Physics Chapter 1: Units, dimensions & Vectors

Questions (pg 35-39)

1. a) $100\frac{\cancel{km}}{\cancel{h}} \cdot \frac{\cancel{1h}}{3600sec} \cdot \frac{1000m}{\cancel{1km}}$

$100 \cdot \frac{1}{3600} \cdot \frac{1000}{1}$

$\Rightarrow 27.7\dot{7}\ m/s$

b) $100\frac{\cancel{km}}{h} \cdot \frac{0.621\ mi}{\cancel{1km}}$

$= 62.1\ mi/hr$

2. Volume = Area x thickness

$\therefore$ thickness $= \frac{Volume}{Area}$

$= \frac{3.78 \times 10^{-3}\ m^3}{25\ m^2}$

$= 1.512 \times 10^{-4}\ m$

$= 0.1512\ mm$

3. a. $\frac{\Delta V}{\Delta t} \frac{30}{7 \times 60} = \frac{1}{14}$ gal/sec

b. $\frac{30}{7 \times 60} = \frac{1}{14} \cdot \frac{3.78 \times 10^{-3}}{1\ sec}$

$= 0.27\ L/sec$

c. $t = \frac{Vol}{rate} = \frac{1\ m^3}{0.27 \times 10^{-3}\ m^3/s}$

$= 3704\ sec$

$\Rightarrow 1.028\ hrs$

4. $V = 36 \times 10^{-6}\ m^3$

$\hookrightarrow 36 \times 10^{-4}\ mm^3$

$\hookrightarrow 36 \times 10^{-18}\ m^3$

5. ?

6. ? $\frac{m^3 \cdot s^{-2}}{kg}$

7.

8. $S = C g^{\alpha} t^{\beta} m^{\gamma}$

$L = C(LT^{-2})^{\alpha} T^{\beta} M^{\gamma}$

$L^1 = C\ L^{\alpha}\ T^{-2\alpha}\ T^{\beta}\ M^{\gamma}$

$\alpha = 1$

$-2\alpha + \beta = 0$

$\gamma = 0$

$\beta = 2$

$\therefore\ S = Cgt^2$

Manar Al Khodari

Physics Chapter 1: Units, dimensions & vectors

9. ? 10. ? 11. ?

12. a. $|A| = \sqrt{1+4+1} = \sqrt{6}$

$A+B = i - j + 3k$

$A - 2B = i - 4j - 3k$

13. $V_x = V\cos\frac{\pi}{3}$

$= 3 \cdot \frac{1}{2}$

$= 1.5$

$V_y = V\sin\frac{\pi}{3}$

$= 3 \cdot \frac{\sqrt{3}}{2}$

$= 2.6$

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14. $a(6i-8j) + b(-8i+3j) + 26i + 19j = 0$

$(6a-8b+26)i \; (-8a+3b+19)j = 0i + 0j$

$6a - 8b + 26 = 0$

$-8a + 3b + 19 = 0$

$\frac{6a}{6} = \frac{8b-26}{6}$

$a = \frac{8b-26}{6}$

$-8\left(\frac{8b-26}{6}\right) + 3b + 19 = 0$

$-\frac{32}{3}b + \frac{104}{3} + 3b + 19 = 0$

$\frac{23}{3}b = \frac{161}{3}$

$b = 7 \quad \therefore a = 5$

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15. $\hat{A} = \frac{A}{|A|} \Rightarrow \frac{8i - 2j + 4k}{\sqrt{64+4+16}}$

$= \frac{8i - 2j + 4k}{\sqrt{84}}$

$\hat{B} = \frac{B}{|B|} \Rightarrow \frac{3i - 4j + 5k}{\sqrt{9+16+25}}$

$\Rightarrow \frac{3i - 4j + 5k}{\sqrt{50}}$

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17. $AB\cos\theta = A \cdot B$

$AB\sin\theta = A \times B$

$AB\sin\theta = AB\cos\theta$

$\frac{\sin\theta}{\cos\theta} = 1$

$\tan\theta = 1$

$\theta = 45°$

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16. $M = 6i + 2j - k$

$N = 2i - j - 3k$

$M \times N = R$

$$\begin{array}{ccc} + & - & + \\ \left| \begin{array}{ccc} i & j & k \\ 6 & 2 & -1 \\ 2 & -1 & -3 \end{array} \right| \end{array}$$

$-7i + 16j - 10k$

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18. $A+B+C = L$

$(4i - j) + (-3i + 2j) + (-3j)$

$L = i - 2j$

19. a. $A = 0i + 20j$

$B = 40\cos(45) \quad 40\sin 45$

$= 28.28i + 28.28j$

$C = 30\cos 45 \quad 30\sin 45$

$= 21.21i - 21.21j$

b. $A + B + C = J$

$(0j + 20j) + (28.28i + 28.28j) + (21.21i - 21.21j)$

$= 49.49i + 27.07j$

$\Rightarrow \sqrt{(49.49)^2 + (27.07)^2}$

$= 56.41$

$\theta = \tan^{-1}\left(\frac{27.07}{49.49}\right)$

$\Rightarrow 28.67°$

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20. ? 21. ? 22. ? 23. ?

24. b. $A = 3i + 2j + 3k \quad B = i - j + 2k$

$A \cdot B = AB\cos\theta$

* $\theta = \cos^{-1}\left(\frac{(3 \times 1) + (2 \times -1) + (3 \times 2)}{\sqrt{3^2 + 2^2 + 3^2} \cdot \sqrt{1^2 + 1 + 2^2}}\right)$

$\theta = \cos^{-1}\left(\frac{7}{\sqrt{20} \cdot \sqrt{6}}\right)$

$\theta = 52.46$

27. ? 28. ? 29. ?

25. b. $A = 2i - 7j + 11k$

$B = 5i - j + 2k$

$A \times B = AB\sin\theta$

* $\theta = \sin^{-1}\left(\frac{\sqrt{(-3i)^2 + 51j^2 + 33k^2}}{\sqrt{174}\ \sqrt{30}}\right) = 57.3$

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26. (a) $|A| = \sqrt{1 + 4 + 25}$

$= \sqrt{30}$

$|B| = \sqrt{4 + 9 + 4}$

$= \sqrt{17}$

(b) $A + B = C$

$= (-i + 2j - 5k) + (2i + 3j - 2k)$

$C = i + 5j - 7k$

(c) $|C| = \sqrt{75}$

$\hat{C} = \frac{i + 5j - 7k}{\sqrt{75}}$

(d) $A \cdot B \Rightarrow \theta = \cos^{-1}\left(\frac{14}{\sqrt{30}\sqrt{17}}\right) = 51.7°$

(e) $A \times B \Rightarrow \theta = \sin^{-1}\left(\frac{\sqrt{121 + 144 + 49}}{\sqrt{30}\ \sqrt{17}}\right) = 51.7°$

Physics Chapter 2 : BioStatics

Torque (τ) ⇒ $rF\sin\theta$ where (r) is the distance between the axis of rotation & the point of contact of the force

angle between r & F

Example 2.1

$F = (2i + 3j)$ N along z coordinate

$r = (4i + 5j)$ m

find τ

$\tau = r \times F$

$$\tau = \begin{vmatrix} \overset{+}{i} & \overset{-}{j} & \overset{+}{k} \\ 4 & 5 & 0 \\ 2 & 3 & 0 \end{vmatrix}$$

$= 2k$ N.m

Example 2.2 –

$\tau = -10 \times 0.25 - 9 \times 0.25 + 12 \times 0.1$

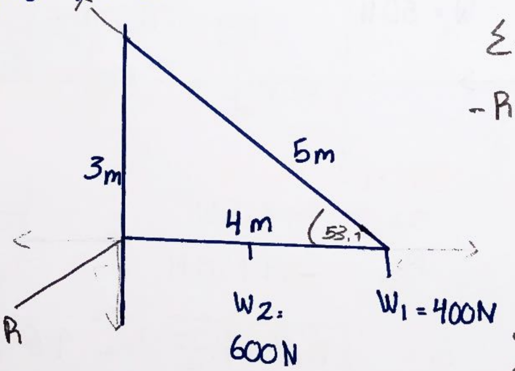
$\tau = -3.55$ Nm

Static equilibrium ⇒ objects that are not moving

where $\sum F = 0 < \begin{matrix} \sum F_x = 0 \\ \sum F_y = 0 \end{matrix}$

$\sum \tau = 0$

Example 2.5



$\sum F_x = 0$

$-R_x - T\cos 53.1 = 0$

$R_x = -T\cos 53.1$

$\sum F_y = 0$

$-R_y + T\sin 53.1 - 600 - 400 = 0$

$R_y = T\sin 53.1 - 1000$

$\sum \tau = 0$

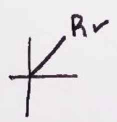
$\cancel{\tau_R} - \tau_{W_1} - \tau_{W_2} + \tau_T = 0$

$= -(4)(400)\sin 90 - (2)(600)\sin 90 + (4)T\sin 53.1$

$T = \dfrac{1600 + 1200}{4\sin 53.1} = 875.3$ N

⇒ $R_x = -525.5$ N

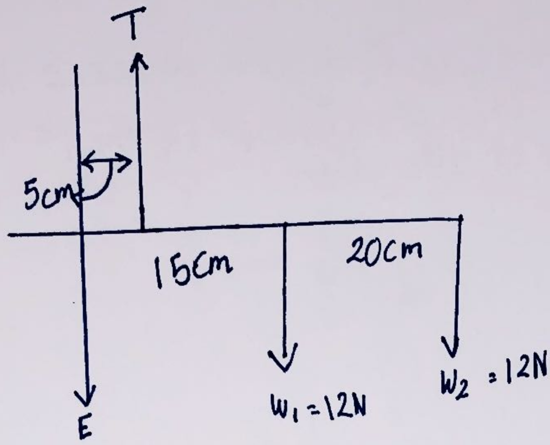
⇒ $R_y = -300.03$ N

∴ R = 

$R = \sqrt{R_x^2 + R_y^2} = 605.1$ N

$\theta = \tan^{-1}\left(\dfrac{300}{525.5}\right) = 29.72°$

Example 2.7:



$\sum F_x = 0$

$\sum F_y = T - E - W_1 - W_2 = 0$

$\hookrightarrow T - E - 24 = 0$

$\sum \tau = 0$

$\cancel{\tau_E} + \tau_T - \tau_{W_1} - \tau_{W_2} = 0$

$0.05\,T - 0.35(12) - 0.15(12)\ 0$

$T = \dfrac{6}{0.05}$

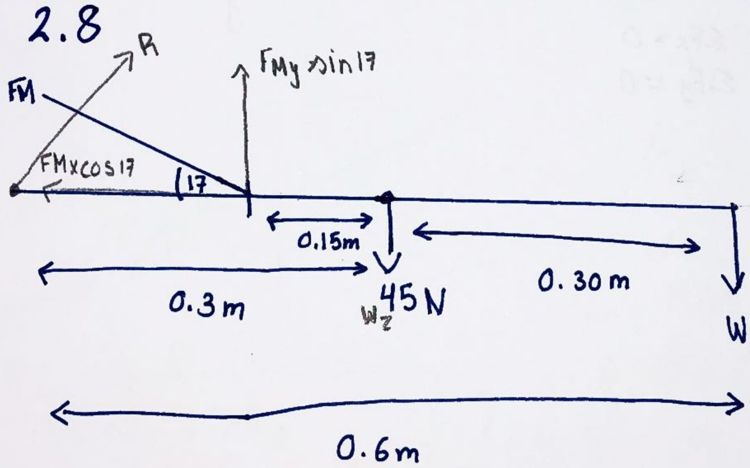
$= 120\text{ N}$

$E = T - W_1 - W_2$

$120 - 24$

$= 96\text{ N}$

Example 2.8



$\sum F_x = 0$

$R_x - FM\cos 17 = 0$

① $R_x = FM\cos 17$

$\sum F_y = 0$

$R_y + FM\sin 17 - 45 - 50 = 0$

② $R_y = -FM\sin 17 + 95$

$\sum \tau = 0$

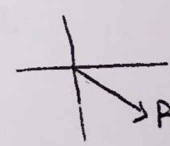
$\cancel{\tau_R} + \tau_{FM} - \tau_{W_1} - \tau_{W_2} = 0$

