P510/1
Physics
Paper 1
Nov. 2023
2 ½ hours

ANKOLE DIOCESE EXAMINATIONS SECRFTARIAT

S.5 PROMOTIONAL EXAMINATIONS – 2023

PHYSICS

Paper 1

2 HOURS 30 MIN.

INSTRUCTIONS TO CANDIDATES:

- *Answer only **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 electronic calculators may be used.*
- *Assume where necessary:*
  - *Acceleration due to gravity, g* = $9.81\ ms^{-2}$
  - *Density of water* = $1000Kgm^{-3}$
  - *Specific heat capacity of water* = $4{,}200Jkg^{-1}\ K^{-1}$
  - *Specific latent heat of vaporization of water* = $2.26 \times 10^{6}\ Jkg^{-1}$
  - *Electronic mass , e* = $1.6 \times 10^{-19}\ C$
  - *Electric mass* = $9.11 \times 10^{-31} kg$
  - *Mass of the earth* = $5.97 \times 10^{24} kg$
  - *Plank's constant h* = $6.6 \times 10^{-34} Js$
  - *Speed of light in a vacuum, c* = $3.0 \times 10^{8} ms^{-1}$
  - *Radius of earth* = $6.4 \times 10^{6} m$
  - *Radius of sun* = $7 \times 10^{8} m$
  - *Radius of the earth's orbit about the sun* = $1.5 \times 10^{11} m$
  - *Avogadro's number* N_A = $6.02 \times 10^{23}\ mol^{-1}$
  - *Charge to mass ratio, e/m* = $1.8 \times 10^{11} Ckg^{-1}$
  - *Gas constant, R* = $8.31\ Jmol^{-1}k^{-1}$

Turn over

SECTION A

1. (a) (i) What is meant by a ***conservative force***? *(1 mk)*

(ii) Give ***two*** examples of a conservative forces *(1 mk)*

(b) (i) State the law of ***conservation of mechanical energy*** *(1 mk)*

(ii) A body of mass m is projected vertically upwards with speed u. Show that the law of conservation of mechanical energy is obeyed throughout its motion. *5 mks)*

(iii) Sketch a graph showing variation of kinetic energy of the body with time *(1 mk)*

(c) (i) Describe an experiment to measure the coefficient of static friction. *(4 mks)*

(ii) State ***two*** disadvantages of friction. *(1 mk)*

(d) A bullet of mass 20g moving horizontally strikes and gets embedded in a wooden block of mass 500g resting on a horizontal table. The block slides through a distance of 2.3m before coming to rest. If the coefficient of kinetic friction between the block and the table is 0.3. Calculate the;

(i) friction force between the block and the table. *(3 mks)*

(ii) velocity of the bullet just before it strikes the block. *(4 mks)*

2. (a) State the condition under which the law of conservation of linear momentum will be conserved. *(1 mk)*

b) Two balls A and B of mass m_1 and m_2 respectively lie on a smooth surface in a straight line. If the balls are projected with velocities u_1 and u_2 respectively in the same direction. Show that on colliding elastically ball A will move with a velocity

$$V = \frac{(m_1 - m_2)\,u_1 + 2m_2u_2}{(m_1 + m_2)}$$ *(7 mks)*

c) Two pendula of equal length l have each a bob A and B of masses 3M and M respectively. The pendula are hung with bobs in contact as shown in figure 1.

