PRACTICE EXAM 10: FE OTHER DISCIPLINES SIMULATION (110 QUESTIONS)

This standalone practice exam contains 110 applied engineering questions. Allow 5 hours and 20 minutes of active testing time, use the supplied FE Reference Handbook, and select the single best answer for every item. Consult the answer key and explanations only after completing the exam.

1. During a multidisciplinary design review, solve $2x - 3 = 4$ for x.

A. -0.5
B. 2.5
C. 3.5
D. 4.5

2. For an engineering quality-control check, what is the area of a circle with radius 2.5 m?

A. 7.85 m^2
B. 19.6 m^2
C. 15.7 m^2
D. 9.82 m^2

3. While evaluating an operational alternative, evaluate $f(x) = 3x^2 + 2x - 5$ at $x = 3$.

A. 33
B. 10
C. 23
D. 28

4. In a preliminary technical assessment, for $y = \ln(5x)$, what is dy/dx at $x = 1$?

A. 1
B. 2
C. 1.61
D. 5

5. For an implementation-planning decision, find the determinant of the matrix [[6, 1], [1, 3]].

A. 9
B. 17
C. 15
D. 19

6. During a multidisciplinary design review, solve $7x - 8 = 4$ for x.

A. 2.71
B. 0.714
C. 1.71
D. 0.571

7. For an engineering quality-control check, what is the area of a circle with radius 5 m?

A. 15.7 m^2
B. 78.5 m^2
C. 39.3 m^2
D. 31.4 m^2

8. While evaluating an operational alternative, evaluate $f(x) = 3x^2 + 2x - 5$ at $x = 8$.

A. 35
B. 208
C. 203
D. 198

9. In a preliminary technical assessment, for y = ln(10x), what is dy/dx at x = 1?

A. 1
B. 2.3
C. 2
D. 10

10. For an implementation-planning decision, find the determinant of the matrix [[11, 1], [1, 3]].

A. 14
B. 34
C. 30
D. 32

11. During a multidisciplinary design review, what is the arithmetic mean of [2, 4, 6, 8]?

A. 5
B. 4
C. 6
D. 20

12. For an engineering quality-control check, a component fails with probability 0.25. What is the probability it does not fail?

A. 0.94
B. 0.75

C. 0.25
D. 0.06

13. While evaluating an operational alternative, for a binomial variable with n = 7 and p = 0.40, what is the expected value?

A. 4.2
B. 0.4
C. 2.8
D. 3.8

14. In a preliminary technical assessment, which measure is most resistant to a single extreme outlier?

A. Arithmetic mean
B. Sample variance
C. Standard deviation
D. Median

15. For an implementation-planning decision, what is the arithmetic mean of [6, 8, 10, 12]?

A. 36
B. 8
C. 10
D. 9

16. During a multidisciplinary design review, a component fails with probability 0.45. What is the probability it does not fail?

A. 0.55
B. 0.45
C. 0.80

D. 0.20

17. For an engineering quality-control check, for a binomial variable with n = 11 and p = 0.40, what is the expected value?

A. 0.4
B. 4.4
C. 6.6
D. 5.4

18. While evaluating an operational alternative, a solution has $[H^+]$ = 1.00e-03 mol/L. What is its pH?

A. 4
B. 11
C. 3
D. 2

19. In a preliminary technical assessment, what mass of water corresponds to 2 mol if its molar mass is 18.015 g/mol?

A. 18 g
B. 54 g
C. 36 g
D. 0.111 g

20. For an implementation-planning decision, in an oxidation-reduction reaction, oxidation is best described as which process?

A. Gain of electrons
B. Loss of electrons
C. Gain of protons only

D. Loss of neutrons

21. During a multidisciplinary design review, a solution has $[H^+]$ = 3.16e-05 mol/L. What is its pH?

A. 4.5
B. 9.5
C. 3.5
D. 5.5

22. For an engineering quality-control check, what mass of water corresponds to 5 mol if its molar mass is 18.015 g/mol?

A. 45 g
B. 108 g
C. 0.278 g
D. 90.1 g

23. While evaluating an operational alternative, in an oxidation-reduction reaction, oxidation is best described as which process?

