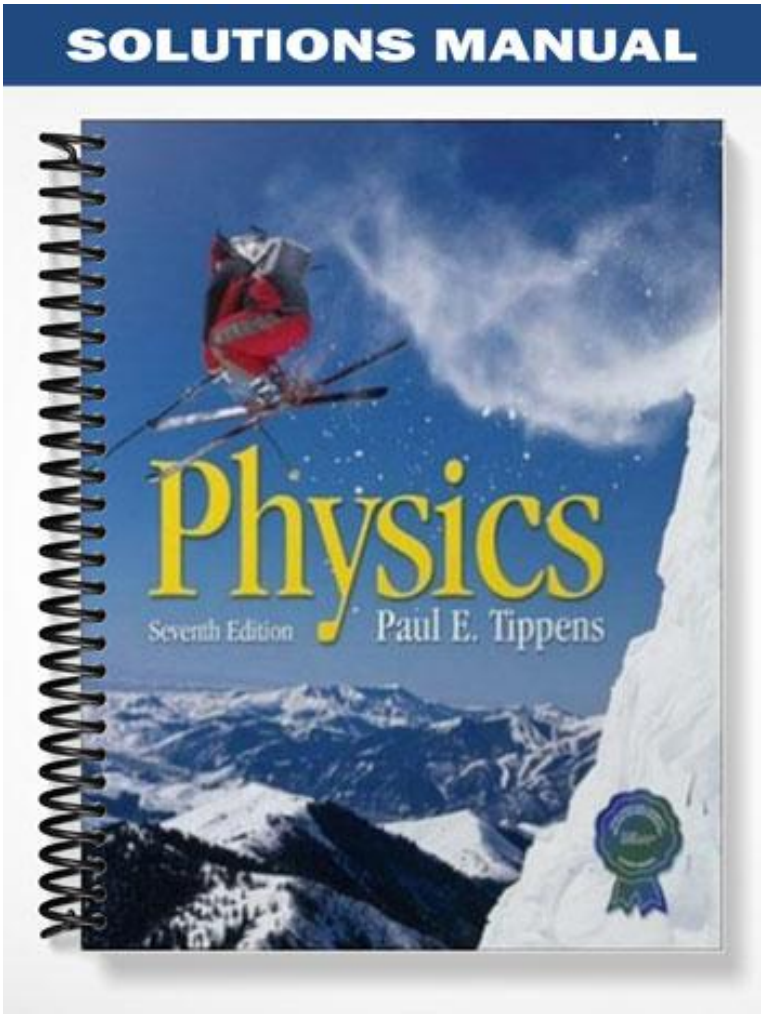
SOLUTIONS MANUAL



Chapter 2. Technical Mathematics

Signed Numbers

2-1. +7 **2-8.** -17 **2-15**. +2 **2-22**. +12

2-2. +4 **2-9.** +6 **2-16**. -2 **2-23**. +8

2-3. +2 **2-10**. -32 **2-17**. -4 **2-24**. -4

2-4. -2 **2-11**. -36 **2-18**. -3 **2-25**. 0

2-5. -10 **2-12**. +24 **2-19**. +2 **2-26**. +220

2-6. -33 **2-13**. -48 **2-20**. -4 **2-27**. +32

2-7. -5 **2-14**. +144 **2-21**. -3 **2-28**. -32

2-29. (a) -6^0C; (b) -17^0C; (c) 36^0C

2-30. $\Delta L = 2\text{ mm}[(-30^0\text{C}) - (-5^0\text{C})] = 2\text{ mm}(-25) = -50\text{ mm}$; Decrease in length.

Algebra Review

2-31. x = (2) + (-3) + (-2) = -3; x = -3

2-32. x = (2) – (-3) – (-2) = +7; x = +7

2-33. x = (-3) + (-2) - (+2) = -7; x = -7

2-34. x = -3[(2) – (-2)] = -3(2 + 2) = -12; x = -12

2-35. $x = \dfrac{b-c}{a} = \dfrac{-3-(-2)}{2} = \dfrac{-3+2}{2}$; $x = -\dfrac{1}{2}$

2-36. $x = \dfrac{2+(-3)}{-2} = \dfrac{2-3}{-2}$; $x = +\dfrac{1}{2}$

2-37. $x = (-3)^2 - (-2)^2 = 9 - 4 = 5$; x = 5

2-38. $x = \dfrac{-b}{ac} = \dfrac{-(-3)}{(2)(-2)} = -\dfrac{3}{4}$; $x = -\dfrac{3}{4}$

2-39. $x = \dfrac{2}{(-3)(-2)}\big[2-(-2)\big] = \dfrac{1}{3}(4)$; $x = \dfrac{4}{3}$

