



Numerical Answers to Calculation Questions

Chapter 1 - Algebraic Operations, Logarithms, and Problem Solving

Objective 1

2. a) 3
b) -3
c) -5
d) 80.1416
3. a) 5
b) 11
c) -5
d) 1
4. a) 10
b) -54
c) -4
d) 4
e) 0.7854

**Objective 2**

5. $\frac{a+23}{20}$
6. a) $x+y+1$
b) $x-y-4$
c) $a-b-c-2$
7. a) $\frac{5x+7\pi}{6}$
b) $\frac{x+3}{2(x+\pi)}$

Objective 3

8. x^4

Objective 4

9. $T_2 = \frac{30}{mc_p} + T_1$
10. $-\frac{Q}{mc} + T_2 = T_1$ **or** $T_1 = T_2 - \frac{Q}{mc}$
11. $d_2 = -\frac{2D}{V} + d_1$ **or** $d_2 = d_1 - \frac{2D}{V}$

Objective 5

12. $a = \sqrt{\frac{147c}{b}}$
13. a) 2
b) 0.5
c) 2
14. $-u + \frac{2s}{t} = v$ **or** $v = \frac{2s}{t} - u$
15. $s = \frac{v^2 - u^2}{2a}$
16. $v = 4.429$

Objective 6

17. $n = \frac{\log\left(\frac{P_1}{V_1}\right)}{\log\left(\frac{P_2}{V_2}\right)}$
18. $x = -2$
19. $x = 1.401$
20. $n = 1.384$
21. $P_2 = 1132.4$ Pa



Chapter 2 - Trigonometry

Objective 1

2. a) 360°
b) 180°
c) 45°
3. a) $\frac{\pi}{4}$
b) π
c) $\frac{\pi}{2}$

Objective 3

5. a) $\alpha = 60^\circ$
b) $\alpha = 35^\circ$
c) $\alpha = 120^\circ$
6. 100 km
7. 19.2 in (A 19 inch LCD display would be suitable)
8. $\alpha = 53.15^\circ$

Objective 4

9. 14.14 m

Objective 6

11. $x = 1.9994$ or 2 m, $\alpha = 45^\circ$
12. 7.67 m, 11.81 m
13. 55.959 km
14. $c = 6.0323$, $A = 56.932^\circ$ and $B = 86.075^\circ$

Chapter 3 - Mensuration

Objective 1

1.
 - a) 14.5 m
 - b) 17 500 mm
 - c) 27.94 cm
 - d) 10 000 mm
 - e) 929.98 yd
 - f) 1.61 m
 - g) 999.74 in
2.
 - a) 0.02 m^2
 - b) $100\,000 \text{ cm}^2$
 - c) 1.55 in^2
 - d) 4.16 m^2
 - e) 18.66 in^2
 - f) 1 km^2
 - g) $40\,500 \text{ m}^2$
3.
 - a) 1.552 L
 - b) 0.25 dm^3
 - c) 1558 cm^3
 - d) 103.66 in^3
 - e) 100 US gal
 - f) 7.56 L
 - g) 6.678 m^3

Objective 2

4.
 - a) 7.5 m^2
 - b) 0.5773 m^2
5. 321.4 m

Objective 3

6.
 - a) square, 9 m^2
 - b) rhombus, 98 m^2



- c) rectangle, 8 m^2
 - d) rhomboid, 16 m^2
 - e) 28 cm^2
7. 32 m^2

Objective 5

- 9. 18.3 cm^2
- 10. 19.73 cm
- 11. 18.41 cm
- 12. 2.46 cm^2
- 13. Area = $11\,545.4 \text{ cm}^2$, Volume = $77\,754 \text{ cm}^3$

Objective 6

- 14. 327.5 cm^3

Objective 7

- 15. Area = 496.09 cm^2 , Volume = 589.63 cm^3
- 16. Area = 3720 cm^2 , Volume = $11\,584 \text{ cm}^3$
- 17. Area = 301.59 cm^2 , Volume = 301.59 cm^3
- 18. Area = 1206.37 cm^2 , Volume = 1671.33 cm^3



Chapter 4 - Forces and Friction

Objective 1

6. 36.3 N at a measured angle of 65° North of East
8. a) $v_x = 3.44$ m/s West, $v_y = 4.91$ m/s South
b) $d_x = 17.73$ m East, $d_y = 3.13$ m North
c) $a_x = 60.00$ m/s² E, $a_y = 32.00$ m/s² N
d) $F_x = 36.06$ N East, $F_y = 54.08$ N North

Objective 3

12. a) $R = 72.45$ N
b) $R = 72.48$ N
13. 82.19 N
14. BC = 707.1 N tension, AB = 500 N compression
15. BC = 6.47 kN, AB = 9.15 kN

Objective 4

17. 4.64 kN at 37.6° S of W
18. a) 2124.71 kN (horizontal equilibrium is satisfied), Load = 2.0 MN

Objective 5

24. 0.2
25. Friction force = 250 N, the box will not slide because the applied force, $F_A = 250$ N, is less than the maximum friction force of 300 N. For the motion to occur, a minimum force, F_A of 300 N is required.