$0.15\,FM\sin 17 - (0.3)(45) - (0.6)(50) = 0$

$FM = \dfrac{43.5}{0.15\sin 17} = 991.88\text{N}$

$R_x = 948.5\text{N}$

$R_y = -194.99\text{N}$

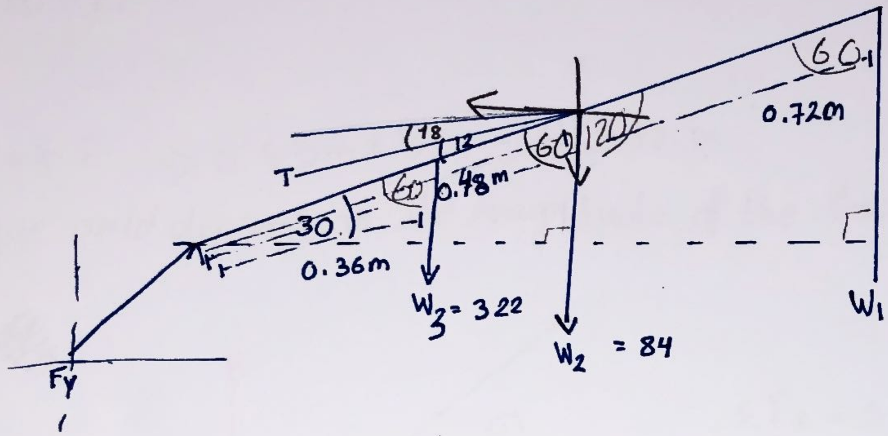


$R = \sqrt{R_x^2 + R_y^2} = 968.38\text{N}$

$\theta = \tan^{-1}\left(\dfrac{194.9}{948.5}\right)$

$= 11.61°$

Example 2.11



$\Sigma F_x = 0$

$F_V - T\cos 18 = 0$

① $F_{V_x} = T\cos 18$

$\Sigma F_y = 0$

$F_V - T\sin 18 - W_1 + W_2 - W_3$

$F_{V_y} = T\sin 18 + 455$

$\Sigma \tau = 0$

$\cancel{\tau_{F_V}} + \tau_T - \tau_{W_1} - \tau_{W_2} - \tau_{W_3} = 0$

$(0.48)T\sin 12 - (0.72)(44)\sin 60 - (0.48)(84)\sin 60 - (0.36)(322)\sin 60$

$T = \dfrac{30.5 + 34.9 + 100.3}{0.48\sin 12}$

$= 1661.25$ N

$F_{V_x} = 1579.95$

≈ 1580 N

$F_{V_y} = 968.35$

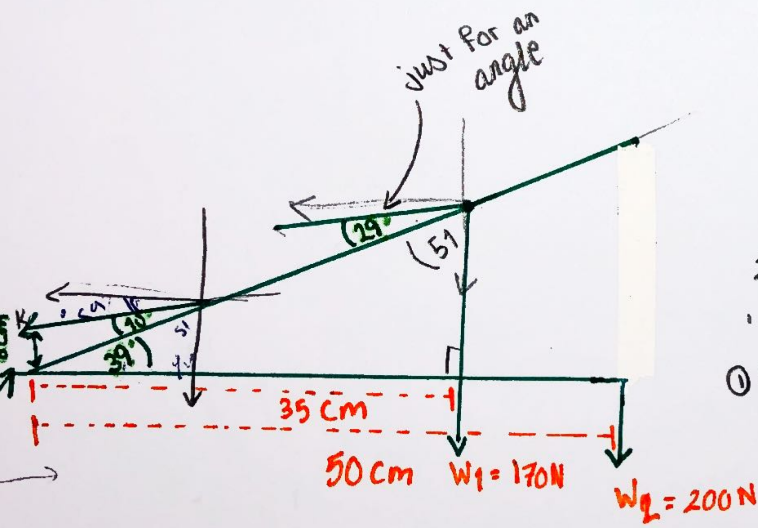
≈ 968.4 N

$F_V = \sqrt{F_{V_x}^2 + F_{V_y}^2}$

$= 1853.04$

$\theta = 31.5°$

Question from the slides:



$\Sigma F_x = 0$

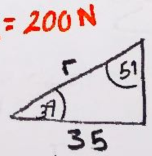
$R_x - K\cos 29 = 0$

① $R_x = K\cos 29$

$\Sigma F_y = 0$

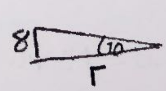
$R_y - K\sin \quad - W_1 - W_2 = 0$

$R_y = K\sin \quad + 370$



$\sin 51 = \dfrac{0.35}{r}$

$r\sin 51 = 0.35$



$r\tan 10 = 8$

$\tau = 0$

$+ \tau_K - \tau_{W_1} - \tau_{W_2} = 0$

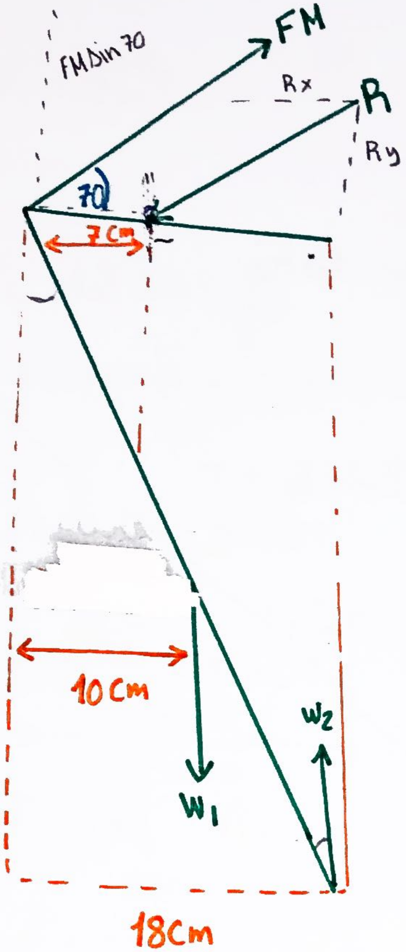
$8K \quad - 0.35(170) - 0.5(200) = 0$

$K = 19.93$

$R_x =$

$R_x =$

Example 2.11



$W_1 = 0.185 W_b$
$= 148$
$W_2 = 800$

$$\Sigma F_x = 0$$
$$-R_x + FM\cos 70 = 0$$
$$① \quad R_x = FM\cos 70$$
$$\Sigma F_y = 0$$
$$-R_y + FM\sin 70 - W_1 + W_2 = 0$$
$$② \quad R_y = FM\sin 70 + 652$$
$$\Sigma \tau = 0$$
$$\overset{0}{\cancel{\tau FM}} - \tau R - W_1 + W_2 = 0$$
$$7\,\underline{R\sin\theta} - 148(0.1) + 800(0.18) = 0$$
$$7\,R_y - 148(0.1) + 800(0.18) = 0$$
$$R_y = \frac{-129.2}{7}$$
$$= -18.45$$

$\underline{\underline{W_1}}$

$$\sin\alpha = \frac{0.1}{r}$$
$$r\sin\alpha = 0.1$$

$\underline{\underline{W_2}}$

$$\sin\theta = \frac{0.18}{L}$$
$$L\sin\theta = 0.18$$
$$r$$

Last Question from Slides

Physics ⇒ Chapter 2

Questions

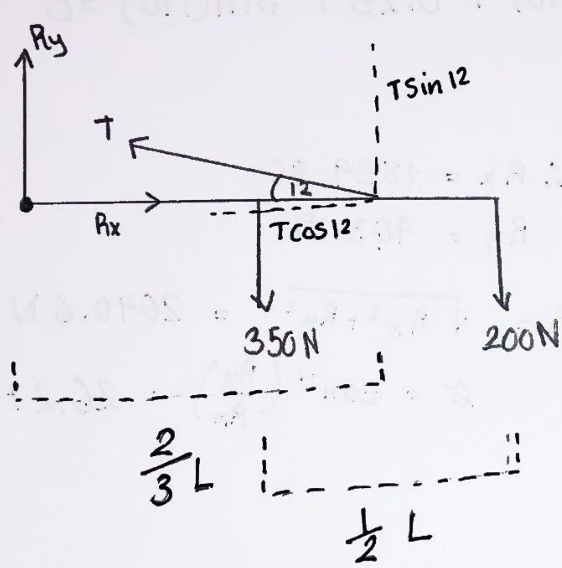
7. $\sum \tau = 0$

$-\tau_{w_1} - \tau_{w_2} - \cancel{\tau_E}_{0} + \tau_T = 0$

$-100 * 35\sin(110) - 12 * 15\sin(110) + T(5)\sin(110) = 0$

$T = 736\ N$

10.



$\sum F_x = 0$

$R_x = T\cos 12$

$\sum F_y = 0$

$R_y = -T\sin 12 + 550$

a. $\sum \tau = 0$

$\cancel{\tau_R}_{0} + \tau_T - \tau_{w_1} - \tau_2 = 0$

$\left(\frac{2}{3}L\right)(T)\sin 12) - \left(\frac{1}{2}L\right)350 - (L)(200) = 0$

divide by L

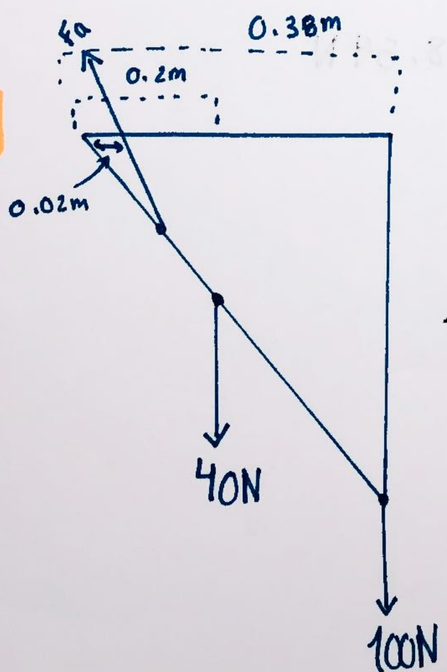
$\frac{2}{3}T\sin 12 - \frac{1}{2}(350) - 200 = 0$

$T = 2705.47\ N$

b. $R_x = (2705.47)\cos 12$

$= 2646.34\ N$

11.

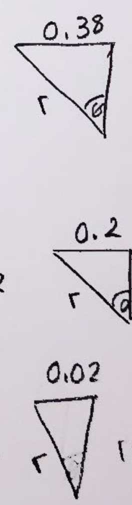


$\sum \tau = 0$

$-\tau_{w_1} - \tau_{w_2} + \tau_{Fa} = 0$

$-100(0.38) - 40(0.2) + Fa(0.02) = 0$

$Fa = 2300\ N$



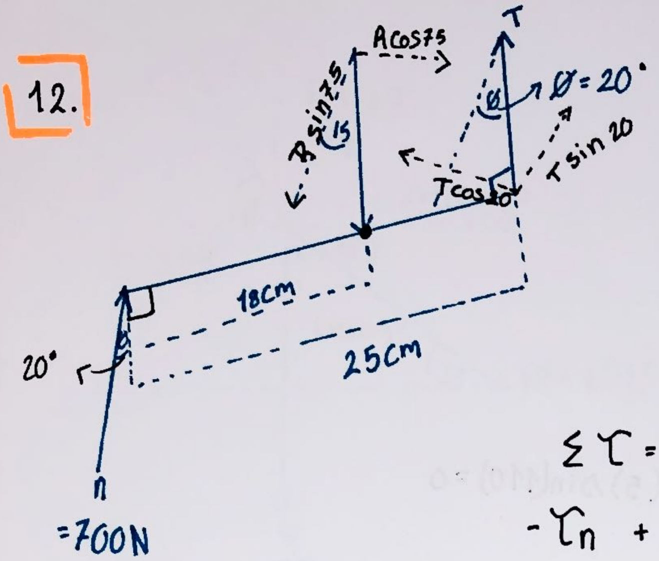
w_1 $\sin\theta = \frac{0.38}{r}$

$r\sin\theta = 0.38$

w_2 $r\sin\theta = 0.2$

Fa $r\sin\theta = 0.02$

12.



