P510/1
PHYSICS
Paper 1
July./Aug. 2024
2½hours

WAKISO-KAMPALA TEACHERS' ASSOCIATION (WAKATA)

WAKATA MOCK EXAMINATIONS 2024

Uganda Advanced Certificate of Education

PHYSICS

Paper 1

2 hours 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	=	$9.81 ms^{-2}$
Electron charge, e	=	$1.6 \times 10^{-19} C$
Electron mass	=	$9.11 \times 10^{-31} kg$
Mass of the earth	=	$5.97 \times 10^{24} kg$
Plank's constant, h	=	$6.6 \times 10^{-34} J s$
Stefan's Boltzmann's constant, σ	=	$5.67 \times 10^{-8} W m^{-2} K^{-4}$
Radius of the earth	=	$6.4 \times 10^{6} m$
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 a vacuum, c	=	$3.0 \times 10^{8} ms^{-1}$
Thermal conductivity of copper	=	$390 Wm^{-1}K^{-1}$
Thermal conductivity of aluminium	=	$210 Wm^{-1}K^{-1}$
Specific heat capacity of water	=	$4{,}200 J kg^{-1}K^{-1}$
Universal gravitational constant, G	=	$6.67 \times 10^{-11} N m^{2} Kg^{-2}$
A vogadro'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	=	$1000 Kgm^{-3}$
Gas constant, R	=	$8.31 J mol^{-1} K^{-1}$
Change to mass ratio, e/m	=	$1.8 \times 10^{11} C kg^{-1}$

Turn Over

SECTION A

1. (a) (i) What is meant by the term **dimensions of a physical quantity**. *(01mark)*

(ii) The velocity, V of a wave in a material of young's modulus E and density, ρ is given by $V = \left(\frac{E}{\rho}\right)^{\frac{1}{2}}$. Show that the relationship is dimensionally correct. *(03marks)*

(b) (i) Distinguish between **laminar** and **turbulent flow**. *(02marks)*

(ii) What are the origins of viscosity? *(02marks)*

(iii) Explain the dependency of viscosity of a liquid on temperature. *(02marks)*

(c) (i) Define the term **coefficient of viscosity of water**. *(01marks)*

(ii) Describe an experiment to measure the coefficient of viscosity of water using Poiseulle's formula. *(05marks)*

(d) (i) Define **uniformly accelerated motion**. *(01 marks)*

(ii) A car starts from rest at point A and accelerates at 1.25 ms^{-2} until it reaches a speed of 20 ms^{-1}. If then travels at this steady speed for a distance of 1.56 km and then decelerates at 2 ms^{-2} to come to point B. Find the distance from A to B. *(03marks)*.

2. (a) (i) Define **surface tension** *(01mark)*

(ii) Explain the origin of surface tension of a liquid using the molecular theory. *(04marks)*

(b) Describe an experiment to measure the surface tension of a liquid by the tube method. *(06marks)*

(c) Derive an expression for the pressure difference in a bubble formed inside the liquid. *(05marks)*

(d) (i) State **Achimede's principle**. *(01mark)*

(ii) A metal block of mass 4kg is completely immersed in water and vertically supported by an inextensible string. If the density of the metal block is $9.2 \times 10^3 Kgm^{-3}$, calculate the tension in the string. *(03marks)*

3. (a) (i) What is meant by a **spring constant?** *(01mark)*

(ii) Derive an expression for the work done to stretch a spring of force constant, k by a distance, e. *(02marks)*

(b) (i) Define **Young's modulus**. *(01mark)*

(ii) Describe an experiment to determine Young's modulus for a steel wire. *(05marks)*

(c) Two wires, one of steel of length, l_1, cross-sectional area, A_1 and Young's Modulus, E_1 and the other of brass of length, l_2, cross-sectional area, A_2 and Young's modulus, E_2 are connected in series.

(i) Show that the tensile force, F required to extend the composite wire by e is given by $F = \frac{eE_1E_2A_1A_2}{E_1l_2A_1+E_2l_1A_2}$ *(04marks)*

(ii) If the wires are disconnected and now connected in parallel, show that the energy stored in the compound wire is given by $\frac{e^2(E_1l_2A_1+E_2l_1A_2)}{2l_1l_2}$

State any assumptions made. *(03marks)*

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

(ii) A simple pendulum of length, l has a bob of mass, m kg. It is displaced from its mean position X to a position Y so that the string makes an angle of θ with the vertical. Show that the maximum potential energy of the bob is

$$\frac{mgl\sin\theta}{1+\cos\theta}$$ *(03marks)*

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

(ii) State Newton's universal law of gravitation and use it to verify Kepler's third law. *(05marks)*

(b) Explain why it is necessary for a bicycle rider moving around a circular path to lean towards the centre of the path. *(04marks)*

(c) (i) What is meant by **free fall motion**. *(01mark)*

(ii) A ball is thrown vertically upwards with a velocity of $14.7ms^{-1}$ from a point 19.6m above the ground. Describe with the aid of a velocity time sketch graph, the subsequent motion of the ball. *(07marks)*

SECTION B

5. (a) What is meant by the term **thermometric property**. *(01mark)*

(b) The resistance of a solid at a temperature of θ°C measured on a standard scale is given by $R_\theta = R_0(1 + \alpha\theta + \beta\theta^2)$, where α and β are constants. Given that $\beta = 0.001\alpha$, calculate the temperature on the resistance thermometer scale if on the standard scale the temperature is 72°C. *(05marks)*

