# Paper-2

# JEE Advanced, 2015

# PART I: PHYSICS

**Note:** Answers have been highlighted in "Yellow" color and Explanations to answers are given at the end

**READ THE INSTRUCTIONS CAREFULLY:**

**GENERAL:**

**1.** This sealed booklet is your Question Paper. Do not break the seal till you are told to do so.

**2.** The question paper CODE is printed on the left hand top corner of this sheet and the right hand top corner of the back cover of this booklet.

**3.** Use the Optical Response Sheet (ORS) provided separately for answering the questions.

**4.** The ORS CODE is printed on its left part as well as the right part. Ensure that both these codes are identical and same as that on the question paper booklet. If not, contact the invigilator.

**5.** Blank spaces are provided within this booklet for rough work.

**6.** Write your name and roll number in the space provided on the back cover of this booklet.

**7.** After breaking the seal of the booklet, verify that the booklet contains **32** pages and that all the **60** questions along with the options are legible.

**QUESTIONS PAPER FORMAT AND MARKING SCHEME:**

**8**. The question paper has three parts: Physics, Chemistry and Mathematics, Each part has three sections.

**9.** Carefully read the instructions given at the beginning of each section.

**10.** Section 1 contains 8 questions. The answer to each question is a single digit integer ranging from 0 to 9 (both inclusive).

Marking scheme: +4 for correct answer and 0 in all other cases.

**11.** Section 2 contains 8 multiple choice questions with one or more than one correct option.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

**12.** Section 3 contains 2 "paragraph" type questions. Each paragraph describes an experiment, a situation or a problem. Two multiple choice questions will be asked based on this paragraph. One of or more than one option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

**OPTICAL RESPONSE SHEET:**

**13.** The ORS consists of an original (top sheet) and its carbon- less copy (bottom sheet.)

**14.** Darken the appropriate bubbles on the original by applying sufficient pressure. This will leave an impression at the corresponding place on the carbon – less copy.

**15.** The original is machine – gradable and will be collected by the invigilator at the end of the examination.

**16.** You will be allowed to take away the carbon – less copy at the end of the examination,

**17.** Do not tamper with or mutilate the ORS.

**18.** Write your name, roll number and the name of the examination center and sign with pen in the space provided for this purpose on the original. **Do not write any of these details anywhere else**. Darken the appropriate bubble under each digit of your roll number.

Note: Answers have been highlighted in "Yellow" color and Explanations to answers are given at the end

**SECTION 1 (Maximum Marks: 32)**

- This section contains **EIGHT** questions
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive
- For each question, darken the bubble corresponding to the correct integer in the ORS
- Marking scheme:
  +4 If the bubble corresponding to the answer is darkened

**Q.1** The densities of two solid sphere A and B of the same radii R vary with radial distance r as $\rho_A(r) = k\left(\frac{r}{R}\right)$ and $\rho_B(r) = k\left(\frac{r}{R}\right)^5$, respectively, where k is a constant. The moments of inertia of the individual spheres about axes passing through their centres are $I_A$ and $I_{sB}$, respectively. If $\frac{I_B}{I_A} = \frac{n}{10}$, the value of n is

**Ans.1** (6)

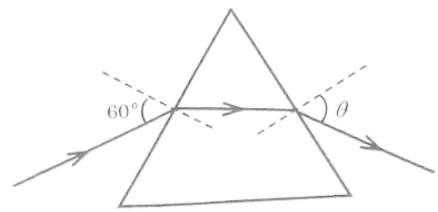
**Q.2** Four harmonic waves of equal frequencies and equal intensities $I_o$ have phase angles 0, π/3, 2π/3 and π. When they are superposed, the intensity of the resulting wave is $nI_o$. The value of n is

**Ans.2** (3)

**Q.3** For a radioactive material, its activity A and rate of change of its activity R are defined as $A = -\frac{dN}{dt}$ and $R = -\frac{dA}{dt}$, where N(t) is the number of nuclei at time t. Two radioactive sources P (mean life τ) and Q (mean life 2 τ) have the same activity at t = 0. Their rates of change of activities at t = 2τ are $R_p$ and $R_Q$, respectively. If $\frac{R_P}{R_Q} = \frac{n}{e}$, then the value of n is