$\Sigma F_x = 0$

$R\cos 75 = T\cos 20$

$\Sigma F_y = 0$

$R\sin 75 = T\sin 20 + 700N$

$\Sigma \tau = 0$

$-\tau_n + \cancel{\tau_R}_{0} + \tau_T = 0$

$-0.18(700)\sin(110) + 0.25T\sin(110) = 0$

$T = 504\ N$

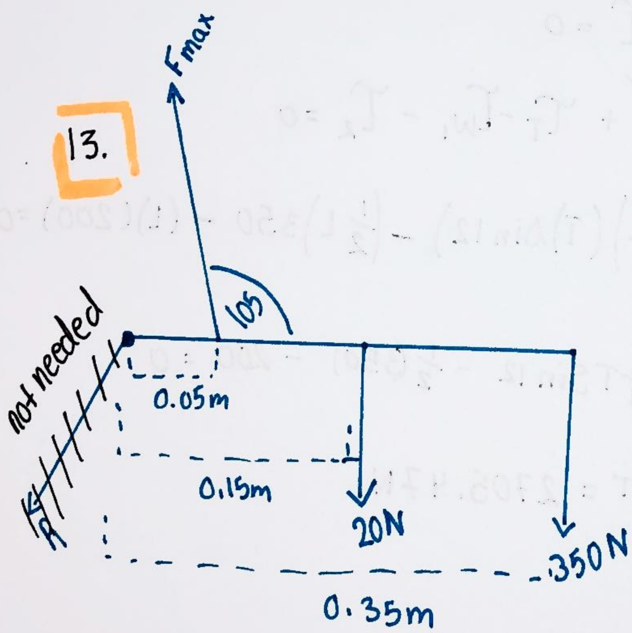
$\therefore R_x = 1829.86$

$R_y = 403.15$

$R = \sqrt{R_x^2 + R_y^2} = 2040.6\ N$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) = 26.27°$

13.



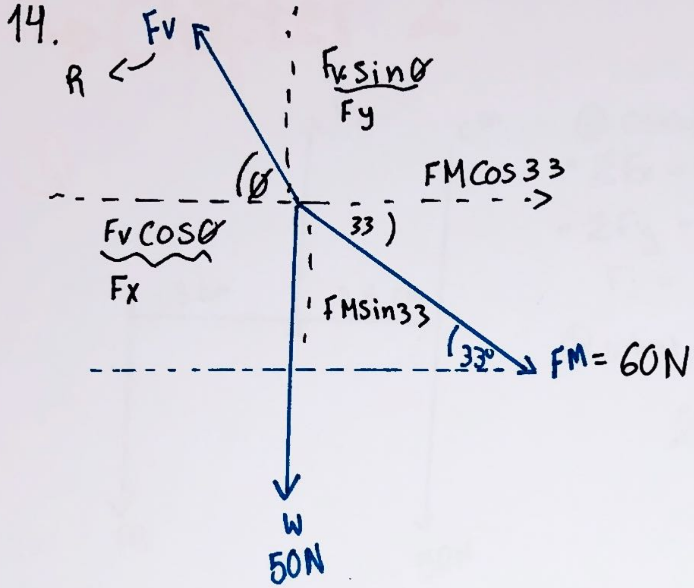
$\Sigma \tau = 0$

$\tau_{F_{max}} - \tau_{w_1} - \tau_{w_2} = 0$

$0.05\ F_{max} \sin(105) - 0.15(20) - 0.35(350) =$

$F_{max} = 2598.54\ N$

14.



$\Sigma F_x = 0$

$F_v \cos\theta = 60 \cos 33$

$\underbrace{F_v \cos\theta} = 50.32$

$F_x = 50.32$

$\Sigma F_y = 0$

$F_v \sin\theta = 60 \sin 33 + 50$

$F_v \sin\theta = 82.67$

$F_y = 82.67$

$$F = \sqrt{F_x^2 + F_y^2} = 96.787$$

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = 58.67°$$

Example 3.2

15 cm stretched 3.7 mm

Note: Elastic modulus = Y

$F = 13.4\ N$ $\quad d = 8.5\ mm$

$\Delta L = 3.7 \times 10^{-3}\ m$ $\quad r = 4.25 \times 10^{-3}\ m$

$L = 0.15 m$

$A = \pi r^2$

$= 5.67 \times 10^{-5}$

$$Y = \frac{\sigma}{\varepsilon} = \frac{F/A}{\Delta L/L}$$

$$= \frac{13.4 / 5.67 \times 10^{-5}}{3.7 \times 10^{-3} / 0.15} = 9.57 \times 10^{6}\ N/m^2$$

Example 3.3

$F = 250 N$ $\quad Y = 5 \times 10^{9}\ N/m^2$

$d = 1\ mm$ $\quad r = 5 \times 10^{-4}$ $\quad A = 7.85 \times 10^{-7}$

$\frac{\Delta L}{L} = ?$

$$\frac{\Delta L}{L} = \frac{(250 \cdot 7.85 \times 10^{-7})}{5 \times 10^{9}}$$

$= 0.0636$

Example 3.4

$F = 400 N$

d of Copper wire $= 0.8 mm$ $\quad$ length of Copper wire $= 16\ cm$

$\Delta L = 4\ mm$

$$\varepsilon = \frac{1}{2} F \Delta L$$

$$= \frac{1}{2}(400)(4 \times 10^{-3})$$

$= 0.8 J$

Example 3.5

$Y = 2\times10^6$

$L = 3mm \rightarrow 3\times10^{-3}$

$A = 0.5cm^2 \rightarrow 0.5\times10^{-4}$

$\Delta L = 1mm \rightarrow 1\times10^{-3}$

$$\mathcal{E} = \frac{1}{2}\frac{YA}{L}\Delta L^2$$

$$= \frac{1}{2}\frac{(2\times10^6)(0.5\times10^{-4})}{3\times10^{-3}}(1\times10^{-3})^2$$

$$= 0.017 J$$

Example 3.6

$L = 90cm$

$A = 6cm^2$

$w = 70kg$

$h = 60cm$

$\sigma_B = 10^9 \ dyn/cm^2$

$Y = 14\times10^{10}$

$$\mathcal{E} = \frac{AL\sigma_B^2}{2Y}$$

$$= \frac{(6\times10^{-4}_{m})(0.9m)(10^{8}_{m})^2}{2(14\times10^{10})}$$

$$= 192.86 J$$

$205.8 > 192.86$

∴ Bone can fracture

$$\mathcal{E} = mgh$$

$$= 70(9.81)(0.6m)$$

$$= 411.6 J$$ (for both legs)

↳ 205.8J (for one leg)

Example 3.7

$\mathcal{E} = ?$

$d = 0.8mm$

$L = 16cm$

$\Delta L = 4mm$

$F = 400N$

$$\mathcal{E} = \frac{1}{2}F\Delta L$$

$$= \frac{1}{2}(400)(4\times10^{-3}m)$$

$$= 0.8 J$$

1. $m = 200 kg$

$L = 4 m$

$A = 0.2 \times 10^{-4} m^2$

$Y = 8 \times 10^{10} N/m^2$

$\Delta L = ?$

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

$$8 \times 10^{10} = \frac{2000 / 0.2 \times 10^{-4}}{\Delta L / 4}$$

$$\Delta L = \frac{1 \times 10^8 \times 4}{8 \times 10^{10}}$$

$$= 5 \times 10^{-3} m$$

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2. rod $L = 35 cm$

$r = 1.8 cm$

$m = 60 kg$

$\Delta L = ?$

$Y = 1.6 \times 10^{10}$

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

$$\Delta L = \frac{(F/A) \cdot L}{Y}$$

$F = 60 \cdot 9.81 = 588.6$

$A = \pi (0.018 m)^2 = 1.02 \times 10^{-3} m$

$L = 0.35 m$

$$= \frac{(588.6 / 1.02 \times 10^{-3}) \cdot 0.35}{1.6 \times 10^{10}}$$

$$= 1.26 \times 10^{-5} m$$

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3. $m = 150 kg$

$L = 38 cm$

$r = 2.1 cm$

$\Delta L = ?$

$Y = 9 \times 10^9$

$A = 1.39 \times 10^{-3} m^2$

$F = 1471.5 N$

$L = 0.38 m$

$$\Delta L = \frac{(F/A) \cdot L}{Y}$$

$$= 4.5 \times 10^{-11} m$$

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4. $Y = 1.5 \times 10^{10}$

$d = 2.5$

$L = 25 cm$

$\therefore A = \pi (0.125)^2$

$= 4.91 \times 10^{-4}$

$F = ?$

$$1.5 \times 10^{10} = \frac{F}{4.91 \times 10^{-4}}$$

@ $F_{max} = 7.365 \times 10^4 N$

ⓑ $$\Delta L = \frac{(F/A) \cdot L}{Y}$$

$$= \frac{(7.365 \times 10^4) / 4.91 \times 10^{-4} \cdot 0.25}{1.5 \times 10^{10}} = 2.5 \times 10^{-3} m$$

5. $mass_{ph} = 72 kg$

$mass_{eq} = 400 kg$

$L = 610 m$

$r = 0.15 m$

$mass = 472 kg$

$\hookrightarrow 4720 N$

$$\Delta L = \frac{(F/A) \cdot L}{Y}$$

$$\Delta L = \frac{(4720/0.07) \cdot 610}{2.10 \times 10^{11}}$$

$$= 1.4 \times 10^{-4} m$$

8. $d = ?$

$L = 18 m$

$\Delta L = 9 mm$

$mass = 380 kg$

$\sigma_{max} = 3 \times 10^{8} N/m^2$

$$E = \frac{F/A}{\Delta L / L}$$

$$\frac{F}{A} = E \frac{\Delta L}{L}$$

$$\frac{3800}{A} = 2 \times 10^{10} \times \frac{9 \times 10^{-3}}{18}$$

$A = 0.000038 m^2$

$$r = \sqrt{\frac{A}{\pi}} = 0.00348 m$$

$$\sigma = \frac{3800}{0.000038} = 10^{5} N/m^2 < \underline{3 \times 10^{8} N/m^2}$$

deformation doesn't occur

6. ?

7. Elastic Limit $= 1.5 \times 10^{8} N/m^2$

$d = ?$ $mass = 10 kg$

$$\sigma = \frac{F}{A}$$

$$1.5 \times 10^{8} = \frac{100}{A}$$

$A = 6.667 \times 10^{-7} m^2$

$$r = \sqrt{\frac{6.667 \times 10^{-7}}{\pi}}$$

$= \underline{4.61 \times 10^{-4} m} \times 2$ $= 0.461 mm$

$d = 9.2 \times 10^{-4} m \rightarrow 0.92 mm$

9. $d = 10 mm$

$L = 50 m$

$\Delta L = 1.6 m$

$mass = 90 kg$

$Y = ?$

$$Y = \frac{F/A}{\Delta L / L} = \frac{900/7.85 \times 10^{-5}}{1.6/50}$$

$$= 3.58 \times 10^{8} N/m^2$$

10. $r_{inner} = 0.02 m$

$r_{outer} = 0.023 m$

$\sigma = 5 \times 10^{7} N m^{-2}$

$F = \sigma A$

$= 5 \times 10^{7} \cdot \pi (0.023^2 - 0.02^2)$

$= 2.026 \times 10^{4} N$

11. $L = 1.2 m$

$\varepsilon = 1.3 \times 10^{-4}$

$\Delta L = ?$

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

$\Delta L = 1.3 \times 10^{-4} \cdot 1.2$

$= 1.56 \times 10^{-4} m$

12. $K = ?$

$A = 10^{-3}$

$L = 0.4 m$

$Y = 1.5 \times 10^{10}$

$$K = Y \frac{A}{L}$$

$$= 1.5 \times 10^{10} \frac{10^{-3}}{0.4}$$

$= 3.75 \times 10^{7} N/m$

13. $L = 1.35 m$ $\Delta L = 8 mm$

$d = 0.85 mm$ $F = ?$

$$Y = \frac{F/A}{\Delta L / L} \rightarrow F = \frac{\Delta L Y A}{L}$$

$$= \frac{(8 \times 10^{-3})(2.1 \times 10^{11})(5.6 \times 10^{-7})}{1.35}$$

$= 722 N$

14. $A = 10^{-3}\ m^2$

$L = 0.4\,m$

$F = 750\ N$

$Y_{bone} = 0.9 \times 10^{10}\ Nm^{-2}$

$\sigma_{max} = 17 \times 10^7\ Nm^{-2}$

a) $\Delta L = ?$

$$\Delta L = \frac{L}{Y_b}\ \frac{F}{A}$$

$$= \frac{0.4}{0.9\times10^{10}} \cdot \frac{\frac{1}{2}(750)}{10^{-3}}$$

$$= 1.667 \times 10^{-5}\ m$$

b) ΔL of fracture

$$\Delta L = \frac{\sigma L}{Y}$$

$$= \frac{17\times10^7(0.4)}{0.9\times10^{10}}$$

$$= 7.55\times10^{-3}\ m$$

c) $K = ?$

$$K = Y\frac{A}{L}$$

$$= 0.9\times10^{10}\ \frac{10^{-3}}{0.4}$$

$$= 22500000\ Nm^{-1}$$

15. $L = 20\ m$ $\quad \Delta x = ?$

$d = 4cm$ $\quad S = 2.5\times10^{10}\ N/m^2$

$F = 900N$

$$\Delta x = \frac{1}{S}\cdot\frac{F}{A}L$$

$$= \frac{1}{2.5\times10^{10}}\cdot\frac{900}{1.25\times10^{-3}}\cdot 20 = 5.73\times10^{-4}$$

