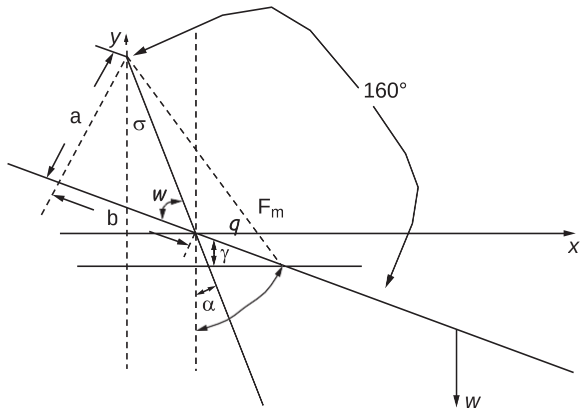
o0030 **1-5.** Following Exercise 1-3 and referring to Fig. E. 1.5

f0020



$$\omega + 160^{\circ} ¼ 180^{\circ}; \omega ¼ 20^{\circ}$$

$$a ¼ 30 \sin 20 ¼ 10{:}3\text{cm}$$

$$b ¼ 30 \cos 20 ¼ 28{:}2\text{cm}$$

$$\theta ¼ \tan^{-1}\frac{a}{b+4} ¼ \tan^{-1}\frac{10{:}3}{28{:}2+4}$$

$$\theta ¼ 17{:}7^{\circ}$$

p0065 The upper arm is at the same angle as in Fig. 1-12. Using results from Exercises 1.3

$$\alpha ¼ \tan^{-1}\frac{x^1}{y^1} ¼ \tan^{-1}\frac{5{:}2}{29{:}4} ¼ 10^{\circ}$$

$$\gamma ¼ \alpha + \omega ¼ 10 + 20 ¼ 30^{\circ}$$

$$\delta ¼ 90 - \gamma ¼ 60^{\circ}$$

p0070 Following Eq. (1-10)

p0075 x component: $F_m \cos(\theta + \delta)$ ¼ $F_r \cos \phi$

p0080 y component: $F_m \sin(\theta + \delta)$ ¼ $F_r \sin \phi + W$

p0085 Torque is: 4 cm $F_m \sin(\theta)$ ¼ 40 cm $W \times \sin \gamma$

p0090 From these we obtain 3 equations

o0035 1. $F_m \cos 77.7$ ¼ $F_r \cos \phi$

o0040 2. $F_m \sin 77.7$ ¼ $F_r \sin \phi + 137$ N

o0045 3. $F_m \sin 17.7$ ¼ $10 \times 137 \times \sin 30^{o}$

p0110 From 3. F_m ¼ 2,253 N (508 lb)

p0115 From 2 & 3 ϕ ¼ 78.4°

p0120 F_r ¼ 2,386 N ¼ 536 lb

o0160 **3-6.** From Eq. 3-24

$$v_t ¼ \frac{W}{CA}^{1=2} \quad \rho ¼ \text{density}$$

$$W ¼ \frac{4}{3}\pi r^3\rho \quad A ¼ \pi r^2$$

$$C ¼ 0{:}88\ \text{kg=m}^3 \text{ðsee text section 3:7Þ}$$

$$r ¼ 0{:}5\ \text{cm} ¼ 5 \times 10^{-3}\text{m}$$

$$\rho ¼ 1g\text{=cm}^3 ¼ 10^3\text{kg=m}^3$$

$$v_t ¼ \frac{4rg\rho}{3c}^{1=2}$$

$$¼ \frac{4 \times 5 \times 10^{-3} \times 9{:}8 \times 10^3}{3 \times 0{:}88}^{1=2} \text{m=sec}$$

