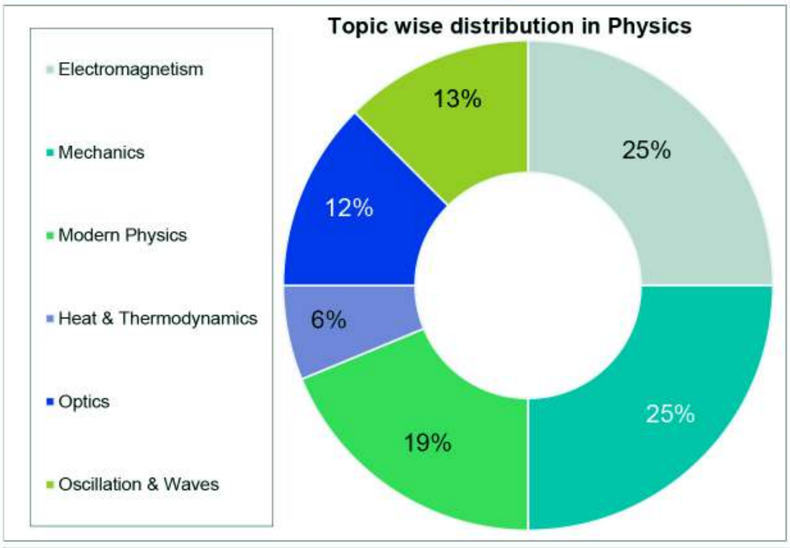
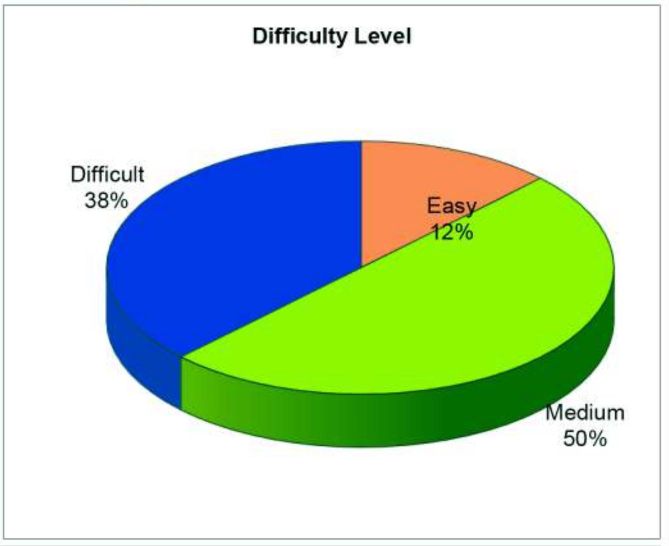
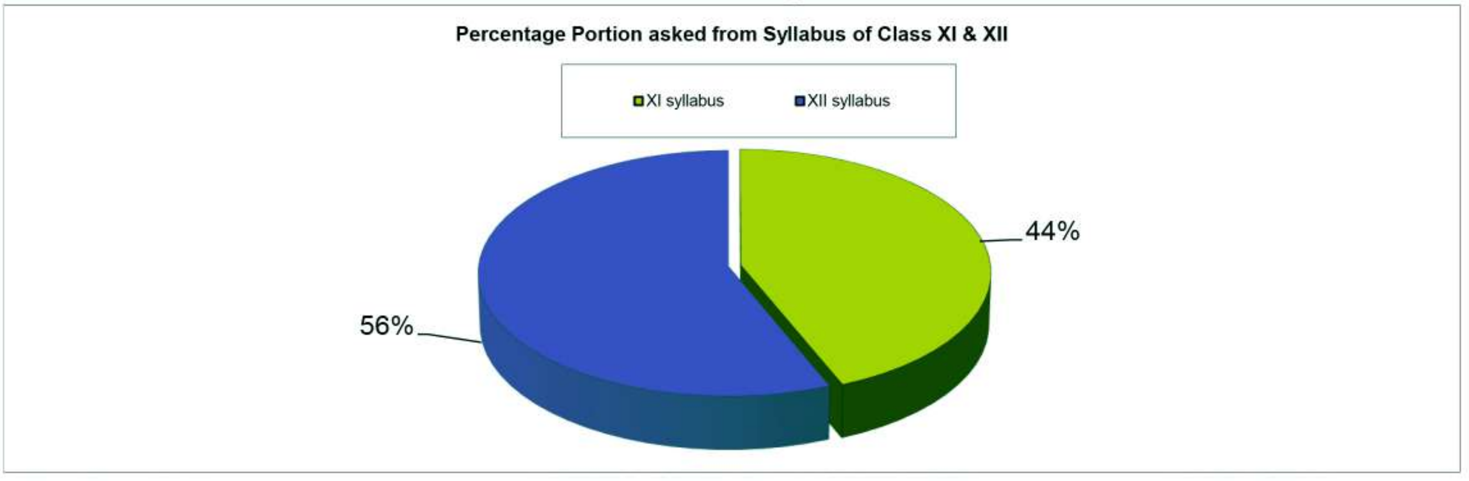
ANALYSIS OF JEE ADVANCED 2025 - PHYSICS PAPER-1

Topics	Syllabus	Easy	Medium	Difficult	Total	*Percentage*
Electromagnetism	XII Class	0	3	1	4	25.00%
Mechanics	XI Class	2	1	1	4	25.00%
Modern Physics	XII Class	0	2	1	3	18.75%
Heat & Thermodynamics	XI Class	0	0	1	1	6.25%
Optics	XII Class	0	1	1	2	12.50%
Oscillation & Waves	XI Class	0	1	1	2	12.50%
Total		**2**	**8**	**6**	**16**	**100%**