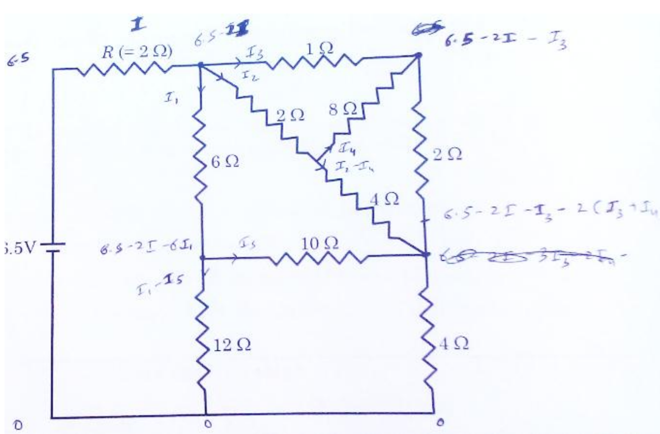
**Ans.3** (2)

**Q.4** A monochromatic beam of light is incident at 60° on one face of an equilateral prism of refractive index n and emerges from the opposite face making an angle θ(n) with the normal (see the figure.) For $n = \sqrt{3}$ the value of θ is 60° and $\frac{d\theta}{dn} = m$. The value of m is




**Ans.4** (2)

**Q.5** In the following circuit, the current through the resistor R (= 2Ω) is I Amperes. The value of I is

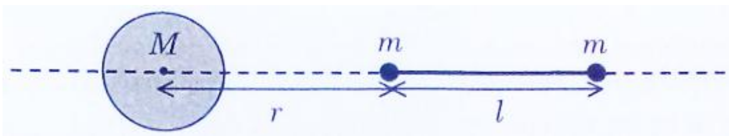



**Ans.5** (1)

**Q.6** An electron in and excited state of $Li^{2+}$ ion has angular momentum 3h/2π. The de Broglie wavelength of the electron in this state is $p\pi a_0$ (where $a_0$ is the Bohr radius). The value of p is

**Ans.6** (2)

**Q.7** A large spherical mass M is fixed at one position and two identical point masses m are kept on a line passing through the centre of M (see figure). The point masses are connected by a rigid massless rod of length l and this assembly is free to move along the line connecting them. All three masses interact only through their mutual gravitational interaction. When the point mass nearer to M is at a distance r = 3l from M, the tension in the rod is zero for $m = k\left(\frac{M}{288}\right)$. The value of k is




**Ans.7** (7)

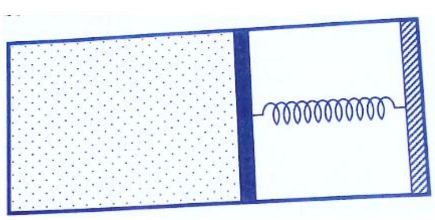
**Q.8** The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-at)$, where a = 0.2 $s^{-1}$. The measurement of A has an error of 1.25%. If the error in the measurement of time is 1.50%, the percentage error in the value of E(t) at t = 5 s is

**Ans.8** (4)

**SECTION 2 (Maximum Marks: 32)**

- This section contains **EIGHT** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- Marking scheme:
  - +4 If the bubble(s) corresponding to all the correct option(s) is(are) darkened
  - 0 If none of the bubbles is darkened
  - -2 In all other cases

**Q.9** An ideal monoatomic gas is confined in a horizontal cylinder by a spring loaded piston (as shown in the figure). Initially the gas is at temperature $T_1$, pressure $P_1$ and volume $V_1$ and the spring is in its relaxed state. The gas is then heated very slowly to temperature $T_2$, pressure $P_2$ and volume $V_2$. During this process the piston moves out by a distance x. Ignoring the friction between the piston and the cylinder, the correct statement(s) is(are)



(A) If $V_2 = 2V_1$ and $T_2 = 3T_1$, then the energy stored in the spring is $\frac{1}{4}P_1V_1$

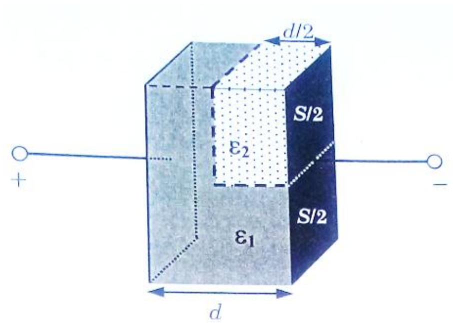
(B) If $V_2 = 2V_1$ and $T_2 = 3T_1$, then the change in internal energy is $3P_1V_1$

