April 2022

APPLIED PHYSICS - I

Time Allowed: 3 Hours *Full Marks: 60*

Answer the following questions from Group A, B & C as directed.

GROUP A

1. Choose the correct alternatives (any ten): 1x10

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

ii. Rate of change of linear momentum is - a) work, b) acceleration, c) force, d) torque answer force

iii. The rise of a liquid in a capillary tube depends on - (a) the material, (b) the length, (c) the outer radius, (d) the inner radius of the tube.

iv. The internal energy of an ideal gas depends on – (a) pressure, (b) volume, (c) temperature, (d) size of the molecules.

v. The number of significant figures in 0.06900 is - a) 3, b) 4, c) 5, d) 2.

vi. The surface which radiates more heat at a given temperature is - (a) Black and Polished, (b) White and polished, (c) White and Rough, (d) Black and Rough.

vii. The ratio of the terminal velocities of two drops of radii R and R/2 is - a) 2, (b) 1, (c) ½, (d) 4.

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

ix. What happens to the viscosity of liquid with the increase in temperature?–
a) increases, b) decreases, c) remains unaltered, d) none.

x. Moment of inertia of a hollow sphere about an axis passing through its centre is -
a) $MR^2/2$, b) $2MR^2/3$, c) $7MR^2/3$, d) $2MR^2/5$.

xi. What is the momentum of a 10000 kg truck whose velocity is 20m/s? - a) 2×10^5 kg-m/s, (b) 1×10^5 kg-m/s, (c) 4 kg-m/s, (d) None of these.

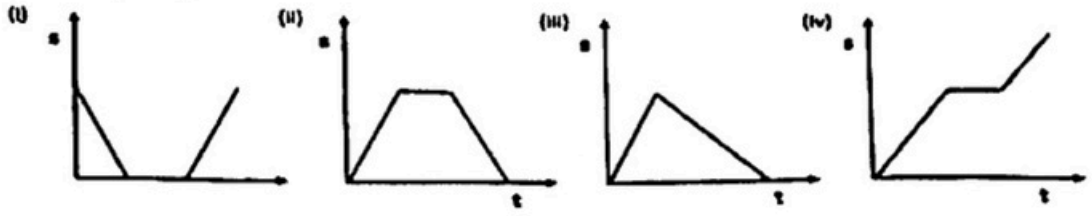
xii. Angular speed of second's hand of a clock is -
a) $\pi/3\ rad/s$, b) $2\pi\ rad/s$ c) $\pi/1800\ rad/s$ d) $\pi/30\ rad/s$.

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

xiv. A liquid in a capillary tube will rise if the angle of contact is - a) acute, b) obtuse, c) 90^0, d) 120^0

xv. If velocity-time (v-t) graph of a moving particle is given below—

What will be its distance-time (s-t) graph?



2. Fill in the blanks (any ten): 1x10

i. The net force required to accelerate a 1000 kg car at 4.00 m/s^2 is _____.
ii. Sap rises from the roots of a planet to its leaves and branches due to _____.
iii. Recoil of a gun is based on _____ principle.
iv. Reciprocal of Bulk Modulus is known as _____.
v. The terminal velocity attained by a spherical body is proportional to the _____ radius.
vi. In Isothermal process _____ remains constant.
vii. Within elastic limit stress is proportional to strain. This is _____ law.
viii. Liquid nitrogen temperature is 77K, its value in Celsius scale is _____.
ix. Volume of water is _____ at 4^0 C.
x. S.I. unit of Specific heat is _____.
xi. 1 N force = _____ dyne.
xii. 1 B.O.T. unit = _____ joule.
xiii. Angle of contact of water with glass surface is _____ than 90°.
xiv. Parsec is a unit of _____.
xv. SI unit of impulse is _____.