A. Gain of electrons
B. Loss of neutrons
C. Loss of electrons
D. Gain of protons only

24. In a preliminary technical assessment, which device converts a physical quantity into a usable electrical signal?

A. A relief valve
B. A flywheel
C. A heat exchanger

D. A transducer

25. For an implementation-planning decision, an ideal 8-bit A/D converter spans 0 to 10 V. What is its nominal resolution using span/2^n?

A. 0.0392 V
B. 0.0391 V
C. 0.0195 V
D. 0.0781 V

26. During a multidisciplinary design review, an ideal 9-bit A/D converter spans 0 to 12 V. What is its nominal resolution using span/2^n?

A. 0.0234 V
B. 0.0235 V
C. 0.0117 V
D. 0.0469 V

27. For an engineering quality-control check, an ideal 10-bit A/D converter spans 0 to 14 V. What is its nominal resolution using span/2^n?

A. 0.0273 V
B. 0.0137 V
C. 0.00684 V
D. 0.0137 V

28. While evaluating an operational alternative, an ideal 11-bit A/D converter spans 0 to 16 V. What is its nominal resolution using span/2^n?

A. 0.00782 V
B. 0.0156 V

C. 0.00781 V
D. 0.00391 V

29. In a preliminary technical assessment, an engineer discovers a design condition posing an imminent danger to the public. What is the engineer's primary ethical obligation?

A. Wait until construction is complete
B. Keep the matter confidential in all circumstances
C. Defer solely to the client's financial interest
D. Notify the appropriate parties and protect public safety

30. For an implementation-planning decision, an engineer is asked to approve calculations prepared outside the engineer's area of competence. What is the proper response?

A. Decline or obtain competent professional involvement
B. Approve it after a brief visual review
C. Seal the work if the client accepts responsibility
D. Delegate the seal to an unlicensed employee

31. During a multidisciplinary design review, a vendor offers an engineer an undisclosed commission for specifying its product. What should the engineer do?

A. Divide it among the design team
B. Accept it because product quality is unchanged
C. Refuse the commission and disclose the conflict
D. Accept it after project completion

32. For an engineering quality-control check, when presenting an engineering report, which practice best supports professional integrity?

A. State relevant assumptions and limitations clearly

B. Omit unfavorable results

C. Guarantee outcomes beyond available evidence

D. Present estimates as exact measurements

33. While evaluating an operational alternative, an engineer reviews a former employer's confidential design data. When may the engineer disclose it?

A. Whenever the information is technically interesting

B. After leaving the employer

C. Whenever it improves a competing proposal

D. When authorized or legally required

34. In a preliminary technical assessment, which action best addresses a potential conflict of interest before accepting an assignment?

A. Conceal it unless financial harm occurs

B. Disclose the conflict to affected parties

C. Transfer it informally to a coworker

D. Proceed because technical work is objective

35. For an implementation-planning decision, before entering a permit-required confined space, which action is essential?

A. Test the atmosphere and establish required controls

B. Enter briefly without monitoring

C. Disable ventilation to avoid turbulence

D. Rely only on odor detection

36. During a multidisciplinary design review, which document communicates chemical hazards, protective measures, and emergency information?

A. Purchase order
B. Safety Data Sheet
C. Calibration certificate
D. Process flow index

37. For an engineering quality-control check, what is the first hierarchy-of-controls preference for a serious workplace hazard?

A. Issue warning signs
B. Require personal protective equipment
C. Provide refresher training only
D. Eliminate the hazard

38. While evaluating an operational alternative, which instrument is appropriate for checking oxygen concentration before confined-space entry?

A. An infrared tachometer
B. A sound-level meter
C. A calibrated multigas atmospheric monitor
D. A clamp-on ammeter

39. In a preliminary technical assessment, what is the principal purpose of lockout/tagout?

A. Document production output
B. Increase equipment cycle speed
C. Prevent unexpected energization during servicing
D. Reduce normal operating voltage

40. For an implementation-planning decision, for a small energized electrical fire, which extinguisher characteristic is required?

A. Combustible metal powder only

B. Nonconductive agent suitable for Class C hazards

C. Pressurized water stream

D. Conductive foam only

41. During a multidisciplinary design review, which control most directly reduces worker exposure to airborne contaminants at their source?

