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Registration number:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
B.Sc. PHYSICS – I SEMESTER
SEMESTER EXAMINATION – March 2022
PH 121 - MECHANICS & PROPERTIES OF MATTER

Time: 3 hrs

Max. Marks: 100

This question paper contains 4 printed pages and 4 parts

PART – A

Answer all the questions of this section continuously.

Do not mix up the question numbers.

The correct **answer along with the corresponding alphabet** should be written.

Answer **ALL** of the following:

(20X1=20)

- Which of the following is a vector quantity
a) Surface Tension b) Moment of inertia
c) Current d) Momentum
- The dimensions of force is
a) $[MLT^{-2}]$ b) $[ML^{-2}T^{-2}]$
c) $[MLT^{-1}]$ d) $[ML^{-1}T^{-1}]$
- The measurement of side of a cube has error of 2%. The error in the measurement of its volume is
a) 2% b) 6%
c) 8% d) 4%
- The dot product between $3\hat{i} + 2\hat{j}$ and $5\hat{i} - 6\hat{j}$ is
a) 5 b) 3
c) 6 d) 12
- If the velocity of the body is doubled then its momentum
a) doubles b) becomes half
c) remains constant d) becomes one fourth
- The total energy of an isolated system
a) cannot change b) can only increase
c) can only decrease d) may increase or decrease

7. If the force applied on the object is doubled and mass is halved what is the ratio of its acceleration?
 a) 1:2 b) 2:1
 c) 1:4 d) 4:1
8. Who proposed special theory of relativity
 a) Galileo b) Lorentz
 c) Isaac Newton d) Albert Einstein
9. If two photons are moving in opposite direction with velocity c then their relative velocity will be
 a) zero b) c
 c) $2c$ d) $3c$
10. A bomb at rest explodes into large number of tiny fragments. The total momentum of all the fragments
 a) is zero b) depends on total mass of all fragments
 c) is infinity d) depends on velocity of all fragments
11. Which of the following wire is harder to twist
 a) lesser radius, shorter length b) lesser radius, longer length
 c) larger radius, longer length d) larger radius, shorter length
12. Within elastic limit the bulk modulus is the ratio of
 a) lateral strain to linear strain b) stress to strain
 c) shear stress to shear strain d) normal stress to volume strain
13. In Searle's double bar if the time periods of flexural oscillation and torsional oscillation is T_1 and T_2 respectively then the Poisson's ratio is given by
 a) $\frac{T_2^2}{2T_1^2} - 1$ b) $\frac{T_1^2}{2T_2^2} - 1$
 c) $\frac{T_2^2}{2T_1^2} - 2$ d) $\frac{T_1^2}{2T_2^2} - 2$
14. Which of the following represents viscosity?
 a) Potential energy stored in fluid b) Resistance to fluid motion
 c) Roughness of the surface d) The pressure difference
15. The force of gravitation isin nature.
 (a) Repulsive (b) Electrostatic
 (c) Conservative (d) non-conservative
16. The gravitational force between two objects is F . If masses of both the objects are halved without altering the distance between them, then the gravitational force would become
 a) $F/2$ b) $F/4$
 c) F d) $2F$

17. A geo-stationary satellite orbits around the Earth once
 a) per month b) per week
 c) per day d) per hour
18. The escape velocity of a body depends upon
 a) mass of the body b) mass of the earth
 b) speed of light d) angle of projection
19. The rise of a liquid in a capillary tube is due to
 a) viscosity b) Osmosis
 c) diffusion d) surface tension
20. By adding detergent to water, its surface tension can be
 a) increased b) decreased
 c) cannot be changed d) cannot be predicted

PART – B

Answer any **FOUR** of the following:

(4X10=40)

1. a) The velocity of a particle moving along a curved path is $\vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta}$. Find the acceleration and hence bring out the concept of centripetal acceleration.
 b) Explain the concept of centre of mass of a system of particles. Show that the centre of mass of two particles divides the line joining the two masses in the inverse ratio of masses. (5+5)

2. a) Distinguish between inertial and non-inertial frame of reference. Explain Newtonian principle of relativity.
 b) State and prove parallel axis theorem (4+6)

3. a) Establish the relation between torque and angular momentum.
 b) Define equivalent length and obtain the expression for the time period of a compound pendulum (3+7)

4. a) Using the method of dimensions deduce Stokes law.
 b) Obtain the general expression for the pressure difference across the curved liquid surface. (4+6)

5. a) Explain stress-strain diagram for a metallic wire.
 b) Derive an expression for bending moment for a beam fixed at one end and loaded at the other. (4+6)

6. a) Arrive at the expressions for the gravitational potential at a point outside and inside a solid sphere.
 b) State Kepler's laws of planetary motion. (7+3)

PART – C

Answer any **SIX** of the following:

(6X5=30)

7. If $\vec{a} = 2\vec{i} + 3\vec{j} + 4\vec{k}$ and $\vec{b} = 4\vec{i} + 3\vec{j} + 2\vec{k}$ find the angle between \vec{a} and \vec{b} .
8. A rocket of mass 20 kg has 180 kg of fuel. The exhaust velocity of fuel is 1.6 km/s. Calculate the final speed gained by the rocket after 45 s if the rate consumption of fuel is 2 kg/s.
9. A rocket ship is 100 m long on the ground. When it is in flight, its length appears to be 99 m to an observer on the ground. What is its speed?
10. A torque of 1 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting angular acceleration?
11. A steel wire of radius 0.25 mm and length 2 m is extended by a constant weight of 1.5 kg. Calculate the extension and the energy stored per unit volume in the wire. Young's modulus of steel is $20 \times 10^{10} \text{ N/m}^2$. ($g = 9.8 \text{ m/s}^2$)
12. A spherical glass ball of radius 2.2 mm and mass 0.134 g falls with uniform velocity through a height of 0.381 m in 6.4 s in a large volume of oil of density 943 kg/m^3 . Calculate the coefficient of viscosity of the oil (Accel_n.due to gravity= 9.8 m/s^2).
13. A satellite is revolving round the earth at an average height of 400 km above the earth's surface. Given the average radius of the earth to be 6600 km and its mean density is $5.57 \times 10^3 \text{ kg/m}^3$. Calculate the orbital velocity and the time period of revolution of the satellite. ($G = 6.67 \times 10^{-11} \text{ SI units}$)
14. Calculate the work done in spraying a spherical drop of mercury of radius 1 mm into a million drops of equal size. Surface tension of mercury 0.55 N/m

PART – C

15. Answer any **FIVE** of the following:

(5X2=10)

- a) The cartesian coordinates of a point are (1,0,0). Find the spherical polar coordinates of this point.
- b) Can a vector have a zero component along a line and still have nonzero magnitude. Justify.
- c) Can kinetic energy of a system be increased by applying any internal force on the system?
- d) The acceleration of a particle is zero as measured from an inertial frame of reference. Can we conclude that no force acts on the particle?
- e) In a girder of rectangular cross section, the longer side is used as depth. Why?
- f) What is the work done in moving an object from one point to another on the surface of a spherical shell? Explain
- g) Why does machines get jammed in winter?