(C) If $V_2 = 3V_1$ and $T_2 = 4T_1$, then the work done by the gas is $\frac{7}{3}P_1V_1$

(D) If $V_2 = 3V_1$ and $T_2 = 4T_1$, then the heat supplied to the gas is $\frac{17}{6}P_1V_1$

**Ans.9** (A,B,C)

**Q.10** A parallel plate capacitor having plates of area S and plate separation d, has capacitance $C_1$ in air. When two dielectrics of different relative permittivities ($\varepsilon_1 = 2$ and $\varepsilon_2 = 4$) are introduced between the two plates as shown in the figure, the capacitance becomes $C_2$. The ratio $\frac{C_2}{C_1}$ is




(A) 6/5 (B) 5/3

(C) 7/5 (D) 7/3

**Ans.10** (D)

**Q.11** A spherical body of radius R consists of a fluid of constant density and is in equilibrium under its own gravity. If P(r) is the pressure at $r(r < R)$, then the correct option(s) is(are)

(A) $P(r=0) = 0$

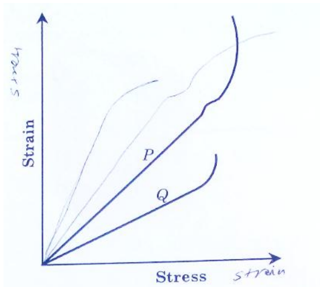
(B) $\frac{P(r=3r/4)}{P(r=2R/3)} = \frac{63}{80}$

(C) $\frac{P(r=3R/5)}{P(r=2R/5)} = \frac{16}{21}$

(D) $\frac{P(r=R/2)}{P(r=R/3)} = \frac{20}{27}$

**Ans.11** (B,C)

**Q.12** In plotting stress versus strain curves for two materials P and Q, a student by mistake puts strain on the y – axis and stress on the x – axis as shown in the figure. Then the correct statements(s) is(are)




(A) P has more tensile strength than Q

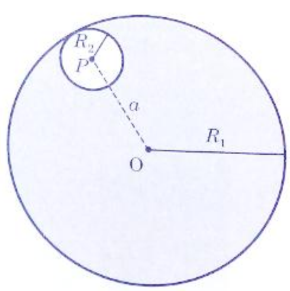
(B) P is more ductile than Q

(C) P is more brittle than Q

(D) The Young's modulus of P is more than that of Q

**Ans.12** (A,B,C)

**Q.13** Consider a uniform spherical charge distribution of radius $R_1$ centred at the origin O. In this distribnution, a spherical cavity of radius $R_2$, centred at P with distance OP = a = $R_1 - R_2$ (see figure) is made. If the electric field inside the cavity at position $\vec{r}$ is $\vec{E}(\vec{r})$, then the correct statement(s) is(are)




(A) $\vec{E}$ is uniform, its magnitude is independent of $R_2$ but its direction depends on $\vec{r}$

(B) $\vec{E}$ is uniform, its magnitude depends on $R_2$ and its direction depends on $\vec{r}$

(C) $\vec{E}$ is uniform, its magnitude is independent of a but its direction depends on $\vec{a}$

(D) $\vec{E}$ is uniform and both its magnitude and direction depend on $\vec{a}$

**Ans.13** (D)

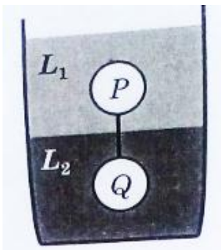
**Q.14** In terms of potential difference V, electric current I, permittivity $\varepsilon_0$, permeability $\mu_0$ and speed of light c, the dimensionally correct equation(s) is(are)

(A) $\mu_0 I^2 = \varepsilon_0 V^2$ (B) $\varepsilon_0 I = \mu_0 V$

(C) $I = \varepsilon_0 cV$ (D) $\mu_0 cI = \varepsilon_0 V$

**Ans.14** (A,C)

**Q.15** Two spheres P and Q of equal radii have densities $\rho_1$ and $\rho_2$, respectively. The spheres are connected by a massless string and placed in liquids $L_1$ and $L_2$ of densities $\sigma_1$ and $\sigma_2$ and viscosities $n_1$ and $n_2$, respectively. They float in equilibrium with the sphere P in $L_1$ and sphere Q in $L_2$ and the string being taut (see figure). If sphere P alone in $L_2$ has terminal velocity $\overrightarrow{V_Q}$, then




