Answers to Selected Even-Numbered Homework Problems

Chapter 1

1.2 (a) MLT^{-1}; (b) ML^4L^{-2}; (c) MT^{-2}
1.4 (a) FLT^{-2}; (b) $FL^{-1}T^{-1}$; (c) $FL^{-3}T$
1.10 (a) FL^{-1}; (b) FL^{-3}; FL
1.12 LT^{-1}; $F^0L^0T^0$; LT^{-1}
1.14 Yes
1.16 1/2, −1/2
1.18 Dimensionless
1.20 (a) 4.32 mm/s; (b) 70.2 kg; (c) 13.4 N; (d) 22.3 m/s^2; (e) 1.12 $N \cdot s/m^2$
1.22 (a) 6.47×10^5 m^2; (b) 56.8×10^{-2} m^3; (c) 3.86×10^5 m; (d) 5.90×10^4 W; (e) 289 K
1.30 (a) 0.240 mi^3; (b) 4.41×10^5 lb
1.32 30.6 kg; 37.3 N
1.34 1150 kg/m^3; 11.3 kN/m^3
1.36 0.0186 ft^3; No
1.38 0.9971 lb
1.40 991.5 kg/m^3
1.42 16.0 kN/m^3; 1.63×10^3 kg/m^3; 1.63
1.44 4.76 kg
1.46 (a) 0.0214 kg/m^3; (b) $\rho_{Mars}/\rho_{earth} = 1.75\%$
1.48 6.44×10^{-3} $slugs/ft^3$; 0.622 lb
1.50 98.7 psia
1.52 668 lb
1.56 0.6 $N \cdot s/m^2$; 1.3×10^{-2} $lb \cdot s/ft^2$
1.58 0.727 $N \cdot s/m^2$
1.60 23.7, 2.55×10^{-2}
1.62 0.277 $N \cdot s/m^2$
1.64 2.05×10^{-5} $N \cdot s/m^2$
1.66 (a) No; (b) Not correct
1.68 184
1.70 $C = 1.43 \times 10^{-6}$ $kg/(m \cdot s \cdot K^{1/2})$; $S = 107$ K
1.72 $D = 1.767 \times 10^{-6}$ $N \cdot s/m^2$; $B = 1.870 \times 10^3$ K; 5.76×10^{-4} $N \cdot s/m^2$
1.74 0.300 $N \cdot s/m^2$
1.76 non-Newtonian
1.78 286 N
1.80 0.0883 m/s
1.82 0.268 ft/s
1.84 3.43×10^{-4} lb
1.86 9.53×10^{-4} $ft \cdot lb$
1.88 (a) 12.7 ft^2/rev; (b) 4.73×10^{-3} $lb \cdot s/ft^2$
1.94 2.03×10^3 psi
1.96 4.14×10^3 psi
1.98 (a) 343 m/s; (b) 1010 m/s; (c) 446 m/s
1.100 104 psi (gage)
1.102 2.88 kg/m^3
1.104 4.25×10^{-3} $slugs/ft^3$; 305 °F
1.108 1.06
1.110 14.1%
1.112 4.74 psi (abs)
1.114 13 kPa (abs)
1.116 5.81 kPa (abs); 0.842 psi (abs)
1.118 0.060 N/m
1.120 538 Pa
1.122 97.9 Pa
1.124 (a) 24.5 deg
1.126 0.0614 in.; Yes
1.128 1.80×10^{-2} ft
1.130 7.49 mm

