Self Study Series

Solution Hints

for the problems
of the Textbook

PHYSICS XI

$E = mc^2$

Ross Nazir Ullah

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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 7 & 8) and you will be through!

For solving problems:

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

Best of Luck.

August 15, 2003

Rots Nazirullah

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.

Typical Example

Problem:
In a relay race the second runner does not start from rest. He covers 100 m in 10 s, finishing with a maximum velocity of 12 m/S. Assuming constant acceleration, determine his initial velocity.

Solution:
Firstly read the problem with **Understanding**, and where some units come, write down the corresponding symbols and their values, as

Corresponding to m, we have distance S,

$S = 100$ m

Corresponding to S, we have time t,

$t = 10$ S

Corresponding to m/s, we have velocity v,

$v = 12$ m/s

We have to determine the initial velocity, v_i, ($v_i = ?$)

so $v = 12$ m/s must be v_f,

$v_f = 12$ m/s

therefore we write the **Data** , as

$S = 100$ m

$t = 10$ s

$v_f = 12$ m/s

$v_i = ?$

On observing the data, we have to look that all quantities should have same **System of Units** , in this case they have same system of units.

Next thing, looking the data, there is no direct **Appropriate formula** for solving this. For calculating v_i, first we must have 'a', then we will be able to calculate v_i,
So using the formula,

$$v_f = v_i + a\,t$$

putting the values

$$12 = v_i + a \times 10 \qquad .....(1)$$

now using

$$S = v_i t + \tfrac{1}{2} a t^2$$

putting the values

$$100 = v_i \times 10 + \tfrac{1}{2} a (10)^2 \qquad .....(2)$$

Finally, in **Calculations**, solving eqs. (1) and (2), simultaneously for the values of 'a' and v_i, then we will get the result.
[In the previous classes we have learnt to solve two equations simultaneously, by two or three methods. Such as ; $2x + 3y = 4 \quad 4x - 7y = 3$]

Now from eq. (2), we have

$$100 = 10\,v_i + 50\,a \qquad .....(3)$$

multiplying eq. (1) with -5, we get

$$-60 = -5\,v_i - 50\,a \qquad .....(4)$$

adding eqs. (3) & (4), we get

$$40 = 5\,v_i$$

or

$$v_i = 40/5 = 8\text{ m/s}$$

Hence the answer is

$$\boxed{v_i = 8\text{ m/s}}$$

Important Formulas

Chapter 2

$A_x = A\cos\theta$

$A_y = A\sin\theta$

$A = \sqrt{A_x^2 + A_y^2}$

$\tan\theta = A_y / A_x$

$\vec{A}\cdot\vec{B} = AB\cos\theta$

$\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$

$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$

$\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$

$\vec{A}\times\vec{B} = AB\sin\theta\, n$

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= (A_y B_z - A_z B_y)\hat{i} + (A_z B_x - A_x B_z)\hat{j} + (A_x B_y - A_y B_x)\hat{k}$$

$\hat{i}\times\hat{j} = \hat{k}$; $\hat{j}\times\hat{i} = -\hat{k}$

$\hat{j}\times\hat{k} = \hat{i}$; $\hat{k}\times\hat{j} = -\hat{i}$

$\hat{k}\times\hat{i} = \hat{j}$; $\hat{i}\times\hat{k} = -\hat{j}$

Chapter 3

$v_{av} = d / t$

$S = v_{av}\, t$

$a_{av} = \Delta v / \Delta t$

$v_f = v_i + a t$

$S = \dfrac{(v_f + v_i)\, t}{2}$

$S = v_i t + \frac{1}{2} a t^2$

$v_f^2 = v_i^2 + 2 a S$

$F = m a$

$\Delta p = m \Delta v$

Impulse = force x time

$F = \dfrac{mv_f - mv_i}{t}$

$\boxed{m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'}$

$F = (m v)/ t$

$v_1' = \dfrac{m_1 - m_2}{m_1 + m_2} v_1 + \dfrac{2 m_2}{m_1 + m_2} v_2$

$v_2' = \dfrac{2m_1}{m_1 + m_2} v_1 + \dfrac{m_2 - m_1}{m_1 + m_2} v_2$

$h = \dfrac{v_i^2 \sin^2\theta}{2g}$

$t = \dfrac{2 v_i \sin\theta}{g}$

$R = \dfrac{v_i^2}{g}\sin 2\theta$

Chapter 4

$W = F\cdot D = Fd\cos\theta$

$P = F.v$

$W = F\cdot d$

$P = W / t$ = work / time

$KE = \frac{1}{2} mv^2$

$PE = mgh$

$Fd = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$

$F = G\dfrac{M m}{r^2}$

$v_{esc} = \sqrt{2GM / R} = \sqrt{2gR}$

$mgh = \frac{1}{2} mv^2 + fh$

Chapter 5

$S = r\theta$

$v = r\omega$

$a = r\alpha$

$\tau = I\alpha$

$\theta = \omega t$

$\omega = \theta / t$

$\omega_f = \omega_i + \alpha t$

$2\alpha\theta = \omega_f^2 - \omega_i^2$

$\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$a = v^2 / r$

$F_c = m v^2 / r = mr\omega^2$

$I = \Sigma m_i r_i^2$

for sphere:

$I = 2/5\, m r^2$

$\vec{L} = \vec{r}\times\vec{p}$

$L = I\omega$

$I_1\omega_1 = I_2\omega_2$

For upward motion:

$T = w + ma$

For downward motion:

$T = w - ma$

$v_o = \sqrt{GM / r}$

Chapter 6

$F = 6\pi\eta r v$

$v = \dfrac{2gr^2\rho}{9\eta}$

$\rho = m / v$

$m = \rho V = \rho Avt$

$A_1 v_1 = A_2 v_2$

$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$

$v_2 = \sqrt{2g(h_1 - h_2)}$

$P_A + \frac{1}{2}\rho v_A^2 = P_A + \frac{1}{2}\rho v_A^2$

Chapter 7

$F = k x$

$f = 1 / T$

$\omega = 2\pi f$

$x = x_o \sin\omega t$

$v = \omega\sqrt{x_o^2 - x^2}$

$a = -\omega^2 x$

for mass-spring case:

$\omega = \sqrt{k / m}$

$a + (k/m)\, x = 0$

$T = 2\pi\sqrt{m / k}$

$v = x_o\sqrt{k/m\,(1 - x^2/x_o^2)}$

$v_o = x_o\sqrt{k/m}$

$v = v_o\sqrt{1 - x^2/x_o^2}$

$T = 2\pi\sqrt{l / g}$

$PE_e = \frac{1}{2} k x^2$

$KE_e = \frac{1}{2} k x_o^2 (1 - x^2 / x_o^2)$

Chapter 8

$v = f\lambda$
$v = \sqrt{E/\rho}$
$v_t = v_o + 0.16\,t$
$\Delta S = n\lambda$
$\Delta S = (2n+1)\lambda/2$
$f_1 = 1/2l\sqrt{F/m}$
$f_n = n f_1$
$\lambda_n = (2/n)\,l$

for both ends open:
$f_n = \frac{n v}{2l}$

for one end closed:
$f_n = \frac{n v}{4l}$

Doppler effect:

$f_A = f\frac{(v + u_o)}{v}$

$f_B = f\frac{(v - u_o)}{v}$

$f_C = f\left(\frac{v}{v - u_s}\right) f$

$f_D = f\left(\frac{v}{v + u_s}\right) f$

Chapter 9

$d = 1/N$

For bright fringes:
$d \sin\theta = m\lambda$

for dark fringes:
$d \sin\theta = (m + \frac{1}{2})\lambda$

P for bright fringe:
$y = m\lambda L/d$

P for dark fringe:
$y = (m + \frac{1}{2})\lambda L/d$

fringe width
$= \Delta y = \lambda L/d$

Michel son's Interferometer:
$L = m\lambda/2$

Diffraction of X-rays:
$2d\sin\theta = n\lambda$

Chapter 10

$1/f = 1/p + 1/q$

$\alpha_{min} = 1.22\,\lambda/D$

$R = \lambda/\Delta\lambda$

$M = \beta/\alpha$

$M = q/p = d/p$

$M = 1 + d/f$

$M = q/p\,(1 + d/f_e)$
$f_o < f_e$

$M = f_o/f_e$; $f_o > f_e$

$L = f_o + f_e$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\sin\theta_c = 1/n$

Chapter 11

$P = \frac{2}{3}\frac{N}{V} < \frac{1}{2} mv^2 >$

$PV = nRT$

$PV = nkT$

$T = 2/3k < \frac{1}{2} mv^2 >$

$P_1 V_1 = P_2 V_2$

$W = P\,\Delta V$

$Q = \Delta U + W$

$C_p - C_v = R$

$\eta = W/Q_1$

$\eta = \frac{Q_1 - Q_2}{Q_1}$

$\eta = 1 - T_2/T_1$

$\Delta S = \Delta Q/T$

1.1) $S = vt$

$= 3\times 10^8 \times 365\times 24\times 60\times 60 = ----$

1.2) a) $365\times 24\times 60\times 60 = ----$

b) $\frac{365\times 24\times 60\times 60}{10^{-9}} = ----$ [nano $= 10^{-9}$

c) $\frac{1}{365\times 24\times 60\times 60} = ----$

1.3) $A = l\times w$

$= 15.3\times 12.8 = ----$

1.4)
2.189
0.089
11.8
5.32
19.398
$\to$ 19.4 Kg

1.5) $T = 2\pi\sqrt{l/g}$

$\Rightarrow g = \frac{4\pi^2 l}{T^2} = \frac{4\pi^2(\frac{100}{100})}{(40.2/20)^2} = ---- = 9.76\, m/s^2$

For length

Absolute Uncertainty $= 1\,mm = 0.1\,cm$

%age Uncertainty $= \frac{0.1}{100}\times\frac{100}{100} = 0.1\%$ [% $\equiv$ per cent $\equiv /100$

For time

Absolute Uncertainty $= 0.1$ sec

Average Uncertainty $= \frac{0.1}{20} = 0.005$ sec

%age Uncertainty $= \frac{.005}{(40.2/20)}\times\frac{100}{100} = 0.25\%$

Total Uncertainty

$= 2\times 0.25 + 0.1 = 0.6\%$

$\hookrightarrow$ [t is squared]

[$\frac{9.76\times .6}{100}$ $= .0582$ $= .06$

Thus $g = 9.76 \pm 0.06\, m/s^2$

1.6) $F = \dfrac{G m_1 m_2}{r^2}$

or $G = \dfrac{F r^2}{m_1 m_2} = [F]\times[L^2]\times[M^{-2}] = N m^2 kg^{-2}$

1.7) $v_f = v_i + at$

$[LT^{-1}] = [LT^{-1}] + [LT^{-2}\,T]$

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

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

proved dimensionally correct dimensions.

1.8) $v = \text{Constant}\ \rho^a E^b$ —— (1) $\quad\Big|\quad \rho = \dfrac{m}{V} = [ML^{-3}]$

$[LT^{-1}] = \text{Const.}[ML^{-3}]^a[ML^{-1}T^{-2}]^b \quad\Big|\quad E = \dfrac{\text{stress}}{\text{strain}} = \dfrac{F/A}{\Delta l/L_0} = \dfrac{ma/A}{\Delta l/L_0}$

$LT^{-1} = \text{Cost.}\,M^a L^{-3a} M^b L^{-b} T^{-2b} \quad\Big|\quad = \dfrac{maL_0}{A\Delta L} = MLT^{-2}\cancel{L}$

$LT^{-1} = \text{const.}\,M^{a+b} L^{-3a-b} T^{-2b} \quad\Big|\quad E = ML^{-1}T^{-2}L^2\cancel{L}$

Equating powers of corresponding quantities on both sides

$a+b=0;\ -3a-b=1;\ -2b=-1$

$\Rightarrow b = 1/2\ \&\ a = -1/2$ —— (2)

From relations (1) & (2)

$v = \text{Constant}\ \rho^{-1/2}E^{1/2} = \text{Constant}\sqrt{E/\rho}$

1.9) $E = mc^2$

$(mgh) = mv^2$

$MLT^{-2}L = ML^2T^{-2}$

or $ML^2T^{-2} = ML^2T^{-2}$

proved dimensionally correct

1.10) $a \propto r^n v^m$

$a = \text{Const.}\ r^n v^m$

$LT^{-2} = \text{Const.}\ L^n L^m T^{-m}$

$LT^{-2} = \text{Const.}\ L^{n+m} T^{-m}$

Equating corresponding powers

$n+m = 1\ \&\ -m = -2$

$\Rightarrow m = 2\ \&\ n = -1$

Chapter 2

2.1) $a\,(-2,-3)$, $b\,(3,9)$

$\vec{A} = \{3-(-2)\}\hat{i} + \{9-(-3)\}\hat{j}$

or $\vec{A} = 5\hat{i} + 12\hat{j}$ ——— ①

& $P(5,12)$

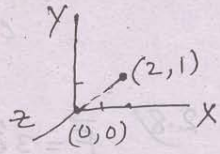
$\vec{P} = 5\hat{i} + 12\hat{j}$ ——— ②

So $\vec{A}$ is same as $\vec{P}$

Now $r = \sqrt{x^2+y^2}$

distance $= \sqrt{(5)^2+(12)^2} = ---- = 13$ units

2.2) $x_1(0,0)$ & $x_2(2,1)$



$\vec{A} = (2-0)\hat{i} + (1-0)\hat{j}$

$\vec{A} = 2\hat{i} + \hat{j}$

Distance $= |\vec{A}| = \sqrt{2^2+1^2} = \sqrt{5} = 2.24\,m$

2.3) $\vec{A} = 4\hat{i} + 3\hat{j}$

$|\vec{A}| = \sqrt{4^2+3^2} = 5$

$\hat{A} = \frac{\vec{A}}{|\vec{A}|} = \frac{4\hat{i}+3\hat{j}}{5} = \frac{4}{5}\hat{i} + \frac{3}{5}\hat{j}$

2.4) $\vec{r}_1 = 3\hat{i} + 7\hat{j}$ & $\vec{r}_2 = -2\hat{i} + 3\hat{j}$

$\vec{r} = \vec{r}_2 - \vec{r}_1 = (-2-3)\hat{i} + (3-7)\hat{j}$

or $\vec{r} = -5\hat{i} - 4\hat{j}$

$\vec{r}$ is vector or vector orientation

$|\vec{r}| = \sqrt{(-5)^2+(-4)^2} = \sqrt{41} = 6.4$

2.5) $(\vec{A}+\vec{B}) + (\vec{A}-\vec{B}) = 2\vec{A}$

$\vec{A} = \frac{2\vec{A}}{2} = \frac{(\vec{A}+\vec{B}) + (\vec{A}-\vec{B})}{2}$

$= \frac{(6\hat{i}+\hat{j}) + (-4\hat{i}+7\hat{j})}{2}$

$\vec{A} = \hat{i} + 4\hat{j}$

So $|\vec{A}| = \sqrt{1^2+4^2} = \sqrt{17} = 4.1$

2.6) $\vec{C} = \vec{A}+\vec{B} = (2\hat{i}+3\hat{j})+(3\hat{i}-4\hat{j})$

or $\vec{C} = 5\hat{i}-\hat{j}$

$|\vec{C}| = \sqrt{5^2+1^2} = \sqrt{26} = 5.1$

$\vec{D} = 3\vec{A}-2\vec{B}$

$= 3(2\hat{i}+3\hat{j})-2(3\hat{i}-4\hat{j})$

$= \cancel{6\hat{i}}+9\hat{j}-\cancel{6\hat{i}}+8\hat{j}$

$\vec{D} = 17\hat{j}$ & $|\vec{D}| = \sqrt{17^2} = 17$

2.7) $\vec{A}\cdot\vec{B} = AB\cos\theta$

or $\cos\theta = \dfrac{\vec{A}\cdot\vec{B}}{AB} = \dfrac{(5\hat{i}+\hat{j})\cdot(2\hat{i}+4\hat{j})}{(\sqrt{5^2+1^2})(\sqrt{2^2+4^2})}$