XII syllabus	**9**	**XI syllabus**	**7**





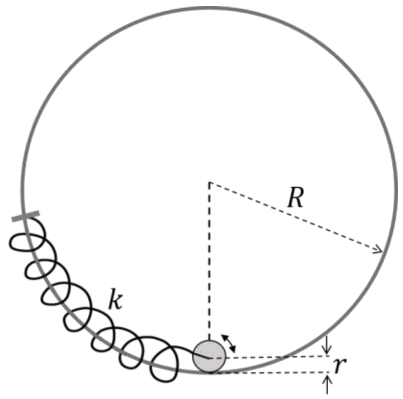


SECTION 1 (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme**:

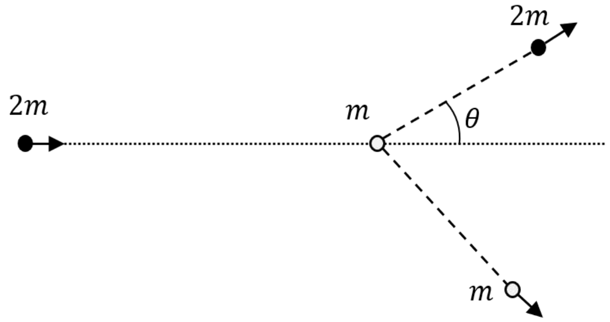
Full Marks : $+3$ If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : -1 In all other cases.

Q.1 The center of a disk of radius r and mass m is attached to a spring of spring constant k, inside a ring of radius $R > r$ as shown in the figure. The other end of the spring is attached on the periphery of the ring. Both the ring and the disk are in the same vertical plane. The disk can only roll along the inside periphery of the ring, without slipping. The spring can only be stretched or compressed along the periphery of the ring, following the Hooke's law. In equilibrium, the disk is at the bottom of the ring. Assuming small displacement of the disc, the time period of oscillation of center of mass of the disk is written as $T = \frac{2\pi}{\omega}$. The correct expression for ω is (g is the acceleration due to gravity):



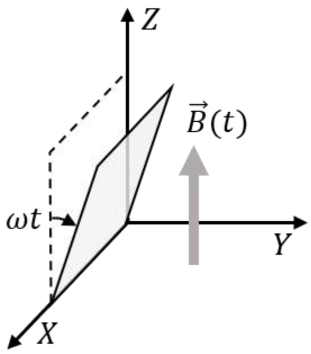
(A)	$\sqrt{\frac{2}{3}\left(\frac{g}{R-r}+\frac{k}{m}\right)}$	(B)	$\sqrt{\frac{2g}{3(R-r)}+\frac{k}{m}}$
(C)	$\sqrt{\frac{1}{6}\left(\frac{g}{R-r}+\frac{k}{m}\right)}$	(D)	$\sqrt{\frac{1}{4}\left(\frac{g}{R-r}+\frac{k}{m}\right)}$

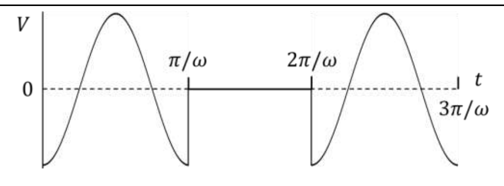
Q.2 In a scattering experiment, a particle of mass $2m$ collides with another particle of mass m, which is initially at rest. Assuming the collision to be perfectly elastic, the maximum angular deviation θ of the heavier particle, as shown in the figure, in radians is:

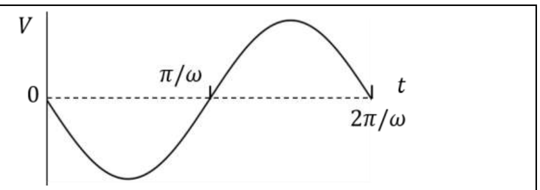


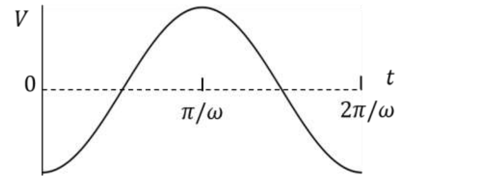
(A)	π	(B)	$\tan^{-1}\left(\frac{1}{2}\right)$	(C)	$\frac{\pi}{3}$	(D)	$\frac{\pi}{6}$

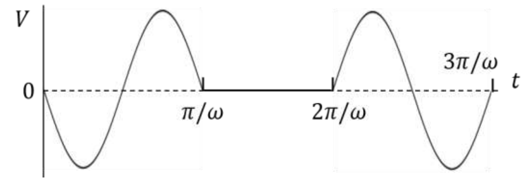
Q.3 A conducting square loop initially lies in the XZ plane with its lower edge hinged along the X-axis. Only in the region $y \geq 0$, there is a time dependent magnetic field pointing along the Z-direction, $\vec{B}(t) = B_0(\cos\omega t)\hat{k}$, where B_0 is a constant. The magnetic field is zero everywhere else. At time $t = 0$, the loop starts rotating with constant angular speed ω about the X axis in the clockwise direction as viewed from the $+X$ axis (as shown in the figure). Ignoring self-inductance of the loop and gravity, which of the following plots correctly represents the induced e.m.f. (V) in the loop as a function of time:



(A)


(B)


(C)


(D)


Q.4 Figure 1 shows the configuration of main scale and Vernier scale before measurement. Fig. 2 shows the configuration corresponding to the measurement of diameter D of a tube. The measured value of D is:

Fig. 1

Fig. 2

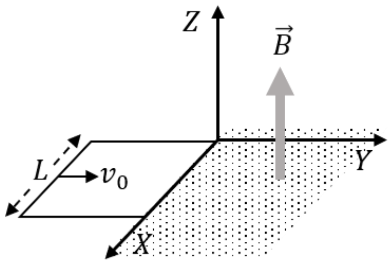
(A)	0.12 cm
(B)	0.11 cm
(C)	0.13 cm
(D)	0.14 cm

SECTION 2 (Maximum Marks: 12)

- This section contains **THREE (03)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme**:

  Full Marks : $+4$ **ONLY** if (all) the correct option(s) is(are) chosen;
  Partial Marks : $+3$ If all the four options are correct but **ONLY** three options are chosen;
  Partial Marks : $+2$ If three or more options are correct but **ONLY** two options are chosen, both of which are correct;
  Partial Marks : $+1$ If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
  Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
  Negative Marks : -2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
  choosing ONLY (A), (B) and (D) will get $+4$ marks;
  choosing ONLY (A) and (B) will get $+2$ marks;
  choosing ONLY (A) and (D) will get $+2$ marks;
  choosing ONLY (B) and (D) will get $+2$ marks;
  choosing ONLY (A) will get +1 mark;
  choosing ONLY (B) will get +1 mark;
  choosing ONLY (D) will get +1 mark;
  choosing no option (i.e. the question is unanswered) will get 0 marks; and
  choosing any other combination of options will get -2 marks.