Chapter 2

2.2 59.2 kPa
2.6 34.7 psi
2.8 404 kPa
2.10 (a) $p = -E_v \ln(1 - \rho_0 gh/E_v)$; (b) 61.4 MPa; (c) 60.6 MPa
2.12 $p = Kh^2/2 + \gamma_0 h$
2.18 464 mm
2.20 62.9%
2.24 4,250 ft
2.26 543 m
2.28 60 kPa
2.32 14.4 psia; 99.3 kPa (abs)
2.34 (a) 18.2 ft; (b) 8.73 psi; 21.7 psia
2.36 0.317 ft
2.38 6.28 ft
2.40 −3.32 kPa
2.42 (a) 4.00 ft; (b) 2.08 ft
2.44 1.45 ft
2.46 (a) 26.9 kPa; (b) 0.202 m
2.48 1.55 $slugs/ft^3$
2.50 94.9 kPa
2.54 21.6 ft
2.56 575 lb/ft^2
2.58 0.100 m
2.60 27.8°
2.62 0.212 m

2.64 0.304 ft
2.66 $\ell = [d + 11.31 - (d^2 + 18.61d + 128)^{1/2}]/2$
2.68 36,000 lb
2.70 $p = 0.416\,\theta$
2.74 2.90 lb
2.76 12.19 ft
2.78 7200 lb
2.80 665 lb
2.82 107 kPa
2.84 7.11 m; No
2.86 $F_B = \gamma\pi R^3/4$
2.88 (a) 9.00 ft; (b) 11,200 lb; (c) 0 lb
2.90 33,900 lb
2.92 373 kN
2.94 314 kN; 497 kN
2.96 1680 lb
2.100 3.63 ft
2.102 (a) 2.11 m; (b) 941 kN
2.104 599 lb
2.106 426 kN, 2.46 m below surface
2.108 2.34 ft
2.110 0.146
2.116 392 kN; 437 kN; Yes
2.118 581 lb; 0.289 psi
2.120 7.77×10^9 lb acting 406 ft above base
2.122 64.4 kN
2.124 3360 psi
2.126 203 kN down
2.128 3370 lb; 882 lb
2.130 485 kN
2.132 46.8 lb/ft^3
2.134 1.22 ft; no change
2.136 786,000 lb; 315,000 lb
2.138 54,600 lb
2.142 127 lb
2.144 18.9 kPa; 0.208 m^3
2.146 681 lb at 6.22 ft to right of A
2.148 89.5%
2.150 8.63 ft/s^2
2.152 (a) 68.9 lb/ft^2; (b) 57.4 lb
2.154 30°
2.156 $h = a\ell/g$
2.158 6.04 rad/s
2.160 5.76 ft
2.162 28.8 kPa

Chapter 3

3.2 13.7 m/s
3.4 −30.0 kPa/m
3.6 −0.838 psi/ft; 0.0292 psi/ft
3.8 (a) $-2\rho a^2 V_0^2\,[1 - (a/x)^2]/x^3$
(b) $p_0 + \rho V_0^2\,[(a/x)^2 - (a/x)^4/2]$
3.12 12.0 kPa; −20.1 kPa
3.14 (a) 4.97 lb/ft^3; 0.681 lb/ft^3
3.20 3.21 N/m^2
3.24 203 ft/s
3.28 46.5 m/s
3.32 20.9 ft/s
3.34 45.7 ft
3.36 1248 lb/ft^2
3.40 20.8 lb/s
3.42 0.0119 ft^3/s
3.44 15.4 m
3.46 0.223 ft; 9.22 lb/ft^2
3.48 2.45×10^5 kN/m^3; 5.50×10^{-6} m^3/s
3.50 3.19 ft
3.52 0.0156 m^3/s for any D
3.54 6.59 ft; B above A
3.56 $D = D_1/[1 - (\pi^2 g D_1^4\, z/8Q^2]^{1/4}$
3.58 3.13 ft
3.60 2.94 m
3.62 0.0758 ft^3/s; 499 lb/ft^2; 488 lb/ft^2; −11.7 lb/ft^2
3.64 (a) 3.98 ft; (b) 36.0 ft/s; −510 lb/ft^2
3.66 19.63 psi
3.68 6.26 m
3.70 (a) 1.06×10^{-3}; (b) 3.02×10^{-3}; 0.118
3.72 29.5 Pa
3.74 0 (gage); 0.146 m
3.76 (a) 0.0696 m^3/s; (b) 0.574 m
3.78 $H/H_0 = 1/(1 + cx/L)^{1/2}$, where
$c = 2\gamma_{H_2O}\, d_{max}/\rho V_0^2$
3.80 0.0132 m^3/s
3.82 2.50 in.
3.84 4
3.86 13.0 psi
3.88 0.607 ft^3/s; (b) 21.3 ft
3.90 0.123 ft^3/s
3.92 0.400 ft
3.94 $R = 0.998\, z^{1/4}$
3.100 404.5 kPa
3.102 252 kPa; 114 kPa
3.104 9.10×10^{-3} m^3/s; 57.9 kPa
3.106 3120 ft^3/s; 2080 ft^3/s; 2200 ft^3/s
3.108 155 N/m^2
3.112 0.630 ft; 4.48 ft
3.116 6.10×10^{-3} m^3/s
3.118 1.016 in.
3.120 1.73 m^2/s
3.122 25.4 m; 6.51 m; −9.59 m

