PHYSICS

PAPER – 1

(THEORY)

(Maximum Marks: 70)

(Time allowed: Three hours)

*(Candidates are allowed additional 15 minutes for **only** reading the paper.*
They must NOT start writing during this time.)

All questions are compulsory.

This question paper is divided into 4 Sections, A, B, C and D as follows:

Section A

Question number 1 is of twelve marks. All parts of this question are compulsory.

Section B

Question numbers 2 to 12 carry 2 marks each with two questions having internal choice.

Section C

Question numbers 13 to 19 carry 3 marks each with two questions having internal choice.

Section D

Question numbers 20 to 22 are long-answer type questions and carry 5 marks each. Each question has an internal choice.

The intended marks for questions are given in brackets [ ].

All working, including rough work, should be done on the same sheet as and adjacent to the rest of the answer.

Answers to sub parts of the same question must be given in one place only. A list of useful physical constants is given at the end of this paper.

A simple scientific calculator without a programmable memory may be used for calculations.

SECTION A

*Answer **all** questions.*

Question 1

(A) Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below: **[5×1]**

(i) Which of the following is not a unit of time?

(a) light year

(b) ns

(c) μs

(d) minutes

(ii) A copper and a steel wire having same length and diameter are joined end-to-end. When a force is applied at the end of the wire, the net length of the wire increases by 1cm. The wires will have:

(a) same stress and same strain

(b) different stresses and different strain

(c) different stresses and same strain

(d) different strains and same stress

(iii) For an adiabatic change of a perfect gas the relation between pressure and volume is:

(a) PV^{γ} = constant

(b) $P^{\gamma}V$ = constant

(c) PV = constant

(d) $PV^{\gamma-1}$ = constant

(iv) Which of the following is approximately the rate of solar energy (in KW) falling per m^2 on the surface area of the earth?

(a) 1

(b) 100

(c) 0·1

(d) 0·0001

(v) The distance between successive nodes and antinodes is:

(a) $\lambda / 2$

(b) λ

(c) $\lambda/4$

(d) 2λ

(B) Answer the following questions briefly and to the point: **[7×1]**

(i) Give the dimensions of **Boltz Mann's** constant.

(ii) A bullet fired vertically upward falls at the same place after some time. What is the displacement of the bullet?

(iii) A constant retarding force of 100N is applied to a body of mass 10kg moving initially with a speed of $30ms^{-1}$. What is the retardation of the body?

(iv) State the **Principle of Continuity** of fluids.

(v) What is the **relation** between the pressure and the kinetic energy per unit volume of a gas?

(vi) Give *any one* essential feature of **Carnot's** ideal heat engine.

(vii) Which physical quantity remains conserved in Simple Harmonic Motion?

SECTION B

*Answer **all** questions.*

Question 2 **[2]**

(a) Round off 3.7846 up to 3 significant figures.

(b) What is meant by **absolute** error?

Question 3 **[2]**

State *any two* limitations of dimensional analysis.

Question 4 **[2]**

Write an expression for magnitude of the **resultant vector** 'R' of two vectors $\vec{A}$ and $\vec{B}$ acting at a point. When will this resultant vector 'R' be **maximum**?

Question 5 **[2]**

(a) A box of 50kg is lifted by a man of mass 60kg to a height of 50m. Calculate the work done by the man.

OR

(b) How much mass of water can be lifted by a pump motor of 9.8KW in one minute to a height of 5m?

Question 6 **[2]**

A shot fired from cannon explodes in air. What will be the changes in the momentum and the kinetic energy?

Question 7 **[2]**

Two bodies of masses 0.5kg and 1kg are lying in the X-Y plane at points (-1, 2) and (3, 4) respectively. Locate the centre of mass of the system.

Question 8 **[2]**

Define **Orbital Velocity**. Obtain the relation between orbital velocity and acceleration due to gravity g, for a satellite orbiting very close to the surface of the earth.

Question 9 **[2]**

(a) Define **Bulk modulus of elasticity** and write an expression in terms of pressure 'P', volume 'V' and change in volume 'ΔV'.

OR

(b) With reference to Elasticity, define the following terms:

1. Stress
2. Strain

Question 10 **[2]**

What is **magnus effect**? Write any one application of this effect.

Question 11 **[2]**

State the **First Law** of thermodynamics. Name the physical quantity that remains **conserved** in this law?

Question 12 **[2]**

An electric heater supplies heat to a system of gas at a rate of 150W. The system performs work at a rate of 50J/s. At what rate is the internal energy increasing?

SECTION C

*Answer **all** questions.*

Question 13 **[3]**

(a) Calculate the acceleration **'a'** of the system and the tensions T_1 and T_2 in the strings as shown in *figure 1*. (Assume that the table and the pulleys are frictionless and the string is massless and inextensible).

