Self Study Series

Solution Hints

for the problems
of the Textbook

PHYSICS XII

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Preface

Solutions of Physics problems in major cases should be a fun! Just throw the values in the final equation and calculate the result. Looks to be nice! For it highlight the useful formulas in your textbook. Remember by heart all the important formulas. After that you must fully understand the background of the symbols of each equation. When you are using your calculator, do not write the calculated result in a single step, but write down the calculations step by step.

I heard that once a healthy man went into a forest and he met with such creatures that do not harm the human beings but simply 'love' them by licking with their tongues the bottom side of the man's feet. Ultimately that man's feet became so soft that he was unable to walk—and he became total dependent and enslaved by them. It is the same case with the keys having hundred percent solutions.

When you go to a new place to meet your friend with someone in a car. Next time you may find some difficulty in locating that place. But if you go by yourself (may be by walk!), then you will be familiar with that way for future. Similarly when you solve the problems independently, then surely you will not find any difficulty to solve that problem again.

November 15, 2004 Ross Nazir Ullah

To Students

This *Solution Hints* is a different approach for solving problems. It's just like an exercise book, to be more specific, your mind's exercise. [You are lucky! In this edition I added bigger hints, nearly full solution for some problems.]

The pre-condition of this book is not to use any key, notes, and guide, even not to ask from anybody.

Just ***memorize Important Formulas*** (pages 9 & 10) and you will be through!

For solving problems:

1. Simply read the problem and try to understand it.
2. Try to solve it, might be in a wrong way.
3. Follow 5 Steps in solving problems.
4. Consult *Solution Hints*.
5. If un-able to solve, put more mental energies for solving the problem.
6. If you fail to solve by yourself take only guideline from your teacher.
7. If you think that the given hints are insufficient, add more hints in your Solution Hints book.

Best of Luck.

CONTENTS

5 Steps in solving problems

1. **Understand** (the theory behind the problem)
2. (Write down the) **Data**
3. System of **Units** (should be same in the data)
4. (From the data look for) Appropriate **formula**
5. **Calculations** (after putting values in the formula)

If you are good in all the above 5 steps, then you can solve major Physics problems in F.Sc. Text Book.

To solve circuit problems

1. Draw the circuit diagram.
2. Select loops such that each resistance included at least once.
3. Assume a current in each loop having same sense for all.
4. Write loop equations.
5. Solve for unknown quantities.

The direction of (conventional) current is taken from +ve to –ve terminals.

Sample Solutions

Problem (14.7): What current should pass through a solenoid that is 0.5 m long with 10,000 turns of copper wire so that it will have a magnetic field of 0.4 T ?

Solution:

[*tentative data*] We have

$I = ?$

$\ell = 0.5m$

$N = 10{,}000$

$B = 0.4\ T$

[Understand]

[looking for appropriate formula in the mind, as remembered by heart the 'important formulas']

$B = \mu_o n I$ looks to be appropriate

Re-adjusting the **data** according to the formula, we have

Number of turns per unit length = $n = N/\ell = 10{,}000 / 0.5$

Magnetic field = $B = 0.4\ T$

& $\mu_o = 4\pi \times 10^{-7}\ WbA^{-1}\ m^{-1}$

current = $I = ?$

[All **units** are O.K.]

using the **formula**

$$B = \mu_o n I$$

or

$$I = \frac{B}{\mu_o n}$$

substituting the values, we have

[**calculations**]

$$= \frac{0.4}{4\pi \times 10^{-7} \times 10{,}000/0.5} = \frac{0.4 \times 0.5}{4\pi \times 10^{-7} \times 10{,}000}$$

[using the calculator in the last equation]

$$= 15.92\ A = 16\ A$$

Hence the passing current through the solenoid is **16 A**

Problem (15.12): A generator has a rectangular coil consisting of 360 turns. The coil rotates at 420 rev per minute in 0.14 T magnetic field. The peak value of emf produced by the generator is 50 V, if the coii is 5.0 cm wide, find the length of the side of the coil?

Solution:

[*tentative data*] We have

[360 turns give] $N = 360$

[420 rev per min gives] $= \omega = 420$ rev/min

[0.14 T gives] $B = 0.14$ T

[50 V gives] V [wrong selection!] = 50 V

[5.0 cm wide gives] $= b = 5.0$ cm

to find length , $\ell = ?$

[**Understand**] [looking for the appropriate formula as remembered by heart from the 'important formulas']

$$\varepsilon_o = N\omega AB$$

[and thinking that $A = b \times \ell$]

Re-adjusting the **data**

Number of turns of the coil = N = 360

Angular speed $= \omega = 420$ rev/min

[adjusting **Units**] $= \dfrac{420 \times 2\pi}{60}$ rad/S

magnetic field $= B = 0.14$ T

maximum emf $= \varepsilon_{max} = \varepsilon_o = 50$ V

width of the coil $= b = 5.0$ cm

$= 5.0 / 100 = 0.05$ m [Units]

Area $= A = b \times \ell$

Using the **formula**

$$\varepsilon_o = N\omega AB$$

or $\varepsilon_o = N\omega (b \times \ell) B$

or $\ell = \dfrac{\varepsilon}{N\omega bB}$

[**Calculations**] $\ell = \dfrac{50}{360 \times (420 \times 2\pi / 60)\, 0.05 \times 0.14}$

[using the calculator in the final equation; may be in more than one step]

$\ell = \dfrac{50 \times 60}{360 \times 420 \times 2\pi \times 0.05 \times 0.14}$ $= 0.4511 = 0.45$ m [writing ans. up to two decimal points with units]

Hence the length of the side of the coil is **0.45 m**

Important Formulas

Chapter 12

$$F_e = \frac{1}{4\pi \in_o} \frac{q_1 q_2}{r^2}$$

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$F = \frac{F}{q_o}; \quad F = mg$$