(A) $\frac{|\overrightarrow{V_p}|}{|\overrightarrow{V_Q}|} = \frac{n_1}{n_2}$ (B) $\frac{|\overrightarrow{V_P}|}{|\overrightarrow{V_Q}|} = \frac{n_2}{n_1}$

(C) $\overrightarrow{V_p}.\overrightarrow{V_Q} > 0$ (D) $\overrightarrow{V_p}.\overrightarrow{V_Q} < 0$

**Ans.15** (A,D)

**Q.16** A fission reaction is given by $^{236}_{92}\text{U} \rightarrow {}^{140}_{54}\text{Xe} + {}^{94}_{38}\text{Sr} + x + y$, where x and y are two particles. Considering $^{236}_{92}\text{U}$ to be at rest, the kinetic energies of the products are denoted by $K_{Xe}$, $K_{Sr}$, $K_x$ (2 MeV) and $K_y$ (2 Me V), respectively. Let the binding energies per nucleon of $^{236}_{92}\text{U}$, $^{140}_{54}\text{Xe}$ and $^{94}_{38}\text{Sr}$ be 7.5 MeV, 8.5 MeV and 8.5 MeV, respectively. Considering different conservation laws, the correct option(s) is(are)

(A) x = n, y = n, $K_{Sr}$ = 129 MeV, $K_{Xe}$ = 86 MeV

(B) x = p, y = $e^-$, $K_{Sr}$ = 129 MeV, $K_{Xe}$ = 86 MeV

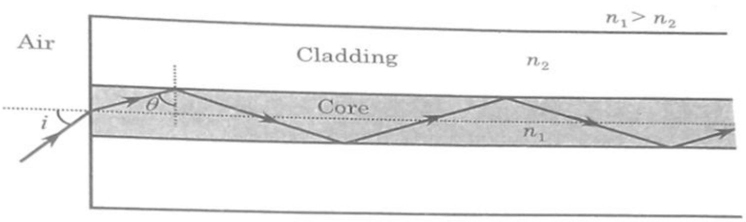
(C) x = p, y = n, $K_{Sr}$ = 129 MeV, $K_{Xe}$ = 86 MeV

(D) x = n, y = n, $K_{Sr}$ = 86 MeV, $K_{Xe}$ = 129 MeV

**Ans.16** (A)

**PARAGRAPH I**

Light guidance in an optical fiber can be understood by considering a structure comprising of thin solid glass cylinder of refractive index $n_1$ surrounded by a medium of lower refractive index $n_2$. The light guidance in the structure takes place due to successive total internal reflections at the interface of the media $n_1$ and $n_2$ as shown in the figure. All rays with the angle of incidence I less than a particular value $i_m$ are confined in the medium of refractive index $n_1$. The numerical aperture (NA) of the structure is defined as sin $i_m$.




**Q.17** for two structures namely $S_1$ with $n_1 = \sqrt{45}/4$ and $n_2 = 3/2$, and $S_2$ with $n_1 = 8/5$ and $n_2$ $7/5$ and taking the refractive index of water to be 4/3 and that of air to be 1, the correct option(s) is(are)

(A) NA of $S_1$ immersed in water is the same as that of $S_2$ immersed in a liquid of refractive index $\frac{16}{3\sqrt{15}}$

(B) NA of $S_1$ immersed in liquid of refractive index $\frac{6}{\sqrt{15}}$ is the same as that of $S_2$ immersed in water in water

(C) NA of $S_1$ placed in air is the same as that of $S_2$ immersed in liquid of refractive index $\frac{4}{\sqrt{15}}$

(D) NA of $S_1$ placed in air is the same as that of $S_2$ placed in water

**Ans.17** (A,C)

**Q.18** If two structures of same cross – sectional area, but different numerical apertures NA, and $NA_2$ ($NA_2 < NA_1$) are joined longitudinally, the numerical aperture of the combine structure is

(A) $\frac{NA_1 NA_2}{NA_1 + NA_2}$

(B) $NA_1 + NA_2$

(C) $NA_1$

(D) $NA_2$

**Ans.18** (D)

- This section contains TWO paragraphs
- Based on each paragraph, there will be TWO questions
- Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s) is(are) correct
- For each question, darken the bubble (s) corresponding to all the correct option (s) in the ORS
- Marking scheme:

  +4 If only the bubble(s) corresponding to all the correct option(s) is (are) darkened

