2018

PHYSICS

(Theory)

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

General Instructions :

(i)   All questions are compulsory.

(ii) Marks for each question are indicated against it.

(iii) There is no overall choice. However, an internal choice has been provided in two questions of two marks each, two questions of three marks each and two questions of five marks.

(iv) Use of ordinary calculator is allowed.

(v)   Mobile phones are not allowed in the Examination Hall.

(vi) Use the following values of physical constants wherever necessary:

Mass of the earth, $M = 6.00 \times 10^{24}$ kg

Radius of the earth, $R_e = 6.4 \times 10^6$ m

Acceleration due to gravity, $g = 9.8$ m/s^2

Gravitational constant, $G = 6.67 \times 10^{-11}$ Nm^2 /kg^2

Universal gas constant, $R = 8.314$J/mole/K

Mechanical equivalent of heat, J = 4.186 J/cal

Avogadro number, $N = 6.022 \times 10^{23}$ /mole

Boltzmann constant, $k = 1.381 \times 10^{-23}$ J/mole/K

GROUP —A

(Multiple choice type questions)

Choose and write the correct answer in the answer script.

$$\frac{1}{2} \times 8 = 4$$

1. The dimensional formula $[ML^2 T^{-2}]$ represents   ½

   (a)   Moment of force

   (b)   Force

   (c)   Acceleration

   (d)   Momentum

2. Light year is the unit of   ½

  (a)   Time

  (b)   Intensity of light

  (c)   Distance

  (d)   Energy

3. In 1.0 second, a particle goes from point A to point B moving in a semi-circle of radius 1.0m as shown in fig. The magnitude of average velocity is   ½

  (a)   3.14 m/s

  (b)   2.0m/s

  (c)   1.0 m/s

  (d)   Zero

A

1.0m

B
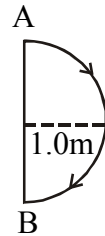
4. To break a wire of 1mm radius, a force of 10 N is required. To break a wire of 3 mm radius, the required force will be.   ½

  (a)   90 N

  (b) $\frac{10}{3}$ N

  (c) $\frac{10}{9}$ N

  (d)   30N

5. The spherical shape of a small water droplet is due to its   ½

  (a)   friction

  (b)   viscosity

  (c)   surface tension

  (d)   density

6. Due to capillarity action, a liquid will rise in a tube, if the angle of contact is   ½

  (a)   acute

  (b)   obtuse

  (c) 90^0

  (d)   zero

7. The equation:
Area x Velocity = constant is called   ½

  (a)   Bernoulli's equation

  (b)   Stoke's equation

  (c)   Equation of continuity

  (d)   Reynold's number

8. A car travels first half of the distance between two places with a speed of 40 km/hr and the second half distance with a speed of 60 km/hr. The average speed of the car is– ½

(a) 50 km/hr

(b) 48 km/hr

(c) 100 km/hr

(d) 25 km/hr

GROUP – B

(*Very short answer type questions*)

Answer the following questions in a few words / sentences. $1 \times 8 = 8$

9. An elastic wire is cut to half its original length. How would it affect the maximum load the wire can support? 1

10. A body is projected horizontally from a height of 10m, with a speed of 9.8m/s. After what time of its projection, will the horizontal and vertical components of velocities be equal? 1

11. A ball is thrown upwards with a velocity of 100 m/s. How much time it will take to reach the ground. (Take g=10 m/s²) 1

12. What is pressure head? 1

13. Find the effective length of a second's pendulum. 1

14. What is the range of frequency of audible sound? 1

15. Which of the three types of elasticity (Y, K, η) is possessed by all the three states of matter (solid, liquid, gas)? 1

16. Give one example each of conservative and non-conservative forces. ½ + ½ = 1

GROUP — C

(*Short answer type –I questions*)

Answer the following questions within *30* words each: $2 \times 8 = 16$

17. Verify whether the following equation is dimensionally correct: 2

$$V^2 - U^2 = 2as$$

Where the symbols have their usual meanings.

