity and state its units. (02marks)

(b) Explain the origin of viscosity in air and account for the effect of temperature on it. (05marks)

(c) Describe, stating the necessary precautions an experiment to measure the coefficient of viscosity of a liquid using Stroke's law. (07marks)

(d) A steel ball bearing of diameter 8.0mm falls steadily through oil and covers a vertical height of 20.0cm in 0.56s. If the density of steel is7800kgm^{-3} and that of oil is 900kgm^{-3}, calculate the

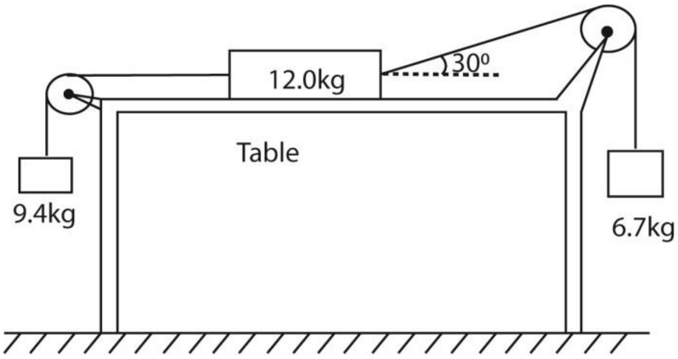
(i) up thrust on the ball (03marks)

(ii) viscosity of the oil (03marks)

25. (a) Using the molecular theory, explain the laws of friction between solid surfaces. (06marks)

(b) With the aid of a labelled diagram, describe how the coefficient of static friction for an interface between a rectangular block of wood and a plane surface can be determined. (06marks)

(c) The diagram below shows three masses connected by inextensible strings which pass over smooth pulleys. The coefficient of friction between the table and the 12.0kg mass is 0.25.



If the system is released from rest, determine the

(i) Acceleration of the 12.0kg mass (05marks)

(ii) Tension in each string (03marks)

26. (a) Define terminal velocity (01mark)

(b) Explain laminar flow and turbulent flow (03marks)

(c) Describe an experiment to measure the coefficient of viscosity of water using Ponselle's formula. (07marks)

(d) (i) State Bernoulli's principle (01 mark)

(ii) Explain why a person standing near a railway line is sucked towards the railway line when a fast moving train passes. (03marks)

(e) A horizontal pipe of cross sectional area $0.4m^2$, tapers to a cross section area of $0.2m^2$. The pressure at the large section of the pipe is $8.0 \times 10^4 Nm^{-2}$ and the velocity of water through the pipe is $11.2ms^{-1}$. If the atmospheric pressure is $1.01 \times 10^5 Nm^{-2}$, find the pressure at the small section of the pipe. (05marks)

27. (a) (i) State the law of conservation of linear momentum (01mark)

(ii) A body explodes and produces two fragments of mass m and M. is the velocities of the fragments are u and v respectively. Show that the ratio of the kinetic energies of the fragments is $\frac{E_1}{E_2} = \frac{M}{m}$ where E_1 is the kinetic energy of m and E_2 is the kinetic energy of M.

(b) Show that the centripetal acceleration of an object moving with constant velocity, v, in a circle of radius, r. is $\frac{v^2}{r}$ (04marks)

(c) A car of mass 1000kg moves round a banked track at constant speed of $108kmh^{-1}$. Assuming the total reaction at the wheels is normal to the track, and the radius of curvature of the truck is 100m, calculate the:

(i) angle of inclination of the track to the horizontal (04marks)

(ii) reaction at the wheels (02marks)

(d) (i) Define uniformly accelerated motion (01mark)

(ii) A train starts from rest at station A and accelerates at $1.25ms^{-2}$ until it reaches a speed of $20ms^{-1}$. It then travels at this steady speed for a distance of 1.56km and then decelerates at $2ms^{-2}$ to come to rest at station B. Find the distance from A to B. (04marks)

28. (a)(i) State Kepler's laws of planetary motion. (03marks)

(ii) Estimate the mass of the sun, if the orbit of the earth around the sun is circular. (04marks)

(b) Explain Brownian motion (03marks)

(c) Explain the energy changes which occur when a pendulum is set into motion. (03marks)

(d) A simple pendulum of length 1m has a bob of mass 100g. It is displaced from mean position A to position B so that the string makes an angle of 45^0 with the vertical. Calculate the;

(i) Maximum potential energy of the bob. (03marks)

(ii) Velocity of the bob when the string makes an angle of 30^0 2ith the vertical. [Neglect air resistance]

29. (a) State Hooke's law. (01mark)

(b) A copper wire is stretched until it breaks.

(i) Sketch a stress- strain graph for the wire and explain the main features of the graph. (04marks)

(ii) Explain what happens to the energy used to stretch the wire at each stage. (04marks)

(iii)Derive the expression for the work done to stretch a spring of force constant, k, by a distance, 2. (03marks)

(c)(i) Define Young's Modulus. (01mark)

(ii) Two identical steel bars A and B of radius2.0mm are suspended from the ceiling. A mass of 2.0kg is attached to the free end of bar A. Calculate the temperature to which B should be raised so that the bars are again equal in length.

[Young's Modulus of steel = $1.0 \times 10^{11} Nm^{-2}$)

[Linear expansivity of steal = $1.2 \times 10^{-5} K^{-1}$] (05mark)

(d) Why does an iron roof make cracking sound at night? (02marks)

30. (a) Define the following terms as applied to oscillatory motion

(i) Amplitude (01mark) (ii) Period (01mark)

(b) State four characteristics of simple harmonic motion. (02marks)

(c) A mass, m is suspended from a rigid support by a straight string of length L. the mass is pulled aside so that the string makes an angle, θ, with the vertical and then released.

(i) Show that the mass executes simple harmonic motion with a period $T = 2\pi\sqrt{\frac{L}{g}}$.

(ii) Explain why this mass comes to a stop after a short time. (02marks)

(d) A piston in a car engine performs a simple harmonic motion of frequency 12.5Hz. If the mass of the piston is 0.50kg and its amplitude of vibration is 45mm, find the maximum force on the piston. (03marks)

(e) Describe an experiment to determine the acceleration due to gravity, g, using a spiral spring, of known constant. (06marks)

31. (a) Explain what is meant by centripetal force. (02marks)

(b)(i) Derive an expression for centripetal force acting on a body of mass, M, moving in a circular path of radius, r. (06marks)

(ii) A body moving in a circular path of radius 0.5m makes 40 revolutions per second. Find the centripetal force if the mass is 1kg (03marks)

(c) Explain the following;

(i) A mass attached to a string rotating at constant speed in a horizontal circle will fly off at a tangent of the string breaks. (02marks)

(ii) A cosmonaut in a satellite which is in a free circular orbit around the earth experiences the sensation of weightlessness even though there is influence of gravitational field on earth. (03marks)

(d) (i) Derive an expression for maximum horizontal distance travelled by a projectile in terms of the initial speed, u, and the angle of projection, θ, to the horizontal. (02marks)

(ii) Sketch a graph to show the relationship between kinetic energy and height above the ground in a projectile. (02marks)

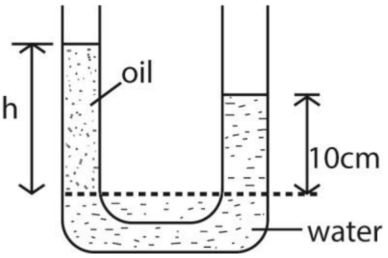
32. (a)(i) What is meant by the following terms, steady flow and viscosity? (02marks)

(ii) Explain the effect of increase in temperature on viscosity of a liquid. (03marks)

(b) (i) Show that the pressure, P, exerted at a depth, h, below the free surface of a liquid of density, ρ, is given by $P = h\rho g$. (03marks)

(ii) Define relative density. (01mark)

(iii)A U-tube whose ends are open to atmosphere, contains water and oil as shown in the figure below



Given the density of oil is $300kgm^{-3}$, find the value of h.

(c) A metal ball of diameter 10mm is timed as it falls through oil at a steady speed. It takes 0.5s to fall through a vertical distance of 0.3m. Assuming that the density of metal is $7500kgm^{-3}$ and that of oil is $900kgm^{-3}$, find;

(i) the weight of the ball (02marks)

(ii) the up thrust on the ball (02marks)

(iii)the coefficient of viscosity of the oil (03marks)

[Assume the viscous force = $6\pi\eta r v_0$ where η is the coefficient of viscosity, r is the radius of the ball, v_0 is the terminal velocity]

33. (a) Define the following terms;

(i) Uniform acceleration (01mark)

(ii) Angular velocity (01mark)

(b) (i) What is meant by banking a track? (01mark)

(ii) Derive an expression for the angle of banking θ for a car of mass, m, moving at speed, v, round a banked tract of radius, r. (04marks)

(c) A bod of mass, m is tied to an inelastic thread of length, L, and whirled with constant speed in a vertical circle

(i) With the aid of a sketch diagram, explain the variation of tension in the string along the circle. (05 marks)

(ii) If the string breaks at one point along the circle, state the most likely position and explain the subsequent motion of the bob.

(d) A body of mass 15kg is moved from earth's surface to a point 1.8x 10^6m above the earth. If the radius of the earth is 6.4 x 10^6m and the mass of the earth is 6.0 x 10^{24}kg; calculate the work done in taking the body to that point (06marks)

34. (a) State Newton's laws of motion. (03marks)

(b) Use Newton's laws of motion to show that when two bodies collide their momentum is conserved. (04marks)

(c) Two balls P and Q travelling in the same line in opposite directions with speeds of 6ms^{-1} and 15ms^{-1} respectively make a perfect collision. If the masses of P and Q are 8kg and 5kg respectively, find the

(i) final velocity of P, (04marks)

(ii) Change in kinetic energy. (04marks)

(d) (i) What is an impulse of a force? (01marks)

(ii) Explain why a long jumper should normally land on sand. (04marks)

35. (a) (i) What is meant by viscosity. (01mark)

(ii) Explain the effect of temperature on viscosity of a liquid. (03marks)

(b) Derive an expression for terminal velocity of a sphere of radius, a, falling in a liquid of viscosity, η. (04marks)

(c) Explain why velocity of a liquid at a wide part of a tube is less than that at a narrow part. (02marks)

(d) A solid weighs 237.5g in air and 12.5g when totally immersed in a fluid of density 9.0 x 10^2 kgm^{-3}. Calculate the density of the liquid in which the sold would float with one fifth of its volume exposed above the liquid surface.

(e) Describe an experiment to measure the coefficient of static friction between a rectangular block of wood and a plane surface. (04marks)

36. (a) (i) What is meant by simple harmonic motion? (01mark)

(ii) State two practical examples of simple harmonic motion. (01mark)

(iii) Using graphical illustrations, distinguish between under damped and critically damped oscillations (04marks)

(b) (i) Describe an experiment to measure acceleration due to gravity using a spiral spring (06marks)

(ii) State two limitations to the accuracy of the value obtained in (b)(i).

(c) A horizontal spring of force constant 200Nm^{-1} fixed at one end has a mass of 2kg attached to the free end and resting on a smooth horizontal surface. The mass is pulled through a distance of 40.0cm and released. Calculate the

(i) Angular speed.

(ii) Maximum velocity attained by a vibrating body. (02marks) (iii)Acceleration when the body is half way towards the centre from its initial position. (02marks)

37. (a) (i) State the law of conservation of linear momentum. (01mark)

(ii) Use Newton's law to derive the law in (a) (i) (04marks)

(b) Distinguish between elastic an inelastic collision (01mark)

(c) An object X of mass M, moving with a velocity of $10ms^{-1}$ collides with a stationary object Y of equal mass. After collision, X moves with a speed u at an angle 30^0 to the initial direction, while Y, moves with a speed V at angle 90^0 to the new direction of X.

(i) Calculate the speeds U and V (05marks)

(ii) Determine whether the collision is elastic or not. (03marks)

(d) (i) Define uniform acceleration. (01mark)

(ii) With the aid of a velocity-time graph, describe the motion of a body projected vertically upwards. (03marks)

(iii)Calculate the range of a projectile which is fired at an angle of 45^0 to the horizontal with a speed of $20ms^{-1}$. (02marks)

38. (a)(i) State Archimedes' principle. (01mark)

(ii) A solid weighs 20.0g in air, 15.0g in water and 16.0g in a liquid, R. Find the density of R (03marks)

(b) (i) What is meant by simple harmonic motion? (01 mark)

(ii) Distinguish between damped and forced oscillations (02marks)

(c) A cylinder of length, L, and cross section area A and density σ floats in a liquid of density, ρ. The cylinder is pushed down slightly and released.

(i) Show that it performs simple harmonic motion. (05marks)

(ii) Derive the expression for period of the oscillation. (02marks)

(d) A spring of force constant $40Nm^{-1}$ is suspended vertically. A mass of 0.1kg suspended from the spring is pulled down a distance of 5mm and released. Find the

(i) period of the oscillation (02marks)

(ii) maximum acceleration of the mass (02marks)

(iii)Net force acting on the mass when it is 2mm below the centre of oscillation. (02marks)

39. (a) Define viscosity of a fluid (01mark)

(b) (i) Derive an expression for terminal velocity attained by a sphere of density, σ, and radius, a, falling through a fluid of density, ρ and viscosity, η. (05marks)

(ii) Explain the variation of viscosity of a liquid with temperature. (02marks)

(c) (i) State the laws of friction. (02marks)

(ii) With the aid of a well labelled diagram, describe an experiment to determine the coefficient of kinetic friction between two surfaces. (05marks)

(d) A body slides down a rough plane inclined at 30^0 to horizontal. If the coefficient of kinetic friction between the body and the plane is 0.4, find the velocity after it has travelled 6m along the plane. (05marks)

40. (a) (i) Describe the terms tensile stress and kinetic strain as applied to a stretched wire. (02marks)

(ii) Distinguish between elastic limit and proportional limit. (02marks)

(b) With the aid of a labelled diagram, describe an experiment to investigate the relationship between tensile stress and tensile strains of a steel wire. (07marks)

(c)(i) A load of 60N is applied to a steel wire of length 2.5m and cross sectional area of

$0.22mm^2$. If Young's Modulus for steel is 120GPa, find the expansion produced. (03marks)

(ii) If the temperature rise of 1K causes a fractional increase of 0.001%, find the change in length of a steel wire of length 2.5 when the temperature increases by 4K. (03marks)

(d) The velocity, V, of a wave in a material of Young's Modulus, E and density, ρ, is given by

$V = \sqrt{\frac{E}{\rho}}$. Show that the relationship is dimensionally correct. (03marks)

41. (a) (i) Define the term impulse (01mark)

(ii) State Newton's laws of motion (03marks)

(b) A bullet of mass 10g travelling horizontally at a speed of $100ms^{-1}$ strikes a block of wood of mass 900g suspended by a light vertical string and is embended in the block which subsequently swings freely. Find the

(i) Vertical height through which the block rises. (04marks)

(ii) Kinetic energy lost by the bullet (03marks)

(c) Explain the terms time of flight and range as applied to projectile motion. (02marks)

(d) A stone is projected at an angle of 200 in horizontal and just clears a wall which is 10m high and 30m from the point of projection. Find the

(i) Speed of projection. (04marks)

(ii) Angle which the stone makes with the horizontal as it clears the wall. (03marks)

42. (a) Define the following terms;

(i) Velocity

(ii) Moment of a force

(b) (i) A ball is projected vertically up wards with a speed of $50ms^{-2}$.on return it passes a point of projection, and falls 78m below. Calculate the total time taken. (05marks)

(ii) State energy changes that occurred during the motion of the ball in (b)(i) above. (03marks)

(c) (i) State the conditions required for mechanical equilibrium to be attained. (02marks)

(ii) A uniform ladder of mass 400kg length 5m, rests with its upper end against a smooth vertical wall and with its lower end at 3m from the wall on a rough ground. Find the magnitude and direction of the force exerted at the bottom of the ladder. (06marks)

(d) State four instances where increasing friction is useful. (02marks)

43. (a) What is meant by simple harmonic motion? (01mark)

(b) A cylindrical vessel of cross-section area A, contains air of volume V, at pressure, P, trapped by frictionless air tight piston of mass, M. the piston is pushed down and released.

(i) If the piston oscillates with simple harmonic motion, show that its frequency, f, is given by

$$f = \frac{A}{2\pi}\sqrt{\frac{P}{MV}}$$ (06marks)

(ii) Show that the expression for f, in (b)(i) is dimensionally correct. (03marks)

(c) A particle executing simple harmonic motion vibrates in a straight line. Given that the speeds of the particle are $4ms^{-1}$ and $2ms^{-1}$ when the particle is 3cm and 6cm respectively from the equilibrium, calculate the

(i) Amplitude of oscillation. (03marks)

(ii) Frequency of the particle. (03marks)

(d) Give two examples of oscillatory motion which approximate to simple harmonic motion and state the assumption made in each case. (04marks)

44. (a) (i) State Archimedes' Principle. (01mark)

(ii) Use Archimedes' Principle to derive an expression for resultant force on a body of weight, W, and density, σ, totally immersed in a fluid of density, ρ. (04marks)

(b) A tube of uniform cross sectional area of $4 \times 10^{-3}m^2$ and mass 0.2kg is separately floated vertically in water of density $1.0 \times 10^3kgm^{-3}$ and in oil of density $8.0 \times 10^2kgm^{-3}$. Calculate the difference in the lengths immersed (04marks)

(c) (i) Define surface tension in terms of work (01mark)

(ii) Use the molecular theory to account for surface tension of a liquid. (04marks)

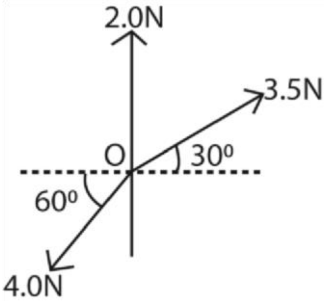
(iii) Explain the effect of increasing temperature of a liquid on its surface tension. (04marks)

(iv) Calculate the excess pressure inside a soap bubble of diameter 3.0cm if the surface tension of the soap solution is $2.5 \times 10^{-2}Nm^{-1}$. (02marks)

45. (a) (i) Define the term velocity and displacement. (02marks)

(ii) Sketch velocity against time for an object thrown vertically upwards. (02marks)

(b)



Three forces of 3.5N, 4.0N and 2.0N, act at O as shown in the figure above. Find the resultant force. (04marks)

(c) (i) What is meant by saying that a body is moving with velocity relative to another? (01marks)

(ii) A ship, A is travelling due north at $20kmh^{-1}$ and ship B is travelling due east at $15kmh^{-1}$. Find the velocity of A relative to B. (03marks)

(iii)If the ship B in (c)(ii) is 10km due west of A at noon. Fins the shortest distance apart and when it occurs. (05marks)

(d) (i) What is meant by a couple in mechanics? (01mark)

(ii) State the conditions for equilibrium of a system of coplanar forces.

46. (a) (i) State the laws of friction between solid surfaces (03marks)
(ii) Explain the origin of friction force between two solid surfaces in contact. (03marks)
(iii)Describe an experiment to measure the coefficient of kinetic friction between two solid surfaces. (03marks)

(b) (i) A car of mass 1000kg moves along a straight surface with speed 0f $20ms^{-1}$. When brakes are applied steadily, the car comes to rest after travelling 50m. Calculate the coefficient of friction between the surface and the tyre. (04marks)

(ii) State the energy changes which occur from the time brakes are applied to the time the car comes to rest. (02marks)

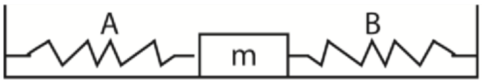
(c) (i) State two disadvantages of friction (01mark)

(ii) Give one method of reducing friction between solid surfaces. (01mark)

(d) Explain what happens when a small steel ball is dropped centrally in a tall jar containing oil. (03marks)

47. (a) (i) Define simple harmonic motion. (01mark)
(ii) A particle of mass m executes simple harmonic motion between two points A and B about equilibrium position O. sketch a graph of the restoring force acting on the particle as a function of distance, r, moved by the particle. (02marks)

(b)



Two springs A and B of spring constant K_A and K_B respectively are connected to mass m as shown in the figure above. The surface on which the mass slides is frictionless.

(i) Show that when the mass is displaced slightly, it oscillates with simple harmonic motion of frequency, f given by $f = \frac{1}{2\pi}\sqrt{\frac{K_A + K_B}{m}}$ (04marks)

(ii) If the two springs in the figure above are identical such that $K_A = K_B = 5.0Nm^{-1}$ and mass m =50g, calculate the period of oscillation (03marks)

(c) (i) With the aid of a diagram, describe an experiment to determine the universal gravitational constant, G. (0marks)

(ii) If the moon moves round the earth in a circular orbit of radius = 4.0×10^8m and takes exactly 27.3 days to go round once, calculate the value of acceleration due to gravity, g, at the earth's surface. (04marks)

48. (a) State

(i) Newton's laws of motion (03marks)

(ii) The principle of conservation of momentum (01mark)

(b) A bod A of mass m_1 moves with velocity u_1 and collides head on elastically with another body B of mass m_2 which is at rest. If the velocities of A and B are v_1 and v_2 respectively and given that X = $\frac{m_1}{m_2}$, show that

(i) $\frac{u_1}{v_1} = \frac{X+1}{X-1}$(04marks)

(ii) $\frac{v_2}{v_1} = \frac{2X}{X-1}$(03marks)

(c) Distinguish between conservative and non-conservative forces. (02marks)

(d) A bullet of mass 40g is fired from a gun at $200ms^{-1}$ and hit a block of wood of mass 2kg which is suspended by a light vertical string 2m long. If the bullet gets embedded in the wooden block,

(i) Calculate the maximum angle the string makes with the vertical. (06marks)

(ii) State a factor on which the angle of swing depends. (01mark)

49. (a) Define simple harmonic motion (SHM). (01mark)

(b) Sketch a graph of velocity against displacement for a body executing SHM. (01marks)

(c) A glass U-tube containing a liquid is tilted slightly and then released.

(i) Show that the liquid oscillates with simple harmonic motion. (04mark)

(ii) Explain why the oscillations ultimately come to rest. (03marks)

(d) Explain why maximum speed of a car on a banked road is higher than on an unbanked road. (04marks)

(e) A small bob of mass 0.2kg is suspended by an inextensible string of length 0.8m. The bob is then rotated in a horizontal circle of radius 0.4m. Find

(i) linear speed of the bob (03marks)

(ii) Tension in the string. (02marks)

50. (a) State Kepler's laws of planetary motion. (03marks)

(b) (i) A satellite moves in a circular orbit of radius, R, about a planet of mass, M, with period T . Show that $R^3 = \frac{GMT}{4\pi^2}$, where G is the universal gravitational constant. (04marks)

(ii) The period of the moon around the earth is 27.3 days. If the distance of the moon from the Earth is 3.83 x 105km, calculate the acceleration due to gravity at the surface of the Earth. (04marks)

(iii)Explain why any resistance to forward motion of an artificial satellite results into an increase in its speed. (04marks)

(c) (i) What is meant by weightlessness? (02marks)

(ii) Why does acceleration due to gravity vary with location on the surface of the earth? (03marks)

51. (a) (i) State the laws of solid friction. (03marks)

(ii) Using molecular theory, explain the laws stated in (a)(i) (03marks)

(b) Describe an experiment to determine the coefficient of static friction for an interface between a rectangular block of wood and plane surface. (04marks)

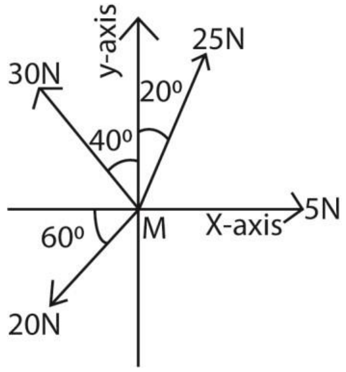
(c) (i) State the difference between conservative and non-conservative forces, give one example each. (03marks)

(ii) State the work-energy theorem. (01mark)

(iii)A block of mass 6.0kg is projected with a velocity of 12ms^{-1} up a rough plane inclined at 45^0 to horizontal. If it travels 5.0m up the plane, find the friction force. (04marks)

(d) Explain the effect of temperature on the viscosity of a liquid.

52. (a) (i) Define vector and scalar quantities and give one example of each. (03marks) (ii)



A body, M, of mass 6kg s acted on by forces of 5N, 20N, 25N and 30N as shown in the figure above. Find the acceleration of M (05marks)

(b) (i) What is meant by acceleration due to gravity? (01mark)

(ii) Describe how you would use a spiral spring, a retort stand with a clamp, a pointer, seven 50g masses, a meter rule and a stop clock to determine the acceleration due to gravity. (06marks)

(iii)State any two sources of error in the experiment in (b)(ii) above. (01marks)

(iv)A body of mass 1kg moving with simple harmonic motion has speeds of $5ms^{-1}$ and $3ms^{-1}$ when it is at distances of 0.10m and 0.2m respectively from equilibrium point. Find the amplitude of the motion. (04marks)

53. (a)(i) What is meant by uniformly accelerated motion? (01marks)

(ii) Sketch the speed against time graph for a uniformly accelerated body. (01mark)

(iii)Derive the expression: $S = ut + \frac{1}{2} at^2$, for the distance, S, moved by a body which is initially travelling with speed u and is uniformly accelerated for time t.

(b) A projectile is fired horizontally from the top of a cliff 250m high. The projectile lands

1.414×10^3m from the bottom of the cliff. Find the

(i) Initial speed of the projectile. (05marks)

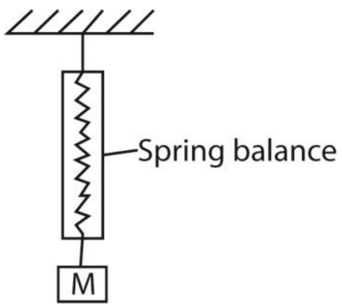
(ii) Velocity of the projectile just before it hits the ground. (05marks)

(c) Describe an experiment to determine the centre of gravity of a plane sheet of material having irregular shape (04marks)

54. (a) (i) Define force and power. (02marks)

(ii) Explain why more energy is required to push a wheel barrow uphill than on a level ground. (03mark)

(b)



A mass, M, is suspended from a spring balance as shown in the figure above. Explain what happens to the reading of the spring balance when the setup is raised slowly to a very high height above the ground. (02marks)

(c) (i) State the work-energy theorem (01mark)

(ii) A bullet of mass 0.1kgmoving horizontally with a speed of 420ms^{-1} strikes a block of mass 2.0kg at rest on a smooth table and becomes embedded in it. Find the kinetic energy lost if they move together. (04marks)

(d) State the condition for equilibrium of a rigid body under the action of coplanar forces. (02marks)

(e) A 3m long ladder rests at an angle 60^0 to the horizontal against a smooth vertical wall on a rough ground. The ladder weighs 5kg and its centre of gravity is one- third from the bottom of the ladder.

(i) Draw a sketch diagram to show the forces acting on the ladder. (02marks)

(ii) Find the reaction of the ground on the ladder (04marks)

55. (a) (i) Define stress and strain (02marks)
(ii) Determine the dimensions of Young's modulus. (03marks)

(b) Sketch a graph of stress versus strain for a ductile material and explain its features. (06marks)

(c) A steel wire of cross section area 1mm^2 is cooled from a temperature of 60^0C to 15^0C. Find the:

(i) strain (02marks)

(ii) Force needed to prevent it from contracting. (03marks)

[Young's Modulus= 2.0×10^{11}Pa, Coefficient of linear expansion of steel = $1.1 \times 10^{-5}K^{-1}$]

(d) Explain the energy changes which occur during plastic deformation (04marks)

56. (a) (i) State Archimedes' Principle. (01mark)

(ii) Describe an experiment to determine the relative density of an irregular solid which floats in water.

(iii)A block of wood floats at an interface between water and oil with 0.25 of its volume submerged in oil. If the density of the wood is $7.3 \times 10^2 kgm^{-2}$, find the density of oil. (04marks)

(b) (i) State Bernoulli's Principle. (04marks)

(ii) Explain the origin of the lift force on the wings of an aeroplane at take-off. (04marks)

(c) Water flowing in a pipe on the ground with a velocity of 8ms^{-1} and at gauge pressure of 2.0×10^3Pa is pumped into a water tank 10m above the ground. The water enters the tank at a pressure of 1.0×10^5Pa. Calculate the velocity with which the water enters the tank. (03marks)

(d) Describe how terminal velocity can be measured. (04marks)

57. (a) Distinguish between scalar and vector quantities giving two example each. (03marks)

(b) The equation for volume, V, of a liquid flowing through a pipe in time t, under steady flow is given by $\frac{V}{t} = \frac{\pi r^4 P}{8\eta L}$ where r = radius of the pipe, P = pressure difference between two point of the pipe, L = length of the pipe. η = coefficient of viscosity of the liquid

If the dimensions of η are $ML^{-1}T^{-1}$, show that the above equation is dimensionally consistent.

(c) (i) define linear momentum. (01mark)

(ii) State the law of conservation of linear momentum. (01mark)

(iii)Show the law in (c)(ii) above follows from Newton's law of motion. (03marks)

(iv)Explain why, when catching a fast moving ball, the hands are drawn back while the ball is being brought to rest. (02marks)

(d) A car of mass 100kg travelling at uniform velocity of $20ms^{-1}$ collides perfectly inelastically with a stationary car of mass 1500kg. Calculate the loss in kinetic energy of the car as a result of the collision. (04marks)

(e) (i) What is meant by conservation of energy? (01mark)

(ii) Explain how conservation of energy applies to an object falling from rest in a vacuum.

(02marks)

58. (a) Explain the term

(i) Ductility (01mark)

(ii) Stiffness (01mark)

(b) A copper wire and steel wire each of length 1.0m and diameter 1.0mm are joined end to end to form a composite wire 2.0m long. Find the strain in each when the composite stretches by 2.0×10^{-3}m. [Young's Modulus for copper and steel are 1.2×10^{11}Pa and 2.0×10^{11}Parespectively] (07marks)

(c) (i) Define centre of gravity (01mark)

(ii) Describe an experiment to find the centre of gravity of a flat irregular piece of cardboard. (03marks)

(d) Explain the laws of solid friction using molecular theory (07marks)

59. (a) What is meant by the following terms?

(i) Velocity gradient. (01mark)

(ii) Coefficient of viscosity (01mark)

(b) Derive an expression for terminal velocity of a steel ball-bearing of radius, r, and density, ρ, falling through a liquid of density, σ, and coefficient of viscosity, η. (05marks)

(c) (i) Define surface tension (01mark)

(ii) Explain the origin of surface tension. (03marks) (iii)Describe an experiment to measure surface tension of a liquid by capillary method. (06marks)

(d) Explain, with the aid of a diagram why air-flow over the wings of an aircraft at take-off cause a lift. (03marks)

60. (a) (i) Define angular velocity. (01marks)

(ii) Derive an expression for the force, F, on a particle of mass, m, moving with angular velocity, ω, in a circle of radius, r. (03marks)

(b) A stone of mass 0.5kg is attached to a string of length 0.5m which will break if the tension in it exceeds 20N. The stone is whirled in a vertical circle, the axis of rotation being at a vertical height of 1.0m above ground. The angular speed is gradually increased until the string breaks.

(i) In what position is the string most likely to break? (02marks)

(ii) At what angular speed will the string break? (03marks)

(iii)Find the position where the stone hits the ground when the string breaks. (03marks)

(c) Explain briefly the action of a centrifuge. (03marks)

(d) Describe how the acceleration due to gravity can be measured using helical spring of unknown force constant, and the other relevant apparatus. (05marks)

61. (a) State the laws of friction (04marks)

(b) A block of mass 5.0kg resting on the floor is given a horizontal velocity of $5.0ms^{-1}$ and comes to rest in a distance of 7.0m. Find the kinetic friction between the block and the floor. (04marks)

(c) (i) State the law of conservation of linear momentum (01mark)

(ii) What are perfectly inelastic collision? (01mark)

(d) A car of 1500kg rolls from rest down a road inclined to the horizontal at an angle 35^0, through 50m. The car collides with another car of identical mass at the bottom of the incline. If the two cars interlock on collision, and the coefficient of kinetic friction is 0.20, find the common velocity of the vehicles. (08marks)

(e) Discuss briefly the energy transformation which occur in (d) above.

62. (a) Define angular velocity (01mark)

(b) A car of mass, m, travels round a circular track of radius, r, with velocity, V.

(i) Sketch a diagram to show the forces acting on the car. (02marks)

(ii) Show that the car does not overturn if$V^2 < \frac{arg}{2h}$, where a is the distance between the wheels, h, is the height of the centre of gravity above the ground and g is acceleration due to gravity. (05marks)

(c) A pendulum bob of mass 0.2kg is attached to one end of an inelastic string of length 1.2m. The bob moves in a horizontal circle with the string inclined at 30^0 to the vertical.

Calculate

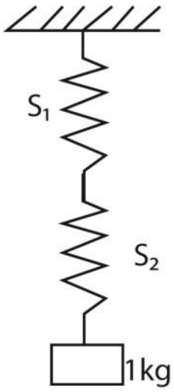
(i) the tension in the string(02marks)

(ii) the period of motion (04marks)

(d) Explain and sketch the variation of acceleration due to gravity with distance from the centre of the earth (06marks)

63. (a) (i) What is meant by simple harmonic motion? (01mark)
(ii) Show with the aid of a suitable sketch graph how kinetic energy of a mass attached at the end of an oscillating light spring changes with distance from equilibrium position. (04marks)

(b)



A mass of 1.0kg is hang from two springs S_1 and S_2 connected in series as shown above.