16. $F = 500N$

$L = 3cm \rightarrow 0.03$

$d = 4cm \rightarrow 0.04$

$$\Delta x = \frac{1}{S}\cdot\frac{F}{A}L$$

$$\Delta x = \frac{1}{8\times10^{10}}\cdot\frac{500}{1.2\times10^{-3}}\cdot 0.03$$

$$= 1.44\times10^{-7}\ m$$

17. $F = 600$

$S = 1\times10^9$ $\quad \Delta x = ?$

$L = 0.7\ cm$

$d = 0.04\ m$

$$\Delta x = \frac{1}{1\times10^9}\cdot\frac{600}{1.25\times10^{-3}}\cdot 0.007$$

$$= 3.34\times10^{-6}\ m$$

18. $\Delta V = 0.2$ $\quad \frac{\Delta V}{V} = \frac{0.2}{100}$

$B = 1.8\times10^9$

$\Delta P = ?$

$$B = \frac{\Delta P}{\Delta V/V}$$

$$\Delta P = (1.8\times10^9)\left(\frac{0.2}{100}\right)$$

$$= 3.6\times10^6\ N/m^2$$

19. $F = 500N$

$L = 1m$

$A = 4\ Cm^2 \rightarrow 0.04\ m^2$

$\sigma = 10^8$

$Y = 14\times10^9$ $\quad V = ?$

$$E = \frac{AL\sigma^2}{2Y} \qquad E = \frac{1}{2}mv^2$$

$$\frac{AL\sigma^2}{2Y} = \frac{1}{2}mv^2$$

$$\frac{(0.04)(1)(10^8)^2}{2(14\times10^9)} = \frac{1}{2}(50)v^2$$

$$V = 2.39\ m/s$$

Book Examples:

Example 4.1 ⇒ $T_C = T_F$

$$\frac{5}{9}(T_C - 32^\circ) = \frac{9}{5}T_F + 32$$

$$T_C = T_F = -40$$

Example 4.2 ⇒ 0.1 mole of O_2 → $16 \times 2 = 32$

@ standard conditions

1 atm $= 1.013 \times 10^5$ Pa ← P = ? V = 1L

@ constant temp. → 273K

D = ?

$$PV = nRT$$

$$P(10^{-3}) = (0.1)(8.314)(273)$$

$$P = 226972.2 \text{ pa} \Rightarrow 2.24\text{atm}$$

$$D = \rho$$

$$\rho = \frac{P M_w}{RT} \Rightarrow \frac{(2.2 \times 10^5)(32 \times 10^{-3})}{8.314 \cdot 273} = 3.2 \text{kg/m}^3$$

Example 4.3 ⇒ $V_1 = 15L$ $V_2 = 12L$

$P_1 = 2atm$ $P_2 = 3.5 atm$

$T_1 = 300K$ $T_2 = ?$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{15 \cdot 2}{300} = \frac{12 \times 3.5}{T_2}$$

$$T_2 = 420K$$

Book Examples

Example 4.4 ⇒ $P = 6\,atm$
$T = 7°C$

ⓐ $P \times 3$ find T_2

$$\frac{1}{T_1} = \frac{3}{T_2} \Rightarrow \frac{1}{280} = \frac{3}{T_2}$$

$T_2 = 840K$

ⓑ heated until $P \times 2$ $V \times 2$ T_2

$$\frac{2\,P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$T_2 = 1120K$

Example 4.5 ⇒ $V = 0.3\,m^2$
2 moles of helium gas
$T = 20\,°C$

ⓐ $K_{av} = ?$
Per atom

$$K_{av} = \frac{3}{2} K_B T$$
$$= \frac{3}{2}(1.38 \times 10^{-23})(293K)$$
$$= 6.07 \times 10^{-21} J$$

ⓑ rms = ?

$$V_{rms} = \sqrt{\frac{3RT}{M_w}}$$
$$= \sqrt{\frac{3(8.314)(293)}{4 \times 10^{-3}}}$$
$$= 1350\ m/s$$

Example 4.6 ⇒ $L_o = 35m$
$T_i = -20\,°C$
$T_f = 35°C$
$\alpha = 1.7 \times 10^{-5}$
$\Delta L = ?$

$$\Delta L = \alpha L_0 \Delta T$$
$$= (1.7 \times 10^{-5})(35)(35+20)$$
$$= 0.0327\,m$$

Example 4.7 ⇒ $L_o = 30m$ $T = 0°C$
$\alpha = 11 \times 10^{-6}\ C^{-1}$

ⓐ ΔL ? ⇒ $T = 40°C$

$$\Delta L = \alpha L_0 \Delta T$$
$$= (11 \times 10^{-9})(30)(40)$$
$$= 30.013\,m$$

ⓑ σ ? @ $40\,°C$
$A = 30\,cm^2$
$Y = 200\,GPa$

$$\sigma = Y \frac{\Delta L}{L_o}$$
$$= 200 \times 10^9 \left(\frac{30.013}{3}\right)$$
$$= 8.7 \times 10^7\,Pa$$

$$F = \sigma A$$
$$= 8.7 \times 10^7 \cdot 3 \times 10^{-3}\ ?$$
$$= 2.6 \times 10^5\,N$$

Example 4.8 ⇒

$\alpha = 130\times10^{-6}\ C^{-1}$

$T = 20\ C$ $\quad r = 2.2cm$

$T = ?$ $\quad r = 2.21\ cm$

$\Delta T = \dfrac{\Delta A}{A_0 2\alpha}$

$A_0 = \pi r^2 = \pi\, 2.2^2 = 15.21\ cm^2$

$A = \pi r^2 = \pi\, 2.21^2 = 15.35\ cm^2$

$T_f = \dfrac{0.14}{15.21(2(130\times10^{-6}))} + 20$

$T_f = 55.4\ °C$

$\Delta A = 15.35 - 15.21 = 0.14\ cm^2$

Example 4.9 ⇒

$L = 30cm$ $\quad \cancel{\ } d = 1.5cm$

$\Delta T = 65°C$

$\alpha = 9\times10^{-6}\ c^{-1}$

ⓐ $\Delta L = ?$

$\Delta L = \alpha L_0 \Delta T$

$= (9\times10^{-6})(30)(65)$

$= 0.01755 cm$

ⓑ $\Delta d = ?$

$A_0 = \pi r^2$

$= \pi \left(\frac{1.5}{2}\right)^2$

$= 1.767\ cm^2$

$\Delta A = 2\alpha A_0 \Delta T$

$= 2(9\times10^{-6})(1.767)(65)$

$= 2.068\times10^{-3} cm^2$

$A = \Delta A + A_0$

$= 1.769\ cm^2$

$r = \sqrt{\dfrac{A}{\pi}} = 0.7504 cm$

$\Delta d = 1.508 - (0.7504\times2)$

$= 0.08 cm$

ⓒ $\Delta V = ?$

$\Delta V = 3\alpha V_0 \Delta T$

$V_0 = \pi\left(\frac{1.5}{2}\right)^2 \times 30$

$= 53.01\ cm^3$

$\Delta V = 3(9\times10^{-6})(53.01)(65)$

$= 0.0904\ cm^3$

Example 4.10 ⇒

$m_x = 50g$

$T_x = 200°C$

$C_w = 4186\ JKg^{-1}°C^{-1}$

$t_w = 20°C$

$m_w = 0.4kg$

$T_f = 22.4°C$

find C_x

$C_x = \dfrac{m_w C_w (T_f - T_w)}{m_x (T_x - T_f)}$

$C_x = \dfrac{(0.4)(4186)(22.4-20)}{(0.05)(200-22.4)}$

$= 453\ J/Kg°C$

Example 4.11 ⇒

$T_{hot} = 91°C$ $\quad T_{cold} = 12°C$

$m_{hot} = ?$ $\quad m_{total} = 800$

$m_h + m_c = 800$

$m_{cold} = ?$ $\quad T_f = 35$

$Qin = Qout$

$m_c C_c (T_f - T_i)_c = m_h C_h (T_f - T_i)_h$

$m_c (35-12)_c = m_h (35-91)$

$m_c\, 23°C = m_h\, 56°C$

$m_c = \dfrac{56}{23} m_h$

$m_c = 2.5\, m_h$

$m_h = m_c$

$m_h = 2m_h$

$3m_h = 800$

$\dfrac{800}{3} = 266$

$m_h = 266.67\ Kg$

$m_c = 800 - 266.67$

$= 533.3\ Kg$

Example 4.12 ⇒

$T_c = 100\,°C$

$L = 12mm \rightarrow 0.012$

$A = 1.5 \times 10^4 mm^2 \rightarrow 0.015 m^2$

$T_h = 102°c$

find heat ransfer rate

$H = kA\frac{(T_h - T_c)}{L}$

(aliminium pot)
$k = 238$

$= 238(0.015)\frac{102-100}{0.012}$

$= 588W$

Compare with Copper pot

$k = 397$

$H = 397(0.015)\frac{102-100}{0.012}$

$= 1003W$

Example 4.13 ⇒

$T_s = 20°C \rightarrow 257.15K$

$T = 37°C \rightarrow 274.15K$

$e = 0.9$

$A = 1.5m^2$

$P = e\sigma A(T^4 - T_s^4)$

$= (0.9)(5.67\times10^{-8})(1.5)(257.15^4 - 274.15^4)$

Example 4.14 ⇒

$T = 6000k$

$\lambda = ?$

$\lambda = \frac{B}{T}$

$= \frac{2.898\times10^{-8}}{6000}$

$= 4.83\times10^{-7}m$

Chapter 4 Book Questions

$\boxed{1}$ $T_c = -145.81^\circ C$

ⓐ F $\Rightarrow \frac{4}{5} -145.81 + 32 = 320.15^\circ F$

ⓑ K $\Rightarrow -145.81 + 237 = 77.3\,K$

$\boxed{2}$ $\Delta T_c = 450^\circ C$

ⓐ $\Delta F = \frac{9}{5}(450) = 810^\circ F$

ⓑ $\Delta T_K = 450K$

$\boxed{3}$ mass of $XeF_4 = 2.5g$

$V = 3L \Rightarrow 3\times10^{-3} m^3 \Rightarrow 3\times10^{-5} m$

$T = 80^\circ C$ $\quad 80 + 237 = 353$

$P = ?$

$PV = nRT$

moles $= \frac{\text{mass}}{\text{molar mass}}$

$n = \frac{2.5}{207.28} = 0.012$ mol

$P = \frac{(0.012)(8.314)(353)}{3\times10^{-5}}$

$= 1.17\times10^4$ Pa

$\boxed{4}$ $V_1 = 100\,cm^3$ $\quad V_2 = 87.2\,cm^3$

$T_1 = 0^\circ C$ $\quad T_2 = ?$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{100}{273} = \frac{87.2}{T_2}$