$$E = \frac{1}{4\pi \in_o} \frac{q}{r^2}$$

$$\Delta U = q\Delta V = W$$

$$E = \frac{V}{d}$$

$$V = \frac{1}{4\pi \in_o} \frac{q}{r}$$

$$q = \frac{mgd}{V}$$

$$r^2 = \frac{9\eta v_t}{2\rho g}$$

$$Q == CV; \quad 1ev = 1.6x10^{-19} J$$

$$Energy = \frac{1}{2}CV^2$$

Chapter 13

$$I = \frac{\Delta Q}{\Delta t}; \quad V = RI$$

$$R_e = R_1 + R_2 + R_3 + ----$$

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ----$$

$$R = \rho\frac{L}{A}; \alpha = \frac{R_t - R_o}{R_o t}$$

$$P = VI; P = I^2R; \quad P = \frac{V^2}{R}$$

$$E = IR + Ir$$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

Chapter 14

$$\vec{F} = I\vec{L} x \vec{B}$$

$$\Phi_B = \vec{B}\cdot\vec{A}$$

$$\sum_{r=1}^{n} (\vec{B}\cdot\Delta\vec{\ell}) = \mu_o I$$

$$B = \mu_o n I$$

$$\vec{F} = q(\vec{v} x \vec{B})$$

$$\frac{e}{m} = \frac{v}{Br}$$

$$\tau = NIBA\cos\alpha$$

$$R_s = \frac{I_g}{I - I_g} R_g$$

$$R_h = \frac{V}{I_g} - R_g$$

Chapter 15

$$\varepsilon = - vBL\sin\theta$$

$$\varepsilon = - N\frac{\Delta\Phi}{\Delta t}$$

$$\varepsilon_s = -M\frac{\Delta I_p}{\Delta t}$$

$$\varepsilon_L = - L\frac{\Delta I}{\Delta t}$$

$$U_m = \frac{1}{2} L I^2$$

$$L = \mu_o n^2 A\ell$$

$$U_m = \frac{1}{2}\frac{B^2}{\mu_o}(A\ell)$$

$$\varepsilon_o = N\omega AB$$

$$V = \varepsilon + IR$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$\frac{V_s}{V_p} = \frac{I_p}{I_s}$$

Chapter 16

$$f = \frac{1}{T}$$

$$\omega = 2\pi f$$

$$V = V_o \sin 2\pi f t$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$I = I_o \sin\omega t$$

$$P = I R$$

$$P = VI$$

$$P = \frac{V^2}{R}$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = \frac{V_{rms}}{I_{rms}} = 2\pi f L$$

$$\theta = \tan^{-1}(\frac{\omega L}{R})$$

$$\theta = \tan^{-1}(\frac{X_C}{R})$$

$$= \tan^{-1}(\frac{1}{\omega CR})$$

$$Z = \sqrt{R^2 + (\omega L)^2}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Chapter 17

$$\sigma = \frac{F}{A}; \quad \varepsilon = \frac{\Delta\ell}{\ell}$$

$$E = \frac{Stress}{Strain}$$

$$Y = \frac{F/A}{\Delta\ell/\ell}$$

$$W = \frac{1}{2}\ell_1 x F_1$$

$$Nm^{-2} = Pa$$

Chapter 18

$I_E = I_C + I_B$

$\beta = \frac{I_C}{I_B}$

$V_{CC} = I_B R_B + V_{BE}$

$V_{CC} = I_C R_C + V_{CE}$

$\text{Gain} = 1 + \frac{R_2}{R_1}$

Chapter 19

$t = \frac{t_o}{\sqrt{1 - v^2/c^2}}$

$\ell = \ell_o \sqrt{1 - v^2/c^2}$

$m = \frac{m_o}{\sqrt{1 - v^2/c^2}}$

$E = m c^2$

$E = \sigma T^4$

$E = n h f$

$p = \frac{h}{\lambda} = \frac{h f}{c}$

$\frac{1}{2} m v_{max}^2 = V_o e$

$hf - \Phi = \frac{1}{2} m v_{max}^2$

$KE_{max} = hf - hf_o$

$\Delta\lambda = \frac{h}{m_o c}(1 - \cos\theta)$

$\lambda = \frac{h}{p} = \frac{h}{mv}$

$\Delta x \cdot \Delta p \approx h$

Chapter 20

$\frac{1}{\lambda} = R_H (\frac{1}{2^2} - \frac{1}{n^2})$

$\frac{1}{\lambda} = R_H (\frac{1}{3^2} - \frac{1}{n^2})$

$\frac{1}{\lambda} = R_H (\frac{1}{p^2} - \frac{1}{n^2})$

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

$h f = E_n - E_p$

$r_n = \frac{n^2 h^2}{4\pi^2 k m e^2}$

$v_n = \frac{2\pi k e^2}{nh}$

$E_n = -\frac{k e^2}{2 r_n}$

$E_n = -\frac{1}{n^2} (\frac{2 \pi^2 k^2 m e^4}{h^2})$

Chapter 21

$\Delta m = Z m_p + (A - Z) m_n - m_{nucleus}$

$B.E. = (\Delta m) c^2$

for β - emission

${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{o}_{-1}e$

$T_{1/2} = \frac{0.693}{\lambda}$

$X + x \rightarrow Y + y + Q$

$D = \frac{E}{m}$; $D_e = D \times RBE$

1 rem = 0.01 Sv ; 1 rad = 0.01 Gy

1 Gy = 1 Jkg^{-1} ; 1 u = 931 MeV

$I = I_o e^{-\mu dx}$

Chapter 12

12.1)

$$F_e = \frac{1}{4\pi \epsilon_o}\frac{q_1 q_2}{r^2};\quad F_y = G\frac{m_1 m_2}{r^2}$$

$m_1 = m_2 = m = 10\text{gm} = 0.01\,\text{kg}$

$q_1 = q_2 = 20\text{x}10^{-6}\text{C}$

$r = 10\text{cm} = 0.1\text{m}$

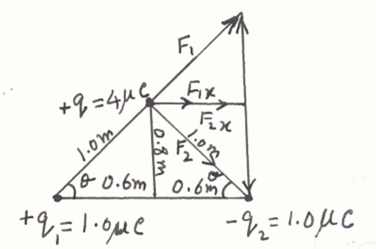
$G = 6.67\text{x}10^{-11}$

$$\frac{F_e}{F_g} = \frac{9\text{x}10^{9}\,\text{x}20\text{x}20\text{x}10^{-6}\,\text{x}10^{-6}}{6.67\text{x}10^{-11}\,\text{x}0.01\text{x}0.01} = 5.397\text{x}10^{14}$$

12.2)

$$F_1 = \frac{1}{4\pi \epsilon_o}\frac{q_1 q}{r^2} = \frac{9\text{x}10^{9}\,\text{x}10^{-6}\,\text{x}\,4\,\text{x}10^{-6}}{(1)^2} = 0.036\text{N}$$

$$\&\ F_2 = \frac{1}{4\pi \epsilon_o}\frac{q_2 q}{r^2} = \text{------} = -0.036\text{N}$$



$$F_{1x} = F_1\cos\theta = 0.036\text{x}\frac{0.6}{1} = 0.0216$$

$$F_{2x} = F_2\cos\theta = +0.036\text{x}\frac{0.6}{1} = -0.0216$$

$$F_{1y} = F_1 \sin\theta = 0.036\ \text{x}\ \frac{0.8}{1} = 0.0288$$

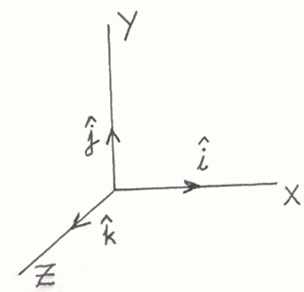
$$F_{2y} = F_2 \sin\theta = -\,0.036\ \text{x}\ \frac{0.8}{1} = -\ 0.0288$$

$F_x = F_{1x} + F_{2x} = 0$

$F_y = F_{1y} - F_{2y} = 0.576\text{N}$

$F = \sqrt{F_x^2 + F_y^2} = 0.576\ \hat{i}\ \text{N}$

The direction of resultant force is along X - axis.