The force constant of the springs are $100Nm^{-1}$ and $200Nm^{-1}$ respectively. Find

(i) The extension produced in combination. (04marks)
(ii) The frequency of oscillation of the mass if it is pulled downwards through a small distance and released. (06marks)

(c) Explain with the aid of a sketch graph, what would happen to the oscillations in (b)(ii) above if the mass was immersed in a liquid such as water. (04marks)

64. (a) (i) Define gravitational field strength. (01mark)
(ii) Draw a sketch graph to show how the gravitational field strength varies with height, h, above the earth's surface. (02marks)

(b) The period of simple pendulum is measured at different locations along a given longitude. Explain what is observed. (06marks)
(c) Derive the expression for the escape velocity of a rocket fired from earth. (03marks)
(d) The rings of the planet Saturn consist of a vast number of small particles, each in a circular orbit about the planet. Calculate the speed of the particles nearest to Saturn if its mass is 6.0×10^{26}kg (04marks)
(e) The moon moves in a circular orbit of radius 3.84×10^{8}m around the earth with a period of 2.36×10^{5}s.Calculate the gravitational field of the earth at the moon. (04marks)

65. (a) Distinguish between fundamental and derived physical quantities. Give two examples of each. (04marks)

(b) (i) What is meant by scalar and vector quantities? (02marks)

(ii) A ball is thrown vertically upwards with a velocity $10m^{-1}$ from a point 3.0m above ground. Describe with the aid of a velocity-time sketch graph, the subsequent motion of the ball. (10marks)

(c) A boat crosses a river 3km wide flowing at $4ms^{-1}$ to reach a point on the opposite bank 5km upstream. The boat's speed in still water is $12ms^{-1}$. Find the direction in which the boat must be headed. (04marks)

66. (a) Define the following terms:

(i) Angular velocity (01mark)

(ii) Centripetal acceleration (01mark)

(b) (i) Explain why a racing car can travel faster on a banked road than on flat track of the same curvature. (04marks)

(ii)Derive an expression for the speed with which a car can negotiate a bend on a banked track without skidding. (03marks)

(c) Show how to estimate the mass of the sun if the period and radius of one of its planets are known. (03marks)

(d) The gravitational potential, U, at the surface of a planet of mass M and radius R is given by $U=-\frac{GM}{R}$, where G is gravitational constant. Derive an expression for the lowest velocity, V, which an object of mass, m, must have at the surface of the planet if it is to escape from the planet. (04marks)

(e) Communication satellites orbit the earth in synchronous orbits. Calculate the height of communication satellite above the earth. (04marks)

67. (a) State the law of floatation. (01mark)

(b) With the aid of a diagram, describe how to measure the relative density of a liquid using Archimedes' Principle of moments (06marks)

(c) A cross sectional area of a ferry at its water-line is $720m^2$.if sixteen cars of average mass 1100kg are placed on board, to what extra depth will the boat sink in the water? (04marks)

(d) (i) Define longitudinal stress and Young's Modulus of elasticity. (02marks)

(ii) Describe how to determine Young's Modulus for steel wire. (07marks)

68. (a) A mass of 0.1kg is suspended from a light spring of force constant $24.5Nm^{-1}$. Calculate the potential energy of the mass. (04marks)

(b) (i) State four characteristics of simple harmonic motion. (04marks)

(ii) Show that the speed of a body moving with simple harmonic motion of angular velocity, ω, is given by $V = \omega(A^2 - x^2)^{½}$,where A is the amplitude and x is the displacement from equilibrium position. (04marks) (iii)Sketch graphs to show the variation with displacement, of kinetic and potential energies of a body moving with simple harmonic motion (02marks)

(c) A mass of 0.1kg suspended from a spring of force constant 24.5Nm^{-1} is pulled vertically downwards through a distance 5.0cm and released. Find the

(i) period of acceleration (02marks)

(ii) Position of the mass0.3s after release. (04marks)

69. (a) (i) what is meant by the dimensions of a physical quantity? (01mark)

(ii) For stream line flow of non-viscous, incompressible fluid, the pressure, P, at a point is related to height, h, and the velocity, V by the equation $(P-a) = \rho g(h-b) + \frac{1}{2}(v^2-d)$ where a, b, and d, are constants and ρ is the density of the fluid and g is the acceleration due to gravity. Given that the equation is dimensionally consistent, find the dimensions of a, b and d. (03marks)

(b) Define simple harmonic motion.(01marks)

(c) Sketch the following graphs for a body performing simple harmonic motion:

(i) velocity against displacement (01mark)

(ii) displacement against time (01mark)

(d) The period of oscillation of a conical pendulum is 2.0s. If the string makes 60^0 to the vertical at the point of suspension, calculate the;

(i) Vertical height of the point of suspension above the circle. (03marks) (ii) length of the string (01 mark)

(iii) Velocity of the mass attached to the string (03marks)

(e) (i) give one example of an oscillatory motion which approximates simple harmonic motion.

(ii) What approximation is made in (e)(i) above? (01mark)

(f) Explain why the acceleration of a ball bearing falling through a liquid decreases continuously until it become zero. (04marks).

70. (a) (i) State Newton's law of universal gravitation. (01mark)

(ii) Show that this law is consistent with Kepler's third law. (03marks)

(iii)Two alternative units for gravitational field strength are Nkg^{-1} and ms^{-1}. Use the method of dimensions to show that the two units are equivalent. (03marks)

(b) (i) Derive an expression for speed of a body moving uniformly n a circular path. (03marks)

(ii) Explain why a force is necessary to maintain a body moving with constant speed in a circular path. (02marks)

(c) A small mass attached to a string suspended from a fixed point moves in a circular path at constant speed in horizontal plane.

(i) Draw a diagram showing the force acting on the mass. (01mark)

(ii) Derive an equation showing the angle of inclination of the string depends on the speed of the mass and radius of the circular path. (03marks)

(d) (i) Define moment of force. (01mark)

(ii) A wheel of radius 0.6m is pivoted at its centre. A tangential force of 4.0N acts on the wheel so that the wheel rotates with uniform velocity. Find the work done by the force to turn the wheel through 10 revolutions. (03marks)

71. (a) (i) Show that the weight of a fluid displaced by an object is equal to up thrust on the object. (05marks)

(ii) A piece of metal of mass 2.60 x 10^{-3}kg and density 8.4 x 10^{3}kgm^{-3} is attached to a block of wax of mass 1.0 x 10^{-2}kg and density 9.2 x 10^{2}kgm^{-3}. When the system is placed in a liquid, it floats with wax just submerged. Find the density of the fluid. (04marks)

(b) Explain the

(i) Term laminar flow and turbulent flow. (04marks)

(ii) Effects of temperature on viscosity of liquids and gases. (03marks)

(c) (i)distinguish between static pressure and dynamic pressure. (02marks)

(ii) A pilot-static tube fitted with a pressure gauge is used to measure the speed of a boat at sea. Given that the speed of the boat does not exceed 10mms^{-1} and the density of water is 1000kgm^{-3}, calculate the minimum pressure on the gauge. (02marks)

72. (a) Define the terms surface tension and surface energy. (01mark)

(b) (i) Calculate the work done against surface tension in blowing a soap bubble of diameter 15mm, if the surface tension of soap solution is 3.0 x 10^{-2}Nm. (03marks)

(ii) A soap bubble of radius r_1 is attached to another bubble of radius r_2. If r_1 is less than r_2. Show that the radius of curvature of the common interface is $\frac{r_1 r_2}{r_2 - r_1}$. (05marks)

(c) (i) Define coefficient of viscosity of a liquid. (01mark)

(ii) Describe an experiment to demonstrate streamline and turbulent flow in liquids. (06marks)

(d) (i) Sketch a graph of potential energy against separation of two molecules of a substance. (01mark)

(ii) Explain the main features of the graph in (d)(i). (03marks)

73. (a) (i) State the principle of conservation of mechanical energy. (01mark)

(ii) Show that a stone thrown vertically upwards obeys the principle in (a)(i) above throughout its upward motion. (04marks)

(b)(i) A wind turbine made of a blade of radius, r, is driven by wind of speed, V. If σ is the density of air, derive an expression for minimum power, P, which can be developed by the turbine in terms of σ, r and V. (03marks)

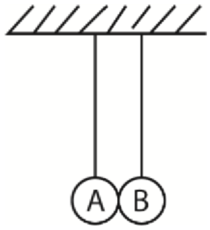
(ii) Explain why the power attained is less than the maximum value in (b)(i) above. (02marks)

(c) State the conditions under which the following will be conserved in collision between two bodies.

(i) linear momentum (10mark)

(ii) kinetic energy (01mark)

(d) Two pendulum bobs A and B of equal length L, and masses 3M and M respectively. The pendula are hung with bobs in contact as shown below.



The bob A is displaced such that the string makes an angle θ with the vertical and released. If A makes a perfectly inelastic collision with B, fins the height to which B rises. (08marks)

74. (a) Define the following terms

(i) Stress (01mark)

(ii) Strain (01mark)

(b) The velocity, V, of sound travelling along a rod made of a material of Young's Modulus, Y, and density, ρ is given by $V = \sqrt{\frac{Y}{\rho}}$. Show that the formula is dimensionally consistent.

(03marks).

(c) State the measurement necessary in the determination of Young's Modulus of a metal wire. (02marks)

(d) Explain why the following precautions are taken during an experiment to determine Young's Modulus of a metal wire.

(i) Two long, thin wires of the same material are suspended from a common support. (02marks)

(ii) The readings of the vernier are also taken when the loads are gradually removed in steps. (01marks)

(e) The ends of a uniform wire of length 2.00m are fixed to points A and B which are 2.00m apart in the same horizontal line.

When a 5kg mass is attached to the mid-point C of the wire, the equilibrium position of C is 7.5 below the line AB. Given that Young's Modulus for the material of the wire is 2.0×10^{11}Pa, find;

(i) the strain in the wire (03marks)

(ii) the stress in the wire, (02marks)

(iii)The energy stored in the wire (04marks)

(iv)State any assumptions made. (01mark)

75. (a) Define surface tension and derive its dimensions. (03marks)

(b) Explain using the molecular theory the occurrence of surface tension. (04 marks)

(c) Derive an experiment to measure surface tension of a liquid by the capillary tube method. (06marks)

(d) (i) Show that the excess pressure in a soap bubble is given by $P = \frac{4\gamma}{r}$, (03marks)

(ii) Calculate the total pressure within a bubble of air of radius 0.1mm in water if the bubble is formed 10cm below the water surface and surface tension of water is

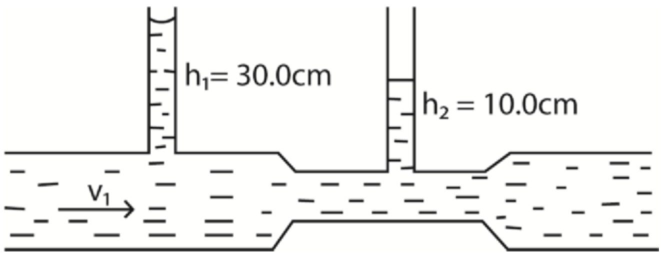
$7.27 \times 10^{-2}Nm^{-1}$. [Atmospheric pressure = 1.01×10^{5}Pa] (05marks)

76. (a) (i) Define coefficient of viscosity and determine its dimensions. (04marks)

(ii) The resistive force on a steel ball bearing of radius, r, falling with speed, V, in a liquid of viscosity, η is given by F = KηrV, where K is a constant. Show that K is dimensionless. (04marks)

(b) Write down Bernoulli's equation for fluid flow, defining all symbols used (03marks)

(c) A venturi meter consists of a horizontal tube with a constriction which replaces part of the piping system as shown below



If the cross-sectional area of the main pipe is $5.81 \times 10^{-3}m^2$ and that of the constriction is

$2.58 \times 10^{-3}m^2$, find the velocity v_1 of the liquid in the main pipe. (5marks)

(d) Explain the origin of the lift on an aeroplane at take-off. (04marks)

77. (a) (i) State Newton's laws of motion (03marks)

(ii) Define impulse and derive its relation to linear momentum of the body on which it acts. (03marks)

(b) A body of mass m_1 and velocity, u_1 collides head on with a body of mass, m_2 having velocity, u_2 in the same direction as u_1. Use Newton's laws to show that the quantity $m_1u_1 + m_2u_2$ is conserved. (5marks)

(c) A ball of mass 0.5kg is allowed to drop from rest, from a point a distance of 5.0m above a horizontal concrete flow. When the ball first hits the floor, it rebounds to a height of 3.0m.

(i) What is the speed of the ball just after the first collision with the floor? (3marks)

(ii) If the collision lasted 0.01s, find the average force which the floor exerts on the ball. (02marks)

78. (a) (i) state Archimedes' Principle. (01mark

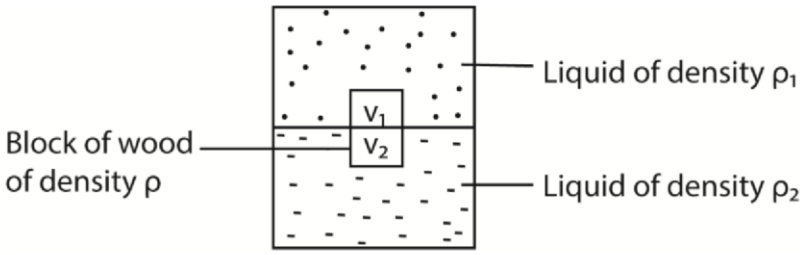
(ii) What is simple harmonic motion? (02marks)

(b) A uniform cylindrical rod of length 0.08m, cross sectional area $0.02m^2$ and density $900kgm^{-3}$ floats vertically in a liquid of density $1000kgm^{-3}$. The rod is displaced through a distance of 0.005m and released.

(i) Show that the rod performs simple harmonic motion. (05marks)

(ii) Find the frequency of the resultant oscillation. (04marks)

(iii) Find the velocity of the rod when it is a distance of 0.004m above the equilibrium position. (03marks)



(c) A block of wood of density ρ floats at the interface between immiscible liquids of densities ρ_1 and ρ_2 as shown in the figure above.

(i) Show that the ratio of volumes v_1 to v_2 of the block in the two liquids is given by $\frac{v_1}{v_2} = \frac{\rho_2 - \rho}{\rho - \rho_1}$ (04marks)

(ii) What happens when this block of wood is replaced with a denser one? (01mark)

79. (a) Distinguish between scalar and vector quantities. Give two examples each. (03marks)

(b) (i) Define the time of flight and range as applied to projectile motion. (02 marks)

(ii) A projectile is fired in air with a speed u ms^{-1} at an angle θ to the horizontal. Find the time of flight of the projectile (02marks)

(c) State the conditions for equilibrium of a rigid body under action of coplanar forces. (02marks)

(d) A mass of 5.0kg is suspended from the end A of a uniform beam of mass 1kg and length 1.0m. The end B of the beam is hinged in a wall. The beam is kept horizontal by a rope attached to A and a point C, in the wall at a height 0.75m above B.

(i) Draw a sketch diagram to show the forces acting on the beam. (02marks)

(ii) Calculate the tension in the rope. (04marks)

(iii) What is the force exerted by the hinge on the beam? (05marks)

80. (a) State Kepler's laws of gravitation (03marks)

(b) (i) Show that the period of a satellite in a circular orbit of radius r about the earth is given by $T = \left(\frac{4\pi^2}{GM_S}\right)^{\frac{1}{2}} r^{\frac{3}{2}}$ where G is the universal constant and Ms is the mass of the earth. (05marks).

(ii) Explain briefly how world-wide radio or television communication can be achieved with the help of satellites. (04marks)

(c) A satellite of mass 100kg is in a circular orbit at height of 3.39 x 10^7m above the earth's surface.

(i) Find the mechanical energy of the satellite (04marks)

(ii) Explain what would happen if the mechanical energy was decreased. (04marks)

SECTION B (HEAT AND THERMAL DYNAMICS)

1. (a) (i) State any three properties of ultraviolet radiation.(03marks)

(ii) What is a black body? (01mark)

(b) A cylindrical metal rod with a well- insulated curved surface has one end blackened and then exposed to thermal radiation from a body at a temperature 500K. If the equilibrium temperature of the blackened end is 400K and the length of the rod is 10cm, calculate the temperature of the other end. [Thermal conductivity of the metal = 500$Wm^{-1}K^{-1}$] (04marks)

(c) (i) Describe Electrical method of determining the specific heat capacity of a good conducting solid. (06marks)

(ii) Give two reasons why the value obtained using the method in (c)(i) may not be accurate. (02marks)

(d) Explain why cloudy nights are warmer than cloudless ones.

2. (a)(i) What is meant by a reversible process? (02marks)

(ii) Distinguish between a saturated vapour and unsaturated vapour. (02marks)

(iii) Explain why evaporation causes cooling(03marks)

(b) Describe an experiment to determine the temperature dependence of saturated vapour pressure of water. (07marks)

(c) (i) State Dalton's law of partial pressures. (07marks)

(ii) A sealed container has liquid water, water vapour and air all at 27^0C. The total pressure inside the container is 69cmHg. When the temperature is raised to 85^0C, the total pressure changes to 96cmHg. If the saturated vapour pressure of water at 27^0C is 5cmHg and water vapour remains saturated, calculate the saturated vapour pressure of water at 85^0C. (05marks)

3. (a) Define the following:
(i) Thermal conductivity. (01marks)
(ii) Specific latent heat of vaporization. (01mark)

(b) A boiler with a base made of rod steel 15cm thick, rests on a hot stove. The area of the bottom of the boiler is 1.5×10^3 cm^2. The water inside the boiler is at 100^0C. If 750g of water is evaporated every 5 minutes, find the temperature of the surface of the boiler in contact with the stove. [Thermal conductivity of steel = 50.2Wm^{-1}K^{-1}, specific latent heat of vaporization of water = 2.26×10^6Jkg^{-1}]

(c) Hot water in a metal tank is kept constant at 65^0C by an immersion heater in the water. The tank has lagging all around it of thickness 20mm and thermal conductivity0.04Wm^{-1}K^{-1} and its surface area is 0.5m^2. The heat lost per second by the lagging is 0.8W per degree excess above the surroundings. Calculate the power of immersion heater if the temperature of the surroundings is 15^0C. (05marks)

(d)(i) Define thermometric property (01mark)

(ii) Define how a liquid-in-glass thermometer can be used to measure temperature in degrees Celsius. (04marks)

(iii) A thermometer is constructed with a liquid which expands according to relation.
$V_t = V_0(1 + \alpha t + \beta t^2)$. Where V_t is the volume at t^0C and V_0 is the volume at 0^0C on the scale of the gas thermometer and α and β are constants.
Given that $\alpha = 1000\beta$, what will the liquid thermometer read when the gas thermometer reads 50^0C.

4. (a) Define the following quantities:
(i) Thermometric property (01mark)
(ii) Specific heat capacity (01mark)

(b) (i) State two examples of commonly used thermometric properties. (01mark)

(ii) Describe briefly how to determine the lower and upper fixed points for an uncalibrated liquid-in-glass thermometer (04marks)

(c) (i) Describe with the aid of a diagram, an experiment to determine the specific heat capacity of a liquid using the continuous flow method. (07marks)

(ii) State two advantages of the continuous flow method over the method of mixtures. (01mark)

(iii) State two disadvantages of the method in (c)(i) (01mark)

(d) The brake lining of the wheel of a car of mass 800kg have total mass of 4.8kg and are made of a material of specific heat capacity 1200Jkg^{-1}K^{-1}. If the car is at 15ms^{-1} and is brought to rest by applying the brakes, calculate the maximum possible temperature rise of the brake lining. (04marks)

5. (a) (i) What is meant by conduction of heat? (01mark)

(ii) Explain why mercury conducts heat better than water. (03marks)

(iii)Explain the occurrence of land and sea breezes. (06marks)

(b) A copper sphere of radius 7cm and density 900kgm^{-3}, is heated to a temperature of 127^{0}C and then transferred to an evacuated enclosure whose walls are at a temperature of 27^{0}C. Calculate

(i) net rate of loss of heat by the copper sphere

(ii) temperature of copper sphere after 5minutes

(c) Explain why heating system based on the circulation of steam are more efficient than those based on circulation of boiling water. (02marks)

6. (a) (i) what is meant by a black body? (02marks)

(ii) Give two examples of a black body. (01mark)

(b) With aid of graphs describe how radiation emitted by a black body varies with wavelength for two temperatures.

(c) (i) Define thermal conductivity. (01mark)

(ii) Describe an experiment to determine thermal conductivity of glass. (07marks)

(d) Radiation from the sun falls normally on a blackened roof measuring 20m x 50m. If half of the solar energy is lost in passing through the earth's atmosphere, calculate the energy incident on the roof per minute. [Temperature of the sun's surface = 6000K; radius of the sun = 7.5 x 10^{8}m, distance of the sun from the earth = 1.5 x 10^{11}m]

7. (a) (i) State the thermometric property used in a constant-volume gas thermometer (01mark)

(ii) Give two characteristic of a good thermometric property, (02marks)

(b) (i) Describe the steps taken to set up a Celsius scale of temperature for a mercury-in glass thermometer. (04marks)

(ii) State four disadvantages of a mercury in glass thermometer. (04marks)

(c) Describe with the aid of a diagram the operation of an optical pyrometer (06marks) (d) When oxygen is withdrawn from a tank of volume 50L, the reading of pressured gauge attached to the tank drops from 4.4 x 10^5 Pa to 7.8 x 10^{5}Pa. If the temperature of gas remaining in the tank falls from 30^{0}C to 10^{0}C, calculate the mass of oxygen withdrawn.

8. (a)(i) What is meant by boiling point? (01marks)

(ii) Explain why boiling point of a liquid increases with increase in the external pressure. (05marks)

(b) (i) Explain how the pressure of a fixed mass of a gas can be increased at

- Constant temperature (03marks)
- Constant volume (03marks)

(c) Sketch a pressure versus volume curve for a real gas undergoing compression (0marks)

(d) The cylinder of an exhaust pump has a volume of 5cm^3. If it is connected through a valve to a flask of volume 225 cm^3 containing air at a pressure of 75cmHg,

(e) Calculate the pressure of air in the flask after two strokes of the pump, assuming that the temperature of the air remain constant.

9. (a) (i) Define thermal conductivity. (01mark)
   (ii) Explain the mechanism of heat transfer by convention. (03marks)

(b) (i) State Newton's law of cooling (01mark)

(ii) Describe briefly an experiment to verify Newton's law of cooling. (05marks)

(c) A wall is constructed using two types of bricks. The temperatures of the inner and outer surface of the wall are 29^0C and 21^0C respectively. The value of thermal conductivity for the inner brick is $0.4Wm^{-1}K^{-1}$ and that of the outer brick is $0.8Wm^{-1}K^{-1}$.

(i) Explain why in a steady state the rate of thermal energy transfer is the same in both layers. (0marks)

(ii) If each layer is 12 cm thick, find the temperature at the interface between the layers. (04mrks)

(d) Explain the greenhouse effect and how it leads to rise of the earth temperature. (04marks)

10. (a) (i) Define specific latent het of fusion (01mark)
   (ii) State effect of impurities on melting point (01mark)

(b) Explain why there is no change in temperature when a substance is melting (04marks)

(c) With the aid of a labelled diagram, describe the continuous flow method of measuring the specific heat capacity of a liquid. (06marks)

(d) In an experiment to determine the specific latent heat of fusion of ice, heating coil is placed in a filter funnel and surrounded by lumps of ice. The following sets of reading were obtained.

V(V)	4.0	6.0
I(A)	2.0	3.0
Mass of water m (g) collected in 500s	14.9	29.8

Calculate

(i) Specific latent heat of fusion of ice (04marks)

(ii) Energy gained in the course of obtaining the first set of readings (03marks)

(e) Why are two sets of reading necessary in (d) above? (01mark)

11. (a) (i) State Dalton's law of partial pressures. (01marks)
   (ii) Using the expression p $= \frac{1}{3}\rho c^2$, where ρ is the pressure of a gas of density ρ and mean square speed c^2, derive Daltons law of partial pressures for two gases. (05marks)

(b) (i) What is meant by isothermal process and adiabatic process? (02marks)

(ii) Explain why adiabatic expansion of a gas causes cooling (03marks)

(c) A gas at a temperature of 17^0C and pressure 1.0×10^5Pa compressed isothermally to half its original volume. It is then allowed to expand adiabatically to its original volume

(i) Sketch a P-V curve the above process (02marks)

(ii) If the specific heat capacity at constant pressure is $2100Jmol^{-1}K^{-1}$ and at constant volume is $1500Jmol^{-1}K^{-1}$, find the final temperature of the gas (04marks)

(d) (i) What is meant by saturated vapour? (01mark)

(ii) Explain briefly the effect of altitude on the boiling point of a liquid (02marks)

12. (a)(i) Define a black body. (01mark)

(ii) Sketch and explain graphs of intensity versus wavelength for three different temperatures of a black body. (03marks)

(b)Describe with the aid of a diagram how an optical radiation pyrometer is used to measure temperature. (06marks)

(c) (i) State Prevost's theory of heat exchanges (01marks)

(ii) Metal sphere of radius 1.5cm is suspended within an evacuated enclosure whose walls are at 320K. The emissivity of the metal is 0.40. Find the power input required to maintain the sphere at a temperature of 320K, if heat conduction long the support is negligible. (04mrks)

(d) A metal boiler is 1.5cm thick. Find the difference in temperature between the inner and outer surfaces if 40kg of water evaporate from the boiler per meter squared per hour. [Latent heat of vaporization of water = $2268kJkg^{-1}$, Thermal conductivity of the metal of the boiler = $63Wm^{-1}K^{-1}$] (05marks)

13. (a) (i) State four desirable properties a material must have to be used as a thermometric substance. (02marks)

(ii) State why scales of temperature based on different thermometric properties may not agree. (01mark)

(b) With the id of diagram explain how a bolometer is used to detect thermal radiation. (06marks)

(c) Describe, with the aid of a diagram an experiment to determine specific heat of vaporization of steam using the method of mixtures. (07marks)

(d) A 600Welectricity heater is used to raise the temperature of a certain mass of water in a thermos flask from room temperature to 80^0C. The same temperature rise is obtained when seam from a boiler is passed into an equal mass of water at room temperature in the same time. If 16g of water were being evaporated every minute in the boiler, find the specific latent heat of vaporization of steam, assuming no heat losses. (04marks)

14. (a) Define the following

(i) Absolute zero (01marks)

(ii) Cooling correction (01marks)

(b) (i) State Dalton's law of partial pressures (01mark)

(ii) The kinetic theory expression for the pressure, P, of ideal gas of density, ρ, and mean square speed, c^2 is $P = \rho c^2$. Use the expression to deduce Dalton's law (03marks)

(c) Explain clearly the steps taken to determine the cooling correction when measuring the specific heat capacity of a poor conductor by the method of mixtures. (07marks)

(d) The density of air at 0^0C and pressure of 101kPa is $1.29kgm^{-3}$. Calculate pressure of 300kPa. (03marks)

15. (a) Define thermal conductivity of material and state its units. (02marks)

(b) Describe an experiment to determine the thermal conductivity of copper. (06marks)

(c) A double glazed window has two glasses each of thickness 4.0mm separated by a layer of air of thickness 1.5mm. If the two inner air-glass surfaces have steady temperature of 20^0C and 4^0C respectively. Find the;

(i) temperatures of the outer air-glass surfaces (03marks)

(ii) The amount of heat that flows across an area of the window of $2m^2$ in 2hours.

[Conductivity of glass = $0.72Wm^{-1}k^{-1}$ and that of air = $0.025Wm^{-1}K^{-1}$]

(d)(i) What is a black body? (01mark)

(ii) Explain how a welder can protect the eyes from damage. (03marks)

(iii)Calculate the wavelength of the radiation emitted by a black body at 6000K.

[Wen's displacement constant = $2.9 \times 10^{-3}mK$] (02marks)

16. (a) (i) State two differences between saturated and unsaturated vapours. (02marks)

(ii) Sketch graphs of vapour against temperature for an ideal gas and for saturated water vapour originally at 0^0C (03marks)

(b) The specific heat capacity of oxygen at constant volume is $719Jkg^{-1}K^{-1}$ and its density at standard temperature and pressure is $1.429kgm^{-3}$. Calculate the specific heat capacity of oxygen at constant pressure (04marks)

(c) (i) With the aid of a labelled diagram, describe an experiment to determine standard saturated vapour pressure of water. (05marks)

(ii) State how the experiment set up in (c) (i) may be modified to determine a saturated vapour pressure of above atmospheric pressure (01marks)

(d)(i) Define ideal gas (01mark)

(ii) State and explain the conditions under which real gases behave as ideal gases. (04marks)

17. (a) (i) What is a black body?(01marks)

(ii) Explain with the aid of a diagram how black body can be approximated. (03marks) (iii)With the aid of sketch graphs explain the silent features of the spectral distribution of black body radiation (04 marks)

(b) Give four properties of ultraviolet radiation. (02marks)

(c) Describe an experiment to compare the energy radiated by two surfaces at different temperatures (04marks)

(d) (i) State Stefan's law. (01mark)

(ii) The earth receives energy from the earth from the sun at the rate of 1.4 x 10^3Wm^{-2}. If the ratio of the earth's orbit to the sun's radius is 216, calculate the surface temperature of the sun. (05marks)

18. (a) Define specific latent heat of vaporization. (01mark)

(b) With the aid of labelled diagram, describe an experiment to measure the specific latent heat of vaporization of a liquid using an electrical method. (07marks)

(c) Explain the effect of pressure on the boiling point of a liquid. (02marks)

(d) A liquid of specific heat capacity 2.8 x 10^3Jkg^{-1}K^{-1} and specific latent heat of vaporization 9.00 x 10^5Jkg is contained in a flask of heat capacity 800JK^{-1} at a temperature of 32^0C. An electric heater rated 1kW is immersed in 2.5kg of the liquid and switched on for 12 minutes, calculate the amount of liquid that boiled off, given that the boiling point of the liquid is 80^0C. (06marks)

(e) (i) Two thermometers are used to measure the temperature of a body. Explain why the temperatures may be different. (02marks)

(ii) A platinum resistance thermometer has a resistance of 5.42Ω at the triple point of water. Calculate the resistance at a temperature of 50.0^0C. (02marks)

19. (a) Define;

(i) Specific heat capacity (01mark)

(ii) Specific latent heat of vaporization of a liquid. (01 mark)

(b) With the aid of a labelled diagram, describe the electrical method of determining the specific heat capacity of a solid (07marks)

(c) An electrical heater rated 48W, 12V is placed in a well-insulated metal of mass 1.0kg at a temperatures of 18^0C. When power is switched on for 5minutes, the temperature of the metal rises to 34^0C. Find the specific heat capacity of the metal (04marks)

(d) (i) State Newton's law of cooling (01marks)

(ii) Use Newton's law of cooling to show that $\frac{d\theta}{dt} = -k(\theta - \theta_R)$

Where $\frac{d\theta}{dt}$ is the rate of fall of temperature and θ_R is the temperature of the surrounding.

(e) Explain why evaporation causes cooling. (03marks)

20. (a) The pressure, P, of an ideal gas is given by P $= \frac{1}{3}\rho \overline{c^2}$, where ρ is the density of the gas and $\overline{c^2}$ its mean square speed.

(i) Show clearly the steps taken to derive this expression (06marks)
(ii) State the assumptions made in deriving this expression (02marks)

(b) Sketch the pressure versus volume curve for a real gas for temperatures above and below the critical temperature. (03marks)

(c) For 1 mole of a real gas, the equation of state is $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

Explain the significance of the terms $\frac{a}{V^2}$ and b. (02marks)

(d) A balloon of volume $5.5 \times 10^{-2} m^3$ is filled with helium to a pressure of $1.10 \times 10^5 Nm^{-2}$ at a temperature of 20^0C. Calculate the;

(i) the number of helium atoms in the balloon (03marks)

(ii) net force acting on the square meter of material of the balloon if the atmospheric temperature is $1.01 \times 10^5 Nm^{-2}$ (04marks)

21. (a) (i) Define thermal conductivity of a material (01mark)

(ii) Describe an experiment to determine the thermal conductivity of copper. (06marks)

(b) (i) What is a black body? (01 marks)

(ii) Describe how infrared radiation can be detected using a bolometer. (03marks)

(iii) Give one characteristic property of infrared radiation. (01mark)

(c) (i) A spherical black body of radius 2.0cm at -73^0C is suspended in an evacuated enclosure whose walls are maintained at 27^0C. If the rate of exchange of thermal energy is equal to $1.85 Js^{-1}$, find the value of Stefan's constant, (05marks)

(ii) Calculate the wavelength at which the radiation emitted by the enclosure ha maximum intensity (03mark)

22. (a)(i) Define the terms specific heat capacity and specific latent heat of fusion (02marks)
(ii) Explain the changes that take place in the molecular structure of substances during fusion and evaporation (04marks)

(b) With the aid of a labelled diagram describe an experiment to determine the specific heat capacity of a liquid using the continuous flow method. (08marks)

(c) Steam at 100^0C is passed into a copper calorimeter of mass 150g containing 340g of water at 15^0C. This is done until the temperature of the calorimeter and its content is 71^0C. If the mass of the calorimeter and its content is found to be 525g, calculate the specific latent heat of vaporization of water. (06marks)

23. (a) (i) Define saturated vapour pressure. (01mark)
(ii) Describe with the aid of a diagram, how saturated vapour pressure of a liquid can be determined at a given temperature. (06marks)

(b) Use the kinetic theory to explain the following observations

(i) Saturated vapour pressure of a liquid increases with temperature. (03marks)

(ii) Saturated vapour pressure is not affected by decrease in volume at constant pressure. (03marks)

(c) When hydrogen gas is collected over water, the pressure in the tube at 15^0C and 75^0C are 65.5cm and 105.6cm of mercury respectively. If the saturated vapour pressure at 15^0C is 1.42cm of mercury, find its value at 75^0C (04marks)

(d) Explain why the molar heat capacity of an ideal gas at constant pressure differs from the molar heat capacity at constant volume (03marks)

24. (a) (i) Define thermal conductivity. (01mark)

(ii) Compare the mechanism of heat transfer in poor conductor and good conductor. (05marks)

(b) Describe, with the aid of a diagram how you would measure the thermal conductivity of a poor conductor, stating the necessary precautions (08marks)

(c) A cylindrical iron vessel with a base of diameter 15cm and thickness 0.30cm has its base coated with a thin film of soot of thickness 0.10cm. It is then filled with water at 100^0C and placed on a large block of ice at 0^0C. Calculate the initial rate at which the ice will melt (06marks) (thermal conductivity of soot=$0.12Wm^{-1}K^{-1}$)

25. (a)(i) State Boyles law (01mark)

(ii) Describe an experiment to verify Boyles' law (06marks)

(iii)Explain why the pressure of a fixed mass of a gas rises if its temperature is increased. (02marks)

(b) (i) Define the term thermometric property and give four examples (03marks)

(ii) State two qualities of a good thermometric property. (01mark)

(c) (i) With reference to a liquid in glass thermometer, describe the step involved in setting up a Kelvin scale of temperature (03marks)

(ii) State one advantage and one disadvantage of the resistance thermometer. (01mark)

(d) A resistance thermometer has resistance of 21.42Ω at the ice point, 29.10Ω at steam point and 28.11Ω at some unknown temperature θ. Calculate θ on the scale of this thermometer. (03marks)

26. (a) Define specific heat capacity of a substance and state its units (02marks)

(b) (i) Describe how specific heat capacity of a liquid can be obtained by continuous flow method. (07marks)

(ii) State one disadvantage of this method. (01mark)

(c) An electric kettle rated 1000W, 240V is used on 220V mains to boil 0.52kg of water. If the heat capacity of the kettle is $400JK^{-1}$ and the initial temperature of water is 20^0C, how long will the water take to boil? (04marks)

(d) (i) Distinguish between isothermal and adiabatic changes (02marks)

(ii) An ideal gas at 18^0C is compressed adiabatically until the volume is halved. Calculate the final temperature of the gas. [Assume specific heat capacities of the gas at constant pressure and volume are $2100Jkg^{-1}K^{-1}$ and $1500Jkg^{-1}K^{-1}$] respectively. (04marks)

27. (a) State Stefan's law of black body radiation. (01marks)

(b) Briefly describe how a thermopile can be used to detect thermal radiation. (05marks)

(c) Explain the temperature distribution along

(i) a perfectly lagged metal bar (02marks)

(ii) an unlagged metal bar. (02marks)

(d) The wall of a furnace is constructed with two layers. The inner layer is made of bricks of thickness 10.0cm and thermal conductivity 0.8 $Wm^{-1}K^{-1}$ and the outer layer is made of material of thickness 10.0 cm and thermal conductivity 1.6 $Wm^{-1}K^{-1}$.

The temperatures of the inner and outer surfaces ate 600^0C and 460^0C respectively.

