

P510/1
PHYSICS

Paper1

2022

2 ½ hours



MATIGO MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

PHYSICS

Paper1

2hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

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	=	$1.6 \times 10^{-19}\text{C}$
Electron mass		=	$9.11 \times 10^{-31}\text{Kg}$
Mass of the earth		=	$5.97 \times 10^{24}\text{Kg}$
Planck's constant,	h	=	$6.6 \times 10^{-34}\text{JS}$
Stefan's-Boltzmann's constant,	σ	=	$5.67 \times 10^{-8}\text{Wm}^{-2}\text{K}^{-4}$
Radius of the earth		=	$6.4 \times 10^6\text{m}$
Radius of the sun		=	$7 \times 10^8\text{m}$
Radius of the earth's orbit about the sun		=	$1.5 \times 10^{11}\text{m}$
Speed of light in a vacuum, c		=	$3.0 \times 10^8\text{ms}^{-1}$
Thermal conductivity of copper		=	$390\text{Wm}^{-1}\text{K}^{-1}$
Specific heat capacity of water		=	$4200\text{Jkg}^{-1}\text{K}^{-1}$
Universal gravitational constant, G		=	$6.67 \times 10^{-11}\text{Nm}^2\text{Kg}^{-2}$
Avogadro's number, N_A		=	$6.02 \times 10^{23}\text{mol}^{-1}$
Density of water		=	1000Kg m^{-3}
Gas constant, R		=	$8.31\text{Jmol}^{-1}\text{K}^{-1}$
Charge to mass ratio, e/m		=	$1.8 \times 10^{11}\text{C Kg}^{-1}$
Specific heat capacity of copper		=	$400\text{Jkg}^{-1}\text{K}^{-1}$

SECTION A

1. a) i) Define the surface tension. (1 mark)
ii) Lycopodium powder is sprinkled over the surface of water in a dish. A small drop of soap solution is then introduced at the center of the surface. Explain what is observed on the surface. (3 marks)
- b) Describe an experiment to determine surface tension of a liquid by capillary tube method. (6 marks)
- c) i) State Bernoulli's principle. (1 mark)
ii) Explain how Bernoulli's principle is applied in a filler pump. (3 marks)
- d) Water flows steadily along a uniform tube of cross-section 30cm^2 . The static pressure is $1.25 \times 10^5 \text{ pa}$ and the total pressure is $1.30 \times 10^5 \text{ pa}$.
Find;
i) The flow velocity. (4 marks)
ii) The mass flow rate. (2 mark)
2. a) Define the following
i) A couple. (1 mark)
ii) Torque. (1 mark)
- b) Show that when a couple rotates a body the work done is equal to the product of the torque and the angle in radians turned through. (3 marks)
- c) State the conditions under which a rigid body is in equilibrium under the action of coplanar forces. (2 marks)
- d) A uniform rod AB of length 2m weighs 3.5kg. A body of mass 12kg hangs from end A and a body of mass 5kg hangs from end B. The system is suspended from point P of the rod where P is X meters from end A so that the rod is horizontal.
Determine;
i) The value of X in meters. (3 marks)
ii) The extra mass which should be added at A, such that P is 0.4m from end A. (2 marks)
- e) i) State the laws of kinetic friction. (3 marks)
iii) Describe an experiment to determine the co-efficient of dynamic friction. (4 marks)

3. a) i) Define simple harmonic motion. (1 mark)
 ii) Explain why oscillations in a simple harmonic motion ultimately die out. (3 marks)
- b) i) Show that a small mass attached to the free end of a suspended inextensible string executes simple harmonic motion when displaced through a small angle and released. (4 marks)
 ii) Explain briefly how the arrangement above can be used to determine acceleration due to gravity. ? (5 marks)
- c) A particle executing simple harmonic motion vibrates in a straight line. Given that the speed of the particle are 4ms^{-1} and 2ms^{-1} when the particle is 3cm and 6cm respectively from the equilibrium position, calculate the;
 i) Amplitude of oscillation. (3 marks)
 ii) Frequency of the particle. (3 marks)
- d) State two practical examples of oscillatory motions that approximate to simple harmonic motion. (2 marks)
4. a) Distinguish between conservative and non-conservative forces and given two examples of each. (4 marks)
- b) i) A car of mass 1000kg moves along a straight surface with a speed of 20ms^{-1} . When brakes are applied steadily, the car comes to rest after travelling 50m. calculate the co-efficient of friction between the surface and the tyre. (4 marks)
 ii) State the energy changes which occur from the time the brakes are applied to the time the car comes to rest. (2 marks)
- c) state;
 i) The Newton's laws of motion. (3 marks)
 ii) The principle of conservation of momentum. (1 mark)
- d) Using the Newton's law of motion deduce the principle of conservation of linear momentum. (4 marks)
- e) Distinguish between elastic and inelastic collisions. (2 marks)

SECTION B

5. a) i) State Boyle's law. (1 marks)
 ii) Describe an experiment that can be used to verify Boyle's law. (5 marks)

