Memory Based Questions & Solutions

PAPER - 2 | SUBJECT : PHYSICS

PAPER-2 : INSTRUCTIONS TO CANDIDATES

- Question paper-2 has three (03) parts: Physics, Chemistry and Mathematics.
- Each part has a total of eighteen (18) questions divided into three (03) sections (Section-1, Section-2 and Section-3).
- Total number of questions in Paper-2 are : Fifty Four (54) and Maximum Marks are One Hundred Eighty Six (186).

Type of Questions and Marking Schemes

SECTION 1 (Maximum Marks : 32)
- This section contains Eight (08) questions.
- Each question has Four options ONE OR MORE THAN ONE of these four options 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 If only (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 and 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 : -1 In all other cases.

SECTION 2 (Maximum Marks : 18)
- 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 : +3 If ONLY the correct numerical value is entered.
  - Zero Marks : 0 In all other cases.

SECTION 3 (Maximum Marks : 12)
- This section contains Two (02) List-Match sets.
- Each List-Match set has Two (02) Multiple Choice Questions.
- Each List-Match set has two lists : List-I and List-II.
- List-I has Four entries (I), (II), (III) and (IV) List-II has Six entries (P), (Q), (R), (S), (T) and (U).
- 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 : +3 If only 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.
Answering Questions:

- To select the option(s), use the mouse to click on the corresponding button(s) of the option(s).
- To deselect the chosen option(s) for the questions of SECTION-1, click on the button(s) of the chosen option(s) again or click on the Clear Response button to clear all the chosen options.
- To deselect the chosen option for the questions of SECTION-3, click on the button of the chosen option again or click on the Clear Response button to clear the chosen option.
- To change the option(s) of a previously answered question of SECTION-1 and SECTION-3 first deselect as given above and then select the new option(s).
- To answer questions of SECTION-2 use the mouse to click on numbers (and/or symbols) on the on-screen virtual numeric keypad to enter the numerical value in the space provided for answer.
- To change the answer of a question of SECTION-2 first click on the Clear Response button to clear the correct answer and then enter the new numerical value.
- To mark a question ONLY for review (i.e. without answering it), click on the Mark for Review & next button.
- To mark a question for review (after answering it), click on Mark for Review & Next button - the answered question which is also marked for review will be evaluated.
- To save the answer click on the Save & Next button, the answered question will be evaluated.

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### SECTION 1 (Maximum Marks: 32)

- This section contains EIGHT (08) questions.
- Each question has FOUR options 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 If only (all) the correct option(s) is(are) chosen.
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- 1. This section contains EIGHT (08) questions.
- 2. Each question has FOUR options ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).
- 3. For each question, choose the option(s) corresponding to (all) the correct answer(s).
- 4. Answer to each question will be evaluated according to the following marking scheme.

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- Negative Marks:
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**Physics**

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- Negative Marks:
  - -1 In all other cases.
1. Consider two plane convex lenses of same radius of curvature and refractive index \( n_1 \) and \( n_2 \) respectively. Now consider two cases:

Case – I : When \( n_1 = n_2 = n \), then equivalent focal length of lens is \( f_0 \)

Case- II : When \( n_1 = n \), \( n_2 = n + \Delta n \), then equivalent focal length of lens is \( f = f_0 + \Delta f \)

Then correct options are:

- (A) \( \frac{n_0}{n_0} \) is correct.
- (B) \( \frac{\Delta f}{f_0} < \frac{\Delta n}{n} \)

2. In YDSE monochromatic light of wavelength 600 nm incident of slits as shown in figure. YDSE भने 600 nm तरंगकेष्का एकांगीय प्रकाश विभाजन छिन्निले पर आघात होता है।

![Diagram](image)

If \( s_1 s_2 = 3 \text{ mm} \), \( OP = 11 \text{ mm} \) then

- (A) If \( \alpha = \frac{30}{\pi} \) degree then destructive interference at point P
(C) If \( \alpha = 0 \) then constructive interfaces at O

