

Students Name:
School Name..... Index Number

P510/1
PHYSICS
PAPER 1
 $2\frac{1}{2}$ HOURS
JUNE/JULY 2025



HES MOCK EXAMINATIONS 2025

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PHYSICS
(THEORY)
PAPER 1

$2\frac{1}{2}$ HOURS

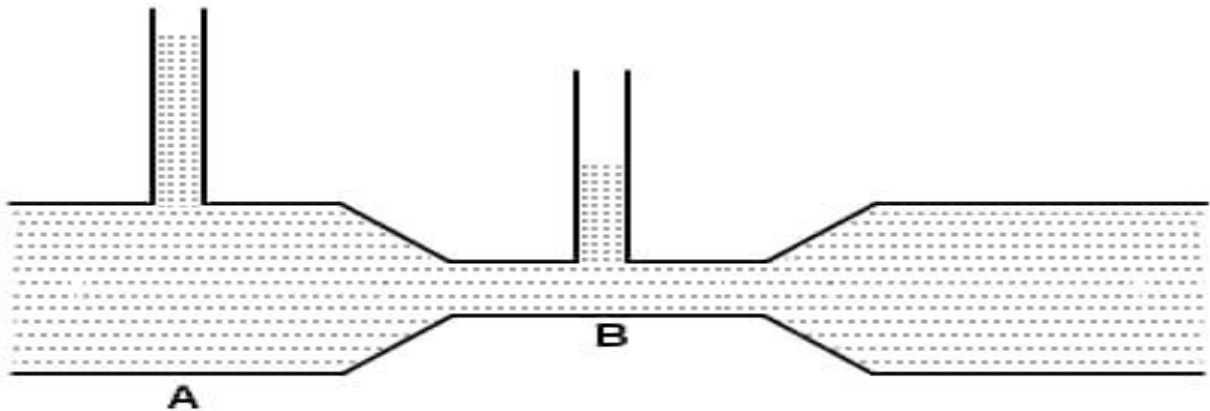
- Answer five questions including at least one but not more than two from each of the sections, A, B and C
- Any additional question(s) answered will not be marked
- Non programmable scientific calculators may be used

Assume where necessary

Acceleration due to gravity, g	$= 9.81ms^{-2}$
Electron charge, e	$= 1.6 \times 10^{-19}C$
Electron mass	$= 9.11 \times 10^{-31}Kg$
Mass of the earth	$= 5.97 \times 10^{-31}Kg$
Plank's constant, h	$= 6.6 \times 10^{-34}Js$
Stefan Boltzmann's constant, σ	$= 5.67 \times 10^{-8}WK^{-1}m^{-1}$
Radius of the earth	$= 6.4 \times 10^6m$
Radius of the sun	$= 7.0 \times 10^8m$
Speed of light in vacuum, C	$= 3.0 \times 10^8ms^{-1}$
Thermal conductivity of copper	$= 390WK^{-1}m^{-1}$
Thermal conductivity of steel	$= 50.2WK^{-1}m^{-1}$
Specific heat capacity of water	$= 4200JKg^{-1}^{\circ}C^{-1}$
Universal gravitational constant G	$= 6.67 \times 10^{-11}Nm^2Kg^{-1}$
Avogadro's constant	$= 6.02 \times 10^{23}mol^{-1}$
Surface tension of water	$= 7.0 \times 10^{-2}Nm^{-1}$
Density of water	$= 1000Kgm^{-3}$
Molar gas constant R	$= 8.31Jmol^{-1}K^{-1}$
Young's modulus of copper	$= 1.2 \times 10^{11}Nm^{-2}$
Young' modulus of steel	$= 2.0 \times 10^{11}Nm^{-2}$

SECTION A

1. (a) i) Define surface tension and surface energy (02 marks)
ii) Calculate the amount of energy liberated when 1000 droplets of water each of diameter $1.0 \times 10^{-1} \text{ cm}$ coalesce under isothermal conditions, to form a bigger drop. (surface tension of water = $7.2 \times 10^{-4} \text{ Nm}^{-1}$) (4 marks)
- b) i) What is meant by upthrust? (1 mark)
ii) A hot air balloon has a volume of 500 m^3 . The balloon moves upwards at a constant speed in air of density 1.2 kgm^{-3} when the density of the hot air inside is 0.8 kgm^{-3} . Calculate the upward acceleration of the balloon when the temperature of the air inside the balloon is increased so that the density becomes 0.7 kgm^{-3} . (4 marks)
- c) i) State Bernoulli's Principle. (1 mark)
ii) Derive the Bernoulli's equation. (5 marks)
- d) The figure below shows part of a Venturi-meter in which a liquid of density ρ flows at a speed V in the main pipe.