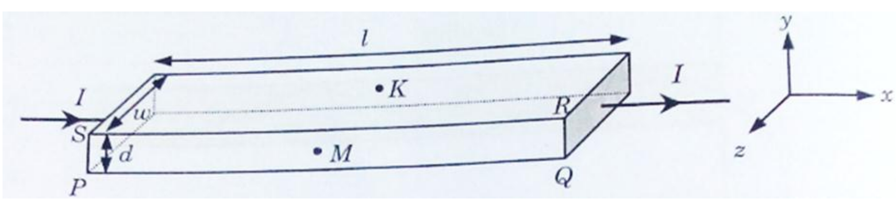
  0 If none of the bubbles is darkened

  -2 In all other cases

**PARAGRAPH 2**

In a thin rectangular metallic strip a constant current I flows along the positive x-direction, as shown in the figure. The length, width and thickness of the strip are l, w and d, respectively.

A uniform magnetic field $\vec{B}$ is applied on the strip along the positive y-direction. Due to this the charge carriers experience a net deflection along the z-direction. This results in accumulation of charge carriers on the surface PQRS and appearance of equal and opposite charges on the face opposite to PQRS. A potential difference along the z-direction is thus developed. Charge accumulation continues until the magnetic force is balanced by the electric force. The current is assumed to be uniformly distributed on the cross section of the strip and carried by electrons.




**Q.19** Consider two different metallic strips (1 and 2) of the same material. Their lengths are the same, widths are $w_1$ and $w_2$ and thicknesses are $d_1$ and $d_2$ respectively Two points K and M are symmetrically located on the opposite faces parallel to the x – y plane (see figure). $V_1$ and $V_2$ are the potential differences between K and M in strips 1 and 2, respectively. Then, for a given current I flowing through them in a given magnetic field strength B, the correct statement(s)is(are)

(A) If $w_1 = w_2$ and $d_1 = 2d_2$, then $V_2 = 2V_1$

(B) If $w_1 = w_2$ and $d_1 = 2d_2$, then $V_2 = V_1$

(C) If $w_1 = 2w_2$ and $d_1 = d_2$, then $V_2 = 2V_1$

(D) If $w_1$ $2w_2$ and $d_1 = d_2$, then $V_2 = V_1$

**Ans.19** (A,D)

**Q.20** Consider two different metallic strips (1 and 2) of same dimensions (length l, width w and thickness d) with carrier densities $n_1$ and $n_2$, respectively. Strip 1 is placed in magnetic field $B_1$ and strip 2 is placed in magnetic field $B_2$, both along positive y- directions. Then $V_1$ and $V_2$ are the potential differences developed between K and M in strips 1 and 2, respectively. Assuming that the current I is the same for both the strips, the correct option(s) is(are)

(A) If $B_1 = B_2$ and $n_1 = 2n_2$, then $V_2 = 2V_1$

(B) If $B_1 = B_2$ and $n_1 = 2n_2$ , then $V_2 = V_1$

(C) If $B_1 = 2B_2$ and $n_1 = n_2$, then $V_2 = 0.5V_1$

(D) If $B_1 = 2B_2$ and $n_1 = n_2$, then $V_2 = V_1$

**Ans.20** (A,C)

# Answer Keys and Explanations

**Sol.1** (6)

$I = \int r^2\, dm \qquad dm = \rho 4\pi\, r^2\, dr.$

$I_A = \int_0^R r^2\, \rho\, 4\pi\, r^2\, dr \qquad I_B = \int_0^R r^2\ \rho\ 4\ \pi\ r^2\ dr.$

$I_A = \frac{4\pi k\, R^5}{6}, \qquad$ similarly $I_B = \frac{4\pi K R^5}{10}$

$\frac{I_B}{I_A} = \frac{6}{10} \Rightarrow n = 6$

**Sol.2** (3)

Resultant wave

$y = A\ e^{\ i(kx - wt)}\ [e^{\circ} + e^{i\ \pi/3} + e^{i2x/3} + e^{i\pi}]$

$= A\ e^{i(kx - wt)}\ [1 + \cos\frac{\pi}{3} + i\sin\frac{\pi}{3} + \cos\frac{2\pi}{3} + i\sin\frac{2\pi}{3} - 1]$

$= A\ e^{i(k\pi - wt)}\ 2i\sin\frac{\pi}{3}$

$\Rightarrow I = 3I_0$

**Sol.3** (2)

$R = R_0 e^{-At}$

$\frac{R_P}{R_Q} = \frac{R_{op}\ e^{-\lambda p\ t}}{R_{oQ}\ e^{-\lambda Q\ t}}$

$= \frac{A_{0p}\ \lambda_p\ e^{-\lambda p\ t}}{A_{0q}\ \lambda_q\ e^{-\lambda q\ t}} \qquad \lambda_p = 1/\tau\ ;\ \lambda_q = \frac{1}{2\tau}$