(D) Fringe width depends on \( \alpha \)

(A) \( \text{Ans.} \quad (A, B, C) \)

Sol. (ABC)

\[ \Delta \lambda = d \sin \theta \]

0. \( \alpha \) : small angle 

\[ \sin \theta = \tan \theta = \frac{Y}{b} \]

\[ \Delta \lambda = d \alpha + \frac{dy}{D} \]

(A) \( \Delta \lambda = 3 \text{mm} \times \frac{0.36}{\pi} \times \frac{\pi}{180} = 3900 \text{nm} \)

3900 \( n \) = \( (2n-1) \frac{\lambda}{2} \), \( (2n-1) \times \frac{600 \text{nm}}{2} \)

\( n = 7 \)

destructive interference happened

(B) \( \Delta \lambda = 3 \text{mm} \times \frac{0.36}{\pi} \times \frac{\pi}{180} + 0 = 600 \text{nm} \)

600 \( n \) = nL

\( n = 1 \)

constructive interference

(C) \( \Delta \lambda = 0 \)

So constructive interference

(D) Fringe width does not depend on \( \alpha \),

\( \text{Ans.} \quad (A, B, C) \).
3. A uniform rigid rod of mass \( m \) & length \( l \) is released from vertical position on rough surface with sufficient friction for lower end not to slip as shown in figure. When rod makes angle 60° with vertical then find correct alternative:

\[
\alpha = \frac{2g\ell}{\ell} \quad \text{(A)}
\]

\[
\omega = \frac{3g}{2\ell} \quad \text{(B)}
\]

\[
N = \frac{mg}{16} \quad \text{(C)}
\]

\[
\theta = \frac{3g}{4} \quad \text{(D)}
\]

**Ans.**

**Sol.**

Treat as hinged

\[
\Delta K + \Delta U = 0
\]

\[
\frac{1}{2} I \omega^2 - (mg) \ell \cos 60° = - \Delta U
\]

\[
\frac{1}{2} \frac{m\ell^2}{3} \omega^2 = \frac{mg \ell}{4}
\]

\[
\omega = \frac{3g}{2\ell}
\]

\[
\Rightarrow \quad \alpha = \tan \frac{\omega}{2} = \frac{3g}{2\ell}
\]

\[
\Rightarrow \quad \alpha = \frac{\ell}{2} \sin 60° + \frac{\ell}{2} \cos 60°
\]

\[
\alpha = \frac{3\sqrt{3}g}{2} + \frac{3g}{8}
\]

\[
\alpha = \frac{9g}{16} + \frac{6g}{16}
\]

\[
mg - N = ma
\]

\[
N = \frac{mg}{16}
\]

---

4. Monoatomic gas A having 5 mole is mixed with diatomic gas B having 1 mole in container of volume \( V_0 \).

Now the volume of mixture is compressed to \( \frac{V_0}{4} \) by adiabatic process. Initial pressure and temperature of gas mixture is \( P_0 \) and \( T_0 \). [given \( 2^{1/2} = 9.2 \)]

Choose correct option:

(A) \( \gamma_{\text{mix}} = 1.6 \)

(B) Final pressure is between 9\( P_0 \) and 10\( P_0 \)

(C) \( |W| = 13RT_0 \)

(D) Average Translational kinetic energy

**Sol.**

\[
\gamma_{\text{mix}} = \frac{n_A C_{P_A} + n_B C_{P_B}}{n_A C_{V_A} + n_B C_{V_B}} = \frac{8}{5}
\]
\[ W = \frac{H V_1 - H P_2 V_2}{\gamma - 1} \]

\[ P_2 V_0^{1/5} = P_2 \left( \frac{V_0}{4} \right)^{1/5} \]

\[ P_2 = 9.2 P_0 \]

\[ W = -\frac{P_2 V_0 - 9.2 P_0 V_0}{3/5} = -13 R T_0 \]

5. The given arrangement is released from rest when spring is in natural length. Maximum extension in spring during the motion is \( x_0 \). \( a_1 \) and \( a_2 \) are accelerations of the blocks. Make the correct options

\[ a_1 - a_2 = a_1 - a_2 \]

\[ x_0 = \frac{4 mg}{3k} \]

\( \frac{x_0}{2} \) is velocity when elongation is \( \frac{3k x_0}{14m} \)

\[ a = \frac{3k x_0}{42m} \]

Sol.