A. Local exhaust ventilation

B. General warning signage

C. Longer work shifts

D. Administrative record retention

42. For an engineering quality-control check, what future amount results from investing $1,000 for 3 years at 5% annual compound interest?

A. $863.84

B. $1,150.00

C. $1,000.15

D. $1,157.63

43. While evaluating an operational alternative, a product has fixed cost $21,000, selling price $51, and variable cost $30 per unit. What is the break-even quantity?

A. 1100.00 units

B. 700.00 units

C. 411.76 units

D. 1000.00 units

44. In a preliminary technical assessment, an asset costs $6,000, has $500 salvage value, and a 5-year life. What is annual straight-line depreciation?

A. $1,100.00/year
B. $1,200.00/year
C. $5,500.00/year
D. $1,300.00/year

45. For an implementation-planning decision, what future amount results from investing $2,500 for 6 years at 5% annual compound interest?

A. $1,865.54
B. $3,250.00
C. $3,350.24
D. $2,500.30

46. During a multidisciplinary design review, a product has fixed cost $24,000, selling price $54, and variable cost $30 per unit. What is the break-even quantity?

A. 800.00 units
B. 1000.00 units
C. 1100.00 units
D. 444.44 units

47. For an engineering quality-control check, an asset costs $7,500, has $500 salvage value, and a 5-year life. What is annual straight-line depreciation?

A. $1,500.00/year
B. $1,600.00/year
C. $1,400.00/year
D. $7,000.00/year

48. While evaluating an operational alternative, a 100-N force acts 30° above the positive x-axis. What is its x-component?

A. 86.6 N
B. 50 N
C. -13.4 N
D. 100 N

49. In a preliminary technical assessment, a simply supported 4-m beam carries a 220-N point load 2 m from the left support. What is the right reaction?

A. 111 N
B. 440 N
C. 55 N
D. 110 N

50. For an implementation-planning decision, a 520-N block rests on a horizontal surface with coefficient of static friction 0.30. What is the maximum static friction?

A. 1.73e+03 N
B. 156 N
C. 0.3 N
D. 364 N

51. During a multidisciplinary design review, a 160-N force acts 30° above the positive x-axis. What is its x-component?

A. -21.4 N
B. 160 N
C. 139 N
D. 80 N

52. For an engineering quality-control check, a simply supported 4-m beam carries a 280-N point load 1 m from the left support. What is the right reaction?

A. 71 N
B. 70 N
C. 210 N
D. 280 N

53. While evaluating an operational alternative, a 550-N block rests on a horizontal surface with coefficient of static friction 0.30. What is the maximum static friction?

A. 165 N
B. 1.83e+03 N
C. 385 N
D. 0.3 N

54. In a preliminary technical assessment, a 220-N force acts 30° above the positive x-axis. What is its x-component?

A. 220 N
B. 110 N
C. -29.5 N
D. 191 N

55. For an implementation-planning decision, a simply supported 4-m beam carries a 340-N point load 2 m from the left support. What is the right reaction?

A. 85 N
B. 171 N
C. 680 N
D. 170 N

56. During a multidisciplinary design review, a 580-N block rests on a horizontal surface with coefficient of static friction 0.30. What is the maximum static friction?

A. 0.3 N
B. 174 N
C. 1.93e+03 N
D. 406 N

57. For an engineering quality-control check, a 280-N force acts 30° above the positive x-axis. What is its x-component?

A. 242 N
B. -37.5 N
C. 140 N
D. 280 N

58. While evaluating an operational alternative, a particle starts at 2 m/s and accelerates uniformly at 3 m/s^2 for 4 s. What is its final speed?

A. 32 m/s
B. 12 m/s
C. 14 m/s
D. 13 m/s

59. In a preliminary technical assessment, what net force accelerates a 6-kg mass at 2 m/s^2?

A. 3 N
B. 118 N
C. 12 N
D. 8 N

60. For an implementation-planning decision, an object moves at 12 m/s in a circular path of radius 5 m. What is its centripetal acceleration?