$T_2 = \frac{87.2}{0.366} = 238.056\,K$

$\boxed{5}$ AP [scribbled out] $\quad T = 20$

ρ of oxygen gas $= O_2$

$\rho = \frac{PM_w}{RT} \Rightarrow \frac{(1.013\times10^5)(32)}{(8.314)(20+273)}$

$= 1330.7\,g/m^3$

$\boxed{6}$ $V = 3L$ $\quad$ fixed temp

$P = 250\,kPa$

$B = -V_1 \frac{\Delta P}{\Delta V}$

$B = -V_1\left(-\frac{P_2}{V_1}\right)$

$P_2 = 250$

$\boxed{7}$ atoms of He (N)

$d = 30$ cm $\quad T = 20^\circ C$ $\quad$ 1 atm

$PV = Nk_BT$

$(1.013\times10^5)(\frac{4}{3}\pi\, 0.15^3) = N(1.38\times10^{-23})(293)$

$N = 3.5418\times10^{23}$ atoms

$K_{avg} = ?$

$K_{av} = \frac{3}{2}k_BT$

$= \frac{3}{2}(1.38\times10^{-23})(293)$

$= 6.0651\times10^{-21}\,J$

$V_{rms} = ?$

$V_{rms} = \sqrt{\frac{3RT}{M_w}} \Rightarrow \sqrt{\frac{3(8.314)(293)}{\frac{4}{6.02\times10^{23}}}}$

$= 1.35\,km/sec$

$\boxed{8}$ Molar mass $= 28.9\,g/mol$

atm $\quad T = 300\,K$ $\quad$ 10 cm

ⓐ mass $= ?$ $\longrightarrow m = nM$

$m = \frac{PV}{RT}M$

$= \frac{1.013\times10^5 \cdot 0.1^3}{8.314 \times 300} \times 28.9$

$= 1.17\times10^{-3}\,kg$

ⓑ weight $= ?$

$F = mg$

$= 1.17\times10^{-3}\cdot 10$

$= 11.7\,mN$

ⓒ $F = ?$

$F = PA$

$= 1.013\times10^5 \times 0.1^2$

$= 1013\,N$

9 $L_0 = 35m$

$T_i = -20$

$T_f = 35$

$L = \alpha L_0 \Delta T$

$= (1.7\times10^{-5})(35)(35+20)$

$\Delta L = 0.0327 m$

10 $d = 4cm \quad r = 0.02 m$

$T = 70C$

$Y = 20.6\times10^{10} N/m^2$

$\alpha = 11\times10^{-6} C^{-1}$

$A = \pi r^2 = \pi 0.02^2$

Tension / F = ?

$\sigma = \frac{F}{A} \quad \varepsilon = \frac{\Delta L}{L_0}$

$\frac{\Delta L}{L_0} = \alpha \Delta T$

$= 11\times10^{-6} C^{-1} \cdot 70$

$= 7.7\times10^{-4}$

$Y = \frac{\sigma}{\varepsilon}$

$20.6\times10^{10} = \frac{\frac{F}{1.25\times10^{-3}}}{7.7\times10^{-4}}$

$F = 2\times10^5 N$

11 $L_0 = 12m \quad \Delta L = ?$

$T_i = -5°C \quad \alpha = 1\times10^{-5} °C^{-1}$

$T_f = 35°c$

$\Delta L = \alpha L_0 (T_f - T_i)$

$= 1\times10^{-5}(12)(35+5)$

$= 0.0048 m$

12 $T_i = 20°c$ — ⓐ ΔL @ $T = 120°C$

$L_0 = 2m$ — ⓑ F? $Y = 2\times10^{11} N/m^2$

$C.S.A = 10 cm^2$

$\alpha = 1.72\times10^{-5} K^{-1}$

ⓐ $\Delta L = (1.72\times10^{-5})(2)(120-20)$

100K

$\Delta L = 0.00344 m$

ⓑ $Y = \frac{\sigma}{\varepsilon} = \frac{\frac{F}{A}}{\frac{\Delta L_c}{L_0}}$

$F = Y \times A \times \frac{\Delta L}{L_0}$

$= (2\times10^{11})(10^{-3})(1.72\times10^{-3})$

$= 3.44\times10^5 N$

13 Period = 1s @ 20°C $\quad \alpha = 3\times10^{-5} C^{-1}$

$T_f = 30 C$

- ⓐ period change
- ⓑ time gain / lost in a week

ⓐ $\tau = 2\pi\sqrt{\frac{L}{g}}$

$1 sec = 2\pi\sqrt{\frac{L}{9.8}}$

$L = 0.24824 m$

$L' = L_0(1 + \alpha \Delta T)$

$= 0.24824(1 + 3\times10^{-5}(30-20))$

$= 0.24831$

$\tau' = 2\pi\sqrt{\frac{L'}{g}} = 2\pi\sqrt{\frac{0.24831}{9.8}}$

$\tau' = 1.0001499$

$\Delta\tau = \tau' - \tau$

$= 1.0001499 - 1$

$= 0.0001499$

$\tau_{weak} = 7 * 24 * 60 * 60 * 0.0001499$

$= 90.71 sec$

$= 1.5 min/week$

$\boxed{14}$ $V = 2\times10^{-7}\ m^3$ $h = ?$

$r = 5\times10^{-5}\ m$

$T = 100^\circ C$

$\gamma = 1.82\times10^{-4}\ K^{-1}$

$\Delta V = \pi r^2 h$ $\Delta V = (\Delta V_{hg} - \Delta V_{bulb})$

$\pi r^2 h = \gamma V_0 \Delta T - 3\alpha V_0 \Delta T$

$$h = \frac{V_0 \Delta T(\gamma - 3\alpha)}{\pi r^2}$$

$$= \frac{((2\times10^{-7})(100))(1.82\times10^{-4} - 3\times3.2\times10^{-6})}{\pi(5\times10^{-5})^2}$$

$\Rightarrow h = 0.439\ m$

$\boxed{15}$ $Q = 46.6\ KJ$

$m = 0.15\ kg$

$T_i = 20$ $T_f = 80$

Specific heat $C = \frac{Q}{m\Delta T}$

$Q = C\ m\ \Delta T$

$= \frac{46.6}{0.15\times60} = 5.18\times10^3\ J/KgK$

$\boxed{16}$ $T_i = 900K$ $m_w = 5kg$

$T_f = 340k$ $C_w = 4200$

$C_i = 440$ $T_w = 300$

$T_f = 340$

$m_w C_w (T_f - T_w) = m_i C_i (T_i - T_f)$

$5\times4200(340-300) = m_i\ 490(900-340)$

$m_i = 3.06kg$

$\therefore Q_{lost} = m_i C_i (T_i - T_f)$

$= (3.06)(490)(900-340)$

$= 84\times10^5 J$

$\boxed{17}$ $S.A = 1.2\ m^2$

$L = 4cm$

$H = 10W$ $K = ?$

$\Delta T = 15^\circ C$

$$H = KA\frac{\overbrace{(T_{hot} - T_{cold})}^{\Delta T}}{L}$$

$10 = K(1.2)\frac{15}{0.04}$

$K = 0.022\ W/mK$

$\boxed{18}$ $T = 5800\ K$

$r = 6.96\times10^8 m$

$e = 0.96$

$\sigma = 5.76\times10^{-8}$

$P = ?$ $P = eA\sigma T^4$

$= 0.96(4\pi(6.96\times10^8)^2)(5.76\times10^{-8})(5800)^4$

$P = 3.76\times10^{26} W$

$\boxed{19}$ $H = 280W$ $d = 0.03m$

$A = 1.5m^2$ $k = 0.2$

$\Delta T = ?$

$280 = (0.2)(1.5)\frac{\Delta T}{0.03}$

$T = 28K$

$\boxed{20}$ $l = 2m$ $d = 10cm$ $T_f = 80$ $T_i = 20$

$e = 1$ $\sigma = 5.76\times10^{-8}$

$A = 2\pi r l \Rightarrow 2\pi(0.05)(2)$

$= 0.628m^2$

$P = eA\sigma(T_f^4 - T_i^4)$

$= 1(0.628)(5.76\times10^{-8})(353 - 293)$

$= 295.07W$

$\boxed{21}$ $A = 3\ m^2$ $T = 75^\circ F$

$L = 0.6\ cm$ $K = 0.8\ W\ m^{-1} k^{-1}$

$H = KA\frac{\Delta T}{L}$

$= 0.8(3)\frac{\frac{5}{9}75}{0.6}$

$= 16.67\ KW$

Examples:

5.1 ⇒ $r = 1cm$

$Q = 3L/min$

@ velocity

$\boxed{Q = \frac{\Delta V}{\Delta t}} = \frac{0.003\, mL}{60\, sec} = 5 \times 10^{-5} m^3/s$

$\boxed{\bar{V} = \frac{Q}{A}} = \frac{Q}{\pi r^2} \Rightarrow \frac{5 \times 10^{-5}}{\pi 0.01^2} = 0.159\, ms^{-1}$

(b) $r = 0.5cm$

$\bar{V}_2 = \frac{5 \times 10^{-5}}{\pi 0.005^2} = 0.6366\, ms^{-1}$

$\boxed{or}$

$\boxed{r_1^2 \bar{V}_1 = r_2^2 \bar{V}_2}$

$\sqrt{\frac{0.01^2 \cdot 5 \times 10^{-5}}{5 \times 10^{-5}}} = r_2$

$r_2 = 0.6366\, ms^{-1}$

5.2 ⇒ $r = 2cm$
$P = 3atm$ > Pipe

hose $r = 0.5$
$h = 10m$

$\bar{V} = ?$

$r_1^2 \bar{V}_1 = r_2^2 \bar{V}_2$

$0.02^2 \bar{V}_1 = 0.005^2 \bar{V}_2$

$V_1 = \frac{0.005^2}{0.02^2} V_2 \Rightarrow \frac{1}{16} V_2$

$V = V_2^2 - V_1^2$

$= V_2^2 - \left(\frac{1}{16} V_2\right)^2$

$= V_2^2 - \frac{1}{256} V_2^2$

flip $= \frac{256 V_2^2 - V_2^2}{256}$

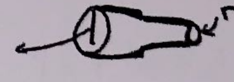
$= \frac{255}{256} V_2^2$

$P + \frac{1}{2}\rho v^2 + \rho g h$

5.3 ⇒ hole

$r = 1cm$

$d = 2cm$



$h = 2m$

$P = 3atm$

time?

5.4 ⇒ $P = ?$

$h = 5\,m$

$P_2 = P_a + \rho g(h)$

$= 1.013\times10^5 + 1000\times10\times5$

$= 1.5\times10^5\,Pa$

5.5 ⇒ $d_1 = 12mm$ wide

$d_2 = 4mm$ narrow

flow rate = ?

$P_1 = 8kPa$ wide

$P_2 = 4kPa$ narrow

$\rho = 1060\ kgm^{-3}$

$P_{out} - P_{in} = \frac{1}{2}\rho(\bar{V}_{in}^2 - \bar{V}_{out}^2)$

out = wide

in = narrow

$r_1^2\bar{V}_1 = r_2^2\bar{V}_2$

$\bar{V}_{wide} = \frac{r^2_{narrow}}{r^2_{wide}}\bar{V}_{nar.}$

$\bar{V}_w = \left(\frac{.4}{12}\right)^2\bar{V}_{nar.}$

$= \frac{1}{9}$ nar.

$8\times10^3 - 4\times10^3 = \frac{1}{2}(1060)\left(\bar{V}_{narrow}^2 - \left(\frac{1}{9}\right)\bar{V}_{narrow}^2\right)$

$\frac{4\times10^3}{530} = \frac{530\left(\bar{V}_n^2 - \frac{1}{81}\bar{V}_n^2\right)}{530}$

$81\cdot\ \frac{400}{53} = \frac{80\bar{V}^2}{81}$ $\cdot81$ multiply by 81

$\frac{81\cdot400}{53} = 80\bar{V}^2$

$\bar{V} = \sqrt{\frac{611.3}{80}}$

$\bar{V}_{n.} = 2.76\ ms^{-1}$

flow rate = Q

$Q = A\bar{V}$ narrow

$Q = \pi r^2\bar{V}_n$

$= \pi(2\times10^{-3})^2\cdot2.76$

$= 34.68\times10^{-6}\ m^3s^{-1}$

5.6 ⇒ venturi

Wide ⇒ $A = 0.08cm^2$

Cross sectional of artery

narrow ⇒ $A = 0.04\,cm^2$

$\bar{V}. = 12.5\,cm\,s^{-1}$

find the drop in pressure...