$= \frac{2}{e} \qquad$ (at $t = 2\tau$)

$n = 2$

**Sol.4** (2)

Sin $i = n \sin r$

Sin $r = \frac{\sqrt{3}}{2n}$

$r = \sin^{-1}\left(\frac{\sqrt{3}}{2n}\right)$

r + r' = A = 60°

snell's law for phase 2

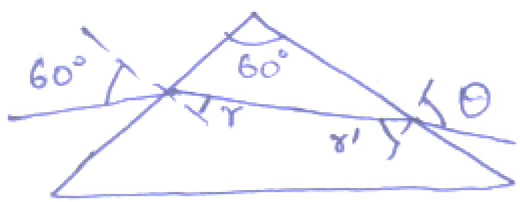
$\sin\theta = n \sin\left(60 - \sin^{-1}\frac{\sqrt{3}}{2n}\right)$

$\cos\theta \frac{d\theta}{dn} = \sin\left(60 - \sin^{-1}\frac{\sqrt{3}}{2n}\right) + n\cos\left(60 - \sin^{-1}\frac{\sqrt{3}}{2n}\right)\left(\frac{-1}{\sqrt{1-\frac{3}{4n^2}}}\right)\times\left(-\frac{\sqrt{3}}{2}\frac{1}{n^2}\right)$

at $n = \sqrt{3}$

$\frac{1}{2}\ \frac{d\theta}{dn} = \sin 30° + \cos 30° \frac{2}{\sqrt{3}} \times \frac{\sqrt{3}}{2}\frac{1}{\sqrt{3}}$

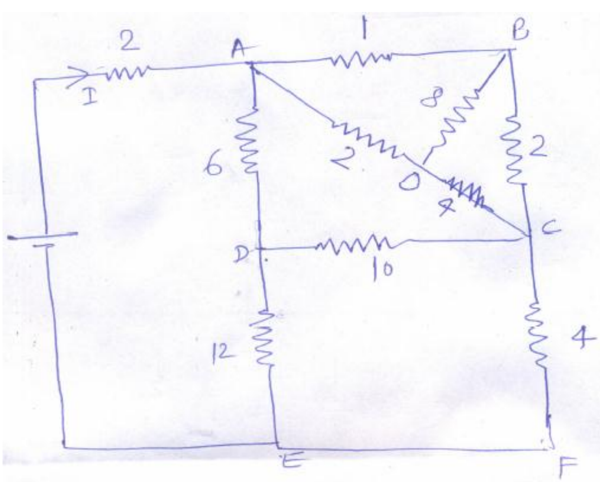
$\frac{d\theta}{dn} = 2$ m = 2




**Sol.5** (1)

In this circuit, there will be two wheat stone bridge resultant resistance will be 6.5Ω

Current will be 1A



ABC O A → wheat stone bridge

Also. A C F E D A → Followed wheat – stone Bridge

I = $V/R_{net} = \frac{\frac{13}{2}}{\frac{13}{2}}$ = 1 Amp.

**Sol.6** (2)

$\vec{L} = \frac{3\,h}{2\,\pi} \Rightarrow$ n = 3

mvr = $\frac{3h}{2\pi}$

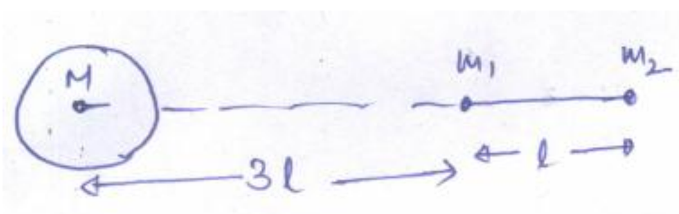
v = $\frac{3\,h}{2\,\pi\,nr}$

$\lambda = \frac{\lambda}{mv}$ and r = $n^2 a_0$

$\lambda = \frac{2\times 3\pi\, a_0}{Z} = 2\,\pi\, a_0$

P = 2

**Sol.7** (7)




For $m_1$

$\frac{G\,m^2}{l^2} + T + \frac{GM\,m}{16l^2}$ = ma

For $m_2$

$-\frac{GM^2}{l^2}$ - T + $\frac{GMm}{91^2}$ = ma

$\Rightarrow$ T = $\frac{GMm}{18l^2}$ - $\frac{GMm}{32l^2}$ $\frac{-2G\,m^2}{l^2}$ = 0

