2016

PHYSICS

(Major)

Paper : 1.1

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

GROUP—A

(Mathematical Methods)

(*Marks* : 20)

1. *(a)* The coordinates of the two points P and
   Q are $(3, 4, -6)$ and $(1, -2, 3)$. Find $\overrightarrow{PQ}$.   1

   (b) What is the geometrical interpretation of
   the vector product of two vectors?   1

   (c) Find $(\vec{a} \cdot \vec{\nabla})\vec{r}$.   1

   (d) Define scalar field and vector field in a
   region R in space.   1

(*Turn Over*)

2. *(a)* If $\hat{a}$ and $\hat{b}$ are unit vectors and θ is the angel between them, then show that $\sin\frac{\theta}{2} = \frac{1}{2}|\hat{a}-\hat{b}|$. 2

(b) Show that two non-zero vectors

$$\vec{A} = A_1\hat{i} + A_2\hat{j} + A_3\hat{k} \text{ and } \vec{B} = B_1\hat{i} + B_2\hat{j} + B_3\hat{k}$$

are parallel if and only if

$$\frac{A_1}{B_1} = \frac{A_2}{B_2} = \frac{A_3}{B_3} \quad 2$$

(c) If $\frac{d}{dt}\vec{u} = \vec{w}\times\vec{u}$ and $\frac{d}{dt}\vec{v} = \vec{w}\times\vec{v}$, then show that $\frac{d}{dt}(\vec{u}\times\vec{v}) = \vec{w}\times(\vec{u}\times\vec{v})$. 2

(d) If $\vec{A}$ and $\vec{B}$ are irrotational, then prove that $\vec{A}\times\vec{B}$ is solenoidal. 2

3. Answer any *two* questions : $\quad 4\times2=8$

(a) If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three non-coplanar vectors, then express $\vec{b}\times\vec{c}$ in terms of $\vec{a}$, $\vec{b}$ and $\vec{c}$.

(b) Prove that

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

(c) Find $\vec{\nabla}\cdot\vec{F}$ and $\vec{\nabla}\times\vec{F}$, where

$$\vec{F} = \vec{\nabla}(x^3 + y^3 + z^3 - 3xyz)$$

A7/46   *(Continued)*

(3

GROUP—

(Mechan

(Marks :

4. *(a)* Write two factors on depends.

(b) Give one example o which is velocity-de

(c) Name the physical c cause of rotational or vector quantity?

(d) There is a stick of steel. The mass of t less than the steel at the wooden end at right angle to its end. Next it is pivo and the same forc wooden end. In angular momentum

(e) A thin rod of length circle and has a m the gravitational pot

5. *(a)* A non-inertial fran angular speed 10 ra 20 kg is at a dista axis of rotation. Fi the centrifugal forc

(b) Show that, $\vec{F} = (2xy + z^2)\hat{i} + x^2\hat{j} + 2xz\hat{k}$ is a conservative force. 2

(c) An observer in Lab. frame finds the velocities of the two particles A and B of masses m_1 and m_2 as v_1 and v_2. Calculate the velocity of each particle and total momentum of the system in centre of mass frame. 2

(d) State the two theorems of moment of inertia. 2

(e) Gravitational potential is always negative in sign. What conclusion can you draw from this statement? Write the relation between gravitational intensity and gravitational potential. 2

6. Answer any *three* questions : 5×3=15

(a) Find the expression of acceleration in non-inertial frame of reference.

(b) Find the centre of mass of a homogenous semicircular disc.

(c) Show that for compound pendulum, the points of suspension and oscillation are interchangeable.

(d) Derive the expression of gravitational potential at a point outside a spherical shell.

(Continued)

---

7. Answer any *one* question :

(a) (i) What are laborato[ry and] mass frames of re[ference?]

(ii) Obtain a relatio[n] angles in these [ ] reference.

(b) (i) Calculate the mo[ment] spherical shell ab[out]

(ii) Two bodies of ma[ss] are moving $(2\hat{i} - 7\hat{j} + 3\hat{k})$ and [ ] Find the velocitie[s] of mass.

(c) (i) Derive an expressi[on] a freely falling bo[dy] force due to rotat[ion]

(ii) Two bodies of ma[ss] are placed at d [ ] Show that at the p[oint] gravitational field [ ] zero, the potential[ ]

$$V = -\frac{G}{d}[M_1 + M]$$

★ ★ ★

2016

PHYSICS

(Major)

Paper : 1.2

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

SECTION—I

(Waves and Oscillations)

(Marks : 40)

Answer Question No. 1 and *any* **five** from the rest

1. *(a)* Define a stationary wave. 1

   (b) If two waves are represented by $x_1 = a \sin(\omega t + \pi/5)$ and $x_2 = a \cos(\omega t - \pi/3)$, then what is the phase difference between the two waves? 1

   (c) What is the ratio between the intensities of the first and fifth harmonics produced in a spring plucked at the midpoint? 1

A7/47

(d) Give an example of application of Fourier series analysis. 1

(e) What is reverberation in sound wave? 1

2. Show that the direction of the acceleration and force are opposite to the direction of motion of the vibrating particle in simple harmonic motion. Calculate the total energy of a vibrating particles in simple harmonic motion. 3+4

3. *(a)* Two tuning forks A and B are of nearly equal frequencies. Frequency of A is 256. When the two tuning forks are used to obtain Lissajous figures, the complete cycle of changes takes place in 10 seconds. When the tuning fork B is loaded with a little wax, the time taken is 20 seconds. Calculate the frequency of B before loading. 4

(b) Find whether the discharge of a condenser through the following inductive circuit is oscillatory :

$C = 0 \cdot 1 \, \mu F, \; L = 10 \, \text{mH}, \; R = 200 \, \Omega$

If it is oscillatory, find the frequency of oscillation. 3

---

4. *(a)* State the difference wave and longitudi

(b) Determine the dis and change in pr progressive wave. P velocity and the ch compare them.

5. *(a)* Obtain the position antinodes of a stan a closed-end organ

(b) Give an example e and forced oscillati

6. *(a)* Calculate the veloci in which two wa 1 meter and 1· 10 beats in 3 seco

(b) What is the role constructing a Calculate the rever auditorium of volu absorbing surface [Given the av coefficient is 0·5.]

7. Analyze, with the help of periodic wave given by f and $f(t) = 0$ for $T/2 \le t \le$ three terms of the Four

8. *(a)* Deduce the expression for the energy of a string vibrating transversely.   5

(b) Calculate the change in intensity level when the intensity of sound increases 200 times of its original intensity.   2

9. *(a)* Find the expression of velocity of a longitudinal wave in a thin solid bar.   5

(b) Distinguish between phase velocity and group velocity.   2

SECTION—II

(Ray Optics)

(Marks : 20)

Answer *any* **four** questions

10. Using Fermat's principle, derive the formula $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ for a spherical mirror.   5

11. Using matrix method, find the matrix for combination of two lenses of focal lengths f_1 and f_2 and separated by a distance d in air.   5

12. Obtain the lens formula for a thick lens of thickness t.   5

(Continued)

13. Derive the relation magnification and longitu of a lens system.

14. Show that spherical ref aplantic with respect to the object.

15. *(a)* What do you mean optical system?

(b) Distinguish betwe astigmatism.

(c) What is achromatic

★ ★ ★