Show that $V = \sqrt{\frac{2ghA_2^2}{A_1^2 - A_2^2}}$ where A_1 and A_2 are cross-sectional areas of the main pipe and the constriction. (3 marks)

2. a) i) State the condition under which the principle of conservation of linear momentum applies. (1 mark)
ii) A particle X moving in a straight line with a velocity, U makes a head-on collision with particle initially at rest. After impact, Y acquires a velocity of $\frac{8}{5}U$. If the collision is elastic, determine the percentage of X's energy transferred to Y. (5 marks)

- b) Describe an experiment to determine the velocity of a bullet in a school laboratory. (5 marks)
- c) What is meant by the term work hardening? (2 marks)
- d) i) A copper rod of a given length, Young's modulus γ , cross-sectional area, A and coefficient of linear expansion, α is fixed between two rigid supports and heated through a temperature rise at 0°C . Derive the expression for the force that develops at the supports. (3 marks)
- ii) A uniform metal bar of length 2cm is fixed between two rigid supports at 25°C . If the temperature of the bar is raised to 75°C , calculate the energy stored in the bar. (4 marks)
- 3.a) i) State Newton's law of Gravitation. (1 mark)
- ii) Explain why the universal gravitation force is not noticeable with ordinary bodies in our every day-to-day life. (2 marks)
- b) State Kepler's laws of planetary motion. (3 marks)
- c) i) Sketch a graph showing the variation of acceleration due to gravity with distance from the center of the earth. (2 marks)
- ii) Derive an expression for the acceleration due to gravity, g inside the earth at a height, h below the earth's surface given that the earth is assumed to be homogeneous. (4 marks)
- d) What I meant by;
- i) a parking orbit. (1 mark)
- ii) escape velocity. (1 mark)
- e) A satellite of mass 100kg is launched in a parking orbit above the earth's surface. Calculate the height of the satellite above the earth's surface. (3 marks)
- 4.a)i) State four characteristics of simple harmonic motion. (2 marks)
- ii) A particle executes simple harmonic motion between two fixed points A and B about the mean position O. sketch a graph of mechanical energy of the particle as a function of displacement X moved by the particle. (2 marks)
- b) Two identical springs each of force constant 5.0 Nm^{-1} are connected on either end of a body of mass 50g resting on a frictionless horizontal surface.
- i) Show that when the body is slightly displaced, it executes a simple harmonic motion of frequency, f given by $f = \frac{2}{\pi} \sqrt{\frac{k}{m}}$ where k is the force constant of each spring. (4 marks)
- ii) Determine the period of oscillation of the body. (2 marks)

- c)i) Define the term angle of banking. (1 mark)
- ii) Explain why an aero plane has to slant in air in order to negotiate a bent horizontal path. (3 marks)
- d) A car of width 170cm goes round a horizontal circular bend of radius 200cm. If the Centre of gravity of the car above the ground is 50cm, calculate the maximum safe speed for the car not to topple. (4 marks)
- e) Explain why a body moving at a constant speed in a circular path is said to be accelerating. (2 marks)

