June 2021

APPLIED PHYSICS-I

Time Allowed: 3 Hours *Full Marks: 60*

Answer to Question No.1 is compulsory and Answer any five questions from Group-A & B, taking at least two from each group.

1. Answer the following questions (any twenty): 20x1

i) The significant figures of the number 60.023 are– (a) 1, (b) 4, (c) 5, (d) 2.

ii) The dimensional formula of torque is– (a) [M L^2 T^2], (b) [ML^2T^{-2}], (c) [MLT] , (d) [ML^{-1} T^{-2}].

iii) If the error in the measurement of radius of a sphere is 2%, then the error in the determination of the volume of the sphere will be– (a) 4%, (b) 6%, (c) 8%, (d) 2% .

iv) Temperature can be expressed as derived quantity in terms of any of the following– (a) length and mass, (b) mass and time, (c) length, mass and time, (d) in terms of none.

v) Impulse (I) of a force (F) acting on a particle for time t is given by– (a) I=Fxt, (b) I=F/t, (c) I=t/F, (d) none of these.

vi) The SI unit of moment of inertia is– (a) meter/second, (b) kg meter, (c) kg $meter^2$,(d) $kg/meter^2$.

vii) Which one is not conserved in uniform circular motion? – (a) Kinetic Energy, (b)Velocity Vector, (c) Angular Velocity, (d) Angular Momentum.

viii) A 10N force applied on a body to produce in it an acceleration of $1m/s^2$. The mass of the body is– (a)15 kg, (b) 20 kg, (c) 10 kg,(d) 5 kg.

ix) The angular velocity of a body moving with a constant speed v in a circle of radius is given by– (a) v^2/r, (b) vr, (c) v/r, (d) r/v.

x) An object at rest may have– (a) momentum, (b) potential energy, (c) velocity, (d) kinetic energy.

xi) The recoil of gun after firing a shell is due to the principle of conservation of– (a) mass, (b) linear momentum, (c) angular momentum, (d) kinetic energy.

xii) Angular momentum L of body with the moment of inertia I and angular velocity ω rad/sec is equal to– (a) $\frac{I}{\omega}$, (b) $I\omega^2$, (c) $I\omega$, (d) none of these.

xiii) Moment of inertia of a thin circular disc of mass M and radius R about any diameter is- (a) MR^2, (b) $MR^2/4$, (c) $MR^2/2$, (d) $2MR^2$.

xiv) The angular speed of a flywheel making 120 revolutions/minute is– (a) 4π rad/s, (b) $4\pi^2$ rad/s, (c) π rad/s,(d) 2π rad/s.

xv) Kinetic energy, with any reference, must be– (a) zero, (b) positive, (c) negative, (d) both (b) & (c).

xvi) Young's modulus is the property of– (a) solids only, (b) solids and liquids, (c) liquids and gases (d) solids, liquids and gases.

xvii) Lubricants _____. – (a) Increase friction, (b) Reduce friction, (c) Both (a) & (b), (d) None.

xviii) Surface tension is measured by – (a) force/mass, (b) force/area, (c) force/volume , (d) force/length.

xix) The unit of coefficient of viscosity is – (a) Nm/s, (b) Nm^2/s, (c) Ns/m^2, (d) Nms^2.

xx) Raindrops are spherical in shape because of – (a) capillary, (b) surface tension, (c) downward motion, (d) viscosity.

xxi) If a liquid does not wet glass, its angle of contact is – (a) zero, (b) acute, (c) obtuse, (d) right angle.

xxii) The relation between the coefficient of linear expansion(α) and the coefficient of superficial expansion (β) of a substance is– (a) $\alpha=2\beta$, (b) $\alpha=\beta$, (c) $\alpha=\frac{\beta}{2}$, (d) $\alpha=\frac{\beta}{3}$.

xxiii) Heat travels through vacuum by– (a) conduction, (b) convection, (c) radiation, (d) both (b) & (c).

xxiv) The direction of heat flow between two objects depends on– (a) Their masses, (ii) Their heat contents, (c) Their temperature, (d) their physical state.

Group-A

2. a) The viscous force (F) on a spherical body moving through a liquid depends upon the velocity (v) of the body, the radius (r) of the body and the co-efficient of viscosity (η) of the liquid. Derive the expression for the viscous force by dimensional method.
   b) State the principle of Dimensional Homogeneity. Check whether the equation $v = ut + \frac{1}{2}at^2$ is dimensionally correct. Symbols have their usual meaning.
   c) Write down the limitations of dimensional analysis. 3+ (1+2) +2

3. a) A wire has mass (0.3±0.003) g, radius (0.5±0.005) m and length (6±0.06) cm. What will be the maximum percentage error in the measurement of density of the wire?
   b) Can a dimensionless quantity have a unit?
   c) Define Impulse of a force. How is it related to momentum?
   d) A 30 g bullet leaves a rifle with a velocity of 300 m/s and the rifle recoils with a velocity of 60 cm/s. Find the mass of the rifle. 3+1+2+2

4. a) Established the relation between linear speed and angular speed of a particle executing circular motion.
   b) Why is centrifugal force called a pseudo force? Calculate the centripetal force acting on a small mass of 0.25 kg rotating 1800 revolution/ min on a radius 200 mm.
   c) Why does a cyclist bend inwards while riding along a curved road? 2+(2+2)+2

5. a) State work-energy principle. An apple of mass 0.1 kg is dropped from a height 1m. Find out the value of the kinetic energy when it hits the ground.
   b) State the laws of limiting friction.
   c) A body is pulled along a horizontal plane through a distance of 5 m by applying a constant force of 4 N. Find the work done by the force when- i) the force is applied along the plane and ii) the force is applied at an angle of 60^0 with the plane. (1+3) +2+2

Group-B

6. a) Write down the relation between torque and angular momentum.
   b) Write down the principle of conservation of angular momentum.
   c) Define moment of inertia. State the theorem of perpendicular axes.
   d) Define Poisson's ratio. What are its limiting values? 2+1+(1+2)+(1+1)

7. a) State Hooke's law. On what factors does the modulus of elasticity of a substance depend?
   b) Define co-efficient of viscosity and write down its SI unit.
   c) What is meant by streamline and turbulent flow of a liquid? What is critical velocity?
   3+(1+1)+3

8. a) State and explain Bernoulli's theorem.
   b) What are the differences between conduction, convection & radiation?
   c) Calculate the rate of loss of heat through a glass window of area 1000 cm^2 and thickness 0.4 cm when temperature inside is 37^0 C and outside is -5^0 C. Co-efficient of thermal conductivity of glass is 2.2×10^{-3} Cal s^{-1} cm^{-1} $^0c^{-1}$. 2+3+3

9. a) Define co–efficient of thermal conductivity and hence find its unit in SI.
   b) A thick glass tumbler often cracks when boiling water is poured into it-why?
   c) Define molar specific heat at constant pressure and molar specific heat at constant volume of a gas. Write down their relationship. (2+1)+2+(2+1)