P-I (1+1+1) H / 19 (N)

2019

PHYSICS (Honours)

Paper Code : I-A & B

[New Syllabus]

Full Marks : 70 Time : Four Hours

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.
- No student will be allowed to leave the examination hall before completion of the examination.
- Using abusive language or employing any other unfair means, he/she will render himself/herself liable to disqualify.
- Use of any mobile phone, calculator or log table etc. in the examination hall is prohibited, except specially instructed in the question paper.

মাল্টি পল 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 |

  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।
- কোন অবস্থাতেই পরীক্ষার্থীকে পরীক্ষাচলাকালীন পরীক্ষাকেন্দ্রের বাইরে যাওয়ার অনুমতি দেওয়া যাবে না।
- অবাঞ্ছিত কোন শব্দ ব্যবহার করা অথবা অবৈধ কোনো কাজকর্মে লিপ্ত থাকলে ছাত্র/ছাত্রী তার পরীক্ষা বাতিলের জন্য নিজেই দায়ী থাকবে।
- প্রশ্নপত্রে নির্দেশিত বিশেষ নির্দেশ ছাড়া পরীক্ষাকক্ষে মোবাইল ফোন, ক্যালকুলেটর অথবা লগ-টেবিল ইত্যাদি ব্যবহার নিষিদ্ধ।

Paper Code : I-A

Full Marks : 15 Time : Thirty Minutes

Choose the correct answer.

Each question carries 1½ marks.

1. If $\vec{A}$ has a constant magnitude but its direction varies with time (t), the angle between $\vec{A}$ and $\frac{d\vec{A}}{dt}$ (provided $\left|\frac{d\vec{A}}{dt}\right| \neq 0$) will be —

   (A) 0°

   (B) 45°

   (C) 90°

   (D) 180°

2. The vector $\vec{A} = f(r)\vec{r}$ will be solenoidal, if $f(r)$ has a value —

   (A) C/r^3, where C is a constant

   (B) C/r^2, where C = constant

   (C) C/r, where C = constant

   (D) Cr, where C = constant

Turn Over

3. If $\vec{A}$ is a vector field such that $\vec{\nabla}.\vec{A} = 2$, $\oiint_S \vec{A}.d\vec{S}$ will have a value (when the closed surface S encloses a volume V) —

   (A) 2S

   (B) S

   (C) V

   (D) 2V

4. A particle describes the curve $r = ae^{\theta}$ with a constant angular velocity $\vec{\omega}$, 'a' being a constant. The radial acceleration of the particle is —

   (A) A constant $(\neq 0)$

   (B) Zero

   (C) Proportional to r

   (D) proportional to $\frac{1}{r}$

5. A solid cylinder of radius 'R' rolls down an inclined plane from rest. If the vertical height of the incline be 'h', the velocity of the cylinder at the bottom of the incline will be —

   (A) $\left(\frac{4}{3}gh\right)^{1/2}$

   (B) $\left(\frac{10}{7}gh\right)^{1/2}$

   (C) $\sqrt{2gh}$

   (D) $\left(\frac{2}{5}gh\right)^{1/2}$

6. The position vector of a particle moving in the x-y plane is $\vec{r} = (a\cos wt)\hat{i} + (b\sin wt)\hat{j}$, where a, b and w are constants. Which of the following statements is true ?

   (A) The motion of the particle is central in nature and takes place along a straight line.

   (B) The motion is central and takes place in a circle.

   (C) The motion is central and takes place in an ellipse.

   (D) The motion is non-central and takes place in an unspecified curve.

7. A particle of mass 'm' and total energy E moves along the x-axis under the influence of a conservative force field having potential $V(x)$. If the particle is located at positions x_1 and x_2 at times t_1 and t_2 respectively, we must have —

   (A) $t_2 - t_1 = \sqrt{\frac{m}{2}} \int_{x_1}^{x_2} \frac{dx}{E - V(x)}$

   (B) $t_2 - t_1 = \sqrt{\frac{m}{2}} \int_{x_1}^{x_2} \frac{dx}{\sqrt{E - V(x)}}$

   (C) $t_2 - t_1 = \sqrt{\frac{2}{m}} \int_{x_1}^{x_2} \frac{dx}{\sqrt{E - V(x)}}$

   (D) $t_2 - t_1 = \sqrt{\frac{2}{m}} \int_{x_1}^{x_2} \frac{dx}{E - V(x)}$

Turn Over

8. The liquid rises in a capillary tube of radius 2.0 mm by a height of 1.0 cm. In another capillary tube of radius 4.0 mm, it will rise upto a height of —

   (A) 2.0 cm

   (B) 1.5 cm

   (C) 4.0 cm

   (D) 0.5 cm

9. The velocity of water in a river is 20 km hour^{-1} near the surface. If the river is 10.0 m deep, and if the coefficient of viscosity (η) of water is 10^{-3} decapoise, the shearing stress between the horizontal layers of water would be —