2-40. $x = (2)^2 + (-3)^2 + (-2)^2$; $x = 17$

2-41. $x = \sqrt{a^2+b^2+c^2} = \sqrt{17}$

2-42. $x = (2)(-3)[(-2) - (+2)]^2$; $x = -6(-4)^2 = -96$

2-43. Solve for *x:* $2ax - b = c$; $2ax = b + c$; $x = \dfrac{b+c}{2a} = \dfrac{-3-2}{2(2)}$; $x = -\dfrac{5}{4}$

2-44. $ax + bx = 4c; \quad (a+b)x = 4c; \quad x = \dfrac{4c}{a+b} = \dfrac{4(-2)}{2+(-3)}; \quad x = +8$

2-45. $3ax = \dfrac{2ab}{c}; \quad 3cx = 2b; \quad x = \dfrac{2b}{3c} = \dfrac{2(-3)}{3(-2)}; \quad x = +1$

2-46. $\dfrac{4ac}{b} = \dfrac{2x}{b} - 16; \quad 4ac = 2x - 16b; \quad x = \dfrac{4ac+16b}{2} = \dfrac{4(2)(-2)+16(-3)}{2}; \quad x = -32$

2-47. $5m - 16 = 3m - 4$

$5m - 3m = -4 + 16$

$2m = 12; \quad m = 6$

2-48. $3p = 7p - 16$

$3p - 7p = -16$

$-4p = -16; \quad p = +4$

2-49. $4m = 2(m - 4)$

$4m = 2m - 8$

$2m = -8; \quad m = -4$

2-50. $3(m - 6) = 6$

$3m - 18 = 6$

$3m = 24; \quad m = +8$

2-51. $\dfrac{x}{3} = (4)(3) = 12; \quad x = 36$

2-52. $\dfrac{p}{3} = \dfrac{2}{6} = \dfrac{1}{3}; \quad p = 1$

2-53. $\dfrac{96}{x} = 48; \quad x = \dfrac{96}{48} = 2$

2-54. $14 = 2(b - 7); \quad 14 = 2b - 14; \quad b = 14$

2-55. $R^2 = (4)^2 + (3)^2 = 16 + 9$

$R^2 = \sqrt{25} \qquad R = 5$

2-56. $\dfrac{1}{2} = \dfrac{1}{p} + \dfrac{1}{6}; \quad \dfrac{6p}{2} = \dfrac{6p}{p} + \dfrac{6p}{6}$

$3p = 6 + p; \quad p = 3$

2-57. $V = IR; \quad R = \dfrac{V}{I}$

2-58. $PV = nRT; \quad T = \dfrac{PV}{nR}$

2-59. $F = ma; \quad a = \dfrac{F}{m}$

2-60. $s = vt + d; \quad d = s - vt$

2-61. $F = \dfrac{mv^2}{R}; \quad FR = mv^2; \quad R = \dfrac{mv^2}{F}$

2-62. $s = \frac{1}{2}at^2; \quad 2s = at^2; \quad a = \dfrac{2s}{t^2}$

2-63. $2as = v_f^2 - v_0^2; \quad a = \dfrac{v_f^2 - v_0^2}{2s}$

2-64. $C = \dfrac{Q^2}{2V}; \qquad V = \dfrac{Q^2}{2C}$

2-65. $\dfrac{1}{R_1} + \dfrac{1}{R_2} = \dfrac{1}{R}; \quad R_2R + R_1R = R_1R_2$

$(R_1 + R_2)R = R_1R_2; \quad R = \dfrac{R_1R_2}{R_1 + R_2}$

2-66. $mv = Ft; \quad \dfrac{mv}{F} = t$

$t = \dfrac{mv}{F}$

2-67. $mv_2 - mv_1 = Ft; \quad mv_2 = Ft + mv_1$

$v_2 = \dfrac{Ft + mv_1}{m}$

2-68. $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}; \quad P_1V_1T_2 = P_2V_2T_1$

