(English Version)

SECTION – I

Answer the following questions (Multiple Choice Questions) : $1 \times 14 = 14$

1. What is the number of significant figures in 0·002020 ?

   a) 6 b) 5

   c) 4 d) 3.

2. A particle is thrown vertically upwards. Its velocity at half of the height is 10 m/s. The maximum height attained by it is ($g = 10\ m/s^2$)

   a) 16 m b) 10 m

   c) 20 m d) 40 m.

3. A cricket ball of mass 0·25 kg hits a bat with a velocity 10 m/s and returns with same velocity in 0·01 s. The force exerted on the bat by the cricket ball is

   a) 25 N b) 50 N

   c) 250 N d) 500 N.

4. A body placed on an inclined plane is just in equilibrium. If μ is the coefficient of friction, then the maximum inclination of the plane with the horizontal is

   a) $\tan^{-1}\mu$ b) $\tan^{-1}(\mu/2)$

   c) $\sin^{-1}(\mu)$ d) $\cos^{-1}(\mu)$.

5. A force $(60\hat{i} + 15\hat{j} - 3\hat{k})$ N acts on a body and produces velocity $(2\hat{i} - 4\hat{j} + 5\hat{k})$ m/s. The magnitude of power at that instant is

   a) 95 W b) 75 W

   c) 45 W d) 100 W.

6. Position vectors of two equal masses with respect to the origin are $\vec{p}$ and $\vec{q}$ respectively. Position vector of the centre of mass of these masses is

   a) $\vec{p} + \vec{q}$ b) $\frac{\vec{p} + \vec{q}}{2}$

   c) $\vec{p} \times \vec{q}$ d) $\frac{\vec{q} - \vec{p}}{2}$

7. Moment of inertia of a circular wire of mass m and radius r about its diameter is

a) mr^2 b) $\frac{1}{2}mr^2$

c) $2mr^2$ d) $\frac{1}{4}mr^2$.

8. If the density of the earth becomes 4 times and radius becomes half of what it is, our weight will

a) be four times of its present value

b) be doubled

c) remains same

d) be halved of its present.

9. Which mode of transmission of heat depends on the force of gravity ?

a) Conduction b) Convection

c) Radiation d) None of these.

10. A platinum wire can easily be sealed in glass, because for glass and platinum

a) densities are equal

b) melting points are equal

c) specific heats are equal

d) coefficients of linear expansion are equal.

11. The r.m.s speed of the molecules of a gas at 100°C is v. The temperature at which the r.m.s. speed will be $\sqrt{3}\ v$ is

a) 546°C b) 646°C

c) 746°C d) 846°C.

12. Which is incorrect ?

a) In an isobaric process $\Delta P = 0$ b) In an isochoric process $\Delta W = 0$

c) In an isothermal process $\Delta T = 0$ d) In an isothermal process $\Delta Q = 0$.

13. A mass of 1 kg attached to the bottom of a spring has a certain frequency of vibration executing SHM. Which of the following mass has to be added extra to it in order to reduce the frequency by half ?

a) 1 kg
b) 2 kg
c) 3 kg
d) None of these.

14. Which of the following does not change when sound enters from one medium to another ?

a) Wavelength
b) Speed
c) Frequency
d) None of these.

SECTION – II

GROUP – A

Answer the following questions in *one* sentence (Alternatives are to be noted) :

$1 \times 4 = 4$

1. For which value of m the vectors $\vec{A} = 2\hat{i} + m\hat{j} + \hat{k}$ and $\vec{B} = 4\hat{i} - 2\hat{j} - 2\hat{k}$ will be perpendicular to each other ?

OR

Can two vectors of different magnitudes be combined to give zero resultant ?

2. Can the centre of mass of a body lie outside the body ?

3. Why does water stick to the fingers, but mercury does not ?

OR

Draw $P - TK$ curve for an ideal gas at constant volume.

4. Which of the tones will be absent in the note emitted from a string clamped at both ends, when it is struck at a distance of one-third of its length from one end ?

OR

Velocity of sound in moist air is ..... than the velocity of sound in dry air. Fill in the blank.

GROUP – B

Answer the following questions in short (Alternatives are to be noted) $2 \times 5 = 10$

5. A physical quantity X is related to four variables a, b, c and d as follows :

$$X = \frac{a^2 b^3}{c\sqrt{d}}$$

If the percentage errors of measurement in a, b, c and d are 3%, 1%, 2% and 4% respectively, then what is the percentage error in the quantity X ?

6. State the laws of static friction. 1 + 1

OR

What is centrifugal force ? Why is it called pseudoforce ? 1 + 1

7. State Bernoulli's theorem and show its mathematical form indicating the significance of each term used.

OR

Derive the relation between surface tension and surface energy.

8. For ideal gas prove that $C_P - C_V = R$.

(Symbols have their usual meaning)

9. Write down the laws of transverse vibration in a stretched string.

OR

What is Doppler effect ? Give an example of Doppler effect in case of light wave.