Objective 6

28. $\mu = 0.2265$, $\theta = 12.76^\circ$

Objective 7

30. 523.4 N pushing
31. 312.9 N pulling
32. 391.1 kg



Chapter 5 - Work, Power, Energy: Linear and Angular Motion

Objective 1

4. Earth = 784.8 N, Moon = 130 N, on the moon the same body appears to be 6 times lighter than on earth
5. Work = 1540 kJ, average distance = 10 m
6. maximum height = 13 m, total time 3.25 s

Objective 2

7. 392.4 W
8. a) 15 kJ
b) 125 W
9. 2.56 kW
10. 87.6%

Objective 3

12. 62.8 MJ
13. 221.47 J

Objective 4

16. 15 km, 53.1°N of E
17. 3117.69 J

Objective 5

18. 54.25 m/s
19. velocity = 68.7 m/s ↓, height = 240 m
20. acceleration = 40 m/s², time = 1 s
21. distance = 96 m, velocity = 22 m/s

Objective 6

23. a) $151.6 \frac{\text{rev}}{\text{min}}$
b) $15.87 \frac{\text{rad}}{\text{s}}$
24. 28 569.6 rad
25. 216 000 rev, 407 km

Objective 7

26. 8120 N
27. 64.5 N



28. a) 14 715 N
b) 29 430 N/m



Chapter 6 - Strength of Materials: Bending of Beams

Objective 2

16. 31 831 kPa
17. a) 34.5 MPa
b) 5.1 cm
18. 32.36 kN
19. 49.6 MPa
20. $\sigma = 5.576$ MPa, $\varepsilon = 0.000026$, $\Delta L = 0.182$ mm
21. $\sigma = 101.9$ MPa, $\varepsilon = 0.0005$, $E = 203.8$ GPa
22. 180 MPa
23. $\sigma = 106.4$ MPa; $\varepsilon = 0.000532$, $\Delta L = 3.724$ mm, $SF = 3.76$
24. 5.94 MPa
25. 30.6 MPa
26. 128.5 kN

Objective 4

37. B = 37.5 kN, A = 32.5 kN
38. B = 41.75 kN, A = 23.25 kN
39. Shear = +26.67 kN downwards, Bending moment = 1973.28 kNm CW
40. 45.17 kN

Objective 5

44. Shear = 740 kN upwards, BM = -7600 kNm CCW
45. Shear = -238.46 kN downwards, BM = -507.68 kNm CCW

Objective 6

47. Support: Shear = 260 kN, BM = 1800 kNm Cross section: Shear = 256 kN downwards, BM = 768 kNm CW



Chapter 7 - Simple Machines, Pressure, Density, and Flow

Objective 1

9. 9.81
10. 400 N
11. 35 m
12. 54%
13. 58%
14. $MA = 14$, $VR = 18$, Efficiency = 0.78 or 78%

Objective 2

16. 0.69, or 69%
17. 788.8 mm, or 7.9 m

Objective 3

19. 444.4 N
20. 0.84, or 84%

Objective 4

22. 424.5 mm
23. $VR = 224.4$, Efficiency = 0.656, or 65.5%

Objective 5

24. a) $VR = 0.43$
b) Force = 21.4 N
25. a) $VR = 5.0$
b) $MA = 3.1$, Efficiency = 62%
26. a) 486 N
b) 1.80
27. 0.814 m
30. 896.5 kg/m^3

Objective 7

31. 0.0016 m^3
32. 26.8 kg
33. 7800 kg/m^3

**Objective 8**

34. a) 245.5 kPa
b) 57.12 mm H₂O
c) 0.065 bar
d) 73.5 psi
e) 0.7 MPa
35. 17.3 kPa
36. 11.28 m

Objective 9

37. top side: 1545 N, bottom side: 3090.15 N, and vertical side: 2317.6 N

Objective 10

39. a) 1.028 m/s
b) 1.92 m/s



Chapter 8 - Heat, State Change, and Calorimetry

Objective 1

5. $-40^{\circ}\text{C} = -40^{\circ}\text{F}$

Objective 2

7. 3.49 min

Objective 3

9. 700 kJ; Since only 650 kJ are transferred and 700 kJ are required the ice will not entirely melt.

Objective 4

10. 15 179.6 kJ

11. $T = -19.8^{\circ}\text{C}$; An equilibrium temperature of -19.8°C is not physically possible; therefore, the ice cube must not have entirely melted.

Objective 6

13. 1.324 kJ/kg $^{\circ}\text{C}$



Chapter 9 - Thermal Expansion and Heat Transfer

Objective 4

7. Volume of new box = $274\,868.61\text{ cm}^3$, Volume new gasoline = $279\,755.08\text{ cm}^3$; Since the volume of the box is smaller than that of the gasoline spillage occurs.

Objective 5

9. 324 MPa; Since $324 < 400$ MPa no failure occurs.

