**2020**

# PHYSICS (Honours)

## Paper Code : I - A & B

### [New Syllabus]

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### Important Instructions
### for Multiple Choice Question (MCQ)

- Write Subject Name and Code, Registration number, Session and Roll number in the space provided on the Answer Script.

  **Example :** Such as for Paper III-A (MCQ) and III-B (Descriptive).

  Subject Code : | III | A | & | B |

  Subject Name : |                                             |

- Candidates are required to attempt all questions (MCQ). Below each question, four alternatives are given [i.e. (A), (B), (C), (D)]. Only one of these alternatives is 'CORRECT' answer. The candidate has to write the Correct Alternative [i.e. (A)/(B)/(C)/(D)] against each Question No. in the Answer Script.

  **Example** — If alternative A of 1 is correct, then write :
  
  **1. — A**

- There is no negative marking for wrong answer.

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# Paper Code : I - A

Answer *all* the Questions.
Choose the Correct Answer.
Each Question Carries 1.5 Marks.

1. For the vectors $\vec{a} = \hat{j} + \hat{k}, \vec{b} = 2\hat{i} + 3\hat{j}, \vec{c} = \hat{j} - \hat{k}$; the vector product of $\vec{a} \times (\vec{b} \times \vec{c})$ is —

   (A) in the direction opposite to $\vec{c}$

   (B) in the same direction as $\vec{c}$

   (C) in the same direction as $\vec{b}$

   (D) in the direction opposite to $\vec{c}$

2. The value of $\vec{\nabla} \cdot \vec{r}$ is —

   (A) 7

   (B) 11

   (C) 2

   (D) 3

3. Eight drops of water of same size are falling through air with terminal velocity of 10 m/sec. If the eight drops combine to form a single drop what will be the new terminal velocity?

   (A) 40 m/s

   (B) 42 m/s

   (C) 45m/s

   (D) 42cm/s

4. The diameter of the orbit of a planet round the Sun is 30 times the diameter of the Earth's orbit round the Sun; both the orbits are assumed to be circular. The time of revolution of that planate about the sun is —

   (A) 170 Year (nearly)

   (B) 164 Year (nearly)

   (C) 185 Year (nearly)

   (D) 183 Year (nearly)

5. The eigen values of the matrix representing the following pair of linear equations $x+iy = 0$ and $ix + y = 0$ are —

   (A) $1 + i,\ 1 + i$

   (B) $1 - i,\ 1 - i$

   (C) $1, i$

   (D) $1 + i,\ 1 - i$

6. Two masses constrained to move on a horizontal plane collided with each other. Given $m_1 = 85g$ , $m_2 = 200g$, $u_1 = 6.48$ cm/s , $u_2 = -6.78$ cm/s. The velocity of centre of mass would be —

   (A) 2.01 cm/s

   (B) 2.01 m/s

   (C) 2.82 m/s

   (D) 2.82 cm/s

7. Given surface tension of soap solution is $20 \times 10^{-3}$ N/m and the radius of soap bubble is $3 \times 10^{-3}$ m. Calculate the surface energy.

   (A) $22.62 \times 10^{-7}$ Joule

   (B) $22.62 \times 10^{-5}$ Joule

   (C) $20.04 \times 10^{-5}$ Joule

   (D) $20.04 \times 10^{-7}$ Joule

8. The acceptable value of Poisson ratio ($\sigma$) for an elastic body may be —

(A) 0.6

(B) $-2.3$

(C) $-1.2$

(D) 0.4

9. $A = \begin{bmatrix} 2 & 4 & 1 \\ 3 & 7 & 2 \\ 0 & 1 & 3 \end{bmatrix}; T_r \, A = ?$

(A) 10

(B) 11

(C) 12

(D) 13

10. Consider a particle of mass '$m$' following a trajectory given by $x = x_0 \cos \omega_1 t$ and $y = y_0 \sin \omega_2 t$, where $x_0, y_0, \omega_1$ and $\omega_2$ constants of appropriate dimensions. The nature of the force will be central.