(i) Explain why in steady state, the rate of thermal energy transfer must be the same in both layers. (01mark)

(ii) Calculate the rate of heat flow per square meter through the wall. (05marks)

(e) Explain the greenhouse effect and how it is related to global warming. (04marks)

28. (a) (i) Define the term specific heat capacity and internal energy and state their units. (03marks)

(ii) Why is the distinction between specific heat capacity at constant pressure and that at constant volume important for gases, but less important for solids and liquids? (04marks)

(b) Explain why the temperature of a liquid does not change when the liquid is boiling? (02marks)

(c) One kilogram of water is converted to steam at a temperature of 100^0C and a pressure of 1.0×10^5Pa. If the density of steam is $0.58kgm^{-3}$ and specific heat of vaporization of water is $2.3 \times 10^6Jkg^{-1}$, calculate the;

(i) external work done (04marks)

(ii) internal energy (03marks)

(d) Explain why the specific latent heat of fusion and specific latent heat of vaporization of a substance at the same pressure are different. (04marks)

29. (a) (i) Explain the difference between isothermal and adiabatic expansion of a gas. (02marks)

(ii) Using same axes and point, sketch graphs of pressure versus volume for fixed mass of a gas undergoing isothermal and adiabatic changes. (03marks)

(b) Show that work, W, done by a gas which expands reversibly from V_0 to V_1 is given by $W = \int_{V_0}^{V_1} \rho dv$(04marks)

(c) (i) State two differences between real and ideal gases (02marks)

(ii) Draw a labelled diagram showing P-V isothermals for a real gas above and below the critical temperature. (03marks)

(d) Ten moles of a gas, initially at 27^0C are heated at constant pressure of 1.01×10^5Pa and volume increased from $0.25m^3$ to $0.375m^3$. Calculate the increase in internal energy.
[Assume $C_p = 28.5Jmol^{-1}K^{-1}$] (06marks)

30. (a) What is meant by the following?
(i) Conduction
(ii) Convection
(iii) Greenhouse effect (06marks)

(b) One end of a long copper bar is heated in a steam chest and the other end is kept cool by current of circulating water. Explain with the aid of sketch graphs, the variation of temperature along the bar, when steady state has been attained if the bar is;

(i) lagged (02marks)

(ii) exposed to the surrounding (02marks)

(c) (i) What is meant by a black body? (01mark)

(ii) Describe how a black body can be approximated in practice. (04marks)

(d) (i) State Prevost's theory of heat exchange. (01mark)

(ii) Sketch the variation with wavelength of the intensity of radiation emitted by a black body at two different temperatures. (01mark)

(e) A cube of side 1.0cm has a grey surface that emits 50% of the radiation emitted by a black body at the same temperature. If the cube's temperature is 700^0C, calculate the power radiated by the cube. (03marks)

31. (a) (i) Define the term thermometric property. (01mark)
(ii) State two thermometric properties. (01mark)
(iii) With the aid of a labelled diagram, describe how the room temperature can be measured using uncalibrated resistance thermometer. (06marks)

(b) (i) Define specific heat capacity of a substance. (01mark)

(ii) Hot water at 85^0C and cold water 10^0C are ran into a bath at a rate of $3.0 \times 10^{-2}m^3min^{-1}$ and V, respectively. At the point of filling the bath, the temperature of the mixture of water 40^0C. Calculate the time taken to fill the bath is its capacity is $1.5m^3$.

(c) The specific latent heat of fusion of a substance is significantly different from its specific latent heat of vaporization at the same pressure. Explain how the difference arises. (04marks)

(d) Explain in terms of specific heat capacity why water is used in a car radiator other than any other liquid. (02mark)

32. (a) (i) state Boyles law. (01mark)

(ii) Describe an experiment that can be used to verify Boyles' law. (06marks)

(b) Explain the following observations using the kinetic theory.

(i) A gas fills any container in which is it placed and exerts pressure on its walls. (03marks)

(ii) The pressure of a fixed mass of a gas rises when temperature is increased at constant volume. (02 marks)

(c) (i) What is meant by a reversible process. (01marks)

(ii) State the conditions necessary for isothermal and adiabatic processes to occur, (04marks)

(d) A mass of an ideal gas of volume $200cm^3$ at 144K expands adiabatically to a temperature of 137K. Calculate its new volume. (Take γ =1.40)

33. (a) Define thermal conductivity. (01mark)

(b)(i) Explain the mechanism of thermal conduction in nonmetallic solids. (03marks)

(ii) Why are metal better thermal conductors than nonmetallic solids? (02marks)

(c) With the aid of a diagram, describe an experiment to determine the thermal conductivity of a poor conductor. (06marks)

(d) (i) What is meant by a black body? (01mark)

(ii) Sketch curves showing the spectral distribution of energy radiated by a black body at three different temperatures. (02marks)

(iii)Describe the main features of the curves you have drawn in (d)(ii) (02marks)

(e) A small blackened solid copper sphere of radius 2cm is placed in an evacuated enclosure whose wall are kept at 100^0C. Find the rate at which energy must be supplied to the sphere to keep its temperature at 127^0C. (03marks)

34. (a) Define the following terms

(i) Specific latent heat of vaporization (01mark)

(ii) Coefficient of thermal conductive

(b) With the aid of a labelled diagram, describe an experiment to measure the specific latent heat of vaporization of water by electrical method (07marks)

(c) An appliance rated 240V, 200W evaporates 20g of water in 5 minutes. Find the heat loss if specific latent heat of vaporization is $2.26 \times 10^6 Jkg^{-1}$. (03marks)

(d) Explain why at a given external pressure a liquid boils at constant temperature. (04marks)

(e) With the aid of a suitable sketch graphs, explain the temperature distribution along lagged and unlagged metal rods, heated at one end. (04marks)

35. (a) Describe an experiment to verify Newton's law of cooling. (05marks)

(b) (i) Distinguish between a real and an ideal gas. (03marks)

(ii) Derive the expression $P = \frac{1}{3}\rho\overline{c^2}$ for the pressure of an ideal gas of density, ρ, and mean square speed $\overline{c^2}$

(c) (i) Explain why the pressure of a fixed mass of a gas in a closed container increases when the temperature of the container is raised. (02marks)

(ii) Nitrogen gas is trapped in a container by a movable piston. If the temperature of the gas is raised from 0^0C to 50^0C at constant pressure of 4.0×10^5Pa and the total heat added is 3.0×10^4J, calculate the work done by the gas. [The molar heat capacity of nitrogen at constant pressure is $29.1 Jmol^{-1}K^{-1}$, $C_p/C_v = 1.4$]

36. (a) (i) State the laws of black body radiation (02marks)

(ii) Sketch the variation of intensity with wavelength in a black for different temperatures. (03marks)

(b) (i) What is a perfectly black body? (01marks)

(ii) How can a perfectly black body be approximated in reality? (04marks)

(c)(i) The energy intensity received by a spherical planet from a star is $1.4 \times 10^3 Wm^{-2}$. The star is of radius 7.0×10^5km and is 14.0×10^7km from the planet.

(i) Calculate the surface temperature of the star. (04marks)

(ii) State any assumptions you have made in (c)(i) above (01marks)

(d) (i) What is convection? (01mark)

(ii) Explain the occurrence of land and sea breeze. (04marks)

37. (a) (i) Define a thermometric property and give two examples (02marks)

(ii) When is the temperature of 0K attained? (02marks)

(b)(i) With reference to constant-volume gas thermometer, define temperature on the Celsius scale (02marks)

(ii) State two advantages and two disadvantages of the constant-volume gas thermometer. (02marks)

(c) (i) Define triple point of water (01mark)

(ii) Describe how you would measure the temperature of a body on the thermodynamic scale using a thermocouple. (03marks)

(d) The resistance, R_θ of platinum varies with the temperature 0^0C as measured by the constant volume gas thermometer according to the equation

$$R_\theta = 50.0 + 0.17\theta + 3.0 \times 10^{-4}\theta^2$$

(i) Calculate the temperature on the platinum scale corresponding to 60^0C on the gas scale. (06marks)

(ii) Account for the difference between the two values and state the temperatures at which they agree. (02marks)

38. (a) (i) Define latent heat (01mark)

(ii) Explain the significance of latent heat in regulation of body temperature. (03marks)

(b) (i) using kinetic theory, explain boiling of a liquid. (03mark)

(ii) Describe how you would determine the specific latent heat of vaporization of water by the method of the mixtures (05marks)

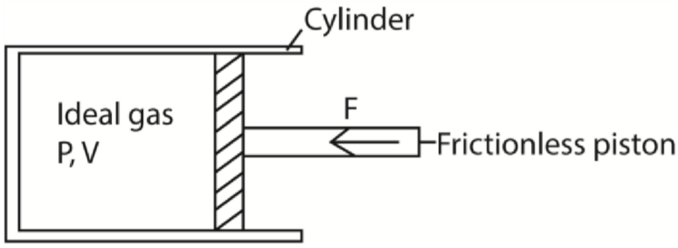
(iii) Explain why latent heat of vaporization is always greater than that of fusion. (02marks)

(c) In an experiment to determine the specific latent heat of vaporization of a liquid using the continuous flow calorimeter, the following results were obtained.

Voltage, V/V	Current, I/A	Mass collected in 300s/g
7.4	2.6	5.8
10.0	3.6	11.3

Calculate the power of the heater required to evaporate 3.0g of water in 2 minutes (06marks)

39. (a)



A fixed mass of an ideal gas is confined in a cylinder by frictionless piston of cross section area A. the piston is in equilibrium under the action of force, F as shown in the figure above. Show that the work done, W, by the gas when it expands from V_1 to V_2 is given by $W = \int_{V_1}^{V_2} PdV$ (03marks)

(b) State the first law of thermodynamics and use it to distinguish between Isothermal and adiabatic changes in a gas. (05marks)

(c) The temperature of 1mole of helium gas at a pressure of 1.0×10^5Pa increases from 20^0C to 100^0C when the gas is compressed adiabatically. Find the final pressure of the gas. (Take $\gamma = 1.67$) (04 marks)

(d) With the aid of a P-V diagram, explain what happens when a real gas is compressed at different temperatures. (04marks)

(e) The root-mean square speed of the molecules of a gas is $44.72ms^{-1}$. Find the temperature of the gas if its density is $9.0 \times 10^{-2}kgm^{-3}$ and the volume is $42.0m^3$. (04marks)

40. (a) Define saturated vapour pressure (S.V.P) (01mark)

(b) Use the kinetic theory of matter to explain the following observations

(i) Saturated vapour pressure of a liquid increases with temperature. (03marks)

(ii) Saturated vapour pressure is not affected by decrease in volume at constant temperature. (03marks)

(c) Describe how saturated vapour pressure of a liquid at various temperatures can be determined. (07marks)

(d) (i) State Dalton's law of partial pressures (01mark)

(ii) A horizontal tube of uniform bore, closed at one end, has some air trapped by a small quantity of water. The length of the enclosed air column is 20cm at 12^0C.

Find stating any assumptions made, the length of air column when the temperature is raised to 38^0C. [S.V.P of water at 12^0C and 38^0C are 10.5mmHg and 49.5mmHg respectively. Atmospheric pressure = 75cmHg] (05marks)

41. (a) (i) Define specific heat capacity of a substance. (01mark)

(ii) State three advantages of the continuous flow method over the method of mixtures in determination of the specific heat capacity of a liquid. (03marks)

(b) In a continuous flow experiment, a steady difference of temperature of 1.5^0C is maintained when the rate of liquid flow is $4.5gs^{-1}$ and the rate of electrical heating is 60.5W. On reducing the liquid flow rate to $1.5gs^{-1}$, 36.5W is required to maintain the same temperature difference. Calculate the;

(i) Specific heat capacity of the liquid. (04marks)

(ii) Rate of heat loss to the surroundings (03marks)

(c) (i) Describe an electrical method for determination of the specific heat capacity of a metal. (06marks)

(ii) State the assumptions made in the above experiment. (02marks)

(iii)Comment about the accuracy of the results of the experiment in (c)(i) above. (01marks)

42. (a)(i) Define thermal conductivity. (01mark)

(ii) Explain the mechanism of heat transfer in metals (03marks)

(b) Two brick walls each of thickness 10cm are separated by an air-gap of thickness 10cm. the outer faces of the brick walls are maintained at 20^0C and 5^0C respectively.

(i) Calculate the temperatures of the inner surfaces of the walls. (06marks)

(ii) Compare the rate of heat loss through the layer of air with that through a single brick wall. (03marks)

[Thermal conductivity of air is $0.02Wm^{-1}K^{-1}$, and that of bricks is $0.6Wm^{-1}K^{-1}$]

(c)(i) State Stefan's law of black body radiation. (01mark)

(ii) The average distance of Pluto from the sun is about 40 times that of the Earth from the sun. If the sun radiated as a black body at 600K, and is 1.5×10^{11}m from the Earth, Calculate the temperature of Pluto. (06marks)

43. (a)(i) What is meant by term fixed point in thermometry? Give two examples (02marks)
(ii) How is temperature on Celsius scale defined on a platinum resistance thermometer? (02marks)

(b) Explain the extent to which two thermometers based on different properties but calibrated using the same fixed points are likely to agree when used to measure temperature.

(i) near one of the fixed point (02marks)

(ii) mid-way between two fixed points (02marks)

(c) The continuous flow method is used in determination of the specific heat capacity of liquids.

(i) What are the principal advantages of this method compared to the method of mixtures? (03marks)

(ii) In such a method, 50g of water is collected in 1 minute. The voltmeter and ammeter readings are 12.0V and 2.50A respectively, while the inflow and outflow temperatures are 20^0C and 28^0C respectively. When the flow rate is reduced to $25gmin^{-1}$, the voltmeter and ammeter read 8.8V and 1.85A respectively while the temperatures remain constant. Calculate the specific heat capacity of water. (05marks)
(d) What are the advantages of a thermocouple over a constant volume thermometer for measuring temperature? (04marks)

44. (a)(i) What is meant by isothermal and adiabatic changes? (02marks)
(ii) Using the same axes, and starting from the same point, sketch a P-V diagram to illustrate the changes in (a)(i) (02marks)

(b) An ideal gas is trapped in a cylinder by a movable piston. Initially it occupies a volume of $8 \times 10^{-3}m^3$ and exerts a pressure of 108kPa. The gas undergoes an isothermal expansion until its volume is $27 \times 10^{-3}m^3$. It is then compressed adiabatically to the original volume of the gas.

(i) Calculate the final pressure of the gas (06marks)
(ii) Sketch and label the two stages on a p-v diagram. (02marks)
[The ratio of the principal molar heat capacities of the gas = 5:3]

(c) (i) Define molar heat capacities at constant pressure. (01mark)

(ii) Derive the expression $C_p - C_v = R$, for 1mole of a gas (05marks)
(iii) In which ways does a real gas differ from an ideal gas? (02marks)
45. (a) (i) Define thermal conductivity. (01mark)
(ii) State two factors which determine the rate of heat transfer through a material (02marks)

(b)(i) Describe with the aid of a diagram an experiment to measure the thermal conductivity of glass. (08marks)

(ii) Briefly discuss the advantages of the apparatus in (b)(i). (02marks)

(c) Metal rods of copper, brass are welded together to form Y shaped figure. The cross-section area of each rod is $2cm^2$. The free end of copper rod are maintained at 100^0C, while the free ends of brass and steel rods are maintained at 0^0C. If there is no heat loss from the surfaces of the rods and the length of the rods are 0.46m, 0.13m and 0.12m respectively.

(i) Calculate the temperature of the junction (05marks)
(ii) Find the heat current in the copper rod. (02marks)

[Thermal conductivities of copper, brass and steel are $385Wm^{-1}K^{-1}$, $109\ Wm^{-1}K^{-1}$ and $50.2\ Wm^{-1}K^{-1}$respectively.]

46. (a) What is meant by:
(i) Thermometric property (01mark)
(ii) Triple point (01mark)

(b) (i) Describe the steps taken to establish a temperature scale. (05marks)

(ii) Explain why two thermometers may give different values for the same unknown temperature. (02marks)

(c) (i) Describe, with the aid of a diagram, how a constant-volume gas thermometer may be used to measure temperature. (06mrks)

(ii) State three corrections that need to be made when using the thermometer in (c)(i) above. (03marks)

(iii)State and explain the sources of inaccuracies in using mercury in glass thermometer, (02marks)

47. (a) Define thermal conductivity of a material and state its units (02marks)
(b) Describe with the aid of a diagram how the thermal conductivity of a poor conductor can be determined. (07marks)

(c) A cooking saucepan made of iron has a base area of $0.05m^2$ and thickness of 2.5mm. It has a thin layer of soot of average thickness 0.5mm on its bottom surface. Water in the saucepan is heated until it boils at 100^0C. The water boils away at a rate of 0.60kg per minute and the side of the soot nearest to the heat source is at 150^0C. Find the thermal conductivity of soot. [Thermal conductivity of iron = $66Wm^{-1}K^{-1}$and specific latent heat of vaporization =2200kJ/kg]

(d) (i) What is a black body? (01mark)

(ii) Sketch the spherical distribution of black body radiation for three different temperatures and describe their main features. (04marks)

48. (a) Derive the expression $P = \frac{1}{3}\rho \overline{c^2}$ for the pressure, P, of an ideal gas of density ρ and mean square speed, $\overline{c^2}$. State any assumptions made (07marks)

(b) A gas is confined in a container of volume $0.1m^3$ at a pressure of $1.0 \times 10^5 Nm^{-2}$ and temperature of 300K. If the gas is assumed to be ideal, calculate the density of the gas.
(The relative molecular mass of the gas is 32) (05marks)

(c) What is meant by
(i) isothermal change
(ii) adiabatic change (02marks)
(d) A gas at a pressure of $1.0 \times 10^6 Pa$ is compressed adiabatically to half its volume and then allowed to expand isothermally to its original volume. Calculate the final pressure of the gas. (06marks) [Assume the ratio of the principal specific heat capacities c_p/c_v, $\gamma = 1.4$]

49. (a) (i) Define molar heat capacity of a gas at constant volume. (01mark)
(ii) The specific heat capacity of oxygen at constant volume is $719 Jkg^{-1}K^{-1}$. If the density of oxygen at s.t.p is $1.429 kgm^{-3}$, calculate the specific heat capacity of oxygen at constant pressure. (04marks)

(b) Indicate the different states of a real gas at different temperatures and pressure versus volume sketch graph.
(c) (i) In deriving the expression $P = \frac{1}{3}\rho \overline{c^2}$ for the pressure of an ideal gas, two of the assumptions made are not valid for a real gas. State these assumptions. (02marks)
(ii) The equation of state of one mole of a real gas is $\left(P + \frac{a}{v^2}\right)(v - b) = RT$

Account for the terms $\frac{a}{v^2}$ and b (02marks)

(d) Use the expression $P = \frac{1}{3}\rho \overline{c^2}$; for the pressure of an ideal gas to derive Dalton's law of partial pressures (04marks)

(e) Explain, with the aid of a volume versus temperature sketch graph, what happens to a gas cooled at constant pressure from room temperature to zero Kelvin. (04marks)

50. (a) What is meant by black body? (01mark)
(b) Describe how an approximate black body can be realized in practice. (02marks)

(c)(i)Draw sketch graphs to show how variation of relative intensity of black body radiation with wavelength for three different temperatures. (02marks)

(ii) Describe the features of the sketch in (c)(i) above. (03marks)

(d)(i) State Stefan's law (01mark)

(ii) A solid copper sphere of diameter 10 mm and temperature of 150K is placed in an enclosure maintained at a temperature of 290K. Calculate, stating assumptions made, the initial rate of rise of temperature of the sphere. (07marks)

[Density of copper = $8.93 \times 10^3 kgm^{-3}$, specific heat capacity of copper = $3.7 \times 10^2 JkgK^{-1}$]

(e) With the aid of a labelled diagram, describe how a thermopile can be used to determine infrared radiation. (04marks)

51. (a) (i)What is meant by kinetic theory of gases? (03marks)

(ii) Define an ideal gas (01mark)

(iii)State and explain conditions under which real gases behave like ideal gases. (04mark)

(b) (i) Describe an experiment to show that a liquid boils only when its saturated vapor pressure is equal to external pressure (05marks)

(ii) Explain how cooking at a pressure of 76cm of mercury and temperature of 100^0C may be achieved on top of high mountains. (03marks)

(c) (i) Define root-mean-square speed of molecules of a gas. (01mark)

(ii) The mass of hydrogen and oxygen atoms are 1.66 x 10^{-27}kg and 2.66 x 10^{-26}kg respectively. What is the ratio of the root mean square speed of hydrogen to that of oxygen molecules at the same temperature? (03marks)

52. (a) State the assumption made in the derivation of the expression $P = \frac{1}{3}\rho\overline{c^2}$ for pressure of an ideal gas (02marks)

(b) Use the expression in (a) above to deduce Dalton's law of partial pressures. (03marks)

(c) Describe an experiment to determine the saturation vapor pressure of a liquid. (06marks)

(d) (i) What is meant by a reversible isothermal change? (02marks)

(ii) State the conditions for achieving a reversible isothermal change. (02marks)

(e) An ideal gas at 27^0C and at a pressure of 1.01 x 10^5Pa is compressed reversibly and isothermally until its volume is halved. It is then expanded reversibly and adiabatically to twice its original volume. Calculate the final pressure and temperature of the gas if γ=1.4 (05marks)

53. (a) Explain the mechanism of heat conduction in solids. (03marks)

(b) Describe a method of determining the thermal conductivity of cork in form of a thin sheet. (06marks)

(c) A window of height 1.0m and width 1.5m contains a double grazed unit consisting of two single glass panes, each of thickness 4.0mm separated by an air gap of 2.0mm. Calculate the rate at which heat is conducted through the window if the temperatures of external surfaces of glass are 20^0C and 30^0Crespectively. (07 marks)

[Thermal conductivities of glass and air are 0.72$Wm^{-1}K^{-1}$ and 0.025 $Wm^{-1}K^{-1}$ respectively]

(d) (i) State Stefan's law. (01mark)

(ii) The element of a 1.0kW electric fire is 30.0cm long and 1.0cm in diameter. If the temperature of the surroundings is 20^0C, estimate the working temperature of the element. [Stefan's constant, $\sigma = 5.7 \times 10^{-18}Wm^{-1}K^{-1}$] (03marks)

54. (a) (i) Define specific heat capacity of a substance (01mark)

(ii) State how heat losses are minimized in calorimetry (02mark)

(b) (i) What is meant by cooling correction? (01marks)

(ii) Explain how the cooling correction may be estimated in the determination of the heat capacity of poor by the method of mixtures (05marks) (iii)Explain why a small body cools faster than a larger one of the same material. (04marks)

(c) Describe how you would determine the specific heat capacity of a liquid by the continuous flow method. (07marks)

55. (a) Define thermal conductivity of a substance and state its units. (02marks)

(b) Flux of solar energy incident on the earth's surface is 1.36x 10^3Wm^{-2}. Calculate

(i) The temperature of the surface of the sun (04marks)

(ii) The total power emitted by the sun (03marks)

(iii)The rate of loss of mass by the sun (03marks)

(c)(i) Explain how heat is conducted through a glass rod. (03marks)

(ii) Why is a metal a better conductor of heat than glass? (02marks)

(iii)Explain briefly why it is necessary to use a thin specimen of large cross-section area in determining thermal conductivity of a poor conductor of heat. (03marks)

56. (a) (i)Explain what happens when a quantity of heat is applied to a fixed mass of a gas (02marks)

(ii) Derive the relationship between the principal molar heat capacities C_p and C_v for an deal gas. (05marks)

(b) (i) What is adiabatic process? (01mark)

(ii) A bicycle pump contains air at 290K. The piston of the pump is slowly pushed in until the volume of the air enclosed is one fifth of the total volume of the pump. The outlet is sealed off and the piston suddenly pulled out to full extension. If no air escapes, find its temperature immediately after pulling the piston. ($Take\ C_p/C_v = 1.4$) (03marks)

(d) (i) Distinguish between unsaturated and saturated vapors. (02marks)

(ii) Draw graphs to show the relationship between pressure and temperature for ideal gas and for saturated water vapour originally at 0^0C. (03marks)

(d) In an experiment, the pressure of a fixed mass of air at constant temperature is 10.4kPa. When the volume is halved, keeping the temperature constant, the pressure becomes 19.0kPa. Discuss the applicability of the above results in verifying Boyle's law. (04marks)

57. (a) Explain why temperature remains constant during change of phase. (04marks)

(b) Describe with the aid of labelled diagram, an electrical method for determination of specific latent heat of vaporization of a liquid. (07marks)

(c) Water vapour and liquid water are confined in an air tight vessel. The temperature of the water is raised until all the water has evaporated.

Draw a sketch graph to show how the pressure of water vapour changes with temperature and account for its main features. (06marks)

(d) Calculate the work done against the atmosphere when 1kg of water turns into vapour at atmospheric pressure of 1.01 x 10^5Pa. [Density of water vapour =0.598kgm^{-3}](03marks)

58. (a)(i) Describe Searle's method of determining the thermal conductivity of a good conductor of heat. (07marks)

(ii) Why is the method in (a)(i) best suited for a good conductor of heat? (02marks)

(b) The two ends of a metal bar of length 1.0m are perfectly lagged up to 20cm from either end. The ends of the bar maintained at 100^0C and 0^0C respectively.

(i) Sketch a graph of temperature versus distance of a bar. (02marks)

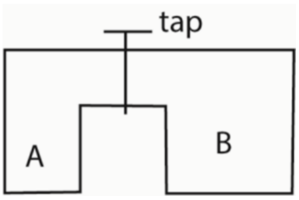
(ii)Explain the features of the graph in (b)(i)(03marks)

(c) The external wall of a house consists of two layers of brick separated by an air cavity. The outer face of the wall is at a temperature of 45^0C while the inside of the house is at 20^0C. If the thickness of each brick layer is 15cm and of air cavity is 5cm, calculate the temperatures of the walls in contact with air in the cavity. (06marks)

59. (a) (i) State Boyles law. (01mark)

(ii) What is meant by partial pressure of a gas (01 mark)

(iii)



Two cylinders A and B of volumes V and 3V respectively are separately filled with a gas. The cylinders are connected as shown above with the tap closed. The pressures of A and B are P and 4P respectively. When the tap is opened the common pressure becomes 60Pa. Assuming isothermal conditions find the value of P. (04marks)

(b) (i) State three differences between ideal and real gases. (03marks)

(ii)Sketch a pressure versus volume curve for a real gas undergoing compression below its critical temperature. (01mark)

(iii)Explain the main features of the curve in (b)(ii) above (03marks)

(c) Two similar cylinders P and Q contain different gases at the same pressure. When gas is released from P the pressure remains constant for some time before it starts dropping. When gas is released from Q the pressure continuously drops. Explain the observation above. (05marks)

(d) Using the expression for the kinetic pressure of an ideal gas, deduce the ideal gas equation of $\frac{1}{2}m\overline{c^2} = \frac{3}{2}K_BT$(02marks)

60. (a)(i) State the desirable properties of a material must have to be used as thermometric substance, (02marks)

(ii) Explain why scales of temperature based on different thermometric properties may not agree.(01marks)

(c) (i) Draw a labelled diagram to show a simple constant volume gas thermometer. (03marks)

(ii) Describe how a simple constant volume gas thermometer cab be used to establish a Celsius scale of temperature. (05marks)

(iii)State the advantages and disadvantages of mercury in glass thermometer and constant volume gas thermometer. (03marks)

(d) The resistance of the element of platinum resistance thermometer is 4.00Ω at ice point and 5.46Ω at steam point. What is the temperature on the platinum resistance scale would correspond to a resistance of 9.84Ω.(03marks)

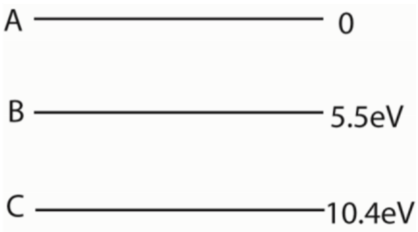
(e) The mean kinetic energy of one mole of helium gas at room temperature is 3.74×10^3J. Calculate room temperature.

SECTION C (MODERN PHYSICS)

1. (a) (i) What are cathode rays? (01marks)
   (ii) State two properties of cathode rays (01mark)
   (iii) Explain two disadvantages of using the discharge tube in producing cathode rays. (02marks)
   (b) With the aid of a diagram, describe Millikan's experiment to determine the charge on an oil drop (07marks)
   (c) A beam of electrons is accelerated through a potential difference of 1.98kV and directed midway between two horizontal plates of length 4.8cm and separated by a distance of 2.0cm. The potential difference applied across the plates is 80.0V.
   (i) Calculate the speed of the electrons as they enter the region between the plates (03marks)
   (ii) Explain the motion of the electrons between the plates (02marks)
   (iii) Find the speed of electrons as they emerge from the region between the plates (04marks)

2. (a)(i) What is meant by thermionic emission? (01marks)
   (ii) Describe how full-wave rectification of a.c can be achieved using four semiconductor diodes. (04marks)
   (b) (i) Draw a labelled diagram to show the main parts of a cathode ray oscilloscope (C.R.O) (03marks)
   (ii) Describe how a C.R.O can be used as an a.c voltmeter. (02marks)
   (c) (i) an electron of charge –e and mass m moves in circular orbit round a central hydrogen nucleus of charge +e. Derive an expression for total energy of electron in an orbit of radius r. (05 marks)
   (ii) Why is this energy always negative (01marks)
   (d) (i) What is meant by excitation potential of an atom? (01marks)

(ii) Some of the energy levels in mercury spectrum are shown in the figure below.



Calculate the wavelength of the radiation emitted when electron makes a transition from level A to level C. (03marks)

3. (a) What is meant by the following as applied to radioactivity?
   (i) Activity (01marks)
   (ii) Half-life of a radioactive material (01marks)

   (b) Using the radioactive decay law $N = N_0e^{-\lambda t}$, show that the half-life $T_{\frac{1}{2}} = \frac{1}{\lambda}$(02marks)

   (c) With the aid of a labelled diagram, describe the action of an ionization chamber. (05marks)

   (d) What is meant by unified atomic unit and electronvolt ?(02marks)

   (e) (i) The nucleus $^{212}_{83}Bi$ decays by alpha emission as follows

   $$^{212}_{83}Bi \rightarrow {}^{208}_{81}Tl + {}^{4}_{2}He$$

   Calculate the energy released by 2g of $^{212}_{83}Bi$. (05marks)

   (ii) Explain two uses of radioactive isotopes. (04marks)

4. (a) Define the following
   (i) Binding energy (01marks)
   (ii) Unified Atomic Energy (01marks)

   (b) Explain how energy is released in a nuclear fusion process. (03marks)

   (c) Explain what is observed in a discharge tube when the pressure is gradually reduced to low values? (05marks)

   (d) With the aid of a diagram, describe the operation of Bainbridge mass spectrometer in the determination of charge to mass ratio. (07marks)

   (e) An ion of mass 2.6 x 10^{-26} kg moving at a speed of 4 x 10^{4}ms^{-1} enter a region of uniform magnetic field of flux density 0.05T. Calculate the radius of the circle described by the ion.

5. (a)(i) State three differences between X-rays and cathode rays. (03marks)
   (ii)Describe using a labelled diagram, the mode of operation of an X-ray tube (06marks)
   (iii)What is the difference between soft and hard X-rays (01mark)

   (b) (i) What is the main distinction between work function and ionization energy? (02marks)

(ii) An electron of charge, e, enters at right angles into a uniform magnetic field of flux density B and rotates at frequency, f, in a circle of radius, r.

Show that the frequency, f, is given by; f = $\frac{Be}{2\pi m}$. (03marks)

(c) An X-ray beam is produced when electrons are accelerated through 50kV are stopped by the target of an X-ray tube. When the beam falls on a set of parallel atomic plates of a certain metal at glancing angle of 16^0, a first order diffraction maximum occurs. Calculate the atomic spacing of the planes. (05marks)

6. (a) State two differences between alpha and beta particles

(b) Describe with the aid of a diagram, the structure and mode of operation of an ionization chamber. (06marks)

(c)(i) Explain the application of carbon-14 in carbon dating. (03marks)

(ii) A sample of dead wood was found to have activity of 20units due to carbon-14 isotope whose half-life is 5600 years. If activity of wood just cut is 47.8 units, estimate the age of the sample. (03marks)

(d) The photoelectric work function of potassium is 2.25eV. Light having a wavelength of 360mm falls on a potassium metal.

(i) Calculate the stopping potential (04marks)

(ii) Calculate the speed of the most energetic electron emitted by the metal (02marks)

7. (a) What is meant by the following

(i) Radioactivity (01mark)

(ii) Isotopes (01marks)

(b) (i) Define mass defect (01mark)

(ii) State the conditions for a heavy nucleus to be unstable (01mark)

(iii) Explain your answer in (b)(ii) (02marks)

(c) A sample of $^{226}{}_{88}Ra$ emits both α-particles and γ-rays. A mass defect of 0.0053u occurs in the decay.

(i) Calculate the energy released in joules. (03 marks)

(ii) If the sample decays by emission of α-particle, each of energy 4.60MeV and γ-rays, find the frequency of the γ-rays emitted. (04marks)

(d) (i) Sketch a graph showing the variation of binding energy per nucleon with mass number, clearly showing the fusion and fissions. (02marks)

(ii) Use the sketch in (d)(i) to explain how energy is released in each of the process of fusion and fission. (03marks)

(e) State two

(i) applications of radioisotopes (01marks)

(ii) health hazards of radioisotopes (01mark)

8. (a) What are X-rays? (01marks)

(b) (i) With the aid of a diagram explain how X-rays are produced in an X-ray tube (05marks)

(ii) State the energy changes that take place in the production of X-rays in an X-ray tube. (02marks)

(c) In an X-ray tube, the electrons strike the target with a velocity of 3.75 x 10^7ms-1 after travelling a distance of 5.0cm from the cathode. If a current of 10mA flows through the tube, find the;

(i) tube voltage (02marks)

(ii) Number of electrons striking the target per second. (02marks)

(ii) Number of electrons within the space of 1cm length between the anode and the cathode. (05marks)

(d) Briefly explain one medical application of x-rays (03marks)

9. (a) state Bohr's postulates of an atom (03marks)

(b) Explain the occurrence of the emission and absorption line spectra. (06marks)

(c) Explain the main observations in Rutherford's α-particles scattering experiment. (06marks)

(d) A beam of alpha particles of energy 3.5MeV is incident normal to the gold foil.

(i) Calculate the least distance of approach to the nucleus of the gold atom given its atomic number is 79, (04marks)

(ii) State the significance of the value of the least distance of approach. (01mark)

10. (a) (i) Distinguish between mass defect and binding of an atomic nucleus (01mark)

(ii) Sketch a graph of nuclear binding energy per nucleon versus mass number for naturally occurring isotopes and use it to distinguish between nuclear fission and fusion. (04marks)

(b) Describe with the aid of a labelled diagram, Millikan's oil drop experiment to determine the charge on an oil drop. (07marks)

(c) (i) Explain briefly diffraction of X-rays by crystals and derive Bragg's law. (06marks)

(iii)A second order diffraction image is obtained by reflection of X-ray at atomic planes of a crystal for a glancing angle of $11^0 24'$. Calculate the atomic spacing of the planes if the wavelength of X-rays is 4.0 x 10^{-11}m (02marks)

11. (a) State Bohr's model of an atom. (02marks)

(b) An electron of mass m and charge –e, is considered to move in circular orbit about a proton.