Chapter 4

4.2 $(9y^2 + 12y + 68)^{1/2}$ ft/s
4.4 $x = y + y^2/2$
4.8 $x = -2,\ y = 2$
4.10 Everywhere; $x^2 + y^2 =$ constant
4.14 $x = -h\,(u_0/v_0)\,\ln\,(1 - y/h)$
4.18 10, 9, 6, 4 ft/s
4.20 $2c^2x^3$; $2c^2y^3$; $x = y = 0$
4.22 $4x\hat{\mathbf{i}} + y\hat{\mathbf{j}} + z\hat{\mathbf{k}}$
4.24 (a) 4ft/s^2; 2 ft/s^2; (b) negative
4.26 10 ft/s; 10 ft/s^2
4.28 -1.65×10^{11} ft/s^2; -5.12×10^9

4.32 720 m/s^2; 1440 m/s^2; 2160 m/s^2
4.34 −33.8 ft/s^2; 1.05
4.36 (225x + 150) m/s^2; 0; 150 m/s^2; 375 m/s^2
4.42 8.02 ft/s
4.46 8860 m/s^2; 7440 m/s^2
4.48 (a) 10 ft/s^2; (b) 20 ft/s^2, 10 ft/s^2; (c) 22.4 ft/s^2
4.50 $a_x = 2c^2x\,(x^2 + y^2)$; $a_y = 2c^2y\,(x^2 + y^2)$
4.52 3.20 m/s^2; 1.48 m/s^2
4.54 −225 ft/s^2; −28.1 ft/s^2; −8.33 ft/s^2
4.56 525 °F/s
4.58 −28.4 °C/s; −25.1 °C/s
4.60 (a) 200 °C/s; 100 °C/s
4.62 5.0 m^3/s for each line
4.64 132 ft^3/s
4.68 (b) 2 $V_0\,hb/3$
4.72 (a) 3000 kg/s; (b) 3.00 m^3/s