12.3)

$$E = \frac{1}{4\pi \epsilon_o}\frac{q}{r^2} = \frac{9\text{x}10^{9}\,\text{x} - 8\text{x}10^{-8}}{(2)^2} = -180\ \text{N/C}$$

along Z - axis, so $-180\ \hat{k}$ N/C

12.4)

$$E = \frac{1}{4\pi \epsilon_o}\frac{q}{r^2} = \frac{9\text{x}10^{9}\,\text{x}5\text{x}10^{-6}}{25} = 1800\text{N/C}$$

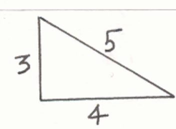
$E_x = E\cos\theta = 1800\text{x}\frac{4}{5} = 1440\,\hat{i}$

$E_y = E\sin\theta = 1800\text{x}\frac{3}{5} = 1080\,\hat{j}$

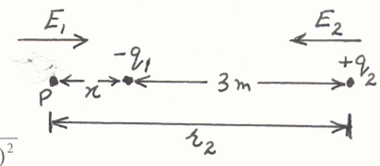
$\vec{r} = 4\,\hat{i} + 3\,\hat{j}$

$r = \sqrt{(4)^2 + (3)^2}$

$r^2 = 16 + 9 = 25$



12.5)



$$E_2 = E_1 = \frac{1}{4\pi \in_o} \frac{-q}{x^2}$$

$$-\frac{1}{4\pi \in_o} \frac{1x10^{-6}}{x} = \frac{1}{4\pi \in_o} \frac{4x10^{-6}}{(3+x)^2} \text{ or } \frac{1}{x^2} = \frac{4}{(3+x)^2}$$

or $9 + x^2 + 6x - 4x^2 = 0$ or $3x^2 - 6x - 9 = 0$

or $x^2 - 3x + x - 3 = 0$ or $x(x-3) + 1(x-3) = 0$

$x = 3 \ \& \ -1 \Rightarrow x = 3m$

12.6)

$F = qE \ \& \ F = mg$

$qE = mg$

$$E = \frac{mg}{q} = \frac{10^{-6} x9.8}{10^{-6}} = 9.8 \frac{kg}{C} \frac{m}{S^2} = 9.8 N/C \quad [N = \frac{kg - m}{S^2}]$$

12.7)

$\Delta KE = q \, \Delta V$

$= 20x1.6x10^{-19} x100J$

$$= 2x10^3 \ eV \quad [1eV = 1.6 \, x \, 10^{-19} J \text{ or } 1J = \frac{1}{1.6x10^{-19}} eV]$$

12.8)

$$r^2 = \frac{9\eta v_t}{2\rho g} \Rightarrow r = ----$$

$$\rho = \frac{4/3 \ \pi r^3}{m} \text{ or } m = \frac{4/3 \ \pi r^3}{\rho} = ----$$

$$\left\{ \text{Density} = \frac{\text{volume}}{\text{mass}} \right.$$

$$q = \frac{mgd}{V} = ----$$

12.9)

a) $\Delta V = Ed$ b) $W = q_o \Delta V$ c) $\Delta U = W$ d) $\Delta KE = W$

e) $KE = \frac{1}{2} mv^2$ or $v = \sqrt{\frac{2KE}{m}} \Rightarrow = ----$

12.10)

$$V = \frac{1}{4\pi \in_o} \frac{q}{r}$$

12.11)

$$\Delta U = V = \frac{1}{4\pi \in_o} \frac{q}{r}$$

$KE = \frac{1}{2} mv^2$ & $T = KE + \Delta U = ----$

12.12)

$$E = \frac{1}{2} CV^2$$

12.13) $Q = CV$

$Q = ne$ or $n = \frac{Q}{e} = ----$

Chapter 13

13.1)

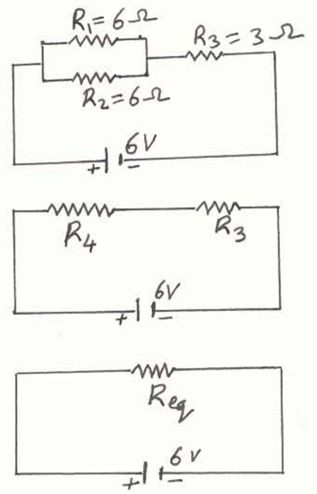
$I = \frac{Q}{t}$ $\qquad [Q = ne]$

or $I = \frac{ne}{t}$

or $n = \frac{It}{e} = ----$

13.2)

$I = \frac{Q}{t}$



13.3)

for parallel: $\frac{1}{R_{eq_1}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{eq_1}} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6} = \frac{1}{3}$

or $R_{eq_1} = 3\Omega$

for series: $R_{eq} = R_4 + R_3$

$R_{eq} = R = 3 + 3 = 6$

$I = \frac{V}{R} = \frac{6}{6} = 1\,\text{amp}$

now $I = I_1 + I_2 = 1\,\text{amp} \Rightarrow I_1 = I_2 = 0.5A$ & $I_3 = 1\,\text{amp}$.

