3 (Sem-1) PHY M 1

2011

PHYSICS

(Major)

Paper: 1.1

Full Marks: 60

Time: 21/2 hours

The figures in the margin indicate full marks for the questions

GROUP-A

(Mathematical Methods)

(Marks : 20)

- Show with examples that vectors can give an algebra.
- 2. (a) Using scalar product of vectors, show
 - $\cos(\alpha + \beta) = \cos\alpha \cos\beta \sin\alpha \sin\beta$ 2
 - (b) Write the null vector in explicit form. 2

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3. BAC rule states

$$\overrightarrow{A} \times (\overrightarrow{B} \times \overrightarrow{C}) = \overrightarrow{B}(\overrightarrow{A} \cdot \overrightarrow{C}) - \overrightarrow{C}(\overrightarrow{A} \cdot \overrightarrow{B})$$

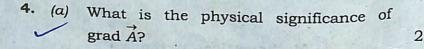
Then show that in general

$$(\overrightarrow{A} \times \overrightarrow{B}) \times \overrightarrow{C} \neq \overrightarrow{A} \times (\overrightarrow{B} \times \overrightarrow{C})$$

Find out the condition where equality holds.

Or

If \vec{a} , \vec{b} and \vec{c} are the position vectors of the points \vec{A} , \vec{b} and \vec{c} in space, what is the area of the triangle?



(b) If some scalar field is given by

$$\phi(\vec{r}) = \phi(r) = r^2 = x^2 + y^2 + z^2$$

then show that $\overrightarrow{\nabla}r$ is a unit vector.

(c) If $\phi(x, y, z)$ is a scalar function, express $d\phi(x, y, z)$ in terms of $\nabla \phi(x, y, z)$. Show that the unit vector $\hat{\nabla} \phi$ must be perpendicular to any $d\vec{r}$ on a surface of constant ϕ .



OR

- 5. (a) Give the diagrammatic representation of the curl of a vector around point P. What is its zero curl representation?
 - (b) (i) The electrostatic force acting between two point charges q and q' at a distance r apart is

$$\vec{E} = \frac{qq'}{r^2} \, \hat{r}_0$$

- where \hat{r}_0 is a unit vector along \vec{r} . Find out curl \vec{E} .
- (ii) Justify the statement that the electric lines of force cannot be closed lines.

GROUP-B

- (Mechanics)
- (Marks: 40)
- 6. (a) Name the fictitious force obtained in the rotating frame of reference.
 - (b) What is the difference between laboratory frame of reference and centre of mass frame of reference?

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(c) What is meant by moment of inertia?

	(α)	the gravitational field of a point mass?	1 .
	(e)	What is meant by acceleration due to gravity? State some methods to determine it experimentally.	
	<i>(f)</i>	Why are cyclones not set up at the equator?	1
7.	(a)	Identify the centrifugal force in the expression of the equation of motion in a rotating frame with angular velocity ω . Justify the statement that centrifugal force is a fictitious force.	2
	(b)	Calculate the mass of the sun, given that the distance between the sun and the earth is 1.49×10^{13} cm and $G = 6.66 \times 10^{-8}$ CGS units.	2
B.	Ans	wer any <i>two</i> questions : $5\times2=$	
	(a)	Show that whenever a body is acted upon by a number of forces such that the resultant is not zero, then the work done by the resultant force is equal to the change in the kinetic energy of the body.	

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(b) The position of a moving particle at an instant is given by

$$\vec{r} = \hat{i}a\cos\theta + \hat{j}a\sin\theta$$

Show that the force acting on the particle is conservative.

- (c) Explain briefly how the acceleration due to gravity is determined by Kater's pendulum in the laboratory.
- 9. Answer any two questions:

10×2=20

- (a) A body of mass m is dropped from rest from height h at latitude 45° in the northern hemisphere (h << radius of the earth). Where will it land relative to a plumb bob suspended from the point of release?
- (b) Show that if a heavy (moving) particle collides elastically with a lighter particle at rest, the particle (incident) can never be scattered perpendicular to the initial direction.
- (c) (i) Calculate the centre of mass of a solid hemisphere.
 - (ii) Show that the external force acting on an extended system of particles is equal to the rate of change of momentum of its centre of mass (CM).

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(d) (i) Show that the angular momentum of an extended system is

$$\vec{L} = \vec{L}_{\rm cm} + \vec{R}_{\rm cm} \times \vec{M}_{\rm cm}$$

where the symbols used in the above expression carry their usual meanings.

(ii) The density of a solid sphere varies inversely with the distance from its centre. Calculate its moment of inertia about (1) any diameter and (2) tangential axis.