P510/1
PHYSICS
Paper 1
July/August, 2023
2 ½ hours

ASSHU ANKOLE JOINT MOCK EXAMINATIONS 2023
Uganda Advanced Certificate of Education
PHYSICS
Paper 1
2 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Attempt **five** questions including at least **one** from each section, but not more than **two** from each of the sections **A**, **B** and **C**.
- **Any** additional question(s) answered will **not** be marked.

Assume where necessary

- Acceleration due to gravity, g = $9.81\ ms^{-2}$
- Electronic charge e = $1.6 \times 10^{-19} C$
- Electron mass = $9.11 \times 10^{-31} kg$
- Plank's constant, h = $9.11 \times 10^{-31} kg$
- Speed of light in a vacuum, C = $3.0 \times 10^{8}\ ms^{-1}$
- Stefan's – Boltzmann's constant = $5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
- Avogadro's number, NA = $6.0^{2} \times 10^{23}\ mol^{-1}$
- Density of water = $1000\ kgm^{-3}$
- Surface tension of water = $7.5 \times 10^{-2}\ Nm^{-1}$
- Surface tension of mercury = $5.47 \times 10^{-1}\ Nm^{-1}$
- Density of mercury = $13600\ kgm^{-3}$
- Mass of earth = $6.07 \times 10^{-11}\ Nm^{-2}kg^{-2}$
- Universal gravitational constant, G = $6.67 \times 10^{-11}\ Nm^{-2}kg^{-2}$
- Radius of earth = $6.4 \times 10^{6}\ m$
- Thermal conductivity of steel = $50.2\ Wm^{-1}k^{-1}$
- Specific latent heat of vaporization of water = $2.26 \times 10^{6}\ Jkg^{-1}$
- Faraday constant = 96500 C

SECTION A

1.(a) (i) What is meant by dimensions of a physical quantity. (1 mark)

(ii) The volume rate, $\frac{V}{t}$ of a liquid flowing through a horizontal pipe of length, l depends on the pressure gradient, $\frac{P}{l}$ the radius, r of the pipe and the coefficient of viscosity, η (of dimensions $ML^{-1}T^{-1}$) of the liquid. Use dimensions to derive an expression for $\frac{V}{t}$ in terms of $\frac{P}{l}$, r and η (take $k = \frac{\pi}{8}$). Hence find the volume per second of a liquid of viscosity $1.2 \times 10^{-3}\ Ns^{-1}m^{-2}$ at 25 °C that flows through a pipe of length 20 m and radius 80 cm when the pressure difference across its ends is $24.5\ Nm^{-2}$ (7 marks)

(b) (i) State Newton's second law of motion (1 mark)

(ii) What is meant by the term impulse? (1 mark)

(iii) A tennis ball of mass 75 g struck by a racket moves horizontally at a speed of $120\ ms^{-1}$. Given that the ball is in contact with the wall for 0.04 s and the area of contact with the wall is $28.5\ cm^2$, find the pressure the ball exerts on the wall. (4 marks)

(iv) Explain briefly why the ball rebounds with a reduced speed. (2 marks)

(c) A stone is projected vertically upwards from the top of a table if the stone finally lands on the floor below the table;

(i) Sketch a speed -time graph for the motion of the stone. (1 mark)

(ii) Describe briefly the features of the graph (3 marks)

2.(a) Differentiate between the terms ductility and malleability. Give two examples of materials that exhibit each of these properties. (4 marks)

(b) A body is supported by a spiral spring and causes the spring to stretch by 1.5 cm. If the mass is now set into vertical oscillation, of small amplitude, calculate the periodic time of the oscillation. (4 marks)

(c) the graph in figure 1. Shows the variation of F; the load applied to two wires P and Q and their extensions e. Both wires are made of iron and have the same length.

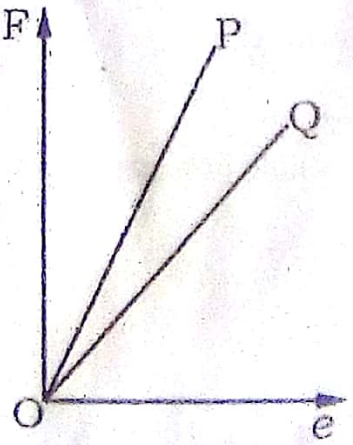

Fig.1

Which of the wires has a smaller diameter? Explain your answer. (4 marks)

(d) (i) Define simple harmonic motion. (1 mark)
(ii) State two practical examples of simple harmonic motion (2 marks)
(iii) A small mass rests on a horizontal platform which vibrates vertically in simple harmonic motion with a period of 0.5 s. find the maximum amplitude of motion which will allow the mass of remain in contact with the platform throughout the motion. (3 marks)

3.(a) Define the following terms as used in circular motion.
(i) angular velocity (1 mark)
(ii) centripetal acceleration (1 mark)

(b) A metallic bob of mass, m, is tied to a string of length, l, so that it is free to oscillate in a vertical plane as shown in figure 2.

