IIT-JEE 2007

PHYSICS

PART -2

[Time allowed: 3 hours] [Maximum Marks: 243]

Note: *(i)* The question paper consists of 3 parts (Chemistry, Mathematics and Physics). Each part consists of 4 sections.

(ii) **Section I** contains 9 multiple choice questions which have only one correct answer. Each question carries **+3 marks** each for correct answer and **-1 mark** for wrong answer.

(iii) **Section II** contains 4 questions. Each question contains STATEMENT -1 (Assertion) and STATEMENT -2 (Reason).

Bubble (A) if both the statements are TRUE and STATEMENT- 2 is the correct explanation of STATEMENT -1.

Bubble (B) if both the statements are TRUE and STATEMENT- 2 is NOT the correct explanation of STATEMENT -1.

Bubble (C) if STATEMENT- 1 is TRUE and STATEMENT -2 is FALSE.

Bubble (D) if STATEMENT- 1 is FALSE and STATEMENT -2 is F TRUE.

Carries **+3 marks** each for correct answer and **-1 mark** for each wrong answer.

(*iv)* **Section III** contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **-1 mark** for wrong answer.

(v) **Section IV** contains 3 questions. Each question contains statements given in 2 columns. Statements in the first column have to be matched with statements in the second column and each question carries **+6 marks** and marks will be awarded if all the four parts are correctly matched. No marks will be given for any wrong match in any question. There is no negative marking.

SECTION – I

Straight Objective Type

This section contains 9 multiple choice questions numbered 1 to 9. Each question has 4 choices (A), (B),(C), and (D), out of which ***ONLY ONE*** *is correct.*

1. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume as shown in the figure. The electric field inside the emptied space is

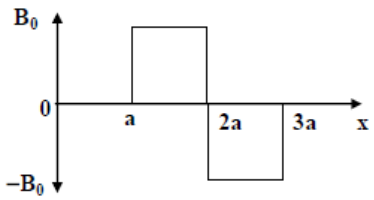
(A) zero everywhere

(B) non-zero and uniform

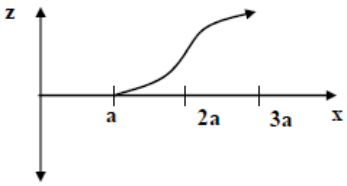
(C) non-uniform

(D) zero only at its center

2. A magnetic field $\vec{B} = B_0 \hat{j}$ exists in the region $a < x < 2a$ and $\vec{B} = -B_0 \hat{j}$, in the region $2a < x < 3a$, where B_0 is a positive constant. A positive point charge moving with a velocity $\vec{V} = V_0 \hat{i}$, where v_0 is a positive constant, enters the magnetic field at $x = a$. The trajectory of the charge in this region can be like,



(A)



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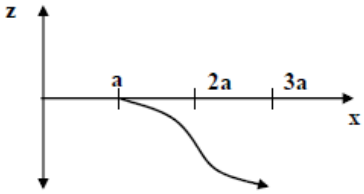
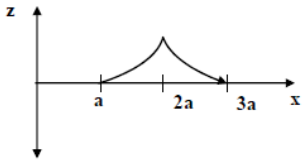
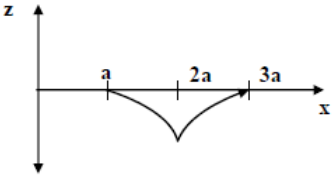


(C)



(D)



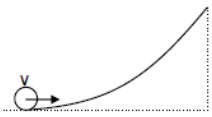
3. A small object of uniform density rolls up a curved surface with an initial velocity v .It reaches up to a maximum height $\frac{3v^2}{4g}$ of with respect to the initial position. The object is

(A) ring

(B) solid sphere

(C) hollow sphere

(D) disc



4. Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength of the emitted X-rays is

(A) $\lambda_0 = \frac{2mc\lambda^2}{h}$

(B) $\lambda_0 = \frac{2h}{mc}$

(C) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$

(D) $\lambda_0 = \lambda$

5. A student performs an experiment to determine the Young's modulus of a wire, exactly $2\,\text{m}$ long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be $0.8\,\text{mm}$ with an uncertainty of $\pm 0.05\,\text{mm}$ at a load of exactly $1.0\,\text{kg}$. The student also measures the diameter of the wire to be $0.4\,\text{mm}$ with an uncertainty of $\pm 0.01\,\text{mm}$. Take $g = 9.8\,\text{m/s}^2$ (exact). The Young's modulus obtained from the reading is