$\Rightarrow$ M = $7\left(\frac{M}{288}\right)$

K = 7

**Sol.8** (4)

$E = A^2 e^{-\alpha t}$

$\text{Log } E = 2 \log A + \alpha t$

$\frac{\Delta E}{E} \times 100 = \frac{2\,\Delta A}{A} \times 100 + \times \frac{\Delta t}{t} \times t \times 100$

$= 2\,(1.25) + 0.2 \times (1.5) \times 5$

$\frac{\Delta E}{E} \times 100 = 4$

**Sol.9** (A,B,C)

Using $\frac{P_2\,V_2}{T_2} = \frac{p_1 V_1}{T_1}$ ................(i)

$P_2 = P_1 + \frac{Kx}{A}$ ...............(ii)

$\Delta Q = \Delta U + \Delta W$ ................(iii)

$\Delta\, U = n\, C_v\, \Delta T = \frac{P_2 V_2 - P_1\, V_1}{(Y-1)}$

$\gamma = \frac{5}{3}$

(A) Energy stored in the spring $= \frac{1}{2}\ kx^2$

$\frac{1}{2}\left[\left(\frac{P_2 - P_1}{x}\right) A\right]\ x^2 = \frac{1}{4} P_1\, V_1$

(B) $\Delta U = \frac{P_2\, V_2 - P_1 V_1}{Y-1}\ = 3P_1V_1$

(C) Work done by the gas

$\Delta W = \int \left(P_1 + \frac{kx}{A}\right)\ A\, dx = P_1\, Ax + \frac{kx^2}{2}$

Substituting the values , we get , $\frac{1}{3} P_1\, V_1$

(d) Heat Supplied,

$\Delta Q = \Delta\, U + p\Delta V\ \neq \frac{17}{6} P_1 V_1$

Hence, A , B, C are correct

**Sol.10** (D)

Calculating Capacitance

$C_1 = \frac{\epsilon_2 \frac{5}{2}}{\frac{d}{2}} = \frac{\epsilon_2 5}{d}$ ..........(i)

$C_2 = \frac{\epsilon_1 \frac{S}{2}}{\frac{d}{2}} = \frac{\epsilon_1 S}{d}$ .........(ii)

$C_3 = \frac{\frac{\epsilon_1 S}{2}}{d} = \frac{\epsilon_1 S}{2d}$ ..........(iii)

Since, $\epsilon_1 = 2$ and $\epsilon_2 = 4$

Also, $C_1$ and $c_2$ are in series and their resultant is in parallel with $C_3$

Therefore $\frac{C_2}{C_1} = \frac{7}{3}$

**Sol.11** (B,C)

Force due to weight in the volume of $(\frac{4}{3}\pi R^3 - \frac{4}{3}\pi r^3)$ acting on the surface area ($4\pi r^2$) will

be balanced by the pressure of the liquid in the volume $\left(\frac{4}{3}\pi r^3\right)$

So,

$P(r)\, 4\pi r^2 = \int dF = \int \frac{G\left(\frac{4}{3}\pi r^3\right)\rho \cdot 4\pi r^2\, dr.\rho}{r^2}$

$P(r) = \frac{\frac{4}{3}\pi^2 G\rho^2 [R^4 - r^4]}{4\pi r^2}$

Substituting the values & compare

Hence, 'B' and 'C'

**Sol.12** (A,B,C)

Tensile is a function of strain, as stress is applied------

So, 'P' has more tensile than 'θ'

Area in the plastic range of P is more than Q for its ductile nature and reverse is true for brittle nature.

Young's modulus $(Y) = \frac{1}{\tan\theta}$

On comparing, we get option 'D' is incorrect

Hence, A and B.

**Sol.13** (D)

Electric field will be uniform in the cavity

$\overrightarrow{E} = \frac{\rho\,\vec{a}}{3\epsilon_0}$

This field is due to vector sum of positive charge density and negative charge density in the Cavity.