---

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\[ a = \frac{3k x_0}{42m} \]
6. A dipole of Dipole moment \( \mathbf{p} = \frac{p_0}{\sqrt{2}} (\hat{i} + \hat{j}) \), is placed at origin. Now a uniform external electric field of magnitude \( E_0 \) is applied along direction of dipole. Two points A and B are lying on an equipotential surface of radius \( R \) centered at origin. A is along axial position of dipole and B is along equatorial position. There correct option are:

(A) Net electric field at point A is 3E₀
(B) Net electric field at point B is Zero
(C) Radius of equatorial surface \( R = \left( \frac{k_0 p_0}{E_0} \right)^{\frac{1}{3}} \)
(D) Radius of equatorial surface \( R = \left( \frac{\sqrt{2k_0 p_0}}{E_0} \right)^{\frac{1}{3}} \)

Ans. \( \text{ABC} \)

Sol. \( E_0 \) should be \( \perp \) to surface so \( k_0 p_0 \) \( \perp \) to \( E_0 \) so \( r = \left( \frac{k_0 p_0}{E_0} \right)^{\frac{1}{3}} \)

\( (E_0)_{\text{net}} = \frac{2k_0 p_0}{r^3} + E_0 \neq 3E_0 \)

\( (E_0)_{\text{net}} = 0 \)
7. A free hydrogen atom after absorbing a photon of wavelength \( \lambda_a \) gets excited from state \( n = 1 \) to \( n = 4 \). Immediately after electron jumps to \( n = m \) state by emitting a photon of wavelength \( \lambda_m \). Let change in momentum of atom due to the absorption and the emission are \( \Delta P_a \) and \( \Delta P_m \) respectively. If \( \lambda_a \lambda_m = 1/5 \), Which of the following is correct.

A free hydrogen atom after absorbing a photon of wavelength \( \lambda_a \) gets excited from state \( n = 1 \) to \( n = 4 \). Immediately after electron jumps to \( n = m \) state by emitting a photon of wavelength \( \lambda_m \). Let change in momentum of atom due to the absorption and the emission are \( \Delta P_a \) and \( \Delta P_m \) respectively. If \( \lambda_a \lambda_m = 1/5 \), Which of the following is correct.

\[ \begin{align*}
(A) & \quad \Delta P_a = \frac{1}{2} \\
(B) & \quad \Delta P_m = \frac{1}{2} \\
(C) & \quad \lambda_a = 418 \text{ nm} \\
(D) & \quad \text{Ratio of K.E. of electron in the state } n = m \text{ to } n = 1 \text{ is } \frac{1}{4}
\end{align*} \]

**Ans. (AD)**

\[ \begin{align*}
\lambda_m &= \frac{E_4 - E_1}{E_4 - E_m} = \frac{1 - \frac{1}{16}}{1 - \frac{1}{m^2}} = \frac{1}{16} \\
\lambda_a &= \frac{12400 \times 4}{13.6} = 3647 \\
K_e &= \frac{\Delta E}{2} = \frac{1}{4} \\
k_1 &= \frac{1}{4}
\end{align*} \]

As kinetic energy is proportional to \( \frac{1}{n^2} \).

