

2019

PHYSICS

(Theory)*Full Marks : 70**Time : 3 hours**The figures in the margin indicate full marks for the questions**General Instructions :*

- (a) 15 minutes time has been allotted to read this question paper. The question paper will be distributed exactly 15 minutes before the commencement of the examination, the students will read the question paper only and will not write any answer on the remaining empty spaces on the question paper during this period.
- (b) All questions are compulsory. There are 30 questions in all.
- (c) This question paper has five sections: Section A (I and II) Section B, Section C, Section D and Section E.
- (d) Section A–I contains five multiple choice questions of one mark each, Section A–II contains very short answer questions of one mark each. Section B contains seven

short answer questions of two marks each. Section C contains nine short answer questions of three marks each. Section D contains one value based question of four marks each and Section E contains three long answer questions of five marks each.

- (e) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
- (f) You may use the following values of standard physical constants wherever necessary.
 - (i) Acceleration due to gravity, $g = 9.8 \text{ ms}^{-2}$
 - (ii) Radius of the earth, $R_e = 6400 \text{ km}$
 - (iii) Universal gas constant, $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
 - (iv) Boltzmann constant, $K_B = 1.381 \times 10^{-23} \text{ J K}^{-1}$
 - (v) Velocity of light $C = 3 \times 10^8 \text{ ms}^{-1}$
 - (vi) Young's modulus of steel $Y = 2.0 \times 10^{11} \text{ Nm}^{-2}$
 - (vii) Avogadro number, $N = 6.023 \times 10^{23}$ per gram mole.

(3)

SECTION – A – I

(Multiple choice questions)

1. The dimensional formula for latent heat is 1

(a) $[M^0 L^2 T^{-2}]$

(b) $[ML^2 T^{-1}]$

(c) $[MLT^{-2}]$

(d) $[ML^2 T^{-2}]$

2. The length of a rod is $(11.05 \pm 0.05)m$. What is the total length of two such rods? 1

(a) $(22.1 \pm 0.05)m$

(b) $(22.10 \pm 0.05)m$

(c) $(22.1 \pm 0.05)cm$

(d) $(22.10 \pm 0.10)m$

3. The time period of an earth satellite in circular orbit is independent of 1

(a) the mass of the satellite

(b) radius of its orbit.

(4)

(c) both the mass of satellite and radius of the orbit.

(d) neither the mass of satellite nor the radius of the orbit.

4. An ideal monatomic gas is taken round the cycle ABCDA as shown in the P - V indicator diagram below: 1

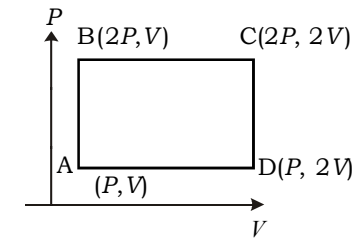
The work done during the cycle is

(a) PV

(b) $2PV$

(c) $\frac{PV}{2}$

(d) Zero



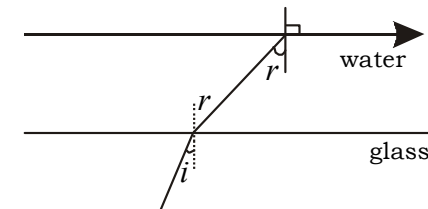
5. A ray of light is incident at the glass-water interface at an angle of incidence i , if it emerges finally parallel to the surface of water, then the refractive index of glass μ_g would be 1

(a) $\frac{4}{3} \sin i$

(b) $\frac{1}{\sin i}$

(c) $\frac{4}{3}$

(d) 1



(5)

SECTION – A-II

(Very short answer type questions)

6. “Multiplying any vector by a scalar”. Give reasons if this algebraic operation is meaningful. 1
7. Write an expression showing the variation of acceleration due to gravity with height above the surface of the earth. 1
8. Give a graphical representation for a body which is vibrating with a time period T. 1
9. State the law of equipartition of energy. 1
10. State Stokes’ law of viscosity. 1

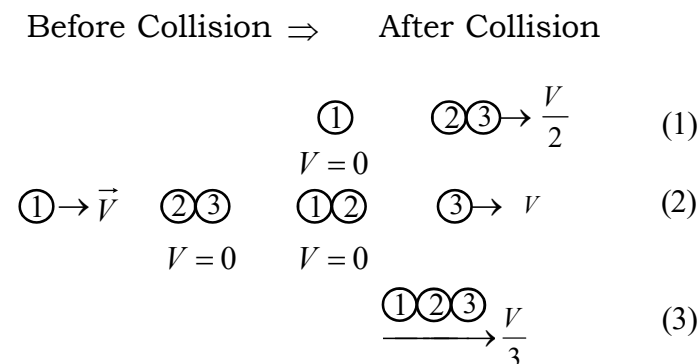
SECTION – B

(Short answer type questions)

11. The length of a given steel rod as measured by the students are 3.14cm, 3.12cm and 3.15cm. Calculate the mean absolute error of these lengths. 2