$\boxed{P_1 - P_2 = \frac{1}{2}\rho(\bar{V}_2^2 - \bar{V}_1^2)}$

$= \frac{1}{2}(1060)\left(\frac{0.08}{0.04}^2 - 0.125^2\right)$

$= 25Pa$

5.7 ⇒ L = 1.7

brain 0.5m above heart

bends ↳ brain 0.4m below heart

blood pressure change?

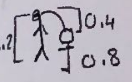
$P_{BS} = P_H + \rho g(h_H - h_B)$

$= 13.3\times10^3 + 1060\cdot10(1.2 - 1.7)$

$= 13.3\times10^3 + 1060\cdot10(-0.5)$

$= 8\times10^3\,Pa$

$P_{Bb} = P_H + \rho g(h_H - h_B)$



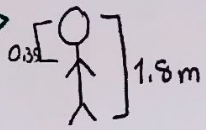
$= 13.3\times10^3 + 1060\cdot10(1.2 - 0.8)$

$= 17.54\times10^3\,Pa$

$\Delta P = 17.54 - 8$

$= 9.54\times10^{-3}\,pa$

5.8 ⇒



accelerating upwards $12\,ms^{-2}$

$P_B = ?$

$P_F = ?$

$P_B = P_H + \rho(g+a)(h_H - h_B)$

$= 13300 + 1060(22)(-0.35)$

$= 5.14 \times 10^3 Pa$

$P_F = P_H + \rho(g+a)(h_H - h_F)$

$= 13300 + 1060(22)(1.45)$

$= 47.11 \times 10^3 Pa$

5.9 ⇒ $L = 5mm \rightarrow 5\times10^{-3}m$

$r = 3\times10^{-6}\,m$

$V_{max} = 0.6\,ms^{-1}$ $\quad V = 0.3$

$\eta = 2.08\times10^{-2}\,P$

$P = ?$ $\qquad r$ = reduced 20%.

$\Delta Q = ?$

$$V = \frac{\Delta P r^2}{8\eta L}$$

$$0.3 = \frac{\Delta P(3\times10^{-6})^2}{8(2.08\times10^{-2})(5\times10^{-3})}$$

$\Delta P = 2.77\times10^6 Pa$

ΔQ ⇒

$r\downarrow 20\%$ $\quad 0.8(3\times10^{-6})$

$\Rightarrow 2.4\times10^{-6}$

$Q = r^4$

$= (0.8)^4 Q_1$

$= 0.407\,Q_1$

5.10 ⇒ $d = 0.4mm$ $\qquad \rho = 1060$

$L = 4cm$ $\qquad \eta = 0.0028 PaS$

$P = 2400pa$

$V = 4cm^3/min$

$h = ?$

$\Delta P \rightarrow Q = \dfrac{\pi \Delta P r^4}{8\eta L}$

$\Delta P = \dfrac{8Q\eta L}{\pi r^4}$

$\Delta P \Rightarrow (P_1 - P_2) = \left(\dfrac{8Q\eta L}{\pi r^4}\right)$

$P_1 = P_2 + \dfrac{8Q\eta L}{\pi r^4}$

$\rho g h = P_2 + \dfrac{8Q\eta L}{\pi r^4}$

$$1060\cdot10\cdot h = 2400 + \frac{8\left(\frac{4\times10^{-6}m^3}{60}\right)(0.0028)(0.04)}{\pi(0.0002)^4}$$

$$\frac{10600h}{10600} = \frac{14283}{10600}$$

$h = 1.34\,m$

5.11 ⇒ $\Delta P = P_1 - P_2$ $\qquad$?

$1060\cdot10\cdot134 - 2400$

$= 11804$

5.12 ⇒ R_f of $r = 5\times10^{-6}\,m$

$r = 5\ cm$

$$\frac{R_f)}{R_f} = \frac{(5\times10^{-2})^4}{(5\times10^{-6})^4} = 10^{16}$$

5.13 ⇒ $r = 4mm$

$Q = 1\,cm^3\,s^{-1}$

ⓐ average & max v

$Q = A\bar{V}$

$$V = \frac{Q}{A} = \frac{1\times10^{-6}}{\pi(4\times10^{-3})^2} = 0.02\,ms^{-1}$$

$V_{max} = 0.02(2)$

$= 0.04\,ms^{-1}$

ⓑ Pressure if $L = 10cm$

$$\Delta P = \frac{8\eta L\bar{v}}{r^2}$$

$$= \frac{8(0.00208)(0.1)(0.02)}{(4\times10^{-3})^2}$$

$= 2.08\ Pa$

ⓒ $R_f = ?$ $\frac{8\eta L}{\pi r^4} \Rightarrow \frac{8(0.00208)(0.1)}{\pi(4\times10^{-3})^4}$

$= 2.08\times10^6\,Pa.s/m^3$

ⓓ $P = \Delta P\,Q$

$= 2.08 \cdot 1\times10^{-6}$

$= 2.08\times10^{-6}\,W$

5.14 ⇒ $d = 2cm$

$Q = 1L/min$ → $\frac{1\times10^{-3}}{60} = 1.6\times10^{-5}$

$\rho = 1060$

$\eta = 2.1\times10^{-3}\,Pa.s$

$$V = \frac{Q}{A} = \frac{1.66\times10^{-5}}{\pi\,0.01^2} = 0.053\,ms^{-1}$$

$$N_R = \frac{2\rho v r}{\eta}$$

$$= \frac{2(1060)(0.053)(0.01)}{2.1\times10^{-3}}$$

$= 535$

$N_R < 2000$

laminar flow

5.15 ⇒ $r = 100\times10^{-6}\,m$

$L = 2cm \Rightarrow 0.02$

ⓐ $R_f = \frac{\Delta P}{Q} = \frac{8\eta L}{\pi r^4} = \frac{8(2.1\times10^{-3})(0.02)}{\pi(100\times10^{-6})^4}$

$= 1.07\times10^{12}\,Pa\cdot s/m^3$

ⓑ $P = 2.3\times10^3\,Pa$ $Q = ?$

$R_f = \frac{\Delta P}{Q}$

$Q = \frac{\Delta P}{R_f} = \frac{2.3\times10^3}{1.07\times10^{12}} = 2.15\times10^{-9}\,m^3/s$

ⓒ $V_{max} = \frac{\Delta P r^2}{4\eta L} = 0.136\,m/s$

ⓓ $P = \Delta P\cdot Q$

$= 2.3\times10^3 \cdot 2.15\times10^{-9}$

$= 4.9\times10^{-6}\,W$

ⓔ $N_R = \frac{2\rho\bar{v}r}{\eta}$ $\frac{2(1060)\left(\frac{2.15\times10^{-9}}{\pi(100\times10^{-6})^2}\right)(100\times10^{-6})}{2.1\times10^{-3}}$

$= 6.9$

laminar flow

- Chapter 6 Examples

6.1 $d = 1mm$

$Q = 40C$

$t = 1hr\ 15min$

$n = 5.8 \times 10^{28}\ e/m^3$

$I = ?$

drift velocity $(v) = ?$

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

$$= \frac{40}{4500} = 0.02A$$

$$v = \frac{I}{n\ e\ a}$$

$$= \frac{0.02}{(5.8 \times 10^{28})(1.602 \times 10^{-19})(\pi(5 \times 10^{-4})^2)}$$

$$= 2.741 \times 10^{-6}\ m/s$$

6.2 $R = ?$

$L = 10\ cm$

$A = 2 \times 10^{-4}\ m^2$

glass $= 3 \times 10^{10}\ \Omega \cdot m\ (\rho)$

Aluminum $= 2.82 \times 10^{-8}\ \Omega \cdot m\ (\rho)$

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

$$R_{glass} = 3 \times 10^{10} \left(\frac{0.1}{2 \times 10^{-4}}\right)$$

$$= 1.5 \times 10^{13}\ \Omega$$

$$R_{Aluminum} = 2.82 \times 10^{-4} \left(\frac{0.1}{2 \times 10^{-4}}\right)$$

$$= 1.41 \times 10^{-4}\ \Omega$$

6.3 $R = ?$ $I = ?$

$r = 0.321\ mm$

$\Delta V = 10V$

$L = 1m$

$\rho = 1.5 \times 10^{-6}$

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

$$= 1.5 \times 10^{-6} \left(\frac{1}{\pi (3.21 \times 10^{-4})^2}\right)$$

$$= 4.6\ \Omega$$

$$I = \frac{\Delta V}{R} = \frac{10}{4.6} = 2.2A$$

6.4 emf $(\varepsilon) = 12V$

$r = 0.05\ \Omega$

$R = 3\ \Omega$

ⓐ $I = ?$

$V = ?$ of battery

ⓑ $P\ r$

$P\ R$

$P\ emf$

$$I = \frac{\varepsilon}{r + R}$$

$$= \frac{12}{0.05 + 3} = 3.93A$$

$$V = \varepsilon - Ir$$

$$= 12 - (3.93 \times 0.05)$$

$$= 11.8\ V$$

$$P = I^2 r$$

$$= (3.93)^2 (0.05)$$

$$= 0.78W$$

$$P = IV$$

$$= 3.93(\overset{I}{3.93} \times \overset{R}{3})$$

$$= 46.5W$$

$$P = IV$$

$$= 3.94 \times 12$$

$$= 47.28W$$

6.5 emf $V = 15v$

$V = 11.6v \rightarrow P = 20\ W$

$R = ?$ $\quad r = ?$

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

$20 = \dfrac{11.6^2}{R}$

$R = 6.73\ \Omega$

$V = IR$

$11.6 = I\ 6.73$

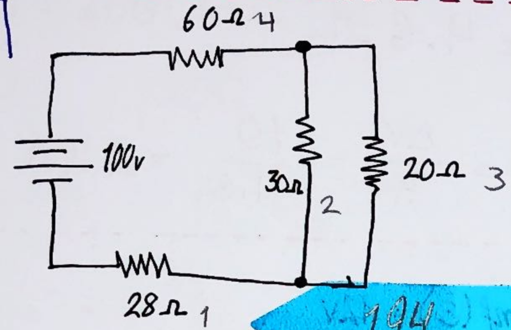
$I = 1.72\ A$

$V = \mathcal{E} - Ir$

$11.6 = 15 - 1.72\ r$

$r = 1.97\ \Omega$

6.6



194

eq $R = ?$ $\quad$ I in 20Ω

total $I = ?$

$\dfrac{1}{R_{eq}} = \dfrac{1}{28} + \dfrac{1}{60} + \dfrac{1}{30} + \dfrac{1}{20}$

$R_{eq} = 7.36\ \Omega$

$I = V/R$
$= \dfrac{100}{7.36} = 13.57\ A$

$I_3 = \dfrac{100}{20} = 5\ A$

6.7 $C = 4\ \mu F$

$Q = ?$ $\quad \mathcal{E} = 12V$

ⓑ $\mathcal{E} = 1.5\ V$

$C = \dfrac{Q}{\Delta V} \Rightarrow 4 \times 10^{-6} = \dfrac{Q}{12}$
$= 48 \times 10^{-6} C$

$C = \dfrac{Q}{\Delta V} \Rightarrow 4 \times 10^{-6} = \dfrac{Q}{1.5} = 6 \times 10^{-6} C$

6.8 $Q = +10\ \mu C$
$-10\ \mu C$

$V = 10V$

ⓐ $C = ?$ $\rightarrow$ $C = \dfrac{Q}{V} = \dfrac{10 \times 10^{-6}}{10}$
$= 1 \times 10^{-6}\ F$