8. In a cylinder a heavy piston is moving with speed \( v \) as shown diagram and gas is filled inside it. A gas molecule is moving with speed \( v_0 \) towards moving piston. Then which of the following is correct (Assume \( v << v_0 \) and collision is elastic)

\[ \begin{align*}
(A) & \quad \text{change in speed after collision is } 2v \\
(B) & \quad \text{change in speed after collision is } 2v_0 \frac{\Delta x}{l} \\
(C) & \quad \text{rate of collision is } V \\
(D) & \quad \text{When piston is at } \frac{l}{2} \text{ its kinetic energy will be four times}
\end{align*} \]
9. If \( f = ax^2 + 2ax \) calculate the work done if a particle moves along path as shown in diagram.

\[ \begin{align*}
1 & \quad A \quad B \\
0.5 & \quad C \quad D \\
0.5 & \quad E
\end{align*} \]

Ans. \(-0.75\)

Sol. 
\[ \begin{align*}
\text{d}w &= F \cdot \text{d}r \\
\text{d}w &= ay \text{d}x + 2ax \text{d}y \\
A &\rightarrow B \quad y = 1, \quad \text{d}y = 0 \quad \text{aA} = 0 \quad \int_{0.5}^{0.5} ay \text{d}x = \alpha \\
B &\rightarrow C \quad x = 1, \quad \text{d}x = 0 \quad \text{aB} = c = 2a \quad 0.5 \int_{0.5}^{0.5} dy = -2\alpha(0.5) = -\alpha \\
C &\rightarrow D \quad y = 0.5 \quad \text{d}y = 0 \quad \text{aC} = 0 \\
& \quad \text{d}w = -\alpha \int_{0.5}^{0.5} ay \text{d}x = -\alpha \frac{\alpha}{4} \\
D &\rightarrow E \quad x = 0.5 \quad \text{d}x = 0 \quad \text{aD} = \alpha = 2a \quad \frac{\alpha}{2} \int_{0.5}^{0.5} dy = \frac{\alpha}{2} \\
\therefore \quad W &= \alpha - \alpha - \alpha - \frac{3\alpha}{2} 
\end{align*} \]
10. In a given circuit of inductor \( L = 1 \, \text{mH} \) and resistance \( R = 1 \, \Omega \) are connected in series to ends of two parallel conducting rods as shown. Now a rod of length 10 cm is moved with constant velocity of 1 cm/s in magnetic field \( B = 1 \, \text{T} \). If rod starts moving at \( t = 0 \) then current in circuit after 1 millisecond is \( x \times 10^{-3} \, \text{A} \). Then value of \( x \) is: (given \( e^{-1} = 0.37 \))

\[
\text{Sol.} \quad e = \left( v \times B \right) t = 10^{-2} \times 1 \times 10^{-3} \\
= 10^{-5} \, \text{volt} \\
I = \frac{10^{-3}}{1 - e^{-1}} \\
= 10^{-4} \left( 1 - 0.37 \right) \\
I = 0.63 \, \text{mA}
\]

11. A prism is shown in the figure with prism angle 75° and refractive index \( \sqrt{3} \). A light ray incidents on a surface at incident angle \( \theta \). Other face is coated with a medium of refractive index \( n \). For \( 0 \leq 60^\circ \) ray suffers total internal reflection find value of \( n^2 \).

75° त्रिज्य कोण तथा \( \sqrt{3} \) आपरात्मक का त्रिज्य विफल सतह दिखाया गया है। प्रकाश तरंग इस पर \( \theta \) कोण पर आपनित होती है। दूसरी तरफ \( n \) आपरात्मक की एक उबली फिल्म लगाई गई है। \( 0 \leq 60^\circ \) के लिये यदि प्रकाश का पूर्ण आपनित परतरंगे हो तो \( n^2 \) होगा।

\[
\text{Sol.} \\
\text{For TIR at coating किन्तु पर TIR के लिये} \\
\text{sinc} = \frac{n}{\sqrt{3}} = \text{sinc} \\
\text{Applying snell's law at first surface, प्रथम सतह पर स्नेल के नियम से} \\
\sin \theta = \sqrt{3} \sin(75^\circ - c) \\
\text{for limiting conduction, at } \theta = 60^\circ \text{ सीमान्त विक्षेपण के लिये, } \theta = 60^\circ \text{ पर} \\
\sin 60^\circ = \sqrt{3} \sin(75^\circ - c)
\[
\frac{\sqrt{3}}{2} = \sqrt{3} \sin(75^\circ - c) \\
\frac{1}{2} = \sin(75^\circ - c) \\
\sin 30^\circ = \sin(75^\circ - c) \\
30^\circ = 75^\circ - c \\
c = 45^\circ \\
\frac{n}{\sqrt{3}} = \frac{1}{\sqrt{2}} \\
n^2 = \frac{3}{2} = 1.50
\]

