



General Instructions

- (i) **Duration:** The total duration of the examination is 3 hours (180 minutes).
- (ii) **Total Marks:** The complete paper carries a maximum of 390 marks.
- (iii) **Structure:** The paper has 4 Sections:
 - **Part 1:** 30 Multiple Choice Questions (Physics).
 - **Part 2:** 30 Multiple Choice Questions (Chemistry).
 - **Part 3:** 10 Multiple Choice Questions (English Proficiency),
20 Multiple Choice Questions (Logical Reasoning)
 - **Part 4:** 40 Multiple Choice Questions (Mathematics/Biology)
- (iv) **Compulsory Questions:** All 130 questions are compulsory, and +12 Questions (Optional Extra Questions)
- (v) Each question has four options. Only **one** option is correct.
- (vi) **Correct Answer:** +3 marks.
- (vii) **Incorrect Answer:** -1 (Negative marking).
- (viii) **Unanswered/Marked for Review:** 0 marks.

Physics

1. An ideal spring with spring-constant k is hung from the ceiling and a mass M is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum

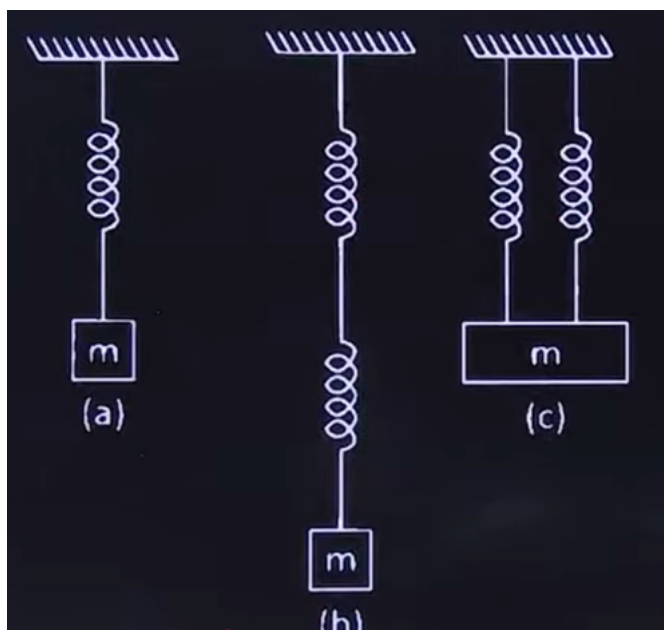
extension in the spring is

- (A) $4Mg/k$
 - (B) $2Mg/k$
 - (C) Mg/k
 - (D) $Mg/2k$
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2. In a mixture of gases, the average number of degrees of freedom per molecule is 6. The rms speed of the molecule of the gas is c , then the velocity of sound in the gas is

- (A) $\frac{c}{\sqrt{3}}$
 - (B) $\frac{c}{\sqrt{2}}$
 - (C) $\frac{2c}{3}$
 - (D) $\frac{3c}{3}$
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3. Five identical springs are used in the three configurations as shown in figure. The time periods of vertical oscillations in configurations (a), (b) and (c) are in the ratio.



- (A) $1 : \sqrt{2} : \frac{1}{\sqrt{2}}$

- (B) $2 : \sqrt{2} : \frac{1}{\sqrt{2}}$
(C) $\frac{1}{\sqrt{2}} : 2 : 1$
(D) $2 : \frac{1}{\sqrt{2}} : 1$
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4. A man of mass m starts falling towards a planet of mass M and radius R . As he reaches near to the surface, he realizes that he will pass through a small hole in the planet. As he enters the hole, he sees that the planet is really made of two pieces: a spherical shell of negligible thickness of mass $3M/4$ and a point mass $M/4$ at the centre. Change in the force of gravity experienced by the man is

- (A) $\frac{3}{4} \frac{GMm}{R^2}$
(B) 0
(C) $\frac{1}{3} \frac{GMm}{R^2}$
(D) $\frac{4}{3} \frac{GMm}{R^2}$
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5. A steel rod of diameter 1.0 cm is clamped firmly at each end when its temperature is 25°C so that it cannot contract on cooling. The tension in the rod at 0°C is ($\alpha = 1 \times 10^{-5}/^\circ\text{C}$, $Y = 2 \times 10^{11} \text{ N/m}^2$)

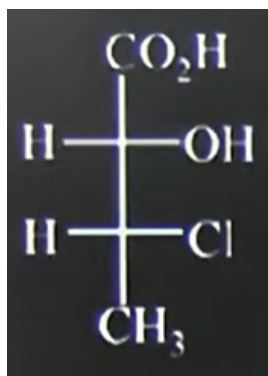
- (A) 3925 N
(B) 7000 N
(C) 7400 N
(D) 4700 N
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CHEMISTRY

6. Half-life of zero order reaction $A \rightarrow \text{product}$ is 1 hour, when initial concentration of reactant is 2.0 mol L^{-1} . The time required to decrease concentration of A from 0.50 to 0.25 mol L^{-1} is:

- (a) 0.5 hour
 - (b) 4 hour
 - (c) 15 min
 - (d) 60 min
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7. The absolute configuration of:



- (a) (2S,3S)
 - (b) (2R,3R)
 - (c) (2R,3S)
 - (d) (2S,3R)
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8. The one giving maximum number of isomeric alkenes on dehydrohalogenation reaction is (excluding rearrangement):

- (a) 1-Bromo-2-methylbutane
 - (b) 2-Bromopropane
 - (c) 2-Bromopentane
 - (d) 2-Bromo-3,3-dimethylpentane
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9. Pick the correct statement about electron and photon:

- (a) both electron and photons are fermions
- (b) electron is a fermion and photons are bosons
- (c) electron is boson and photons are fermions

(d) both electron and photons are bosons

10. Which hydride among the following is less stable?

(a) BeH_2

(b) NH_3

(c) HF

(d) LiH

MATHEMATICS

11. Let $f(x) = \sin x$, $g(x) = \cos x$, $h(x) = x^2$ then

$$\lim_{x \rightarrow 1} \frac{f(g(h(x))) - f(g(h(1)))}{x - 1} =$$

(A) 0

(B) $-2 \sin 1 \cos(\cos 1)$

(C) ∞

(D) $-2 \sin 1 \cos 1$

12. The variance of 20 observations is 5. If each observation is multiplied by 2, then the new variance of the resulting observation is

(A) $2^3 \times 5$

(B) $2^2 \times 5$

(C) 2×5

(D) $2^4 \times 5$

13. If $A = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$, $P = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$ and $X = APA^T$, then $A^T X^{50} A =$

- (A) $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
(B) $\begin{pmatrix} 2 & 1 \\ 0 & -1 \end{pmatrix}$
(C) $\begin{pmatrix} 25 & 1 \\ 1 & -25 \end{pmatrix}$
(D) $\begin{pmatrix} 1 & 50 \\ 0 & 1 \end{pmatrix}$
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14. The locus of the mid-point of a chord of the circle $x^2 + y^2 = 4$, which subtends a right angle at the origin is

- (A) $x + y = 2$
(B) $x^2 + y^2 = 1$
(C) $x^2 + y^2 = 2$
(D) $x + y = 1$
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15. If the system of linear equations $2x + y - z = 7$, $x - 3y + 2z = 1$, $x + 4y + \delta z = k$ (where $\delta, k \in \mathbb{R}$) has infinitely many solutions, then $\delta + k$ is equal to:

- (A) -3
(B) 3
(C) 6
(D) 9
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