

P - I (1+1+1) H / 20 (N)

2020

## PHYSICS (Honours)

Paper Code : I - A & B

[New Syllabus]

### 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
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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.

**মাল্টিপল চয়েস প্রশ্নের (MCQ) জন্য জরুরী নির্দেশাবলী**

- উত্তরপত্রে নির্দেশিত স্থানে বিষয়ের (Subject) নাম এবং কোড, রেজিস্ট্রেশন নম্বর, সেশন এবং রোল নম্বর লিখতে হবে।

উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

Subject Code : 

III	A	&	B
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Subject Name :

- পরীক্ষার্থীদের সবগুলি প্রশ্নের (MCQ) উত্তর দিতে হবে। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে তার উত্তরের স্বপক্ষে (A)/(B)/(C)/(D) সঠিক বিকল্পটিকে প্রশ্ন নম্বর উল্লেখসহ উত্তরপত্রে লিখতে হবে।

উদাহরণ — যদি 1 নম্বর প্রশ্নের সঠিক উত্তর A হয় তবে লিখতে হবে :

1. – A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।

**Paper Code : I - A**

Full Marks : 15

Time : Thirty Minutes

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 planet 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  $m_1=85\text{g}$ ,  $m_2=200\text{g}$ ,  $u_1=6.48\text{ cm/s}$ ,  $u_2=-6.78\text{ cm/s}$ . 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  $20\times 10^{-3}\text{ N/m}$  and the radius of soap bubble is  $3\times 10^{-3}\text{ m}$ . Calculate the surface energy.
- (A)  $22.62 \times 10^{-7}\text{ Joule}$   
(B)  $22.62 \times 10^{-5}\text{ Joule}$   
(C)  $20.04 \times 10^{-5}\text{ Joule}$   
(D)  $20.04 \times 10^{-7}\text{ Joule}$

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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P - I (1+1+1) H / 20 (N)

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  $\left| \frac{d\vec{A}}{dt} \right| \neq 0$ , show that  $\vec{A}$  and  $\frac{d\vec{A}}{dt}$  are mutually perpendicular.  
(c) Discuss in few words about the geometrical interpretation of “gradient of a scalar”.  
(d) Show that  $\vec{\nabla} \cdot (r^n \vec{r}) = (n + 3) r^n$  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  $(r, \theta, \phi) = (8, 30^\circ, 45^\circ)$ . 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  $\frac{\sqrt{2}}{8}$  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  $\frac{2}{\sqrt{3}}$  km/s at  $30^\circ$ 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  $\frac{\pi \eta r^4}{2l}$ , 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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## PHYSICS (Honours)

Paper Code : II - A & B

[New Syllabus]

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Subject Code : 

III	A	&	B
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Subject Name : 

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- 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.

**মাল্টিপল চয়েস প্রশ্নের (MCQ) জন্য জরুরী নির্দেশাবলী**

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উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

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1. – A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।

**Paper Code : II - A**

Full Marks : 15

Time : Thirty Minutes

Answer *all* the Questions.

Choose the Correct Answer.

Each Question Carries 1.5 Marks.

1. Which of the following is the fastest process of heat transfer?
  - (A) Conduction
  - (B) Convection
  - (C) Radiation
  - (D) all three
  
2. A cooking pot is coated black because —
  - (A) Black substances absorb more heat
  - (B) Black substances reflect more heat
  - (C) Black surfaces radiate more heats
  - (D) Above all
  
3. According to van der Waals' gas equation, critical co-efficient  $\frac{RT_C}{P_C V_C}$  is equal to —
  - (A) 8
  - (B) 8.3
  - (C) 8/3
  - (D) 1

4. Viscosity of gas is due to the transport of —
- (A) Velocity
  - (B) Energy
  - (C) Mass
  - (D) Momentum
5. Which of the following is not an applications of Ultrasonic waves?
- (A) For measuring the depth of ocean
  - (B) In sterilizing of a liquid
  - (C) In ultrasonography
  - (D) In sterilizing a needle
6. Name the characteristic of the sound which distinguishes a sharp sound from a grave or dull sound?
- (A) Intensity
  - (B) Echo
  - (C) Pitch
  - (D) Resonance
7. Which of the following is blocked by a Capacitor?
- (A) A.C
  - (B) D.C
  - (C) Both A.C and D.C
  - (D) Neither A.C nor D.C

8. Two spheres of the same radius, one solid and the other hollow, are charged to the same potential. Which will have more charge?
- (A) Solid sphere
  - (B) Hollow sphere
  - (C) Both will have equal charge
  - (D) None of these
9. The potential energy of an electric dipole is maximum when it makes an angle  $\theta$  with electric field. The value of  $\theta$  is —
- (A)  $\pi/2$
  - (B)  $\pi$
  - (C) zero
  - (D)  $2\pi$
10. The Gaussian surface for a line charge will be —
- (A) Sphere
  - (B) Cylinder
  - (C) Cube
  - (D) Cuboid
-

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2020

## PHYSICS (Honours)

Paper Code : II - 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

#### [Heat]

1. State and explain Dulong-Petit's law. Deduce the expressions for the critical constants of a gas obeying van der Waals' equation of state. 5+6
2. Write down the basic postulates of the kinetic theory of gases. From these postulates, establish the relation  $k = \eta C_v$ , where the symbols have their usual meanings. 4+7
3. State and explain Kirchhoff's law of radiation. Show that the energy density of radiation inside a uniformly heated enclosure is given by  $U = (4\pi K)/C$ , terms being usual. 4+7

### Group - B

#### [Sound]

4. Write down the equation of motion of a particle executing one-dimensional forced vibration and explain each term. Solve this equation for the steady state. What are transient beats ? 3+8

5. (a) Deduce an expression for the velocity of transverse waves travelling along a stretched string.
- (b) Derive an expression for the general displacement of a plucked string. 5+6

**Group - C**

**[Electricity - I]**

6. (a) Obtain the multipole expansion of an arbitrary charge distribution by indicating clearly monopole, dipole and quadrupole term.
- (b) Using Biot-Savart law, find an expression for the magnetic field at an axial point of a coil carrying a steady current. 6+5
7. (a) A uniformly charged sphere of radius  $R$  carries a total charge  $Q$ . Calculate the electrostatic self energy of the sphere.
- (b) State Gauss' theorem in electrostatics and obtain its differential form. 5+6
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