Chapter 5

5.2 20 m/s
5.4 3.66 slugs/s
5.6 1.57 in.
5.8 4.99 ft/s
5.10 314 m/s
5.12 −0.0189 kg/s
5.14 0.0125 lb$_m$/ft^3
5.16 1.00 m^3/s
5.18 150 liters/s
5.20 3.63 ft/s
5.22 0.711; 0.791; 0.837; 0.866
5.24 (a) 6280 kg/s
5.26 (a) 0.00456 slug/s increasing; (b) 2.28 × 10^{-4} slug/ft^3 · s
5.28 1260 min
5.30 14.8 m/s
5.32 (a) 15.6 gal/min; (b) 62.4 gal/min
5.34 120 N
5.36 2.66 × 10^{-4} m^3/s
5.38 15.5 lb
5.40 7.01 ft^3/s; 674 lb
5.42 352 lb
5.44 2.69 lb
5.46 (a) 6.26 m/s; (b) 392 N; (c) 675 N
5.48 0 N
5.50 482 N downward
5.52 17,900 lb
5.54 28.7 ft^3/s
5.56 4.02 lb
5.58 (a) W_1 − 9.8 lb; (b) W_2 + 14.7 lb
5.60 −185 kN; 45.8 kN
5.62 1290 lb/ft; 3120 lb/ft
5.64 3580 lb
5.66 2.96 lb
5.68 66.6 N
5.70 13.3 lb
5.72 non-uniform = (4/3) uniform
5.74 (a) 181 lb; (b) 146 lb
5.76 (b) 234 lb
5.78 9170 lb
5.80 78.5 kN
5.88 (a) 231 N · m, 185 rad/s; (b) 200 N · m, 160 rad/s; (c) 116 N · m, 92.5 rad/s
5.90 39.6 hp
5.92 (a) 43 deg; (b) 53.4 ft · lb/s
5.92 −36.8 ft · lb/slug
5.96 −3130 ft · lb/slug
5.100 0.32 ft; right to left
5.102 0.042 m^3/s
5.104 4.58 × 10^{-3} m^3/s
5.106 5660 ft · lb/slug
5.108 926 ft · lb/slug; 200 ft · lb/slug
5.110 734 ft
5.112 2.22 × 10^6 W
5.114 5.48 hp
5.116 Will work for 2 atm., not for 3 atm.
5.118 0.052 m^3/s
5.120 1610 ft · lb/slug; 1110 ft · lb/s
5.122 (a) 4.08 hp; (b) 9.94 ft
5.124 0.58
5.126 1.78 kW
5.128 (a) 0.56; (b) 11.7 lb
5.132 2.36 ft
5.134 (a) 17.2 deg, 4.29 m/s; 558 N · m/s
5.136 (a) 3.43 ft · lb/lb$_m$; (b) 3.36 ft · lb/lb$_m$
5.138 11.6 N · m/kg; 0.796
5.140 148 ft · lb/slug; 0.875

Chapter 6

6.2 $2x$, $4xt^2$; $-2y$, $4yt^2$; $\boldsymbol{V} = 0$; $\boldsymbol{a} = 4\hat{\mathbf{i}} - 4\hat{\mathbf{j}}$ ft/s^2; $a = 5.66$ ft/s^2
6.4 (a) 0; (b) $\omega = -(y/2 + z)\hat{\mathbf{i}} + (5z/2)\hat{\mathbf{j}} - (y/2)\hat{\mathbf{k}}$; No
6.6 $\zeta = 3xy^2\hat{\mathbf{k}}$; No
6.8 $u = -\dfrac{3}{2}x^2 + \dfrac{x^3}{3} + f(y)$
6.10 $\dot{\gamma} = \dfrac{-r_0\omega}{r_0 - r_i}$
6.12 No
6.14 (a) 2.24 m/s, −63.4 deg, $x = y = 0$; (b) 4.12 m/s, 76.0 deg, none
6.16 No
6.18 Second one
6.22 $v = \dfrac{-y^2}{2x} + f(x)$
6.24 $v_\theta = -4r\theta - 9r^2\cos\theta + f(r)$
6.26 (a) $\psi = \dfrac{-Ar^2}{2} + C$; (b) $\psi = -A\ln r + C$
6.30 19.6y − 100 kPa, where y is m
6.34 $\psi = 2x - 4y + C$; $\phi = -4x - 2y + C$
6.36 $\phi = A\ln r + Br\cos\theta + C$; $\theta = \pi$, $r = A/B$
6.38 60.5 psi
6.40 (a) Yes; (b) Yes, $\phi = 2(x + y) + C$; (c) 0

