#### 2014

PHYSICS

( Major )

Paper: 1.1

Full Marks: 60

Time: 2½ hours

The figures in the margin indicate full marks for the questions

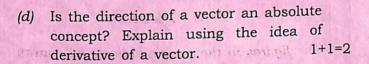
#### GROUP—A

### ( Mathematical Methods )

( Marks : 20 )

- 1. (a) How do you define the direction of angular momentum? Why is the Higgs particle termed as Higgs scalar not Higgs vector?
  - (b) Give the vector diagram representation of  $\overrightarrow{A} \times \overrightarrow{B} = \overrightarrow{C}$  and  $\overrightarrow{B} \times \overrightarrow{A} = \overrightarrow{D}$ . Name a vector physical quantity which is the product of two vectors.

(c) The electric field intensity  $\overrightarrow{X}$  at any point is in the direction of the maximum rate of decrease of potential  $\phi$ . Express it in the mathematical form. Give the mathematical expression of the divergence of a vector over the surface of a unit volume element surrounding a point in a vector field.



- (e) The Euclidean space cannot be considered as a vector space. Why?

  Show how you get a scalar field from a vector field.
- 2. (a) Show that the gradient of any scalar field  $\phi(r)$  is irrotational and the curl of any vector field  $\overrightarrow{V}(r)$  is solenoidal.



(b) Prove that

$$\vec{\nabla} \cdot (\vec{A} \times \vec{B}) = \vec{B} \cdot (\vec{\nabla} \times \vec{A}) - \vec{A} \cdot (\vec{\nabla} \times \vec{B})$$

If  $\overrightarrow{A}$  and  $\overrightarrow{B}$  are irrotational, show that  $\overrightarrow{A} \times \overrightarrow{B}$  is solenoidal.

6

Which is the spokest interection of all

- (c) (i) Let  $\vec{r}(t)$  be a vector of fixed magnitude. Show that  $\frac{d\vec{r}(t)}{dt}$  is perpendicular to  $\vec{r}(t)$ .
  - (ii) If  $\vec{v}(t)$  is a time-dependent vector, show that

a at randomon
$$\vec{v}$$
:  $\frac{d\vec{v}}{dt} = \vec{v} \cdot \frac{dv}{dt}$  shelf as  $\vec{v} \cdot \vec{v} \cdot \vec{v} \cdot \vec{v} \cdot \vec{v} \cdot \vec{v}$ 

where v is the magnitude. How is this relation relevant in connection with the motion of a particle in a circular orbit? Explain. 2+(3+1)=6

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## ( Mechanics )

( Marks : 40 )

- 3. (a) What is integral of the equation of motion?
  - (b) Can you state the relevance of rotating frame of reference with 'Mars Orbital Mission' of India?
  - (c) Give the hint that Tsunami can change the time duration of day and night.

A15-1500/59

( Turn Over )

1

1

1

interactions known in nature?

Which is the weakest interaction of all

(e)	Centre of mass frame is also an inertial frame but all inertial frames cannot be	
	considered as centre of mass frame to	
	investigate a particular physical system.	
	Why?	
(f)	What is the meaning of the statement	
	that there is no absolute velocity?	
	Explain whether the momentum is a	
	frame-dependent quantity or not.	1
(a)	where are the magnitude the	
(~)	Show that the moment of inertia of the	
The state of the s	body about an axis is numerically equal to the torque producing unit angular	
	acceleration about the same axis.	2
(b)	Show that the gravitational force is	4
	conservative.	2
		-
Ans	swer any <i>two</i> questions: $5 \times 2 = 1$	0
(a)	Calculate the centre of mass of	
	semicircular arc and semicircular disc.	
(b)	Derive an expression for the	
	gravitational field inside a sphere of	
PATE	radius R when the mass density at a	

point is  $\rho = a + br^2$  where r is the distance of the point from the centre of the sphere, a and b are two constants.

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5.

(d)

- (c) Find out the mathematical expression of moment of inertia of a spherical shell about a diameter as axis.
- **6.** Answer any two questions:  $10 \times 2 = 20$ 
  - (a) What is Galilean transformation equation? Is it relevant to non-inertial frame of reference? Explain. Derive the equation of motion in a rotating frame of reference.

    1+1+8=10
  - (b) Give the theory of the compound pendulum and show that the centres of suspension and oscillation are reversible. Derive the condition for minimum time period. 3+4+3=10
  - (c) Establish the relations between scattering angles in Lab and CM frames.

    Considering the elastic collision, show that

$$\tan \theta_1 = \frac{\sin \theta_c}{\cos \theta_c + \frac{m_1}{m_2}}$$

where the symbols carry usual meanings. 8+2=10