$$¼ 8{:}6\ \text{m=sec}$$

o0165 **3-7.** Area of parachute 5 A and from Eq. 3-24

$$A ¼ \frac{W}{v_t^2 C}$$

$$W ¼ 70 \times 9{:}8\text{N}$$

$$v_t^2 ¼ 196\ \text{m}^2 \quad C ¼ 0{:}88\ \text{kg=m}^3$$

p0665 Therefore A ¼ 3.98 m^2 ¼ πr^2

p0670 Radius of parachute¼ 1.13 m

o0170 **3-8.** From Eq. 3-24

o0175 (a) $$v_t ¼ \frac{W}{CA}^{1=2}$$

$$\rho ¼ \text{density} ¼ 0{:}92 \times 10^3\text{kg=m}^3$$

$$W ¼ \frac{4}{3}\pi r^3\rho \quad A ¼ \pi r^2$$

$$C ¼ 0{:}88\ \text{kg=m}^3\text{ðsee textÞ}$$

$$r ¼ 5 \times 10^{-3}\text{m}\rho ¼ 0{:}92 \times 10^3\text{kg=m}^3$$

$$v_t ¼ \frac{4rg\rho}{3C}^{1=2}$$

$$¼ \frac{4 \times 5 \times 10^{-3} \times 9{:}8 \times 0{:}92 \times 10^3}{3 \times 0{:}98}^{1=2} \text{m=sec}$$

$$¼ 8{:}3\ \text{m=sec}$$

s0030 CHAPTER 5

o0240 **5-1.** From Eq. 5-13, maximum energy absorbed by the bones of one arm

$$E = \frac{1}{2}\frac{A\ell S_B^2}{Y}, \quad S_B = 10^9\ \text{dyn/cm}^2 \qquad \text{(See Table 5.1)}$$

$$= \frac{1}{2}\frac{14 \times 100 \times 10^{18}}{14 \times 10^{10}} = 14.3 \times 10^8\ \text{erg}$$

$$= 143\ \text{J}$$

p0930 Therefore the kinetic energy of runner that may cause fracture is obtained from

$$\frac{1}{2}mv^2 = 143\ \text{J}\quad m = 50\ \text{kg}$$

$$v = 2.39\ \text{m/sec} = 8.6\ \text{km/hr}$$

$$= 5.3\ \text{m.p.h}$$

o0245 **5-2.** The average impact force is $\frac{mv}{\Delta t}$

p0940 At fracture this will be equal to

$$F_B = 4\ \text{cm}^2 \times 10^9\ \text{dyn/cm}^2$$

$$= 4 \times 10^9\ \text{dyn}$$

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

p0945 Therefore minimum speed for fracture

$$v = \frac{4 \times 10^4 \times \Delta t}{m} = \frac{4 \times 10^4 \times 10^{-2}}{50}$$

$$= 8\ \text{m/sec}$$

p0950 This speed is about 3 times higher than obtained in problem 5-1. However, if the area of impact is smaller the maximum speed of fracture would correspondingly decrease.

p0955 With 1 cm^2 area of impact

p0960 $v = 2$ m/sec

o0250 **5-3.** An impact force F_B that will fracture the skull is

$$F_B = 1\ \text{cm}^2 \times 10^9\ \text{dyn/cm}^2 = 10^9\ \text{dyn}$$

$$= 10^4\ \text{N}$$

p0970 The impulsive force of the falling body is

$$F = \frac{mv}{\Delta t};\ v = (2gh)^{1/2}$$

p1095 Energy stored per leg

$$E \text{ ¼ } \frac{1}{2} \frac{1{:}8 \times 10^{7} \times 10^{-4} \times 10^{-4}}{2 \times 10^{-2}} \text{ ¼ } 4{:}5 \text{ erg}$$

p1100 Total stored in 2 legs ¼ 9.0 erg

p1105 Let h ¼ the height of jump propelled by the energy stored.

$$E \text{ ¼ } mgh \quad m \text{ ¼ } 0{:}5 \times 10^{-3} \text{ g}$$

$$g \text{ ¼ } 980 \text{ cm=sec}^{2}$$

$$h \text{ ¼ } \frac{9{:}0}{0{:}5 \times 10^{-3} \times 980} \text{ ¼ } 18{:}4 \text{ cm}$$

o0290 **6-4.** With the stated assumption

$$A \text{ ¼ } \text{‘}^{2} \text{ and } \Delta\text{‘ ¼ ‘=2}$$

p1115 Therefore

$$E \text{ ¼ } \frac{1}{2} \frac{Y\text{‘}^{2} \text{ ‘}^{2}\text{=4}}{\text{‘}} \quad Y \text{ ¼ } 1{:}8 \times 10^{+7} \text{ dyn=cm}^{2}$$