18. Is the flying of a bird an example of parallelogram law of addition of vectors? Explain ½ + 1½ = 2

19. If the distance (in meter) travelled by a body in time t (second) is given by $\qquad$ 2

$$x = \sqrt{3}t + 6t^2$$

then what will be the acceleration of the body?

Either

20. What is friction? Why is it called a self adjusting force?

$$1 + 1 = 2$$

Or

Define instantaneous power. Show that $\qquad$ 2

$$P = \vec{F}.\vec{v}$$

where symbols have their usual meanings.

21. An aircraft executes a horizontal loop of radius 1km with a steady speed of 900km/h. Compare its centripetal acceleration with the acceleration due to gravity. $\qquad$ 2

Either,

22. An ideal gas is compressed at constant temperature. Will its internal energy increase or decrease? Explain. $\qquad$ 2

Or

Define isothermal change. Write the expression for work done during an isothermal change. $\qquad$ 1 + 1 = 2

23. Calculate the r.m.s. velocity of oxygen molecules at S.T.P., the molecular weight of oxygen being 32. $\qquad$ 2

24. A steel rod 100cm long is clamped at its middle. The fundamental frequency of longitudinal vibrations of the rod is given to be 2.53 *kHz*. What is the speed of sound in steel? $\qquad$ 2

GROUP — D

(*Short answer type – II questions*)

Answer the following questions in *30* to *40* words each : $\qquad$ $3 \times 9 = 27$

25. Obtain an expression for the position vector of the centre of mass of a system consisting of two particles. $\qquad$ 3

Either,

26. Two vectors are inclined at an angle θ. Find magnitude and direction of resultant vector. $\qquad$ 3

Or

What is position vector and displacement vector? Distinguish between them with illustration.

27. The relation between the displacement x and the time 't' of a particle moving under constant force is $t = \sqrt{x} + 3$, where x is in metre and t in seconds. Determine (i) the displacement of the particle at the instant when velocity is zero (ii) work done by the force in first 6 seconds.

$$1\frac{1}{2} + 1\frac{1}{2} = 3$$

28. Establish the relation between torque and angular acceleration. Hence define moment of inertia. 2 + 1 = 3

29. Two ball bearings each of mass '*m*' moving in opposite directions with equal velocities *v* collide head on with each other. Predict the outcome of the collision, assuming it is perfectly elastic. 3

30. Explain the principle of working of a heat engine with diagram. Define its efficiency. 2 + 1 = 3

Either,

31. Why and how Laplace corrected Newton's formula for velocity of sound in gas? 3

Or

What are beats? Show the formation of beats graphically. 1 + 2 = 3

32. State three assumptions of kinetic theory of gases. 3

33. Prove that for a harmonic oscillator (a massless loaded spring). 3

$$v = \frac{1}{2\pi}\sqrt{\frac{Spring\ factor}{inertia\ factor}}$$

GROUP — E

(*Long Answer type questions*)

Answer the following questions in *70* to *80* words each : $5 \times 3 = 15$

Either,

34. State and explain Newton's second law of motion. Show that Newton's second law of motion is the real law of motion. 2 + 3 = 5

Or

Explain with the help of a neat diagram, how banking provides the centripetal force necessary for a car to go in a circular track. 1 + 4 = 5

35. Define escape velocity? Prove that the velocity of escape of a body from the earth's surface is $\sqrt{2}$ times the orbital velocity of a satellite revolving close to the surface of earth. 1 + 3 + 1 = 5

Either,

36. *(a)* What is Stoke's law? Derive the relation by the method of dimensions.   ½ + 2 = 2½

   (b) Show that the terminal velocity (v) of a sphere of radius (r), density (ρ) falling vertically through a viscous fluid of density (σ) and coefficient of viscosity (η) is given by   2½

$$v = \frac{2}{9} \times \frac{(\rho - \sigma)r^2 g}{\eta}$$

Or

Define with example, capillarity and angle of contact. Derive an expression for the ascend of a liquid in a capillary tube.

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