$\cos\theta = \dfrac{10+4}{\sqrt{26\times 20}}$

$\theta = \cos^{-1}\dfrac{14}{\sqrt{26\times 20}} = \text{----} = 52°$

$\left[\begin{array}{l}\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = 1\\ \hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{i} = 0\end{array}\right.$

2.8) $\vec{F} = 3\hat{i}+2\hat{j}$

$\vec{d} = \vec{r}_2-\vec{r}_1 = (6\hat{i}+4\hat{j})-(2\hat{i}-\hat{j}) = 4\hat{i}+5\hat{j}$

$W = \vec{F}\cdot\vec{d} = (3\hat{i}+2\hat{j})\cdot(4\hat{i}+5\hat{j}) = 12+10 = 22$ Units

2.9) $\vec{A} = \hat{i}+\hat{j}+\hat{k}$; $\vec{B} = 2\hat{i}-3\hat{j}+\hat{k}$; $\vec{C} = 4\hat{i}+\hat{j}-5\hat{k}$

$\vec{A}\cdot\vec{B} = (\hat{i}+\hat{j}+\hat{k})\cdot(2\hat{i}-3\hat{j}+\hat{k}) = 2-3+1 = 0$

$\vec{B}\cdot\vec{C} = (2\hat{i}-3\hat{j}+\hat{k})\cdot(4\hat{i}+\hat{j}-5\hat{k}) = 8-3-5 = 0$

$\vec{C}\cdot\vec{A} = (4\hat{i}+\hat{j}-5\hat{k})\cdot(\hat{i}+\hat{j}+\hat{k}) = 4+1-5 = 0$

Since $\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{C} = \vec{C}\cdot\vec{A} = 0$ $\quad\left[\vec{A}\cdot\vec{A}_\perp = A^2\cos 90° = 0\right.$

$\Rightarrow$ they are mutually perpendicular to each other.

2.10) Projection of $\vec{A}$ on $\vec{B}$ will be $A\cos\theta$

$\vec{A}\cdot\vec{B} = AB\cos\theta$

or $A\cos\theta = \dfrac{\vec{A}\cdot\vec{B}}{B}$

$= \dfrac{(\hat{i}-2\hat{j}+3\hat{k})\cdot(3\hat{i}-4\hat{k})}{\sqrt{3^2+(-4)^2}}$

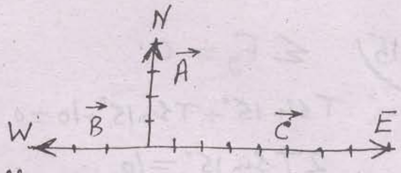
$= \dfrac{(\hat{i}-2\hat{j}+3\hat{k})\cdot(3\hat{i}+0\hat{j}-4\hat{k})}{\sqrt{3^2+(-4)^2}} = \dfrac{3+0-12}{5}$

$= -9/5$

2.11) a)

$\vec{A} \times \vec{B} = AB \sin 90^\circ \hat{n}$

$= (4)(3)\ \hat{n}$



$\vec{A} \times \vec{B} = 12$ units, vertically up [Direction from right-hand-rule

b) $\vec{A} \times \vec{C} = AC \sin 90^\circ \hat{n}$

$= (4)(8)\ \hat{n}$

$= 32$ units, vertically down

c) $\vec{B} \times \vec{C} = BC \sin 180^\circ \hat{n}$ [$\sin 180^\circ = 0$

$= (3)(8) \times 0 \times \hat{n}$

$=$ zero

2.12) $\vec{\tau} = \vec{r} \times \vec{F} = (7\hat{i} + 3\hat{j} + \hat{k}) \times (-3\hat{i} + \hat{j} + 5\hat{k})$

$= (15-1)\hat{i} + (-3-35)\hat{j} + (7+9)\hat{k}$

$\vec{\tau} = 14\hat{i} - 38\hat{j} + 16\hat{k}$ [$\vec{A} \times \vec{B} = (A_yB_z - A_zB_y)\hat{i} + (A_zB_x - A_xB_z)\hat{j} + (A_xB_y - A_yB_x)\hat{k}$

2.13) $\vec{F} = \hat{i} - 2\hat{j}$; $\vec{r}_1 = \hat{i} + \hat{k}$; $\vec{r}_2 = -\hat{j} + \hat{k}$

Moment of F (or τ)

$\vec{\tau}_2 = \vec{r}_2 \times \vec{F} = (-\hat{j} + \hat{k}) \times (\hat{i} - 2\hat{j})$

$= \boxed{\hat{k} + \hat{j} + 2\hat{i}}$

[$\hat{j} \times \hat{i} = -\hat{k}$
$\hat{j} \times \hat{j} = 0$
$\hat{k} \times \hat{i} = \hat{j}$
$\hat{k} \times \hat{j} = -\hat{i}$

$\vec{r} = \vec{r}_2 - \vec{r}_1 = (-\hat{j} + \hat{k}) - (\hat{i} + \hat{k})$

$= (-\hat{i} - \hat{j})$

$\vec{\tau}_1 = \vec{r} \times \vec{F} = (-\hat{i} - \hat{j}) \times (\hat{i} - 2\hat{j})$

$\vec{\tau}_1 = 2\hat{k} + \hat{k} = \boxed{3\hat{k}}$

[$\vec{F}$ passes through $\vec{r}_2$ and would pass through $\vec{r}_1$, so $\vec{r} = \vec{r}_2 - \vec{r}_1$
See Solved Example 2.6 on page 38 of the Text Book.

2.14) $|\vec{A} \cdot \vec{B}| = 6\sqrt{3}$

$|\vec{A} \times \vec{B}| = 6$

$\vec{A} \cdot \vec{B} = AB \cos\theta$

$|\vec{A} \cdot \vec{B}| = AB\cos\theta = 6\sqrt{3}$ —— ①

$\vec{A} \times \vec{B} = AB \sin\theta\ \hat{n}$

$|\vec{A} \times \vec{B}| = AB \sin\theta = 6$ —— ②

Dividing eqn ② by ①

$\sin\theta / \cos\theta = 6 / 6\sqrt{3}$ or $\tan\theta = \frac{1}{\sqrt{3}}$

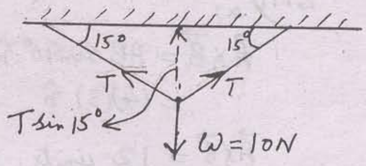
$\Rightarrow \theta = \tan^{-1} 1/\sqrt{3} = 30^\circ$