Q.5 A conducting square loop of side L, mass M and resistance R is moving in the XY plane with its edges parallel to the X and Y axes. The region $y \geq 0$ has a uniform magnetic field, $\vec{B} = B_0\hat{k}$. The magnetic field is zero everywhere else. At time $t = 0$, the loop starts to enter the magnetic field with an initial velocity $v_0\hat{j}$ m/s, as shown in the figure. Considering the quantity $K = \frac{B_0^2 L^2}{RM}$ in appropriate units, ignoring self-inductance of the loop and gravity, which of the following statements is/are correct:

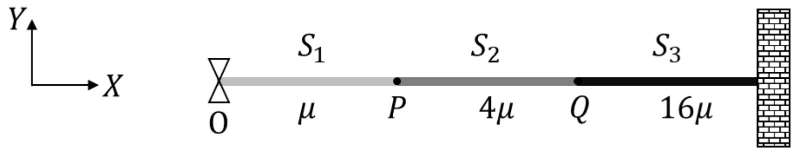


(A)	If $v_0 = 1.5KL$, the loop will stop before it enters completely inside the region of magnetic field.
(B)	When the complete loop is inside the region of magnetic field, the net force acting on the loop is zero.
(C)	If $v_0 = \frac{KL}{10}$, the loop comes to rest at $t = \left(\frac{1}{K}\right)\ln\left(\frac{5}{2}\right)$.
(D)	If $v_0 = 3KL$, the complete loop enters inside the region of magnetic field at time $t = \left(\frac{1}{K}\right)\ln\left(\frac{3}{2}\right)$.

Q.6 Length, breadth and thickness of a strip having a uniform cross section are measured to be 10.5 cm, 0.05 mm, and 6.0 μm, respectively. Which of the following option(s) give(s) the volume of the strip in cm^3 with correct significant figures:

(A)	3.2×10^{-5}	(B)	32.0×10^{-6}	(C)	3.0×10^{-5}	(D)	3×10^{-5}

Q.7 Consider a system of three connected strings, S_1, S_2 and S_3 with uniform linear mass densities μ kg/m, 4μ kg/m and 16μ kg/m, respectively, as shown in the figure. S_1 and S_2 are connected at the point P, whereas S_2 and S_3 are connected at the point Q, and the other end of S_3 is connected to a wall. A wave generator O is connected to the free end of S_1. The wave from the generator is represented by $y = y_0 \cos(\omega t - kx)$ cm, where y_0, ω and k are constants of appropriate dimensions. Which of the following statements is/are correct:



(A)	When the wave reflects from P for the first time, the reflected wave is represented by $y = \alpha_1 y_0 \cos(\omega t + kx + \pi)$ cm, where α_1 is a positive constant.
(B)	When the wave transmits through P for the first time, the transmitted wave is represented by $y = \alpha_2 y_0 \cos(\omega t - kx)$ cm, where α_2 is a positive constant.
(C)	When the wave reflects from Q for the first time, the reflected wave is represented by $y = \alpha_3 y_0 \cos(\omega t - kx + \pi)$ cm, where α_3 is a positive constant.
(D)	When the wave transmits through Q for the first time, the transmitted wave is represented by $y = \alpha_4 y_0 \cos(\omega t - 4kx)$ cm, where α_4 is a positive constant.

SECTION 3 (Maximum Marks: 24)

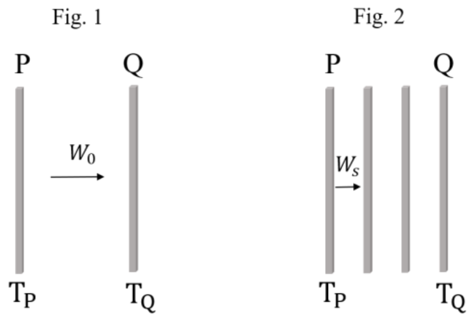
- This section contains **SIX (06)** questions.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated **according to the following marking scheme**:

  Full Marks : $+4$ If ONLY the correct numerical value is entered in the designated place;
  Zero Marks : 0 In all other cases.

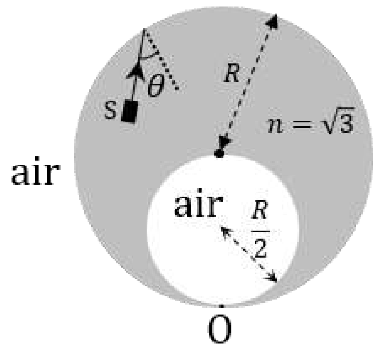
Q.8 A person sitting inside an elevator performs a weighing experiment with an object of mass 50 kg. Suppose that the variation of the height y (in m) of the elevator, from the ground, with time t (in s) is given by $y = 8\left[1 + \sin\left(\frac{2\pi t}{T}\right)\right]$, where $T = 40\pi$ s. Taking acceleration due to gravity, $g = 10$ m/s^2, the maximum variation of the object's weight (in N) as observed in the experiment is ____

Q.9 A cube of unit volume contains 35×10^7 photons of frequency 10^{15} Hz. If the energy of all the photons is viewed as the average energy being contained in the electromagnetic waves within the same volume, then the amplitude of the magnetic field is $\alpha \times 10^{-9}$ T. Taking permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ Tm/A, Planck's constant $h = 6 \times 10^{-34}$Js and $\pi = \frac{22}{7}$, the value of α is____

