P510/1
Physics
Paper 1
June/July, 2023
$2\frac{1}{2}$ *Hours*

MATIGO EXAMININATIONS BOARD
PRE MOCK 2023
UGANDA ADVANCED CERTIFICATE OF EDUCATION
PHYSICS PAPER 1
2Hours: 30 Minutes

INSTRUCTIONS TO CANDIDATES

*Attempt not more than **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

Where necessary, assume the following constants:

Acceleration due to gravity, g	=	$9.81\ m\ s^{-2}$
Electronic charge, e	=	$1.6 \times 10^{-19} C$
Electronic mass	=	$9.11 \times 10^{-31} kg$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Mass on earth	=	$5.97 \times 10^{24} kg$
Charge to mass ratio of an election	=	$\mathbf{1.8 \times 10^{11} C Kg^{-1}}$
One electron volt, eV	=	$1.6 \times 10^{-19} J$
Planck's constant, h	=	$6.6 \times 10^{-34} J\ s$
Radius of the earth	=	$6.4 \times 10^{6} m$
Specific heat capacity of water	=	$4.2 \times 10^{3}\ J\ kg^{-1} K^{-1}$
Specific latent heat of fusion of ice	=	$3.36 \times 10^{3} J Kg^{-1} K^{-1}$
Stefan's – Boltzmann's constant, δ	=	$5.67 \times 10^{-8}\ W\ m^{-2} K^{-4}$
Speed of light in Vacuum, c	=	$3.0 \times 10^{8}\ m\ s^{-1}$
Unified mass unit, U	=	$1.66 \times 10^{-27}\ kg$
Universal gravitational constant, G	=	$6.67 \times 10^{-11} N M^2 Kg^{-2}$
Gas constant, R	=	$8.31 J mol^{-1} K^{-1}$
Permittivity of free space, $\in_o$	=	$8.85 \times 10^{-12} Fm^{-}$

Turn Over

SECTION A

1(a) (i) State the principle of conservation of mechanical energy. (1mark)

(ii)A body of mass, m is projected vertically upwards with speed , u. Show that the principle of conservation mechanical energy is obeyed throughout its motion. (4marks)

(b)(i)Describe an experiment to determine the coefficient of kinetic friction. (4marks)

(ii) State one limitation of the experiment in (b)(i) above. (1mark)

(c) From the top of a tower 156.8m high above the ground a projectile is thrown up in a velocity of $39.2ms^{-1}$making an angle of 30° to the horizontal. Find the

(i) time taken to strike the ground. (3marks)
(ii) distance from the foot of the tower to where it strikes the ground. (2marks)
(iii) velocity with which it strikes the ground. (3marks)

(d)Briefly explain why mountain roads rarely go straight up. (2marks)

2(a) (i) State the factors that affect the rate of flow of a liquid in a pipe. (2 marks)
(ii) With aid of a diagram, describe an experiment to measure the co efficient of viscosity of water using poisseulle's formular. State any assumption made. (7marks)

(b) Explain why you should blow over a piece of paper and not under in order to keep it horizontal. (3marks)

(c) A horizontal pipe of cross sectional area $0.4m^2$ tapers to cross sectional area $0.2m^2$ 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 $1.2ms^{-1}$If atmospheric pressure is $1.01 \times 10^5 Pa$Find the :

(i) Velocity at the small section of the pipe. (4marks)
(ii) Pressure at the small section of the pipe. (2marks)
(d)Explain the effect of temperature on viscosity of liquids. (2marks)

3 (a) (i) State Newton's universal law of gravitation. (1 mark)

(ii) A satellite is launched at a height h, above the earth's surface of radius, R and density, ρ .show that the time period, T of the satellite is given by:

$$T = 2\pi\sqrt{\frac{3\pi(R+h)^3}{G\rho R^3}}$$

Where G is the gravitational constant. (4marks)

(b) (i) What is meant by a parking orbit ? (1 mark)

(ii) Explain briefly how satellites are used in world -wide radio or television communication. (4marks)

(c) A body of mass 1200kg raised to a height of 500km above the earth's surface.

Calculate

(i) the acceleration due to gravity at that point. (3marks)
(ii) Its mechanical energy. (3marks)

(d) A mass, m is suspended from a rigid support by a string of length, l.The mass is pulled aside so that the string makes an angle, θ him the vertical and then released. Show that the mass executes simple harmonic motion

period, $T = 2\pi\sqrt{\frac{l}{g}}$ (4marks)

4(a)(i) Distinguish between surface tension and surface energy. (2marks)

(ii) Show that surface energy and surface tension are numerically equal.(3marks)

(iii)Explain why a drop of liquid under no external force is always spherical in shape? (3marks)

(b) One end of a clean capillary tube having internal diameter 0.6mm is dipped into a beaker containing water which rises up to a vertical height 5.0cm above the water surface in the beaker.