SECTION B

- 5.a) Calculate cooling correction a used in calorimeter experiments. (1 mark)
- b) An electrical heater rated 8.5V, 4A of negligible heat capacity is used to heat 350g of a liquid in a copper calorimeter of mass 120g and specific heat capacity $4400\text{Jkg}^{-1}\text{K}^{-1}$ initially at 30°C . The heater I operated for exactly 8 minutes and after this time, the temperature was observed to be 38.5°C . The temperature falls subsequently to 36°C in 5s. Calculate the;
- i) corrected temperature rise. (3 marks)
- ii) specific heat capacity of the liquid. (2 marks)
- c) i) Define specific latent heat of vaporization. (1 mark)
- ii) Describe an experiment to determine the specific latent heat of vaporization of a liquid using the Dewar flask. (6 marks)
- iii) An electrical heater of 2kW is used to heat 0.5kg of water in a kettle of specific heat capacity $440\text{Jkg}^{-1}\text{K}^{-1}$. The initial temperature of the liquid is 20°C . Calculate the time it will take to boil away 50mg of water. (5 marks)
- d) Explain the specific latent heat of fusion of pure ice is greater at -5°C than at 0°C . (2 marks)
- 6.a)i) Distinguish between a real and an ideal gas. (2 marks)
- ii) The equation of state of one mole of a real gas is given by the expression, $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. Account for the term, $\frac{a}{V^2}$ and b where P , V , R and T carry their usual meaning. (2 marks)
- b) i) State Graham's law of diffusion. (1 mark)
- ii) Calculate the root mean square speed of molecules of an ideal gas at 207°C gixen that the density of the gas at 0°C is 1.5kgm^{-3} . (3 marks)
- c)i) Distinguish between saturated and unsaturated vapor. (2 marks)
- ii) Explain the effects of volume change on saturated vapor pressure at a constant temperature. (2 marks)
- d) Define thermal conductivity of a material and temperature gradient.

(2 marks)

e) In a double-glazing window, two thick glasses, each of thickness 30mm are separated by 10mm thickness of air gap. The thermal conductivity of glass is $1.0\text{Wm}^{-1}\text{K}^{-1}$ and that of air is $0.02\text{Wm}^{-1}\text{K}^{-1}$. The external surfaces of each glass are at 50°C and 20°C respectively. Calculate the;

i) Temperature of air in contact with each inner glass surface. (4 marks)

ii) Thickness of glass which is thermally equivalent to 120mm thickness of air in this case. (2 marks)

7.a)i) State Prevost's theory of heat exchange. (1 mark)

ii) Describe an experiment to show that dull surfaces are good thermal emitters than shiny surfaces. (4 marks)

b) A solid copper metal sphere, A at 327°C is placed in an enclosure at 27°C . The sphere cools at a rate of 3.80K per minute. Determine the rate of cooling of solid copper sphere, B at 227°C placed in the same temperature enclosure given that the radius of the sphere, B is twice that of A. (5 marks)

c)i) What is meant by a black body? (1 mark)

ii) State any two laws of black body radiation. (2 marks)

iii) Explain why welders are advised to wear black gases. (2 marks)

d)i) Define emissivity. (1 mark)

ii) An unlagged thin-walled copper pipe of diameter 2.0cm carries water at a temperature of 40K above that of the surrounding air. Estimate the net power loss per unit length of the pipe if the pipe emits 80% as a perfect black body, given that the surrounding air is at a temperature of 27°C . (4 marks)

SECTION C

8a) Define the following;

i) Unified atomic mass unit (1 mark)

ii) Binding energy per nucleon (1 mark)

b)i) Sketch a graph of binding energy per nucleon against mass number, clearly indicating the regions of nuclear fission and fusion. (2 marks)

ii) Explain the origin of fusion energies. (2 marks)

c)i) What is meant by Activity? (1 mark)

ii) A radioactive isotope ^{60}Co decays to ^{60}Ni which spontaneously decays to give two gamma ray photons, the half-life of ^{60}Co is 5.3 years . Estimate the power obtainable from 20g of ^{60}Co . Given that;

Mass of $^{60}\text{Co} = 59.93381\text{U}$

Mass of $^{60}\text{Co} = 59.93079\text{U}$

$1\text{U} = 931\text{MeV}$ (5 marks)

d)i) Describe the operation of a Geiger Muller tube with the aid of a well labelled diagram. (5 marks)

ii) A Geiger Muller tube is placed 20cm from a 2.0g sample of Radon – 222 ($^{222}_{86}\text{Rn}$). The tube registers a count rate of 85 counts per second. If the entrance Mica window has a diameter of 12cm, calculate the half-life of Radon. (3 marks)

9.a)i) Define specific charge of an ion. (1 mark)

ii) With the aid of a well labelled diagram, describe an experiment to determine the specific charge of an ion using a Bain Bridge mass spectrometer. (5 marks)