2.15) $\Sigma F_y = 0$

$T\sin 15^\circ + T\sin 15^\circ - 10 = 0$

$2T\sin 15^\circ = 10$

$T = \dfrac{10}{2\sin 15^\circ} = \text{----} = 19.3N$



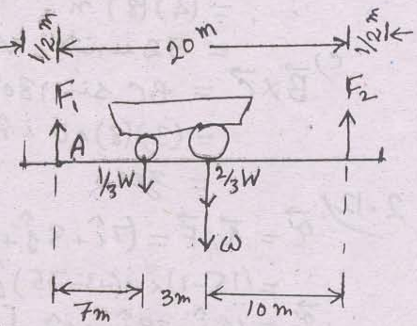
2.16) Tractor weight = W = 15000N

Bridge weigh = ω = 8000N

Bridge length = l = 21m

Tractor length = 3m

Forces on bridge supports $= F_1$ & $F_2 = ?$



Applying 2nd condition of Eq. at point A

$\Sigma \tau = 0$

$F_2 \times 20 - (\tfrac{1}{3}W \times 7) - (\tfrac{2}{3}W \times 10) - \omega \times 10 = 0$

or $F_2 \times 20 - (\tfrac{15000}{3} \times 7) - (\tfrac{2 \times 15000}{3} \times 10) - 8000 \times 10 = 0$

$\Rightarrow F_2 = \text{-----} = 10750N = 10.75kN$

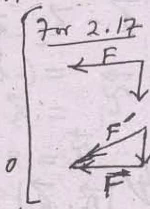
Applying $\Sigma F_y = 0$

$F_1 + F_2 - \tfrac{1}{3}W - \tfrac{2}{3}W - \omega = 0$

or $F_1 + 10750 - \tfrac{15000}{3} - \tfrac{2 \times 15000}{3} - 8000 = 0$

$\Rightarrow F_1 = \text{----} = 12250N = 12.25kN$

For 2.17



2.17) Applying 2nd Cond. at point A

$\Sigma \tau = 0$

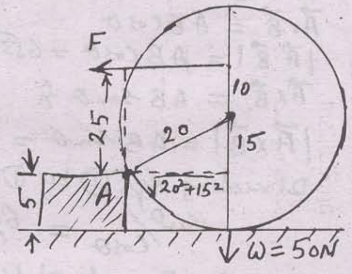
$F \times 25 - \omega \times \sqrt{20^2 + 15^2} = 0$

$\Rightarrow F = \text{----} = 26N$

Total Force : F'

$F' = \sqrt{\omega^2 + F^2} = \sqrt{50^2 + 26^2}$

$= 56N$



2.18/

Applying 2nd part of 1st Cond. of Eq.

$\Sigma F_y = 0$

$T\cos 30° - W = 0$

$T\cos 30° - 10 = 0$

$\Rightarrow T = ---- = 11.6N$

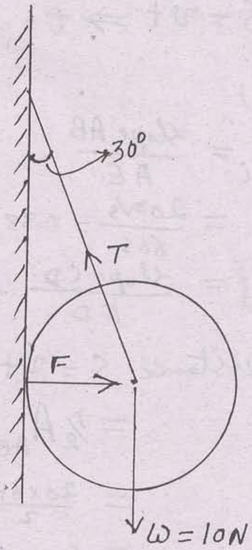
Applying

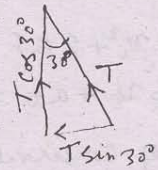
$\Sigma F_x = 0$

$F - T\sin 30° = 0$

$F - 11.6\sin 30° = 0$

$\Rightarrow F = ---- = 5.77N$

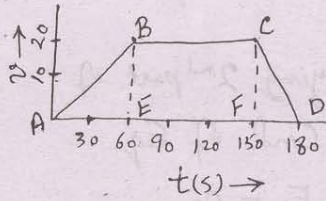




Chapter 3

3.1) $S = vt \Rightarrow t = \text{-----}$

3.2) a)



$$a_i = \frac{\text{slope } AB}{AE}$$

$$= \frac{20\,m/s}{60\,s} = 0.33\,m/s^2$$

b)

$$a_f = \frac{\text{slope } CD}{FD} = \frac{-20\,m/s}{30\,s} = -0.67\,m/s^2$$

c) Distance $S = vt$ = total area ABCDA

$$= \tfrac{1}{2}A_{ABE} + A_{BCFE} + \tfrac{1}{2}A_{FCD}$$

$$= \frac{20\times60}{2} + 20\times90 + \frac{20\times30}{2}$$

$$= 600 + 1800 + 300 = 2700\,m = 2.7\,km$$

3.3) $v_f^2 = v_i^2 + 2as \Rightarrow a = \text{----}$

$v_f = v_i + at \Rightarrow t = \text{----}$

3.4) Law of Conservation of Mom.

Initial Mom. = Final Mom.

$$0 = m_1 v_1 + (-m_2 v_2)$$

or $m_1 v_1 = m_2 v_2 \Rightarrow v_1/v_2 = \dfrac{m_2}{m_1}$

3.5) $F = ma = m\dfrac{v}{t} = \dfrac{m}{t}v$

or $F = \dfrac{m}{t}v = 1.0\times10^{-13} \times 1.0\times10^{-4} = 1\times10^{-17}\,N$

$F = ma$

or $a = \dfrac{F}{m} = \dfrac{1\times10^{-17}}{1\times10^{-12}} = 1\times10^{-5}\,m/s^2$

3.6) Law of Cons. of Mom.

Initial Mom. = Final Mom.

$0 = m_1 v_1 + m_2 v_2$

$\Rightarrow v_1 = \text{-----}$

$m_1 = 40\,gm = 0.04\,kg$
$m_2 = 200\,gm = 0.2\,kg$
$v_2 = 3\,m/s$
$v_1 = ?$

3.7) $v_2' = \frac{2m_1}{m_1+m_2} v_1 + \frac{m_2-m_1}{m_1+m_2} v_2$

$v_2' = \frac{2m_1}{m_1+m_2} v_1 = \text{-----}$ $\left[v_2 = 0 \right.$

3.8) Total Mom. before Collision = Total Mom. after collision

$m_1 v_1 + m_2 v_2 = (m_1+m_2) v$ $\left[v_2 = 0 \right.$

$\Rightarrow v = \text{-----}$

3.9) Loss PE = gain in KE $= \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$

$10 = \frac{1}{2}(2) v_1^2 + \frac{1}{2}(0.5) v_2^2$

or $10 = v_1^2 + \frac{1}{4} v_2^2$ ——— ①

& Initial Mom. = Final Mom.

$0 = m_1 v_1 + m_2 v_2$

$0 = 2 v_1 + \frac{1}{2} v_2$ ——— ②

Solving the two eqs. for two unknowns,

$v_1 = \text{-----}$

$v_2 = \text{-----}$

3.10) $R = \frac{v_i^2}{g} \sin 2\theta \Rightarrow v_i = \text{-----}$

3.11) $S = v_i t + \frac{1}{2} a t^2$

For vertical case:

$y = v_{iy} t + \frac{1}{2} g t^2$

or $10 = 0 + \frac{1}{2} \times 9.8 \times t^2 \Rightarrow t = \text{-----} = 1.41 \text{ sec}$

$S = vt$

For horizontal case:

$R = v_i \times t = \text{-----}$

$v_f = v_i + at$

For vertical case:

$v_{fy} = 0 + 9.8 \times t^2 = \text{-----}$

& $v_{ix} = v_{fx} = 21 \text{ m/s}$ $\left[\text{horz. vel. remains const.} \right.$

$v_f = \sqrt{v_{fy}^2 + v_{fx}^2} = \text{-----}$

3.12) $S = v_i t + \frac{1}{2} a t^2$

For vertical case:

$y = v_{iy} t + \frac{1}{2} g t^2$

$490 = 0 + \frac{1}{2} \times 9.8 \times t^2 \Rightarrow t = \text{-----}$

$S = vt$

For horz. case:

$R = v_{ix} * t = \text{------}$

$\left[v = 300 \text{ km/h} = \frac{300 \times 1000}{60 \times 60} \text{ m/s} \right.$

3.13) $R = \frac{v_i^2}{g} \sin 2\theta$ ——— ①

$h = \frac{v_i^2 \sin^2\theta}{2g}$ ——— ②

Equating ① & ② for given conditions

$\frac{\cancel{v_i^2} \sin 2\theta}{\cancel{g}} = \frac{\cancel{v_i^2} \sin^2\theta}{2\cancel{g}}$

$2 \sin 2\theta = \sin^2\theta$

$\left[\sin 2\theta = 2 \sin\theta \cos\theta \right.$

$2 \times 2 \cancel{\sin\theta} \cos\theta = \sin\theta \cancel{\sin\theta}$

or $\frac{\sin\theta}{\cos\theta} = \tan\theta = 4 \Rightarrow \theta = \tan^{-1} 4 = 76°$

3.14) $R = \frac{v_i^2}{g} \sin 2\theta$

For R_{max}, $\theta = 45°$

$R = \frac{v_i^2}{g} \sin(2 \times 45°) = \frac{v_i^2}{g} \sin 90°$

taking $R_1 = \frac{v_i^2}{g} \sin(90+\theta)$

$R_2 = v_i^2/g \sin(90-\theta)$

For the given conditions

$R_1 = R_2$

$\frac{\cancel{v_i^2}}{\cancel{g}} \sin(90+\theta) = \frac{\cancel{v_i^2}}{\cancel{g}} \sin(90-\theta)$

$\sin(90+\theta) = \sin(90-\theta)$

$\sin 90 \cos\theta + \cos 90 \sin\theta = \sin 90 \cos\theta - \cos 90 \sin\theta$

or $\cos\theta = \cos\theta \Rightarrow R_1 = R_2 \rightarrow$ proved

3.15) $R = \frac{v_i^2}{g} \sin 2\theta \Rightarrow v_i = \text{-----}$

$t = \frac{2 v_i \sin\theta}{g} = \text{-----}$

Chapter 4

4.1) $W = Fd\cos\theta = ----$

4.2) W.done by gravity = Loss of PE = $mgh = ----$
W.done against friction = $-f \times d = -mgh = ----$

4.3) Total mass = $m = 9 \times 1.5 = 13.5\,kg$ [No work done for 1st brick
Combined height = h

$$h = \frac{1\times6 + 2\times6 + 3\times6 + -----+9\times6}{9} = 30\,cm = 0.3\,m$$

$W = mgh = -----$

4.4) $KE_1 = \frac{1}{2}mv^2$; $KE_2 = \frac{1}{2}m(2v)^2 = 4\times\frac{1}{2}mv^2 = 4\times KE_1$
or $KE_2 = -----$

4.5) $KE = \frac{1}{2}mv^2$

4.6) $\rho = \frac{m}{V}$ or $m = \rho V$
$PE = mgh = \rho Vgh = ----- (=W)$
$P = \frac{W}{t} = ------$

4.7) $P = Fv\cos 0° = -----$ [$\cos 0° = 1$, $v = 80\,km/h = \frac{80\times1000}{60\times60}\,m/s$

4.8) $Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \Rightarrow F = ----$ [$d = 5\,cm = 0.05\,m$

4.9) Loss of PE = gain in KE
$mg(h_1 - h_2) = \frac{1}{2}\cancel{m}v^2 \Rightarrow v = ----$

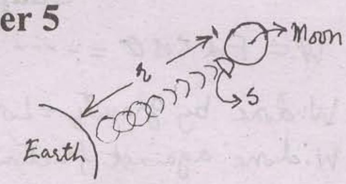
4.10) a) Loss of PE = gain in KE
$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2 \Rightarrow v = ----- = 8.8\,m/s$

b) KE with the velocity 6 m/s
$KE_1 = \frac{1}{2}mv^2 = ------ = 18m$ Joules
KE with 8.8 m/s velocity
$KE_2 = \frac{1}{2}mv^2 = ----- = 38.72m$ Joules

%age Lost = $\frac{38.72m - 18m}{38.72m}\times100 = --- = 54\%$

Chapter 5

5.1) $S = r\theta$ $\left[\right.$ 



5.2) $\alpha = \dfrac{\omega_f - \omega_i}{t} = ----$

5.3) $L = I\omega ; \tau = I\alpha$ $\left[\begin{array}{l}\omega \text{ is constant} \\ \alpha = \dfrac{\Delta\omega}{t} = \dfrac{0}{t} = 0\end{array}\right.$

5.4) $\tau = rF\sin 90° = rF = -----$

$\tau = I\alpha$ or $\alpha = \dfrac{\tau}{I}$ $\left[I = \frac{1}{2} m r^2 \right.$

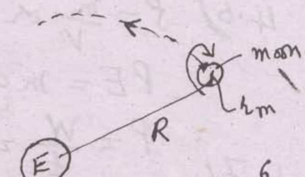
5.5) $L = I\omega = \frac{2}{5} m r^2 \omega = -----$

$KE = \frac{1}{2} I\omega^2 = \frac{1}{2}(\frac{2}{5} m r^2) \times \omega^2 = ----$ $\left[\begin{array}{l}\omega = \dfrac{\theta}{t} = \dfrac{2\pi}{20\,\text{days}} \\ \omega = \dfrac{2\pi}{20 \times 24 \times 60 \times 60} \\ I = \frac{2}{5} m r^2\end{array}\right.$

5.6) $F_c = \dfrac{mv^2}{r} = ----$

5.7) $a_c = g = \dfrac{v^2}{r} \Rightarrow v = ----$

5.8) $L_o = (MR^2)\omega ; L_s = (\frac{2}{5} M r_m^2)\omega$



$$\frac{L_s}{L_o} = \frac{(\frac{2}{5}\cancel{M} r_m^2)\cancel{\omega}}{\cancel{M}R^2\cancel{\omega}} = \frac{2r_m^2}{5R^2} = ----$$

$\left[\begin{array}{l} r_m = 1.74 \times 10^6\,m \\ R = 3.85 \times 10^8\,m \end{array}\right.$

5.9) $I_1\omega_1 = I_2\omega_2$

$(\frac{2}{5} MR^2)\,\omega_1 = \{\frac{2}{5} M(\frac{R}{2})^2\}\,\omega_2$ $\left[\omega = \dfrac{2\pi}{T} \right.$

or $\dfrac{2}{5}\cancel{M}R^2 \dfrac{2\pi}{T_1} = \dfrac{2}{5} \dfrac{\cancel{M}R^2}{4} \dfrac{2\pi}{T_2}$

or $T_2 = \dfrac{T_1}{4} = -----$ $\left[T_1 = 24 \text{ hours} \right.$

5.10) $v = \sqrt{\dfrac{GM}{r}} = ----$ $\left[G = 6.67 \times 10^{-11}\,Nm^2 kg^{-2} \right.$

Chapter 6

6.1) $v_t = \dfrac{2 g r^2 \rho}{9\eta} \Rightarrow r = \text{-----}$

6.2) $A_1 v_1 = A_2 v_2$

$\cancel{\pi} r_1^2 v_1 = \cancel{\pi} r_2^2 v_2$

$\left(\frac{D_1}{2}\right)^2 v_1 = \left(\frac{D_2}{2}\right)^2 v_2 \Rightarrow D_2 = \text{----}$