Q.10 Two identical plates P and Q, radiating as perfect black bodies, are kept in vacuum at constant absolute temperatures T_P and T_Q, respectively, with $T_Q < T_P$, as shown in Fig. 1. The radiated power transferred per unit area from P to Q is W_0. Subsequently, two more plates, identical to P and Q, are introduced between P and Q, as shown in Fig. 2. Assume that heat transfer takes place only between adjacent plates. If the power transferred per unit area in the direction from P to Q (Fig. 2) in the steady state is W_S, then the ratio $\frac{W_0}{W_S}$ is ___



Q.11 A solid glass sphere of refractive index $n = \sqrt{3}$ and radius R contains a spherical air cavity of radius $\frac{R}{2}$, as shown in the figure. A very thin glass layer is present at the point O so that the air cavity (refractive index $n = 1$) remains inside the glass sphere. An unpolarized, unidirectional and monochromatic light source S emits a light ray from a point inside the glass sphere towards the periphery of the glass sphere. If the light is reflected from the point O and is fully polarized, then the angle of incidence at the inner surface of the glass sphere is θ. The value of $\sin\theta$ is ____



Q.12 A single slit diffraction experiment is performed to determine the slit width using the equation, $\frac{bd}{D} = m\lambda$, where b is the slit width, D the shortest distance between the slit and the screen, d the distance between the m^{th} diffraction maximum and the central maximum, and λ is the wavelength. D and d are measured with scales of least count of 1 cm and 1 mm, respectively. The values of λ and m are known precisely to be 600 nm and 3, respectively. The absolute error (in μm) in the value of b estimated using the diffraction maximum that occurs for $m = 3$ with $d = 5$ mm and $D = 1$ m is ___

Q.13 Consider an electron in the $n = 3$ orbit of a hydrogen-like atom with atomic number Z. At absolute temperature T, a neutron having thermal energy $k_{\mathrm{B}}T$ has the same de Broglie wavelength as that of this electron. If this temperature is given by $T = \frac{Z^2 h^2}{\alpha \pi^2 a_0^2 m_{\mathrm{N}} k_{\mathrm{B}}}$, (where h is the Planck's constant, k_B is the Boltzmann constant, m_{N} is the mass of the neutron and a_0 is the first Bohr radius of hydrogen atom) then the value of α is ___

SECTION 4 (Maximum Marks: 12)

- This section contains **THREE (03)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists: **List-I** and **List-II**.
- **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated **according to the following marking scheme**:

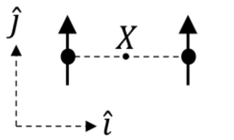
  Full Marks : $+4$ **ONLY** if the option corresponding to the correct combination is chosen;
  Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
  Negative Marks : -1 In all other cases.

Q.14 List-I shows four configurations, each consisting of a pair of ideal electric dipoles. Each dipole has a dipole moment of magnitude p, oriented as marked by arrows in the figures. In all the configurations the dipoles are fixed such that they are at a distance $2r$ apart along the x direction. The midpoint of the line joining the two dipoles is X. The possible resultant electric fields $\vec{E}$ at X are given in List-II.

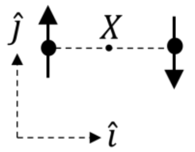
Choose the option that describes the correct match between the entries in **List-I** to those in **List-II**.

List-I

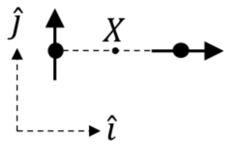
(P)



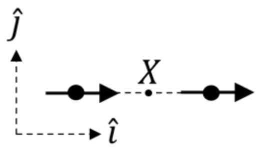
(Q)



(R)



(S)



List-II

(1) $\vec{E} = 0$

(2) $\vec{E} = -\frac{p}{2\pi\epsilon_0 r^3}\hat{j}$

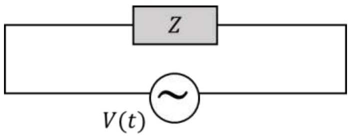
(3) $\vec{E} = -\frac{p}{4\pi\epsilon_0 r^3}(\hat{\imath} - \hat{j})$

(4) $\vec{E} = \frac{p}{4\pi\epsilon_0 r^3}(2\hat{\imath} - \hat{j})$

(5) $\vec{E} = \frac{p}{\pi\epsilon_0 r^3}\hat{\imath}$

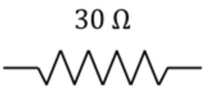
(A)	P→3, Q→1, R→2, S→4
(B)	P→4, Q→5, R→3, S→1
(C)	P→2, Q→1, R→4, S→5
(D)	P→2, Q→1, R→3, S→5

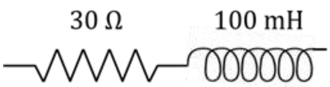
Q.15 A circuit with an electrical load having impedance Z is connected with an AC source as shown in the diagram. The source voltage varies in time as $V(t) = 300\sin(400t)$ V, where t is time in s. List-I shows various options for the load. The possible currents $i(t)$ in the circuit as a function of time are given in List-II.

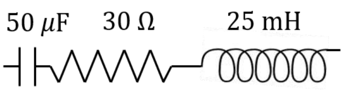


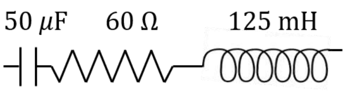
Choose the option that describes the correct match between the entries in **List-I** to those in **List-II**.