13.4)

$R = \rho \frac{L}{A} = ----$

13.5)

$\alpha = \frac{R_t - R_o}{R_o t}$

or $\alpha R_o t = R_t - R_o$

or $R_t = \alpha R_o t + R_o$

or $R_{500} = ----$

13.6) $E = IR + Ir$

or $E = V_{terminal} + Ir$

$V_{terminal} = E - Ir$

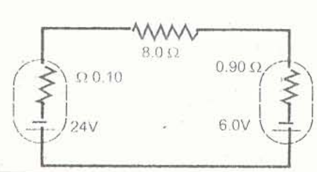
$R_e = r_1 + R + r_2 = 0.1 + 8 + 0.9 = 9\,\Omega$

$V = 24 - 6 = 18$ volts

so $I = \frac{V}{R} = \frac{18}{9} = 2A$

so $V_{24_t} = 24 - 2x0.1 = 23.8V$

$V_{6_t} = 6 - (-2) \times 0.9 = 7.8\ V$



13.7) Applying Kirchhoff's 2nd rule on both loops

$-9+(I_1-I_2)18=0$ or $18I_1-18I_2-9=0$

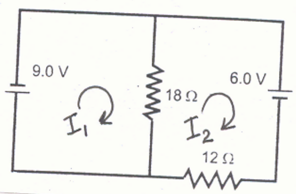
or $2I_1-2I_2=1$ .....(1)

for second loop

$(I_2\text{-}I_1)18 - 6 + I_2x12=0$

$18I_2-18I_1-6+12I_2=0$ or $30I_2-18I_1-6=0$

or $5I_2-3I_1=1$ .....(2)



Multiplying (1) by 5 and (2) by 2, we get

$10I_1-10I_2=5$ .....(3)

$10I_2-6I_1=2$ .....(4)

Adding (3) and (4)

$4I_1=7 \Rightarrow I_1=7/4=1.75$ A

and from (2)

$$5I_2-3x\frac{7}{4}=1 \text{ or } I_2=\frac{1+3x\frac{7}{4}}{5}=1.25A$$

Now $I_{18\Omega}=I_2-I_1=1.75-1.25=0.5A$

& $I_{12\Omega}=I_2=1.25A$

13.8) Applying Kirchhoff's 2nd rule on both loops

$E_1+I_1R_1+(I_1-I_2)R_2+I_1R_3=0$

or $6+I_1+(I_1-I_2)2+I_1=0$

or $6+I_1+2I_1-2I_2+I_1=0$

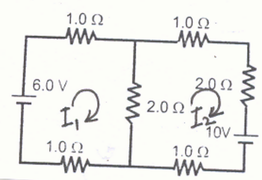
or $-2I_2+4I_1+6=0$

or $-I_2+2I_1=-3$ .....(1)

& $(I_2\text{-}I_1)2+I_2+2I_2-E_2+I_2=0$

or $2I_2-2I_1+I_2+2I_2-10+I_2=0$

or $6I_2-2I_1=10$ .....(2)



Adding (1) and (2)

$$5I_2=7 \quad \Rightarrow \quad I_2=\frac{7}{5}= 1.4 \text{ A}$$

$$\text{from (1)};\ I_1=\frac{-3+\frac{7}{5}}{2}=-\ 0.8A$$

[Power $=P=I^2R$]

CURRENTS: $R_1=0.8A; R_2=1.4+0.8=2.2A; R_3=0.8A; R_4=1.4A; R_5=1.4A; R_6=1.4A$

POWER: $R_1=(0.8)^2=0.64W; R_2=9.68W; R_3=0.64; R_4=1.96; R_5=3.92W; R_6=1.96$ W

Chapter 14

14.1) $\vec{F} = I\,\vec{L} \times \vec{B} = ILB\sin\theta$

$F = BIL$ [for max value, $\theta = 90^{o}$]

or $B = \frac{F}{IL}$

14.2) $\vec{F} = +e\,\vec{v} \times \vec{B} = evB\sin\theta$

$F = evB$ [for max value, $\theta = 90^{\circ}$]

& $w = mg$

from the given conditions; $F = w$

$evB = mg$ or $v = \frac{mg}{eB} =$ ----

14.3) $\vec{E} = \frac{\vec{F}}{q_o}$; $\vec{F} = q(\vec{v} \times \vec{B})$

or $F_e = qE$ & $F_m = q\,v\,B$

$F_e = F_m$ or $qE = q\,v\,B$ or $v = \frac{E}{B} =$ ----

14.4) $\tau = NIBA\cos\alpha$ [for max value $\cos\alpha = 1$

14.5) $\sum_{r=1}^{n}(\vec{B}\cdot\Delta\vec{\ell}) = \mu \cdot I$

or $B \times 2\pi r = \mu_o I$ or $B = \frac{\mu_o I}{2\pi r}$

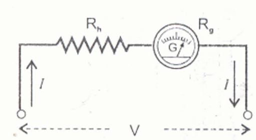
14.6) $B = \mu_o n I$ or $n = \frac{B}{\mu_o I}$

14.7) $B = \mu_o n I$

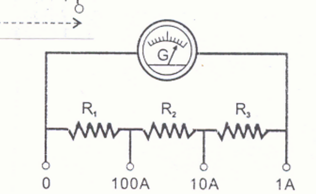
$I = \frac{B}{\mu_o n}$ [$n = \frac{N}{\ell} = \frac{10,000}{0.5}$]

14.8) $R_s = \frac{I_g}{I - I_g} R_g$

14.9) $R_h = \frac{V}{I_g} - R_g$



14.10) $R_s = \frac{I_g}{I - I_g} R_g$



for R_1 : $R_1 = \frac{I_g}{I_1 - I_g} R_g$

for R_2 : $R_2 = \frac{I_g}{I_2 - I_g} R_g$; for R_3 : $R_3 = \frac{I_g}{I_3 - I_g} R_g$

Chapter 15

15.1) $\varepsilon = -vBL\sin\theta$ [v, L & θ are same]

$\varepsilon_1 = -vB_1L\sin\theta$ & $\varepsilon_2 = -vB_2L\sin\theta$

$\frac{\varepsilon_1}{\varepsilon_2} = \frac{B_1}{B_2}$ or $B_2 = B_1\frac{\varepsilon_2}{\varepsilon_1} = ----$

15.2) $\varepsilon = -vBL\sin\theta$ [θ with vertical i.e. with $\vec{B}$ is $(90 - 60) = 30^{o}$]

15.3) $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$ [$\Phi = BA\cos\theta, \theta = 0^\circ$]

or $\varepsilon = -N\frac{BA\cos\theta}{\Delta t}$ [$\theta = 0^\circ$]

or $\varepsilon = -N\frac{BA}{\Delta t}$ [$B = 0.06 - 0.05 = 0.01\,T$]

[- ve emf is induced emf]

15.4) $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$

or $\varepsilon = -N\frac{BA\cos\theta}{\Delta t}$

$$\left\{\begin{array}{l} A = \pi r^2 \\ B = 0.5 - 0.2 = 0.3\,T \\ \theta = 90^\circ - 40^\circ = 50^\circ \end{array}\right.$$