$$E \text{ ¼ } \frac{Y\text{‘}^{3}}{8}$$

p1120 also

$$E \text{ ¼ } mgh \quad m \text{ ¼ } 50 \text{ kg ¼ } 50 \times 10^{3} \text{ g}$$

$$g \text{ ¼ } 980 \text{ cm=sec}^{2}$$

$$h \text{ ¼ } 50 \text{ cm}$$

p1125 Therefore

$$\frac{1{:}8 \times 10^{7} \text{ ‘}^{3}}{8} \text{ ¼ } 50 \times 10^{3} \times 980 \times 50$$

$$\text{‘}^{3} \text{ ¼ } 1{:}08 \times 10^{3}$$

$$\text{‘ ¼ } 10{:}3 \text{ cm}$$

o0370 **8-5.** (a) Q ¼ $\frac{\pi R^4 \eth P_1 - P_2 \text{Þ}}{8\eta L}$

p1355 Flow is proportional to R^4

$$\frac{Q_1}{Q_2} ¼ \left(\frac{R_1}{R_2}\right)^4 ¼ \left(\frac{0{:}08}{0{:}1}\right)^4 ¼ 0{:}41$$

o0375 (b) $\left(\frac{R_1}{R_2}\right)^4$ ¼ 0:1

p1365 Therefore

$$\frac{R_1}{R_2} ¼ 0{:}56$$

o0380 **8-6.** Q ¼ 5‘=min ¼ 83:3 cm^3=sec

Q ¼ $v \times A$ A ¼ πr^2

$$v ¼ \frac{83{:}3}{\pi \times 1} ¼ 26{:}5 \text{ cm=sec}$$

o0385 **8-7.** The blood flow is constant throughout the body

p1375 Let no be the number of capillaries

p1380 Total flow Q ¼ 5 liter/min ¼ 83.3 cm^3/sec $A \times v \times$ no.

Area of capillaries ¼ πr^2 ¼ $\pi \times$ 8=2 $\times$ 10^{-4} cm ^{2}

¼ 5:02 $\times$ 10^{-7} cm

v ¼ 3:3 $\times$ 10^{-2}cm=sec

$$\text{no} ¼ \frac{Q}{Av}$$

$$¼ \frac{83{:}3 \text{ cm}^3\text{=sec}}{5{:}02 \times 10^{-7} \text{ cm}^2 \times 3{:}3 \times 10^{-2} \text{ cm=sec}}$$

¼ 5:03 $\times$ 10^9

o0390 **8-8.** From Eq. 8-5

$$\Delta P ¼ \frac{\rho v_1^2}{2}\left[\left(\frac{A_1}{A_2}\right)^2 - 1\right]$$

$$\frac{A_1}{A_2} ¼ \left(\frac{R_1}{R_2}\right)^4$$

v_1 ¼ 50 cm=sec

ρ ¼ 1:05 g=cm^3

$$\Delta P ¼ \frac{1{:}05 \times 2{:}5 \times 10^3}{2} [81 - 1]$$

¼ 1:05 $\times$ 10^5 dyn=cm^2

¼ 79 torr

s0065 CHAPTER 13

o0585 **13-1.** (a) ΔQ ¼ $C\,\Delta V$ ¼ $3 \times 10^{-7} \times 100 \times 10^{-3}$ ¼ 3×10^{-8} coulomb

p2160 Number of ions entering per meter of axon

$$¼ \frac{3 \times 10^{-8}}{1{:}6 \times 10^{-19}} ¼ 1{:}88 \times 10^{11}$$

o0590 (b) Number of sodium ions per cm^3 ¼ $15 \times 10^{-3} \times 6.02 \times 10^{20}$ ¼ $9.03 \times 10^{18}/cm^3$

p2170 Volume of axon/meter length of axon ¼ $\pi r^2 \times$ ‘ ¼ $\pi \times 25 \times 10^{-12} \times 1$