- b) Explain the following observations using kinetic theory.
- A gas fills any container in which it is placed and exerts a pressure on its walls. (3 marks)
 - The pressure of a fixed mass of a gas rises when its temperature is increased at constant volume. (2 marks)
- c) i) What is meant by a reversible process? (1 mark)
- ii) State the conditions necessary for isothermal and adiabatic processes to occur. (4 marks)
- d) When air saturated with water vapor in a rigid cylinder, at 100°C and pressure $2.0 \times 10^5 \text{ Pa}$, is cooled to 20°C , the pressure drops to $7.98 \times 10^4 \text{ Pa}$. Neglecting the expansivity of the cylinder. Calculate the saturated vapor pressure of water at 20°C . (Atmospheric pressure = $1.03 \times 10^5 \text{ Pa}$) (Assume $\gamma = 1.4$) (4 marks)
6. a) i) Define specific heat capacity of a substance. (1 mark)
- ii) State the factors that determine the rate of cooling of a body. (2 marks)
- iii) Explain why a small body cools faster than a bigger one of the same material. (3 marks)
- b) With the aid of a well labeled diagram, describe an electrical method of determining the specific latent heat of vaporization of water. (6 marks)
- c) i) Define thermal conductivity of a substance. (1 mark)
- ii) In an experiment to determine the thermal conductivity of a poor conductor, the specimen is made thin and of large cross-section area, explain why? (2 marks)
- iii) A circular disc of glass 3mm thick and 110mm diameter is placed between two brass slabs A and B. The temperature of the lower slab becomes constant at 92°C while the temperature of A is 96°C . B is warmed above 92°C when insulated on top and its cooling pattern studied. The rate of cooling at 92°C is found to be 0.042 K s^{-1} . Calculate the thermal conductivity of the glass if the mass of B is 0.94kg and its specific heat capacity is $400 \text{ J kg}^{-1} \text{ K}^{-1}$. (5 marks)
7. a) With the aid of a diagram, describe the action of an ether thermoscope in detecting infra-red radiation in a beam of sun light. (4 marks)
- b) i) What is meant by a black body radiation? (1 mark)
- ii) Sketch curves to show how energy is distributed among the various wave

- lengths of blackbody radiation for three different temperatures. (3 marks)
- iii) Explain why cavities in a fire look brighter than the rest of the fire. (2 marks)
- iv) The intensity of radiant energy from a black body is a maximum at a wave length of $1.5 \times 10^{-6} \text{m}$. Calculate the temperature of the black body. (3 marks)
- c) i) Distinguish between a real and an ideal gas. (2 marks)
- ii) Derive the expression

$$P = \frac{1}{3} \rho \overline{c^2} \text{ for the pressure of an ideal gas of density, } \rho \text{ and mean square spread } \overline{c^2}. \quad (5 \text{ marks})$$

SECTION C

8. a) i) Sketch the I-V characteristics for gaseous conduction. (2 marks)
- ii) Explain the main features of the curve in (a) (i) above. (3 marks)
- b) i) What is meant by thermionic emission? (1 mark)
- ii) Describe an experiment to show that cathode rays carry a negative charge. (4 marks)
- c) A horizontal beam of electrons, moving with a uniform speed, enters a uniform electric field between two horizontal parallel charged plates. Show that the path between the plates is a parabola. (5 marks)
- d) In a Millikan oil-drop experiment, a single negatively charged drop of radius $6 \times 10^{-6} \text{m}$ was found to fall under gravity at a terminal velocity of $4 \times 10^{-3} \text{ cms}^{-1}$ and to rise at $1.2 \times 10^{-2} \text{ cms}^{-1}$ when a field of 2×10^5 was suitably applied. Given that the viscosity of the medium was $2.122 \times 10^{-5} \text{ Nsm}^{-2}$, determine the number of electrons on the drop. (5 marks)
9. a) i) Distinguish between α -rays and cathode rays. (2 marks)
- ii) In an x-ray tube, explain the features adopted for the structure and materials of the anode. (4 marks)
- b) Explain x-ray diffraction by a crystal and derive Bragg's law. (6 marks)
- c) i) What is meant by the term photo electric effect? (1 mark)
- ii) Define the terms work function and threshold frequency. (2 marks)

- iii) When light of wave length 450nm falls on a certain metal surface, it ejects photo electrons with maximum velocity of $6.0 \times 10^5 \text{ms}^{-1}$ calculate the work function and the threshold frequency for the metal surface. (5 marks)

10. a) Define the following terms.

- i) Half-life. (1 mark)
ii) Decay constant. (1 mark)

b) Given the radioactive law $N=N_0e^{-\lambda t}$, obtain between λ and half-life. (3 marks)

c) Explain how a Geiger- muller tube can be used to determine half life of a radio active sample ? (4 marks)

d) i) Define binding energy per nucleon (1 mark)

ii) Sketch a graph of binding energy per nucleon against nucleon number (2 marks)

iii) Explain the features of the graph in d(ii) above. (3 marks)

e) Calculate the binding energy per nucleon, in joules, for ${}^{59}_{26}\text{Fe}$ given that

Mass of ${}^{59}_{26}\text{Fe} = 58.93488\text{u}$

Mass of proton = 1.00728u

Mass of neutron = 1.008677u and $1\text{u} = 931 \text{ Mev}$. (3 marks)

f) State conditions necessary for nuclear fusion and nuclear fission (2 marks)

END