15.5) for mutual induction

$\varepsilon_s = M\frac{\Delta I_p}{\Delta t}$

[Induced current will have opposite direction, so taking $\varepsilon_s = -M(-\frac{\Delta I_p}{\Delta t}) = M\frac{\Delta I_p}{\Delta t}$]

or $M = \frac{\varepsilon}{\Delta I_p / \Delta t}$ [$\frac{\Delta I_p}{\Delta t} = 200\ A/S$]

15.6) $\varepsilon_S = M\frac{\Delta I_P}{\Delta t}$

& $\varepsilon_S = N_S\frac{\Delta\theta_S}{\Delta t}$ [Δt is same = 0.025 S]

or $\Delta\theta = \frac{\varepsilon_S\Delta t}{N_S} = ----$

15.7) $N\Phi = LI$ or $\Phi = \frac{LI}{N} = ----$

& $\varepsilon_L = -L\frac{\Delta I}{\Delta t} = ----$ [- ve emf is induced emf]

15.8) $L = \mu_o n^2 A\ell$ [$n = \frac{N}{\ell} = \frac{520}{0.08} = ----$]

$\varepsilon = L\frac{\Delta I}{\Delta t}$

15.9) $\varepsilon = -L\dfrac{\Delta I}{\Delta t}$ & $U_m = \dfrac{1}{2}LI^2$

or $L = \dfrac{\varepsilon}{\Delta I / \Delta t} = ----$ [induced emf = -40×10^{-3} V]

$\Delta U_m = \dfrac{1}{2}LI_2^2 - \dfrac{1}{2}LI_1^2 = ----$

15.10) $U_m = \dfrac{1}{2}\dfrac{B^2}{\mu_o}(A\ell)$

15.11) $\varepsilon_o = N\omega AB$ or $\omega = \dfrac{\varepsilon_o}{NAB}$

15.12) $\varepsilon_o = N\omega AB = N\omega \ell b B$ [$A = \ell \times b$]

or $\ell = \dfrac{\varepsilon_o}{N\omega b B} = ----$ [$b = 5$ cm $= 0.05$ m]

15.13) $\varepsilon_o = N\omega AB$ [$\omega = 2\pi f$]

$B = \dfrac{\varepsilon_o}{N 2\pi f A} = ----$ [$f = 50$ Hz]

15.14) $\varepsilon = N\omega AB$

$\varepsilon_1 = N\omega_1 AB$ & $\varepsilon_2 = N\omega_2 AB$ [N, A & B are same]

$\dfrac{\varepsilon_1}{\varepsilon_2} = \dfrac{N\omega_1 AB}{N\omega_2 AB}$ or $\varepsilon_1 = \varepsilon_2 \dfrac{\omega_1}{\omega_2} = ----$

15.15) $V = \varepsilon + IR$

or $\varepsilon = V - IR = ----$

15.16) $\varepsilon = -N\dfrac{\Delta\varphi}{\Delta t} = \dfrac{NAB\pi r^2}{\Delta t}$

$I = \dfrac{\varepsilon}{R}$

$\Delta\varphi = \Delta BA\cos 180^\circ$
$= -\Delta BA = -B\pi r^2$
& $N = 1$

15.17) $\varepsilon = -N\dfrac{\Delta\varphi}{\Delta t}$ [$\Delta\varphi = \Delta BA\cos 0^\circ = \Delta BA$]

$= -\dfrac{N\Delta BA}{\Delta t} = ----$ [- ve emf is induced emf]

15.18) $V_p I_p = V_s I_s$

or $P_s = V_s I_s$ or $I_s = \dfrac{P_s}{V_s} = ----$

& $\dfrac{V_s}{V_p} = \dfrac{N_s}{N_p}$ or $\dfrac{N_s}{N_p} = \dfrac{V_s}{V_p}$

$P_s = V_s I_s = 30$ W
$V_s = 12$ V
$V_p = 240$ V

Chapter 16

16.1) $I = I_o \sin 2\pi f t$ .....(1) $I = 20 \sin 100\pi t$ .....(2)

$I_{rms} = \frac{I_o}{\sqrt{2}}$ .....(3)

comparing (1) & (2) gives; $I_o = 20, \; f = 50$ & $I_{rms} = \frac{I_o}{\sqrt{2}} = \frac{20}{\sqrt{2}} = ----$

16.2) $I_{rms} = \frac{I_o}{\sqrt{2}}$; $I = I_o \sin 2\pi f t$

16.3) $X_L = 2\pi f L$

$X_L = \frac{V}{I}$ or $I = \frac{V}{X_L} = ----$

16.4) $X_L = 2\pi f L = ----$

$Z = \sqrt{R^2 + (\omega L)^2} = ----$ $[\omega = 2\pi f]$

16.5) $V = V_o \sin 2\pi f t$ .....(1) $V = 350 \sin(100\pi t)$ .....(2)

comparison of (1) & (2) gives $f = 50$ Hz & $V_o = 350$ volts

$Z = \sqrt{R^2 + (\omega L)^2} = \sqrt{R^2 + (2\pi f L)^2}$

or $I_o = \frac{V}{Z}$ & $I_{rms} = \frac{I_o}{\sqrt{2}}$

$\theta = \tan^{-1}(\frac{\omega L}{R}) = \tan^{-1}(\frac{2\pi f L}{R})$

16.6) $Z = \sqrt{R^2 + (2\pi f L)^2} = ----$

or $I = \frac{V}{Z} = ----$ & $P = VI$

16.7) $X_C = \frac{1}{2\pi f C} = ----$; $I = \frac{V}{X_C} = ----$

16.8) $X_C = \frac{1}{2\pi f C} = ----$; $\varphi = \tan^{-1}(\frac{X_C}{R}) = ----$

16.9) $f_r = \frac{1}{2\pi \sqrt{LC}} = ----$

16.10) $f_r = \frac{1}{2\pi \sqrt{LC}}$

$f_{max} = \frac{1}{2\pi \sqrt{LC_{max}}}$ $[C_{max} = 500\text{pF}]$

$f_{min} = \frac{1}{2\pi \sqrt{LC_{min}}}$ $[C_{min} = 20\text{pF}]$

Chapter 17

17.1) $$\text{Stress} = \sigma = \frac{F}{A} = ---- \quad [A = \pi r^2 = \pi (\frac{D}{2})^2 ; F = mg]$$
$$= ----\ N\,m^{-2} \quad [N\,m^{-2} = Pa ;\ MPa = 10^6\,Pa]$$