6.42 (a) $\phi = U(0.866x + 0.500y)$; $\psi = U(0.866y - 0.500x)$; (b) $\dfrac{\partial p}{\partial y} = -\gamma$
6.46 −7.10 kPa
6.48 $\psi = 5x^2y - 5y^3/3 + C$
6.50 92.3 ft
6.52 3.10 ft
6.54 (a) $1.60 \times 10^3/r^3$ kPa/m; (b) 184 kPa
6.56 0.00796 ft to right of slit; 0.0250 ft
6.60 80 mph; 53.3 mph; 40 mph
6.62 $h^2 = \text{m}/2\pi A$
6.64 $\sin\theta = (\Gamma/2\pi rU)\ln(r/4)$
6.66 (b) 0; 68.2 mph
6.68 8.49×10^{-4} m/s
6.74 $(2/3)^{1/2}$
6.76 10
6.80 0.00620 lb/ft^2
6.84 $\tau_{xy} = 30\mu xy$; $\tau_{yz} = \tau_{xz} = 0$
6.86 (a) $\partial v/\partial y = -2x$; (b) a $= 2x^3\hat{\mathbf{i}}$; (c) $\partial p/\partial x = 2\mu - 2\rho x^3$
6.88 43.2 lb/ft^3; 0.75 ft/s
6.90 $q = -2\rho g h^3/3\mu$
6.92 (a) $u = Uy/b$; (b) $Ub/2$
6.94 $u = [(U_1 + U_2)/b]y - U_2$
6.96 $y/b = 1/3$
6.98 $v_\theta = R^2\omega/r$
6.100 (a) $\mathcal{T} = 2\pi r_0^3\,\mu\omega\ell/(r_0 - r_i)$; (b) $\dot{\gamma} = -U/b$
6.102 57.1 N/m^3; 0.252 m/s
6.106 Δp (nonuniform)/Δp (uniform) = 3.52
6.108 $V_0 = (\Delta p/\ell)[2r_i^2 \ln(r_i/r_0) - (r_i^2 - r_0^2)]/4\mu$

Chapter 7

7.6 (a) 103 m/s; (b) 444 m/s
7.8 $q/(b^{3/2}g^{1/2}) = \phi\,(H/b, \mu/b^{3/2}g^{1/2}\rho)$
7.10 $Q/A^{5/4}\,g^{1/2} = \phi(\varepsilon/A^{1/2}, S_0)$
7.12 $\omega\ell^{1/2}/g^{1/2} = \phi(h/\ell)$
7.14 $Q/d^{5/2}\,g^{1/2} = \phi(\rho_g/\rho_a, h/d)$
7.16 $\delta/d = \phi\,(\ell/d, \rho V^2/E, \mu V/dE)$
7.18 $h/\ell = \phi(\sigma/\ell^2\,g\rho)$
7.20 $h/D = \phi(\sigma/\gamma D^2)$
7.22 $\Delta p \propto 1/D^2$ (for a given velocity)
7.26 $t\sqrt{g/d} = \phi(\forall/d^3, \rho\sqrt{g}\,d^{3/2}/\mu)$
7.28 (a) $VD\sqrt{\rho/\mathcal{W}} = \phi(b/d, d/D)$; (b) $V = \sqrt{2\mathcal{W}b/\pi\rho dD^2}$
7.30 5.58×10^7; 1.88; 1.44; 4.17×10^{-3}
7.32 $\Delta p/\rho V_1^2 = -1.10\,(A_1/A_2)^2 + 1.07\,(A_1/A_2) - 0.0103$; 6.26 lb/ft^2
7.34 $\Delta p/(\rho V^2) = 0.505\,(D/d)^{3.99}$
7.36 (a) $H/b = \phi(h/b, \ell/b)$; (b) $H/b = 0.0833\,(h/b)^{-1.00}$
7.38 (a) Correct; (b) $t = 1.36\,\mu$
7.40 (a) −1/2; (b) Yes
7.42 (a) $\theta = 2.98 \times 10^3\,(\omega\mu\ell^3/K)$
7.44 11.0 m/s
7.46 Colder
7.48 Double pressure
7.50 6.52×10^{-2} ft/s
7.52 129 m/s
7.54 3750 mph; No
7.56 1170 km/hr
7.58 187 mph
7.60 (a) 4.50 mph; (b) 8.00 ft
7.62 0.125; 0.0625
7.64 (a) $h/H = \phi(d/H, b/H, \rho g/\gamma_s, V/\sqrt{gH})$; (b) 21.2 mph
7.66 26.4 lb
7.68 50.2 kPa (abs)
7.70 (a) $\Delta p/\rho c^2 = \phi(E/\rho c^2 d^3)$
7.72 (a) $V_{0m}\,t_m/D_m = V_0\,t/D$, $\omega_m\,t_m = \omega t$, $\rho_m\,V_{0m}\,D_m/\mu_m = \rho V_0\,D/\mu$, $D\,\Delta p_\ell/\rho V_0^{\,2} = D_m\,\Delta p_{\ell m}/\rho_m\,V_{0m}^2$; (b) 160 rad/s
7.74 100 mph to 450 mph
7.76 (a) 0.0006 slugs/ft^3; (b) 9.49 ft/s; (c) 1.90 Hz
7.78 (a) 2.91 m/s; (b) 2.61 N
7.80 (a) 400 N; (b) 7220 W
7.82 (a) $V\ell^2/Q = \phi(\ell_i/\ell,\ Q^2/\ell^5 g,\ \rho Q/\ell\mu)$; no (b) 0.410 gpm; 2.46 in.
7.84 (a) $nD/V = \phi(VD/\nu)$; (b) Yes; (c) 7.54 ft/s
7.86 (a) $V_m/U_m = V/U$, $V_m\,D_m/\nu_{sm} = VD/\nu_s$, $V_m^2/g_m\,D_m = V^2/gD$, $(\rho - \rho_s)_m/\rho_m = (\rho - \rho_s)/\rho$; (b) No
7.86 0.440 ft; 2.80 ft^3/s
7.92 (a) $d^2y^*/dx^{*2} = (P\ell^2/EI)(x^* - 1)$
7.94 $\partial u^*/\partial t^* = (X/\rho h\omega^2)\,\cos t^* + (\mu/\rho h^2\omega)\partial^2 u^*/\partial y^{*2}$