3. Answer the following questions in one or two sentences (any ten): 1x10

i. Write the SI unit of (a) Temperature and (b) Electric Current.
ii. What is isochoric process?
iii. What is meant by critical velocity of liquid?
iv. What is Jurin's law?
v. What does the slope of stress versus strain curve give?
vi. Moment of inertia of a ring about one of its diameter is I. What will be its moment of inertia about a tangent parallel to its diameter?
vii. Cloudy nights are warmer than the nights with clean sky - state the reason.
viii. Can a quantity unit be dimensionless? Give one example.
ix. What is the dot product of two similar unit vectors?
x. What is the S.I. unit of Poisson's ratio?
xi. How is angular momentum related to linear momentum?
xii. What is the dimension of Surface Tension?
xiii. Which mode of transfer of heat is quickest?
xiv. What is the direction of velocity vector of a particle in circular motion?
xv. If $x=a+bt+ct^2$, where x is in metre and t in second, then what is the unit of c?

GROUP B

4. Answer the following questions (any six): 2x6

i. Define conservative and non-conservative force with example.
ii. State the principle of conservation of angular momentum.
iii. The angle θ covered by a body in rotational motion is given by the equation $\theta = 6t + 5t^2 + 2t^3$. Determine the angular velocity and angular acceleration at time t= 2s.
iv. A large vertical cylinder of height 20m is filled with water. Find the velocity of efflux of water through a very small hole made at the bottom of its vertical wall. Take $g = 10\ m/s^2$.
v. "Strain is more fundamental than Stress" – Justify the statement.
vi. What is the difference between accuracy and precision?

vii. What do you mean by Reynolds number? How is it related with streamline and turbulent flow?
viii. State two factors that influence surface tension.
ix. Pendulum clock goes fast in winter and slow in summer – explain.
x. When wax is rubbed on cloth, the cloth becomes water proof. Why?

GROUP C

5. Answer the following question (any one):

i. (a) Write down the names of the fundamental physical quantities and their SI unit.
(b) Length of a rod as measured in an experiment was found to be 2.48 m, 2.46 m, 2.49 m, 2.50 m and 2.48 m. Find the (i) average length (ii) mean absolute error (iii) relative error and (iv) percentage error. 2+4

ii. (a) Show that impulse of a force on a body is equal to change in momentum of the body.
(b) What are the differences between centripetal and centrifugal force? (c) Find the angle of banking of a road of radius of curvature of 600m so that a car can move safely at a maximum speed of 180 km/hour. 2+2+2

iii. (a) Define angular displacement, angular velocity and angular acceleration and state their SI units.
(b) Write down the expression for centripetal force mentioning the physical meaning of the symbols. 4+2

6. Answer the following question (any one):

i. (a) Define the term Power. Is it a scalar or vector quantity? Give its dimension and unit in SI system.
(b) A man weighing 60kg climbs up a staircase carrying a load of 30kg on his head. The staircase has 20 steps each of height 0.3m. If he takes 10s to climb, find his power. 3+3

ii. (a) What constant unbalanced torque is required to increase the speed of a flywheel of moment of inertia 0.1 Kg-m^2 from 3 rps to 9 rps in 18 revolutions?
(b) State the theorem of parallel axes. 4+2

iii. (a) Rotational kinetic energy of two bodies of inertia 9 kgm^2 and 1kgm^2 are same. What will be the ratio of their angular momentum?
(b) What is friction?
(c) Discuss some ways to reduce friction. 3+1+2

7. Answer the following question (any one):

i. (a) Define surface tension and surface energy. Write down their relation.
(b) Establish the relation between co-efficient of linear expansion and co-efficient of volume expansion of solid. 3+3

ii. (a) Define the term angle of contact. On what factor does it depend?
(b) State Bernoulli's theorem.
(c) Define coefficient of thermal conductivity. What is the value of thermal conductivity of a perfect heat conductor and a perfect heat insulator? 2+2+2

iii. (a) What is meant by streamline flow of a fluid?
(b) A capillary tube of radius 0.2 mm is dipped in water of surface tension 72×10^{-3} N/m. Find the rise of water in the tube. ($g = 10m/s^2$, angle of contact = 0°)
(c) Does the internal energy of an ideal gas change in an isothermal process? Give reason in support of your answer. 1+3+2