ⓑ $V = ?$ between the conductors

$Q = +100 \times 10^{-6}$
$Q = -100 \times 10^{-6}$

$V = \dfrac{Q}{C} = \dfrac{100 \times 10^{-6}}{1 \times 10^{-6}}$
$= 100v$

6.9 $\mathcal{E} = 12V$

$C = 5 \times 10^{-6} F$

$R = 0.8 \times 10^{6}\ \Omega$

$t = ?$ $\quad$ max $Q = ?$ $\quad I_{max} = ?$

Q & I as function of time

$\tau = RC$
$= 0.8 \times 10^{6} \cdot 5 \times 10^{-6}$
$= 4$ sec

$Q_{max} = C\mathcal{E}$
$= 5 \times 10^{-6} \cdot 12$
$= 60 \times 10^{-6} C$

$I_{max} = \dfrac{\mathcal{E}}{R} = \dfrac{12}{0.8 \times 10^{6}} = 15 \times 10^{-6} A$

$I_{(t)} = \dfrac{\mathcal{E}}{R} e^{\frac{-t}{RC}}$
$= 15 \times 10^{-6} e^{-t/4}$

$Q(t) = C\mathcal{E}\ e^{\frac{-t}{RC}}$
$= 60 \times 10^{6} e^{\frac{-t}{4}}$

$\boxed{6.11}$ $C = 10 \times 10^{-6}$ F

$\mathcal{E} = 200$ v

$V = 120$ v

$R = ?$ after 5 sec of switching off (series)

$$V_c(t) = \mathcal{E}(1 - e^{-t/RC})$$

$$\frac{120}{200} = \frac{200(1 - e^{\frac{-5}{RC}})}{200}$$

$$\frac{3}{5} - 1 = 1 - e^{\frac{-5}{RC}} - 1$$

$$-\frac{2}{5} = -e^{\frac{-5}{RC}}$$

$$RC = \frac{-5}{\ln \frac{2}{5}}$$

$$= 5.456$$

$$R = \frac{5.456}{10 \times 10^{-6}}$$

$$= 545600 \, \Omega$$

$\boxed{6.12}$ discharged capacitor

$\boxed{6.13}$ $C = 20 \times 10^{-6}$ F

$V = 500$ v discharged

$R = ?$

@ $t = 60$ $V = 185$ V

$$V_c(t) = V_0 \, e^{-t/RC}$$

$$185 = 500 \, e^{-60/RC}$$

$$0.37 = e^{\frac{-60}{RC}}$$

$$RC = \frac{-60}{\ln 0.37}$$

$$RC = 60.34$$

$$R = \frac{60.34}{20 \times 10^{-6}}$$

$$= 3017342.86 \, \Omega$$

$\boxed{6.14}$ $C = 0.1 \times 10^{-6}$ F

$V = 100$ v discharged $R = 1 \times 10^{6} \, \Omega$

ⓐ I_0

$$I_0 = \frac{V}{R} = \frac{100}{1 \times 10^{6}} = 100 \times 10^{-6} \text{ A}$$

ⓑ t

$$t = RC = 1 \times 10^{6} \cdot 0.1 \times 10^{-6} = 0.1 \text{ sec}$$

ⓒ Q

$$Q = C\mathcal{E} = 0.1 \times 10^{-6} \cdot 100 = 10 \times 10^{-6} \text{ C}$$

I after 0.1 sec

Current + Charge + voltage drops 0.37 of it's initial

$$I = I_0 \cdot 0.37 = 37 \times 10^{-6} \text{ A}$$

q after 0.1 sec

$$q = Q \cdot 0.37 = 3.7 \times 10^{-6} \text{ C}$$

6.15 $\lambda = 1\ cm \rightarrow 0.01 m$

$r = ?$

$P_m MA = 40\ \Omega.m^2$

$P_a = 2\ \Omega.m$

$$(\lambda)^2 = \left(\sqrt{\frac{P_m r}{2 P_a}}\right)^2$$

$$1\times10^{-4} = \frac{40\ r}{2(2)}$$

$$r = 1\times10^{-5} m$$

6.16 $V = 80\times10^{-3} V$

Cell wall

$d = 9\times10^{-9} m$

$E = ?$

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

$$= \frac{80\times10^{-3}}{9\times10^{-9}} = 8.89\times10^{6}\ V/m$$

6.18 $d = 7.5\times10^{-9} m$

$V_0 = -90\times10^{-3} V$

$C = 0.01\ F/m^2$

magnitude + direction

$$E = \frac{V}{d} = \frac{-90\times10^{-3}}{7.5\times10^{-9}}$$

$$= 1.2\times10^{7}\ V/m$$

dielectric constant (ε)

$$C_m = \frac{C}{A} = \frac{\varepsilon}{d}$$

$$\varepsilon = C_m \cdot d$$

$$= 0.01 \cdot 7.5\times10^{-9}$$

$$= 7.5\times10^{-11}\ F/m$$

6.17 $V = ?$

$d = 8\times10^{-9} m$

$E = 5.5\times10^{6}\ V/m$

$$V = Ed$$

$$= 5.5\times10^{6} \cdot 8\times10^{-9}$$

$$= 4.4\times10^{-2} V$$

6.14 myelinated

$d = 10\times10^{-6} m$

$\lambda = 0.5\ cm \rightarrow$

$V = ?$

$\varepsilon = ?$

$L = 1 mm$

$$V = \frac{r}{2 C_m P_a}x$$

$$V = \frac{\lambda^2}{C_m P_m}x$$

$$= \frac{2.5\times10^{-5}}{(5\times10^{-5})(}$$

216

Chapter 6 ⇒ Bioelectricity
Book Questions

[1] $I = ?$
$Q = 4C$
$t = 4h$

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

$= \frac{4}{4 \times 3600}$
$= 2.77 \times 10^{-4} A$

[2] $R = 500\Omega$
$I = 10 \times 10^{-3} A$
$V = ?$

$\boxed{V = IR}$

$= 10 \times 10^{-3}(500)$
$= 5V$

[3] ⓐ $I = 12A$
$t = 0.01s$
$Q = ?$

$I = \frac{Q}{t}$
$12 = \frac{Q}{0.01}$
$Q = 0.12C$

ⓑ electrons

$\boxed{Ne = \frac{\Delta Q}{q_e}}$

$= \frac{0.12}{1.6 \times 10^{-19}}$
$= 7.5 \times 10^{17}$ electrons

[4] $Q = 10000C$
$I = 0.5 \times 10^{-3} A$
$t = ?$

$I = \frac{Q}{t}$
$0.5 \times 10^{-3} = \frac{10000}{t}$
$t = 2 \times 10^{7} s$

electrons

$Ne = \frac{\Delta Q}{q_e}$
$= \frac{10000}{1.6 \times 10^{-19}}$
$= 6.25 \times 10^{22}$ electrons

[5] $R = ?$ $L = 20m$ $\rho = 1.72 \times 10^{-8}$
$d = 2.053mm$

$\boxed{R = \rho \frac{L}{\pi r^2}}$

$= 1.72 \times 10^{-8} \frac{20}{\pi (1.0265 \times 10^{-3})^2}$
$= 0.1034\Omega$

[6] $T_0 = 20C$
$R = 2R_0$

$R = R_0(1 + \alpha \Delta T)$
$2R_0 = \alpha \Delta T$
$\Delta T = \frac{1}{\alpha} = \frac{1}{3.4 \times 10^{-3}}$
$T = 20 + 256 = 276°C$

[7] $I = 250A$
$V = 24V$
$P = ?$

$\boxed{P = IV}$
$= 250 \cdot 24$
$= 6 \times 10^{3} W$

[8] Req in 10 resistors $R = 275$
ⓐ series
$R_1 + R_2 + R_3 \ldots R_{10} = R_{eq}$
$275 \times 10 = 2750\Omega$
ⓑ parallel
$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \ldots \frac{1}{R_{10}}$
$\frac{1}{275} \cdot 10 = 3.64 \times 10^{-2}$
$\Rightarrow \frac{1}{3.64 \times 10^{-2}} = 27.5\Omega$

[9] $V = 48V$
$R_1 = 24\Omega$ $R_2 = 96\Omega$

Series
$R_{eq} = 24 + 46$
$R_{eq} = 120$
$I = \frac{V}{R_{eq}}$
$= \frac{48}{120}$
$= 0.4A$

Parallel
$\frac{1}{R_{eq}} = \frac{1}{24} + \frac{1}{96}$
$R_{eq} = 19.2$
$I = \frac{V}{R_{eq}}$
$= \frac{48}{19.2}$
$= 2.5A$

10 $I = 3\times10^{-4}$

$r = 2\,\Omega$

$\mathcal{E} = 3V$

$V = ?$

$$\boxed{\Delta V = \mathcal{E} - Ir}$$

$$= 3 - 3\times10^{-4} \cdot 2$$

$$= 2.9994V$$

11 $r = ?$

$\mathcal{E} = 12\,V$

$V = 15\,V$

$I = 8\,A$

$$\Delta V = \mathcal{E} - Ir$$

$$15 = 12 - 8r$$

$$r = 0.375\,\Omega$$

~~12~~ ~~13~~

14 $R = 150.4\,\Omega$ $T = 20$

$R = 162.4\,\Omega$ $T = 40$

$\alpha = ?$

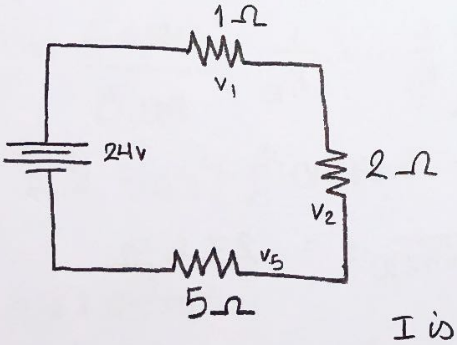
$$R_T = R_0(1 + \alpha(T - T_0))$$

$$\alpha = \frac{1}{R_0}\frac{R_T - R}{T - T_0}$$

$$= \frac{1}{150.4}\frac{162.4 - 150.4}{40 - 20}$$

$$\alpha = 3.44\times10^{-3}\,°C^{-1}$$

15

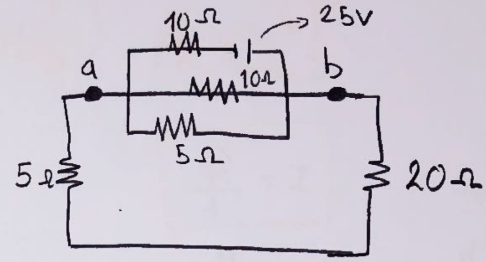


I is constant in series

$$V = \frac{I}{R}$$

16 ⓐ I in 20Ω resistor

ⓑ V between a & b



$$\frac{1}{R_{eq}} = \frac{1}{5} + \frac{1}{5} + \frac{1}{10} + \frac{1}{10} + \frac{1}{20}$$

$$=$$

19 $C = 0.5 \times 10^{-6}\ F$ $\quad \tau = RC$

$R = ?$ $\quad \rightarrow \tau = 2s$

$\rightarrow \tau = 15$

$R = \frac{\tau}{C}$

$= \frac{2}{0.5 \times 10^{-6}}$ $\quad \Rightarrow \frac{15}{0.5 \times 10^{-6}}$

$= 4 \times 10^{6}\ \Omega$ $\quad = 3 \times 10^{7}\ \Omega$

20 72 Per minute

$C = 25 \times 10^{-9}\ F$ (one time)^{5}

$R = \frac{t}{C}$ $\quad \frac{60}{72} = 0.833$

$= \frac{0.833}{25 \times 10^{-8}}$ $= 3.33 \times 10^{7}\ \Omega$

21 $\tau = 0.1 \times 10^{-6}\ s$

@ $R = 0.04\ \Omega$ $\quad \tau = ?$

$C = ?$ $\quad R = 800 \times 10^{3}\ \Omega$

$C = \frac{\tau}{R}$ $\quad \tau = RC$

$= \frac{0.1 \times 10^{-6}}{0.04}$ $\quad = 800 \times 10^{3} \cdot 2.5 \times 10^{-6}$

$= 2.5 \times 10^{-6}\ F$ $\quad = 2$ Secs

22 $A = 2 \times 10^{-4}\ m^{2}$

$d = 1\ mm \rightarrow 1 \times 10^{-3}\ m$

$C = ?$

$$\boxed{C = \frac{\varepsilon_0 A}{d}}$$

$\Rightarrow \frac{8.85 \times 10^{-12} \cdot 2 \times 10^{-4}}{1 \times 10^{-3}}$