(i) Write down the expression for the electric force on the electron. (02marks)

(ii) Derive an expression for total energy given that the angular momentum for the electron is equal to $\frac{nh}{2\pi}$ where n is an integer and h is Plank's constant. (06marks)

(c) With the aid of a labelled diagram, describe the operation of a diffusion type cloud chamber. (06marks)

(d) The energy levels of an atom have values

E_1 = - 21.4eV

E_2= -4.87 eV

E_3 = -2.77 eV

E4 = -0.81eV
E_∞ = 0.00eV

(i) Calculate the wavelength of radiation emitted when an electron makes a transition from E_3 to E_2 (03marks)

(ii) State the region of the electromagnetic spectrum where the radiation lies (01mark)

12. (a) Describe how positive rays are produced. (03marks)

(b) Describe how a Bainbridge spectrometer can be used to detect isotopes. (05marks)

(c) (i)What is time base as applied to a Cathode Ray Oscilloscope? (01mark)

(ii) Draw a sketch graph showing the variation of time base voltage with time (01mark)

(d) An alternating p.d applied to the Y-plate of an oscilloscope produces five complete waves on a 10cm length of the screen when the time base setting is $10mscm^{-1}$. Find the frequency of the alternating voltage. (03marks)

(e) (i) Explain the motion of an electron projected perpendicularly into a uniform magnetic field. (03marks)

(ii) An electron accelerated from rest by a p.d of 100V, enters perpendicularly into a uniform electric field intensity 105Vm-1. Find the magnetic field density, B, which must be applied perpendicularly to the electric field so that the electron passes undeflected through the fields. (04marks)

13. (a) (i) Define Avogadro's constant and Faraday's constant. (02marks)

(ii) Show that the charge carried by a monovalent ion is 1.6×10^{-19}C. (02marks)

(b) With the use of a labelled diagram, describe Millikan's oil drop experiment for the determination of the charge of an electron. (07marks)

(c) A beam of positive ions moving with velocity v enters a region of a uniform magnetic field density B with the velocity at right angles to the field B. By use of a diagram, describe the motion of ions. (03marks)

(d) A charged oil drop of density 880kgm^{-3} is held stationary between two parallel plates 6.0mm apart held at a potential difference of 103V. When the electric field is switched off, the drop is observed to fall a distance of 2.0mm in 35.7s. (Viscosity of air = 1.8 x 10^{-5}Nsm^{-2}, Density of air = 1.29kgm^{-3}).

(i) Calculate the radius of the drop. (03marks)

(ii) Estimate the number of excess electrons on the drop. (03marks)

14. (a) (i) State the laws of photoelectric emission (04marks)

(ii) Explain briefly one application of photoelectric effect. (04marks)

(b) In a photoelectric set up. A point source of light of power 3.2 x 10^{-3}W emits mono-energetic photons of energy 5.0eV. The source is located at a distance of 0.8m from the center of a stationary metallic sphere of work function 3.0eV and radius 8.0 x 10^{-3}m. The efficiency of photoelectron emission is one in every 10^{6} incident photons.
Calculate;

(i) Number of photoelectrons emitted per second. (04marks)
(ii) Maximum kinetic energy in joules, the photo electrons. (02marks)

(c) (i) State Bragg's law of X-ray diffraction (01marks)

(ii) Show that density, ρ, of a crystal can be given by

$$\rho = \frac{M\sin^3\theta}{125N_A(n\lambda)^3}$$

where θ is the glancing angle, n, is the order of diffraction, λ is the X-ray wavelength and M is the molecular weight of the crystal. (05marks)

15. (a) With reference to a Geiger-Muller tube, define the following

(i) quenching agent (01mark)

(ii) back ground count rate (01mark)

(b) (i) With the aid of a labelled diagram, describe the operation of a Geiger-Muller (GM) tube (06marks)

(ii) Explain how the half-life of a short lived radioactive source can be obtained by use of a Geiger Muller tube. (04marks)

(c) A radioactive isotope $^{32}{}_{15}P$ which has a half-life of 14.3days, disintegrates to form a stable product. A sample of the isotope is prepared with initial activity of 2.0 x $10^6 s^{-1}$. Calculate the

(i) the number of ^{32}P atoms present (03marks)

(ii) activity after 30days (03marks)

(iii) number of ^{32}P atoms after 30 days (02marks)

(Assume $N = N_0e^{-\lambda t}$)

16. (a) State Rutherford's model of the atom. (02marks)

(b) Explain how Bohr's model of the atom addresses the two main failures of Rutherford's model. (07marks)

(c) With the aid of a labelled diagram, describe how cathode rays are produced. (05marks)

(d) (i) What is binding energy of a nucleus? (01mark)

(ii) Calculate the energy in MeV released by fusing four protons to form an alpha particle and two beta particles.

Mass of beta particle = 0.000549u

Mass of hydrogen atom = 1.007825u

Mass of helium atom = 4.002664u
[1u = 931MeV] (05marks)

17. (a) What is photo electric emission? (01mark)

(b)(i) Describe an experiment to demonstrate photo electric effect. (04marks)

(ii) When a clean surface of a metal in a vacuum is irradiated with light of wave length 5.5 x 10^{-7}m, electrons just emerge from the surface. However when light of wavelength 5 x 10^{-7}m is incident on the metal surface, electrons are emitted each with energy 3.62 x 10^{-20}J. Find Plank's constant. (04marks)

(c) (i) With the aid of a labelled diagram, describe an X-ray tube and how X-rays are produced. (05marks)

(ii) Describe how the intensity and quality of X-rays is controlled in an X-ray tube. (02marks)

(d) An X-ray tune operates at 1.5 x 10-3V and the current through it is 1.0 x 10-3A.

Find the;

(i) Number of electrons crossing the tube per second. (02marks)

(ii) kinetic energy gained by electron traversing the tube (02marks)

18. (a)(i) What is specific charge? (01mark)

(ii) State the **unit** of specific charge (01mark)

(iii) Describe with the aid of a diagram how the specific charge of positive ions can be determined using a mass spectrometer. (06marks)

(b) A beam of strongly ionized carbon atoms passes undeflected through a region of crossed magnetic and electric field of 0.10T and 1.0 x 10^4NC^{-1} respectively. When it enters a region of uniform magnetic field, it is deflected through an arc of radius 0.75m. Calculate the magnetic flux density of this magnetic field. (Mass of carbon atom = 2.0 x 10^{-26}kg) (05marks)

(c) (i) Draw a graph to illustrate the variation of ionization current and p.d across an ionization chamber and explain its features. (03marks)

(ii) Explain how ionization chamber can be used to detect ionization radiation (04marks)

19. (a) Explain briefly how positive rays are produced (03marks)

(b) An electron of charge, e, and mass, m, is emitted from a hot cathode and then accelerated by an electric field towards the anode. If the potential difference between the cathode and the anode is V, show that the speed of the electron, u, is given by

$u = \sqrt{\left(\frac{2eV}{m}\right)}$ (03marks)

(c) An electron starts from rest and moves in an electric field intensity of 2.4 x 10^3Vm^{-1}. Find the

(i) force on the electron (02 marks)

(ii) acceleration of the electron. (02marks)

(iii) velocity acquired in moving through a p.d of 90V (02marks)

(d) A beam of electrons each of mass, m, and charge, e, is directed horizontally with speed, u, into an electric field between two horizontal metal plates separated by a distance, d.

(i) If the p.d between the plates is V, show that the deflection y of the beam is given by

$y = \frac{1}{2m}\left(\frac{eV}{du^2}\right)x^2$ where, x, is the horizontal distance travelled. (06marks)

(ii) Explain the path of the electron beam as it emerges out of the electric field. (02marks)

20. (a) The table below shows the energy levels of a hydrogen atom.

Principal quantum number, n	Energy,eV
6	-0.38
5	-0.54
4	-0.85
3	-1,51
2	-3.39
1	-13.60

(i) Why are the energies for the different levels negative? (01mark)

(ii) Calculate the wavelength of the line arising from a transition from the third to the second level. (03marks)

(iii) Calculate the ionization energy in joules of hydrogen atom. (02marks)

(b) Explain the physical processes in an X-ray tube that account for

(i) cut off wavelength (03marks)

(ii) characteristic lines (04marks)

(c) Calculate the maximum frequency of radiation emitted by an X-ray tube using an accelerating voltage of 33.0kV (03marks)

(d) Derive Bragg's law of X-ray diffraction in crystals. (04marks)

21. (a) A beam of α-particles is directed normally to a thin metal foil

Explain why

(i) Most of the α-particles passed straight through the foil (02marks)
(ii) Few α-particles are deflected through angles more than 900. (02marks)

(b) Calculate the least distance of approach of a 3.5MeV α-particles to the nucleus of a gold atom. (Atomic number of gold= 79) (04marks)

(c) (i) Define space charge as applied to thermionic diodes. (01mark)
(ii) Draw anode current-diode voltage curves of a thermionic diode for two different filament currents and explain their main features. (06marks)

(d) (i)What is a decay constant?
(ii) A sample from fresh wood of a certain species of tree has activity of 16.0 counts per minute per gram. However, the activity of 5g of dead wood of the same species of tree is 10 counts per minute. Calculate the age of the deadwood. (Assume half-life of 5730years) (04marks)

22. (a) (i) What are cathode rays?
(ii) With the aid of a diagram, describe an experiment to show that cathode rays travel in straight line (04mrks)

(b) A beam of electrons is accelerated through a potential difference of 500V. The beam enters midway between two similar parallel plates of length 10cm and are 3cm apart. If the potential difference across the plates is 600V, find the velocity of an electron as it leaves the region between the plates. (08marks)
(c) State the laws of photoelectric emission (04marks)
(d) Explain how line emission spectra are produced. (03marks)

23. (a) (i) what is meant by terms: radioactive decay, half-life and decay constant? (03marks)
(ii) show that the half-life, $t_{\frac{1}{2}}$ of a radioactive isotope is given by $t_{1/2} = \frac{0.693}{\lambda}$ where λ is the decay constant (Assume the decay law $N = N_0e^{-\lambda t}$)

(b) With the aid of a labelled diagram, describe the structure and action of a cloud chamber (05marks)

(c) A radioactive isotope ${}_{43}^{99}X$ decays by emission of a gamma ray. The half-life of the isotope is 360minutes. What is the activity of 1mg of the isotope? (06marks)

(d) Explain the term avalanche as applied to an ionization chamber. (03marks)

24. (a) Define the terms below as applied to a triode
(i) space charge (01mark)
(ii) Amplification factor (01mark)
(iii) Mutual conductance (01mark)

(b) With the aid of a labelled diagram explain full wave rectification. (07marks)

(c) Derive an expression for the amplification factor, μ, in terms of anode resistance, R_a and mutual conductance, g_m, for a triode valve. (03marks)

(d) A triode with mutual conductance $3mAV^{-1}$ and anode resistance of 10kΩ is connected to a load resistance of 20kΩ, Calculate the amplitude of output signal, if the input signal is 25mV. (04marks)

(e) (i) Sketch the output characteristics of a transistor. (02marks)

(ii) Identify on the sketch in (e)(i), the region over which the transistor can be used as amplifier. (01).

25. (a) (i) Describe with the aid of a well labelled diagram, the structure and mode of operation of a C.R.O (06marks)

(ii) State the advantages of C.R.O over a moving coil voltmeter. (02marks)

(b) In the determination of the electron charge by Millikan's method, a potential difference of 1.5kV is applied between horizontal metal plates, 12mm apart. With the field switched off, a drop of oil of mass $1{,}0\text{x } 10^{-14}$ kg is observes to fall with constant velocity, $4 \text{ x } 10^{-4}ms^{-1}$ between two metal plates. When a potential difference of 1.5kV is applied across the plates, the drop rises with constant velocity of $8.0 \text{ x } 10^{-5}ms^{-1}$.
How many electron charges are there on the drop? (Assume air resistance is proportional to the velocity of the drop and neglect air buoyancy.

(c) Explain why;
(i) the apparatus in Millikan's experiment is surrounded with a constant temperature enclosure, (03marks)
(ii) Low vapor-pressure oil is used. (02marks)

(d) In Millikan's experiment, the radius, r, of the drop is calculated from $r = \sqrt{\frac{9\eta v}{2\rho g}}$

where η is the viscosity of air and ρ is the density of oil. Identify the symbol v and describe briefly how it is measured. (02mark)

26. (a) (i) Explain how X-rays are produced in an X-ray tube (04 marks)
(ii) Explain the emission of X-ray characteristic spectra. (03 marks)
(iii) Derive the Bragg X-ray diffraction equation (04marks)
(iv) Under what conditions does X-ray diffraction occurs? (02marks)

(b) With the aid of a labelled diagram, describe how a Bainbridge mass spectrometer is used to measure specific charge. (07marks)

27. (a) What is meant by unified atomic mass unit? (01mark)
(b) (i) Distinguish between nuclear fusion and nuclear fission (02marks)
(ii) State the conditions necessary for each of the nuclear reaction in (b) (i) to occur.

(02marks)

(c) (i) With the aid of a labelled diagram, describe the operation of an ionization chamber.

(06marks)

(ii) Sketch the curve of ionization current against applied p.d and explain its main features. (04marks)

(d) A typical nuclear reaction is given by:

$$23592U + 10n \rightarrow 4295Mo + 13957La + 210n + -01e$$

Calculate the total energy released by 1g of uranium. (05marks)

Mass of ${}^{1}{}_{0}n = 1.009$u

$_{-}{}^{0}{}_{1}e = 0.00055$u

${}_{42}{}^{95}Mo = 94.906$u

${}^{139}{}_{57}La = 138.906$u

${}^{235}{}_{92}U = 235.044$u

1u $= 1.66\ x\ 10^{-27}kg$

28. (a) (i) With the aid of a labelled diagram, describe what is observed when a high tension voltage is applied across a gas tube in which pressure is gradually reduced to vary low value. (05marks)

(ii) Give two applications of discharge tubes. (01mark)

(b) Describe Thomson's experiment to determine the specific charge of an electron. (06marks)

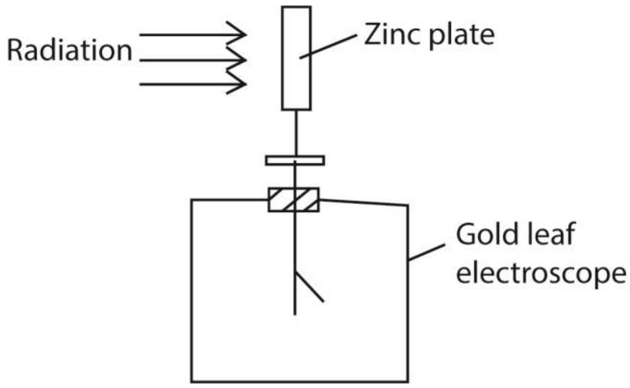
(c) In a Millikan's experiment, a charged oil drop of radius 9.2 x 10^{-7}m and density 800kgm-3 is held stationary in an electric field of intensity 4.0 x 10^{4}Vm^{-1}.

(i) How many electron charges are on the drop? (04marks)

(ii) Find the electric field intensity that can be applied vertically to move the drop with velocity 0.005ms-1 upwards.
[Density of air = 1.29kgm^{-3}, coefficient of viscosity of air = 1.8 x 10^{-5}Nsm^{-1}]

29. (a) Explain what is meant by photoelectric effect. (02marks)

(b)



Ultraviolet and infrared radiations are directed in turns on to a zinc plate which is attached to a gold leaf electroscope as shown in the figure above

Explain that happens when

(i) Ultraviolet radiation falls on the zinc plate (02marks)

(ii) Infrared falls on the zinc plate. (01mark)

(iii) The intensity of each radiation is increased. (02marks)

(c) An X-ray of wavelength 10^{-10}m is required for the study of its diffraction in a crystal. Find the least accelerating voltage to be applied on an X-ray tube in order to produce these X-rays. (04marks)

(d) Sodium has a work function of 2.0eV and is illuminated by radiation of wavelength 150nm. Calculate the maximum speed of the emitted electrons. (04marks)

(e) With the aid of a well labelled diagram, describe how stopping potential of a metal can be measured. (05marks)

30. (a) (i) What is meant by mass defect? (01marks)

(ii) Sketch a graph showing how binding energy per nucleon varies with mass number and explain its features. (03marks)

(iii) Find the binding energy per nucleon of $^{56}{}_{26}Fe$ given that

Mass of 1 proton = 1.007825u

Mass of 1neutron = 1.008665u

[1u = 931MeV) (03marks)

(b) With the aid of a diagram, explain how an ionization chamber works (06marks)

(c) (i) Show that an alpha particle collides head on with an atom of atomic number, Z, the closest distance of approach to the nucleus X_0 is given by

$$X_0 = \frac{ze^2}{\pi\varepsilon_0 mv^2}$$

Where **e** is electronic charge , ε_0 is permittivity of fee space **m** is mass of alpha particle **v** is initial speed of alpha particle (04marks)

(ii) In a head on collision between an alpha particle and a gold nucleus, the minimum distance of approach is 5 x 10-14m. Calculate the energy of alpha particle (in MeV) [atomic number of gold= 79]

31. (a) State four differences between cathode rays and positive rays (02marks)

(b) An electron having energy of 4.5 x 10^3eV moves at right angles to a uniform magnetic field of flux density 1.5 x 10^{-3}T. Find the

(i) Radius of the path followed by the electron. (04marks)

(ii) Period of the motion. (03marks)

(c) (i) Define the term Avogadro constant and Faraday constant (02marks)

(ii) Use the Avogadro constant and Faraday constants to calculate the charge on anion of monatomic element. (03marks)

(d) Explain the meaning of the following terms as applied to a Geiger-Muller tube.

(i) threshold potential difference (02marks)

(ii) Dead time (02marks)

(iii) A quenching agent (02marks)

32. (a) State the laws of photoelectric effect (04marks)

(b) Describe an experiment to determine the stopping potential of a metal surface. (05 marks)

(c) A 100mW beam of light of wavelength 4.0 x 10^{-7}m falls on caesium surface of a photocell.

(i) How many photons strike the caesium surface per second? (03marks)

(ii) If 65% of the photons emit photoelectrons, find the resulting photocurrent. (03marks)

(iii) Calculate the kinetic energy of each photon if the work function of caesium is 2.20eV. (03marks)

(d) Distinguish between continuous and line spectra in an X-ray tube. (02marks)

33. (a) (i) Explain the observation made in the Rutherford α-particle scattering experiment. (06marks)

(b) Distinguish between excitation and ionization energies of an atom. (02marks)
(c) Draw a labelled diagram showing the main components of an X-ray tube (03marks)

(d) An X-ray tube is operated at 50kV and 20mA. If 1% of the total energy supplied is emitted as X- ray radiation, calculate the

(i) maximum frequency of emitted radiation (03marks)

(ii) Rate at which heat must be removed from the target in order to keep it at a steady temperature. (03marks)

(e) A beam of X-ray of wavelength 0.2nm is incident on a crystal at glancing angle 300. If the interplanar separation is 0.20nm, find the order of diffraction. (02marks)

34. (a) What is meant by a line spectrum? (02marks)

(b) Explain how line spectrum accounts for existence of discrete energy levels in an atom. (04marks)

(c) The energy levels in mercury atom are -10.4eV, -5.5eV, -3.7eV and -1.6eV.

(i) Find the ionization energy of mercury in joules (02marks)

(ii) What is likely to happen if mercury atom in unexcited state is bombarded with an electron of energy 4.0eV, 6.7eV or 11.0eV? (03marks)

(d) Describe with the aid of a diagram, the action of an X-ray tube. (05marks)

(e) An X-ray tube is operated at 20kVwith electron current 16mA in the tube. Estimate the:

(i) The number of electrons hitting the target per second. (02marks)

(ii) Rate of production of heat, assuming 99.5% of the kinetic energy of electron is converted to heat. (e = 1.6 x 10^{-19}C)

35. (a) (i) Define the term binding energy (01marks)

(ii) Sketch a graph showing the variation of binding energy per nucleon with mass number (02marks)

(iii) Use the sketch graph you have drawn in (a)

(iv) To explain how energy is released during fission and fusion. (03marks)

(b) Explain why a high temperature is required during fusion of nuclides. (01mark)

(c) The isotope $^{238}{}_{92}U$ emits an alpha particle and forms an isotope of thorium (Th), while the isotope$^{235}_{92}U$ when bombarded by a neutron, forms$^{144}_{56}Ba$, $^{90}_{36}Kr$ and neutrons.

(i) Write the nuclear equation for the reaction of $^{238}{}_{92}U$ and $^{235}{}_{92}U$. (02marks)

(ii) How does the reaction of $^{235}{}_{92}U$ differ from that of $^{238}{}_{92}U$ (03marks)

(d) A steel piston ring contains 15g of radioactive iron, $^{54}_{26}Fe$. The activity of $^{54}_{26}Fe$ is 3.7×10^5 disintegration per second. After 100 days of continuous use, the crankcase oil was found to have a total activity of 1.23×10^3 disintegrations per second. Find the:

(i) Half-life of $^{54}_{26}Fe$ (05marks)

(ii) Average mass of iron worn off the ring per day, assuming that all the metal from the ring accumulates in the oil. (03marks)

36. (a) Describe the mechanism of thermionic emission (03marks)

(b) Explain the following terms as applied to a vacuum diode

(i) space charge limitation (03marks)

(ii) Saturation (01 mark)

(iii) Rectification (02marks)

(c) Sketch the current potential difference characteristics of a thermionic diode for two different operating temperatures and explain their main features (05marks)

(d) (i) A triode valve with an anode resistance of $3.0 \times 10^3 \Omega$is used as an amplifier. A sinusoidal alternating signal of amplitude 0.5Vis applied to the grid of the valve. Find the r.m.s value of the output voltage if the amplification factor is 15 and anode load is 50kΩ.

(ii) Draw an equivalent circuit of a triode as a single-stage amplifier. (01marks)

37. (a) Describe briefly the mechanism of thermionic emission (03marks)

(b) (i) Draw a labelled circuit to show a triode being used as a single-stage voltage amplifier. (03maks)

(ii) With the aid of an equivalent circuit of a triode as an amplifier, obtain an expression for voltage gain (04marks)

(iii) A triode with mutual conductance of 3.0×10^{-3} AV^{-1} and anode resistance of 1 x 104Ω, is used as a single-stage amplifier. If the load resistance is $3 \times 10^4 \Omega$, calculate the voltage gain of the amplifier. (05marks)

(c) (i) Describe the structure of a junction transistor. (02marks)

(ii) Sketch and describe the collector-current against collector-emitter voltage characteristic of a junction transistor. (03marks)

38. (a) What are isotopes? (01mark)

(b) With the aid of a diagram, describe the operation of Bainbridge spectrometer in determining the specific charge of ions. (06marks)

(c) Explain the purpose of each of the following in a Geiger-Muller tube

(i) a thin mica window

(ii) Argon gas at low pressure

(iii) Halogen gas mixed with argon gas

(iv) An anode in the form of a wire (04marks)

(d) (i) What is meant by binding energy per nucleon of a nucleus? (01mark)

(ii) Sketch a graph of binding energy per nucleon against mass number for naturally occurring nuclides (01marks)

(iii) State one similarity between nuclear fusion and nuclear fission. (01mark)

(e) (i) At a certain time, an α-particle detector registers a count rate of $32s^{-1}$. Exactly 10days later, the count rate dropped to $8s^{-1}$. Find the decay constant. (04marks)

(ii) State two industrial uses and two health hazards of radioactivity. (04marks)

39. (a) (i) Describe, with aid of a diagram, the production of cathode rays

(ii) State and justify two properties of cathode rays (02marks)y

(b) Explain each of the following terms as applied to photoelectric emission:

(i) stopping potential (01marks)

(ii) threshold frequency (01mark)

(c) Explain X- ray diffraction by crystals and derive Bragg's law (06marks)

(d) The potential difference between the cathode and anode of an X-ray tube is 5.0×10^{-4}V. If only 0.4% of the kinetic energy of the electrons is converted into X-rays and the rest is dissipated as heat in the target at a rate of 600W, find the

(i) current that flows (03marks)

(ii) Speed of the electrons striking the target. (03marks)

40. (a) (i) What is a photon? (01mark)

(ii) Explain, using quantum theory, the experimental observation on the photoelectric effect. (06marks)

(iii) When light of wavelength 150nm falls on a certain metal, electrons of maximum kinetic energy 0.76eV are emitted. Find the threshold frequency for the metal. (04marks)

(b) Explain, using suitable sketch graph, how X-ray spectrum in an X-ray tube are formed. (06marks)

(c) A beam of X-rays of wavelength 8.42×10^{-11}m is incident on a sodium chloride crystal of interplanar separation 2.82×10^{-10}m. Calculate the first order of diffraction angle. (03marks)

41. (a) (i) A beam of electrons, having a common velocity, enters a uniform magnetic field in a direction normal to the field. Describe and explain the subsequent path of the electrons (04marks)

(ii) Explain whether a similar path would be followed if a uniform electric field were substituted for magnetic field (01mark)

(b) Describe an experiment to measure the ratio of the charge to mass of an electron (07marks)

(c) Electrodes are mounted at opposite ends of low pressure discharge tube and a potential difference of 1.20kV applied between them. Assuming the electrons are accelerated from rest, calculate the maximum velocity which they could acquire.
[Specific electron charge =-1.76 x 10^{11} Ckg^{-1}) (02marks)

(d) (i) Give an account of the stages observed when an electric discharge passes through a gas at pressure varying from atmospheric to about 0.01mmHg as air is pumped out when the p.d across the tube is maintained at extra high tension. (05marks)

(ii) State two disadvantages of discharge tubes when used to study cathode rays. (01mark)

42. (a) (i) What is meant by half-life of a radioactive material? (01mark)

(ii) Given the radioactive law, $N_t = N_0 e^{-\lambda t}$, obtain the relationship between λ and half-life $T_{\frac{1}{2}}$ (02marks)

(iii) What are radioisotopes? (01mark)

(iv) The radioisotope ${}_{38}^{90}Sr$ decays by emission of β-particles. The half-life of the radioisotope is 28.8years. Determine the activity of 1g of the isotope (05marks)

(b) (i) With aid of a diagram describe the structure and action of Geiger-Muller tube. (06marks)

(ii) Sketch the current –voltage characteristic of the Geiger- Muller tube and explain its main features. (03marks)

(iii) Identify, giving reasons, the suitable range in (b)

(iv) of operation of the tube (02marks)

43. (a)(i) Draw a labelled diagram of an X-ray tube. (02marks)

(ii) Use the diagram in (a)(i) to describe how X-rays are produced. (03marks)

(iii) State one industrial and one biological use of X-rays. (01marks)

(b)(i) Sketch a graph of intensity versus wavelength of X-rays from an X-ray tube and describe its main features. (04marks)

(ii) Calculate the maximum frequency of X-rays emitted by an X-ray tube operating on voltage of 34.0kV. (03marks)

(c) In the measurement of electron charge by Millikan's apparatus, a potential difference of 1.6kV is applied between two horizontal plates 14mm apart. With the potential difference switched off, an oil drop is observed to fall with constant velocity 4.0 x $10^{-4}ms^{-1}$. When the potential difference is switched on, the drop rises with constant velocity 8.0 x $10^{-5}ms^{-1}$.
If the mass of the oil drop is 1.0 x 10^{-14}kg, find the number of electron charges on the drop.
[assume air resistance is proportional to velocity of the oil drop and neglect the up thrust due to air] (07marks]

44. (a) (i) State the laws of photo-electric emission. (04marks)

(ii) Write down Einstein's equation for photo electric emission. (02marks)

(iii) Ultra –violet light of wavelength 3.3 x 10-8m is incident on a metal. Given the work function of the metal is 3.5eV, calculate the maximum velocity of the liberated electron. (03marks)

(b) Describe, with aid of a diagram, the structure and mode of operation of a cathode ray oscilloscope (C.R.O) (06marks)

A C.R.O has its y-sensitivity set to $10Vm^{-1}$. A sinusoidal input voltage is suitably applied to give a steady trace with time base switched on so that the electron beam takes 0.01s to traverse the screen. If the trace seen has a peak-to-peak height of 4.0cm and contains two complete cycles, find the

(i) r.m.s value of the input voltage. (03marks)

(ii) Frequency of the input signal. (02marks)

45. (a) define binding energy of nuclide (01mark)

(b) (i) Sketch a graph showing how binding energy per nucleon varies with mas number (01mark)

(ii) Describe the main features of the graph in (b)(i). (03marks)

(c) Distinguish between nuclear fission and nuclear fusion and account for the energy released. (03mark)

(d) (i) With the aid of a labelled diagram describe the working of the Geiger-Muller tube. (05marks)

(ii) How would you use a Geiger-Muller tube to determine the half-life of a radioactive sample? (04marks)

(e) A radioactive source produces alpha particles each of energy 60eV. If 20% of the alpha particles enter an ionization chamber a current of 0.2μA flows. Find the activity of the alpha source, if the energy needed to make an ion pair in the chamber is 32MeV. (03marks)

46. (a) (i) Describe with the aid of a labelled diagram the main features of a cathode ray oscilloscope (C.R.O) (08marks)

(ii) State two uses of C.R.O (01mark)

(iii) The gain control of a C.R.O is set on $0.5Vcm^{-1}$ and an alternating voltage produces a vertical trace of 2.0cm long with the time base off. Find the root mean value of the applied voltage. (02marks)

(b) A beam of electrons is accelerated through a potential difference of 2000V and is directed mid-way between two horizontal plates of length 5.0cm and separation of 2.0cm. The potential difference across the plates is 80V.

(i) Calculate the speed of the electron as they enter the region between the plates. (03marks)

(ii) Explain the motion of the electrons between the plates. (02marks)

(iii) Find the speed of electrons as they emerge from the region between the plates. (04marks)

47. (a) Explain the term stopping potential as applied to photo electric effect. (02marks)

(b) Explain how intensity and penetrating power of X-rays from X-ray tube would be affected by changing:

(i) the filament current (02marks)

(ii) the high tension potential difference across the tube (02marks)

(c) When a p.d of 60kV is applied across an X-ray tube, a current of 30mA flows. If 99% of the power supplied is converted into heat at the anode, calculate the rate at which the temperature of the water rises. {Specific heat capacity of water = $4.2 \times 10^3 Jkg^{-1}K^{-1}$] (05marks)

(d) (i) Derive Bragg's law of X-ray diffraction. (05marks)

(ii) Calculate the atomic spacing of sodium chloride if the relative atomic mass of sodium is 23.0 and that of chlorine is 35.5. [Density of sodium chloride = $2.18 \times 10^3 kgm^{-3}$] (04marks)

48. (a) (i) Explain briefly the mechanism of thermionic emission. (02marks)

(ii) Draw a labelled diagram of the circuit used to determine the anode current and anode voltage characteristics of a thermionic diode. (02marks)

(iii) Sketch the characteristic expected in (a) (ii) at constant filament current, and account for its special features. (04marks)

(b) Describe, with the aid of a labelled diagram, the structure and action of a diffraction cloud chamber (06marks)

(c) (i) Define radioactivity and half-life of a radioactive substance (02marks)

(ii) A radioactive isotope of strontium of mass 5.0μg has a half-life of 28years. Find the mass of the isotope left after 14 years. [Assume the decay law $N = N_0e^{-\lambda t}$]

49. (a) (i) State Rutherford's model of the atom. (02marks)

(ii) Explain two main features of Rutherford's model of the atom. (03marks)

(b) (i) Explain how Millikan's experiment for measuring the charge of an electron proves that charge is quantized. (04marks)

(ii) Oil droplets are introduced into the space between two flat horizontal plates, set 5.0mm apart. The plate voltage is then adjusted to exactly 780V so that one of the droplets is held stationary. Then the plate voltage is switched off and the selected droplet is observed to fall a measured distance of 1.5mm in 11.2s. Given the density of oil used is $900 kgm^{-3}$ and the viscosity of air is $1.8 \times 10^{-5} Nsm^{-2}$, calculate the charge on the droplet. (06marks)

(c) A beam of positive ions is accelerated through a potential difference of 1 x 103V into a region of uniform magnetic field of flux density 0.2T. While in magnetic field it moves in a circle of radius 2.3cm. Derive an expression for the charge to mass ration of the ions, and calculate the value. (05marks)

50. (a) (i) What is meant by thermionic emission? (01mark)

(ii) Sketch the current-potential difference characteristics of a thermionic diode for two different operating temperature and explain their main features. (05marks)

(iii) Describe one application of a diode. (02marks)

(b) (i) What features of an x-ray tube make it suitable for continuous production of X-rays. (03marks)

(ii) Sketch a graph of intensity versus frequency of a radiation produced in an X-ray tube and explain its main feature. (05marks)

(iii) A mono chromatic X-ray beam of wavelength 1.0×10^{-10}cm is incident on a set of planes in a crystal of spacing 2.8×10^{-10}m.What is the maximum order possible with these X-rays? (04marks)

51.(a) What is meant by the following terms:

(i) nuclear number (01mark)

(ii) binding energy (01marks)

(b) Calculate the energy released during the decay of ${}^{220}_{86}Rn$ nucleus into ${}^{216}_{84}P_0$ and α-particle

$$\left\{\begin{array}{ll} \text{Mass of } {}^{220}_{86}Rn = & 219.964176\text{u} \\ \text{Mass of } {}^{216}_{84}Po = & 215.955794\text{u} \\ \text{Mass of } {}^{4}_{2}He \ = & 4.001566\text{u} \\ (1\text{u} = 931\text{eV}) & \end{array}\right\}$$

(04marks)

(c) Describe the Bainbridge mass spectrometer and explain how it can be used to distinguish between isotopes (07marks)

(d) (i) Explain how you would use a decay curve for a radioactive material to determine its halflife. (02marks)

(ii) A radioactive source contain 1.0μg of plutonium of mass number 239. If the source emits 2300 α-particles per second, calculate the half-life of plutonium.
[Assume the decay law $N + N_0e^{-\lambda t}$] (05mark)

52.(a) What is meant by

(i) Bohr atom (01mark)

(ii) binding energy of a nucleus (02marks)

(b) The total energy, E, of an electron n an atom may be expressed as

$$E = \frac{-mq^4}{8\varepsilon_0^2 n^2 h^2}$$

(i) Identify the quantities, m, q, n and h in this expression (02marks)

(ii) Explain the physical implication of the fact that E is always negative (02marks)

(iii) Draw an energy level diagram for hydrogen to indicate emission of ultraviolet, visible and infrared spectral lines. (03marks)

(c)(i) Explain briefly the sources and absorption of infrared radiation. (04 marks)

(ii) Describe briefly, the method of detecting infrared radiation (03marks)

(d) The atomic nucleus may be considered to be a sphere of positive charge with a diameter very much less than that of an atom. Discuss the experimental evidence which supports this view. (03marks)

53. (a) (i) What are cathode rays? (01mark)

(ii) An electron gun operating at 3 x 10^3V is used to project electrons into the space between two oppositely charged parallel plates of length 10cm and separation 5cm. Calculate the deflection of the electrons as they emerge from the region between the charged plates when the potential difference is 1 x 10^3V. (03marks)

(b) (i) Describe a simple experiment to demonstrate photoelectric emission. (04marks)

(ii) Explain why the wave theory of light fails to account for the photoelectric effect. (06marks)

(iii) Describe an experiment to verify Einstein's equation for the photoelectric effect and explain how Plank's constant may be obtained from the experiment. (06marks)

54. (a) What is meant by

(i) half-life of radioactive element (01mark)

(ii) nuclear fission (01mark)

(iii) Nuclear fusion

(b) An atom of ^{222}Ra emits an α-particle of energy 5.3eV. Given that the half-life of ^{222}Ra is 3.8days. Use the decay law, $N= N_0e^{-\lambda t}$ to calculate the:

(i) decay constant (03marks)

(ii) amount of energy released by 3.0 x 10^{-9}kg of ^{222}Ra after 3.8days (05marks)

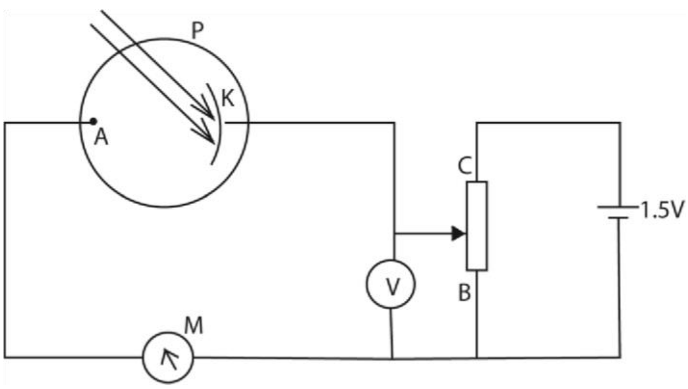
(c) Describe a simple form of a mass spectrometer and explain how it is used to distinguish between isotopes (07marks)

(d) The nucleus of $_{17}^{37}Cl$ emits an α-particle followed by two β-particles. Show that the final nucleus is an isotope of chlorine (02mark)

55. (a) (i) Write down the Einstein photo-electric equation (01mark)

(ii) Explain how the equation in (a)(i) above accounts for the emission of electrons from metal surfaces illuminated by radiation. (04marks)

(b)



P is a vacuum photocell with anode, A, and cathode, K, made from the same metal of work function 2.0eV. The cathode is illuminated by monochromatic light of constant intensity and wavelength 4.4 x 10^{-7}m

(i) Describe and explain how the current shown by the micro ammeter, M will vary as the slider of potential divider is moved from B to C. (03marks)

(ii) What will the reading of the high-resistance voltmeter, V, be when photo-electric emission just ceases? (03marks)

(c) With the slider set mid-way between B and C, describe and explain how the reading of M would change if;

(i) the intensity of the light was increased, (03marks)

(ii) the wavelength of the light was changed to 5.5 x 10^{-7}m

56.(a) What is meant by the following

(i) an alpha particle, (01mark)

(ii) radioactivity (01mark)

(b) Show that when an alpha particle collides head –on with an atom of atomic number Z, the closest distance of approach to the nucleus b_o, is given by

$$b_o = \frac{Ze^2}{\pi\varepsilon_0 mv^2}$$

Where e is the electronic charge, ε0 is the permittivity of free space, m, mass of the alpha particle and v is the initial velocity of the particle. (06marks)

(c) Describe the structure and action of a cloud chamber. (06marks)

(d) State four uses of radioactive isotopes (02marks)

(e) One kilogram of wood from a ship wreck has activity of 1.2 x 10^2 counts per second due to ^{14}C, whereas the same amount of wood had an activity of 2.0 x 10^2counts per second. Find the age of the ship wreck. [Half-life of 14C = 5.7 x 10^3years] (04 marks)

57.(a) What is meant by emission line spectra?