(A) $(2.0 \pm 0.3) \times 10^{11}\ \text{N/m}^2$

(B) $(2.0 \pm 0.02) \times 10^{11}\ \text{N/m}^2$

(C) $(2.0 \pm 0.1) \times 10^{11}\ \text{N/m}^2$

(D) $(2.0 \pm 0.05) \times 10^{11}\ \text{N/m}^2$

6. Positive and negative point charges of equal magnitude are kept at $\left(0,\, 0,\, \frac{a}{2}\right)$ and $\left(0,\, 0,\, \frac{-a}{2}\right)$, respectively. The work done by the electric field when another positive point charge is moved from $(-a, 0,\, 0)$ to $(0,\, a,\, 0)$ is

(A) positive

(B) negative

(C) zero

(D) depends on the path connecting the initial and final positions

7. In the experiment to determine the speed of sound using a resonance column,

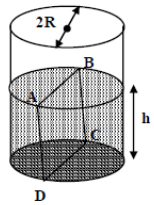
(A) prongs of the tuning fork are kept in a vertical plane

(B) prongs of the tuning fork are kept in a horizontal plane

(C) in one of the two resonances observed, the length of the resonating air column is close to the wavelength of sound in air

(D) in one of the two resonances observed, the length of the resonating air column is close to half of the wavelength of sound in air

8. Water is filled up to a height h in a beaker of radius R as shown in the figure. The density of water is ρ, the surface tension of water is T and the atmospheric pressure is P_0. Consider a vertical section $ABCD$ of the water column through a diameter of the beaker. The force on water on one side of this section by water on the other side of this section has magnitude



(A) $\left|2P_0Rh+\pi R^2\rho gh-2RT\right|$

(B) $\left|2P_0Rh+R\rho gh^2-2RT\right|$

(C) $\left|P_0\pi R^2+R\rho gh^2-2RT\right|$

(D) $\left|P_0\pi R^2+R\rho gh^2+2RT\right|$

9. A particle moves in the $X-Y$ plane under the influence of a force such that its linear momentum is $\vec{p}(t)=A\left[\hat{i}\cos(kt)-\hat{j}\sin(kt)\right]$, where A and k are constants. The angle between the force and the momentum is

(A) 0°

(B) 30°

(C) 45°

(D) 90°

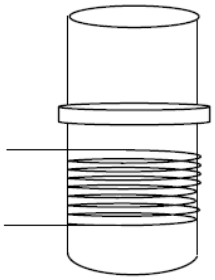
SECTION – II

Assertion - Reason Type

*This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B),(C), and (D), out of which **ONLY ONE** is correct.*

10. STATEMENT-1

A vertical iron rod has a coil of wire wound over it at the bottom end.An alternating current flows in the coil. The rod goes through a conducting ring as shown in the figure. The ring can float at a certain height above the coil.



Because

STATEMENT-2

In the above situation, a current is induced in the ring which interacts with the horizontal component of the magnetic field to produce an average force in the upward direction.

(A) Statement -1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.

(B) Statement -1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.

(C) Statement -1 is True, Statement-2 is False.

(D) Statement -1 is False, Statement-2 is True.

12. STATEMENT-1

The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

because

STATEMENT-2

The molecules of a gas collide with each other and the velocities of the molecules change due to the collision.

(A) Statement -1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.

(B) Statement -1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.

(C) Statement -1 is True, Statement-2 is False.

(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1

A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the
table.

because

STATEMENT-2

For every action there is an equal and opposite reaction.

(A) Statement -1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.

(B) Statement -1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.

(C) Statement -1 is True, Statement-2 is False.

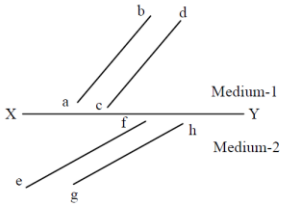
(D) Statement -1 is False, Statement-2 is True.

SECTION – III
Linked Comprehension Type

This section contains 2 paragraphs P_{14-16} and P_{17-19}: Based upon each paragraph, 3 multiple choice questions have to be answered. Each questions has (A), (B), (C), and (D), out of which **ONLY ONE** is correct.