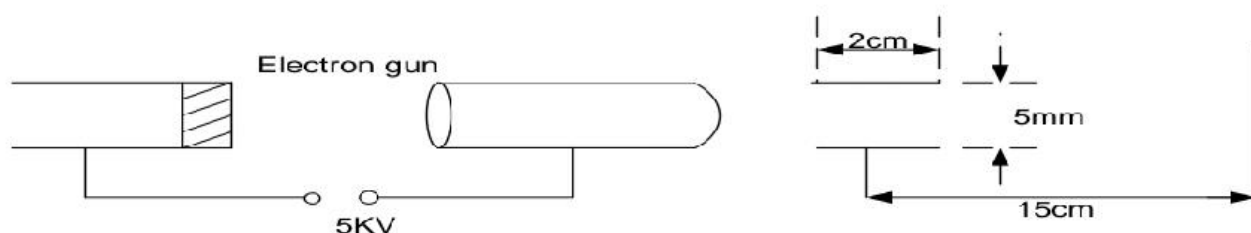
c) The following measurements were made in a mass spectrograph for a beam of doubly ionized Neon atoms. $B = 0.005T$, $r = 53\text{mm}$, $E = 1.25 \times 10^2 \text{Vm}^{-1}$. Calculate the atomic mass of Neon atom.

(Given that the magnetic flux density in both magnetic fields is the same and $1\text{u} = 1.66 \times 10^{-27}\text{kg}$) (3 marks)

iv) Explain how the mass spectrometer reveals the abundancy of isotopes. (2 marks)

b) A charge, Q with mass, m is accelerated through a p.d, V into a uniform electric field of strength, E between two horizontal parallel plates of length, x is deflected through an angle θ . Show that $\cot \theta = \left(\frac{2V}{Ex}\right)$. (4 marks)

c) The figure below shows parts of an electron gun, deflecting and fluorescent system of a C.R.O.



Use the indicated data to calculate the deflection sensitivity of the Y-plates of the C.R.O. (5 marks)

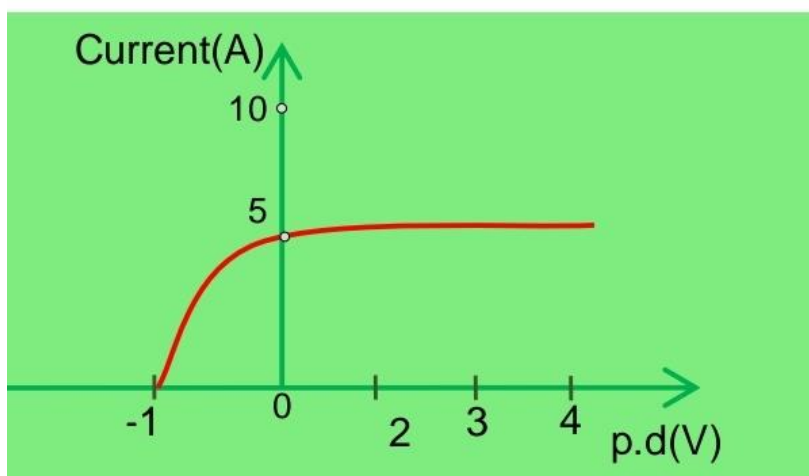
10a) State the characteristics of photoelectric emission. (4 marks)

b) Describe an experiment to determine the work function of a metal surface using the Millikan's apparatus. (6 marks)

c) A photo cell is connected in the circuit shown below.



The photo cathode is illuminated with monochromatic light of wavelength $390nm$. A graph of photo current, I against the p.d, V applied between the anode and the cathode is plotted and it is as shown below.



- i) Find the maximum Kinetic energy of the photo electrons. (2 marks)
- ii) What is the work function of the photo cathode. (3 marks)
- d)i) What is meant by mutual inductance as applied to triodes. (1 mark)
- ii) A triode with mutual inductance of $3mAV^{-1}$, anode resistance of $2 \times 10^4\Omega$ and load resistance of $20,000\Omega$ is used as a single voltage amplifier. Calculate the voltage gain. (2 marks)

END