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12. Perfectly reflecting mirror of mass \( M \) mounted on a spring constitute a spring mass system of angular frequency \( \Omega \) such that \( \frac{4\pi M \Omega}{h} = 10^{24} \text{m}^{-2} \), where \( h \) is plank constant. \( N \) photons of wavelength \( \lambda = 6\pi \times 10^{-6} \text{m} \) strikes the mirror simultaneously at normal incidence such that the mirror gets displaced by \( 1 \text{ \mu m} \). If the value of \( N \) is \( x \times 10^{12} \), then find value of \( x \).

\[ M \text{ (mass)} = \text{Einstein equation of motion} = \lambda = 6\pi \times 10^{-6} \text{m} \] 
\[ \lambda = 8\pi \times 10^{-6} \text{m} \] 
\[ \text{N photons} = 1 \text{ \mu m} \]

\[ \text{Sol.} \]

Momentum transferred on mirror \( \text{gen.} \) \( \text{calc.} \) \( \lambda \)

\[ \frac{2nh}{\lambda} = \frac{V_{\text{mean, position}}}{\lambda} \] 
\[ V_{\text{mean, position}} = \Omega A \] 
\[ \text{where} \] 
\[ A = 1 \text{ \mu m} \] 
\[ \frac{2nh}{\lambda} = \frac{M_0 A}{\lambda} \] 
\[ \text{where} \] 
\[ A = 8\pi \times 10^{-6} \text{m} \] 
\[ \text{N} = \frac{4\pi M_0}{h} \times 10^{-24} \times 10^{-12} \] 
\[ N = 1 \times 10^{12} \]

\[ x = 1 \]

Ans. 1

13. A particle is projected with speed \( v_0 \) at an angle \( \theta (\theta = 90^\circ) \) with horizontal and it bounce at same angle with horizontal. If average velocity of journey is 0.8 \( v_0 \) where \( v_0 \) is average velocity of first projectile then \( \alpha \) is.

\[ V_{\text{final}} = \alpha \times \text{velocity}\] 
\[ v_0 \text{ is the initial velocity} \]

\[ v_0 \text{ is the final velocity} \]

\[ v_0 \text{ is the initial velocity} \]

\[ v_0 \text{ is the final velocity} \]
For first projectile 

\[ V = \frac{R}{T} = \frac{U_0}{V_0} \]

For journey की कोणते

\[ V = R_1 + R_2 + \ldots + R_n \]

\[ \frac{1}{T_1} + \frac{1}{T_2} + \ldots + \frac{1}{T_n} \]

\[ \frac{2U_0}{g} \left[ 1 + \frac{1}{\alpha^2} + \ldots + \frac{1}{\alpha^{n-1}} \right] = 0.8 V_0 \]

\[ \frac{1}{1 + \alpha} \left[ \frac{1}{1} - \frac{1}{\alpha} \right] = 0.8 V_0 \]

\[ \frac{1}{\alpha} = 0.8 \]

\[ \alpha = 4 \]

14. available soon

SECTION 3 (Maximum Marks : 12)

- This section contains TWO (02) List-Match sets.
- Each List-Match set has TWO (02) Multiple Choice Questions.
- Each List-Match set has two lists: List-I and List-II.
- List-I has Four entries (I), (II), (III) and (IV). List-II has Six entries (P), (Q), (R), (S), (T) and (U).
- 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 : +3 If ONLY the option corresponding to the correct combination is chosen.
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  - Negative Marks : -1 In all other cases.