$T_2 = \dfrac{P_2V_2T_1}{P_1V_1}$

2-69. $v = v_o + at; \quad v - v_0 = at$

$a = \dfrac{v - v_0}{t}$

2-70. $c^2 = a^2 + b^2; \quad b^2 = c^2 - a^2$

$b = \sqrt{c^2 - a^2}$

Exponents and Radicals

2-71. 2^{12} **2-72**. $3^5 2^3$ **2-73.** x^{10} **2-74.** x^5

2-75. $1/a$ **2-76**. a/b^2 **2-77.** $1/2^2$ **2-78.** a^2/b^2

2-79. $2x^5$ **2-80.** $1/a^2b^2$ **2-81.** m^6 **2-82.** c^4/n^6

2-83. 64×10^6 **2-84.** $(1/36) \times 10^4$ **2-85.** 4 **2-86.** 3

2-87. x^3 **2-88.** a^2b^3 **2-89.** 2×10^2 **2-90.** 2×10^{-9}

2-91. $2a^2$ **2-92.** $x + 2$

Scientific Notation

2-93. 4.00×10^4 **2-94**. 6.70×10^1 **2-95.** 4.80×10^2

2-96. 4.97×10^5 **2-97**. 2.10×10^{-3} **2-98.** 7.89×10^{-1}

2-99. 8.70×10^{-2} **100**. 9.67×10^{-4} **2-101.** 4,000,000

2-102. 4670 **2-103**. 37.0 **2-104**. 140,000

2-105. 0.0367 **2-106**. 0.400 **2-107**. 0.006

2-108. 0.0000417 **2-109**. 8.00×10^{6} **2-110**. 7.40×10^{4}

2-111. 8.00×10^{2} **2-112**. 1.80×10^{-8} **2-113**. 2.68×10^{9}

2-114. 7.40×10^{-3} **2-115**. 1.60×10^{-5} **2-116**. 2.70×10^{19}

2-117. 1.80×10^{-3} **2-118**. 2.40×10^{1} **2-119**. 2.00×10^{6}

2-120. 2.00×10^{-3} **2-121**. 2.00×10^{-9} **2-122**. 5.71×10^{-1}

2-123. 2.30×10^{5} **2-124**. 6.40×10^{2} **2-125**. 2.40×10^{3}

2-126. 5.60×10^{-5} **2-127**. -6.90×10^{-2} **2-128**. -3.30×10^{-3}

2-129. 6.00×10^{-4} **2-130**. 6.40×10^{6} **2-131**. -8.00×10^{6}

2-132. -4.00×10^{-2}

Graphs

2-133. Graph of speed vs. time: When t = 4.5 s, v = 144 ft/s; When v = 100 m/s, t = 3.1 s.

2-134. Graph of advance of screw vs. turns: When screw advances 2.75 in., N = 88 turns.

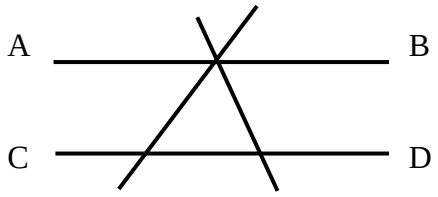
2-135. Graph of wavelength vs. frequency: 350 kHz $\rightarrow$ 857 m; 800 kHz $\rightarrow$ 375 m.

2-136. Electric Power vs. Electric Current: 3.20 A $\rightarrow$ 10.4 W; 8.0 A $\rightarrow$ 64.8 W.

Geometry

2-137. 90^0. 180^0, 270^0, and 45^0

2-138.



2-139a. A = 17^0, B = 35^0, C = 38^0 **2-139b**. A = 50^0 Rule 2; B = 40^0 Rule 2.

2-140a. A = 50^0 Rule 3; B = 130^0 **2-140b**. B = 70^0, C = 42^0 Rule 2

Right Triangle Trigonometry

2-141. 0.921 **2-147**. 19.3 **2-153.** 684 **2-159**. 54.2^0 **2-165.** 36.9^0

2-142. 0.669 **2-148**. 143 **2-154.** 346 **2-160**. 6.73^0 **2-166.** 76.0^0

2-143. 1.66 **2-149**. 267 **2-155.** 803 **2-161**. 50.2^0 **2-167.** 31.2^0

2-144. 0.559 **2-150**. 32.4 **2-156.** 266 **2-162**. 27.1^0

2-145. 0.875 **2-151**. 235 **2-157.** 2191 **2-163**. 76.8^0

2-146. 0.268 **2-152**. 2425 **2-158.** 1620 **2-164**. 6.37^0

Solve triangles for unknown sides and angles (Exercises 168 – 175):

2-168. $\tan\theta = 18/35$, $\theta = 35.8^0$; $R = \sqrt{18^2 + 25^2}$ R = 30.8 ft

2-169. $\tan\phi = 600/400$, $\phi = 56.3^0$; $R = \sqrt{40^2 + 80^2}$ R = 721 m.

2-170. $y = 650 \sin 21^0 = 233$ m; $x = 650 \cos 21^0 = 607$ m.

2-171. $\sin\phi = 200/500$, $\phi = 23.6^0$; $500^2 = x^2 + 200^2$, x = 458 km.

2-172. $\sin\theta = 210/400$, $\theta = 31.7^0$; $500^2 = m^2 + 200^2$, m = 340 m.

2-173. $x = 260 \cos 51^0 = 164$ in.; $y = 260 \sin 51^0 = 202$ in.