A. 2.4 m/s²

B. 28.8 m/s²

C. 720 m/s²

D. 4.8 m/s²

61. During a multidisciplinary design review, a particle starts at 5 m/s and accelerates uniformly at 3 m/s² for 4 s. What is its final speed?

A. 17 m/s

B. 13 m/s

C. 44 m/s

D. 12 m/s

62. For an engineering quality-control check, what net force accelerates a 9-kg mass at 2 m/s²?

A. 11 N

B. 4.5 N

C. 177 N

D. 18 N

63. While evaluating an operational alternative, an object moves at 15 m/s in a circular path of radius 5 m. What is its centripetal acceleration?

A. 45 m/s²

B. 6 m/s²

C. 1.12e+03 m/s²

D. 3 m/s²

64. In a preliminary technical assessment, a particle starts at 8 m/s and accelerates uniformly at 3 m/s² for 4 s. What is its final speed?

A. 56 m/s
B. 12 m/s
C. 13 m/s
D. 20 m/s

65. For an implementation-planning decision, what net force accelerates a 12-kg mass at 2 m/s^2?

A. 14 N
B. 235 N
C. 24 N
D. 6 N

66. During a multidisciplinary design review, an object moves at 18 m/s in a circular path of radius 5 m. What is its centripetal acceleration?

A. 7.2 m/s^2
B. 64.8 m/s^2
C. 1.62e+03 m/s^2
D. 3.6 m/s^2

67. For an engineering quality-control check, a tensile load of 20 kN acts on a bar with cross-sectional area 400 mm^2. What is the normal stress?

A. 50 MPa
B. 0.05 MPa
C. 25 MPa
D. 5e+04 MPa

68. While evaluating an operational alternative, a 2-m bar elongates 0.0011 m. What is its axial strain?

A. 0.055000

B. 1818.181818
C. 0.002200
D. 0.000550

69. In a preliminary technical assessment, within the elastic range, a material has E = 200,000 MPa and strain 0.00060. What is the stress?

A. 3e-09 MPa
B. 3.33e+08 MPa
C. 120 MPa
D. 60 MPa

70. For an implementation-planning decision, a tensile load of 26 kN acts on a bar with cross-sectional area 430 mm². What is the normal stress?

A. 60.5 MPa
B. 6.05e+04 MPa
C. 30.2 MPa
D. 0.0605 MPa

71. During a multidisciplinary design review, a 2-m bar elongates 0.0014 m. What is its axial strain?

A. 1428.571429
B. 0.000700
C. 0.070000
D. 0.002800

72. For an engineering quality-control check, within the elastic range, a material has E = 200,000 MPa and strain 0.00075. What is the stress?

A. 3.75e-09 MPa

B. 150 MPa
C. 2.67e+08 MPa
D. 75 MPa

73. While evaluating an operational alternative, a tensile load of 32 kN acts on a bar with cross-sectional area 460 mm^2. What is the normal stress?

A. 0.0696 MPa
B. 6.96e+04 MPa
C. 69.6 MPa
D. 34.8 MPa

74. In a preliminary technical assessment, a 2-m bar elongates 0.0017 m. What is its axial strain?

A. 1176.470588
B. 0.003400
C. 0.085000
D. 0.000850

75. For an implementation-planning decision, within the elastic range, a material has E = 200,000 MPa and strain 0.00090. What is the stress?

A. 4.5e-09 MPa
B. 90 MPa
C. 2.22e+08 MPa
D. 180 MPa

76. During a multidisciplinary design review, which material property measures resistance to localized plastic indentation?

A. Specific heat

B. Hardness

C. Ductility

D. Thermal conductivity

77. For an engineering quality-control check, what commonly happens to the strength and ductility of a cold-worked metal?

A. Strength increases while ductility decreases

B. Both remain unchanged

C. Both strength and ductility increase

D. Strength decreases while ductility increases

78. While evaluating an operational alternative, which crystal defect is a one-dimensional imperfection central to plastic deformation?

A. A pore volume

B. A grain

C. A dislocation

D. A vacancy

79. In a preliminary technical assessment, why is galvanic corrosion promoted when dissimilar metals are electrically connected in an electrolyte?