6.3) $v_2 = \sqrt{2g(h_1 - h_2)}$

$\rho = \frac{m}{V}$ or $m = \rho V = \rho A v t$ $\left\{ \begin{array}{l} A = 0.06\,cm^2 \\ t = 1\,sec \\ \rho = 1\,gm/cm^3 \end{array} \right.$

or $m = \rho A v t = \text{-----}$

6.4) $P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$ $\left[h_1 - h_2 = 3\,m \right.$

or $P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) + \rho g(h_1 - h_2)$

6.5) $P_A + \frac{1}{2}\rho v_A^2 = P_B + \frac{1}{2}\rho v_B^2$

or $P_A - P_B = \frac{1}{2}\rho(v_B^2 - v_A^2) = \text{-----}$

6.6) $A_1 v_1 = A_2 v_2$

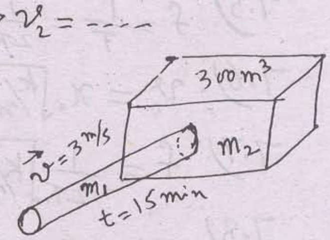
or $\pi r_1^2 v_1 = A_2 v_2 \Rightarrow v_2 = \text{----}$

6.7) $\rho = \frac{m}{V}$

or $m = \rho V = \rho A v t$

For $m_1 = m_2$

$\rho_1 A_1 v_1 t_1 = \rho_2 A_2 v_2 t_2$



or $A_1 v_1 t_1 = V_2$

or $\pi r_1^2 v_1 t_1 = V_2 \Rightarrow r_1 = \text{-----}$ $\left\{ \begin{array}{l} \rho_1 = \rho_2 \\ Avt = V \\ A = \pi r^2 \end{array} \right.$

6.8) $P_1 - P_2 + \frac{1}{2}\rho(v_1^2 - v_2^2) + \rho g(h_1 - h_2) = 0$ $\left\{ \begin{array}{l} P_1 - P_2 = 1000\,N m^{-2} \\ h_1 - h_2 = 1\,m \\ v_2 = 160\,m/s \end{array} \right.$

$\Rightarrow v_1 = \text{-----}$

6.9) $P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$ $\left\{ \begin{array}{l} v_1 = v_2 \\ h_1 - h_2 = 15\,m \end{array} \right.$

or $P_2 - P_1 = \rho g(h_1 - h_2) = \text{-----}$

Chapter 7

7.1) $F = mg = kx \Rightarrow k = ----$

$T = 2\pi\sqrt{m/k} \Rightarrow m = ----$

7.2) $F = mg = kx \Rightarrow k = ----$ $[m = 15.0\,gm = 0.015\,kg$

$T = 2\pi\sqrt{m/k} \Rightarrow T = ----$ $[m = 294\,g = 0.294\,kg$

$v_0 = x_0\sqrt{k/m} \Rightarrow v_0 = ----$ $[m = (.015 + .294)\,kg$

7.3) $F = kx \Rightarrow k = ----$

$T = 2\pi\sqrt{m/k} = -----$

$a + k/m\,x = 0 \Rightarrow a = ----$

$v = x_0\sqrt{k/m\,(1 - \frac{x^2}{x_0^2})}$

$KE = \frac{1}{2}kx_0^2(1 - x^2/x_0^2)$ $[x = 12\,cm = 0.12\,m$

$PE = \frac{1}{2}kx^2$

7.4) $PE_g = PE_e$

$mgh = \frac{1}{2}kx_0^2 \Rightarrow x_0 = ----$

7.5) $f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{g/l} = ----$

7.6) $v_0 = x_0\sqrt{k/m} = -----$

7.7) $f = \frac{1}{2\pi}\sqrt{k/m} = -----$ $\left[\begin{array}{l} k = 4k = 4 \times 20{,}000\,Nm^{-1} \\ m = (1300+160)\,kg \end{array}\right.$

7.8) $x = 0.25\cos\underbrace{(\pi/8)}_{(=\omega)}t$

$x_0 = 0.25 \times 1$

$x_0 = 0.25$ $[(\cos\omega t)_{max} = 1$

$\omega = 2\pi f$ or $\frac{\pi}{8} = 2\pi f \Rightarrow f = -----$

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

$x = 0.25\cos(\pi/8) \times 2 = 0.25\cos(\frac{\pi}{8} \times 2) = -------$

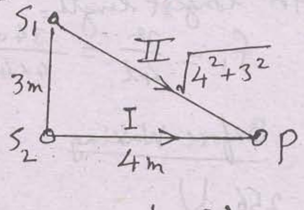
Chapter 8

8.1) $v = f\lambda \Rightarrow v = \text{------}$

$v = f_2\lambda_2 \Rightarrow \lambda_2 = \text{------}$

8.2) $\Delta S = S_1P - S_2P$

$= \sqrt{4^2+3^2} - 4 = \text{----} = 1$



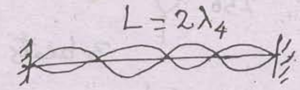
For $n = 1$,

$\Delta S = n\lambda$

$\Rightarrow \lambda = 1\times 1 = 1\,m$

$v = f\lambda = \text{-----}$

8.3) $L = 2\lambda_4$



$\lambda_4 = L/2 = \frac{120}{2} = \text{---}$

$f_n = nf_1$

& $f_4 = 4f_1 \Rightarrow f_1 = \text{----}$ $\quad [f_4 = 120\,Hz$

8.4) $f_1 = \frac{1}{2l}\sqrt{F/m}$

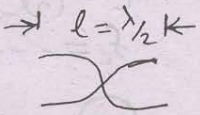
a) For $l' = (1-1/3)l = \frac{2}{3}l$

$f_1' = \frac{1}{2(2/3\,l)}\sqrt{F/m} = \frac{3}{2}\times\frac{1}{2l}\sqrt{F/m} = \frac{3}{2}f_1 = \frac{3}{2}(300) = \text{----}$

b) For $T' = (1+1/3)F = \frac{4}{3}F$

$f_1' = \frac{1}{2l}\sqrt{\frac{4/3\,F}{m}} = \sqrt{\frac{4}{3}}\times\frac{1}{2l}\sqrt{F/m} = \sqrt{\frac{4}{3}}\times f_1 = \text{-----}$

8.5)
a) $l = \lambda/2$

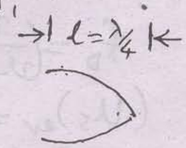


& $\lambda = 2l = 2\times 50 = \text{----}$

$f_1 = \frac{v}{2l} = \text{-----}$ $\quad \left[f_n = \frac{nv}{2l},\ n = 1 \right.$

$f_2 = 2f_1 \Rightarrow f_2 = \text{----}$ $\quad [f_n = nf_1$

b) $f_1 = \frac{v}{4l}$ $\quad \left[f_n = \frac{nv}{4l} \right.$



$f_2 = 2f_1 = \text{------}$

8.6) For one end open:

$$f_n = \frac{n v}{4l}$$

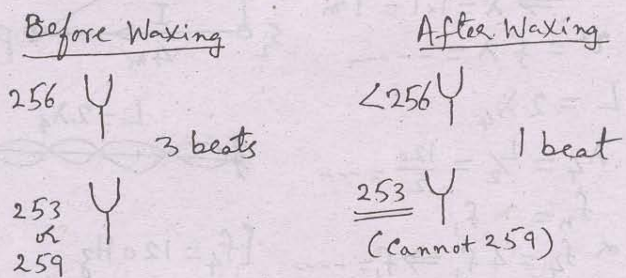
For minimum length:

$$f_1 = \frac{v}{4l} = \frac{340}{4 \times \frac{30}{1000}} = \text{-----} = 2833\,Hz$$

For longest length:

$$f_1 = \frac{v}{4l} = \frac{340}{4 \times 4} = \text{-----} = 21\,Hz$$

8.7)