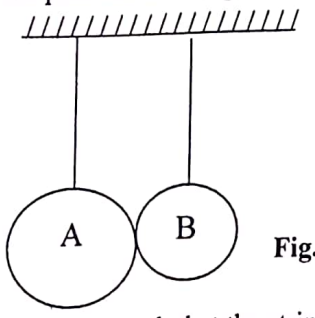

Fig. 1

The bob A is displaced such that the string makes an angle Θ with the vertical and released. If A makes a perfectly inelastic collision with B, show that the height, h to which B rises is given by $h = \frac{9l\,(1-\cos\theta}{16}$ ***(6 mks)***

d) (i) What is meant by the terms ***centre of gravity*** and *a uniform body*. ***(2 mks)***

(ii) Describe an experiment to locate the centre of gravity of an irregular object. ***(4 mks)***

3. (a) (i) Define the terms ***velocity*** and ***displacement***. ***(2 mks)***

(ii) Sketch a graph of velocity against time for an object thrown vertically upwards. ***(2 mks)***

(b)(i) Define vector and scalar quantities and two example of each. ***(4 mks)***

(ii)

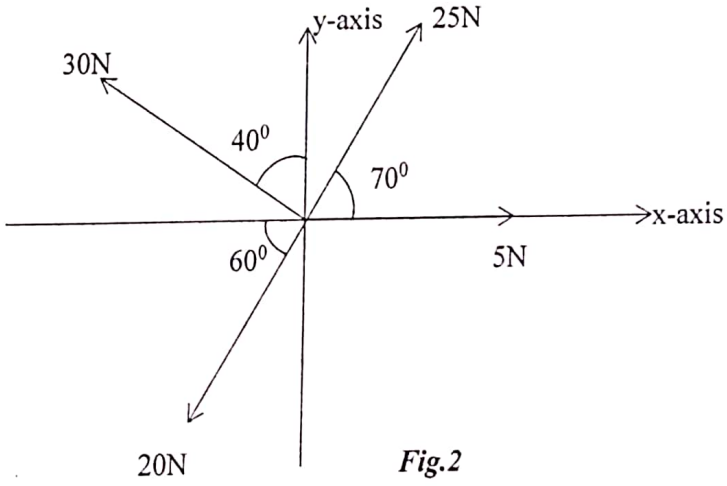

Fig.2

A body M of mass 6kg is acted on by forces of 5N, 20N, 25N and 30N as shown in figure 2. Find the acceleration of M ***(5 mks)***

(1 mk)

c) (i) What is meant by a ***couple, in mechanics***? (2 mks)

(ii) State the conditions for equilibrium of a system of coplanar forces. (1 mk)

d) (i) What is meant by ***dimensions of a physical quantity***?

(ii) The centripetal force F on a body of mass m moving at constant speed V round a circular path of radius r is given by $F = \frac{MV^2}{r}$. Show that the equation is dimensionally consistent. (3 mks)

(3 mks)

4. (a) State ***Newton's laws of motion***. (4 mks)

(b) Use Newton's laws of motion to show that when two bodies collide their momentum is conserved

c) Two balls P and Q travelling in the same line in opposite directions with speeds of $6ms^{-1}$ and $15ms^{-1}$ respectively make a perfect inelastic collision. If the masses of P and Q are 8kg and 5kg respectively. Find the; (4 mks)

(i) final velocity of P (4 mks)

(ii) change in kinetic energy. (1 mk)

d) (i) What is ***an impulse of a force***? (4 mks)

(ii) Explain why along jumber should normally land on sand.

SECTION B

5. (a) What is meant by (1 mk)

(i) ***thermometric property.*** (1 mk)

(ii) ***triple point of water***

(b) (i) Describe the steps taken to establish centigrade temperature scale (5 mks)

(ii) Explain why two thermometers may give different values for the same unknown temperature (2 mks)

c) (i) Describe with the aid of a diagram how a constant volume gas thermometer may be used to measure temperature. *(6 mks)*

(ii) State ***three*** corrections that need to be made when using the thermometer in (c) (i) above. *(3 mks)*

(iii) State and explain the sources of inaccuracies in using mercury in-gas thermometer. *(2 mks)*

6. (a)(i) Define ***latent heat.*** *(1 mk)*

(ii) Explain the significance of latent heat in regulation of body temperature. *(3 mks)*

(b) (i) Using kinetic theory, explain boiling of a liquid *(3 mks)*

(ii) Describe how you would determine the specific latent heat of vaporization of water by method of mixtures. *(5 mks)*

(iii) Explain why latent heat of vaporization is always greater than that of fusion *(2 mks)*

c) In an experiment to determine specific latent heat of vaporization of a liquid using the continuous flow calorimeter, the following results were obtained.

