PAPER 2 1½ hours
ESSAY
[60 marks]

Answer **eight** *questions in* **all**; **five** *questions from Part* **I** *and* ***three*** *questions from Part* **II**.

PART I
[15 marks]

Answer any **five** *questions from this part.*

All *questions carry* **equal** *marks.*

1. (*a*) State the unit of :
   (i) inductance;
   (ii) universal gravitational constant. G

   (*b*) A student expressed momentum P of a body as $P = \frac{mv^2t}{d}$. where m = mass;

   v = velocity; t = time; d = distance
   Use dimensional analysis to show that the equation is correct. [3 marks]

2. State **three** evidences that support the particle nature of matter. [3 marks]

3. A geostationary satellite is moving in a circular orbit at a height of 3000 km from the earth's surface. Calculate its speed. [Radius of the earth, R = 6400km] [3 marks]

4. (*a*) What does the area under a stress-strain curve represent?

   (*b*) State **two** examples of projectile in sports.

   [3 marks]

5. Explain why the Young's modulus of aluminium is greater than that of rubber. [3 marks]

6. (*a*) State the mathematical relationship between the maximum height H reached by an oblique projectile and its time of flight T.

   (*b*) A body is projected with a speed of 8 m s^{-1} to attain a maximum range. Calculate its velocity at the highest point. [g = 10 m s^{-2}]

   [3 marks]

7. (*a*) State the principle on which fibre optics is based.

   (*b*) State the **two** main parts of an optical fibre.

   [3 marks]

PART II
[45 marks]

Answer **three** *questions from this part.*
All *questions carry* **equal** *marks.*

8. (*a*) (i) What is *natural frequency* of an oscillating system?

(ii) Two identical springs each of force constant 20 N m^{-1} are attached to the opposite side of a block of mass 400 g resting on a smooth surface. The free ends of the springs are fixed to a rigid support. If the mass is displaced from rest to execute simple harmonic motion, calculate the period of oscillation of the block.

[5 marks]

(*b*) (i) Draw a block and tackle system of a pulley with a velocity ratio of 6. In the diagram indicate clearly the direction of the load and effort.

(ii) A 75 kg box is steadily raised through a vertical distance of 450 mm using a block -and - tackle pulley system with a velocity ratio of 8. If the effort is 80N, calculate the:

(α) distance moved by the effort.

(β) work done by the effort in lifting the load.

[6 marks]

(*c*) A uniform metre rule is pivoted at its center. Three loads, 5.0 N, *P* N, and 7.0 N are positioned on the rule at the 30.0 cm, 40.0 cm and 80.0 cm marks respectively.

(i) Draw a force-diagram illustrating the arrangement.

(ii) Calculate P if the metre rule is in equilibrium.

[4 marks]

9. (*a*) (i) Define *relative density.*

(ii) A bowl of cross-sectional area 0.38 m^2 is filled with ice to a depth of 14 mm in a refrigerator. Calculate the mass of ice in the bowl. [density of ice = 917 kg/m^3]

[4 marks]

(*b*) (i) Define *specific latent heat of fusion of ice.*

(ii) State **two** factors that affect the specific latent heat of fusion of a liquid

[4 marks]

(*c*) (i) State **three** advantages of a thermocouple over liquid-in -glass thermometer

(ii) In an experiment to determine the upper fixed point of a thermometer using the hypsometer, state **one** function **each** of a

(α) hypsometer jacket;

(β) manometer.

in the experiment.

(iii) The electrical resistances of the elements in a platinum resistance thermometer at 0 °C , room temperature and 100 °C are 53.000 Ω , 60.310 Ω and 82.412 Ω respectively. Determine the room temperature.

[7 marks]

Turn over

10 (a) State **three** differences between *umbra* and *penumbra* regions of a shadow. [3 marks]

(b) Use a ray diagram to show how parallel rays of light close to the principal axis are reflected by

(i) concave mirror;

(ii) convex mirror

[4 marks]

(c) Explain why a hypermetropic person would not require the use of a corrective lens when viewing distant objects. [2 marks]

(d) A luminous object and a screen are kept at a distance 100 cm apart. A convex mirror between the object and screen forms real images at two different positions separated by 20 cm. Calculate the power of the lens. [6 marks]

11 (a) (i) Define *capacitance* of a capacitor.

(ii) State **three** factors on which the magnitude of charges deposited on a parallel plate capacitor depends.

[5 marks]

(b) Draw the electrical circuit symbol for **each** of the circuit elements below:

(i) transformer;

(ii) diode;

(iii) galvanometer;

(iv) fuse.

[2 marks]

(c) (i) List **four** uses of X-rays.

(ii) In an X-ray tube, an electron is accelerated from rest towards a tungsten target biased at a potential of 42 kV. Calculate the kinetic energy of the electron.

(iii) Define the *binding energy* of a nucleus

[8 marks]

12 (a) (i) Define *isotopes* of an element.

(ii) Hydrogen has **three** isotopes. Write the specific name and symbol of the nuclei of **each** of the isotope of hydrogen.

(b) State specifically what determines the:

(i) nuclear properties of an atom;

(ii) chemical properties of an atom

[5 marks]

[2 marks]

(c) Using the Bohr's model of atom, show that the total energy, E of an electron of elementary charge, e at a distance , r, from the nucleus in a hydrogen atom is given by

$$E = \frac{-e^2}{8\pi\epsilon_0 r}$$

Where ϵ_0 is the permittivity of free space.

[3 marks]

(d) A stationary nucleus emits a packet of an electromagnetic radiation of energy 6.2 eV. Calculate the:

(i) wavelength of the emitted radiation;

(ii) momentum of the photons.

[$h = 6.6 \times 10^{-34}$ J s, $c = 3.0 \times 10^{8}$ m s^{-1} , 1 eV = 1.6×10^{-19} J]

[5 marks]

END OF ESSAY TEST