2-174. $\tan\theta = 40/80$, $\theta = 26.6^0$; $R = \sqrt{40^2 + 80^2}$ R = 89.4 lb

2-175. $\phi = 180^0 - 120^0 = 60^0$; y = 300 sin 60^0 = 260 m; x = 300 cos 60^0 = 150 m, left

Additional Problems

2-176. 30.21 – 0.59 in. = 29.62 in.

2-178. $\Delta T = T_f - T_0 = -15^0C - (29^0C)$; $\Delta T = -44\ C^0$.

2-179. $T_f - T_0 = -34^0C$; $T_f - 20^0C = -34^0C$; $T_f = -14^0C$

2-180. Six pieces @ 4.75 in. = 6(4.75 in.) = 28.5 in.; Five cuts @ 1/16 = 5/16 = 0.3125 in.

Original length = 28.5 in. + 0.3125 in. = 28.8 in.

2-181. $V = \pi r^2 h$; Solve for h: $h = \dfrac{V}{\pi r^2}$

2-182. $F = \dfrac{mv^2}{R}$; $R = \dfrac{mv^2}{F}$

2-183. Solve for x and evaluate: a = 2, b = -2, c = 3, and d = -1

$xb + cd = a(x + 2) \rightarrow xb + cd = ax + 2a \rightarrow xb - ax = 2a - cd \rightarrow (b - a)x = 2a - cd$

$x = \dfrac{2a - cd}{b - a}$; $x = \dfrac{2a - cd}{b - a} = \dfrac{2(2) - (3)(-1)}{(-2) - (2)} = \dfrac{7}{-4}$; $x = -\dfrac{7}{4}$

2-184. $c^2 = b^2 + a^2$ $b = \sqrt{c^2 - a^2}$; $b = \sqrt{50^2 + 20^2} = 53.9$ $b = 53.9$

2-185. $F = \dfrac{Gm_1m_2}{R^2} = \dfrac{(6.67 \text{ x } 10^{-11})(4 \text{ x } 10^{-8})(3 \text{ x } 10^{-7})}{(4 \text{ x } 10^{-2})^2}$; $F = 5.00 \text{ x } 10^{-22}$

2-186. $L = L_0 + \alpha L_0(t - t_0)$; $L = 21.41 \text{ cm} + (2 \text{ x } 10^{-3}/C^0)(21.41 \text{ cm})(100^0C - 20^0C)$;

$L = 24.84$ cm.

2-187. Construct graph of $y = 2x$ and verify that $x = 3.5$ when $y = 7$ (from the graph).

2-188. (a) $A + 60^0 = 90^0$; $A = 30^0$. $A + C = 90^0$; $C = 60^0$. $B = 60^0$ by rule 2.

(b) $D + 30^0 = 90^0$; $D = 60^0$. $A = 60^0$ (alt. int. angles); $B = 30^0$; $C = 120^0$.

Critical Thinking Problems

2-189. A = (-8) – (-4) = -4; B = (-6) + (14) = 8; C = A – B = (-4) – (8) = -12; C = - 12 cm.

B – A = (8) – (-4) = +12. There is a difference of 24 cm between B – A and A – B.

2-190. $T = 2\pi\sqrt{\frac{L}{g}} \rightarrow T^2 = 4\pi^2\frac{L}{g} \rightarrow L = \frac{gT^2}{4\pi^2}$

Let L = $4L_o$; Since $\sqrt{4} = 2$, the period will be doubled when the length is quadrupled.

Let $g_m = g_e/6$, Then, T would be changed by a factor of $\sqrt{\frac{1}{1/6}} = \sqrt{6} = 2.45$

Thus, the period T on the moon would be 2(2.45) or 4.90 s.

2-191. (a) Area = LW = (3.45 x 10^{-4} m)(9.77 x 10^{-5} m); Area = 3.37 x 10^{-8} m^2.

Perimeter (P) = 2L + 2W = 2(L + W); P = 2(3.45 x 10^{-4} + 9.77 x 10^{-5}) = 8.85 x 10^{-4} m.

(b) L = $L_0/2$ and W = $2W_0$: A = $(L_0/2)(2W_0) = L_0W_0$; No change in area.

P – P_0 = [$2(L_0/2)$ + $2(2W_0)$] - [$2L_0$ + $2W_0$] = $2W_0 – L_0$

$\Delta P = 2(9.77 \times 10^{-5}) – 3.45 \times 10^{-4}$ ΔP = -1.50 x 10^{-4} m.

The area doesn't change, but the perimeter decreases by 0.150 mm.

2-192. Graph shows when T = 420 K, P = 560 lb/$in.^2$; when T = 600 K, P = 798 lb/$in.^2$

2-193. Graph shows when V = 26 V, I = 377 mA; when V = 48 V, I = 696 mA.