बंद 3 (अभ्यास अंक: 12)

- इस क्षेत्र में हो (02) सूची-सूची सेट (List-Match) रेटिंग (set) है।
- प्रारूपक सूची-सूची सेट (set) में हो (02) एकल विकल्प प्रश्न (Multiple Choice Question) है।
Match the column

A sample of monoatomic gas undergoes different thermodynamic process. \(Q\) = Heat given to the gas, \(W\) = Work done by the gas, \(U\) = Change in internal energy of the gas.

15. The sample of monoatomic gas undergoes a process as represented by P-V graph (if \(P_0/V_0 = 1/3 \, RT_0\)) then

- (P) \(W_{1\to 2} = 1/3 \, RT_0\)
- (Q) \(Q_{1\to 2\to 3} = 11/6 \, RT_0\)
- (R) \(U_{1\to 2} = RT_0/T_0\)

Which of the following options are correct?
(A) \(P, Q, R, S\) are correct  
(B) Only \(P, Q\) are correct  
(C) Only \(R, S\) are correct  
(D) Only \(P, R, S\) correct

Sol.
\[P_{1\to 2} = \frac{1}{3} \, RT_0\]
\[Q_{1\to 2} = nC_v \Delta T = n \left( \frac{f}{2} \right) \Delta T = \frac{f}{2} \, 2V_0 P_0 = \frac{f}{2} V_0 P_0 = \frac{f}{2} \, RT_0\]
\[Q_{1\to 2\to 3} = nC_v \Delta T = n \left( \frac{f}{2} + 1 \right) \Delta T = \frac{f}{2} \, 2V_0 P_0 = \frac{f}{2} \, 2V_0 = \frac{5}{6} \, RT_0\]
\[W_{1\to 2\to 3} = 1/3 \, RT_0\]
\[U_{1\to 2} = nC_v \Delta T = \frac{3}{2} \, RT_0\]
\[= \frac{RT_0}{2}\]
Which of the following option are correct:

(A) $P$, $Q$ are incorrect
(B) $R, S$ are incorrect
(C) $P, Q, S$ are incorrect
(D) none of these

(A) $P$, $Q$ are incorrect
(B) $R, S$ are incorrect
(C) $P, Q, S$ are incorrect
(D) इनमें कोई नहीं

**Ans. (D)**

**Sol.**

\[ W_{1\to 2} = nRT_0/n2 \]

\[ Q_{1\to 2\to 3} = Q_{1\to 2} + Q_{2\to 3} \]

\[ = dW_{1\to 2} + dU_{2\to 3} \]

\[ = \frac{RT_0}{3}/n2 + \frac{n^2}{2}RT_0 \]

\[ = \frac{RT_0}{3}/n2 + \frac{3}{3^2}RT_0 \]

\[ U_{1\to 2} = 0 \]

\[ W_{1\to 2\to 3} = \frac{1}{3}RT_0/n2 + 0 \]

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17. Length of string of a musical instrument is varied from $L_0$ to $2L_0$ in 4 different cases. Wire is made of different materials of mass per unit length $\mu$, $2\mu$, $3\mu$, $4\mu$ respectively. For first case (string-1) length is $L_0$. Tension is $T_0$ then fundamental frequency is $f_0$. For second case length of the string is $\frac{3L_0}{2}$ (3rd Harmonic), for third case length of the string is $\frac{5L_0}{4}$ (5th Harmonic) and for the fourth case length of the string is $\frac{7L_0}{4}$ (14th harmonic). If frequency of all is same then tension in strings in terms of $T_0$ will be:

(A) String _रस्ती_1  
(P) $T_0$

(B) String _रस्ती_2  
(Q) $\frac{T_0}{\sqrt{2}}$

(C) String _रस्ती_3  
(R) $\frac{T_0}{2}$

(D) String _रस्ती_4  
(S) $\frac{T_0}{16}$

(T) $\frac{3T_0}{16}$

This solution was downloaded from Resonance JEE (ADVANCED) 2019 Solution portal
Sol. (A) → P, (B) → R, (C) → T, (D) → S