List-I

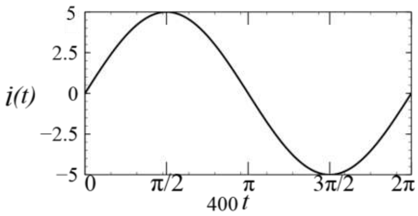
(P) 

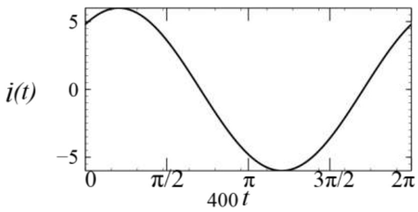
(Q) 

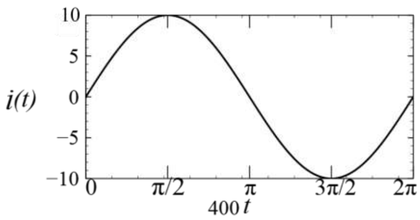
(R) 

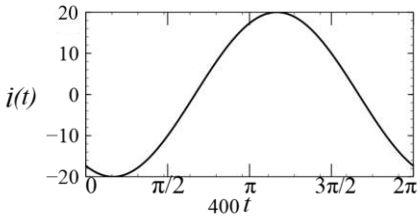
(S) 

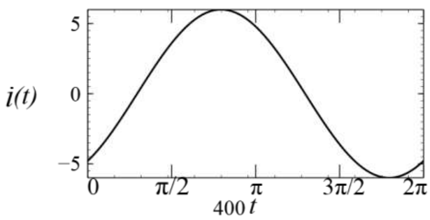
List-II

(1) 

(2) 

(3) 

(4) 

(5) 

(A)	P→3, Q→5, R→2, S→1
(B)	P→1, Q→5, R→2, S→3
(C)	P→3, Q→4, R→2, S→1
(D)	P→1, Q→4, R→2, S→5

Q.16 List-I shows various functional dependencies of energy (E) on the atomic number (Z). Energies associated with certain phenomena are given in List-II.

Choose the option that describes the correct match between the entries in **List-I** to those in **List-II**.

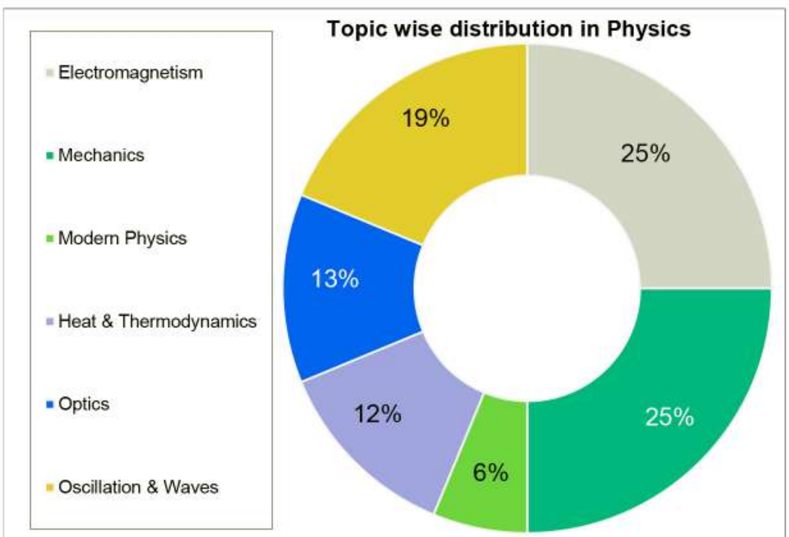
List-I	List-II
(P) $E \propto Z^2$	(1) energy of characteristic x-rays
(Q) $E \propto (Z-1)^2$	(2) electrostatic part of the nuclear binding energy for stable nuclei with mass numbers in the range 30 to 170
(R) $E \propto Z(Z-1)$	(3) energy of continuous x-rays
(S) E is practically independent of Z	(4) average nuclear binding energy per nucleon for stable nuclei with mass number in the range 30 to 170
	(5) energy of radiation due to electronic transitions from hydrogen-like atoms

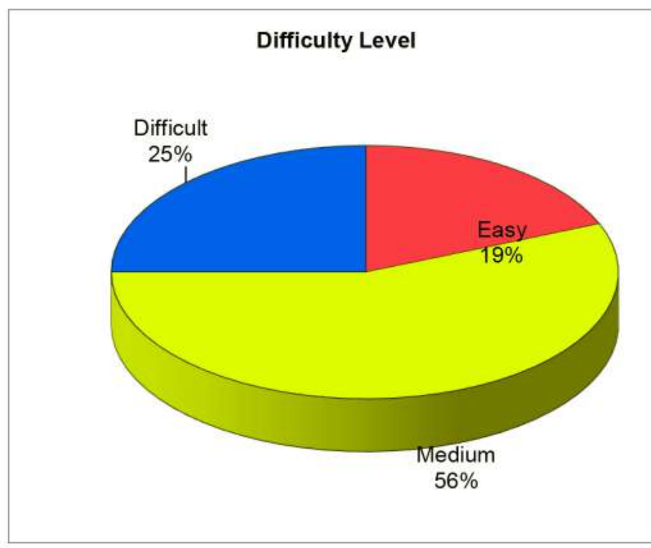
(A)	P→4, Q→3, R→1, S→2
(B)	P→5, Q→2, R→1, S→4
(C)	P→5, Q→1, R→2, S→4
(D)	P→3, Q→2, R→1, S→5