17.2) $$\text{Tensile strain} = \varepsilon = \frac{\Delta\ell}{\ell}$$
$$\%\text{age elongation} = \varepsilon \times 100 = ---- \%$$

17.3) $$\varepsilon = \frac{\Delta \ell}{\ell}$$
$$Y = \frac{F/A}{\Delta \ell / \ell}$$
$$W = \text{Energy} = \frac{1}{2} \ell_1 x F_1$$
i) $$\varepsilon = \frac{\Delta \ell}{\ell} = ----$$
ii) $$Y = \frac{F/A}{\Delta \ell / \ell} = ----$$
iii) $$\text{Energy} = \frac{1}{2} \ell_1 x F_1 = \frac{1}{2} \Delta\ell \times F = ----$$

17.4) $$E = \frac{\text{stress}}{\text{strain}}$$
$$\text{or } Y = \frac{\text{stress}}{\Delta\ell / \ell} \qquad [\frac{\Delta\ell}{\ell} = \frac{0.01}{100}]$$
$$\text{or Stress} = Y \times \frac{\Delta \ell}{\ell} = ----$$
$$\text{Stress} = \frac{F}{A}$$
$$\text{or } F = \text{stress} \times A \qquad [A = \pi r^2 = \pi (\frac{D}{2})^2]$$

NOTE : Verfy your answer with other class - fellows and mark the correct answer in the Textbook!

17.5) $$Y = \frac{F / A}{\Delta\ell / \ell}$$
$$\text{or } \Delta\ell = \frac{F / A}{Y / \ell} = ----$$
$$W = \frac{1}{2} \ell_1 x\, F_1$$
$$\text{or } W = \frac{1}{2} \Delta\ell \times F = ----$$

17.6)

$$Y = \frac{F / A}{\Delta\ell / \ell};$$

for Copper :

$$Y_C = \frac{F / A}{\Delta\ell_C / \ell} \quad .....(1)$$

for Steel : $Y_S = \dfrac{F / A}{\Delta\ell_S / \ell}$ .....(2)

$$\frac{Y_C}{Y_S} = \frac{\Delta\ell_S}{\Delta\ell C}$$

or $\dfrac{1.2 \text{ x } 10^{11}}{2.0\text{x}10^{11}} = \dfrac{\Delta\ell_S}{\Delta\ell_C}$

$$\Rightarrow \quad \Delta\ell_S = \frac{1.2}{2} \text{ x } \Delta\ell_C \quad .....(3)$$

from the given condition,

$$x = (\Delta\ell_C + \Delta\ell_S) = 0.003 \text{ m}$$

or $\Delta\ell_C = 0.003 - \Delta\ell_S$ .....(4)

from (3) & (4)

$$\Delta\ell_S = \frac{1.2}{2}(0.003 - \Delta\ell_S)$$

or $\dfrac{2}{1.2}\Delta\ell_S + \Delta\ell_S = 0.003$

or $\Delta\ell_S(\dfrac{2}{1.2} + 1) = 0.003$

or $\Delta\ell_S = \dfrac{0.003}{(2 / 1.2 + 1)} = ----$ (5)

from (3) & (5); $\Delta\ell_C = ----$ (6)

Now Strain $= \varepsilon = \dfrac{\Delta\ell}{\ell}$

$$\varepsilon_{copper} = \frac{\Delta\ell_C}{\ell} = ----$$

& $\varepsilon_{steel} = \dfrac{\Delta\ell_S}{\ell} = ----$

from (1) we have, $Y_C = \dfrac{F / \pi (D/2)^2}{\Delta\ell_C/\ell}$

or $F = \dfrac{Y_C \Delta\ell_C/\ell}{\pi (D/2)^2} = ----$

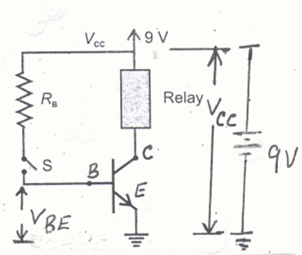
Chapter 18

18.1)

$$\beta = \frac{I_C}{I_B} \text{ or } I_C = \beta \times I_B = ----$$

$$I_E = I_C + I_B = ----$$

$$\frac{I_C}{I_E} = ----$$



18.2)

$$\beta = \frac{I_C}{I_B}$$

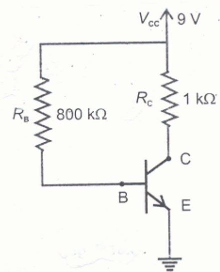
$$\text{or } I_B = \frac{I_C}{\beta} = ---- \qquad [I_C = 10\text{ mA}]$$

We apply Kirchhoff's 2nd rule to the base - emitter closed loop (see the fig.)

$$V_{CC} = I_B R_B + V_{BE}$$

$$\text{or } R_B = \frac{V_{CC} - V_{BE}}{I_B} = ---- \qquad \left[V_{CC} = 9V \;\&\; V_{BE} = 0.6V \;\&\; I_B = ---- \right.$$

18.3)



i) $V_{CC} = I_B R_B + V_{BE}$ (V_{BE}) base potential is very small 0.7V for Si & 0.3V for Ge

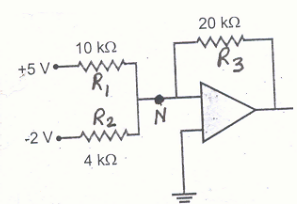
$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

ii) $\beta = \frac{I_C}{I_B}$ or $I_C = \beta \times I_B = ----$

iii) pot drop across R_C : $V_C = V_{CC} - V_{CE} = ----$

iv) $V_{CC} = I_C R_C + V_{CE}$ or $V_{CE} = V_{CC} - I_C R_C$

18.4)



Applying Kirchhoff's 1st rule at point N

$$I_1 + I_2 = I_3$$

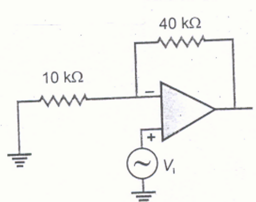
$$\frac{5}{10 \times 10^3} + \frac{-2}{4 \times 10^3} = \frac{V_o}{20 \times 10^3}$$

$$\Rightarrow V_o = \frac{20 \times 10^3 \times 5}{10 \times 10^3} - \frac{2 \times 20 \times 10^3}{4 \times 10^3}$$

$$= 10 - 10 = 0$$

So out put voltage V_o is zero.