Objective 7

12. 23.92°C



Chapter 10 - Steam Properties and Calculations

Objective 2

6. 176.997°C, 2775.44 kJ/kg

Objective 3

7. 3435.22 kJ/kg

Objective 5

10. 39 721.5 kJ, 187.99°C

Objective 7

14. 34 940.6 kJ/s = 34 940.6 kW, 250.40°C

15. Boiler A: Factor of Evaporation = 1.01, Boiler B: Factor of Evaporation = 1.38; The equivalent evaporation of Boiler A is higher, therefore, Boiler A has a larger capacity.



Chapter 11 - Gas Laws and Calculations

Objective 1

2. 600 kPa

Objective 2

4. 262.31 kPa, 1.535 kg; 262.31 kPa is well under the maximum of 345 kPa and there should be no concern for the tires.

Objective 7

10. 2.35 m³, -1384 kJ

Objective 8

12. a) -1047.1 kJ
b) -1019.44 kJ
c) -1042.88 kJ



Chapter 12 - Chemistry Fundamentals

Objective 5

14. 0.0171 kmoles

15. 10.9 kg



Numerical Answers to Calculation Questions

Chapter 2 - Code Calculations - ASME Section I

Objective 1

- 3. b) 2.75 mm
- 4. 6.18 MPa or 6180 kPa
- 5. 1.33 mm
- 6. 2.16 mm

Objective 2

- 9. d) 8.84 MPa
- 11. 2.91 mm
- 12. 5.32 mm
- 13. 6.46 MPa or 6460 kPa
- 14. 4.14 MPa or 4140 kPa



Objective 3

15. d) 3.6 mm
16. 31.54 mm; The head thickness is greater than the shell thickness; therefore, PG-29.4 is satisfied
17. 50.76 mm

Objective 4

21. c) 2352 kg/h
25. 11 475 kg/h
26. 13 525 kg/h; In this case, the minimum relief capacity is increased by 17% for the watertube boiler compared to the firetube boiler with the same heating surfaces.
27. d) 9285 kg/h

Chapter 3 - Fuels, Combustion, and Fuel Gas Analysis

Objective 3

7. Thus 1 kg H₂ requires 8 kg O₂ × (100 kg air/23 kg O₂) = 34.8 kg air.
The above indicates that 1 kg H₂ requires 8 kg O₂. Therefore, 8 kg H₂ would require 64 kg O₂ for complete combustion. If, for every kilogram of hydrogen, 34.8 kg air is required, then 8 kg H₂ would require 278.4 kg air.
8. 10.26 kg/kg of fuel

Objective 5

15. 22.2 MJ/ kg of fuel



Chapter 4 - Piping Design, Connections, and Support

Objective 3

10. a) NPS 10
- b) For NPS 10, the next schedule size up from 7.95 mm wall thickness is schedule 40 pipe with wall thickness 9.27 mm.

Objective 8

35. 371 mm

Chapter 5 - Steam Traps, Water Hammer and Insulation

Objective 3

13. 18.2 kg/h

Chapter 7 - Electric Theory and DC Machines

Objective 6

21. 983.46 V

Objective 7

23. 1687.14 V

Objective 8

35. 5.22%

Objective 10

40. 24.1 mWb

Chapter 8 - AC Theory and Machines

Objective 9

52. 0.12 kV = 120 V

Chapter 10 - Electrical Calculations

Objective 1

2. $R_T = 99 \Omega$, $I_T = 1.01 \text{ A}$, $V_{R1} = 39.4 \text{ V}$, $V_{R2} = 27.3 \text{ V}$, and $V_{R3} = 33.3 \text{ V}$
3. $V_T = 95 \text{ V}$, $R_1 = 7.49 \Omega$, $R_2 = 9.58 \Omega$, and $R_3 = 11.38 \Omega$
4. $R_T = 14.8 \Omega$, $I_T = 8.11 \text{ A}$, $I_1 = 2.67 \text{ A}$, $I_2 = 2.31 \text{ A}$, $I_3 = 3.16 \text{ A}$
5. $V = 675 \text{ V}$, $I_2 = 13.0 \text{ A}$, $R_3 = 84.4 \Omega$, $I_T = 36 \text{ A}$



Objective 2

7. 204 Ω , 420.5 Ω

Objective 3

9. 1.80 A, 25.0 V

10. 10.08 kWh/week, 36 288 000 J/week

11. 144 Ω

Objective 4

16. 0.0025 s

17. 21 978 Hz = 22.0 kHz

Objective 5

19. 170 V

20. 15.0 A

Objective 6

24. 12.44 Ω , 19.3 A

25. 0.0334 H = 33.4 mH

29. 60 Hz

30. 60 V

32. 44.6 Ω

33. 22.0 Ω , 5.45 A

Objective 7

36. 0.83

37. 2182 kW, 0.87

Objective 8

43. 28.7 MVA, 22.9 MW

44. 9195 V = 9.2 kV

Chapter 11 - Control Loops and Strategies

Objective 5

41. 0.4

42. 77.5%