E_∞ ……………………………………………………….	0eV
E_4……………………………………………………….	-0.81eV
E_3……………………………………………………….	-2.77eV
E_2……………………………………………………….	-4.87eV
E_1……………………………………………………….	-27.47eV

(ii) The figure above shows some energy levels of neon. Determine the wavelength of the radiation emitted in an electron transition from E_4 to E_3. In what region of the electromagnetic spectrum does the radiation lie? (04marks)

(b) Outline the principles of generation of continuous line spectra of X-rays in X-ray tube. (05marks)

(c) State Bragg's law of X-ray diffraction. (01mark)

(d) A beam of X-rays of wavelength 1.0 x 10-10m is incident on a set of cubic planes in a sodium chloride crystals. The first order diffraction m is obtained for a grazing angle of 10.2^0. Find;

(i) The spacing between consecutive planes (03marks)

(ii) The density of the sodium chloride (04marks)

58. (a) State the laws of pho electric emission. (04marks)

(b) (i) Describe an experiment Plank's constant. (05marks)

(ii) Violet light wavelength 0.4μm is incident on a metal surface of threshold wavelength 0.65μm. Find the maximum speed of emitted electrons

(iii) Explain why light whose frequency is less than the threshold frequency cannot cause photo emission. (02marks)

(c) (i) What are X-rays? (01marks)

(ii) Explain how the intensity and penetrating power of X-rays produced by an X-ray tune can be varied. (04marks)

59. (a)(i) Define the terms half-life and decay constant as applied to radioactivity. (02marks)

(ii) State relationship between half-life and decay constant. (01mark)

(b) The radioisotope ^{60}Co decays by emission of a β-particle and γ-rays. Its half-life is 5.3years.

(i) find the activity of a source containing 0.10g of ^{60}Co. (04marks)

(ii) In which ways do γ-rays differ from β-particles (03marks)

(c) (i) What is meant by mass defect in nuclear physics? (01mark)

(ii) Calculate the mass defect for ${}_{26}^{59}Fe$, given the following information

Mass of ${}_{26}^{59}Fe$ nucleus = 58.93488u

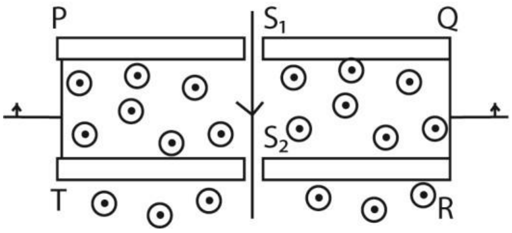
Mass of a proton = 1.00728u

Mass of neutron = 1.00867u (04marks)

(d) Describe the structure and action of ionization chamber. (05marks)

60. (a) What is meant by specific charge of an ion? (01mark)

(b)



Positive ions of the same charge are directed through slit S_1 into a region PQRT as shown in the figure above. There is a uniform electric field of intensity 300NC^{-1} between the plate PT and QR. A uniform magnetic field of flux density 0.6T is directed perpendicularly out of the paper as shown above.

(i) Calculate the velocity of the ions which go through slit S_2. (03marks)

(ii) Describe the motion of ions in the region TR. (3marks)

(c) When fast moving electrons strike a metal target in X-ray tube, two type of X-ray spectra are produced

(i) Draw a sketch graph of intensity against wavelength of the X-rays (02marks)

(ii) Account for the occurrence of the two types of spectra (05marks)

(d) Outline the experimental evidences for the quantum theory of matter. (06marks)

PHYSICS P510/2 REVISION QUESTIONS

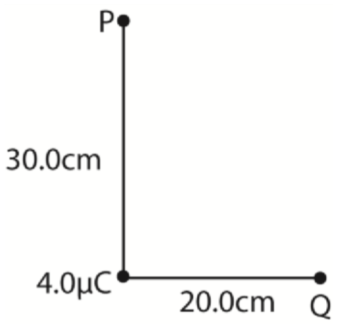
CURRENT ELECTRICITY, ELECTROSTATICS AND CAPACITOR

1. (a) State Coulomb's law of electrostatics (01marks)

(b) (i) Describe how a conductor may be positively charge but remains at zero potential(03marks)

(ii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere.

(c) In the figure below, points P and Q are at a distances 30.0cm and 20.0cm from a point charge of 4.0μC respectively.



Calculate

(i) Electric potential difference between P and Q (05marks)

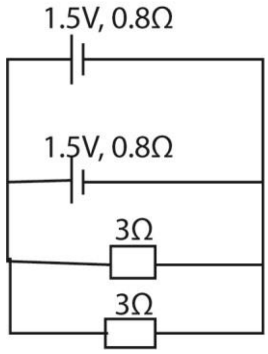
(ii) Energy required to bring a charge of +1.0μC from infinity to Q. (03marks)

(d) Describe with the aid of a diagram an experiment to show that excess charge resides only on outside of hollow conductor.

2. (a)(i) Define e.m.f of a battery. (01marks)

(ii) Explain why e.m.f of a battery left standing in a room for long decreases. (02marks)

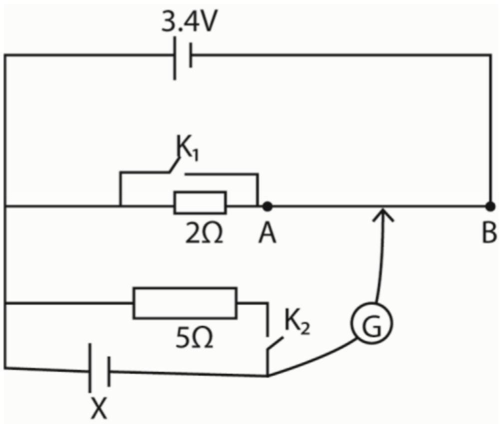
(b) The figure below shows a network resistors connected to show identical cells of e.m.f 1.5V and internal resistance 0.8Ω.



Calculate the current supplied by the cells (04marks)

(c) Describe an experiment which can be carried out to determine the resistance of a wire using a potentiometer. (06marks)

(d) The figure below shows a uniform resistance wire AB, 100cm long and resistance 4.0Ω connected with a 2.0Ω resistor through switch K_2. When K_1 is closes and K_2 open, the balance length is 53cm.



Find the

(i) Balance length when K_1 and K_2 are both open (04marks)

(ii) Internal resistance of cell X if the balance length is 44.1cm when both K_1 and K_2 are closed (01marks)

3. (a)(i) Define farad. (01mark)

(ii) Describe briefly the energy transformations that take place when charging a capacitor using a dry cell. (02marks)

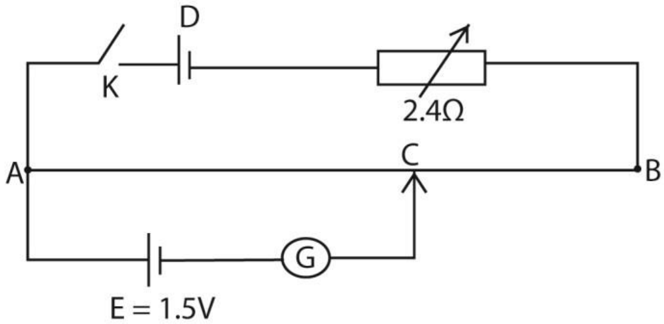
(b)(i) What is meant by dielectric constant? (02marks)

(ii) A parallel plane capacitor is connected to 100V and then isolated. When a sheet of a dielectric is inserted between the plates, the p.d. decreased to 30V. Calculate the dielectric constant of the dielectric. (03marks)

(c) A 60μF is charged from a 120V supply. It is then connected across the terminals of a 20μF capacitor. Calculate the ;

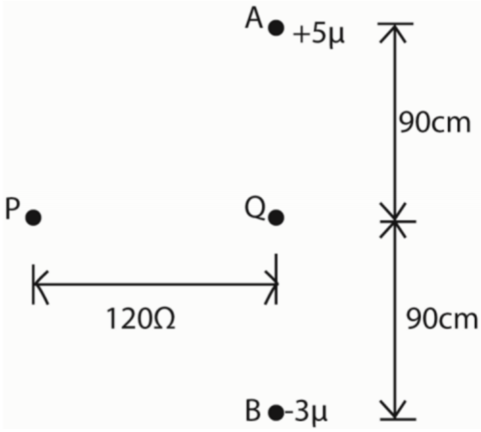
(i) final p.d. across the combination (03marks)
(ii) Difference in the initial and final energies stored in the capacitor and comment on the difference. (05marks)
(d) Explain the principles of operation of a lightning conductor. (05marks)

4. (a) Define the following as applied to a battery:
(i) Electromotive force (ii) Internal resistance
(b) A battery of e.m.f E and internal resistance, r, is connected across a load of resistance, R. Derive an expression for maximum power delivered to the load. (04marks)
(c) Determined how resistance of a resistor may be determined using a slide wire potentiometer (05marks)
(d) Explain why the potentiometer is more suitable for measuring small resistance than Wheatstone bridge (02marks)
(e) In the figure below, AB is a uniform resistance wire of resistance 2.0Ω, and length 100cm, E is a cell of e.m.f 1.5V and D is a driver cell of negligible internal resistance. When switch K is closed the balance length AC is 82.5cm.



(i) Find e.m.f of D (03marks)
(ii) If E and the galvanometer are replaced by a voltmeter of resistance 20.0Ω, find the reading of the voltmeter when contact C is placed at the mid-point of AB and the value of R is 1.0Ω.

5. (a) (i) Define electric field intensity and potential difference. (02marks)
(ii) Derive an expression for electric potential difference between two points a and b in the field of a sing point charge +Q (04marks)
(b) Describe an experiment to show that when two dissimilar dielectrics are rubbed together, they acquire equal but opposite charge.
(c) Two point charges of +5μF and -3μF are placed at points A and B as shown in the figure below.



Calculate the;

(i) Electric potential at P (03marks)

(ii) Work done in moving a charge -3μC from P to Q. (04marks)

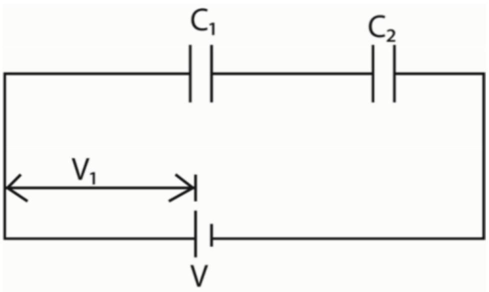
(d) State any two characteristics of an equipotential (02marks)

6. (a) Define the following

(i) Capacitance (01mark)

(ii) Relative permittivity (01mark)

(b) Two capacitors of capacitances C_1 and C_2 are connected in series with a battery of e.m.f V as shown below.

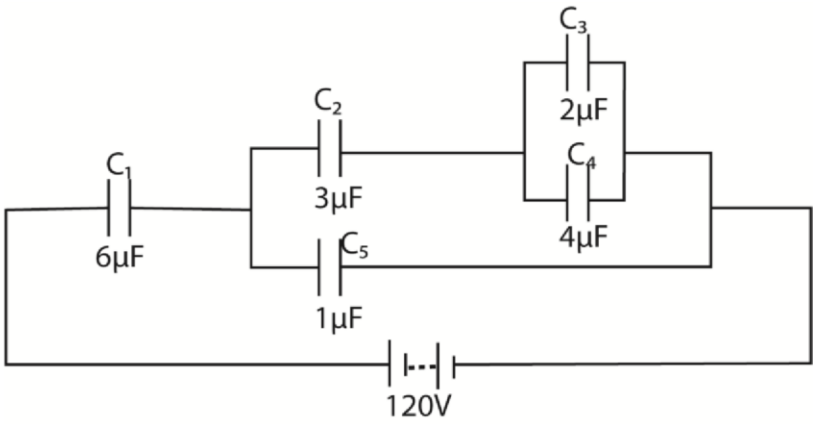


If the p.d across the capacitor of capacitance C_1 is V_1 show that

$$\frac{1}{V_1} = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)\frac{C_1}{V}$$

(c) Describe an experiment to determine the capacitance of a capacitor using a vibrating reed circuit.

(d) A battery of e.m.f120V is connected to a network of capacitors as shown in the figure below



Calculate the

(i) Charge on C_1 (04marks)

(ii) Energy stored in C_5 (03marks)

(e) Describe how the effect of a dielectric medium on the capacitance of a capacitor may be determined. (03marks)

7. (a)(i) State the law of conservation of current at a junction in an electric circuit. (01marks)

(ii) Explain why current from a battery is greater when bulbs are connected in parallel than when they are in series across a battery. (03marks)

(b) A conductor of length L and cross sectional area A has n free electrons per unit volume. The average drift velocity of the electrons is v and each electron carries charge e.

Derive an expression for the current which flows (03marks)

(c) A battery with an e.m.f of 12V and internal resistance 2Ω is connected to a wire of resistance 10Ω.

(i) Calculate the p.d across the wire. (02marks)

(ii) What is the p.d across the wire become if a 15Ω resistor is connected parallel to it? (03marks)

(d)(i) Define electrical resistivity and state its units (02marks)

(ii) Describe an experiment to determine the resistivity of the material of a wire using an ammeter, meter rule and voltmeter.

8. (a) (i) Define temperature coefficient of resistance and state its units. (02marks)

(ii)Explain why temperature coefficient of resistance is positive for metals. (03marks)

(b) (i) Derive the conditions for balance of Meter Bridge. (05marks)

(ii) Explain why the meter bridge is unsuitable for comparison of low resistances. (02marks)

(c) A standard resistor is connected across the right hand gap of a meter bridge and a coil X across the left hand gap of meter bridge. When the coil is heated to a temperature of 400C, the balance length is 525mm from left-hand end of the bridge.

When the temperature of X is raised to 100^0C, the balance point is 546mm from the left end.

(i) Calculate the temperature coefficient of resistance of the coil X (06marks)

(ii) Why are standard resistors made of alloys such as constantan and magnesium? (02marks)

9. (a) Derive an expression for energy stored in a capacitor of capacitance, C, charged to voltage, V. (04marks)

(b) A parallel plate capacitor with plate area of $2 \times 10^{-2} m^2$ and plate separation of $5.0 \times 10^{-3} m$ is connected to a 500V supply.

(i) Calculate the energy stored in the capacitor (04marks)

(ii) If the space between the plates is completely filled with oil and the total charge in the capacitor becomes $4.42 \times 10^{-8} C$. Find the dielectric constant of the oil (03marks)

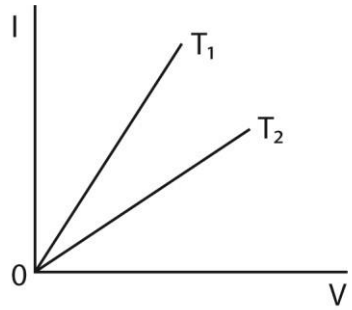
(c) Explain how a lightning conductor may protect a building from damage by lightning. (05marks)

(d) Describe an experiment to show that charge on a hollow conductor resides on the outer surface. (04marks)

10.(a)(i) Define electrical resistivity. (01mark)

(ii) Explain how length and temperature of a conductor affect its resistance. (04marks)

(iii) The figure below shows a circuit-voltage graphs for a metallic wire at two different temperatures T_1 and T_2.

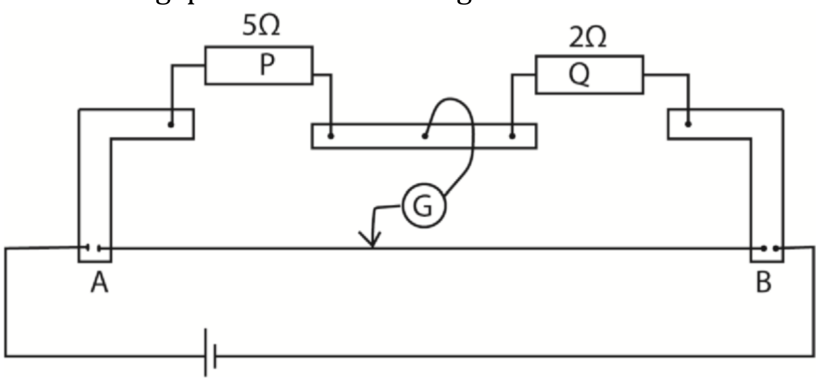


State which of the two temperatures is greater and explain your answer (03marks)

(b) (i) Derive the balance condition when using a meter bridge to measure resistance. (03marks)

(ii) State **two** precautions taken to achieve an accurate measurement. (02marks)

(c) The figure below shows two resistors P and Q of resistance 5Ω and 2Ω respectively connected in the two gaps of the meter bridge.



A resistor X of cross-sectional area 1mm^2 is connected across P so that the balance point is 66.7cm from A. if the resistivity of wire X is 1.0 x $10^{-5}\Omega$m and the resistance wire AB of the meter bridge is 100cm long, calculate the length of X. (04marks)

(d) Explain how electrons attain a steady drift velocity when current flows through a conductor. (02marks).

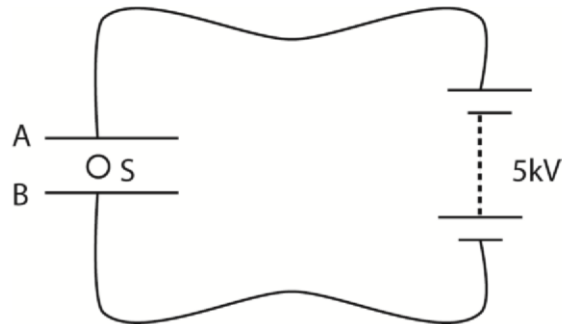
11.(a) (i) Explain equipotential surface. (04marks)

(ii) Give an example of an equipotential surface (01mark)

(b) (i) State coulomb's law. (01 marks)

(ii) with the aid of a diagram, explain the variation of electric potential with distance from the center of charged metal sphere (03marks)

(iii) Two metal plates A and B, 30cm apart are connected to a 5kVd.c supply as shown in the figure below.



When a small charged sphere, s, of mass 9.0 x 10^{-3}kg is placed the plates, it remains stationary. Indicate the forces acting on the sphere and determine the magnitude of the charge on the sphere. (04marks)

(c) (i) Define electric field intensity. (01marks)

(ii) With the aid of a diagram, explain electrostatic shielding. (04marks)

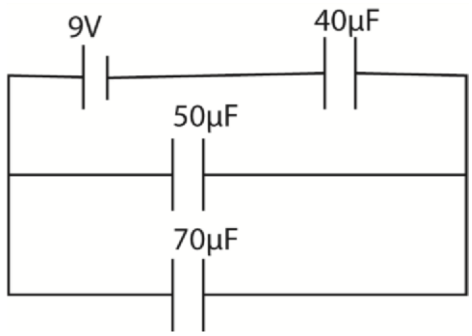
(d) Explain briefly why a neutral metal body is attracted to a charged body when brought near it. (02marks)

12.(a) (i) What is meant by capacitance of a capacitor? (01mark)

(ii) A parallel plate capacitor is connected across a battery and charged fully. When a dielectric material is now inserted between its plates, the amount of charge stored in the capacitor changes. Explain the change. (04marks)

(iii) Describe an experiment to determine the relative permittivity of a dielectric. (04marks)

(b) A network of capacitors of capacitances 40μF, 50μF and 70μF is connected to a battery of 9V as shown in the figure below



Calculate;

(i) Charge stored in the 50μF capacitor. (05marks)

(ii) Energy stored in the 40μF (03marks)

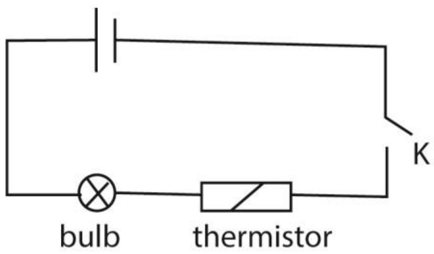
(c) Explain corona discharge

13. (a)(i) Define temperature coefficient of resistance (01mark)

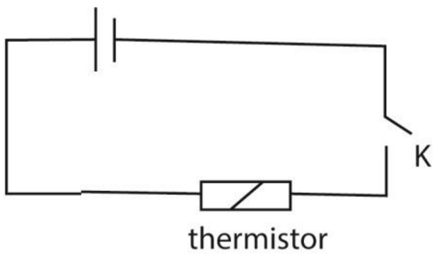
(ii) Explain the origin of the heating effect of electric current in metal conductor. (03marks)

(iii) Describe with the aid of an I-V sketch the variation of current with p.d across a semiconductor diode. (02marks)

(b) A cell, a bulb, a switch and a thermistor with negative temperature coefficient of resistance are connected as shown in the figures (i) and (ii) below



(i)



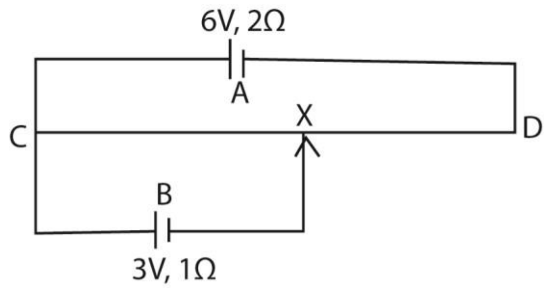
(ii)

(i) Explain what would happen when in figure (i) switch K is closed (04marks)

(ii) If the bulb in figure (i) is removed and the circuit connected as shown in figure (ii), explain what would happen when switch K is closed (03marks)

(c) State the law of conservation of current at the junction (01mark)

(d) Two cells A of e.m.f6V and internal resistance 2Ω and B of e.m.f3V and internal resistance 1Ω respectively are connected across a uniform resistance wire Cd of resistance 8Ω as shown in the figure below



If X is exactly in the middle of the wire CD, Calculate the

(i) Power dissipated in C_X.(04marks)

(ii) P.d across the terminals of cell A.(02marks)

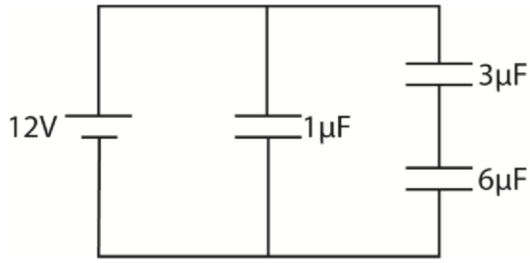
14.(a)(i) Define capacitance of a capacitor (01mark)

(ii) Describe briefly an experiment to show the effect of placing a sheet of glass or mica between the plates of a capacitor on capacitance. (05marks)

(b) Describe how the unknown capacitance of a capacitor can be determined using a ballistic galvanometer. (04marks)

(c) Explain briefly how a charged capacitor can be fully discharged. (02marks)

(d) A 3μF capacitor is connected in series with a 6μF capacitor. The combination is then connected in parallel with 1μF capacitor to 12V battery as shown in the figure below



Calculate;

(i) Charge stored on each capacitor (05marks)

(ii) Energy stored in the 6μF capacitor when fully charged (03marks)

15.(a) (i) Define the following; electric field intensity and electric potential at a point (02marks)

(ii) Show that the electric field intensity at a point is equal to the negative potential gradient at that point. (04marks)

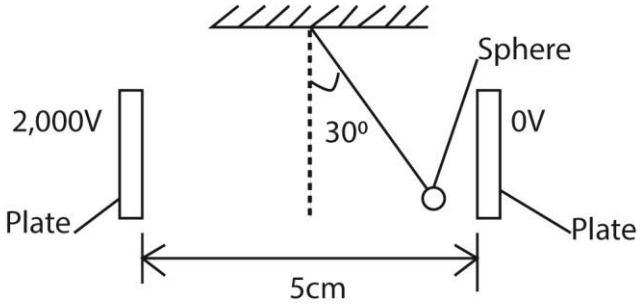
(b) (i) Explain with the aid of a diagram, how an insulated metal sphere can be charged by induction using a negatively charged rod. (03marks)

(ii) Describe how a gold leaf electroscope can be used to detect the presence of a charge on the body

(c) (i) Write down the equation for the electrostatic force between two isolated point charges in a vacuum. (01mark)

(ii) Sketch the electric field lines between two negatively charged spheres carrying unequal charges and use the sketches to explain a neutral point. (02marks)

(d) A charged polystyrene sphere of mass 2g is suspended by affine nylon thread between two plates 5cm apart as shown in the figure below



When a p.d of 2000V is supplied across the plates, the thread attached to a sphere deflects through an angle of 30^0. Calculate the charge on the sphere.

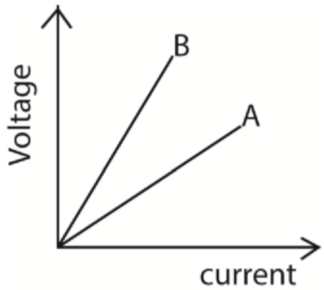
16.(a) Describe an experiment to verify Ohm's law, (04marks)
(b) Derive an expression for combined resistance of three resistors in parallel. (04marks)
(c)(i) Explain the principle of operation of a slide wire potentiometer. (04marks)
(ii) Two cells A and B connected in series give a balance length of 80.0cm along a potentiometer wire. When Cell B is reversed, the balance length falls to 15.0cm. If the e.m.f of cell A is 1.5V, calculate the e.m.f of cell B. (04marks)
(d) A battery of e.m.f 20.0V and internal resistance 4.0Ω is connected to a resistor of resistance 10.0Ω. Calculate;
(i) power generated (02marks)
(ii) efficiency of the circuit (02marks)

17.(a)(i) Define capacitance and dielectric constant. (02marks)
(ii) State the factors which affect the capacitance of a capacitor. (02marks)
(b) A capacitor of capacitance C_1 is charged by a battery of e.m.f, V_0. The charging battery is then removed and the capacitor is connected to uncharged capacitor of capacitance, C_2. Show that the loss of energy after connection is given by

$$E = \frac{1}{2}\left[\frac{C_1 C_2}{C_1 + C_2}\right] V_0^2 \qquad \text{(05marks)}$$

(c) Describe an experiment to measure the capacitance of a capacitor using a ballistic galvanometer. (05marks)
(d) A capacitor, X of 5.0μF and another, Y of 8.0μF are connected in series with a 20V supply. Calculate the;
(i) Charge on X (04marks)
(ii) Potential drop across X (02marks)

18.(a)The voltage versus current graphs for two wires A and B of the same material, same radii and at the same temperature are shown in the figure below



Account for the difference between the graphs

(b) Three identical cells are connected in series with resistors of 3Ω and 5Ω. A current of 1.2A flows in the circuit. When the two resistors are connected in parallel across the three cells in series, the current in the circuit is 2.2A. Calculate the;

(i) internal resistance of each cell(03marks)

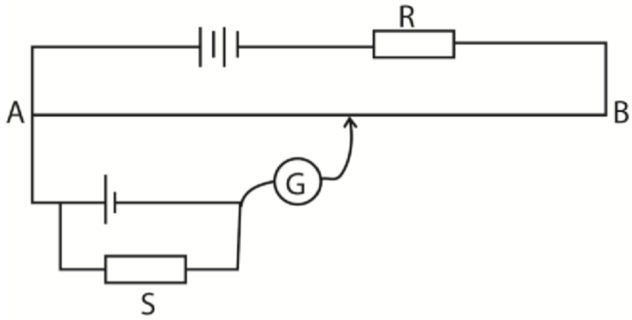
(ii) e.m.f of each cell (1mark)

(iii) power dissipated in the 3Ω resistor for parallel connection (04marks)

(c) Two students X and Y performed separate experiments using a potentiometer arranged as shown below and both obtained a balance point.

X increased the value of R

Y decreased the value of S



Explain what happened to the position of balance point when

(i) X increases the value of R (02marks)

(ii) Y decreases slightly the value of S from an initially large value (02marks)

(d) Describe an experiment to determine the e.m.f of a thermocouple (06marks)

19.(a) Define the following

(i) Capacitance (01mark)

(ii) Dielectric (01mark)

(b) Describe an experiment that can be used to show how capacitance of a capacitor depends on permittivity of dielectric. (04marks)

(c) A capacitor of capacitance C, is fully charged from a 200V battery. It is then discharged through a small coil of wire embedded in thermally insulated block of heat capacity $250KJ^{-1}$.

If the temperature rose by 0.4K, Calculate C. (04marks)

(d)(i) State three properties of an equipotential surface. (03marks)

(ii) What is meant by charge quantization? (0marks)

(e) With the aid of a labelled diagram, describe the structure and action of a Van de Graff generator. (06marks)

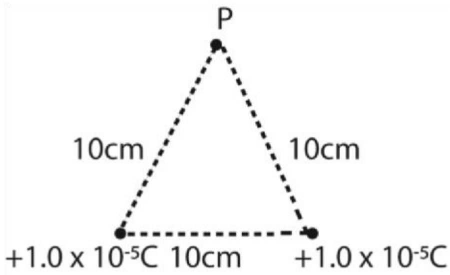
20.(a) (i) State Coulomb's law of electrostatics (01marks)

(ii) Sketch the electric field pattern for positively charged metallic sphere and for negative point charge. (02marks)

(b) (i) Define electric field intensity and electric potential at a point. (02marks)

(ii) What is the relationship between them? (01mark)

(c) Two charges of 1.0 x 10-5C are placed 10cm apart as shown in the figure below



Calculate the

(i) Electric field intensity at P (06marks) (ii) Electric potential at P (03marks)

(d) Two conducting spheres A and B supported on insulating stand are placed in contact. A negatively charged rod is then held near sphere A. the spheres are then separated after which the rod is removed. With the aid of suitable diagrams, explain the processes which occur. (05marks)

21.(a) What is meant by electromotive force of a cell? (01mark)

(b) Describe an experiment to determine e.m.f and internal resistance of a cell using ammeter, a resistance box and voltmeter. (05marks)

(c) (i) Define temperature coefficient of resistance (01mark)

(ii) Explain why the resistance of a thermistor reduces when current is passed through it. (02marks)

(d) (i) Derive the balance conditions for Wheatstone bridge. (04marks)

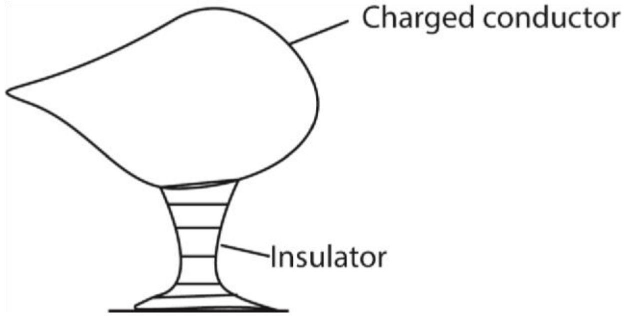
(ii) Explain one reason other than faulty apparatus and poor electrical contact, why it may not be possible to obtain balance in a Wheatstone bridge in an experiment to compare two resistances. (02marks)

(e) In an experiment to investigate the variation of resistance with temperature, a nickel wire and a 10Ω standard resistor were connected in the left-hand gap and right-hand gap respectively of Meter Bridge. When the nickel wire was at 0^0C, a balance point is 40cm from the end of the bridge adjacent to the nickel wire. When the nickel wire is at 100^0C, the balance point is 50cm from the same end of the bridge.

Calculate the temperature of the nickel wire if the balance length is 42cm. (05marks)

22.(a) (i) What is meant by electric field intensity at a point? (01mark)

(ii) Describe how distribution of charge on a charged conductor of the shape shown below can be investigated.

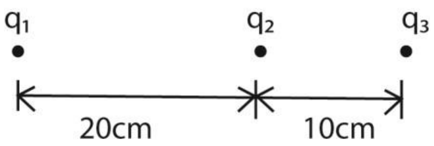


(iii) Explain how a lightning conductor protects a house from lightening. (04marks)

(b) (i) What is electric field line?

(ii) Derive an expression for electric potential at a point a distance a from isolated charge of magnitude Q in air.