GROUP – C

Answer the following questions in short (Alternatives are to be noted) : $3 \times 9 = 27$

10. A particle is projected with a velocity u in a direction making an angle θ with the horizontal.

i) Deduce the equation for the path of the projected particle.

ii) Find the total time of flight of the particle and its horizontal range. 1 + 2

11. State law of conservation of linear momentum. Establish Newton's 3rd law of motion from it. 1 + 2

12. a) A block of mass 30 kg rests on a rough horizontal surface. A force of 200 N is applied on the block. The block acquires a speed of 4 m/s in 2s from rest. What is the value of coefficient of friction ?

b) Show that coefficient of friction is a dimensionless quantity. 2 + 1

OR

a) A cyclist is moving in a circular path of radius 20 m with a velocity 36 km h^{-1}. What is his inclination with the vertical ? ($g = 10\ ms^{-2}$)

b) Establish relation between linear velocity and angular velocity. 2 + 1

13. a) State Work-Energy theorem.

b) The potential energy of a spring when stretched through a distance x is 25 J. If the spring is stretched by an additional distance $5x$ what is the potential energy stored in the spring ? 1 + 2

OR

a) Show that the total mechanical energy of a body falling under gravity along a frictionless inclined surface is constant.

b) A motor vehicle drives a body along a straight line with a constant force. Draw the power (P) developed by the motor vehicle *vs* time (t) curve. 2 + 1

14. a) Define centre of mass.

b) If the radius of earth contracts to half of its present value without changing its mass, what will be the new duration of day ? 1 + 2

15. a) If T is the period of revolution of an artificial satellite orbiting very close to the earth's surface and ρ is the density of earth, then show that ρT^2 = constant.

b) The conservation of what physical quantity does Kepler's second law refer to ? 2 + 1

OR

a) Define acceleration due to gravity.

b) Derive an expression for acceleration due to gravity at a place of latitude λ on the surface of the earth due to rotation about its own axis. 1 + 2

16. What is escape velocity ? Assuming the earth to be a sphere of radius R, determine the expression for escape velocity of a body on the surface of the earth. 1 + 2

OR

a) A body weighs 63 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth ?

b) Define gravitational potential at a point. 2 + 1

17. Derive the expression for pressure of an ideal gas from Kinetic theory of gases. 3

OR

a) What do you call the straight line path described by a gas molecule between two successive collisions ?

b) What is the relation between pressure p of a gas and its energy density E ?

c) Define degree of freedom. 1 + 1 + 1

18. a) State the mathematical form of first law of thermodynamics.

b) Between the adiabatic curves and isothermal curves on a P-V diagram, which one is steeper and why ? 1 + 2

OR

Write two differences between isothermal and adiabatic processes. Give an example of extensive variable. 2 + 1

GROUP – D

Answer the following questions (Alternatives are to be noted) : $5 \times 3 = 15$

19. a) Given $\vec{A} = 2\hat{i} + 3\hat{j}$ and $\vec{B} = \hat{i} + \hat{j}$. Find the magnitude of scalar component of vector $\vec{A}$ along $\vec{B}$.

b) What is meant by the term unit vector ?

c) The position vectors of A, B and C of the vertices of a triangle are $2\hat{i} + 4\hat{j} - \hat{k}$, $4\hat{i} + 5\hat{j} + \hat{k}$ and $3\hat{i} + 6\hat{j} - 3\hat{k}$. What type of triangle is it ?

$2 + 1 + 2$

OR

a) The displacement of a particle along X-axis is given by $x = 3 + 8t - 2t^2$ metre. What is its acceleration ? At what time it will come at rest ?

b) A body is moving with uniform acceleration in a straight line. Its velocity after 5 s is 25 m/s and after 8 s is 34 m/s. Calculate the distance traversed in 9th second.

c) Draw acceleration-time curve of a body falling freely. $2 + 2 + 1$

20. a) On being heated, the length of each side of a cube increases by 2%. What is the percentage increase in the volume of the cube ?

b) The density of mercury at 0°C and 100°C are $13{\cdot}6 \times 10^3$ kg/m^3 and $13{\cdot}35 \times 10^3$ kg/m^3 respectively. Determine the coefficient of real volume expansion of mercury.

c) What is Thermal stress ? $2 + 2 + 1$

OR

a) What is Poisson's ratio ? Why is it not called modulus ?

b) Eight water drops of equal size are falling through air with constant velocity 2 ms^{-1}. If the drops are allowed to coalesce to form a single drop, what would be its terminal velocity ?

c) State Hooke's law. $(1 + 1) + 2 + 1$

21. a) What is beat ? Two waves $y_1 = A \sin \omega_1 t$ and $y_2 = A \sin \omega_2 t$ are superposed on each other. If the two frequencies are nearly equal, show that the number of beats produced per second by the waves is equal to the difference of their frequencies.

b) For progressive wave deduce the relation between particle velocity and wave velocity. (1 + 2) + 2

OR

a) Find the expression for total energy of a particle executing simple harmonic motion. Draw the variation of energy *vs* displacement curve.

b) For a particle executing SHM, find the distance from the mean position at which its potential and kinetic energy are equal. (2 + 1) + 2