¼ 78.5×10^{-12}/meters^3 ¼ 78.5×10^{-6} cm^3/meter of axon

p2175 No. of Na^+/meter of axon ¼ $78.5 \times 10^{-6} \times 9.03 \times 10^{18}$ ¼ 7.09×10^{14}/meter of axon

p2180 The number of potassium ions is ten times as great.

o0595 **13-2.** Multiply both sides of Eq. 13-4 by $R_T + R_m$

$$R_T^2 + R_T R_m ¼ 2R\,R_T + 2RR_m + R_T R_m$$

$$R^2 + 2RR_T - 2R\,R_m ¼ 0$$

p2190 Solving for R_T yields Eq. 13-5

o0600 **13-3.** Using the voltage divider relationship with

p2200 R_0 ¼ R_i ¼ R

$$V_B ¼ \frac{V_A \dfrac{R_m R_T}{R_m + R_T}}{\dfrac{R_m R_T}{R_m + R_T} + 2R}$$

p2205 Multiply by $R_m + R_T$ and divide by $R_m\,R_T$ yields Eq. 13-6

o0605 **13-4.** Substituting in Eq. 13-6 for R and R_m the relationships given in the text, we obtain

$$R_T ¼ r\Delta x + \left(r^2 \Delta x^2 + \frac{2r\Delta x}{g_m \Delta x} \right)^{1=2}$$

$$\text{As } \Delta x \,!\, 0 \;\; R_T ¼ \left(\frac{2r}{g_m} \right)^{1=2}$$

o0610 **13-6.** V_2 ¼ $V_1 \left(1 - \frac{\Delta x}{\lambda}\right)$

$$V_3 ¼ V_2 \left(1 - \frac{\Delta x}{\lambda}\right) ¼ V_1 \left(1 - \frac{\Delta x}{\lambda}\right)^2$$

p2220 Proceeding section by section we obtain Eq. 13-11

s0085 CHAPTER 18

o0690 18-2. Radius of particle ¼ R Radius of atom ¼ r

p2505 number of silver atoms on particle surface ¼

p2510 (areaofparticlesurface)/(crosssectionalareaofatom) ¼ $4\pi R^2/\pi r^2$ ¼ $4R^2/r^2$

p2515 number of silver atoms in particle volume ¼

p2520 (volume of particle)/(volume of atom) ¼ $(4/3\pi R^3)/(4/3\pi r^3)$ ¼ R^3/r^3

p2525 number ratio of surface to volume atoms ¼ $(4R^2/r^2)/(R^3/r^3)$ ¼ $4r/R$

o0695 (a) R ¼ 10 nm; r ¼ 0.3 nm. Number ratio of surface to volume atoms ¼ $4r/R$ ¼ (4x0.3)/10 ¼ 0.12

o0700 (b) R ¼ 1 mm ¼ 10^6 nm; r ¼ 0.3 nm.

p2540 Number ratio of surface to volume atoms ¼ $4r/R$ ¼ $4x0.3/10^6$ ¼ $1.2x10^{-6}$

p2545 To be inserted in the in the “Answers to numerical Exercises".

o0705 18-2. (a) Number ratio of surface to volume atoms ¼ 0.12

o0715 (b) Number ratio of surface to volume atoms ¼ $1.2x10^{-6}$

o0720 18-7. Volume of average particle: $\frac{4}{3}\pi r^3$ where r is the particle radius

p2570 r ¼ D/2 ¼ 50nm ¼ $5x10^{-6}$ cm

p2575 Volume ¼ 5.23 x 10^{-16} cm^3

p2580 With density of particle ¼ 1g/cm^3, mass per particle ¼ 5.23 x 10^{-16} g/particle

p2585 Mass of particles/m^3 ¼ $12x10^{-6}$ g/m^3 ¼ $12x10^{-12}$g/cm^3

p2590 Number of particle/cm^3 ¼ (mass of particles/cm^3)/ (mass per particle) ¼

p2595 ¼ ($12x10^{-12}$g/cm^3)/(5.23 x 10^{-16} g/particle) ¼ $2.29x10^4$ particles/ cm^3)

p2600 Volume of average breath ¼ 500 cm^3

p2605 No. of particles entering the lung one breath ¼ (2.29 x10^4 particles/ cm^3)x cm^3 ¼ $1.15x10^7$