(i) Derive an expression for surface tension of water in terms of radius, r of the capillary tube, density,ρ of water, angle of contact, θ and length, h of water in the capillary tube. (3 marks)

(ii) Calculate the surface tension of water assuming angle of contact is zero

(2marks)

(iii)If the length of the capillary tube above the water surface is 3.0cm. Explain what would happen to the liquid in the capillary tube. (2 marks)

(c)(i)State Archimedes principle. (1mark)

(ii) Briefly describe how density of a liquid can be obtained using Archimedes principle. (4marks)

SECTION B

5(a) (i) Define the terms absolute zero and specific heat capacity. (2marks)
(ii) Explain why temperature less than absolute zero is not possible. (3marks)
(iii)Explain why the coolant used in car should have high specific capacity. (2marks)

(b)(i) State Newton's law of cooling. (1mark)

(ii) Describe an experiment to verify Newton's law of cooling. (6marks)

(c)An electrical heater of 2KW is used to heat 500g of water initially at 20℃ in a kettle of heat capacity $400Jk^{-1}$
(i) how long will it take to heat the water to its boiling point? (3marks)
(ii) Calculate the mass of water boiled away in 5 minutes. (3marks)

6(a)(i) State the assumptions of kinetic theory of gases. (2marks)
(ii)Using those assumptions in a(i) above derive an expression for pressure, p exerted by a gas of density ρ, and mean square speed $\overline{C^2}$ of its molecules. (5marks)

(b) Helium gas of relative molecular mass 4 occupies a volume of $0.004m^3$ at a pressure of $2 \times 10^5 Pa$ and temperature 27℃ .Calculate the
(i) Root mean square speed of its molecules. (3marks)
(ii) Total kinetic energy. (3marks)
(iii) root mean as square speed when the gas is heated at constant pressure to a temperature of 159℃ . (3marks)

(c)(i)Define saturated vapour pressure. (1mark)

(ii) Explain the effect of temperature on saturated vapour pressure of a liquid. (3mark)

7(a) (i) Define emissivity. (1mark)
(ii) Give the main features of Prevost's theory of exchanges. (2marks)

(b)(i) With help of a diagram, describe an experiment to determine the normal conductivity of a metal. (6marks)
(ii)Why is the method above in b(i) above best suited for a metal? (2marks)

(c) A body which has a surface area of $5.0cm^2$ and temperature727℃ is placed in an enclosure at 37^0C and radiates $300J$ of energy each minute
(i) What is its emissivity? (3marks)
(ii) Calculate the wavelength emitted by the body at maximum intensity. (2marks)
(d)Water is boiled at 100c in a rectangular steel tank of thickness 2.0cm by a constant temperature furnace .Due to vaporization water level falls at a steady rate of 1.0cm in 9minutes. Calculate the temperature of the furnace. (3marks)

SECTION C

8(a) Explain the main observations made in Rutherfords α -particle scattering experiment. (6marks)

(b)(i) Show that when an α -particle collides head on with an atom of atomic number Z, the least 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 free space m is mass of -particle and V is initial speed of the α –particles. (3marks)

(ii) In a head of collision between an α - particle and gold nucleus of atom, Z number 79 the minimum distance of approach is 5.2×10^{-14}.
Calculate the energy of the α -particle in Mev (3marks)
(c) (i) With help of a diagram , describe the mode of operation of an x-ray tube.

(5marks)

(ii) When $x - ray$ beam of wavelength 2.3Å fills on sodium chloride crystal of molar mass 58.5 and density $2.18 \times 10kgm^{-3}$, a second order diffraction maxima occurs. Calculate the glancing angle. (3mark)

9(a) (i) what are positive rays? (1mark)

(ii) State two differences between positive rays and cathode rays. (2marks)

(b)(i) With aid of a diagram, describe Millican's experiment to determine the charge on an oil drop. (6marks)

(ii) Explain the size of oil drops should be small. (1mark)

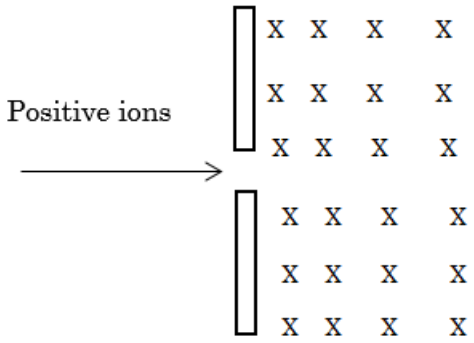
(c) Oil droplets are introduced into the space between two horizontal plates 5mm apart. When the plate voltage is 780V, one of the droplets is held stationary, when the plate voltage is switched off, the selected droplet is observed to fall a distance of 1.50mm in 11.2 seconds. Given that the density of oil is $900kgm^{-3}$ and viscosity of air at 20℃ is $1.8 \times 10^{-5}pa$.

Calculate the:

(i) Mass of the droplet (4marks)

(ii) charge of droplet (3marks)

(d)



The figure above shows a beam of positive ions each mass, m and charge, q accelerated from rest by electric field of p.d, V and enter normally into a region of uniform magnetic field of flux density, B. Show that the radius of the path described in magnetic field is given by

$$r = \sqrt{\frac{2Vm}{qB^2}} \qquad (3marks)$$

10 (a) What is meant by
(i) Decay constant. (1mark)
(ii) Electron volt. (1mark)
(b) (i) Describe the structure and operation of an expansion cloud chamber.

(6marks)

(ii) Explain the effect of reducing pressure in the cloud chamber on the length of track by alpha particles. (3marks)

(c) A radioactive sample of ^{222}Ra of half-life 3.8days emits an alpha particle of energy 5.6MeV. After 7.2 days, Calculate the:

(i) number of atoms remaining in 3μKg of the sample (4marks)
(ii)Energy released in Joules in (i) above (2marks)
(d)Describe one industrial use of radioactivity. (3marks)

END