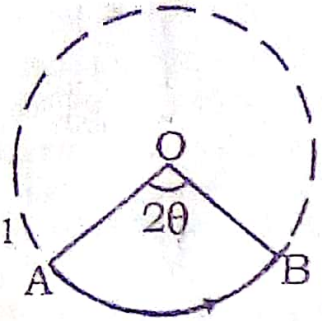

Fig.1

When pushed from position A, the bob moves describing a path as shown.

If O is the centre of the path taken,
(i) Show that the acceleration of the bob along line AB is zero and that its acceleration along AO is $\frac{V^2}{l}$ (4 marks)

(c) An object of mass 0.5 kg is rotated in a horizontal circle. Using a string of length 1m. The maximum tension in the string before it breaks is 316 N. What is the greatest number of revolutions made by the object in one second? (4 marks)

(d) (i) What is meant by a parking orbit of a satellite? (1 mark)
(ii) Calculate the height of a communication satellite above the earth's surface. (4 marks)
(iii) Show that a satellite close to the earth's surface takes about 84 minutes to move around the earth once. (4 marks)

4.(a) (i) Define surface tension in terms of surface energy. (1 mark)
(ii) Explain using Kinetic theory the temperature dependence of surface tension. (3marks)

(b) (i) Describe an experiment, to determine surface tension of a liquid using a capillary tube. (6 marks)
(ii) When a capillary tube is placed vertically in a beaker containing water, water rises in the tube 5.8 cm above that in the beaker. The tube is removed dried and placed vertically in a trough of mercury. Calculate the depression of mercury in the tube. (angle of contact for water = 0°, angle of contact for mercury = 130°)

(c) State Bernoulli's Principle of fluid flow. (1 mark)
(d) Water flows steadily along a horizontal pipe at a volume rate of

$8.0 \times 10^{-3}\ m^3s^{-1}$. If the area of cross section of the pipe is 40 cm^2, determine the;

(i) flow velocity of the water. (2 marks)

(ii) total pressure in the pipe if the static pressure is 3.0×10^4 Pa (3 marks)

SECTION: B

5.(a) (i) Define specific heat capacity of a substance. (1 mark)

(ii) In reference to a continuous flow calorimeter for determining specific heat capacity of a liquid, explain why two sets of readings are used and the temperature difference for inflow and out flow liquid is made the same. (2 marks)

(ii) Oil at 15.6 °C enters a long glass tube containing an electrically heated platinum wire and leaves it at 17.4 °C. The rate of flow of the oil is 25 cm^3 per minute and electrical energy supplied by the coil per second is 2.30 J. When the rate of flow is reduced by 10 cm^3 per minute and the electrical energy supplied per second is reduced by 40%, the same temperature difference is again, achieved. Calculate the specific heat capacity of the oil given that its density is 870 kgm^{-3}. (6 marks)

(b) (i) Define specific latent heat of vaporization. (1 mark)

(ii) With the aid of a labeled diagram describe how specific latent heat of a liquid can be determined by a method which involves a constant rate of evaporation. (6 marks)

(iii) Explain briefly why at night it is much colder in the valley than at the top of the hills. (2 marks)

6.(a) (i) Define thermal conductivity. (1 marks)

(ii) Explain the mechanism of heat transfer in non-metal solids. (3 marks)

(b) Describe an experiment to determine thermal conductivity of iron. (6 marks)

(c) A boiler with a steel bottom 1.5 cm thick rests on a hot stove. The area of the boiler's bottom is 1500 cm^2. The water inside the boiler is at a temperature of 100 °C and 750 g evaporates every 5 minutes. Find the

(i) temperature of the lower surface of the boiler. (4 marks)

(ii) amount of heat passing through 80 cm^2 are of the bottom of the boiler per hour. (3 marks)

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

(ii) State two examples of black bodies. (1 mark)

(iii) Explain briefly why back body radiation is sometimes called temperature radiation (1 mark)

7.(a) (i) Define the terms absolute zero and an ideal gas (2 marks)

(ii) State two differences between an ideal gas and a real gas. (2 marks)

(b) (i) State and derive Dalton's law of partial pressures. (5 marks)

(ii) What is meant by saturated vapour?