Chapter 8

8.2 Turbulent
8.4 3.36 ft
8.6 4.95×10^{-6} m^3/s at 20 °C
8.8 3 m; 8.83 N/m^2
8.10 2 m/s; 1 m/s; 1.26×10^{-3} m^3/s
8.12 0.15 lb/ft^2; 0.06 lb/ft^2; 0 lb/ft^2
8.14 (b) to (a)
8.16 0.354 D
8.18 3.43 m; 166 kPa
8.20 $z = 1 + e^{-(t/2.8 \times 10^5)}$ ft, where t is seconds
8.22 1.89 m/s; 7.42×10^{-3} m^3/s
8.24 (a) 4.69×10^{-3} ft^3/s; 3.30×10^{-3} ft^3/s
8.26 8.88×10^{-8} m^3/s
8.28 2.4×10^{-4} m^3/s
8.30 (a) 0.707 R; (b) 0.750 R
8.34 1.02×10^{-4} ft
8.36 B to A; A to pump
8.38 (a) 0.266 psi; (b) 1.13 psi; (c) −0.601 psi
8.40 2.04×10^{-3} W
8.42 0.0300
8.44 0.0162
8.46 0.211 psi/ft
8.48 0.0404
8.50 19.6 m
8.52 0.0132 ft
8.54 (a) 0.556 ft; (b) 3.70 ft; (c) 0.926 ft

