2011

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. Show with examples that vectors can give an algebra. 1

2. *(a)* Using scalar product of vectors, show that

$$\cos(\alpha+\beta)=\cos\alpha\cos\beta-\sin\alpha\sin\beta$$ 2

(b) Write the null vector in explicit form. 2

3. BAC rule states

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

Then show that in general

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

Find out the condition where equality holds. 5

Or

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

4. *(a)* What is the physical significance of grad $\vec{A}$? 2

(b) If some scalar field is given by

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

then show that $\vec{\nabla} r$ is a unit vector. 3

(c) If $\phi(x, y, z)$ is a scalar function, express $d\phi(x, y, z)$ in terms of $\vec{\nabla}\phi(x, y, z)$. Show that the unit vector $\hat{\nabla}\phi$ must be perpendicular to any $d\vec{r}$ on a surface of constant ϕ. 2+3

5. *(a)* Give the diagram
the curl of a v
What is its zero

(b) *(i)* The electr
between two
at a distanc

$$\vec{E}$$

where $\hat{r}_0$ is

Find out cu

(ii) Justify the
electric line
closed lines.

GROU

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(Marks

6. *(a)* Name the fictitiou
rotating frame of

(b) What is the
laboratory frame
of mass frame of

(c) What is meant by moment of inertia? 1

(d) Can we have equipotential surfaces of the gravitational field of a point mass? 1

(e) What is meant by acceleration due to gravity? State some methods to determine it experimentally. 1

(f) 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 $1{\cdot}49\times10^{13}$ cm and $G = 6{\cdot}66\times10^{-8}$ CGS units. 2

8. Answer any *two* questions : 5×2=10

(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.

(b) The position of a r
instant is given by
$\vec{r} = \hat{i}a\cos$

Show that the f
particle is conserv

(c) Explain briefly how
to gravity is det
pendulum in the l

9. Answer any *two* questio

(a) A body of mass m
from height h at
northern hemisphe
earth). Where will
plumb bob suspend
release?

(b) Show that if a hea
collides elastically w
at rest, the particle
be scattered perpen
direction.

(c) (i) Calculate the
solid hemisphe

(ii) Show that the
on an extended
is equal to th
momentum of
(CM).

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

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

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.

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2011

PHYSICS

(Major)

Paper : 1.2

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 40)

1. *(a)* Indicate the type of motion described by the equation

$$m\ddot{x} + R\dot{x} + kx = 0$$ 1

(b) Define group velocity. 1

(c) What is the ratio between the intensities of the fundamental and the third harmonic in a string plucked at the midpoint of its length? 1

(d) What simplification is obtained in the Fourier series if the function is even? 1

(e) A sine wave is travelling in a medium. What is the minimum distance between the two particles, always having same speed? 1

(f) What is the difference between transverse and longitudinal waves? 1

2. (a) Write down the expression of wave travelling in negative direction along x-axis and having an amplitude 0·02 m, frequency 440 Hz and velocity 330 ms^{-1}. 2

(b) In a one-dimensional motion of a mass 10 g, it is acted on by a restoring force 10 dyne/cm and a resisting force 2 dyne sec/cm. Find—

(i) whether the motion is aperiodic or oscillatory;

(ii) the resisting force per unit velocity which will make the motion critically damped. 2

3. Answer any *two* questions : 5×2=10

(a) Using the method of separation of variables, find the general solution of the differential wave equation in one dimension.

(b) Derive the expres
density of a plan

(c) Calculate the ave
a plane progres
the intensity leve
relative to the
10^{-12} watt/m^2.
in air = 330 m/s.

4. (a) Two simple ha
simultaneously o
angles to each oth
of the particle will
two motions have
different amplitud

What happens whe
between the moti
figure is produce
vertical and a horiz
motion. The patte
with the vertical
with the horizont
frequency is 2 kH
frequency?

O

Derive the expres
and the decay of
density with time
Sabine's definition

(b) State Fourier's theorem. Analyse, with the help of Fourier's theorem, a square periodic wave given by

$$y = A \text{ (constant) for } 0 \le t \le \frac{T}{2}$$
$$= 0 \text{ for } \frac{T}{2} \le t \le T$$

Also plot the Fourier synthesis with first four terms. 2+6+2=10

Or

Find the differential equation of transverse vibration of a stretched string. Find an expression for the energy eigen-modes for vibration of a string fixed at the two ends and plucked at the middle. 4+6=10

SECTION—II

(*Marks* : 20)

5. State Fermat's principle of least action. 1

6. (a) Define conjugate foci of a lens. 2

(b) What is achromatic doublet? 2

7. Answer any *one* questi

(a) Establish the refra refraction of a ray surface separating indices n_1 and n_2.

(b) Find the condition two thin lenses se distance.

8. Answer any *one* questio

(a) (i) Using Fermat's the laws of ref plane surface.

(ii) Obtain the co for refraction surface with p

(b) (i) What is dis Distinguish cushion an distortions.

(ii) What is meant Show that surface is apl to certain posit

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