Voltage V(V)	**Current I (A)**	**Mass collected in 300s(g)**
7.4	2.6	5.8
10.0	3.6	11.3

Calculate the power of the heater required to evaporate 3.0g of the liquid. *(6 mks)*

7. (a) Describe an experiment to verify Newton's law of cooling. *(5 mks)*

(b) (i) Distinguish between a real and an ideal gas *(3 mks)*

(ii) Derive the expression $P = \frac{1}{3}\rho C^2$ for the pressure of an ideal gas of density ρ and mean square speed C^2 *(6 mks)*

c) (i) Explain why the pressure of a fixed mass of a gas in a closed container increases when temperature of the container is raised. *(2 mks)*

(ii) Nitrogen gas is tapped in a container by a movable piston. If the temperature of the gas is raised from 0^0C to 50^0C at a constant pressure of 4.0×10^5Pa and the total heat added is 3.0×10^4J. Calculate the work done by the gas. (The molar heat capacity of nitrogen at constant pressure is 29.1J mol $^{-1}$ k $^{-1}$, $^{CP}/_{CV} = 1.4$) *(4 mks)*

SECTION C

8. (a) With a reference to a Geiger-Muller tube, define the following;

(i) quenching agent *(1 mk)*

(ii) background count rate. *(1 mk)*

(b) (i) With the aid of a labelled diagram, describe the operation of a Geiger-Muller tube (GMT). *(6 mks)*

(ii) Explain how the half-life of a short lived radioactive source can be obtained by use of a Geiger-Muller tube. *(4 mks)*

c) A radioactive isotope $^{32}_{15}P$ which has a half-life of 14.3days, disintegrates to form a stable product. A sample of the isotope is prepared with an initial activity of $2.0 \times 10^6 s^{-1}$. Calculate the;

(i) number of $^{32}_{15}P$ atoms initially present. *(3 mks)*

(ii) activity after 30 days *(3 mks)*

(iii) Number of $^{32}_{15}P$ atoms after 30 days (Assume $N = Noe^{-\lambda t}$) *(2 mks)*

9. (a) State the laws of photoelectric effect *(4 mks)*

(b) Describe an experiment to determine the stopping potential of a metal surface. *(5 mks)*

c) A 100mW beam of light of wavelength 4.0×10^{-7}m falls on a caesium surface of a photocell.

(i) How many photons strike the caesium surface per second? *(3 mks)*

(ii) If 65% of the photons emit photoelectrons, find the resulting photo current. *(3 mks)*

(iii) Calculate the kinetic energy of each photon if the work function of caesium is 2.20ev. *(3 mks)*

d) Distinguish between continuous and line spectra in an x –ray tube. *(2 mks)*

10. (a) Explain the term stopping potential as applied to photo-electric effect. *(2 mks)*

(b) Explain how intensity and penetrating power of x – rays from an x – ray tube would be affected by changing.

(i) the filament current. *(2 mks)*

(ii) the high tension potential difference across the tube. *(2 mks)*

(c) When a p.d of 60kv is applied across an x – ray tube, a current of 30mA flows. The anode is cooled by water flowing at a rate of $0.060 kgs^{-1}$. If 99% of the power supplied is converted into heat at the anode, calculate the rate at which the temperature of the water rises. *(5 mks)*

(d) (i) Derive Bragg's law of x – ray diffraction *(5 mks)*

(ii) Calculate the atomic spacing of sodium chloride if the relative atomic mass of sodium is 23.0 and that of chlorine is 35.5. (Density of sodium chloride = $2.18 \times 10^{3} kgm^{-3}$) *(4 mks)*

END