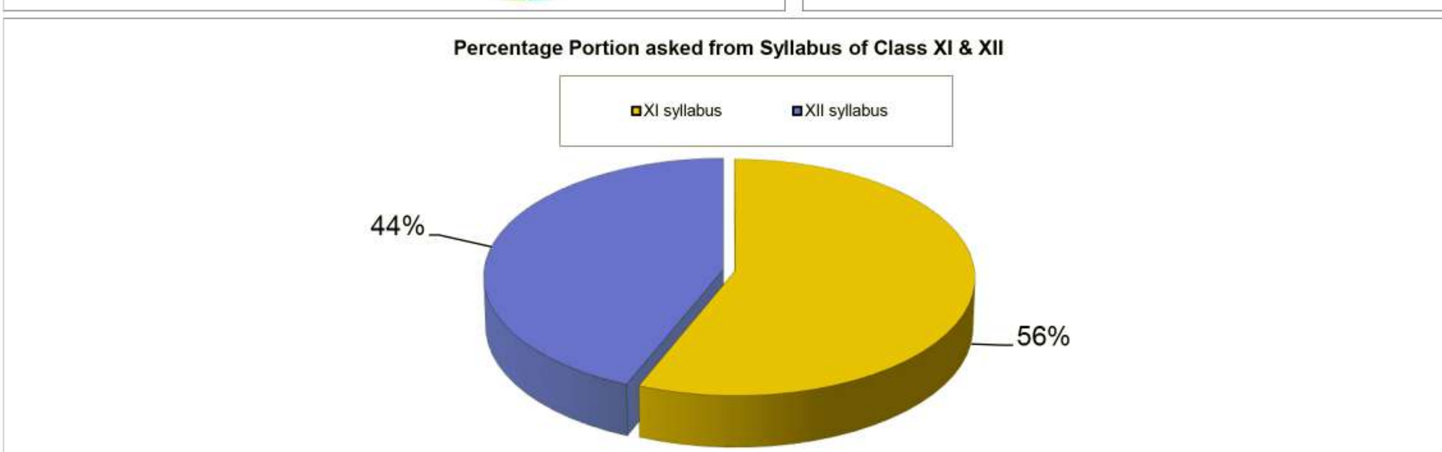
ANALYSIS OF JEE ADVANCED 2025 - PHYSICS PAPER-2

Topics	Syllabus	Easy	Medium	Difficult	*Total*	*Percentage*
Electromagnetism	XII Class	1	3	0	*4*	25.00%
Mechanics	XI Class	2	1	1	*4*	25.00%
Modern Physics	XII Class	0	0	1	*1*	6.25%
Heat & Thermodynamics	XI Class	0	2	0	*2*	12.50%
Optics	XII Class	0	1	1	*2*	12.50%
Oscillation & Waves	XI Class	0	2	1	*3*	18.75%
Total		***3***	***9***	***4***	***16***	***100%***

XII syllabus	**7**	**XI syllabus**	**9**







SECTION 1 (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme**:

Full Marks	:	$+3$	If **ONLY** the correct option is chosen;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	-1	In all other cases.

Q.1 A temperature difference can generate e.m.f. in some materials. Let S be the e.m.f. produced per unit temperature difference between the ends of a wire, σ the electrical conductivity and κ the thermal conductivity of the material of the wire. Taking M, L, T, I and K as dimensions of mass, length, time, current and temperature, respectively, the dimensional formula of the quantity $Z = \frac{S^2\sigma}{\kappa}$ is:

(A)	$[M^0L^0T^0I^0K^0]$	(B)	$[M^0L^0T^0I^0K^{-1}]$
(C)	$[M^1L^2T^{-2}I^{-1}K^{-1}]$	(D)	$[M^1L^2T^{-4}I^{-1}K^{-1}]$

Q.2 Two co-axial conducting cylinders of same length ℓ with radii $\sqrt{2}R$ and $2R$ are kept, as shown in Fig. 1. The charge on the inner cylinder is Q and the outer cylinder is grounded. The annular region between the cylinders is filled with a material of dielectric constant $\kappa = 5$. Consider an imaginary plane of the same length ℓ at a distance R from the common axis of the cylinders. This plane is parallel to the axis of the cylinders. The cross-sectional view of this arrangement is shown in Fig. 2. Ignoring edge effects, the flux of the electric field through the plane is (ϵ_0 is the permittivity of free space):

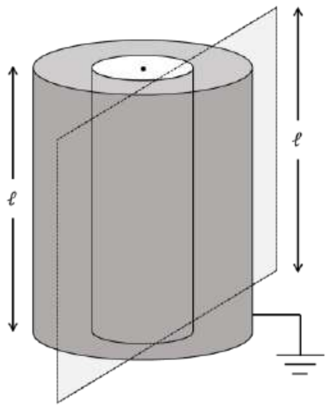


Fig. 1

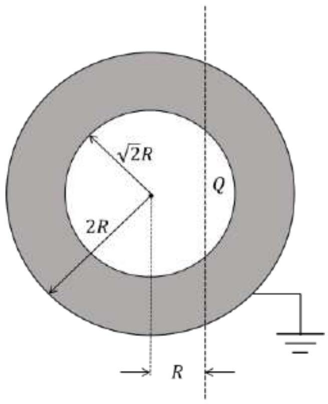


Fig. 2

(A)	$\frac{Q}{30\epsilon_0}$	(B)	$\frac{Q}{15\epsilon_0}$	(C)	$\frac{Q}{60\epsilon_0}$	(D)	$\frac{Q}{120\epsilon_0}$

Q.3 As shown in the figures, a uniform rod OO' of length l is hinged at the point O and held in place vertically between two walls using two massless springs of same spring constant. The springs are connected at the midpoint and at the top-end (O') of the rod, as shown in Fig. 1 and the rod is made to oscillate by a small angular displacement. The frequency of oscillation of the rod is f_1. On the other hand, if both the springs are connected at the midpoint of the rod, as shown in Fig. 2 and the rod is made to oscillate by a small angular displacement, then the frequency of oscillation is f_2. Ignoring gravity and assuming motion only in the plane of the diagram, the value of $\frac{f_1}{f_2}$ is:

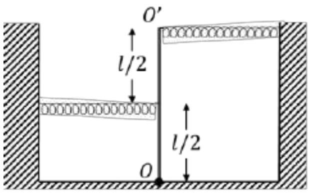


Fig. 1

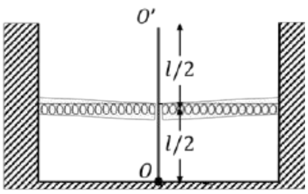


Fig. 2

(A)	2	(B)	$\sqrt{2}$	(C)	$\sqrt{\frac{5}{2}}$	(D)	$\sqrt{\frac{2}{5}}$

Q.4 Consider a star of mass m_2 kg revolving in a circular orbit around another star of mass m_1 kg with $m_1 \gg m_2$. The heavier star slowly acquires mass from the lighter star at a constant rate of γ kg/s. In this transfer process, there is no other loss of mass. If the separation between the centers of the stars is r, then its relative rate of change $\frac{1}{r}\frac{dr}{dt}$ (in s^{-1}) is given by:

(A)	$-\frac{3\gamma}{2m_2}$	(B)	$-\frac{2\gamma}{m_2}$	(C)	$-\frac{2\gamma}{m_1}$	(D)	$-\frac{3\gamma}{2m_1}$

SECTION 2 (Maximum Marks: 16)

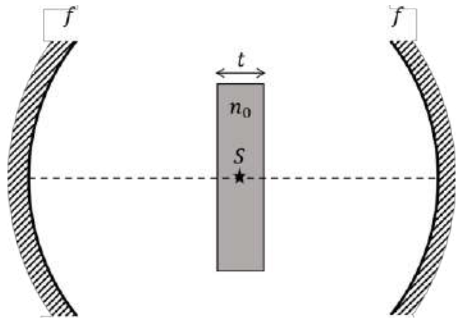
- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme**:

  Full Marks : $+4$ **ONLY** if (all) the correct option(s) is(are) chosen;
  Partial Marks : $+3$ If all the four options are correct but **ONLY** three options are chosen;
  Partial Marks : $+2$ If three or more options are correct but **ONLY** two options are chosen, both of which are correct;
  Partial Marks : $+1$ If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
  Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
  Negative Marks : -2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
  choosing ONLY (A), (B) and (D) will get $+4$ marks;
  choosing ONLY (A) and (B) will get $+2$ marks;
  choosing ONLY (A) and (D) will get $+2$ marks;
  choosing ONLY (B) and (D) will get $+2$ marks;
  choosing ONLY (A) will get +1 mark;
  choosing ONLY (B) will get +1 mark;
  choosing ONLY (D) will get +1 mark;
  choosing no option (i.e. the question is unanswered) will get 0 marks; and
  choosing any other combination of options will get -2 marks.

Q.5 A positive point charge of 10^{-8} C is kept at a distance of 20 cm from the center of a neutral conducting sphere of radius 10 cm. The sphere is then grounded and the charge on the sphere is measured. The grounding is then removed and subsequently the point charge is moved by a distance of 10 cm further away from the center of the sphere along the radial direction. Taking $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ Nm^2/C^2 (where ϵ_0 is the permittivity of free space), which of the following statements is/are correct:

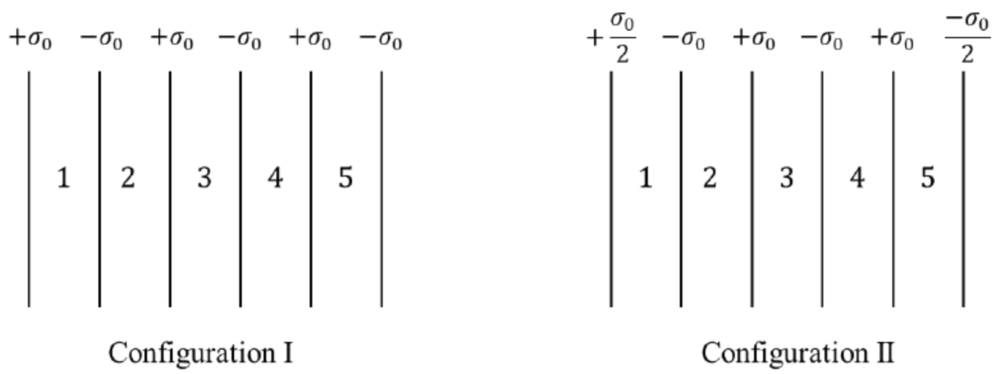
(A)	Before the grounding, the electrostatic potential of the sphere is 450 V.
(B)	Charge flowing from the sphere to the ground because of grounding is 5×10^{-9} C.
(C)	After the grounding is removed, the charge on the sphere is -5×10^{-9} C.
(D)	The final electrostatic potential of the sphere is 300 V.

Q.6 Two identical concave mirrors each of focal length f are facing each other as shown in the schematic diagram. The focal length f is much larger than the size of the mirrors. A glass slab of thickness t and refractive index n_0 is kept equidistant from the mirrors and perpendicular to their common principal axis. A monochromatic point light source S is embedded at the center of the slab on the principal axis, as shown in the schematic diagram. For the image to be formed on S itself, which of the following distances between the two mirrors is/are correct:



(A)	$4f + \left(1 - \frac{1}{n_0}\right)t$	(B)	$2f + \left(1 - \frac{1}{n_0}\right)t$
(C)	$4f + (n_0 - 1)t$	(D)	$2f + (n_0 - 1)t$

Q.7 Six infinitely large and thin non-conducting sheets are fixed in configurations I and II. As shown in the figure, the sheets carry uniform surface charge densities which are indicated in terms of σ_0. The separation between any two consecutive sheets is 1 μm. The various regions between the sheets are denoted as 1, 2, 3, 4 and 5. If $\sigma_0 = 9\ \mu\text{C/m}^2$, then which of the following statements is/are correct: (Take permittivity of free space ϵ_0 = 9×10^{-12} F/m)



(A)	In region 4 of the configuration I, the magnitude of the electric field is zero.
(B)	In region 3 of the configuration II, the magnitude of the electric field is $\frac{\sigma_0}{\epsilon_0}$.
(C)	Potential difference between the first and the last sheets of the configuration I is 5 V.
(D)	Potential difference between the first and the last sheets of the configuration II is zero.

Q.8 The efficiency of a Carnot engine operating with a hot reservoir kept at a temperature of 1000 K is 0.4. It extracts 150 J of heat per cycle from the hot reservoir. The work extracted from this engine is being fully used to run a heat pump which has a coefficient of performance 10. The hot reservoir of the heat pump is at a temperature of 300 K. Which of the following statements is/are correct:

(A)	Work extracted from the Carnot engine in one cycle is 60 J.
(B)	Temperature of the cold reservoir of the Carnot engine is 600 K.
(C)	Temperature of the cold reservoir of the heat pump is 270 K.
(D)	Heat supplied to the hot reservoir of the heat pump in one cycle is 540 J.