A. Both metals become perfect insulators

B. Mechanical stress becomes zero

C. The electrolyte removes all ions

D. A potential difference drives electrochemical current

80. For an implementation-planning decision, which test primarily measures a material’s energy absorption during sudden fracture?

A. Thermal expansion test
B. Charpy impact test
C. Rockwell hardness test
D. Creep rupture test

81. During a multidisciplinary design review, what is creep?

A. Time-dependent deformation under sustained stress
B. Instantaneous elastic recovery
C. Cyclic crack growth only
D. Surface oxidation without strain

82. For an engineering quality-control check, water flows through an area of 0.020 m^2 at an average velocity of 3 m/s. What is the volumetric flow rate?

A. 0.06 m^3/s
B. 150 m^3/s
C. 60 m^3/s
D. 0.00667 m^3/s

83. While evaluating an operational alternative, what gauge pressure is produced by a 2.5-m column of water with density 1000 kg/m^3?

A. 3.92e+03 Pa
B. 2.5e+03 Pa
C. 2.45e+04 Pa
D. 24.5 Pa

84. In a preliminary technical assessment, for water with $\rho = 1000$ kg/m^3 and $\mu = 0.001$ Pa·s flowing at 2.2 m/s in a 0.05-m pipe, what is Reynolds number?

A. 111
B. 2.2e+06
C. 1.1e+05
D. 110

85. For an implementation-planning decision, in incompressible pipe flow, diameter decreases from 0.10 m to 0.05 m. If upstream velocity is 2.3 m/s, what is downstream velocity?

A. 4.6 m/s
B. 9.2 m/s
C. 0.575 m/s
D. 1.15 m/s

86. During a multidisciplinary design review, water flows through an area of 0.024 m^2 at an average velocity of 3 m/s. What is the volumetric flow rate?

A. 125 m^3/s
B. 72 m^3/s
C. 0.008 m^3/s
D. 0.072 m^3/s

87. For an engineering quality-control check, what gauge pressure is produced by a 4.5-m column of water with density 1000 kg/m^3?

A. 4.5e+03 Pa
B. 2.18e+03 Pa
C. 44.1 Pa
D. 4.41e+04 Pa

88. While evaluating an operational alternative, for water with ρ = 1000 kg/m^3 and μ = 0.001 Pa·s flowing at 2.6 m/s in a 0.05-m pipe, what is Reynolds number?

A. 131
B. 130
C. 1.3e+05
D. 2.6e+06

89. In a preliminary technical assessment, in incompressible pipe flow, diameter decreases from 0.10 m to 0.05 m. If upstream velocity is 2.7 m/s, what is downstream velocity?

A. 1.35 m/s
B. 10.8 m/s
C. 5.4 m/s
D. 0.675 m/s

90. For an implementation-planning decision, water flows through an area of 0.028 m^2 at an average velocity of 3 m/s. What is the volumetric flow rate?

A. 0.084 m^3/s
B. 0.00933 m^3/s
C. 107 m^3/s
D. 84 m^3/s

91. During a multidisciplinary design review, what gauge pressure is produced by a 6.5-m column of water with density 1000 kg/m^3?

A. 6.5e+03 Pa
B. 1.51e+03 Pa
C. 6.38e+04 Pa
D. 63.8 Pa

92. For an engineering quality-control check, for water with $\rho = 1000\ kg/m^3$ and $\mu = 0.001\ Pa \cdot s$ flowing at 3.0 m/s in a 0.05-m pipe, what is Reynolds number?

A. 1.5e+05
B. 150
C. 3e+06
D. 151

93. While evaluating an operational alternative, in incompressible pipe flow, diameter decreases from 0.10 m to 0.05 m. If upstream velocity is 3.1 m/s, what is downstream velocity?

A. 1.55 m/s
B. 12.4 m/s
C. 6.2 m/s
D. 0.775 m/s

94. In a preliminary technical assessment, water flows through an area of 0.032 m^2 at an average velocity of 3 m/s. What is the volumetric flow rate?