(c) (i) Define **specific latent heat of vaporization of a liquid**. *(01mark)*

(ii) Describe with the aid of a labeled diagram, an electrical method for determination of specific latent heat of vaporization of a liquid. *(07marks)*

(d) Water in a vacuum flask is boiled steadily by a coil of wire immersed in water. When the p.d across the coil is 4.60V and the current through it is 2.00A, 5.50g of water evaporates in 30 minutes. When the p.d and the current are maintained at 3.00V, 1.40A, 2.20g of water evaporates on 30 minutes. Calculate the specific latent heat of evaporation of water *(04marks)*

(e) Explain using simple kinetic theory how evaporation causes cooling. *(02marks)*

6. (a) (i) What is meant by a **reversible process** *(01mark)*

(ii) State the difference between isothermal and adiabatic expansion of a gas. *(02marks)*

(iii) State the conditions necessary for isothermal and adiabatic process. *(02marks)*

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

(c) For one 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) (i) Define **molar heat capacities at constant pressure**. *(01mark)*

(ii) Derive the expression $C_p - Cv = R$ for 1 mole of a gas. *(05marks)*

(e) An ideal gas at 17°C has a pressure of 760mmHg and is compressed a diabatically until its volume is halved reversibly. Calculate the final pressure and temperature of the gas assuming $C_p = 2100\ \text{J kg}^{-1}\text{K}^{-1}$ and $Cv = 1500\text{J kg}^{-1}\text{K}^{-1}$. *(04marks)*

7. (a) What is meant by **a black body** *(01mark)*

(b) Describe how an approximate black body can be realized in practice. *(02marks)*

(c) (i) State **Stefan's law**. *(01mark)*

(ii) A solid copper sphere of diameter 12mm and temperature 146K is placed in an enclosure, maintained at a temperature of 300K. Calculate, stating any assumptions made, the initial rate of rise of temperature of the sphere,
(Density of copper = 40,000Kgm^{-3} specific heat capacity of copper = 370Jkg^{-1})
(06marks)

(d) With the aid of a labeled diagram, describe how a thermopile can be used to detect infrared radiation. *(04marks)*

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

(ii) A circular disc of glass 3mm thick and 110mm diameter is placed between two brass slabs X and Y. The temperature of the lower slab Y becomes 92°C while the temperature of X is at 96°C. Y 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 Ks^{-1}. Calculate the thermal conductivity of the glass if the mass of Y is 0.94Kg and its specific heat capacity is 400$JKg^{-1}K^{-1}$. *(05marks)*

SECTION C

8. (a) What is meant by **photo electric emission**. *(01mark)*

(b) State the laws of **photo electric effect**. *(04marks)*

(c) (i) Define **work function of a metal**. *(01mark)*

(ii) Describe an experiment to determine work function of a metal surface. *(06marks)*

(d) Explain why the wave theory of light fails to account for the photo electric effect. *(06marks)*

(e) In an experiment on photo electric effect using radiation of frequency 5.4 x 10^{14}Hz, maximum electron energy was observed to be 1.2 x 10^{-19}J. With radiation of frequency 6.6 x 10^{14}Hz, maximum electron energy was 2.0 x 10^{-19}J. Derive the value of plank's constant. *(03marks)*

9. (a) (i) What is meant by **nuclear binding energy**? *(01mark)*

(ii) Explain what is observed when a beam of α – particles is incident on a gold foil. *(06marks)*

(iii) Find the binding energy in joules per nucleon of $^{56}_{26}Fe$ given that: *(04marks)*

Mass of 1 proton = 1.007825U
Mass of 1neutron = 1.008665U
Mass of $^{56}_{26}Fe$ nucleus = 55.934939U
(1U = 931MeV)

(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, x_0 is given by $x_0 = \frac{ze^2}{\pi\varepsilon_0 mV^2}$

Where, e = electron charge
ε_0 = permittivity of free space
m = mass of alpha particle
V = initial velocity of the alpha particle.

(04marks)

(c) (i) State Bragg's law of × – ray diffraction *(01mark)*

(ii) A beam of $\times -$ rays of wave length 1.0×10^{-10} is incident on set of cubic planes of a sodium chloride crystal. Calculate the angle for the 1st order diffraction given that; Density of sodium chloride is $1980 kgm^{-3}$
Molecular mass of sodium chloride is 58.5 *(04marks)*

10. (a) (i) List **four** main properties of cathode rays. *(02marks)*

(ii) A high p.d is applied across two electrodes in air contained in a closed glass tube. Describe with the aid of a labeled diagram what will be observed when the pressure in the tube is progressively reduced down to a very low value. *(05marks)*

(b) Describe the mechanism of thermionic emission. *(03marks)*

(c) Explain the following terms as applied to a thermionic diode.

(i) Space charge *(01mark)*
(ii) Half wave rectification *(01mark)*
(iii) Full wave rectification *(01mark)*

(d) An electron of energy 10KeV enters mid way between two horizontal plates each of length 5.0cm and separated by a distance of 2.0cm. A p.d of 20V is applied across the plates. A fluorescent screen is placed 20cm beyond the plates.
Calculate the vertical deflection of the electron on the screen. *(07marks)*

END