P_{14-16} : Paragraph for Question Nos. 14 to 16

The figure shows a surface XY separating two transparent media, medium -1 and medium -2. The lines ab and cd represent wavefronts of a light wave travelling in medium-1 and incident on XY. The lines ef and gh represent wavefronts of the light wave in medium -2 after refraction.



14. Light travels as a

(A) parallel beam in each medium

(B) convergent beam in each medium

(C) divergent beam in each medium

(D) divergent beam in one medium and convergent beam in the other medium.

15. The phases of the light wave at c, d, e and f are ϕ_c, ϕ_d, ϕ_e and ϕ_f respectively. It is given that $\phi_c \neq \phi_f$

(A) ϕ_c cannot be equal to ϕ_d

(B) ϕ_d can be equal to ϕ_e

(C) $(\phi_d - \phi_f)$ is equal to $(\phi_c - \phi_e)$

(D) $(\phi_d - \phi_c)$ is not equal to $(\phi_f - \phi_e)$

16. Speed of the light is

(A) the same in medium -1 and medium -2

(B) larger in medium -1 than in medium -2

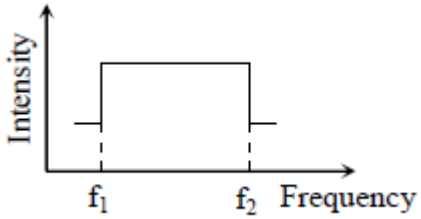
(C) larger in medium -2 than in medium -1

(D) different at b and d

P_{17-19} : Paragraph for Question Nos. 17 to 19

Two trains A and B are moving with speeds $20\,\text{m/s}$ and $30\,\text{m/s}$ respectively in the same direction on the same straight track, with B ahead of A. The engines are at the front ends. The engine of train A blows a long whistle.

Assume that the sound of the whistle is composed of components varying in frequency from $f_1 = 800\,Hz$ *to* $f_2 = 1200\,Hz$, as shown in the figure. The spread in the frequency (highest frequency − lowest frequency) is thus $320\,Hz$. The speed of sound in still air is $340\,\text{m/s}$



17. The speed of sound of the whistle is

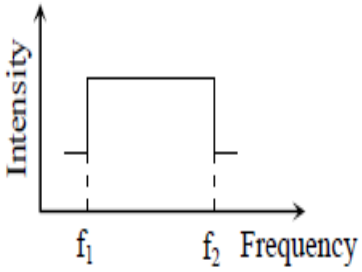
(A) $340\,\text{m/s}$ for passengers in A and $310\,\text{m/s}$ for passengers in B

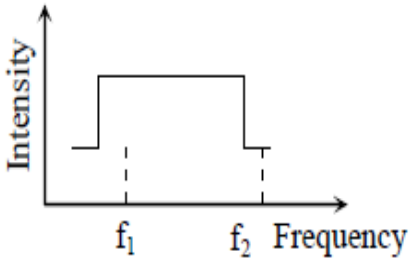
(B) $360\,\text{m/s}$ for passengers in A and $310\,\text{m/s}$ for passengers in B

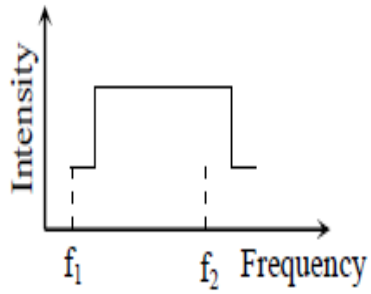
(C) $310\,\text{m/s}$ for passengers in A and $360\,\text{m/s}$ for passengers in B

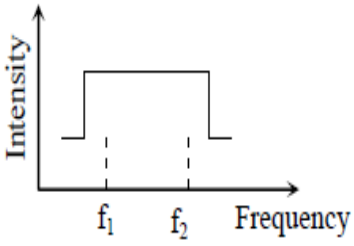
(D) $340\,\text{m/s}$ for passengers in both the trains

18. The distribution of the sound intensity of the whistle as observed by the passengers in train A is best represented by

(A)


(B)


(C)


(D)