(c) The figure below shows charges q_1, q_2 and q_3 of +46.3μF, -34.7μF and +23.4μF respectively, placed in straight line in air.



Find the force on q_3.

23.(a) Define the following terms

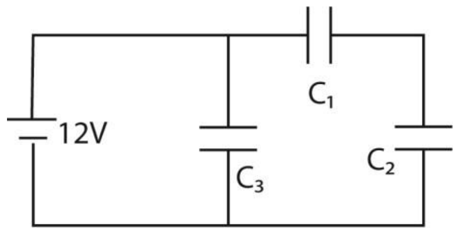
(i) The farad (01mark)

(ii) Relative permittivity (01mark)

(b) You are provided with the following apparatus, a battery, two switches, a capacitor of known capacitance, a ballistic galvanometer and connecting wires.

Describe an experiment that can be carried out using the above apparatus to determine the unknown capacitance of a capacitor (05marks)

(c) The diagram below shows arrangement of three capacitors C_1, C_2, and C_3 of capacitance 8μF, 2μF and 6μF respectively.



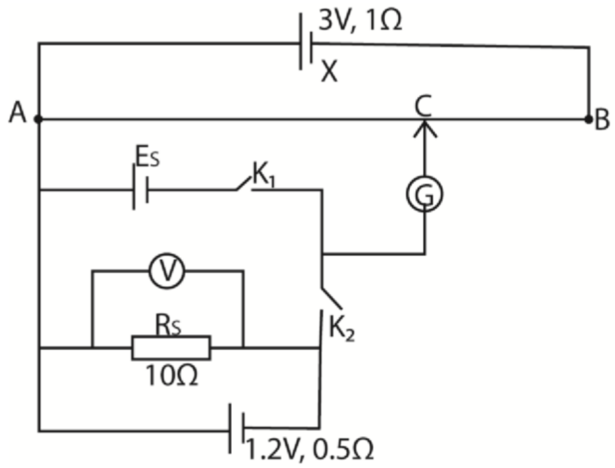
Calculate the total energy stored;

(i) In all capacitors when fully charged. (04marks)

(ii) When the space between the plates of C_2 is filled with a dielectric of constant 1.25. (04marks)

(d) A capacitor of capacitance, C, is charged by a battery and then later isolated. When the plates of the capacitor are taken apart, deduce what happens to the potential difference between the plates. (03marks)
(e) Explain what happens if a conductor instead of dielectric is placed between the plates of charged capacitor. (02marks)

24.(a)(i) Define electromotive force of a battery. (01mark)
(ii) A cell of e.m.f, E and internal resistance r, drives current through a resistor of resistance, R connected in series with it. Derive an expression for efficiency of the circuit. (04marks)
(b) Describe with the aid of a diagram how you would standardize a slide wire potentiometer. (03marks)
(c) In the figure below, AB is a uniform resistance wire of length 1m and resistance 4Ω. X is a driver cell of e.m.f 3V and internal resistance 1Ω and E_S is a standard cell, R_S is a standard resistor of resistance 10Ω which is connected in series with cell Y of e.m.f 1.22 V and internal resistance 0.5Ω



With switch K_1 closed and K_2 open, the balance length, AC is 60cm while the voltmeter reading is 1.14V.with K_1 open and K_2 closed, the balance length is 80cm. Calculate the
(i) E.m.f E_S, of standard cell. (03marks)
(ii) Percentage error in the voltmeter reading (03marks)
(d) Describe with the aid of a circuit diagram how you would measure the temperature coefficient of resistance of a material in form of a wire. (06marks)

25.(a) State coulomb's law of electrostatics. (01marks)
(b) Derive the relation between electric field intensity, E, and electric potential, V, due to a charge at a point. (04marks)
(c) Two pith ball P and Q each of mass 0.1gare separately suspended from the same point by threads 30cm long. When the balls are given equal charges, they repel each other and come to rest 18cm apart. Calculate the magnitude of charge on each ball. (06marks)
(d) Describe how you would investigate the distribution of charge on pear shaped conductor. (04marks)
(e) Explain how a charged body attracts uncharged conductor. (03marks)

(f) Describe how an electroscope can be used to distinguish a conductor from an insulator. (01mark)

26.(a) Define dielectric strength. (01mark)

(b) (i)Explain briefly how a capacitor in which the potential difference, V_0 across the plates, can be fully discharged. (02marks)

(ii) Sketch a graph showing a variation of potential difference with time for the process in (b)(i) above

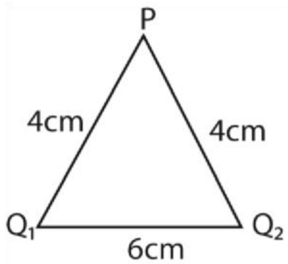
(c) (i) Two capacitors of capacitance C_1 and C_2 are connected in series. Show that the effective capacitance, C, is given by

$$C = \frac{C_1 C_2}{C_1 + C_2}$$

(ii) A 10.0μF capacitor charged to 200V is connected across uncharged 50μF capacitor. Calculate the total energy stored in both capacitors before and after connection (04marks)

(iii) Account for the difference in the energies calculated in (c)(ii) above. (01mark)

(d) In the figure below, Q_1 and Q_2 are point charges of magnitude +5.0μCand -5.0μC respectively



Calculate the;

(i) Electric field intensity at P

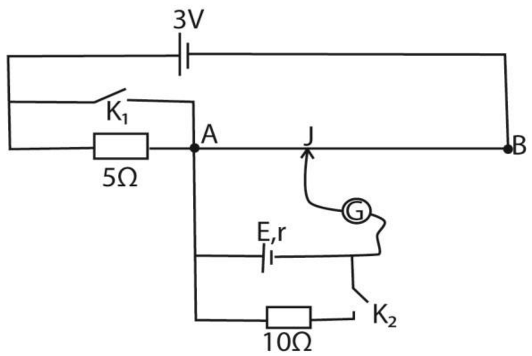
(ii) Potential energy of appoint charge Q_3 of 0.8μF placed at P

27.(a) (i) Define electrical resistivity and state its units (02marks)

(ii) What is meant by e.m.f and internal resistance of a battery (02marks)

(b)Explain why resistance of a metal increases when temperature of the metal is increased. (02marks)

(c) Describe with the aid of labelled diagram, how a slide wire potentiometer may be used to determine the e.m.f of a battery. (06marks) (d)



The circuit in the figure above shows a uniform slide wire AB of length 100cm and resistance 10Ω. The wire is connected in series with a resistor of resistance 5Ω across 3.0V battery of negligible internal resistance. A cell of resistance, E and internal resistance, r, is connected as shown. With switches K_1 and K_2 open, the galvanometer, G shows no deflection when AJ is 75.0cm. With K_1 and K_2 closed, the galvanometer shows no deflection when AJ is 65.0cm. Find the;

(i) Value of e.m.f, E.

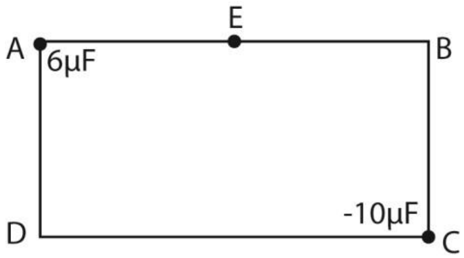
(ii) Internal resistance, r

(iii) Balance length when K_1 is closed, and K_2 is open

28.(a) (i) Define electric potential (01mark)

(ii) Derive an expression for electric potential at a point which is a distance, r, from a point charge Q (04marks)

(b) Two charges of magnitude 6μF and -10μF are placed at the corners of a rectangle ABCD as shown in the figure below



AB = 6cm and BC = 4cm. Point E is the mid-point of AB. Find the work done in taking a point charge of 1.6×10^{-10}C from D to E. (05marks)

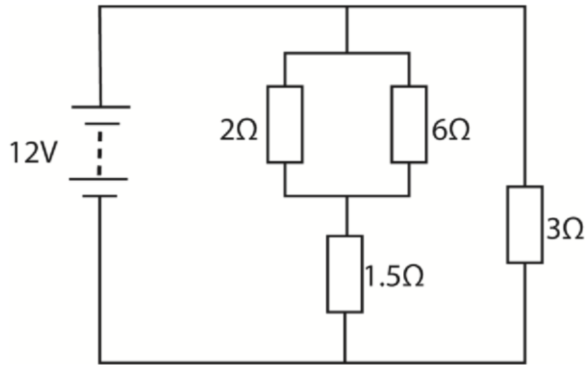
(c) A negatively charged ebonite rod is brought up to an uncharged pith ball suspended by a silk thread. The pith-ball first moves to the rod, touches it and then moves away. Explain these observations (04marks)

29.(a) (i) State Ohm's law. (01mark)

(ii) Give two examples of non-Ohmic conductors and sketch their current-voltage characteristic. (03marks)

(b) (i) Derive an expression for electrical energy dissipated in a resistor of resistance, R ohms carrying current I ampere for t seconds. (03marks)

(ii) A network of resistors of 2Ω, 6Ω, 1.5Ω and 3Ω are connected to a 12V d.c. supply of negligible internal resistance as shown below



Calculate the power dissipated in the 6Ω resistor. (04marks)

(c) (i) Define temperature coefficient of resistance (01mark)

(ii) Explain why semiconductors have negative temperature coefficient of resistance. (02marks)

(d) An electric heater consists of 5.0m of nichrome wire of diameter 0.58mm. When connected to a 240V supply, the heater dissipated 2.5kW and the temperature of the heater is found to be 1020^0C. if the resistivity of nichrome at 10^0C is $10.2x\ 10^{-7}\Omega$m, calculate;

(i) The resistance of nichrome at 10^0C (03marks)

(ii) The mean temperature coefficient of resistance of nichrome between 10^0C and 100^0C. (03marks)

30.(a) Define electric potential difference (01mark)

(b) Explain briefly what happens to the potential energy as two point charges of the same sign are brought closer. (02marks)

(c) Three point charges of +5μC, -3μC and +2μC are placed respectively at three corners of a square of side 6.3cm in a vacuum.

(i) Sketch the electric field lines due to the charges. (02marks)

(ii) Calculate the electric filed potential at the fourth corner of the square (04marks) (iii) Find the electric potential energy, if a charge of -4μC is placed at the fourth corner. (02marks)

(d) Describe, with the aid of a diagram, how a high voltage can be generated using a Van de Graaff generator. (06marks)

(e) Explain how two insulating bodies rubbed together acquire charge.

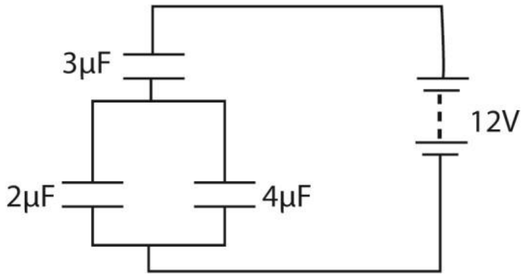
31.(a) (i) Define capacitance of a capacitor. (01mark)

(ii) Drive an expression for energy stored in a capacitor of capacitance C charged to a p.d, V. (04marks)

(b)(i) Explain the effect of placing an insulator between the plates of a charged capacitor. (05marks)

(ii) State two physical properties desirable in a material to be used as a dielectric in a capacitor. (02marks)

(c)



A battery of e.m.f12V is connected across a system of capacitors as shown in the figure above . Find the

(i) Charge on the 3μF capacitor (03marks)

(ii) Energy stored in the 4μFcapacitor (03marks)

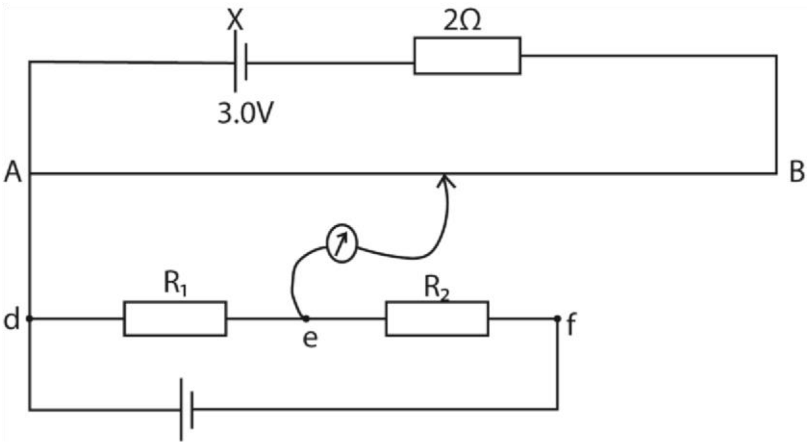
(d) Describe a simple experiment to show that capacitance of a capacitor increases with surface area of the plates. (02marks)

32.(a) (i) Derive the formula for combined resistance of three resistors in series. (04marks)

(ii) Explain why a metal wire becomes hot when an electric current flows through it. (04marks)

(iii) What advantage does the potentiometer have over Wheatstone bridge when used to compare two low resistances? (02marks)

(b)



In the figure above, AB is a slide wire of length 1.0m and resistance 10Ω. X is a driver cell of e.m.f 3.0V and negligible internal resistance. When the center –zero galvanometer is connected in turns to points e and f, the balance lengths obtained are 45.0cm and 80.0cm respectively. Calculate the;

(i) The current flowing through R_1. (04marks)

(ii) Resistances of R_1 and R_2. (02marks)

(c) Describe with aid of a diagram, how a calibrated slide wire potentiometer may be used to measure thermoelectric e.m.fs. (04marks)

33.(a) Explain why a redistribution of charge occurs on uncharged metal rod when a positively charged metal sphere is brought near one end (03marks)

(b) Sketch a graph showing the variation of potential

(i) Relative to the earth along the axis of metal rod in (a) from the center of the charged sphere to the furthest end of the rod. (02marks)

(ii) Along the axis of the rod in (a) from the center of the sphere if the rod is earthed. (02marks)

(c) Explain why the electric field intensity close to the surface of a charged conductor is always at right angles to the surface of the conductor. (03marks)

(d) Describe with the aid of a diagram the mode of operation of Van de Graff generator. (006marks)

(e) A proton is fired from infinity with a speed of 3.7 x 10^6ms^{-1} towards a stationary charge of +50e. Calculate the speed of the proton at a point 10^{12}m from stationary charge. (Assume mass of proton = 1.6 x 10^{-27}kg) (04marks)

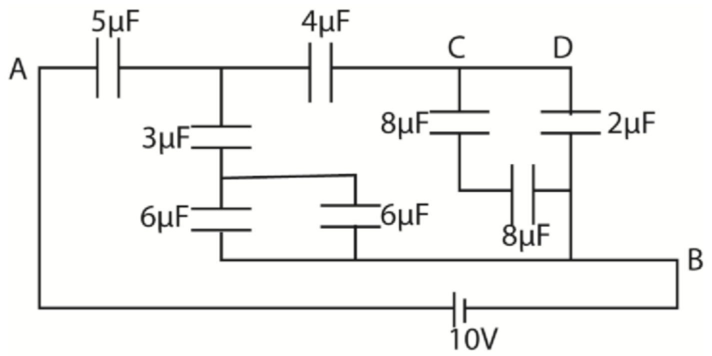
34.(a)(i) What is meant by a dielectric material? (01marks)

(ii) Explain the effect of a dielectric on the capacitance of a capacitor. (05marks)

(b) Two capacitors of capacitances, C_1 and C_2, are connected in series with a battery of e.m.f, V. Show that the p.d, V_1 across all the capacitor of capacitance, C_1 is given by

$V_1 = \left(\frac{C_2}{C_1 + C_2}\right) V$ (04marks)

(c) The figure below shows a network of capacitors connected to a 10V battery. Calculate the total energy stored in the network. (06marks)



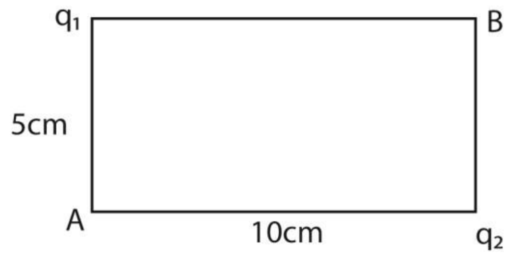
(d) Describe how the unknown capacitance of a capacitor can be determined using a ballistic galvanometer

35.(a)(i) State Coulomb's law of electrostatics (01mark)

(ii) Define the terms electric field intensity and electric potential at a point. (02marks)

(b) Sketch graphs of variation of electric potential and electric field intensity with distance from the center of a charged conducting sphere. (02marks)

(c) Charges q_1 and q_2 of -5.0μF and +2.0μF respectively are placed at two opposite corners of a rectangle of sides5cm and 10 cm as shown below.



Calculate the;

(i) Electric potential at A (04marks)

(ii) Electric field intensity at A (05marks)

(d) (i) What is meant by corona discharge? (02marks)

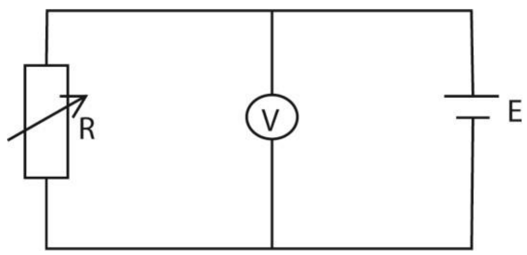
(ii) Explain how the lightning conductor works (04marks)

36.(a) Define current density and the ohm and state their units. (03marks)

(b) (i) Sketch the current versus voltage characteristic for a gas discharge tube (01mark)

(ii) Explain the main features of the graph in (b)(i) above. (03marks)

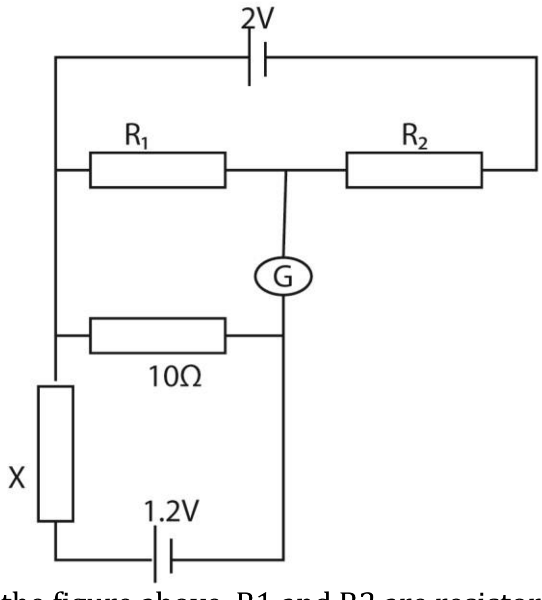
(c)



The figure above shows a cell of e.m.f, E and internal resistance, r, connected to a voltmeter, V, and variable resistor R.

Explain how the value of V varies with R. (04marks)

(d)



In the figure above, R1 and R2 are resistors of 10Ω and 90Ω respectively. If the cells have negligible internal resistances, find the value of X for which G shows no deflection. (04marks)

(e) Describe how the internal resistance of a cell can be measured using a slide wire potentiometer. (05marks)

37.(a) (i) Define capacitance and state its units (02marks)

(ii) With the aid of a labelled diagram, describe an experiment to measure capacitance of a capacitor. (05marks)

(b) A capacitor is charged by a 30V d.c supply. When the capacitor is fully charged, it is found to carry charge of 5.0μC. Calculate the:

(i) Capacitance of the capacitor. (02marks)

(ii) energy stored in the capacitor (03marks)

(c) Derive the expression for effective capacitance of three capacitors C1, C2 and C3 respectively connected in series. (04marks)

(d) Describe briefly an experiment to show the effect of varying the distance of separation of the plates of a capacitor on capacitance. (04marks)

38.(a) Define the terms electrical resistivity and temperature coefficient of resistance (02marks)

(b) (i) Explain why the temperature coefficient of resistance is positive for metals. (03marks)

(ii) what is a super conductor (01marks)

(c) The temperature coefficient of resistance of two wires A and B of diameters 1.20mm and 0.80mm are $0.0004K^{-1}$ and $0.0003K^{-1}$ respectively. If the ratio of their resistances at 0^0C is 1.5, calculate

(i) the ratio of resistances at 100^0C

(ii) their electrical resistance at 100^0C

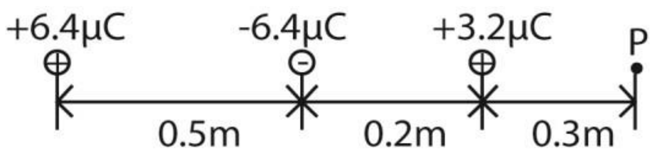
(d) (i) Derive the balance condition for Wheatstone bridge. (04marks)

(ii) Explain why the Wheatstone bridge is not suitable for measuring very low or very high resistances. (04marks)

39.(a)(i) Define electric potential and electric field intensity. (02marks)

(ii) What is the relationship between electric potential and electric field intensity? (01mark)

(b)



Three point charges of +6.4μC, -6.4μC and 3.2μC are arranged in line as shown in the figure above. Find the field intensity at P. (06marks)

(c) (i) Explain with the aid of a diagram, how a charged body cab be screened against external electric fields (03marks)

(ii) Describe briefly how the sign of a charge on a given body can be detected using a gold leaf electroscope (04marks) What is meant by action points in electrostatics? (04marks)

40.(a) define the farad (01mark)

(b) Describe briefly the energy transformations that take place when charging a capacitor using a dry cell. (03marks)

(c) The capacitance of a variable radio capacitor can be can be charged continuously from10pF to 900pF by turning the dial from 0^0 to 140^0. With the dial set at 140^0, the capacitor is connected to a 9V battery. After charging, the capacitor is disconnected from the battery and the dial turned to 00. Calculate the

(i) Charge on capacitor. (03marks)

(ii) Energy stored in the capacitor with the dial at 140^0. (03marks)

(iii) Work required to turn the dial from 140^0 to 0^0 if the friction is neglected. (03marks)

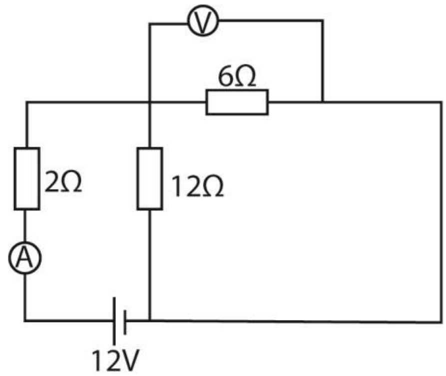
(d) Describe an experiment to determine the effect of area of overlap on capacitance of a parallel plate capacitor (04marks)

(e) Explain why the capacitance of a capacitor Changes when a dielectric is placed between its plates. (04marks)

41.(a) (i) Define a volt. (01mark)

(ii) Derive the formula for the combined resistance of three resistors in parallel. (04marks)

(iii)



In the circuit above, has negligible internal resistance. Find the ammeter and voltmeter readings (04marks)

(b) (i) Draw a labelled diagram of a meter bridge and derive the relation for balance. (05marks)

(ii) Explain why the balance point should be close to the middle of the wire (02marks)

(c) A coil of a wire has resistance of 30Ω at 200C and 34.5Ω at 600C. Calculate its temperature coefficient of resistance. (04marks)

42.(a) Explain the principle of a slide wire potentiometer. (03marks)

(b)(i) Using a labelled diagram, describe how an ammeter is calibrated using a slide wire potentiometer. (06marks)

(ii) What is the advantage of the potentiometer over an ordinary voltmeter in measurement of voltages? (02marks)

(c) Two cells A and B connected in series, give a balance length of 758mm along a potentiometer wire. When cell B is reversed, the balance length falls to 123mm. If the e.m.f of cell A is 1.5V, calculate the e.m.f of cell B. (04marks)

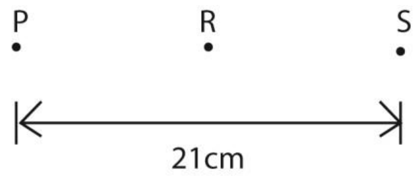
(d) The resistance of a nichrome element of an electric fire is 50.9Ω at 20.0^{0}C. When operating on a 240V supply, the current flowing through it is 4.17A. Calculate the steady temperature reached by the electric fire if the temperature coefficient of resistance of nichrome is 1.7 x 10-4K^{-1}

43.(a) Explain the meaning of an equipotential surface as applied to electric field. (02marks)

(b) With the aid of a diagram, describe an experiment to show that excess charge resides only on the outside surface of a hollow conductor. (05marks)

(c) State Coulomb's law of electrostatics (01mark)

(d)



Two point charges P and S of -17.6μC and -9.0μC respectively are placed in a vacuum at a distance of 21cm apart. When a third charge, R, is placed midway between P and S as shown above, the net force on S is zero.

(i) Determine the charge on R (05marks)

(ii) Calculate electric potential at position of R (05marks)

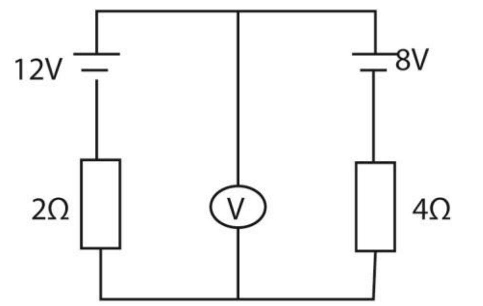
(iii) Sketch the electric field lines corresponding to the charge distribution (02marks)

44. (a) (i) define electrical resistivity and state its units (02marks)

(ii) Describe with the aid of circuit diagram, an experiment to determine the electrical resistivity of a given wire using a meter bridge. (07marks)

(iii) The resistivity of mild steel is 15 x 10^{-8}Ωm at 20^{0}C and its temperature coefficient is 50 x $10^{-4}K^{-1}$. Calculate the resistivity at 60^{0}C. (05marks)

(b)



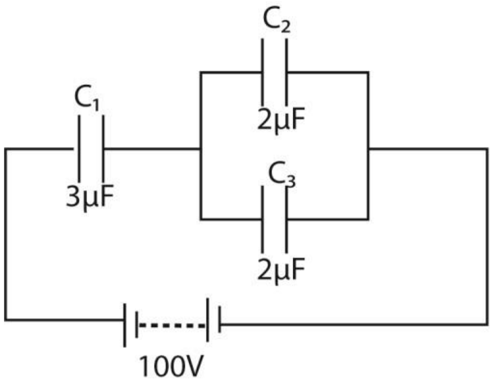
Resistors of 2Ω and 4Ω are connected in series with power supplies of 12V and 8V as shown in the figure above. Calculate;

(i) The reading of voltmeter (04marks)

(ii) The power dissipated in the 4Ω resistor (02marks)

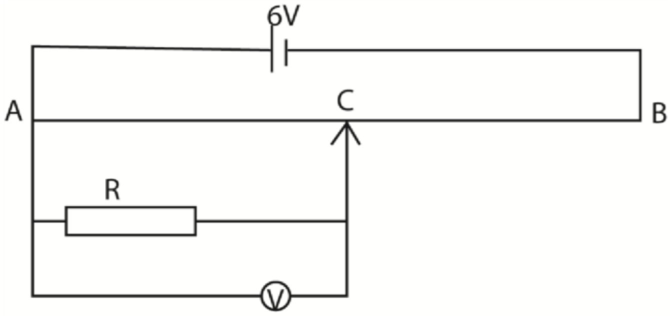
45.(a) Define the following
(i) Capacitance of capacitor (01mark)
(ii) Dielectric constant (01mark)
(b) Explain the effect of dielectric on the capacitance of a capacitor. (04marks)
(c) Derive an expression for energy stored in a capacitor of capacitance, c, charged to a voltage, V. (05marks)

(d)



In the figure above, C_1, C_2, and C_3 are capacitors of capacitances 3μF, 2μF and 2μF respectively, connected to a battery of e.m.f 100V.
(i) Calculate the energy stored in the system of capacitors if the space between the plates of C_1 is filled with an insulator of dielectric constant 3, and the capacitors are fully charged. (06marks)
(ii) Account for the change in energy stored by an isolated parallel plate capacitor when the plate separation is doubled. (03marks)

46.(a) (i) Define electrical resistivity and the ohm. (02marks)
(ii) Describe an expression to determine the electrical resistivity of a material in form of a wire using a meter bridge. (07marks)



(b)
In the figure above wire AB of length 1.00m has a resistance of 10Ω. If point C is the midpoint of AB, and the voltmeter reading is 2.0V, find the value of R. (06marks)
(c) Describe the current versus voltage characteristics of a
(i) semi-conductor diode (02marks)
(ii) filament lamp (02marks)
(d) Why does Ohm's holds at constant temperature only? (01mark)

47.(a) Define the terms dielectric constant and capacitance (02marks)

(b) An air capacitor of capacitance 400μF is charged to 180V and then connected across an uncharged capacitor of capacitance 500μF.

(i) Find the energy stored in the 500μF capacitor. (04marks)

(ii) With the capacitor still connected a dielectric of dielectric constant 1.5 is inserted between plates of the 400μF capacitor.

If the separation between the plates remains the same find the new p.d across the two capacitors. (03marks)

(c) (i) State the characteristics of an equipotential surface. (02marks)

(ii) Describe how a conductor can be charged at zero potential (03marks)

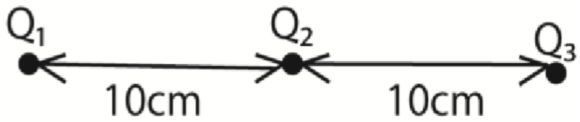
(d) Describe with the aid of a diagram how a high voltage can be generated using a Van de Graff generator. (06marks)

48.(a) (i)State coulomb's law (01marks)

(ii) Show that the electric flux through a spherical surface enclosing a charge in vacuum is Q/E_0

(b) Define the term electric field intensity and electric potential (02marks)

(c)



Three point charges Q_1, Q_2, and Q_3 of magnitude +5μF, +6μF and -20μF respectively are situated along a straight line as shown in figure above. Calculate the electric field

(i) Intensity midway between Q_1 and Q_2 (03marks)

(ii) Potential midway between Q_1 and Q_2 (03marks)

(d) (i) Explain why two insulating bodies rubbed together acquire equal and opposite charges. (03marks)

(ii) Describe how a gold leaf electroscope can be used to verify the observation in (d)(i) above (06marks)

49.(a) State ohm's law (01mark)

(b) Describe with the aid a circuit diagram, an experiment to determine the relationship between the resistance and the length of the wire. (06marks)

(c) A dry cell gives a balance length of 84.8cm on a potentiometer wire. When a resistor of resistance 15Ω is connected across the terminals of the cell, a balance length of 75.0cm is obtained. Find the internal resistance of the cell. (04marks)

(d) A battery of e.m.f 18.0V and internal resistance 3.0Ω is connected a resistor of resistance 8Ω. Calculate the:

(i) Power generated (02marks)

(ii) Efficiency. (02marks)

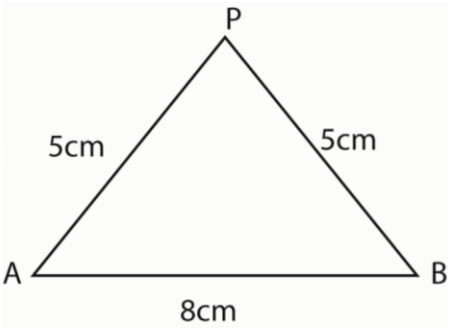
(e) If the 8Ω resistor in (d) is replaced by a variable resistor, sketch graphs to show the variation of power and efficiency with the load. (03marks)

(f) Explain why a metal wire gets hot when current is passed through it. (02marks)

50.(a) Define electric potential. (01mark)

(b) Obtain an expression for the electric potential at a point a distance, r, from a point charge, Q, situated in a vacuum. (04marks)

(c)



Two point charges A and B of charges +0.10μC and +0.05μC are separated by a distance of 8.0cm along the horizontal as shown in the figure above. Find the electric field intensity at P. (09marks)

(d) Sketch the electric field pattern due to the charge distribution in (c). (02marks)

(e) Explain how a lightning conductor works. (04marks)

51.(a) Sketch the electric field lines between two large parallel metal plates across which a p.d is applied. (01mark)

(b) (i) Describe, with aid of a diagram, how you would investigate the factors which affect the capacitance of a parallel plate capacitor. (07marks)

(ii) Calculate the capacitance of parallel capacitor whose plates are 10cm by 10cm separated by an air gap of 5mmm. (02marks)

(c) A hollow spherical conductor of diameter 21.4cm carrying a charge of 6.9×10^{-10}C is raised to a potential of 50V. Find the permittivity of surrounding medium.

(d) (i) show that the effective capacitance, C, of two capacitances, C_1 and C_2, connected in series is given by

$$C = \frac{C_1 + C_2}{C_1 + C_2}$$ 04marks)

(ii) A 20μF capacitor is charged to 40V and then connected across uncharged 60μF capacitor. Calculate the potential difference across the 60μF capacitor.

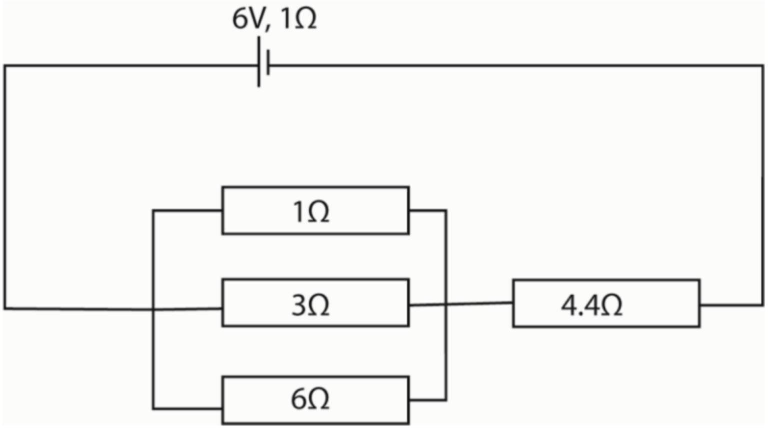
52.(a) Derive the condition for a Wheatstone bridge to be balanced. (04marks)

(b) (i) Define temperature coefficient of resistance. (01mark)

(ii) When a coil X connected across the left hand gap of a meter bridge is heated to a temperature of 30^0C, the balance point is found to be 51.5cm from the left-hand end of the slide wire. When the temperature is raised to 100^0C, the balance point is 54.6cm from the left end. Find the temperature coefficient of resistance of X. (06marks)

(c) (i) A battery of e.m.f E and internal resistance, r, is connected to a resistor of variable resistance, R. Obtain the expression for maximum power dissipated in a resistor.