If second fork has 259 Hz, then we would get more than 3 beats, not 1 as required.
So second tuning fork has frequency 253 Hz

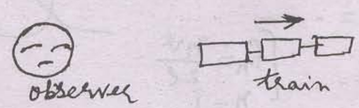
8.8)

Its the case = Source is moving towards Stationary Observer

$$f_c = \left(\frac{v}{v - U_s}\right) f \qquad \begin{cases} v = 340\,m/s \\ U_s = (20-12) = 8\,m/s \\ f = 830\,Hz \end{cases}$$

$$f_c = \text{-----}$$

8.9)



Its the case = Source is moving away from Stationary Observer

$$f_D = \left(\frac{v}{v + U_s}\right) f \Rightarrow U_s = \text{----} \qquad \begin{cases} f = 1200\,Hz \\ f_D = 1140\,Hz \\ v = 340\,m/s \\ t = 50\,s \\ S = v_{av} t \end{cases}$$

$$(U_s)_{av} = \frac{0 + U_s}{2} = \text{----}$$

$$S = (U_s)_{av} \times t = \text{-----}$$

8.10) a) $\lambda' = 478\,nm$ is $> \lambda = 397\,nm$

or $f' = \frac{c}{478}\,Hz$ is $< f = \frac{c}{397}\,Hz$ $\left[\begin{array}{l} c = f\lambda \\ \text{or } f = \frac{c}{\lambda} \end{array}\right.$

Its the case = Source is moving away from the stationary observer

So the galaxy is moving away from the Earth.

b) $f_c = \left(\frac{v}{v + u_s}\right) f$ $\left[\begin{array}{l} c = f\lambda \\ f = c/\lambda \\ f_c = c/\lambda' \end{array}\right.$

or $f_c = \left(\frac{c}{c + u_s}\right) f$

or $\frac{c}{\lambda'} = \left(\frac{c}{c + u_s}\right) \frac{c}{\lambda}$

$\Rightarrow u_s = - - - - -$

Chapter 9

9.1) i) $d \sin\theta = (m+\frac{1}{2})\lambda \Rightarrow \theta = \text{----}$ $\left[\begin{array}{l} d = 0.1mm \\ \;\;= 0.001m \\ m = 0 \end{array}\right.$

ii) $\Delta y = \frac{\lambda L}{d} = \text{------}$

9.2) $y = m\frac{\lambda L}{d} \Rightarrow \lambda = \text{----}$ $[m = 1$

9.3) $d \sin\theta = m\lambda \Rightarrow d = \text{----}$ $[m = 2$

9.4) $L = m\frac{\lambda}{2} \Rightarrow m = \text{----}$

9.5) $d \sin\theta = m\lambda$

$\Rightarrow \lambda = \text{----}$

$\left[\begin{array}{l} d = \frac{1}{N_1} = \frac{1}{5400 \text{ lines/cm}} \\ d = \frac{1}{540000 \text{ lines/m}} \\ m = 2 \end{array}\right.$

9.6) $d \sin\theta = m\lambda \Rightarrow \lambda = \text{----}$

9.7) $d \sin\theta = m\lambda$

$\Rightarrow m = \text{----}$

$\left[\begin{array}{l} \text{For highest order} \\ \theta = 90^\circ \end{array}\right.$

9.8) $\underbrace{d}_{(=1/N)} \sin\theta = m\lambda$ $\left[d = \frac{1}{N}\right.$

$\Rightarrow N = \text{----}$

9.9) $2d \sin\theta = n\lambda$

$\Rightarrow d = \text{----}$

9.10) <u>For Second wavelength</u>

$2d \sin\theta = n\lambda \Rightarrow d = \text{---}$

<u>For First wavelength</u>

$2d \sin\theta = n\lambda$

$\Rightarrow \lambda = \text{----}$

Chapter 10

10.1) i) $1/f = 1/p + 1/q \Rightarrow p = ----$

ii) $M = 1 + d/f = -----$

iii) $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ $\left[\begin{array}{l} q = \infty \\ 4\ \frac{1}{\infty} = 0 \end{array}\right.$

or $\frac{1}{f} = \frac{1}{p} + 0$

$\Rightarrow p = f$

$M = d/p = ---$

10.2) i) $M = f_o/f_e \Rightarrow f_e = ----$

since $D \propto f$

$\frac{D_e}{D_o} = f_e/f_o \Rightarrow D_e = ----$

10.3) $M = f_o/f_e = -----$

10.4) i) $\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{p(=f_e)} + \frac{1}{q(=-q)} = \frac{1}{f(=f_e)}$

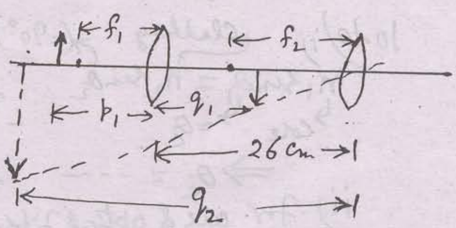
$\Rightarrow \frac{1}{5} - 1/q = 1/5 \Rightarrow q = ---- = \frac{1}{0} = \infty$

ii) $M = f_o/f_e = ----$

10.5) $1/f = 1/p + 1/q$

i) $\frac{1}{f_1} + \frac{1}{p_1} + \frac{1}{q_1}$

$\Rightarrow q_1 = ----$



$p_2 = 26 - q_1$

$= ---- = 8\,cm$

$1/f_2 = \frac{1}{p_2} + 1/q_2$

$\Rightarrow q_2 = -----$

10.6) $M = \frac{q}{p}\left(1+\frac{d}{f_e}\right)$; $f_o < f_e$

$\frac{1}{f_o} = \frac{1}{p} + \frac{1}{q} \Rightarrow q = ----$

$\frac{1}{f_e} = \frac{1}{p(=p_e)} + \frac{1}{q(=-q=25cm)} \Rightarrow p_e = ----$

$L = q + p = ----$

$M = q/p\,(1 + d/f_e)$

10.7) $\alpha_{min} = 1.22\frac{\lambda}{D} \Rightarrow \lambda_{min} = ----$

For max α_{min}, we should use $\lambda_{violet} = 4.1 \times 10^{-7}$ m

$\alpha'_{min} = 1.22\frac{\lambda_{violet}}{D} = -----$

10.8) $M = \frac{f_o}{f_e} \Rightarrow f_o = M f_e = 5 f_e$

$L = 24\,cm = f_o + f_e \Rightarrow 24 = 5f_e + f_e \Rightarrow f_e = ----$

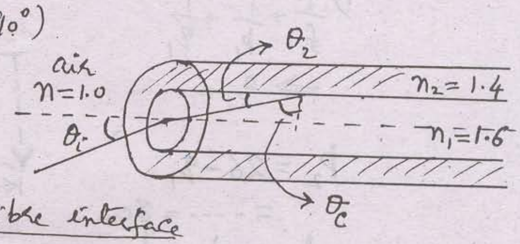
& $L = f_o + f_e \Rightarrow f_o = -----$

10.9) $\sin\theta_c = 1/n \Rightarrow n = ----- = n_1$

$\underbrace{n_1}_{\text{glass light}} \sin\theta_1 = \underbrace{n_2}_{\text{water}} \sin\theta_2^{\to(=90°)} \Rightarrow \theta_1 = ----$

10.10) i) $\underbrace{n_1}_{\text{core}} \sin\underbrace{\theta_1}_{=\theta_c} = \overbrace{n_2}^{\text{cladding}} \sin\theta_2^{(=90°)}$