Case 1. \( L = L_{cm}, T = T_0, f = f_0 \)
\[ f_1 = \frac{1}{2L_0} \frac{1}{\mu} \]

Case 2. \( L = \frac{3L_0}{2} \)
\[ f_2 = \frac{3}{2} \frac{1}{2L_0} \] \( \Rightarrow \) \( f_0 = \frac{1}{\sqrt{2L_0}} \) \( \Rightarrow \) \( T_2 = \frac{T_0}{2} \)

Case 3. \( L = \frac{5L_0}{2} \)
\[ f_3 = \frac{5}{2} \frac{3}{3L_0} \] \( \Rightarrow \) \( f_0 = \frac{2}{\sqrt{3L_0}} \) \( \Rightarrow \) \( T_3 = \frac{3T_0}{16} \)

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SECTION 3 (Maximum Marks : 12)

- This section contains TWO (62) List-Match sets.
- Each List-Match set has TWO (02) Multiple Choice Questions.
- Each List-Match set has two lists: List-I and List-II.
- List-I has Four entries (I), (II), (III) and (IV) List-II has Six entries (P), (Q), (R), (S), (T) and (U).
- 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 : +3 If ONLY 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.

Answering Questions:

- To select the option(s), use the mouse to click on the corresponding button(s) of the option(s).
- To deselect the chosen option(s) for the questions of SECTION-I, click on the button(s) of the chosen option(s) again or click on the Clear Response button to clear all the chosen options.
- To deselect the chosen option for the questions of SECTION-3, click on the button of the chosen option again or click on the Clear Response button to clear the chosen option.
- To change the option(s) of a previously answered question of SECTION-I and SECTION-3 first deselect as given above and then select the new option(s).
- To answer questions of SECTION-2 use the mouse to click on numbers (and/or symbols) on the on-screen virtual numeric keypad to enter the numerical value in the space provided for answer.
- To change the answer of a question of SECTION-2 first click on the Clear Response button to clear the correct answer and then enter the new numerical value.
- To mark a question ONLY for review (i.e. without answering it), click on the Mark for Review & next button.
- To mark is question for review (after answering it), click on Mark for Review & Next button - the answered question which is also marked for review will be evaluated.
- To save the answer click on the Save & Next button, the answered question will be evaluated.
Case 4.

$$L = \frac{7L_0}{4}$$

$$f_4 = \frac{14}{2} \frac{T_4}{4\mu} = f_0 = \frac{2}{L_0} \frac{T_4}{\mu} \Rightarrow T_4 = \frac{T_0}{16}$$

18. The free length of all four strings is varied from $L_0$ to $2L_0$. Find the maximum fundamental frequency of 1, 2, 3, 4 in terms of $f_0$ (tension is same in all strings).

The correct option is (P).

(A) String (μ) $f_0$ - 1
(B) String (2μ) $f_0$ - 2
(C) String (3μ) $f_0$ - 3
(D) String (4μ) $f_0$ - 4

Sol. (A) $\rightarrow$ P, (B) $\rightarrow$ R, (C) $\rightarrow$ S, (D) $\rightarrow$ Q

Fundamental frequency is maximum when length is minimum i.e. $L_0$, and the ratio of tension is the same. Hence, the answer is $f_0$ for $L_0$. 

Case 1.

$$L = L_0, \quad T = T_0, \quad f = f_0$$

$$f_1 = \frac{1}{2L_0} \frac{T_0}{\mu}$$

Case 2.

$$f_2 = \frac{1}{L_0} \frac{T_0}{2\mu} = f_0$$

Case 3.

$$f_3 = \frac{1}{L_0} \frac{T_0}{3\mu} = \frac{f_0}{\sqrt{3}}$$

Case 4.

$$f_4 = \frac{1}{L_0} \frac{T_0}{4\mu} = \frac{f_0}{2}$$