(iii) The saturated vapour pressure (S.V.P) of a certain liquid vapour at 0°C is 18.5 mmHg and at 30 °C it is 54.2 mmHg.
The volume of the closed vessel is kept constant and contains air and sufficient liquid for saturation. If the observed pressure is 100 mmHg at 30°C, what will its value be at 0°C? (4 marks)

(c) (i) Define molar heat capacity of an ideal gas at constant pressure. (1 mark)

(ii) Explain why the distinction between specific heat capacity at constant pressure and that at constant volume is important for gases but less important for solids and gases. (3 marks)

(iii) The temperature of a gas in an expandable container is raised from $^{-}15$ °C to 65 °C at constant pressure.
The total heat added to the gas is 5.8×10^4 J. find the number of moles of the gas. (Molar heat capacity of the gas at constant pressure = 29.0 $Jkg^{-1}K^{-1}$) (2 marks)

SECTION C

8.(a) (i) What are cathode rays? (1 mark)

(ii) State four properties of cathode rays. (2 marks)

(iii) Explain briefly the term thermionic emission. (3 marks)

(b) Describe briefly how frequency of an a.c signal can be determined using a cathode ray oscilloscope (C.R.O) (3 marks)

(c) A C.R.O has its y-sensitivity set to 6 Vcm^{-1}. A sinusoidal input, voltage is suitably applied to give a steady p.d. the time base is switched on so that the election beam takes 0.02 s to traverse the screen. If the trace seen has a peak-to-peak height of 4 cm, and containing two complete cycles, determine the;

(i) root- mean- square value of the input voltage. (3 marks)

(ii) frequency of the signal. (2 marks)

(d) In an experiment to determine charge of an electron using Millikan's oil drop method, state why a

(i) constant temperature bath is used (1 mark)

(ii) non -volatile oil is used. (1 mark)

(e) In a Millikan's oil drop experiment, a single negatively charged drop of radius 6.0×10^{-3} mm was found to fall under gravity at a terminal velocity of 0.004 cms^{-1} and to rise at 0.012 cm^{-1} when an electric field of intensity 2.0×10^5 Vm^{-1} was suitably applied. Given that the viscosity of the medium was 2.122×10^{-5} Nsm^{-2}, determine the number of electrons on the drop, (neglect air buoyancy). (4 marks)

9.(a) (i) State any two processes of ejecting electrons from a metal surface. (2 marks)

(ii) Describe a simple experiment to determine plank's constant. (5 marks)

(b) When light of wavelength 450nm falls on a certain metal surface, it ejects phot electrons with maximum velocity of 6.0×10^5 ms^{-1}. Calculate the

(i) work function of the metal
(ii) threshold frequency of the metal surface (4 marks)

(c) (i) State Bragg's law of x-ray diffraction. (1 mark)

(ii) A beam of x-rays of frequency 3.56×10^{18} Hz is incident on a potassium chloride (KCl) crystal and the first order Bragg's reflection occurs at 7°4′. The density of KCl is 1.98×10^{3} kgm^{-3} and its molecular mass is 74.5. Calculate the value of Avogadro's number. (5 marks)

(d) (i) Define Faraday constant. (1 mark)

(ii) Use the Avogadro's constant and Faraday constant to calculate the charge on an ion of a monovalent element. (2 marks)

10(a) Define the terms

(i) Radioactivity (1 mark)

(ii) Nuclear fission (1 mark)

(b) (i) State one condition for nuclear fission to occur.

(ii) Why are neutrons preferred to alpha particles for inducing nuclear reactions? (2 marks)

(c) With the aid of a labelled diameter describe how a diffusion cloud chamber is used to detect ionizing radiation (6 marks)

(d) Lanthanum has a stable Isotope, La-139 and radioactive Isotope La-138 of half-life 1.1×10^{10} years whose atoms are 0.1% of the stable isotope. Estimate the rate of decay of La-138 with 1kg of La-139. (4 marks)

(e) Uranium $^{238}_{92}U$ nucleus decays according to the equation.

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He.$$

Determine the Kinetic energy of the emitted alpha-particle given that

Mass of the nucleus of $\begin{cases} ^{238}_{92}U = 3.85395 \times 10^{-25}\text{kg} \\ ^{234}_{90}Th = 3.78737 \times 10^{-25}\text{kg} \end{cases}$

Mass of alpha particle $= 6.64807 \times 10^{-27}$ kg (5 marks)

END