P510/1
PHYSICS
Paper 1
July/August 2024
2½ hours

WAKISSHA JOINT MOCK EXAMINATIONS

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 silent 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 earth		=	$5.97 \times 10^{24}\ kg$
Planck's constant,	h	=	$6.6 \times 10^{-34}\ Js$
Stefan – Boltzmann's constant,	σ	=	$5.67 \times 10^{-8}\ Wm^{-2}\ K^{-4}$
Radius of the earth		=	$6.4 \times 10^{6}\ m$
Radius of the sun		=	$7.0 \times 10^{8}\ m$
Radius of earth's orbit about the sun		=	$1.5 \times 10^{11}\ m$
Speed of light in a vacuum		=	$3.0 \times 10^{8}\ m$
Specific heat capacity of water		=	$4,200 Jkg^{-1}\ K^{-1}$
Specific latent heat of fusion of ice		=	$3.34 \times 10^{5}\ Jkg^{-1}$
Universal gravitational constant,	G	=	$6.67 \times 10^{-11}\ Nm^{2}kg^{-2}$
Avogadro's number	N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Density of mercury		=	$13.6 \times 10^{3}\ kgm^{-3}$
Charge to mass ratio,	e/m	=	$1.8 \times 10^{11}\ Ckg^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$		=	$9.0 \times 10^{9}\ F^{-1}m$
Density of water		=	$1000\ kgm^{-3}$
Gas constant	R	=	$8.31 Jmol^{-1}\ K^{-1}$
Wien's displacement constant		=	$2.90 \times 10^{-3}\ m\ K$
Surface tension of soap solution		=	$2.0 \times 10^{-2}\ Nm^{-1}$
Electron charge to mass ratio, e/m		=	$1.8 \times 10^{11}\ C\ kg^{-1}$
Specific latent heat of Vaporation		=	$2.23\ X\ 10^{6}\ J\ kg^{-1}$

SECTION A

1. (a) (i) Define dimensions of a **physical quantity?** (01 mark)

(ii) The equation for the pressure difference per unit length, P between the ends of a pipe of radius **r** for a liquid of coefficient of viscosity ŋ, is $P = \frac{8\eta V}{\pi r^4}$ where **V** is the volume per unit time of the liquid flowing. If the dimensions of ŋ is $ML^{-1}T^{-1}$, show that the equation is dimensionally consistent. (03 marks)

(b) (i) State **Newton's Laws of motion.** (03 marks)

(ii) Towns P, Q and R lie on the same highway in that order with town P a distance 95 km to town Q and town Q to town R is 80 km. A bus is travelling along the highway in the direction of the towns P, Q, R with an acceleration of **a** ms^{-2}.
The bus passes through town P with 'u' m/s and reaches town Q 1.2 hours later and R 0.8 hours after that.
Calculate the values of 'u' and 'a'. (04 marks)

(c) Define the terms as applied to projectiles:
(i) **Time of flight** (01 mark)
(ii) **Range** (01 mark)

(d) A helicopter is travelling horizontally at 20 ms^{-1} at height of 50 m above a point 'P' on a horizontal ground when it releases a package.
Calculate;
(i) the time taken for the package to reach the ground. (02 marks)
(ii) the distance from P where the package lands. (02 marks)
(iii) the vertical velocity of the package as it reaches the ground. (03 marks)

2. (a) (i) State the principle of **conservation of linear momentum.** (01 mark)

(ii) Describe the principle of **rocket propulsion.** (03 marks)

(b) A bullet of mass 40 g is fired from a gun and hits a block of wood of mass 960 g lying on a rough horizontal surface which is attached to a spring fixed at one end and has a force constant 50 Nm^{-1}. The spring is compressed through a compression of 4.5 cm. If the coefficient of friction is 0.2.
Calculate the initial speed of the bullet. (04 marks)

(c) (i) Explain using molecular theory the laws of solid friction. (06 marks)

(ii) Describe an experiment to determine the coefficient of static friction. (03 marks)

(d) Explain why a car tyre moving on a hard-rough surface on a hot day may burst. (03 marks)

3. (a) What is meant by the following terms;
   (i) **Elasticity** (01 mark)
   (ii) **Young's Modulus** (01 mark)
   (iii) **Plastic deformation** (01 mark)

   (b) A uniform rod AB weighing 100 kg and 0.75 m long is hinged to a vertical wall at end A and held horizontally by a stretched thin wire of diameter 0.8 mm fixed at end B and at C on the vertical wall, 1.0 m above A. If the wire was initially 1.23 m long, find;
   (i) The tension in the wire. (03 marks)
   (ii) Young's modulus for the wire. (03 marks)

   (c) (i) State the laws of **planetary motion.** (03 marks)
   (ii) Describe how the universal gravitational constant can be determined. (05 marks)

   (d) Explain why a racing car can travel faster around a banked track than on a flat track of the same radius. (03 marks)

4. (a) Define the terms;
   (i) **surface tension** (01 mark)
   (ii) **angle of contact** (01 mark)

   (b) With the aid of a labelled diagram, describe an experiment to measure the surface tension of a liquid by capillary tube method. (04 marks)

   (c) A glass capillary tube of uniform bore of diameter 0.050 cm is held vertically with its lower end in water. Calculate the capillary rise. (surface tension of water = $7.0 \times 10\ Nm^{-1}$) (03 marks)

   (d) (i) What is meant by **damped oscillations?** (01 mark)
   (ii) Sketch a displacement-time graph for damped oscillations. (02 marks)