(A) only if $\omega_1 = \omega_2$

(B) only if $\omega_1 = \omega_2$ and $x_0 = y_0$

(C) only if $\omega_1 \neq \omega_2$ and $x_0 = y_0$

(D) only if $\omega_1 = 2\omega_2$

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**2020**

# PHYSICS (Honours)

## Paper Code : I - B

### [New Syllabus]

Full Marks : 55                                    Time : Three Hours Thirty Minutes

*The figures in the margin indicate full marks.*

Answer *five* questions taking at least *one* from each group.

### Group - A

### [Mathematical Methods]

1. (a) Find the unit tangent vector to any point on the curve $x = t^2 + 1$, $y = 4t - 3$, $z = 2t^2 - 6t$. Determine the unit tangent at the point where $t = 2$.

   (b) If $A$ has a constant magnitude and $\left|\dfrac{d\vec{A}}{dt}\right| \neq 0$, show that $\vec{A}$ and $\dfrac{d\vec{A}}{dt}$ are mutually perpendicular.

   (c) Discuss in few words about the geometrical interpretation of "gradient of a scalar".

   (d) Show that $\vec{\nabla} \cdot \left(r^n \vec{r}\right) = (n + 3) r^n$                    4+2+2+3

2. (a) Verify Stoke's theorem for vector field $\vec{A} = y\hat{i} - x\hat{j}$ for a circle of radius 1 unit with centre at the origin in $x - y$ plane.

   (b) Find the Fourier series for $f(x) = x$ in the closed interval $(-\pi, \pi)$.

(c) Two cards are selected at random from 10 cards, numbered 1 to 10. If the two cards are drawn together, find the probability that the sum is odd.

4+4+3

3. (a) Prove that the eigenvalues of a Hermitian matrix are real.

(b) If $A$ is a non-singular matrix, show that eigenvalues of $A^{-1}$ are reciprocals of those of $A$ and every eigenvector of $A$ is also an eigenvector of $A^{-1}$.

(c) Prove the recurrence relation : $H_{n+1}(x) = 2x\, H_n(x) - 2nH_{n-1}(x)$; where, $H$ denotes the Hermite polynomial. 3+4+4

## Group - B

### [Mechanics]

4. (a) A particle is moving along a curve in a plane. Using plane polar co-ordinate $(r, \theta)$ derive the expression for radial and transverse component of velocity and acceleration.

(b) The polar co-ordinates of a point are $(r, \theta, \phi) = (8, 30°, 45°)$. Find the Cartesian co-ordinates of that point. 8+3

5. (a) Establish the differential equation of motion of a particle under a central force system.

(b) If a planet suddenly stopped moving along its circular orbit, show that it would fall into the sun at a time which is $\dfrac{\sqrt{2}}{8}$ times its time period. 7+4

6. (a) Derive the expression for Coriolis force due to earth's rotation.

(b) Calculate the magnitude and direction of Coriolis acceleration of a rocket moving vertically upward with a velocity of $\dfrac{2}{\sqrt{3}}$ km/s at 30°S latitude.

7+4

## Group - C

## [General Properties of Matter]

7. (a) Show that for a homogeneous isotropic medium $Y = 2\eta(1+\sigma)$; where the symbols have their usual meaning.

   (b) Show that when a solid cylinder is twisted, the torsional couple per unit angular twist is $\dfrac{\pi\eta r^4}{2l}$, where the symbols are of usual meaning. What will be the form of couple if we consider a hollow cylinder?   5+6

8. (a) Derive an expression for the excess pressure acting inside a curved liquid membrane.

   (b) What do you mean by streamline flow of a liquid?

   (c) In the Poiseuille's experiment the following observations were made: volume of water collected in 5 minutes = 50 c.c.; head of water = 0.5 m; length of capillary tube = 0.602 m and radius of capillary tube = $0.52 \times 10^{-3}$ m. Calculate the co-efficient of viscosity of water.   5+2+4

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