(6)

12. The position of an object is given by the equation $x = 2 + 2.5 t^2$, where the constants 2 and 2.5 indicate the displacement and constant acceleration of an object respectively. Find the average velocity between $t = 2$ sec and $t = 4$ sec by using calculus. 2
13. What is a conservative force? Mention its various properties. 2
14. Two identical ball bearings in contact with each other and resting on a frictionless table are hit head on by another of identical ball bearing moving initially with a speed V . If the collision is elastic which of the following diagrams is a possible result after collision. Support your answer with valid equation. 2



15. In a hydrogen atom, an electron revolves around the nucleus in a circular orbit of radius 0.45 \AA with a speed of $3.1 \times 10^6 \text{ ms}^{-1}$. Find its angular momentum. 2

(7)

- 16.** *Either*
State any two Kepler's laws of Planetary motion. 2
OR,
What are Geostationary satellites? Name atleast one such satellite owned and used by India. 2
- 17.** Using the expression for escape velocity from the surface of the planet earth, calculate the numerical value of escape velocity of a body of mass 10kg from the surface of the earth. 2

SECTION — C

Short answer type – (3 marks each)

- 18.** Obtain the equation of maximum range of a projectile projected at an angle θ with the horizontal at an initial velocity V_0 . 3
- 19.** (a) Derive an expression for stopping distance for vehicles.
(b) A car moving along a straight highway with speed of 126km h^{-1} is brought to rest within a distance of 200m. What is the retardation (assumed uniform) of the car and how long does it take for the car to stop. 3
- 20.** Prove the work-energy theorem for a variable force. Mention one important uses of this theorem. 3

(8)

- 21.** *Either,*
Show that the torque acting on a particle is equal to the rate of change of angular momentum. 3
OR
Derive the expression for the kinetic energy of a rotating body in terms of the moment of inertia of the body. 3
- 22.** Explain the basic requirement of heat engines with the help of a schemetic diagram representation. $2\frac{1}{2} + \frac{1}{2} = 3$
- 23.** Derive an expression for the work done during an adiabatic process. Give the necessary P - V indicator diagram. $2\frac{1}{2} + \frac{1}{2} = 3$
- 24.** What is Doppler's effect? Derive an expression for the apparent pitch heard by the listener at rest when
(a) the source of sound is approaching the listener
(b) the source of sound is receding away from the listener. $1 + 1 + 1 = 3$
- 25.** The value of G in CGS system is 6.67×10^{-8} dyne cm^2g^{-2} . Use dimensional analysis to find the value of G in SI unit. 3

(9)

- 26.** A 4kg mass is attached to a spring of spring constant 400 Nm^{-1} . It is made to vibrate on a frictionless rod. The mass is displaced through a distance of 10cm from the equilibrium position and then released. Calculate (a) the time period of oscillation (b) the maximum speed of vibration (c) the maximum acceleration of the attached mass.
- 1 + 1 + 1 = 3

SECTION — D

Value based question– (4 marks)

- 27.** A dead snake remain submerged at the bottom of the water tank and could not be visible to the observer outside the tank. This dead snake could be made visible only by pouring more water into the tank so that the apparent position of the dead snake is raised due to refraction of light. If the height of the tank is 5 m, what should be the level of water to be poured into the tank so that an observer at a particular position can see the dead snake only when its position is raised by 1m above the bottom of the tank?
- 4

SECTION — E

(Long answer type)

- 28.** (a) Explain briefly the working principle of a hydraulic lift. State the law involved.
- 2 + 1 =3

(10)

- (b) Torricelli's barometer used mercury. Pascal duplicated it by using French wine of density 984 kg m^{-3} . Determine the height of the wine column for normal atmospheric pressure [Take normal atmospheric pressure $P = 1.013 \times 10^5 \text{ Nm}^{-2}$]
- 2

Or

- (a) Define heat. Draw a simple pictorial labelled diagram to represent the different modes of transference of heat.
- (b) The co-efficient of volume expansion of glycerin is $4.5 \times 10^{-5} \text{ K}^{-1}$. What is the fractional change in its density for 30°C rise in its temperature.

- 29.** (a) Derive the equation of the time period of a simple pendulum.
- (b) Show that the length of a seconds pendulum is nearly 1m.

Or

- (a) Derive the equation of refractive index of a glass prism in terms of the angle of minimum deviation.
- (b) A ray of light passing through a glass prism of refracting angle 60° undergoes a minimum deviation of 30° . Calculate the velocity of light in glass.

30.

Either

What is banking of roads? What is the need for banking of a road? Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ . The co-efficient of friction between the wheels and the road is μ .

Or

$$1 + 1 + 3 = 5$$

Show that the equation of path of a projectile is a parabola. Obtain an expression for the horizontal range of a projectile.

$$2\frac{1}{2} + 2\frac{1}{2} = 5$$

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