(iii) A battery of e.m.f 6V and internal resistance 1Ω is connected across a network of resistor as shown in the diagram below

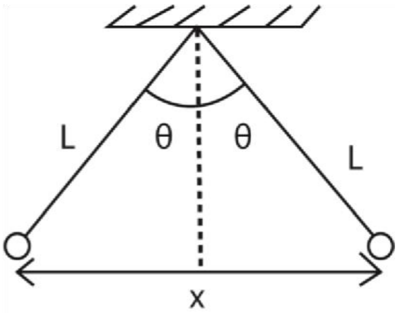


Find the current supplied by the battery. (04marks)

53.(a) State coulomb's law of electrostatics (01marks)

(b) (i) Define electric field intensity and electric potential. (02marks)

(ii) Two identical conducting balls of mass, m, are each suspended in air from a silk thread of length L. when the two balls are each given identical charge, q, they move apart as shown in the figure below



If at equilibrium each thread makes a small angle θ with the vertical, show that the separation, x, is given by

$$x = \left[\frac{q^2 L}{2\pi\varepsilon m g}\right]^{\frac{1}{3}}$$; Where ε is permittivity of air

(c) (i) Define the term capacitance of a capacitor. (01mark)

(ii) State the factors that affect capacitance of a capacitor (03marks)

(iii) Show that the energy stored n a capacitor of capacitance, C charged to a p.d V is equal to $\frac{1}{2}CV^2$. (03marks)

(d) The plates of parallel plate capacitor each of area 2.0cm^{2}are 5mm apart. The plates are in vacuum and potential difference of 10,000V is applied across the capacitor. Find the magnitude of the charge on the capacitor (04marks)

54.(a)Define temperature efficiency of resistance and electrical resistivity. (02marks)

(b) A nichrome wire of length 1.0m and diameter 0.72mm at 25^0C, is made into a coil. The coil is immersed in 200cm^3 of water at the same temperature and current of 5.0A is passed through the coil for 8minutes until when the water starts to boil at 100^0C. Find

(i) The resistance of the coil at 25^0C. (02marks)

(ii) The electrical energy expended assuming all of it goes into heating the water (02marks)

(iii) The mean temperature coefficient of resistance of nichrome wire between 0^0C and 100^0C. (06marks)

(c) Describe, with the aid of circuit diagram how a slide wire potentiometer can be used to measure e.m.f of a cell. (04marks)

(d) An accumulator of e.m.f 2.0V is connected across a uniform wire of length 1.0m and resistance 8.0Ω. A cell of e.m.f 1.50V is connected in series with a galvanometer and connected across a length L of slide wire. The galvanometer shows no deflection when L is 90.0cm. Find the internal resistance of an accumulator. (04marks)

55.(a) Distinguish between e.m.f and terminal p.d of a battery. (02marks)

(b)(i) define electrical resistivity (01mark)

(ii) Explain any two factors on which the resistance of a conductor depends. (05marks)

(c) Two wires A and B have length which are in ratio 4:5, diameter which are in ratio 2:1, and resistances in ratio of 3:2. If the wires are arranged in parallel and a current of 1.0A flows through the combination, find the

(i) Ratio of resistance of wire A to that of wire B (04marks)

(ii) Current through wire A (03marks)

(d) Explain why a wire becomes hot when current flows through it. (05marks)

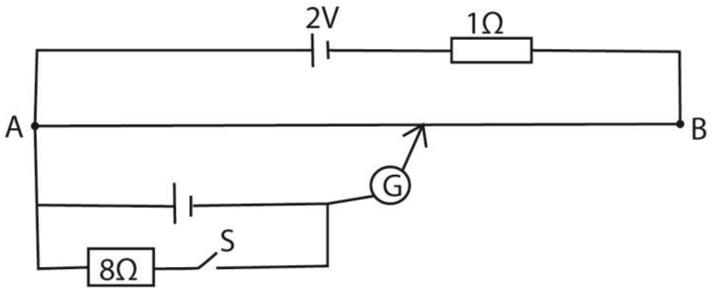
56.(a)(i) state Ohm's law (01marks)

(ii) State the factors which affect the resistance of a conductor. (02marks)

(iii) A conductor of length L and cross section area A has free electrons per unit volume each of charge e. find the drift velocity, v, of these electrons if a current, I, flows through the conductor. (04marks)

(b) Outline the principle of a slide wire potentiometer. (04marks)

(c)



In the figure above the slide wire AB is 1m long and has resistance 4Ω. When switch S is:

(i) Open the balance length Ac is 88.8cm. find the value of the e.m.f of the cell (03mark)

(ii) Closed, the balance length is found to be 82.5cm. Calculate the internal resistance of a cell.(04marks)

(e) State two advantages of using a potentiometer for measuring voltage (02marks)

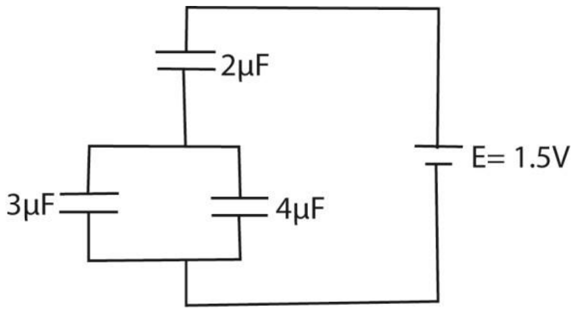
57. (a) What is a dielectric material

(b) A capacitor filled with a dielectric is charge and then discharged through a milliammeter. The dielectric is then withdrawn half way and the capacitor charged to the same voltage, and discharged through the milliammeter again, show that the relative permittivity, E_r of the dielectric is given by $E_r = \frac{I}{2I'-I}$ where I and I' are the readings of the milliammeter respectively. (06marks)

(c) Describe with the aid of a diagram how you would determine the capacitance of a capacitor.

(05marks)

(d)



A battery of e.m.f 15V is connected across a system of capacitors as shown above, find the

(i) Charge on the 4μF capacitor (04marks)

(ii) Energy stored in the 3μF capacitor. (04marks)

A' LEVEL PHYSICS PAPER TWO REVISION QUESTIONS

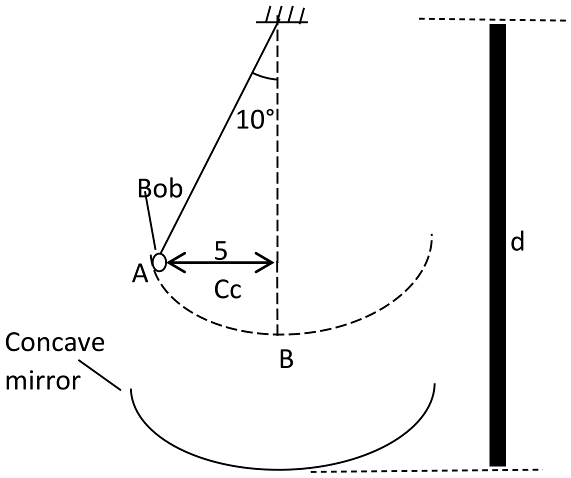
LIGHT

1. a) Define the terms principal focus and Centre of curvature as applied to concave mirror. (2marks)

b) Explain why a paraboroidal mirror is used in search lights instead of a concave mirror. (3marks)

c)(i) Derive the expression relating the radius of curvature of a convex lens to the object and image distances. (4marks)

(ii) Sketch a graph of image distance against object distance for a concave mirror and use it to describe the image formed by the mirror as the object distance varies from a large to very small values. (3marks)



The diagram above shows a swing pendulum swinging above a concave mirror of radius of curvature 20 cm. B is a long the principal axis of the mirror. A real image of the bob of the pendulum at B is 30 cm from the mirror. Find the;

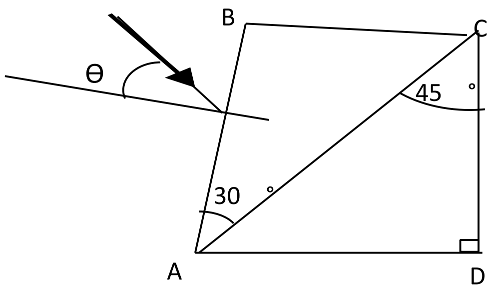
(i) Height d. (4marks)

(ii) Position of the image of bob at B if a small quantity of liquid of refractive index 1.33 is dropped on the reflecting surface of the mirror. (4marks)

2. a) State the laws of refraction (2 marks)

b) Explain why stars twinkle at night whereas planets don't twinkle. (3marks)

c) The diagram below shows two prisms ABC of refractive index 1.54 and ACD of refractive index 1.64 placed against one another.



Find the value of angle Θ for which the ray will just emerge through side CD. (5marks)

d) (i) Sketch a graph of deviation, d, against angle of incidence, i for a ray of light through a glass prism. (2marks)

(ii) Give the interpretation of the minimum value of your graph? (2mark)

e)(i) Describe an experiment to determine refractive index of a glass prism of known refracting angle.(4marks)

(ii) State two uses of prisms. (2marks)

3. a) Define the terms magnifying power and visual angle as applied to optical instruments. (2 marks)

b) (i) With the help of the diagram, discuss the problem terrestrial telescopes try to solve compared to astronomical telescopes. (4 marks)

(ii) State two disadvantages of terrestrial telescopes compared to astronomical telescopes. (2marks)

c) A compound microscope objective has a focal length of 4.0 cm while the eye piece has focal length, fe. A small object is placed 5.0 cm from the objective. The final virtual image is formed in the plane of the object and is 30 cm from the eyepiece.

(i) Why is the object viewed with the eye very close to the eyepiece? (1mark)

(ii) Find the focal length, f_e of the eye piece. (4marks)

(iii) Find the angular magnification when the objective is replaced with another convex lens of focal length 4.05 cm. (5marks)

(iv) Sketch a ray diagram to show formation of final image in (iii) above. (2marks)

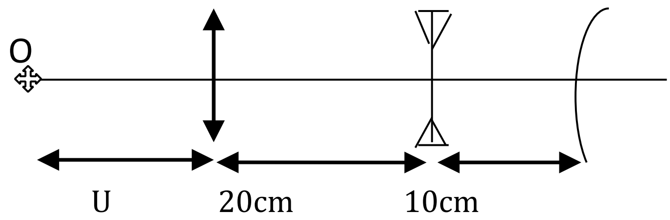
4. a) Explain why a convex lens converges parallel beam of light incident on it whereas concave lens diverges it. (4 marks)

b) Explain two defects of the lenses and state how to minimize them. (4 marks)

c) (i) Describe an experiment to determine the focal length of a lens in an inaccessible tube.(5marks)

d) (ii) Derive the formula used in (i) above. (3marks)

d)



In the diagram above, a convex lens of focal length 10 cm, concave lens of focal length 15 cm and convex mirror of focal length 10 cm are arranged coaxially as shown. If a point object O coincide with its image at O, find the distance, U. Illustrate with a ray diagram. (5marks)

WAVES

5. (a) state two differences between sound and light waves [02]

(b) Define the following:

(i) Beats [01]

(ii) Resonance [01]

(c) (i) describe an experiment to determine frequency of a tuning fork using a resonance tube in a region of known speed of sound in air. [04]

(ii) State one hazard of resonance [01]

(d) (i) define Doppler effect [01]

(ii) A car travelling at $10ms^{-1}$ sounds its horn which has a frequency of 500 Hz, and this is heard in another car which is travelling behind the first car, in the same direction, with a velocity of $20ms^{-1}$. The sound can also be heard in the second car by reflection from a bridge ahead. Calculate the frequency of frequency of beats that will be heard by the driver of the second car. (Speed of sound in air $=340ms^{-1}$) [04]

(iii) Explain how to measure the speed of a star that is moving towards the earth. [03]

e) (i) define reverberation [01]

(ii) Explain why reverberations are not heard in small rooms. [02]

6. (a) state huygen's principle [01]

(b) Monochromatic light propagating in air is incident obliquely onto a plane boundary with a material of refractive index, n.

(i) use huygen's principle to show that the speed , v, of the light in the material is given by $V = \frac{c}{n}$, where c is speed of light in air [05]

(ii) If the wave length of the light is 600nm in air, what will it be in a material of refractive index 1.51? [03]

(c) What is a diffraction grating? [01]

(d) State three differences between the spectra produced by a prism and that by a diffraction grating. [03]

(e) (i) what is meant by interference of waves?[01]

(ii) State the conditions necessary for interference fringes to be observed. [02]

7. (a) Distinguish between the terms nodes and antinodes with reference to stationary waves . (2)

(b) A steel wire of length 40.0 cm and diameter 0.0250 cm vibrates transversely in unison with a tube, closed at one end and of length 56.4 cm and end correction 3.6 cm, when each is sounding its fundamental note. The air temperature is 27°C. Find the tension in the wire. (Assume the velocity of sound in air at 0°C is $331ms^{-1}$ and density of steel is $7800kgm^{-3}$.)(4)

(c) With the aid of a sonometer, describe an experiment to show how the frequency of a vibrating string is affected by changes of length. (5).

d) (i) Define the term Doppler Effect (1)

(ii) An observer moving at a speed of $10\ ms^{-1}$ between two sources of sound A and B hears beats at $5\ s^{-1}$. If the frequency of waves produced by source A is 515 Hz and the observer is moving towards A, find the frequency of sound produced by B.

(Speed of sound in air is $340\ ms^{-1}$) (5)

(iii) Explain how Doppler Effect can be used to determine plasma temperature (3)

8. a) What is meant by **diffraction** and **polarization** of light waves? (2)

b) A Transmission diffraction grating of spacing ***d*** is illuminated normally with light of wavelength λ.

i) Derive the condition for occurrence of diffraction maxima. (3)

ii) Describe briefly the intensity distribution on a screen placed beyond the grating. (2)

iii) What is the effect on the diffraction pattern, of using a grating with a larger number of lines? (2)

c) Light of wave length 5.8×10^{-7}m is incident on a diffraction grating with 500lines per mm. Find the;

i) Diffraction angle for the 2nd order image. (3)

ii) Maximum number of images possible. (2)

d. i) Describe how polarized light can be produced by reflection. (4)

ii) List **two** uses of polarized light. (2)

9.(a)(i) State the conditions which must be satisfied in order to observe an interference pattern due to two wave motions. (1)

(ii) Account briefly, for the interference pattern produced by transparent thin film. (4).

(iii) A liquid film of uniform thickness is just thick enough to cause maximum reflection of light of wavelength 560nm at normal incidence. The refractive index of the liquid is 1.40. Find the thickness of the film. (3).

(b) A diffraction grating spectrometer is set up to measure the wavelength of monochromatic light.

(i) Draw a labeled diagram to show the essential features of the spectrometer.

(ii) State the initial adjustments that have to be carried out before the spectrometer can be used. (3).

(c) A light source emits two wavelengths 450nm and 600nm. The light is incident normally on a diffraction grating of 500lines per mm. Find,

(i) the angular separation of these lines in the second order spectrum.(4)

(ii) The respective orders for the two wavelengths to overlap.

10. (a) (i) With aids of suitable sketch diagrams, distinguish between free and damped oscillation (3mks)

(ii) State one application of damping (1mk)

(b)(i) Define a wave and wave front (2mks)

(ii) What is meant by beats in sound? (2mks)

(iii) State one use of beats (1mk)

(c) (i) what is meant by Doppler effect? (1mk)

(ii) A police car traveling at 108km/hr is chasing a lorry which is traveling at 72km/hr. Both are about to pass a stationary bystander and the police car siren emits a sound of frequency 400Hz. Calculate the apparent frequency of the note from the siren as observed by the lorry driver. (3mks)

(d) (i) Define resonance (1mk)

(ii) State one and one hazard of resonance (2mks)

(iii) A cylindrical pipe of length 29cm is closed at one end. The air in the pipe resonates with a tuning fork of frequency 860Hz sounded near the open end of the tube. Determine the mode of vibration and find the end correction. (4mks).

11. (a) (i) what is meant by coherent sources of (1mk)

(ii) Distinguish between interference and diffraction of light (2mks)

(b) With the aid of suitable sketches, explain the following;

(i) Division of wave front (2mks)

(ii) Division of amplitude (2mks)

(c) In young's two slits experiment;

(i) State the conditions necessary for an interference fringes to be visible and explain why these conditions are necessary. (3mks)

(ii) Monochromatic light of wavelength $5x10^{-7}$m is incident on two slits of separation $4x10^{-4}$m. Calculate the fringe separation on a screen placed 1.5m from the slit. (3mks)

(d) Two microscope slides 7.5cm long are separated at one end by a thin piece of thread and are just touching at the other end. The slides are illuminated normally with monochromatic light. A series of dark and bright bands are formed at a distance x cm from each other.

(i) With help of a labeled diagram, explain how the bands formed. (4mks)

(ii) If x = 0.27 cm how many bright bands are seen when viewed in the reflected light. (3mks)

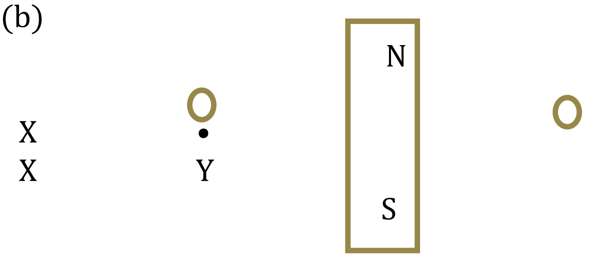
MAGNETISM

12. (a) Define the following terms

(i) Magnetic flux density [1]

(ii) Direction of magnetic line of force [1]

(b)

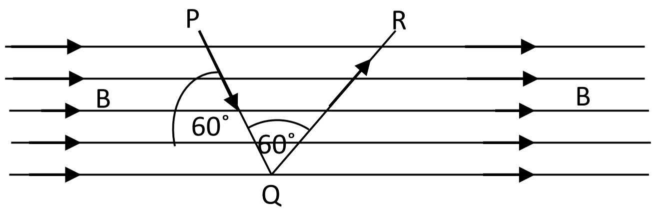


In the figure above, parallel electric currents flow near an isolated bar magnet. With the aid of a well sketched magnetic field pattern, explain the effects of the bar magnet on the wires x and Y, [4]

(c)(i) Define the term magnetic moment [1]

(ii) With the aid of a well labeled, describe the structure of a ballistic galvanometer [4]

(ii)



The figure shows two straight conductors PQ and QR joined at Q, carrying a current of 2.0A and subjected to a uniform magnetic field of flux density 0.02T whose direction lies in the plane PQR at 60° to PQ . Both PQ and QR are 6.0cm long. The angle PQR IS 60°. Calculate the forces on PQ and QR. What movement do the two forces together try to produce? [4]

(d)With the aid of a labeled diagram, describe the absolute measurement of current [5]

13. (a) (i) Define self-induction and state one of its applications [2]

(ii) Explain why when a current is switched off in some circuits, a spark is seen across the gap.[3]

(b)With the aid of a well labeled diagram describe how an a.c. generator works, and state how you can modify it into a d.c. motor [7]

(c)(i) Explain the term back emf in a dc motor [2]

(ii) Show how back emf in a motor is related to the efficiency of the motor [3]

(d)The current in a coil falls at $2.0As^{-1}$ and consequently induces an emf of 4.0mV in a second coil close to it. What induced voltage would occur in the first coil due to a $4.0As^{-1}$ fall of current in the second coil [3]

14. (a) Distinguish between electrical resistance and reactance [2]

(b)With the aid of a diagram describe how a thermocouple meter works.[4]

(c)An alternating current I flows through a coil of inductance L. The instantaneous value of current is $I=I_o \sin 2\pi ft$, where I_o is the amplitude and f is the frequency.

(i) Derive the expression for the voltage V across the coil. [4]

(ii) State the phase of V relative to that of I [1]

(iii) If the coil is a pure inductor, explain why it is non-dissipative. [3]

(d)Define root mean square value of alternating current [1]

(e)A sinusoidal voltage of rms 20V is applied across a 70μF capacitor. If the frequency of the a.c supply is 50HZ, calculate;

(i) The r.m.s value of the current through the capacitor [3]

(ii) The maximum charge on the capacitor [2]

15. a)(i) Define amplitude and root mean square value of an alternating current. (2).

(ii) An electric kettle draws 1.5kW from 250V (r.m.s) mains supply. Find the amplitude of the current drawn by the kettle, if the voltage is sinusoidal. (2).

b) A sinusoidally alternating voltage of 20V (r.m.s) and frequency 60Hz is applied to a capacitor of capacitance 10μF.

(i) Find the rms current which flows. (2)

(iii) Explain why a.c apparently flows through a capacitor but d.c does not? (3)

(c)With the aid of a labeled diagram, describe the structure and action of a hot-wire ammeter. (5)

(d)Draw a circuit diagram of a bridge full-wave rectifier and explain how it works. (3).

(e)(i) distinguish between reactance and impedance [01]

(ii) a coil of 1 H is connected in series with a resistor of 100Ω. A voltage of 5vr.m.s, 50Hz, is connected across the combination. Calculate the power absorbed in the circuit. [02]

(f) Explain why an ordinary voltmeter cannot measure alternating voltage. [02]

17. (a) State the laws of electromagnetic induction. (2)

(b)What are:

(i) Self-induction? (1)

(ii) Mutual induction? (1).

(c) (i)Describe the construction and operation of an ac transformer. (5)

(ii) An ac transformer operates on 240V. If the transformer is 90% efficient, calculate the current in the primary coil when a 36W lamp is connected across the secondary. (4)

d) (i) What is back emf? (2)

(ii) Give two applications of back emf (1)

(iii)Describe a simple experiment to demonstrate the damping effect of eddy currents. (4).

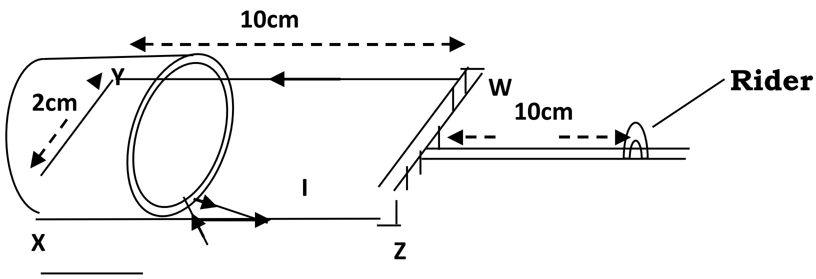
17. a) (i)Define the term magnetic field line (1)

(ii) Sketch the resultant magnetic field pattern of a current currying straight wire at right angle to a uniform magnetic field and use it to explain neutral point (3)

b) Explain how hall voltage is produced across the face of a metal strip carrying a current I at right angles to uniform magnetic field of flux density B. (3)

c) A copper wire has **1.0×10^{29}** free electrons per cubic metre, across – sections area of **$2.0mm^2$** and carried a current of **5.0A.** Calculate the force acting on each electron if the wire is now placed in a magnetic field of flux density **0.15T** which is perpendicular to the wire.

(4) d) (i)

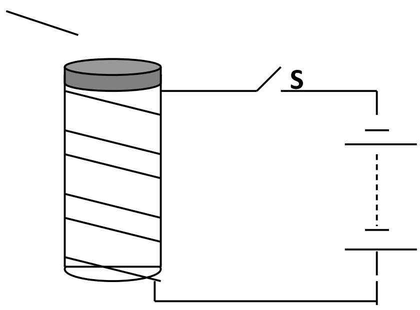


A rectangular wire WXYZ is balanced horizontally so that the length XY is at the center of a solenoid of 800 turns per metre. A current I is passed through XY and 2.5 A through the solenoid, a rider of mass 2.5×10^2kg has to be placed at a distance of 7.0cm from WZ to restore balance. Find the value of I. (4)

(ii)State two advantages of using a current balance to measure current over an ammeter. (2)

19. a) The figure below shows an Aluminium ring resting on a solenoid

Aluminum ring



(i) On closing switch S the ring jumps up. Explain this behaviour. (3)

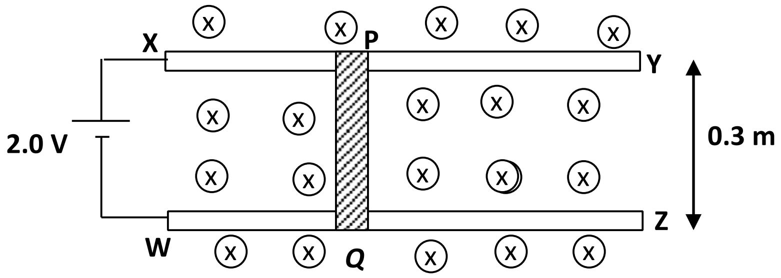
(ii) What would happen to the ring if a high alternating current was instead passed through the solenoid? (3)

b) A circular coil of 50 turns of mean radius 50 cm is arranged so that its plane is perpendicular to the magnetic meridian. The coil connected to a ballistic galvanometer of sensitivity 5.7×10^4 rad C^{-1}. The total resistance of the coil and galvanometer is 100Ω. The coil is then rotated through 180° about the vertical axis, the B.G deflects through 0.8 radians. Calculate the horizontal component of the earth's magnetic flux density. (5)

c(i) What is back e.m.f in a motor (2)

(ii) Explain the importance of back e.m.f in the operation of a motor. (2)

d) XY and WZ are conducting coils in figure below along which is a conducting rod PQ of length 0.3 m which can slide without friction across a uniform magnetic field of 0.6 T. The conductor PQ moves to the right with a constant velocity of 10 ms^{-1}. Assume that the resistance of the conducting loop XPQW stays at 4Ω.



(i) Indicate and describe the forces acting on the conductor PQ. (2)

(ii) The magnitude and direction of the emf induced in loop XPQW. (2)

(iii) Calculate the current flowing through PQ (2)

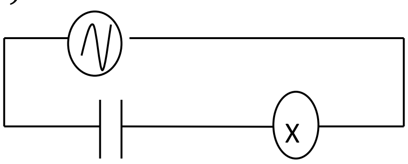
(iv) Find the efficiency of the circuit (2)

20. a) i) Define the **root mean square** (r.m.s) value of an alternating current. (1)

ii) A sinusoidal alternating current $I = 3\sin(120\pi t)$ amperes flows through a resistor of resistance 2.5Ω. Find the mean power dissipated in the resistor. (3)

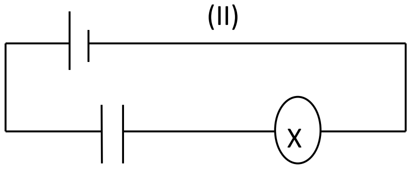
b) The circuit below shows two circuits. Circuit (I) shows a capacitor connected in series with a bulb W and ac source. Circuit (II) shows a capacitor identical to one in circuit (I) connected in series with dc source and bulb Z. Bulbs W and Z are identical. Explain what happens to bulbs W and Z (4)

(I)



W

(II)



Z

c) In an experiment to measure the reactance of a capacitor, the r.m.s current is measured to be 10mA. The peak to peak voltage is measured to be 16V. If the frequency is 10Hz, find the capacitance of the capacitor. (3)

d) With the aid of a diagram, describe how a repulsion type of meter works. (5)

e) Distinguish between self-induction and mutual induction (2)

f) Explain why a spark is observed when a switch is opened. (2

ELECTRICITY

21. (i) Define the terms resistivity and temperature coefficient of resistance (2marks)
(ii) explain why temperature coefficient for metals is positive and negative for semi-conductors (4marks)

b) A piece of aluminum of length 1.0 m and diameter 1.00mm, at a temperature of 20°C is placed in the left hand gap of a metre bridge. The slide contact is at 40 cm from the left hand side of the metre bridge. If the temperature of aluminum is raised to 70°C, how the balance may be restored by;

(i) adjusting the slide contact (4marks)

(ii) By keeping the contact at 40 cm from left hand side. (4marks)

(resistivity of aluminum wire $=7.85 \times 10^{-6}\Omega$m, temperature coefficient of resistance = $4 \times 10^{-3}K^{-1}$)

c) Describe an experiment to show the variation of resistance with temperature. (6marks)

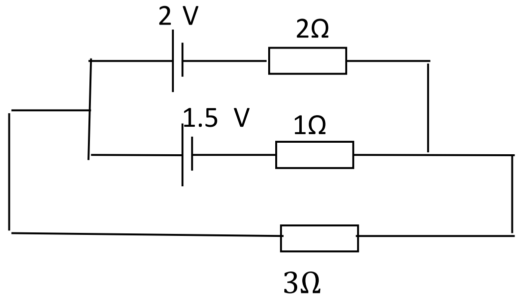
22. a) Define e.m.f and internal resistance of the cell. (2 marks)

b) Explain the effect in current when cells are connected in series and parallel.(3marks)

c) An accumulator of e.m.f ***3.0 V*** and of negligible internal resistance is joined in series with a resistance of ***6 Ω*** and unknown resistance ***R***. The readings of a voltmeter successively across the ***500 Ω*** resistance and ***R*** are $\frac{3}{5}$ V and $\frac{6}{5}$ V respectively. Calculate the value of ***R*** and the resistance of the voltmeter. (6marks)

d) d) Describe the connections and values of resistors used in the construction of the voltmeter and ammeter. (4marks)

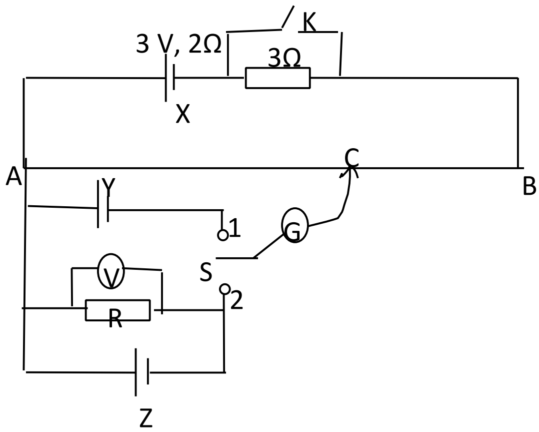
e) In the circuit shown find the power developed in the 3Ω resistor (6marks)



23. a) Explain the principle of operation of a potentiometer (4marks)

b) Describe an experimenter to measure internal resistance using a potentiometer (5marks)

c)



In the circuit above, AB is a slide wire of length 1.00m and resistance 10Ω. The driver cell X has e.m.f 3.0V and internal resistance 2Ω. Y is a standard cell of e.m.f 1.05 V.

(i) Find the balance length when K is open and S connected to position 1. (2marks)

(ii) When K is closed and S connected to position 2, the voltmeter reading is 1.30V and the balance length is 50 cm from end A. find the percentage error in the voltmeter reading. (3marks)

(iii) When R is replaced with 8Ω resistor while S is at position 2 and K closed, the balance length is 54.4 cm from end A. Find e.m.f and internal resistance of cell Z. (5marks)

d) State the advantages of using a potentiometer to measure p.d compared to a voltmeter.

24. a) (i) State Ohm's law (1mark)

(ii) Describe an experiment to verify ohm's law (4marks)

b) What meant by a passive resistor and explain why a loudspeaker is not a passive resistor. (3mark)

c) Explain why loading resistors on dynamo or battery should have a high resistance. (2marks)

d) show that for a battery of e.m.f E and internal resistance r when connected to a variable resistor R, the maximum power delivered to R occurs when R = r (4marks)

e) An electric heating coil is connected in series with a resistance of XΩ across the 240 V mains, the coil being immersed in a 1 kg of water at 20°C.

f) The temperature of water rises to boiling point in 10 minutes. When a second heating experiment is made with the resistance X short – circuited, the time required to develop the same quantity of heat is reduced to 6 minutes. Calculate the value of X. (6marks)

25. . (a) (i) Define the capacitance of a conductor. (1mk)

(ii) Explain the energy changes that take place in a Van de Graff generator. (3mks)

(c) Two capacitors each of capacitance 10μF are connected in parallel across a source of 100V supply.

(i) Calculate the energy stored in the capacitors (4mks)

(ii) Calculate the energy transferred by the source of e.m.f (2mks)

(iii) Account for the energy difference in (i) and (ii) above (2mks)

26.(a)(i) State coulomb law of electrostatics. (1mk)

(ii) Explain how a body gets charged by rubbing (3mks)

(b)With a suitable diagram explain electrostatics shielding (3mks)

(c) Given a charged pear shaped conductor, describe an experiment to show that;

(i) There is high concentration of charge at sharp point (3mks)

(ii) The surface of the conductor is equipotential surface (2mks)

(d) Two point charges repel each other with a force of 2.0 x 10 $^{-4}$ N. When the charges are moved 6 mm further apart, the repulsive force reduces to 8 x10^{-6} N.

(i) How far apart the charges were originally? (5marks)

(ii) If the two charges were identical, find the magnitude of each of the charges. (2 marks)

(iii) explain how the presence of a neutral conductor near a positively charged sphere may reduce its potential (3marks)

27. (a)(i) Define *electric potential energy* of a charge. (1)

(ii) Derive an expression for the electric potential energy of two point charges of Q_1 and Q_2 a distance x apart, in air. (4)

(b)

Three charges of -5x10-9C, +7x10-9C and +6x10-9C are placed at the vertices A, B and D respectively of a rectangle, in air. The rectangle is of sides 3cmx5cm as in the figure above. Calculate the electric field intensity at C. (7)

(c)(i) What is an equipotential surface? (1)

(ii) Show that the electric field intensity is always perpendicular to the equi-potential surface. (2)

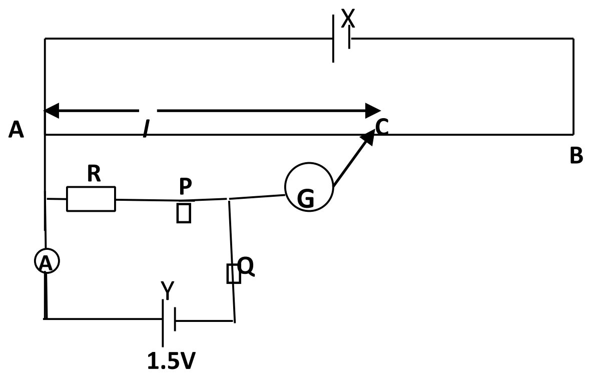
(d) Describe an experiment to show that charge resides only on the outside surface of a charged hollow conductor. (5)

28. a) Distinguish between the terms temperature coefficient of resistance and resistivity of a material [2]

b) Explain the factors affecting resistance of a material of a metal wire [6]

c) Describe an experiment to determine the temperature coefficient of resistance of a metal wire. [6]

d) A potentiometer is connected to a resistor, R, an ammeter, A, and a source Y of emf 1.5 V and internal resistance, r, as shown in the diagram below. The potentiometer wire has resistance of 5 Ω and cell X has negligible internal resistance and an emf of 2v.



When a resistor of resistance R_S is connected at P, the balance length l is 70 cm and the ammeter reads 0.266 A. When R_s is now connected at Q, the balance length l changes to 60 cm. Find the values of r, R, and R_S. [6]

29. (a) Derive an expression for the current density in a metal having n free electrons per m^3 drifting with a velocity v under an application of a p.d. (4).

(b)(i) State ohm's law (1)

(ii) Define internal resistance of a cell (1)

(iii) Sketch a graph of current against p.d. for a tungsten filament bulb and explain its features. (3)

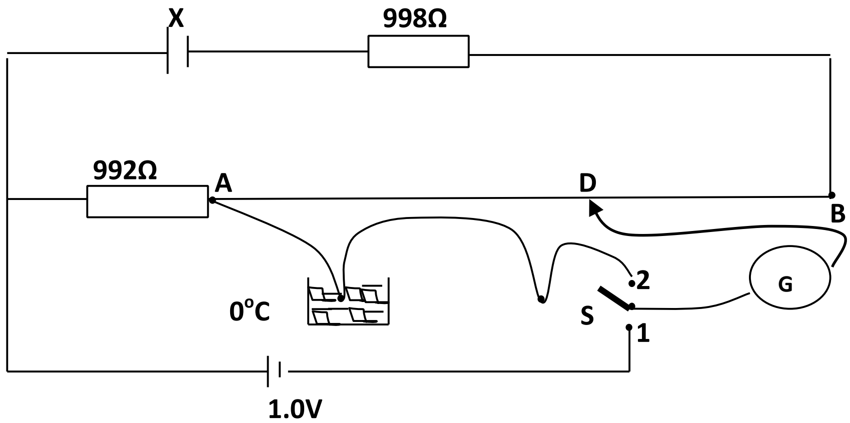
(c) Derive the formula for the effective resistance of three resistors in parallel.(4)

(d)In the circuit below, X is an accumulator of negligible internal resistance; AB is a uniform wire of length 1.0m, diameter $3.57x10^{-4}$m, and electrical resistivity $1.0x10^{-6}\Omega$m, G is a galvanometer connected to a contact, S is D. When switch S is thrown into position 1, G shows no deflection when AD= 80.0cm. When switch S is thrown into position 2, G shows no deflection when AD=40.0cm. Find,

(i) The resistance of AB. (3)

(ii) The e.m.f of the thermocouple. (2).