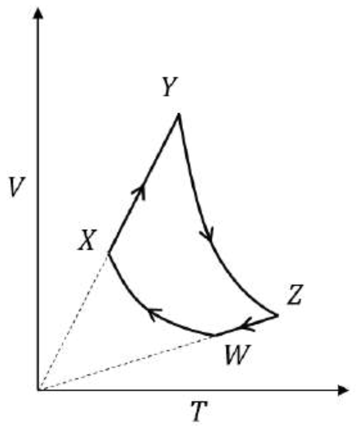
SECTION 3 (Maximum Marks: 32)

- This section contains **EIGHT (08)** questions.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated **according to the following marking scheme**:
  Full Marks : $+4$ If ONLY the correct numerical value is entered in the designated place;
  Zero Marks : 0 In all other cases.

Q.9 A conducting solid sphere of radius R and mass M carries a charge Q. The sphere is rotating about an axis passing through its center with a uniform angular speed ω. The ratio of the magnitudes of the magnetic dipole moment to the angular momentum about the same axis is given as $\alpha \frac{Q}{2M}$. The value of α is ___

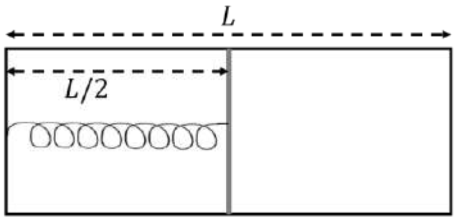
Q.10 A hydrogen atom, initially at rest in its ground state, absorbs a photon of frequency ν_1 and ejects the electron with a kinetic energy of 10 eV. The electron then combines with a positron at rest to form a positronium atom in its ground state and simultaneously emits a photon of frequency ν_2. The center of mass of the resulting positronium atom moves with a kinetic energy of 5 eV. It is given that positron has the same mass as that of electron and the positronium atom can be considered as a Bohr atom, in which the electron and the positron orbit around their center of mass. Considering no other energy loss during the whole process, the difference between the two photon energies (in eV) is ___

Q.11 An ideal monatomic gas of n moles is taken through a cycle $WXYZW$ consisting of consecutive adiabatic and isobaric quasi-static processes, as shown in the schematic V-T diagram. The volume of the gas at W, X and Y points are, $64\ \text{cm}^3$, $125\ \text{cm}^3$ and $250\ \text{cm}^3$, respectively. If the absolute temperature of the gas T_W at the point W is such that $nRT_W = 1$ J (R is the universal gas constant), then the amount of heat absorbed (in J) by the gas along the path XY is ___

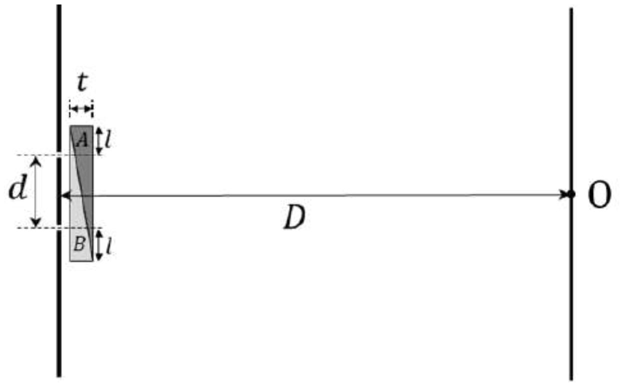


Q.12 A geostationary satellite above the equator is orbiting around the earth at a fixed distance r_1 from the center of the earth. A second satellite is orbiting in the equatorial plane in the opposite direction to the earth's rotation, at a distance r_2 from the center of the earth, such that $r_1 = 1.21\, r_2$. The time period of the second satellite as measured from the geostationary satellite is $\frac{24}{p}$ hours. The value of p is ___

Q.13 The left and right compartments of a thermally isolated container of length L are separated by a thermally conducting, movable piston of area A. The left and right compartments are filled with $\frac{3}{2}$ and 1 moles of an ideal gas, respectively. In the left compartment the piston is attached by a spring with spring constant k and natural length $\frac{2L}{5}$. In thermodynamic equilibrium, the piston is at a distance $\frac{L}{2}$ from the left and right edges of the container as shown in the figure. Under the above conditions, if the pressure in the right compartment is $P = \frac{kL}{A}\alpha$, then the value of α is ____



Q.14 In a Young's double slit experiment, a combination of two glass wedges A and B, having refractive indices 1.7 and 1.5, respectively, are placed in front of the slits, as shown in the figure. The separation between the slits is $d = 2$ mm and the shortest distance between the slits and the screen is $D = 2$ m. Thickness of the combination of the wedges is $t = 12$ μm. The value of l as shown in the figure is 1 mm. Neglect any refraction effect at the slanted interface of the wedges. Due to the combination of the wedges, the central maximum shifts (in mm) with respect to O by ____



Q.15 A projectile of mass 200 g is launched in a viscous medium at an angle 60° with the horizontal, with an initial velocity of 270 m/s. It experiences a viscous drag force $\vec{F} = -c\vec{v}$ where the drag coefficient $c = 0.1$ kg/s and $\vec{v}$ is the instantaneous velocity of the projectile. The projectile hits a vertical wall after 2 s. Taking $e = 2.7$, the horizontal distance of the wall from the point of projection (in m) is ____

Q.16 An audio transmitter (T) and a receiver (R) are hung vertically from two identical massless strings of length 8 m with their pivots well separated along the X axis. They are pulled from the equilibrium position in opposite directions along the X axis by a small angular amplitude $\theta_0 = \cos^{-1}(0.9)$ and released simultaneously. If the natural frequency of the transmitter is 660 Hz and the speed of sound in air is 330 m/s, the maximum variation in the frequency (in Hz) as measured by the receiver (Take the acceleration due to gravity $g = 10$ m/s^2) is ___