   (e) A uniform wooden rod floats upright in water with a length of 30 cm immersed. If the rod is depressed slightly and then released, (density of wood 800 kgm^{-3})
   (i) Prove that its motion is simple harmonic. (04 marks)
   (ii) Calculate the period of oscillations. (02 marks)

SECTION B

5. (a) (i) What is an **ideal gas?** (01 mark)
   (ii) Derive the expression $P = {}^1/_3\, \rho \overline{c^2}$ for the pressure P of an ideal gas of density ρ and mean square speed $\overline{c^2}$, stating any assumptions made. (06 marks)

   (b) Explain the following observations;
   (i) the gas fills up the container in which it is placed. (02 marks)
   (ii) pressure of a fixed mass of a gas varies with temperature. (02 marks)

Turn Over

(c) A mass of air occupying initially a volume 2000 cm^3 at a pressure of 76 cmHg and temperature of 200 ^0C is expanded adiabatically and reversibly to twice its volume. It is then compressed isothermally and reversibly to a volume of 3000 cm^3. Find the final temperature and pressure of air. ($\gamma = 1.4$) (03 marks)

(d) (i) Define **saturated vapor pressure.** (01 mark)

(ii) Describe an experiment to investigate the relationship between saturated vapour pressure and temperature. (05 marks)

6. (a) (i) Define **thermal conductivity.** (01 mark)

(ii) Explain the mechanism of heat transfer in solids. (03 marks)

(iii) Describe an experiment to determine the thermal conductivity of silver. (06 marks)

(b) (i) Explain why black body radiation is referred to as a temperature regulator. (02 marks)

(ii) Draw sketch graphs to show the variation of relative intensity with wave length for two different temperatures. (02 marks)

(iii) Describe the main features of the graph in b(ii) above. (02 marks)

(c) A heating element in form of a cylinder 60 cm long and 15 mm in diameter has an output of 2 kW. If its radiation is 80% that of a black body. Find;

(i) its temperature. (02 marks)

(ii) the wave length of the radiation emitted. (02 marks)

7. (a) (i) Define **Kelvin** (01 mark)

(ii) State properties of a good thermometric property. (02 marks)

(b) (i) With reference to a thermocouple thermometer, describe the steps taken to establish a Kelvin scale. (03 marks)

(ii) The length of the liquid column is 2.0 cm at the ice point, 2.7 cm at steam point and 8.4 cm at unknown temperature. Calculate the unknown temperature in Kelvin. (03 marks)

(c) (i) Explain why latent heat of vaporization is greater than latent heat of fusion of the same substance. (02 marks)

(ii) Describe an experiment to determine the specific latent heat of vaporization of a liquid by Dewar flask method. (06 marks)

(d) Steam is passed through a calorimeter of heat capacity 40 Jk^{-1} containing ice of mass 200 g. The mixture attains a final temperature of 10 ^0C after some time. Calculate the total mass of the liquid in the calorimeter. (03 marks)

SECTION C

8. (a) (i) Distinguish between X-rays and cathode rays. (02 marks)

(ii) In an X-ray tube, explain the features adopted for the structure and material of the anode. (03 marks)

(b) (i) State **Bragg's Law** (01 mark)

(ii) What is the condition for obtaining many orders of X-rays diffraction. (01 mark)

(iii) A monochromatic beam of X-rays of wave length 1.10×10^{-10} m is incident on a set of cubic atomic planes in a potassium chloride crystal. First order diffraction maxima are observed at a glancing angle of 19^0. Determine the density of potassium chloride if its relative molecular mass is 75.5. (04 marks)

(c) (i) What is meant by Work function as applied to photoelectric effect? (01 mark)

(ii) Describe how you would determine Planck's constant in a school laboratory. (04 marks)

(iii) When monochromatic light of frequency 6.0×10^{14} Hz falls on a metal surface, the stopping potential is 0.4 V while when the same surface is struck by light of frequency 1.0×10^{15} Hz, the stopping potential becomes 2.2 V.
Determine the work function of the metal. (04 marks)

9. (a) (i) Distinguish between radioactivity and nuclear fission? (02 marks)

(ii) Define binding energy of a nucleus? (01 mark)

(b) (i) What is half-life of a radioactive substance? (01 mark)

(ii) Derive the relationship between half-life and the decay constant of a radioactive substance. (04 marks)

(c) A nucleus of uranium 238 of half- life 4500 years decays with emission of nucleus X and an alpha particle.
Find the power developed by 2 g of uranium disintegration.
Mass $^{238}U = 238.12492U$
Mass of $X = 234.11650U$
Mass of $4He = 4.00387U$.
$IU = 931$ mev

(05 marks)

Turn Over

(d) A beam of electrons is accelerated through a potential difference of 1800 V and is directed mid-way between two horizontal plates of 4 cm long and a separation of 4 cm. The potential difference across the plates is 90 V.

(i) Calculate the speed of the electrons as they enter the region between the plates. (03 marks)

(ii) Describe the motion of the electrons between the plates. (01 mark)

(iii) Find the rate at which the electron beam emerges out of the field a across the plates. (03 marks)

10. (a) (i) Define **positive rays?** (01 mark)

(ii) Describe how positive rays can be produced in a discharge tube. (03 marks)

(b) Sketch and explain the current – voltage characteristic curve for the discharge tube. (05 marks)

(c) With the aid of a diagram, describe how a C.R.O is operated. (06 marks)

(d) (i) What is meant by anode resistance as applied to triodes. (01 mark)

(ii) A triode with mutual conductance of 5 $m\Omega V^{-1}$, a node resistance $2 \times 10^4\ \Omega$ and load resistance 10,000 Ω is used as a single stage voltage amplifies. Calculate the voltage gain. (04 marks)

END