8.56 47.5
8.58 39.7 kPa; 39.7 kPa, 93.0 kPa
8.60 13
8.62 0.223 lb/ft^2
8.64 9
8.66 Disagree
8.68 1.54 kPa
8.70 0.188 m
8.72 0.899 lb/ft^2
8.74 (a) 135 ft; (b) 137 ft
8.76 84.0 ft
8.78 0.750 psi
8.80 24.4 hp
8.82 21.2 psi
8.84 16.5 ft
8.86 48.0 psi
8.88 379 kW
8.90 5.46×10^{-4} m^3/s
8.92 0.0615 ft^3/s
8.94 0.0289 m^3/s
8.96 155 hp
8.98 0.0494 ft^3/s
8.100 0.476 ft
8.102 0.535 ft
8.104 0.155 ft
8.106 0.0445 m
8.108 0.500 ft^3/s
8.112 0.0180 m^3/s
8.114 0.0284 m^3/s; 0.0143 m^3/s; 0.0141 m^3/s
8.118 18.0 m^3/s
8.120 32.4 kPa
8.122 0.528 ft^3/s
8.124 0.0221 m^3/s
8.126 5.69 ft^3/s
8.128 0.0936 ft^3/s
8.130 11.1 in.

Chapter 9

9.2 (a) 0.06 ($\rho U^2/2$); (b) 2.40
9.4 No
9.6 5.43 kN
9.8 0.142
9.12 1.12 m; 7.92×10^{-3} m
9.14 6.65×10^{-6} m^2/s
9.16 7.54×10^{-3} ft/s; 0.471 ft/s; 2.62×10^{-5} ft/s
9.20 $d = 1 + 0.0304\sqrt{x}$ ft where x is ft
9.22 (a) 27.6 ft/s; (b) 20.5 mph
9.26 (a) 0.171 ft; (b) 0.134 ft
9.28 (b) $\delta/x = 5.48/\sqrt{Re_x}$
9.30 (b) $\delta = 5.83\sqrt{\nu x/U}$
9.34 0.707
9.36 48.8 lb
9.38 10,300 lb
9.40 1.4; upright
9.42 85.4 kW
9.44 1.88×10^4 lb; 33.3%
9.46 2.83 $\mathcal{D}_U$; 0.354 $\mathcal{D}_U$
9.52 0.0438 N · m
9.54 1.06 m/s
9.58 (a) 567 ft/s; (b) 118 ft/s; (c) 13.5 ft/s
9.60 133 N
9.62 77.0 ft/s
9.64 7080 N · m
9.68 30.6 ft/s
9.70 378 lb
9.72 58.4 hp
9.74 0.946 ft/s in water; 30.2 ft/s in air
9.76 (a) 2.44 m/s; (b) 2.13 m/s
9.78 5.31 m/s
9.80 1.42 lb; 142 lb
9.82 7220 m/s^2
9.84 9.65 lb/ft^2
9.86 (a) 4.31 MN; (b) 4.17 MN
9.88 53.5 kW; 4.46 kW
9.92 3
9.94 4.35%
9.96 41.6 ft/s
9.98 30.8 hp
9.100 (a) 0.0166 hp; (b) 32.4 hp
9.102 0.851; 0.301
9.104 65.9 hp
9.106 0.225
9.108 1.72 U
9.110 0.206
9.114 Yes
9.116 0.480; 0.409; 0.451; 0.482
9.118 5.72%
9.122 28.4%

Chapter 10

10.2 Subcritical
10.4 Subcritical; 1.04 m
10.8 5.66 ft
10.10 2.80 m/s
10.12 175 ft/s
10.14 616 km/hr
10.16 2.45 m or 0.388 m
10.18 5.82 ft or 1.129 ft
10.20 1.774 ft or 1.974 ft
10.24 1.828 ft
10.26 0.694 ft
10.30 2 ft or 3.51 ft; 2 ft or 1.38 ft
10.34 0.000532
10.36 626.9 ft
10.38 3.49 N/m^2
10.42 (a) 1.80 lb/ft^2; (b) 0.0469; (c) 0.636
10.44 7.42 min
10.46 23.7%
10.48 5.73 ft/s
10.50 Yes
10.52 40.9 m^3/s
10.54 8.42 ft/s