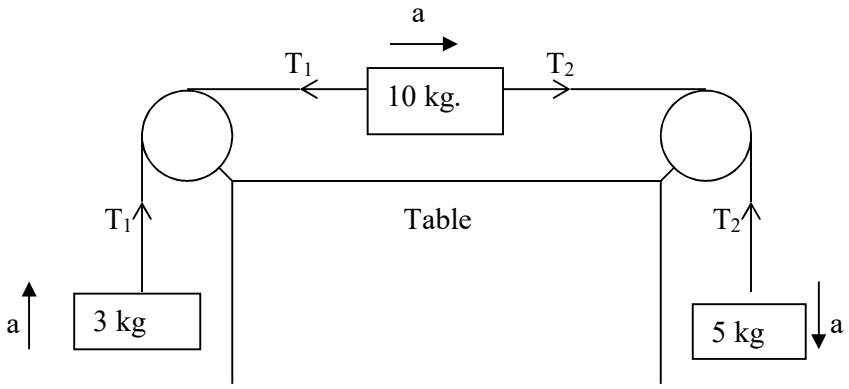

Figure 1

OR

(b) A body of mass 50kg is hung by a spring balance in a lift. Calculate the reading of the balance when:

(i) The lift is ascending with an acceleration of $2m/s^2$.

(ii) The lift is descending with a constant velocity of 2m/s.

(iii) The lift is descending with an acceleration of $2m/s^2$.

Question 14 **[3]**

Derive an equation for **displacement** of a projectile fired at an angle θ from the ground.

Question 15 **[3]**

When a cyclist negotiates a circular path of radius 'r' with velocity 'v', making an angle θ with the horizontal, show that $\tan\theta = \frac{v^2}{rg}$.

Question 16 **[3]**

A fly wheel is rotating at a speed of 160 r.p.m. whose weight is 20 Kg and its centre of mass is at a distance of 0.01m from the axis of rotation. Calculate:

(i) moment of inertia of the fly wheel.

(ii) the energy stored in the fly wheel.

Question 17

(a) (i) Calculate the height to which the water will rise in a capillary tube of 1.5mm diameter (surface tension of water = 74 x 10^{-3}Nm^{-1}, angle of contact between water and glass = 0). **[3]**

(ii) Plot a graph of terminal velocity verses time.

OR

(b) (i) A soap film is on a rectangular wire ring of size 2cm x 3cm. If the size of the film is changed to 3cm x 3cm, calculate the work done in this process. (the surface tension of soap solution is 3.0x10^{-2}Nm^{-1}).

(ii) What is the effect on the surface tension of a liquid with an **increase** in the temperature.

Question 18 **[3]**

Derive Newton's law of **cooling** to show that the rate of loss of heat from the body is proportional to the temperature difference between the body and its surroundings.

Question 19 **[3]**

16 tuning forks are arranged in the order of decreasing frequency. Any two successive forks give 8 beats per second when sounded together. If the first tuning fork gives the octave of the last, then determine the frequency of the last fork.

SECTION D

*Answer **all** questions.*

Question 20 **[5]**

(a) (i) The distance of the planet Jupiter from the Sun is 5.2 times that of the Earth. Find the period of Jupiter's revolution around the Sun.

(ii) Obtain an equation for the period of revolution of an artificial satellite revolving at **height 'h'** from the surface of Earth.

OR

(b) (i) Calculate the area covered per second (m^2s^{-1}) by the Moon for one complete revolution round the Earth (distance of Moon from Earth = 3.845×10^8m and period of revolution of Moon = $27\frac{1}{3}$ days).

(ii) Obtain an expression for the **gravitational potential**.

Question 21 **[5]**

(a) (i) If $A = -\hat{i} + 3\hat{j} + 2\hat{k}$ and $B = 3\hat{i} + 2\hat{j} + 2\hat{k}$ then find the value of $\vec{A} \times \vec{B}$.

(ii) Using the **second law** of motion show that impulse is equal to the change in momentum.

OR

(b) (i) Calculate the work done when $F = (-5\hat{i} + 3\hat{j} + 2\hat{k})$N and $S = (3\hat{i} - \hat{j} + 2k)$ m acting in same direction.

(ii) Show with the help of a vector diagram that the work done is a scalar product of force and displacement.

Question 22 **[5]**

(a) (i) Derive an equation for the first mode of vibration of an air column in a **closed** organ pipe.

(ii) What is the phase difference between the incident wave and the reflected wave in the following?

1. Wave reflected from rigid boundary.
2. Wave reflected from free boundary.

OR

(b) (i) Derive an equation for the first mode of vibration of an air column in an **open** organ pipe.

(ii) State *any two* characteristics of a plane progressive wave.

Useful Constants and Relations:

1. $g = 9.8$ m/s^2.
2. Density of water = $10^3 Kg / m^3$.