   (A) 5.55×10^{-4} N.m^{-2}

   (B) 5.55×10^{-3} N.m^{-2}

   (C) 5.55×10^{-2} N.m^{-2}

   (D) 5.55×10^{-1} N.m^{-2}

10. The dimension of the bulk modulus of elasticity of a solid is —

    (A) MLT^{-1}

    (B) $ML^{-1}T^{-2}$

    (C) $ML^{-2}T^{-2}$

    (D) $ML^{-2}T^{-1}$

P-I (1+1+1) H / 19 (N)

2019

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) Define polar and axial vectors. Give one example of each. 2

(b) Prove that $\vec{A}\times\left(\vec{B}\times\vec{C}\right)+\vec{B}\times\left(\vec{C}\times\vec{A}\right)+\vec{C}\times\left(\vec{A}\times\vec{B}\right)=0$. Under what conditions will you get $\vec{A}\times\left(\vec{B}\times\vec{C}\right)=\left(\vec{A}\times\vec{B}\right)\times\vec{C}$? 3+1

(c) C is a closed curve in the X-Y plane. $\vec{A}$ is a vector given by $\vec{A}=-\hat{i}y+\hat{j}x$. Applying Stokes' theorem, prove that $\oint_C \vec{A}\cdot d\vec{r}=2S$, where S is the area enclosed by the curve. Hence, show that the area of an ellipse in πab. 2+3

2. (a) Verify Gauss's divergence theorem for the vector $\vec{A}=4xz\hat{i}-y^2\hat{j}+yz\hat{k}$ with respect to a unit cube with two opposite corners at (0, 0, 0) and (1, 1, 1) respectively. 5

Turn Over

(b) Expand $f(x)=x$ in a Fourier series in the range $-\pi<x<\pi$. Hence, show that

$$\frac{\pi}{4}=1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\ldots$$ 4+2

3. (a) Define a unitary matrix and prove that the matrix

$$[A]=\begin{bmatrix}\frac{1}{\sqrt{2}} & i/\sqrt{2}\\ -i/\sqrt{2} & -\frac{1}{\sqrt{2}}\end{bmatrix}$$ is unitary. 1+2

(b) Solve the differential equation $\left(D^2+4\right)y=x^2$ by the method of undetermined coefficients. 4

(c) Find Fourier transform of the function :

$$f(x)=\begin{cases}1, & \text{for } |x|<a\\ 0, & \text{for } |x|>a\end{cases}$$

What will be the transform if $k=0$? 3+1

Group - B

[Mechanics]

4. (a) If the total angular momentum of a system of particles referred to an arbitrary fixed point as origin is $\vec{L}$, show that

$\vec{L}=\vec{L}_{cm}+\vec{R}_{cm}\times\vec{P}$, terms being usual. 5

(b) Two particles of masses M and m are at a distance 'd' apart. Calculate the moment of inertia of the system about an axis passing through the centre of mass and perpendicular to the line joining the two masses. If γ be the frequency of revolution, find the rotational kinetic energy of the system. 3+1

(c) If a force $\vec{F}$ acts on a particle at right angles to its velocity $\vec{v}$, prove that $|\vec{v}|$ is a constant. 2

5. (a) Show that the path of a projectile as seen from another projectile is always a straight line. 3

(b) What is a central force ? Show that the angular momentum of a particle moving in a central force-field remains conserved. What is the physical significance of the result ? 1+2+1

(c) The motion of a particle under the influence of a central force is described by $r = a \sin\theta$, where a = constant. Find the law of force. 4

6. (a) Using Galilean transformation equations, show that if a collision is elastic in one inertial frame, it is elastic in all inertial frames. 3

(b) What is a compound pendulum ? Obtain an expression for its time-period of oscillation.

A uniform square lamina of side $2a$ is hung up by one corner and swings in its own vertical plane. Show that the length of the equivalent simple pendulum is $\frac{4\sqrt{2}a}{3}$. 1+3+2

(c) What is 'escape velocity' ? Write down its value on the earth's surface. 1+1

Group - C

[General Properties of Matter]

7. (a) Define Y, n and σ of an isotropic solid, where the terms bear usual significance. Find a relation among them. 6

(b) Show that the work done per unit volume in deforming a body is $\frac{1}{2}$ × stress × strain. 3

Turn Over

(c) Explain the terms 'surface tension' and 'angle of contact' of a liquid. 2

8. (a) With necessary assumptions deduce Poiseuille's formula for the viscous flow of a liquid in a capillary tube. 6

(b) Two vessels of equal cross-sectional area 'α' are joined near their bases by a horizontal narrow tube of length 'l' and internal radius 'r'. Initially the liquid surfaces are at heights $3h$ and h respectively above the capillary tube. Calculate the time taken for the difference in levels to become 'h', if the coefficient of viscosity is 'η' and the density is 'd'. 5