(iii) The e.m.f of cell, X. (2)



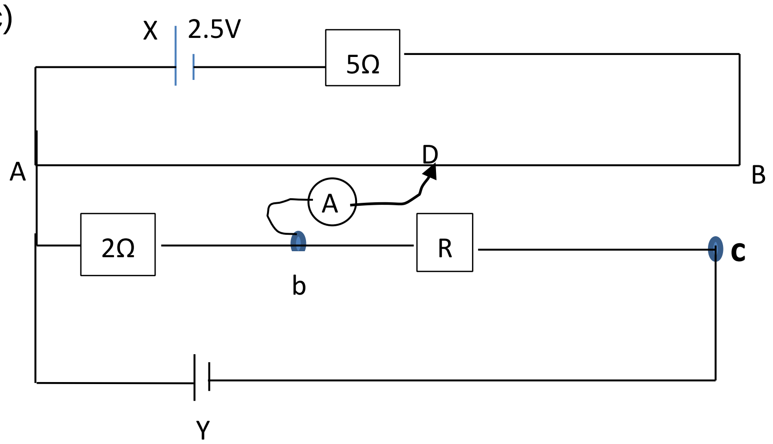
30.(a) (i) Define the terms electromotive force and internal resistance of a cell [02]

(ii) Explain why the terminal p.d is usually less than the e.m.f of a cell. [02]

(b) (i) Briefly describe how a slide wire potentiometer works [03]

(ii) Explain one advantage of using a potentiometer over a moving coil galvanometer [02]

(c)



In the figure, AB is a uniform wire of length 1m and resistance 10Ω. X is a driver cell of e.m.f 2.5V and negligible internal resistance. When the galvanometer G is connected in turn to points b and c, the balance lengths are 0.640m and 0.900m respectively. Calculate the ;

(i) Current flowing through the resistor R [03]

(ii) Emf of cell Y given that the cell has negligible internal resistance [03]

(d) (i) Define temperature coefficient of resistance [01]

(ii) Give one example of a material with negative temperature coefficient [01]

(iii) The resistance of a coil at 30°C is 48.4Ω. When connected to a 220V supply, a steady temperature is soon attained with a current of 3.91 A flowing through it. Calculate the value of the steady temperature if the coefficient of resistance of the material of the coil is $2.1\times10^{-4}K^{-1}$ [03]

31. (a) (i) Define electrostatic potential at a point. [01]

(ii) Derive an expression for the electric potential at a point a distance r from a charge Q coulombs [04]

(iii) Two identical spheres P and R separated by 1m are charged with 12μC and 9μC respectively. A third identical uncharged sphere C is first touched with P and then with R afterwards, and moved away. What is the electrostatic force between P and R? [05]

(b) With the aid of a labeled diagram describe the assembly of a van-der Graaff generator and explain its mode of action [05]

(c) What is meant by action at points? [03]

(d) Give two characteristics of equi-potential surfaces [02]

32.(a) Define capacitance of an isolated conductor [01]

(b) Describe an experiment to investigate how a capacitance of a capacitor varies with area of overlap of a parallel plate capacitor. [04]

(c) (i) explain why the capacitance of a capacitor changes when a dielectric material is placed between its plates [05]

(ii) Explain what would happen if a conductor instead of a dielectric material was placed between the plates of a capacitor [02]

(d) Derive an expression for capacitance C of a parallel plate capacitor in terms of the area, A, separation of plates, d, and permittivity of free space, ε_0 [03]

(e) A potential difference of 600V is established between the top cap and the case of a calibrated electroscope by means of a battery which is then removed, leaving the electroscope isolated. When a parallel plate capacitor with air dielectric is connected across the electroscope, the potential difference is found to drop to 400V. If the capacitance of the parallel plate capacitor is 10pF, calculate;

(i) the capacitance of the electroscope. [02]

(ii) the change in electrical energy which results from sharing of the charge [03]

33. (a) (i) define the term relative permittivity of an insulator. [01]

(ii) Describe with a diagram, how to determine the relative permittivity of an insulator.[04]

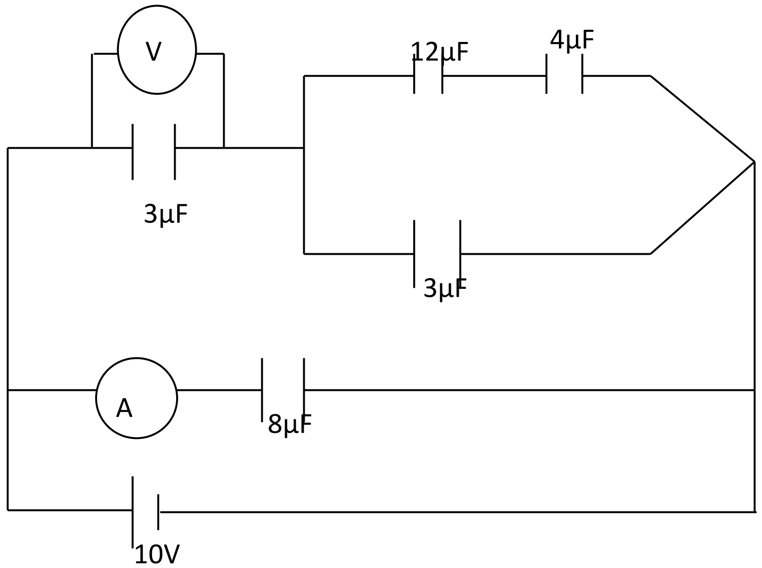
(iii) Describe what happens to the p.d across a charged capacitor when an insulator is placed between its plates. [03]

(b) (i) define a farad [01]

(ii) Show that capacitance of a parallel plate capacitor is $C=\frac{\varepsilon_o A}{d}$ Where ε_o is permittivity of free space A is area of each plate d is separation of the plate.

(c) Obtain an expression for the energy stored in a charged parallel plate capacitor.

(d)



The figure shows a circuit containing an ammeter of negligible resistance and a voltmeter.

(i)Explain what is observed on an ammeter [01]

(ii)Find the voltmeter reading [03]

END

SELF-TEST SET ONE PAPER P510/2

Where necessary, use the following constants:

Permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}\ Fm^{-1}$

The constant $\frac{1}{4\pi\varepsilon_o} = 9.0 \times 10^9\ F^{-1}m$

1. (a) (i) State the laws of refraction of light. (2 marks)

(ii) With the aid of ray a diagram, explain why a pond appears to be shallow when viewed directly from above. (3 marks)

(b) Draw a well-labelled diagram of the telescope part of the spectrometer and describe how it can be adjusted. (4 marks)

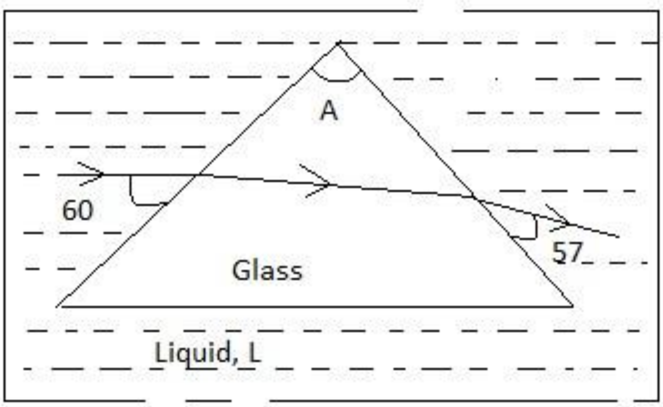


Fig.1

In Fig. 1, a ray of light passing through a liquid of refractive index 4/3 is incident on a prism of refractive index 3/2. Find the refracting angle, A, of the prism. (4 marks)

(d) Describe an application of a convex mirror. (2 marks)

(e) A window of area $1.44m^2$ is 100cm in front of a curved mirror. If an image of area $36cm^2$ forms on a screen in front of the mirror, find the:

(i) Magnification of the image. (2 marks)

(ii) Focal length of the mirror. (3 marks)

2. (a) Define principal focus of a diverging lens. (1 mark)

(b) Explain the effect of a convex lens on a parallel beam of light. (3marks)

(c)(i) Draw a ray diagram to show how a bi-convex lens forms an image of an object placed perpendicular to its principle axis and between the focal plane and the pole. (2 marks)

(ii) Describe how the set-up in 2 (b) (i) above can be used. (2 marks)

(d) A lens is fixed in a tube opened at both ends. Describe an experiment to measure the focal length of the lens. (6 marks)

(e) A plano-concave glass lens of refractive index 3/2 and surface radius 12 cm filled with a liquid, L, is placed on a plane mirror facing up as shown in figure 2. A horizontal pin, viewed from above the combination coincides with its image at 72cm from the mirror.

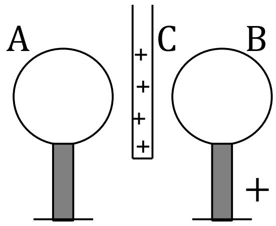
Fig. 2

Find the refractive index of liquid L. (6 marks)

3. (a) Explain how objects get charged by rubbing. (3 marks)

(b) The diagram shows two metallic spheres A and B placed apart and each supported on an insulating stand. A positively charged plate C is placed mid-way between them but without touching them.

A +



B is momentarily earthed in the presence of C. Finally C is withdrawn.

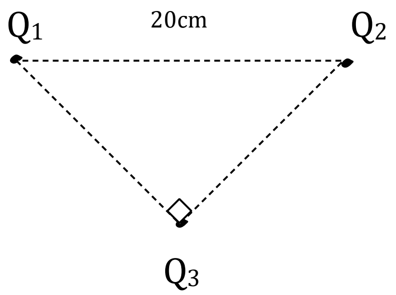
(i) Draw the spheres at the end of the operation and show the charge distribution over them. (2 marks)

(ii) On the same diagram sketch the electric field pattern in the region of the spheres. (2 marks)

(iii) Explain the change in p.d between the spheres as the spheres are moved further apart. (2 marks)

(c)(i) Describe an experiment to investigate the distribution of charge over a conductor. (5 marks)

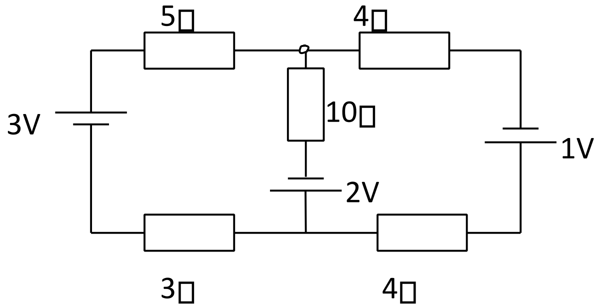
(d) In the figure below $Q_1 = -2\mu C$, $Q_2 = +2\mu C$ and $Q_3 = +3\mu C$



Find the resultant electric field intensity at point P, midway between Q_1 and Q_2, due to the charges. (6 marks)

4. (a) (i) State Kirchhoff's circuit laws. (2 marks)

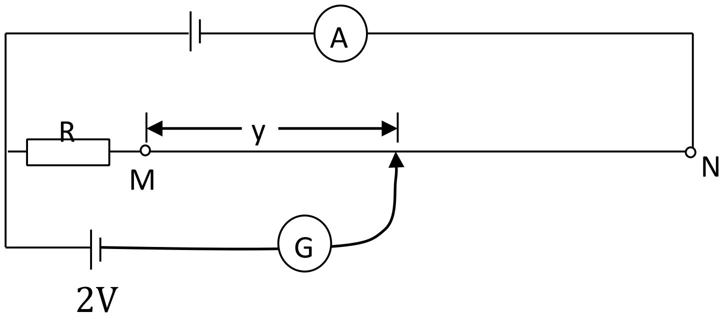
(ii) In the circuit shown below find the current through the 10 Ω resistor. (4 marks)



(b) (i) Explain the principle of a slide wire potentiometer. (4 marks)

(ii) State one advantage of using a potentiometer over a moving-coil voltmeter. (1 mark)

(c) In a potentiometer experiment the following circuit was set up.



The ammeter, A, reads 0.1 A and the balance length, y, found for the 2V cell is 30 cm. MN is a uniform wire of length 100 cm. When the 2V cell is replaced with another cell, X, the balance length becomes 50 cm and when the two cells are connected in series the combination gives a balance length of 90 cm.

Determine the

(i) Resistance per cm of MN. (5 marks)

(ii) value of resistance R (2 marks)

(iii) e.m.f of cell X. (2 marks)

5. (a) (i) Define ***capacitance***. (1 mark)

(ii) Distinguish between **dielectric constant** and **dielectric strength** of a Substance. (2 marks)

(iii) Describe an experiment to determine the dielectric constant of a substance by the vibrating-reed switch method. (6 marks)

(b) Derive an expression for the energy stored in a capacitor. (6 marks) (c)The following operations were carried out on two parallel-plate capacitors A and B, each of capacitance 6μF, having air as the dielectric.

I: Each was separately charged to a p.d of 120 V and then isolated

II: A substance of dielectric constant 3 was inserted in between the plates of B to completely fill the space.

III: The capacitors were finally connected in parallel, similar charged plates being connected together. Find the final p.d across the combination. (5 mks)

SELF-TEST SET TWO PAPER P510/2

Acceleration due to gravity, g	*9.81* ms^{-2}
Speed of light in vacuum, c	$= 3.0 \times 10^{8}\ ms^{-1}$
Electron charge, e	$= 1.6 \times 10^{-19}\ C$
Electron mass, m_e	$= 9.11 \times 10^{-31}\ kg$
Permeability of free space, μ_0	$= 4.0\ \pi \times 10^{-7}\ Hm^{-1}$
Permittivity of free space, ε_0	$= 8.85 \times 10^{-12}\ Fm^{-1}$

The constant $\frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^{9}\ F^{-1}$

1. (a) (i) Distinguish between ***angle of incidence*** and ***glancing angle*** for a ray that is incident on a surface. (2)

(ii) A ray is incident on a plane mirror. The ray is kept fixed in direction while the mirror is rotated through an angle α. Derive the relationship between the rotation of the reflected ray and the angle α. (3)

(iii)Explain the action of a device that applies the principle in (a)(ii) above. (5)

(b) Opio, whose height is 172 cm, plans to fix a plane mirror on a vertical wall in his room so that he sees the image of the whole of himself. If his eyes are 12 cm below the highest point of his head, find;

(i) How high above the floor the lowest edge of the mirror should be. (3)

(ii) The minimum height of the mirror. (2)

(c) You are provided with a small plane mirror, a metre rule, an optical pin and a convex mirror. Describe an experiment to determine the focal length of the convex mirror using the given apparatus. (5)

2. (a) (i) State the conditions for total internal reflection. (2)

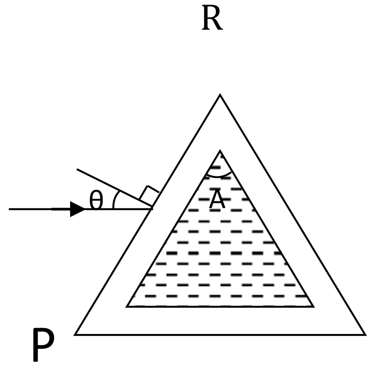
(ii) Draw a labeled diagram of a named device to show (without description) an application of total internal reflection. (2)

(b) Explain how a fish in a pond is able to enjoy a 180° field of view. (3)

(c) Show that when a ray of light passes through different media separated by plane boundaries $n \sin i =$ constant where n is the absolute refractive index of a medium and i is the angle made by the ray with the normal in the medium. (4)

(d) Describe an experiment to measure the refractive index of glass of rectangular shape by the apparent depth method. (4)

(e) The figure below shows a liquid of refractive index 1.33 enclosed by glass of uniform thickness. Q



A ray of light, incident on face PQ at an angle of incidence, θ, emerges through face QR. As the angle θ is reduced, suddenly the emergent ray disappears when θ = 16°. Find the angle A. (5)

3. (a) What is meant by

(i) Focal length of a diverging lens. (1)

(ii) Conjugate points for a lens. (1)

(b) Draw a ray diagram to show how a converging lens forms a real image of a virtual object. (2)

(c) Two lenses of respective focal lengths f_1 and f_2 are placed coaxially in contact. Derive an expression for the focal length of the combination. (5)

(d) Describe an experiment to determine the refractive index of a liquid using a plane mirror and a converging lens. (5)

(e) A lens L_1 forms a real image, at A, of a distant object.

When another lens, L_2, is placed between L_1 and point A, at a distance of 10 cm from L_1, the image shifts by 4 cm towards L_1. When L_2 is placed 5 cm from L_1, the image shifts further by 3.5 cm towards L_1. Find the focal length of each lens. (6)

4. (a) (i) What is meant by ***electrostatic induction***? (1)

(ii) State the advantages of charging by induction. (2)

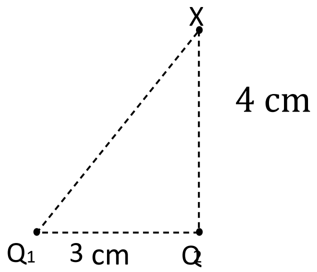
(b) Explain why a neutral conductor is attracted by charged body nearby. (3)

(c) Describe an experiment to investigate the charge distribution over a conductor, showing how the conclusion is arrived at. (4)

(d) (i) Derive an expression for the electric potential at a distance d from a point charge Q in a medium of permittivity ε. (4)

(e) In the figure below, Q_1 and Q_2 are point charges of 3.0 μC and -2.0 μC respectively.

(f)



Find

(i) The electric potential energy of Q_2. (2)

(ii) The magnitude of the electric intensity at point X (4)

5. (a) (i) Define ***capacitance***. (1)

(ii) What is meant by ***dielectric strength***? (1)

(iii) Explain the action of a dielectric. (4)

(b) Describe an experiment to show the relationship between capacitor charge and potential difference. (5)

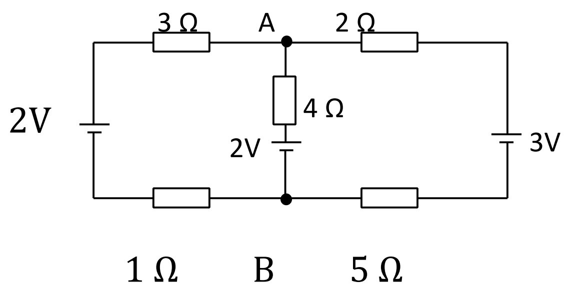
(c) Derive an expression for the energy stored in a capacitor of capacitance, C, charged to a voltage V. (5)

6. (a) (i) What is meant by ***potential difference***? (1)

(ii) Define a ***volt***. (1)

(b) Explain why the terminal p.d across a source decreases when a bigger current is drawn from the source. (3)

(c)



In the circuit shown above, find

(i) The current flowing in the 4-ohm resistor. (4)

(ii) The p.d between points A and B. (2)

(d) Describe an experiment to measure the internal resistance of a cell. (5)

(e) When a battery of emf 3 V is connected in series with a cell C, the combination gives a balance length of 90.0 cm. When cell C is reversed, the balance length falls to 18.0 cm. What is the e.m.f of cell C? (4)

END

SELF-TEST SET THREE PAPER P510/2

Where necessary, use the following constants:

Acceleration due to gravity, g $= 9.81\ m\,s^{-2}$

Permeability of free space, μ_0 $= 4.0\,\pi \times 10^{-7}\ Hm^{-1}$

Permittivity of free space, ε_0 $= 8.85 \times 10^{-12}\ Fm^{-1}$

Speed of light in a vacuum, c $= 3.0 \times 10^{8} ms^{-1}$

Electronic charge, e $= 1.6 \times 10^{-19}\ C$

The constant $\frac{1}{4\pi\varepsilon_o} = 9.0 \times 10^{9}\ F^{-1}m$

1. (a) For a converging mirror define the terms

(i) radius of curvature (1)

(ii) principal focus (1)

(b) With the aid of a ray diagram derive the mirror formula for a convex mirror. (6)

(c)(i) With the aid of a ray diagram, describe the structure and action of a reflecting telescope in normal adjustment. (5)

(ii) State two advantages of a reflecting telescope over a refracting one. (2)

(d) An astronomical telescope with an objective of focal length 84.0 cm and an eyepiece of focal length 8.0 cm. The eyepiece is shifted until the final image is formed at a distance of 64.0 cm from the objective.

Find the distance between the two lenses. (5)

2. (a) (i) Distinguish between **free** and **damped** oscillations. (2)

(ii) What is a **wave**? (1)

(b) A mechanical wave in a certain medium is represented by the equation

$y = 0.3\sin 2\omega(35t - 0.4x)$ where all distances are in metres.

(i) State what each of the symbols x and y represents. (2)

(ii) Find the velocity of the wave (3)

(c)(i) What is meant by **resonance** in waves? (1)

(ii) Describe an experiment to determine the velocity of sound in air using the resonance method. (6)

3. (a) What is meant by the terms:

(i) Magnetic meridian (1)

(ii) Magnetic declination (1)

(b) Explain what happens to the angle of dip as one moves along the same longitude from the Equator to the North pole. (2)

(c)(i) Write down an expression for the magnetic flux density at the centre of a narrow circular coil of radius r having N turns when a current I is flowing in it.

(ii) Describe an experiment to determine horizontal component of the Earth's magnetic flux density at a certain location. (5)

(d) A circular coil of 4 turns and diameter 14.0 cm carries a current of 0.35A. It is placed at the equator with its plane along the magnetic meridian. Calculate the direction and magnitude of the resultant magnetic flux density at the position if the earth's magnetic flux density at the location is 1.8×10^{-5} T. (4)

(e) (i) What is meant by the term ***magnetic moment*** of a coil? (1)

(ii) Explain why a moving coil galvanometer must have the following:

A radial magnetic field,

Fine hair springs,

Large number of turns

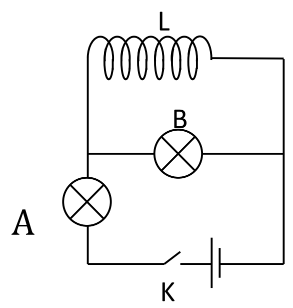
A conducting former. (5)

4. (a) What is meant by

(i) self-induction (1)

(ii) eddy current (1)

(b) The diagram shows an iron-cored coil, L, of many turns and negligible resistance with identical bulbs, A and B, connected in a circuit.



(i) When switch K is closed, at first both bulbs A and B light up, but soon B dims out while A becomes brighter. Explain these observations. (3)

(ii) If now K is opened, state and explain what is observed. (3)

(c)(i) Explain the origin of the back e.m.f in a motor. (2)

(ii) A motor, whose armature resistance is 2Ω, is operated on 240V mains supply. If it runs at 3000 rev min^{-1} when drawing a current of 5 A, at what speed will it run when drawing a current of 15 A? (3)

(d) (i) With the aid of a labeled diagram, describe the mode of action of a simple d.c generator. (5)

(ii) Sketch the output against time of a simple d.c generator. (1)

(iii) State two factors that determine the polarity of the output of a d.c generator. (1)

5. (a) For a source of electricity, what is meant by

(i) electromotive force (1)

(ii) Internal resistance? (1)

(b) (i) State the factors which determine the resistance of a wire of a given material. (2)

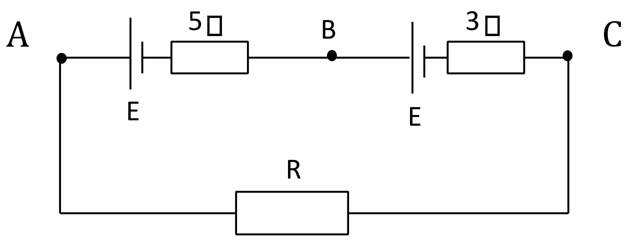
(ii) Explain why the resistance of a metal increases when the temperature of the metal is increased. (2)

(iii) Derive an expression for the equivalent resistance of three resistances, R_1, R_2 and R_3 connected in series. (3)

(c)You are provided with about 1 m of a bare constantan wire, an ammeter, a voltmeter, crocodile clips and some connecting wires.

Describe an experiment you would perform, using all but only the items provided, to determine the internal resistance of a cell. Give a diagram of your setup. (5)

(d) In the circuit shown below, each source has en emf of 2V and negligible internal resistance.



When a voltmeter is connected between A and B, it reads 0V.

Find

(i) The value of the resistance R. (4)

(ii) The reading of the voltmeter when connected between B and C. (2)

END

SELF-TEST SET THREE PAPER P510/2

INSTRUCTIONS TO CANDIDATES

Answer **FIVE** *questions, including* **ONE** *from each of sections* ***A&B*** *and at least* **ONE** *but not more than* **TWO** *from each of the sections* ***C*** *and* ***D***.

Assume where necessary:

Acceleration due to gravity, g	=	$9.81\ ms^{-2}$
Speed of light in vacuum, c	=	$3.0 \times 10^{8}\ ms^{-1}$
Electron charge, e	=	$1.6 \times 10^{-19}\ C$
Electron mass, m_e	=	$9.11 \times 10^{-31}\ kg$
Permeability of free space, μ_0	=	$4\pi \times 10^{-7}\ Hm^{-1}$
Permittivity of free space, ε_0	=	$8.85 \times 10^{-12}\ Fm^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0 \times 10^{9}\ F^{-1}$
One electron-volt (eV)	=	$1.6 \times 10^{-19}\ J$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ mol^{-1}$

SECTION A

1. (a) (i) Explain the difference between the terms **magnifying power** and **magnification** as applied to optical instruments. (3)

(ii) State what is meant by **normal adjustment** in the case of an astronomical telescope. (1)

(iii) With the aid of a ray diagram, explain how the two lenses of a telescope form, at infinity, a magnified virtual image of a real distant object. (4)

(b) A telescope has an objective of focal length 80cm and an eyepiece of focal length 2.0cm. It is focused on the moon, whose diameter subtends an angle of 8.0×10^{-3} rad at the objective. The eyepiece is adjusted so as to project a sharp image of the moon onto a screen placed 20cm from the eyepiece lens. Calculate:

(i) The diameter of the intermediate image formed by the objective lens. (3)

(ii) The diameter of the image on the screen. (3)

(iii) The separation of the lenses. (2)

(c) Explain, with the aid of a diagram, the formation of the **eye-ring** in a telescope and state why it is the best position for the eye of the observer. (4)

2. (a) (i) What is meant by ***refraction of light***? (1)

(ii) Explain why a pond of clear water appears shallower, than it actually is, to an observer. (3)

(iii) Describe an experiment to determine the refractive index of a liquid using the air-cell method. (6)

(b) A lens forms a sharp image of height h_1 on a fixed screen. As the lens is moved towards the screen another sharp image of height h_2, of the same object, is formed on the screen. If the object position remained the same in both cases, obtain an expression for the height of the object. (4)

(c) A converging lens of focal length 30 cm is placed between an object and a diverging lens of focal length 5 cm. If the object is 6 metres from the converging lens and 6.20 metres from the diverging lens, determine

(i) The position and nature of the image formed. (4)

(ii) The magnification of the image. (2)

SECTION B

3. (a) Distinguish between progressive and stationary waves. (4)

(b) A string under tension has a number of natural frequencies. Briefly describe an experiment to show that such a string vibrates freely only at its natural frequencies. (5)

(c) A uniform wire of length 1.00m and mass 2.0×10^{-2} kg is stretched between two fixed points. The tension in the wire is 200N. The wire is plucked in the middle and released.

Calculate the:

(i) Speed of the transverse waves. (2)

(ii) Frequency of the fundamental note. (3)

(d) (i) Explain how beats are formed. (3)

(ii) Derive an expression for the beat frequency. (3)

4. (a) (i) What is meant by interference of waves? (2)

(ii) State the conditions necessary for the observation of interference pattern.(2)

(iii) Describe how interference can be used to test for the flatness of a surface. (3)

(b) Describe with the aid of a labeled diagram, how the wavelength of monochromatic light is measured using Young's double-slit method. (5)

(c) Two microscope slides are in contact at one end and are separated by a thin piece of paper at the other end. Monochromatic light is directed normally on the wedge.

(i) What type of fringes will be observed? (2)

(ii) Explain what will be observed if a liquid is introduced between the slides.(2)

(d) When monochromatic light of wavelength 5.0×10^{-7}m is incident normally on a transmission grating, the second order diffraction line is observed at an angle of 27^0. How many lines per centimeter does the grating have? (4)

SECTION C

5. (a) (i) Define the unit of magnetic flux density. (1)

(ii) A rectangular coil of length *l and breadth **b** has* **N** turns and carries a current I. It is placed with its plane vertical in a horizontal magnetic field of flux density **B.**

Derive an expression for the torque exerted on the coil when the normal to its plane makes an angle **θ** with the magnetic field. (5)

(b) Explain the origin of the force on a current-carrying conductor placed in a magnetic field. (3)

(c) (i) Define the term angle of Dip as applied to the earth's magnetism. (1)

(ii) A circular coil of 4 turns and diameter 11.0 cm carries a current of 0.35A. It is placed with its plane in the magnetic meridian. Calculate the direction and magnitude of the resultant magnetic flux density at a position where the horizontal component of the earth's magnetic flux density is 1.8×10^{-6} T. (5)

(d) Explain why a moving coil galvanometer must have the following:- A radial magnetic field, fine hair springs, large number of turns and a conducting former. (5)

6. (a) Explain the meaning of the terms

(i) ***self-induction*** (1)

(ii) ***Mutual induction***. (1)

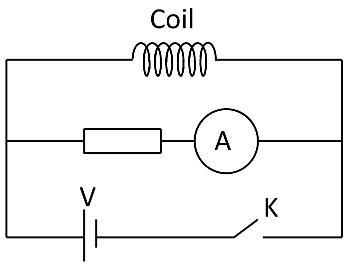
(b) (i) State the laws of electromagnetic induction. (2)

(ii) By using a suitable illustration with a North Pole, explain how Lenz's law serves as a good example of the principle of conservation of energy. (4)

(c) (i) Explain the main energy losses in a transformer and how they can be minimized. (4)

(ii) An a.c. transformer operates on a 240 V mains. The voltage across the secondary is 20 V. If the transformer is 80% efficient, calculate the current in the primary coil when a resistor of 40Ω is connected across the secondary.(3)

(d)



An iron-cored coil is connected as shown in the circuit above. Explain what happens to the reading of the Ammeter, A, when the switch k is

(i) First closed. (3)

(ii) Opened. (2)

7. (a) Define the following terms as applied to voltage in alternating current circuits.

(i) ***Root-mean-square value***. (1)

(ii) ***Peak value***. (1)

(b) Derive the relationship between the root mean square value and the peak value of the alternating current. (4)

(c) With the aid of a labeled diagram, describe the mode of operation of a repulsion type moving iron ammeter. (5)

(d) A source of alternating current voltage of ***frequency f*** is connected across the ends of a pure inductor of ***self inductance L***. Derive an expression for the inductive reactance of the circuit and explain the phase difference between the voltage and the current that flows. (5)

(e) A pure inductor of inductance 2H, is connected in series with a resistor of 500 Ω across a source of e.m.f 240 $V_{(r.m.s)}$, alternating at a frequency of 50 Hz. Calculate the potential difference across the resistor. (4)

SECTION D

8. (a) Explain why the terminal p.d falls as the current drawn from a source increases. (3)

(b) A d.c source of emf 12 V and negligible internal resistance is connected in series with two resistors of 400 and R ohms, respectively. When a voltmeter is connected across the 400 resistor, it reads 4 V while it reads 6 V when connected across the resistor of R ohms. Find the:

(i) resistance of the voltmeter (6)

(ii) value of R (1)

(c) Describe how you would use a slide wire potentiometer to measure the internal resistance of a dry cell. (5)

(d) In the circuit diagram shown below, AB is a slide wire of length 1.0 m and resistance 10 Ω. X is a driver cell of emf 3.0 V and negligible internal resistance. Y is a cell of emf 2.2 V and internal resistance 1.0Ω

When the centre-zero galvanometer is connected in turns to points **e** and **f**, the balance lengths obtained are 45.0 cm and 80.0 cm respectively.

Calculate the:

(i) Current flowing through R_1. (3)

(ii) Resistances of R_1 and R_2. (2)

9. (a) Define

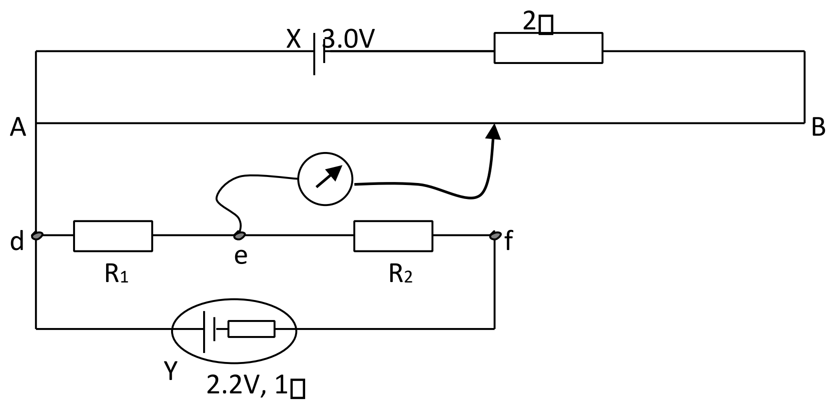
(i) capacitance (1)

(ii) dielectric strength (1)

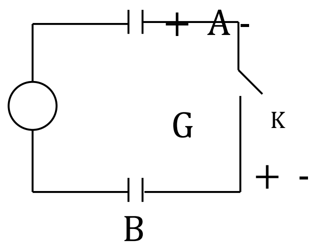
(b) Explain the action of a dielectric in a capacitor. (4)

(c) Describe an experiment to show that capacitance is affected by the thickness of the dielectric. (4)

(d) Derive an expression for the energy stored in a capacitor of capacitance C charge to a p.d V. (5)



(e) In the circuit shown below switch K is open, capacitors A and B have respective capacitances of 10μF and 15 μF and are charged to p.ds of 25 V and 20 V respectively.



A ballistic galvanometer G, with sensitivity of 2 divisions per μC joins the positive plates of the capacitors. If K is now closed, what will be the throw on G? (5)

10. (a) (i) State Coulomb's law of electrostatics. (1)

(ii) Define the terms ***electric field intensity*** and ***electric potential at a point***. (2)

(b) (i) Sketch graphs of the variation of electric potential and electric field intensity with distance from the centre of a charged conducting sphere. (2)

(ii) Describe how a conducting body may be positively charged but remains at zero potential. (3)

(iii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere. (3)

END