19. The spread of frequency as observed by the passengers in train B is

(A) $310\,Hz$

(B) $330\,Hz$

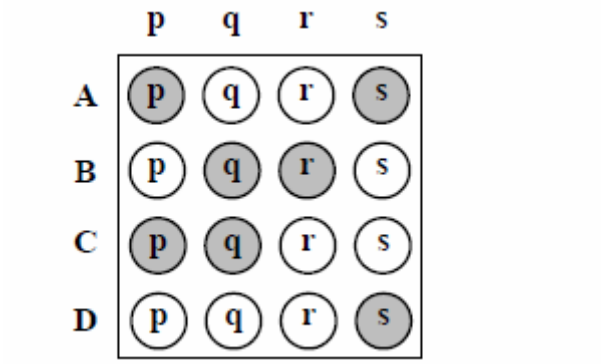
(C) $350\,Hz$

(D) $290\,Hz$

SECTION -IV

This section contains 3 questions. Each question contains statements given in two columns have to be matched. Statements (A, B, C, D)in column I have to be matched with statements (p, q, r, s) in column II. The answer to these questions have to be appropriately bubbled as illustrated in the following example.

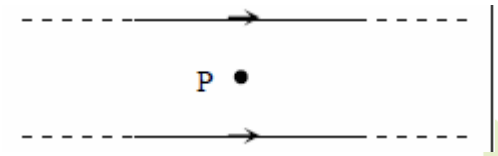
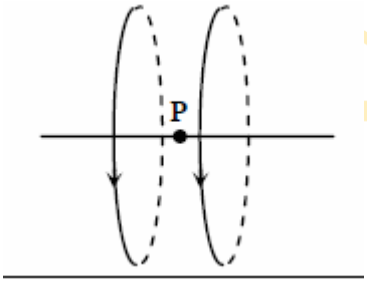
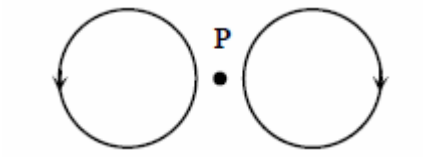
If the correct matches are A-p. A-s. B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 x 4 matrix should be as follows:



20. **Column I** describe some situations in which a small object moves. **Column II** describes some characteristics of these
motions. Match the situation in **Column I** with the characteristics in **Column II** and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the ORS.

Column I	Column II
(A)The object moves on the x-axis under a conservative force in such a way that its "speed" and "position" satisfy $v = c_1\sqrt{c_2 - x^2}$, where c_1 and c_2 are positive constants.	(p) The object executes a simple harmonic motion.
(B) The object moves on the x-axis in such a way that its velocity and its displacement from the origin satisfy v = kx, where k is a positive constant.	(q) The object does not change its direction.
(C) The object is attached to one end of a massless spring of a given spring constant. The other end of the spring is attached to the ceiling of an elavator. Initially everything is at rest. The elevator starts going upwards with a constant acceleration a. The motion of the object is observed from the elevator during the period it maintain this acceleration.	(r) The kinetic energy of the object keeps on decreasing.
(D) The object is projected from the earth's surface vertically upwards with a speed $2\sqrt{GM_e/R_e}$, where, M_e is the mass of the earth and R_e is the radius of the earth. Neglect forces from objects other than the earth.	(s) The object can change its direction inly once.

21. Two wires each carrying a steady current I are shown in four configurations in **Column I**. Some of the resulting effects
are described in **Column II**. Match the statements in **Column I** with the statements in **Column II** and indicate your
answer by darkening appropriate bubbles in the 4 × 4 matrix given in the ORS.

Column I	Column II
(A) Point P is situated midday between the wires. 	(p) The magnetic fields (B) at P due to the currents in the wires are in the same direction.
(B) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii. 	(q) The magnetic fields (B) at P due to the currents in the wires are in the same direction.
(C) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii. 	(r) There is no magnetic field at P.
(D) Point P is situated at the common center of the wires.	(s) The wires repel each other.

22. **Column I** gives some devices and **Column II** gives some process on which the functioning of these devices depend.

Match the devices in **Column I** with the processes in **Column II** and indicate your answer by darkening appropriate

bubbles in the 4 × 4 matrix given in the ORS.

Column I	Column II
(A) Bimetallic strip	(p) Radiation from a hot body
(B) Steam engine	(q) Energy conversion
(C) Incandescent lamp	(r) Melting
(D) Electric fuse	(s) Thermal expansion of solids