23

25 $R = 500\,\Omega$

uncharged $C = 1.5\times10^{-9}\,F$

$\mathcal{E} = 6.16\,V$

series

ⓐ $I = ?$

$I = \frac{V}{R}$

$= \frac{6.16}{500}$

$= 12.32\times10^{-3}\,A$

ⓑ RC time constant

$\tau = RC$

$= 500 \cdot 1.5\times10^{-9}$

$= 7.5\times10^{-4}\,s$

ⓒ $I_{(t)} = ?$

$\boxed{I_{(t)} = I e^{-t/RC}}$

$= 12.32\times10^{-3}\, e^{-1}$

$= 4.56\times10^{-3}\,A$

ⓓ $V_{(t)} = ?$

$\boxed{V_{(t)} = \mathcal{E}(1-e^{-1})}$

$= 6.16(1-e^{-1})$

$= 3.88V$

26 $C = 2\times10^{-9}\,F$

$Q = 5.1\times10^{-6}\,C$

discharged $R = 1.3\times10^{3}\,\Omega$

ⓐ $I = ? \rightarrow t = 9\times10^{-6}\,s$

$I_{(t)} = -I_0 e^{-t/RC}$

$= \boxed{\frac{Q}{RC} e^{-t/RC}}$

$= \frac{5.1\times10^{-6}}{(2\times10^{-9})(1.3\times10^{3})} e^{\frac{-9\times10^{-6}}{(2\times10^{-9})(1.3\times10^{3})}}$

$= 0.0615\,A$

ⓑ $Q = ?$ after $8\times10^{-6}\,s$

$q_{(t)} = 5.1\times10^{-6} e^{\frac{-8\times10^{-6}}{(2\times10^{-9})(1.3\times10^{3})}}$

$= 0.235\times10^{-6}\,C$

ⓒ $I_{max} = ?$

$I_0 = \frac{Q}{RC} \Rightarrow 1.962A$

27 $R = 1\times10^{6}\,\Omega$ $\mathcal{E} = 30V$

$C = 5\times10^{-6}\,F$

ⓐ $\tau = ?$

$\tau = RC$

$= 5\,sec$

ⓑ Q_{max} after switch is closed

$Q_{max} = C\mathcal{E}$

$= 5\times10^{-6} \cdot 30$

$= 150\times10^{-6}\,C$

ⓒ $I = ?$

Switched $t = 0$

10 sec later

$I_{(t)} = \frac{\mathcal{E}}{R} e^{\frac{-t}{RC}}$

$= \frac{30}{1\times10^{6}} e^{-\frac{10}{5}}$

$= 4.06\times10^{-6}\,A$

28

29 $\tau = 10\times10^{-3}\,sec$

ⓐ $C = 8\times10^{-6}\,F$

$R = ?$

$R = \frac{10\times10^{-3}}{8\times10^{-6}}$

$= 1.25\times10^{3}\,\Omega$

ⓑ $V_0 = 12\times10^{3}\,V$

$V = 6\times10^{2}\,V$

$\boxed{\tau = -RC\ln\left(\frac{V}{V_0}\right)}$

$= -(10\times10^{-3})\ln\left(\frac{600}{1.2\times10^{4}}\right)$

$= 2.99\times10^{-2}\,sec$

Slide Questions

Chapter 4

↳ How much energy would be needed to heat 450g of Copper metal from 25°C to 75°C. Specific heat at 25°C = 0.385 J/g°C

$$Q = Cm\Delta T$$
$$= 0.385(450)(75-25)$$
$$= 17325\ J$$

↳ A student tries to decide what to wear. room = 20°C Skin = 37°C. heat lost in 10 mins

$e = 0.9$

$SA = 1.5m^2$

$$Q = P \cdot \Delta t \rightarrow 10(60)$$
$$0.9\ \sigma\ 1.5(37^4 - 20^4)$$

↳ A girl has a surface area of $1.2m^2$

jacket 3cm thick

thermal conduction coeff = $0.02\ Wm^{-1}K^{-1}$

Skin = 34°C loses 85W by conduction

lowest T = ?

$$H = KA\frac{(T-T)}{L}$$
$$85 = (0.02)(1.2)\frac{(34-T)}{0.03m}$$
$$T = -72.25$$

Chapter 5

↳ if an elevator accelerates upward at $10ms^{-2}$ what is the average blood pressure in the brain and the feet? $P_B = P_H + \rho(g+a)(h_H - h_B)$

$$= 13300 + 1060(10+10)(-0.3)$$
$$= 6.94\times10^3\ Pa$$

$$P_F = P_H + \rho(g+a)(h_H - 0)$$
$$= 13300 + 1060(20)(1.4) = 43\times10^3\ Pa$$

↳ downwards acceleration

$$P_B = P_H\ \cancel{\rho(g-a)(h_H - h_B)}$$

$P_B = 13300$

$P_F = 13300$

↳ if the total flow resistance of blood through three similar parallel arteries of length 30 cm is $4\times10^8\ Pa.sm^{-3}$

find ⓐ diameter of each artery

ⓑ if the power dissipated in pumping the blood in each artery is 0.4m W, determine if the flow type of blood in the artery, laminar or turbulent?

$\eta = 3.14\times10^{-2}$

$\rho = 1100$

$R_f = 4\times10^8 \quad L = 30$

$$R_f = \frac{8\eta L}{\pi r^4} \Rightarrow 4\times10^8 = \frac{8(3.14\times10^{-2})(0.3)}{\pi r^4}$$

$$r = \sqrt[4]{\frac{5.996\times10^{-11}}{4\times10^8}} = 1.967\times10^{-5}$$

$$d = 3.9\times10^{-5}m$$

ⓑ $P = 0.4\times10^{-3}\ W$

$P = \Delta P\ AV$

$0.4\times10^{-3} = 8\eta L \cdot A \cdot V$

$V = \frac{0.4\times10^{-3}}{9.095\times10^{-11}}$

$V = 4.39\times10^6$

$$N_R = \frac{2\rho\bar{v}r}{\eta}$$
$$= \frac{2(1100)(4.39\times10^6)(1.967\times10^{-5})}{\eta}$$
$$\eta = 6039572.379\ \therefore \text{Turbulent}$$

Chapter6

↳ An uncharged Capacitor of 2000×10^{-6}F is conected to a 100Volt DC Supply in series, resistor 5000 Ω. Calculate

ⓐ maximum Charge

$$Q = C\mathcal{E} \Rightarrow 2000 \times 10^{-6} \cdot 100 = 0.2C$$

ⓑ maximum Current

$$I_{max} = \frac{Q}{RC} \Rightarrow \frac{0.2}{5000 \cdot 2000 \times 10^{-6}} = 0.02A$$

ⓒ time Constant

$$\tau = RC \Rightarrow 10 \text{ sec}$$

ⓓ voltage after 8 sec of charging

$$V_{(t)} = \mathcal{E}(1 - e^{-\frac{t}{RC}})$$
$$= 100(1 - e^{-\frac{8}{10}}) = 55.06V$$

ⓔ Charging current after 8 sec.

$$I_{(t)} = \frac{Q}{RC} e^{\frac{-t}{RC}}$$
$$= 0.02 e^{\frac{-8}{10}} = 8.98 \times 10^{-3}$$

ⓕ time it takes for Capacitor to be 80 volts Charged

$$V_{(t)} = \mathcal{E}(1 - e^{\frac{-t}{RC}})$$

$$80 = 100(1 - e^{\frac{-t}{10}})$$

$$\frac{1}{5} = e^{\frac{-t}{10}}$$

$$t = 10 \ln 5$$

$$t = 16.09 \text{ sec}$$

↳ A myelinated axon with a space parameter of 0.5 cm. take resistivity of axon = 2 Ω·m, membrane resistivity = 40 Ω m², $d = 0.5 \times 10^{-6}$m, $\mathcal{E} = 25 \times 10^{-12}$ F/m, Calculate speed of Propagation along 1mm

$$V = \frac{\lambda^2}{C_m \, P_m \, Y} \Rightarrow \frac{(5 \times 10^{-3})^2}{(5 \times 10^{-5})(40)(1 \times 10^{-3})}$$

$$= 12.5 \text{ m/s}$$

↳ A pipe 100 mm in diameter Carries oil density 900 Kg/m3 at a rate of 4 Kg/s. The pipe diameter reduces to 60mm and rises 120m in altitude. The gauge pressure at this point is zero.

determine (a) speed of oil at each Section

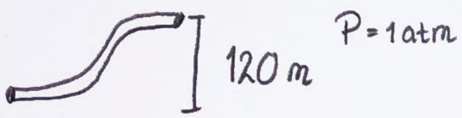
(b) the preasure at the lower end

$d_1 = 100\,mm \Rightarrow r_1 = \frac{0.01m}{2} = 5\times10^{-3} m$

$\rho = 900\, kg/m^3$

$Q = \frac{4}{900} = 4.44\times10^{-3}$

$d_2 = 60\,mm \Rightarrow r_2 = 0.03m$



(a) $\bar{v}_1 = \frac{Q_1}{A_1} = \frac{4.44\times10^{-3}}{\pi(5\times10^{-3})^2} = 0.56\ m/s$

$Q_1 = Q_2$

$V_1 \cdot A_1 = V_2 \cdot A_2$

$0.56\cdot(\pi(5\times10^{-3})^2) = V_2\cdot(\pi(0.03)^2)$

$V_2 = 1.55\ m/s$

(b) $\Delta P = \frac{1}{2}\rho\Delta v^2 + \rho g h$

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

$P_1 - P_2 = \frac{1}{2}900(1.55^2 - 0.56^2) + 900(10)(120-0)$

$P_1 = 940.005 + 1080000 + 1.013\times10^5$

$P_1 = 1182240\ Pa$

$= 11.67\ atm$

↳ The Polmonary artery, which connects the heart to the lungs, has an inner radius of 26mm and 84 cm long. if the pressure drop between the heart and the lungs is 400 Pa

Find (a) average blood speed

(b) flow rate

(c) type of flow

(d) flow resistance

(e) power dissipated

Viscousity @ 37°C is 2.1cP $\eta = 2.1\times10^{-2}$

$\rho = 100\ Kgm^{-3}$

$r = 26mm = 0.026\ m$

$L = 84cm = 0.84m$

$P = 400 Pa$

$\eta = 2.1\times10^{-2}$

(a) $V = \frac{\Delta P r^2}{8\eta L} \Rightarrow \frac{400(0.026)^2}{8(2.1\times10^{-2})(0.84)}$

$= 1.91\ m/s$

(b) $Q = AV \Rightarrow \pi(0.026^2)(1.9)$

$= 4.06\times10^{-5}\ m^3/s$

(c) $N_R = \frac{2\rho v r}{\eta} \Rightarrow \frac{2(900)(1.9)(0.026)}{2.1\times10^{-2}}$

$= 4987 > 3000$

∴ Turbulent

(d) $R_f = \frac{\Delta P}{Q} \Rightarrow \frac{400}{4.06\times10^{-5}} = 9.85\times10^{6}\ Pa\cdot s/m^3$

(e) $P = \Delta P Q$

$= 400 \cdot 4.06\times10^{-5}$

$= 1.62\times10^{-2}\ W$

↳ a myelinated nerve with a space parameter of 0.5 cm. take the resisitivity of the axon equal $2\,\Omega\cdot m$, membrane resisitivity of $40\,\Omega m^2$ and the membrane Capacitance is $5\times10^{-5}\ F/m^2$. Calculate the speed of propagation of a Pulse along 1 mm. if the thickness of the membrane is $0.5\,\mu m$, determine the dielectric costant of the membrane?

@ $v = \frac{r}{2 C_m P_a x} = \frac{\lambda^2}{C_m P_m x} \Rightarrow \frac{(5\times10^{-3})^2}{(5\times10^{-5})(40)(\cancel{1}\times10^{-3})}$

$\Rightarrow 12.5\ m/s$

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

$5\times10^{-5} \cdot 5\times10^{7} \Rightarrow 2.5\times10^{-11}\ F/m$