10.56 6.22 ft/s
10.58 17.1 ft
10.60 18.2 m^3/s
10.64 119 ft^3/s
10.66 1.19 m
10.68 0.841 m
10.70 0.861 m
10.72 Each requires the same.
10.74 No
10.76 5.16 ft
10.78 2.59 m
10.80 10.66 m
10.82 1.22 m
10.84 5.94 ft
10.86 0.00226
10.88 0.000664
10.90 0.000269
10.92 0.452 in.
10.94 1.68 m
10.96 401 kW
10.100 84.5 m^3/s
10.102 0.0378 m
10.104 0.0577; 0.000240
10.106 0.652 m; 2.61 m
10.108 0.116 m^3/s
10.110 4.70 ft
10.112 20.1 s
10.118 0.350 m^2/s

Chapter 11

11.4 (a) 71,700 J/kg; (b) 100,000 J/kg; (c) -1.58 kg/m^3; (d) 396 J/kg · K
11.8 -5.08×10^6 N · m/kg; -7.16×10^6 N · m/kg; -1.40×10^4 N · m/kg
11.10 387 °R
11.12 905 °R; -4.17×10^6 ft · lb/slug; 877 ft · lb/slug
11.16 5300 m/s; 1470 m/s; 340 m/s
11.18 (a) 2000 ft/s; (b) 2930; (c) 893 m/s
11.20 (a) 0.0328; (b) 0.0722; (c) 0.131
11.22 (a) 732 m/s; (b) 2400 ft/s; (c) 1636 mph
11.24 8.75 m
11.28 (a) 590 mph; (b) 866 ft/s; (c) 264 m/s
11.30 From 0.47 to 0.75
11.32 No
11.34 (a) 0.528, 0.833; (b) 0.546, 0.869; (c) 0.488, 0.752
11.36 283 m/s; 0.89
11.38 269 m/s; 0.90
11.42 1.8; 1580 ft/s
11.44 26.5 kg/s
11.50 9.8%
11.52 (a) 1.70 kg/s; (b) 1.52 kg/s
11.54 1.55 kg/s
11.58 17 psia; 868 ft/s; 1390 Btu/s
11.64 2.29
11.66 1.9; 648 m/s
11.68 92 kPa (abs); 82 kPa (abs)
11.70 1160 °R; 132 psia; 0.81 slug/s
11.72 1.35 m
11.74 at duct entrance $T = 130$ K; $p = 6.0$ kPa (abs); $T_0 = 293$ K; $p_0 = 101$ kPa (abs); $V = 571$ m/s; just upstream of shock $T = 296$ K; $p = 17$ kPa (abs); $T_0 = 396$ K; $p_0 = 47.7$ kPa (abs); $V = 448$ m/s; just downstream of shock $T = 354$ K; $p = 30.8$ kPa (abs); $T_0 = 396$ K; $p_0 = 46.4$ kPa (abs); $V = 299$ m/s; at duct exit $T = 351$ K; $p = 26.6$ kPa (abs); $T_0 = 407$ K; $p_0 = 45.9$ kPa (abs); $V = 337$ m/s

Chapter 12

12.2 55.4 deg
12.4 10.8 lb/ft^2
12.8 -71 ft · lb/slug
12.10 (b) fan; (c) 1780 ft^2/s^2
12.12 379 ft · lb/lb_m
12.14 (b) 891 ft · lb
12.16 61.3 ft
12.18 107 gpm
12.20 (a) 5.15 ft; (b) -2.49 ft
12.22 (a) 2.07 kW; (b) 12.6 m
12.26 1400 gal/min
12.28 158 gal/min; Yes
12.30 1740 gal/min; Yes
12.34 0.0328 m^3/s; 8.00 m
12.36 Yes
12.38 1000 gpm; 800 ft
12.40 Centrifugal
12.42 1900 rpm
12.44 (a) 18.3 ft; radial-flow
12.48 (a) -15.6 m^2/s^2; (b) -15.6 m^2/s^2
12.50 -19.8 hp
12.52 16.6 m^2/s^2; 0.849
12.54 0.0109 ft^3/s; 0.0409 hp
12.56 816 kW pump
12.58 23,200 kW
12.60 26,600 N; 37.6 m/s; 707 kg/s
12.64 70 m
12.68 impulse