18.5)



$$\text{Gain} = 1 + \frac{R_2}{R_1} = ---- \qquad \left[R_1 = 10\text{ K}\Omega \;\; R_2 = 40\text{ K}\Omega \right.$$

Chapter 19

19.1)

$$t = \frac{t_o}{\sqrt{1 - v^2/c^2}} = ----$$

19.2)

$$m = \frac{m_o}{\sqrt{1 - v^2/c^2}} = ----$$

19.3) $E = hf;\ E = pc$

$$pc = hf \text{ or } p = \frac{hf}{c} = \frac{h}{\lambda}$$

$$\left[\begin{array}{l} c = \lambda f \\ f = \dfrac{c}{\lambda} \end{array}\right.$$

$$E = hf = \frac{hc}{\lambda}$$

$$E_{100} = \frac{hc}{\lambda_{100}} = ---- \quad [nm = 10^{-9} m]$$

$$E_{550} = \frac{hc}{\lambda_{550}} = ----$$

$$E_X = \frac{hc}{\lambda_X} = ----$$

19.4)

$$\frac{1}{2}mv_{max}^2 = V_o e \quad .....(1) \qquad hf - \Phi = \frac{1}{2}mv_{max}^2 \quad .....(2)$$

from (1) & (2); $hf - \Phi = V_o e \quad .....(3)$

or $\dfrac{hc}{\lambda} - \Phi = V_o e \quad .....(4)$

$$\left[\begin{array}{l} c = \lambda f \\ f = \dfrac{c}{\lambda} \end{array}\right.$$

from eq. (1)

$$\frac{1}{2}mv_{max}^2 = KE_{max} = V_o e = ---- \quad [e = 1.6x10^{-19} C]$$

from eq. (4)

$$\Phi = V_o e + \frac{hc}{\lambda} = ----$$

19.5)

$$\Delta\lambda = \frac{h}{m_o c}(1 - \cos\theta) = ----$$

$$\left[\begin{array}{l} h = 6.63x10^{-34} Js;\ m_o = 9.1x10^{-31} kg \\ c = 3x10^8 m/s;\ \theta = 85^\circ \end{array}\right.$$

19.6) $E = \dfrac{hc}{\lambda}$ or $\lambda = \dfrac{hc}{E} = ----$ $\quad [h = ---;\ c = ---;\ E = ---]$

$$\Delta\lambda = \frac{h}{m_o c}(1 - \cos\theta) \text{ or } \Delta\lambda = \lambda' - \lambda = \frac{h}{m_o c}(1 - \cos\theta)$$

$$\left[\begin{array}{l} \lambda' \text{ is scattered photon} \\ \lambda \text{ is incident photon} \end{array}\right.$$

or $\lambda'_{30} = \lambda + \dfrac{h}{m_o c}(1 - \cos\theta) = ---- \quad [\theta = 30^\circ]$

& $\lambda'_{60} = \lambda + \dfrac{h}{m_o c}(1 - \cos\theta) = ---- \quad [\theta = 60^\circ]$

19.7)

$$E = \frac{h\,c}{\lambda}$$

$$\text{or } \lambda = \frac{h\,c}{E}$$

$$\left\{\begin{array}{l} h = --- \\ c = --- \\ E = 0.51\,\text{MeV} \\ \quad = 0.51\text{x}10^{6}\,\text{x}1.6\text{x}10^{-19}\ \text{J} \end{array}\right.$$

19.8)

$$a)\ \lambda = \frac{h}{m\,v} = ----$$

$$b)\ \lambda = \frac{h}{m\,v} = ----$$

$$c)\ \lambda = \frac{h}{m\,v} = ----$$

19.9)

$$KE = \frac{1}{2} m\,v^2$$

$$\text{or } v = \sqrt{\frac{2\,KE}{m}} = ----$$

$$\lambda = \frac{h}{m\,v} = ----$$

19.10)

$$\Delta p \cdot \Delta x \approx h$$

$$\text{or } m\,\Delta v \approx \frac{h}{\Delta x}$$

$$\text{or } \Delta v \approx \frac{h}{\Delta x \cdot m}$$

$$= ----$$

$$\left\{\begin{array}{l} h = --- \\ m = 9.1\text{x}10^{-31}\,\text{kg} \\ \Delta x = 1.0\text{x}10^{-10}\,\text{m} \end{array}\right.$$

Chapter 20

20.1)

a) $r_n = \frac{n^2h^2}{4\pi^2 \, kme^2}$

$r_1 = -----$

b) $m v r = \frac{n h}{2 \pi}$

or $m v = p = \frac{n h}{2 \pi r_1} = -----$

c) $L = \frac{n h}{2 \pi} = -----$

d) $KE = \frac{1}{2} m v_n^2 = \frac{k e^2}{2 r_n} = \frac{k e^2}{2 r_1} = -----$

e) $PE = U = -\frac{k e^2}{r_n} = -\frac{k e^2}{r_1} = -----$

f) $E = KE + U = -----$

$$\begin{cases} n = 1 \\ h = ---- \\ k = 9x10^9 \, Nm^2C^2 \\ e = 1.6x10^{-19} \, C \end{cases}$$

20.2)

$E = \frac{h c}{\lambda} = -----J = -----x \frac{1}{1.6x10^{-19}} \; eV$

$E_1 = \frac{h c}{\lambda_1} = -----$

$E_2 = \frac{h c}{\lambda_2} = -----$

$E_3 = \frac{h c}{\lambda_3} = -----$

20.3)

$h f = E_n - E_p$

or $\frac{h c}{\lambda} = E_f - E_i$

or $\lambda = \frac{h c}{E_f - E_i} = -----$

$$\begin{cases} c = \lambda \, f \\ f = \frac{c}{\lambda} \end{cases}$$

20.4)

$\frac{1}{\lambda} = R_H(\frac{1}{p^2} - \frac{1}{n^2})$

$\Rightarrow \lambda = -----$

$$\begin{cases} p = 3 \\ n = 6 \\ R_H = 1.0974m^{-1} \end{cases}$$

20.5)

for Balmer Series,

$\frac{1}{\lambda} = R_H(\frac{1}{2^2} - \frac{1}{n^2})$

$\Rightarrow \lambda = -----$

{for shortest λ , $n \to \infty$

20.6) for Paschen Series

$$\frac{1}{\lambda} = R_H\left(\frac{1}{3^2} - \frac{1}{n^2}\right)$$

$$\Rightarrow \lambda = -----$$

for longest λ
$n = 4$

20.7)

$$KE = h f_{max}$$

$$\& \ KE = V e$$

$$\text{so } h f_{max} = V e$$

$$\frac{h c}{\lambda_{min}} = V e$$

$$\text{or } \lambda_{min} = \frac{h c}{V e} = -----$$

$c = \lambda f$

$f = \frac{c}{\lambda}$

for maximum frequency
λ is minimum

20.8)