$\vec{E} = \frac{\rho\,\overrightarrow{a}}{3\epsilon_0}$

Hence 'D'

**Sol.14** (A,C)

Writing the dimensional formula of individuals,

$\mu_0 = [M\,L^2\,T^{-2}\,A^{-1}]$

$I = [A]$

$V = [M\,L^2\,T^{-3}\,A^{-1}]$

$\epsilon_0 = [M^{-1}\,L^{-3}\,T^4\,A^2]$

$C = [LT^{-1}]$

On substituting and comparing,

We get

Options A and C are correct

**Sol.15** (A,D)

Terminal velocity of 'P' would be directed upward and 'Q' directed downward.

For P. $Th - W = 6\pi\,n_2\,r\,V_p$

For Q $W - Th = 6\pi n_1\,r\,V_Q$

Since, both the balls will go in opposite direction

Therefore, $\frac{V_p}{V_Q} = \frac{n_1}{n_2}$ Also, $V_P \cdot V_Q < 0$

**Sol.16** (A)

In the fission reaction K.E. of $U^{-235} = 0$

Kinetic Energies of Xe and Sr will be calculated by using Binding Energy of the fission reaction

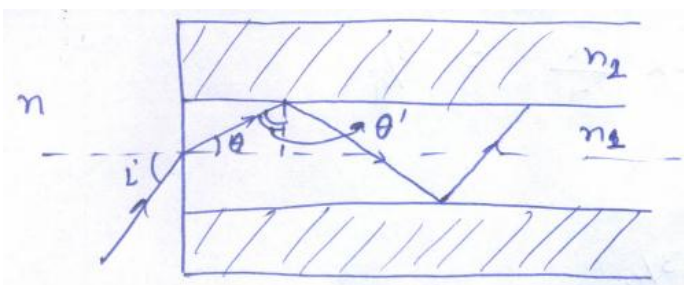
$BE = \Delta m\, c^2 = \Delta mc^2 (MeV)$

Calculating for x = n and y = n

$(KE)_{Sr} = 129$ MeV and $(KE)_{\lambda e} = 86$ MeV

Hence 'A' is correct

**Sol.17** (A, C)




$\Theta_1 = (90 - \theta)$

By snell's law,

$N \sin i_m = n_1 \sin \theta$

For TIR,

$\text{Sin } \theta_c = \frac{n_2}{n_1}$

$\Rightarrow NA = \sin i_m = \frac{n_1 \sin\theta}{n}$

$= \frac{n_1}{n} \sin (90 - \theta_c) = \frac{n_1}{n} \cos \theta_c = \frac{n_1}{n} \sqrt{1 - \sin^2 \theta_c}$

Or, $NA = \sin i_m = \frac{\sqrt{n_1^2 - n_2^2}}{n}$

(A) $NA_1 = \frac{\sqrt{\frac{45}{16} - \frac{9}{4}}}{\frac{4}{3}} = \frac{9}{16}$

$NA_2 = \frac{\sqrt{\frac{64}{25} - \frac{49}{25}}}{\frac{16}{3}\sqrt{15}} = \frac{9}{16}$

(B) $NA_1 = \frac{\sqrt{15}}{8}$

$NA = \frac{3\sqrt{15}}{20}$

(C) $NA_1 = \frac{3}{4}$

$NA_2 = \frac{\sqrt{15}}{5} \times \frac{\sqrt{15}}{4} = \frac{3}{4}$

(D) $NA_1 = \frac{3}{4}$

$NA_2 = \frac{3\sqrt{15}}{20}$.

**Sol.18** (D)

Since $NA_2 < NA_1$, only those '$i_m$' of one structure will pass through another if this value is less than '$i_m$' of other structure. So, $NA_2$ (which is smaller) will be the numerical aperture of the combination.

**Sol.19** (A, D)

For balancing of forces,

$e \cdot v_d \cdot B = eE$

Where, $V_d$ = Drift velocity.

E = charge of electron.

$\Rightarrow V_d \cdot B = E$

$\Rightarrow \frac{j}{ne} \; B = E$ ; y = current density

$\Rightarrow \frac{I}{A\,ne} \cdot B = E$ n = number density.

$\Rightarrow \frac{I.B}{A \cdot n\,e} = \frac{v}{w}$; w = width & v = potential differences between the two faces.

$\Rightarrow \frac{I\,B}{w.d.ne} = \frac{v}{w}$

$\Rightarrow \frac{I\,B}{d\,ne} = V$

'V' doesn't depend on 'w' but on 'd' only.

For Q.19,

$$V = \frac{k}{d}\text{; k = constant.}$$

So, (A), (D)

**Sol.20** (A,C)

For this question,

$V = k'\frac{B}{n}$ ; $k^1$ = constant.

So, (A) and (C)