$\Rightarrow \theta_c = ---$



ii) For air & optical fibre interface

Angle of refraction $= \theta_2 = 90 - \theta_c = ----$

$\underbrace{n_1}_{\text{air}} \sin\underbrace{\theta_1}_{\theta_i} = \underbrace{n_2}_{=1.6} \sin\theta_2 \Rightarrow \theta_i = -----$

Chapter 11

11.1) $T = \frac{2}{3k}\langle \frac{1}{2} m v^2 \rangle$

$\Rightarrow \langle v^2 \rangle = \frac{3kT}{m}$

or $\langle v \rangle = \sqrt{\frac{3kT}{m}} = -----$

$\left[\begin{array}{l} T = 273\,K \\ k = 1.38 \times 10^{-23}\,J/k \\ m = \frac{\text{molecular mass}}{N_A} \\ = \frac{28}{6.022 \times 10^{23}} \end{array} \right.$

11.2) $T = \frac{2}{3k}\langle \frac{1}{2} m v^2 \rangle$

$\Rightarrow \underbrace{T_1 = \frac{2}{3k}\langle \frac{1}{2} m_1 v_1^2 \rangle = \frac{2}{3k}\langle \frac{1}{2} m_2 v_2^2 \rangle}= T_2$

$\Rightarrow \frac{\sqrt{v_1^2}}{\sqrt{v_2^2}} = \frac{\sqrt{m_2}}{\sqrt{m_1}}$

11.3) $W = P\Delta V$

$\Rightarrow \Delta V = ----$

11.4) $Q = \Delta U + W$

or $Q = -(300) - (120) = ----$

11.5) $\eta = 1 - T_2/T_1$; $\eta = \frac{W}{Q_1}$; $\eta = 1 - \frac{Q_2}{Q_1}$

i) $\eta = 1 - \frac{(127+273)}{(227+273)} = ----- = 20\%$

ii) $\eta = \frac{W}{Q_1}$ or $20\% = \frac{10000}{Q_1} \Rightarrow Q_1 = \frac{10000}{20/100} = ----$

iii) $\eta = 1 - \frac{Q_2}{Q_1} \Rightarrow Q_2 = (1-\eta)Q_1 = ------$

11.6) $\eta = 1 - \frac{Q_2}{Q_1} = \frac{(T_1 - T_2)}{T_1}$ $\quad \left[(T_1 - T_2) = 100 + 273 \right.$

$\Rightarrow T_1 = ----$

& $T_2 = T_1 - 100 = -----$

11.7) $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{27+273}{327+273} = ---- = 50\%$

His claim of 52% is not correct.

11.8) $\eta = \frac{W}{Q_1} = ----$

$\eta = \frac{Q_1 - Q_2}{Q_1} \Rightarrow Q_2 = -----$

11.9) $\eta = 1 - \frac{T_2}{T_1} \Rightarrow T_1 = ----$

$\eta' = 1 - \frac{T_2}{T_1'} \Rightarrow T_1' = ----$

$T_1' - T_1 = ----$

11.10) $\eta = 1 - \frac{T_2}{T_1} = ------$

11.11) $\Delta S = \frac{\Delta Q}{T} = \frac{336 \times 30}{(0+273)} = ------$

Conversion Factors-I

Units of Length:

1 inch = 2.54 cm = 25.4 mm
1 foot = 12 inches = 30.48 cm = 304.8 mm
1 yard = 3 ft = 36 inches = 91.44 cm = 0.914 m
1 meter = 100.0 cm = 39.40 inches = 3.28 ft = 1.09 yds
1 mile = 1.609 km = 5280 ft = 1760 yds
1 km = 0.621 miles = 1000.0 m; 1 nautical mile (international) =1.852 km
1 parsec (pc) = 30.857 x 10^{15} m; 1 astronomical unit (Au) = 0.1496 x 10^{12} m
1 fathom = 6 ft = 1.8288 m; 1 statute mile = 1.609344 km

Units of Area:

1 $inch^2$ = 6.452 cm^2
1 ft^2 = 144 $inch^2$ = 929.03 cm^2
1 acre = 43560 ft^2 = 4047 m^2 = 0.4047 hectrares
1 $mile^2$ = 640.0 acres = 259.0 hectares = 2.59 km^2
1 km^2 = 247.11 acres = 100 hectares
1 hectare = 10,000 m^2 = 2.471 acres

Volume:

1 ft^3 (of water) = 7.48 U.S. gallons = 28.307 litre
= 6.227 Imp. Gallons = 62.43 lbs
1 m^3 = 1000 litres = 220 Imp. Gallons
= 264 U.S. gallons = 2283 lbs = 25.31 ft^3
1 acre ft = 43560 ft^3 = 1234 m^3
1 Imp. gallon of water = 10 lbs = 1.201 U.S. gallons = 4.55 litre
1 litre of water = 2.2 lbs
1 ft^3 (water) = 62 .5 lb 1 ft^3 (water) = 6.25 Imper4ial gallons
1 ft^3 = 7.48 U.S. gallons 1 Imperial gallon = 10 lbs

Weight:

1 lb = 16 oz = 7000 grains = 453.6 gm
1 gm = 15.43 grains; 1 kg = 2.2056 lbs
1 short ton = 2000 lbs = 0.9078 metric tons
1 long ton = 2240 lbs

Power:

1 kilowatt = 1.341 horse-power = 737.6 ft. lb/sec
1 horse-power = 0.7457 kilowatt = 746 watts = 550 ft.lb/sec
= 33000 ft.lb/min

Discharge:

1 ft^3/sec (Cusec) = 449 U.S. gallons/min
= 374 Imp. gallons/min
= 1.98 acre ft /day
= 724 acre ft /year
= 28.3 litre/sec
= 0.08 acre ft /hour
1 m^3/sec = 22.83 mgd = 35.32 ft^3 /sec
1 mgd = 1.548 ft^3 /sec

Temperature:

$^{o}F = 32 + 9/5 \times {^{o}C}$; $^{o}C = 5/9\,(^{o}F - 32)$; $K = 273 + {^{o}C}$

2.3 ft (column of water) = 1 lb /in^2 (pressure)
1 ft (high column of water) = 0.434 lb /in^2

Conversion Factors-II

	To change British to S.I. units	To change S.I. to British units
Mass	lb → kg : x 0.454	kg → lb : x 2.20
Length	ft → m : x 0.305	m → ft : x 3.28
	mi → km : x 1.61	km → mi : x 0.621
Speed	ft/S → m/S : x 0.305	m/S → ft/S : x 3.28
	mi/h → m/S : x 0.447	m/S → mi/h : x 2.24
Acceleration	ft/S^2 → m/S^2 : x 0.305	m/S^2 → ft/S^2 : x 3.28
Force	pdl → N : x 0.138	N → pdl : x 7.23
	lbf → N : x 4.45	N → lbf : x 0.225
Pressure	lbf/in^2 → Pa : x 6890	Pa → lbf/in^2 : x 1.45×10^{-4}
Energy	ft pdl → J : x 0.042	J → ft pdl : x 23.7
	ft lbf → J : x 1.36	J → ft lbf : x 0.735
	Btu → J : x 1055	J → Btu : x 9.48×10^{-4}
Power	hp → W : x 746	W → hp : x 1.34×10^{-3}

	c.g.s. → S.I	S.I. → c.g.s.
Force	dyn → N : x 10^{-5}	N → dyn : x 10^{5}
	gf → N : x 9.81×10^{-3}	N → gf : x 102
Energy	erg → J : x 10^{-7}	J → erg : x 10^{7}
	cal → J : x 4.186	J → cal : x 0.239
Area	mile^2 → m^2 : x 2.59×10^{6}	m^2 → mile^2 : x 3.86×10^{-7}
	acre → m^2 : x 4.05×10^{3}	m^2 → acre : x 2.47×10^{-4}