$$h f = E_n - E_p$$

$$h f = \Delta E$$

$$\text{or } \Delta E = \frac{h c}{\lambda} = -----$$

$c = \lambda f$

$f = \frac{c}{\lambda}$

20.9)

$$\lambda_{min} = \frac{h c}{V e} = -----$$

20.10)

a) $$v_n = \frac{2\pi k e^2}{nh}$$

$$\text{or } n = \frac{2\pi k e^2}{v_n h} = -----$$

b) $$r_n = \frac{n^2 h^2}{4\pi^2 k m e^2} = -----$$

c) $$E_n = -\frac{1}{n^2}\left(\frac{2\pi^2 k^2 m e^4}{h^2}\right) = -----$$

Chapter 21

21.1) $\Delta m = Z m_p + (A - Z) m_n - m_{nucleus}$

$$B.E. = (\Delta m) c^2$$

$$= \text{-----} J = \text{-----} x \frac{1}{1.6x10^{-19}} eV$$

$$= \text{-----} \ MeV \quad [10^6 eV = MeV]$$

$m_p = 1.007276$ u
$m_n = 1.008665$ u
$Z = 1, \ A = 3$
$m_{nuc.} = 3.016049$ u

21.2) $T_{1/2} = \frac{0.693}{\lambda}$

or $\lambda = \frac{0.693}{T_{1/2}} = \text{-----}$

21.3) for β - emission :

$${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{o}_{-1}e$$

or ${}^{234}_{91}P \rightarrow {}^{234}_{92}U + \beta$

The daughter element is Uranium ${}^{234}_{92}U$.

21.4) $Q = (\text{mass of } {}^{14}_{7}N + \text{mass of } {}^{4}_{2}He) - (\text{mass of } {}^{17}_{8}O + \text{mass of } {}^{1}_{1}H)$

$= (14.0031 + 4.002603) - (16.9991 + 1.007825)$ $[1 u = 931 eV]$

- ve sign means that so much energy/mass is needed for this reaction.

21.5) $Q = (\text{mass of } {}^{14}_{6}C) - (\text{mass of } {}^{14}_{7}N + \text{mass of } {}^{o}_{-1}e)$

$= (14.0077) - (14.0031 + 0.00055)$ $[1 u = 931 MeV]$

$= \text{----} u = \text{----} x\ 931 MeV = \text{----}$

[If Q is + ve, the reaction is EXOERGIC, i.e. energy is released in the process
If Q is - ve, the reaction is ENDOERGIC i.e. energy is absorbed from outside source.]

21.6) ${}^{233}_{92}U \rightarrow {}^{229}_{90}U + {}^{4}_{2}He$

${}^{229}_{90}U \rightarrow {}^{225}_{88}Y + {}^{4}_{2}He$

so ${}^{A}_{Z}Y = {}^{225}_{88}Ra$

The resulting isotope is RADIUM being its atomic number 88.

NOTE : Verify your result with other class fellows and check the Textbook.

21.7) $Q = (\text{mass of } {}^{2}_{1}H + \text{mass of } {}^{3}_{1}H) - (\text{mass of } {}^{4}_{2}He + \text{mass of } {}^{1}_{0}n)$

$= (2.014102 + 3.01603) - (4.002603 + 1.008665)$

$= \text{----} x\ 931 MeV$

21.8) The formula for γ - rays when pass through a substance is :

$I = I_o e^{-\mu dx}$

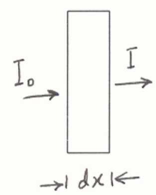
where I_0 = Initial intensity of the beam

I = Intensity after traversing distance dx

& μ is absorption coefficient

for 1st case

$I = 0.4 \times I_o = I_o e^{-\mu \cdot 5}$



taking natural log.

$\ln(0.4) = -\mu \cdot 5$ .....(1)

for 2nd case

$0.5 \times I_o = I_o e^{-\mu \cdot dx}$

or $\ln(0.5) = -\mu \cdot dx$ .....(2)

dividing (1) by (2),

$$\frac{\ln(0.4)}{\ln(0.5)} = \frac{5}{dx}$$

$$\text{or } dx = \frac{5 \times \ln(0.5)}{\ln(0.4)} = 3.7824 \text{ mm}$$

21.9) from the given condition,

$$I \propto \frac{1}{r^2} \text{ or } I = \frac{K}{r^2}$$

$$\text{for } I_{1m} = \frac{K}{r_1^2} \quad \& \quad I_{3m} = \frac{K}{r_3^2}$$

Dividing both equations.

$$\frac{I_{1m}}{I_{3m}} = \frac{K/r_1^2}{K/r_3^2} = \frac{r_3^2}{r_1^2}$$

$$\text{or } \frac{360}{I_3} = \frac{(3)^2}{(1)^2} \quad \text{or } I_3 = \frac{360}{9} = 40 \text{ counts/min}$$

21.10) a) $D = \dfrac{E}{m}$

or $E = mD = 75 \times 24$ kg mrad

$= ----\text{x}10^{-2}$ mJ

b) $D_e = D \times RBE$ [D_e in Sv]

or $D_e = 0.01\text{x}24\text{x}10^{-3}\ \text{J kg}^{-1}\text{x}12\ \text{Sv}$

$= 0.01\text{x}24\text{x}10^{-3}\ \text{J kg}^{-1}\ \text{x}\ 12 \times 100$ rem

$= -----$ rem [1 Sv = 100 rem]

100 rad = 1 J / kg
or 1 kg rad = 10^{-2} J
m rad = 10^{-3} rad
1 rad = 0.01 Gy
1 Gy = 1 J / kg

Fundamental Forces

Name of the force	Range	Strength at 10^{-13}cm in comparison with strong force	Source	Name of carrier	Mass at rest (GeV/c^2)	Spin	Electric charge	Life time (sec.)	Remarks
Gravity	Infinite	10^{-38}	Mass	Graviton	0	2	0	---	Hypothetical or Conjectured
Electro-magnetism	Infinite	10^{-2}	Electric charge	Photon	0	1	0	10^{-20}	Observed directly
Weak force	$< 10^{-16}$ cm	10^{-13}	"Weak charge"	Intermediate Boson: W^+, W^-, Z^o	81, 81, 93	1, 1, 1	+1, -1, 0	10^{-8}	All three observed directly
Strong force	$< 10^{-13}$ cm	1	"Colour charge"	Gluons	0	1	0	10^{-21}	Permanently confined

Elementary Particles