A. 0.0107 m^3/s
B. 96 m^3/s
C. 93.8 m^3/s
D. 0.096 m^3/s

95. For an implementation-planning decision, a 12-V source is applied across a 4-Ω resistor. What current flows?

A. 3 A
B. 48 A
C. 16 A
D. 0.333 A

96. During a multidisciplinary design review, what is the equivalent resistance of 5 Ω and 7 Ω connected in series?

A. 35 Ω
B. 12 Ω
C. 2 Ω
D. 2.92 Ω

97. For an engineering quality-control check, a device operates at 12 V and draws 2 A. What electrical power does it consume?

A. 6 W
B. 14 W
C. 0.167 W
D. 24 W

98. While evaluating an operational alternative, a 18-V source is applied across a 7-Ω resistor. What current flows?

A. 126 A
B. 0.389 A
C. 2.57 A
D. 25 A

99. In a preliminary technical assessment, what is the equivalent resistance of 8 Ω and 10 Ω connected in series?

A. 18 Ω
B. 2 Ω
C. 80 Ω
D. 4.44 Ω

100. For an implementation-planning decision, a device operates at 15 V and draws 2 A. What electrical power does it consume?

A. 0.133 W
B. 17 W
C. 7.5 W
D. 30 W

101. During a multidisciplinary design review, how much heat is required to raise 2.0 kg of water by 10°C if c_p = 4.18 kJ/(kg·°C)?

A. 8.36 kJ
B. 83.6 kJ
C. 0.0836 kJ
D. 41.8 kJ

102. For an engineering quality-control check, heat transfer is 520 W through 2 m² with a 25 K temperature difference. What is the overall heat-transfer coefficient?

A. 20.8 W/(m²·K)
B. 260 W/(m²·K)
C. 10.4 W/(m²·K)
D. 2.6e+04 W/(m²·K)

103. While evaluating an operational alternative, a heat engine receives 1100 kJ and produces 320 kJ of work. What is its thermal efficiency?

A. 29.1%
B. 70.9%
C. 343.8%
D. 41.0%

104. In a preliminary technical assessment, how much heat is required to raise 2.6 kg of water by 13°C if c_p = 4.18 kJ/(kg·°C)?

A. 10.9 kJ
B. 54.3 kJ
C. 141 kJ
D. 0.141 kJ

105. For an implementation-planning decision, heat transfer is 580 W through 2 m² with a 25 K temperature difference. What is the overall heat-transfer coefficient?

A. 2.9e+04 W/(m²·K)
B. 11.6 W/(m²·K)
C. 290 W/(m²·K)
D. 23.2 W/(m²·K)

106. During a multidisciplinary design review, a heat engine receives 1250 kJ and produces 350 kJ of work. What is its thermal efficiency?

A. 38.9%
B. 357.1%
C. 72.0%
D. 28.0%

107. For an engineering quality-control check, how much heat is required to raise 3.2 kg of water by 16°C if c_p = 4.18 kJ/(kg·°C)?

A. 66.9 kJ
B. 214 kJ
C. 13.4 kJ
D. 0.214 kJ

108. While evaluating an operational alternative, heat transfer is 640 W through 2 m² with a 25 K temperature difference. What is the overall heat-transfer coefficient?

A. 25.6 W/(m²·K)

B. 320 W/(m²·K)

C. 3.2e+04 W/(m²·K)

D. 12.8 W/(m²·K)

109. In a preliminary technical assessment, a heat engine receives 1400 kJ and produces 380 kJ of work. What is its thermal efficiency?

A. 27.1%

B. 368.4%

C. 37.3%

D. 72.9%

110. For an implementation-planning decision, how much heat is required to raise 3.8 kg of water by 19°C if c_p = 4.18 kJ/(kg·°C)?

A. 15.9 kJ

B. 0.302 kJ

C. 302 kJ

D. 79.4 kJ

Practice Exam 10: Answer Key and Explanations

1. C — Adding 3 to both sides gives 2x = 7. Dividing by 2 gives x = 3.5. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

2. B — The area of a circle is πr². Substituting r = 2.5 m produces 19.6 m². This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

3. D — Direct substitution gives $3(3)^2 + 2(3) - 5 = 28$. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

4. A — The derivative of $\ln(5x)$ is $1/x$ because the constant factor cancels by the chain rule. At $x = 1$, the value is 1. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

5. B — For a 2×2 matrix, the determinant is $ad - bc$. Thus $(6)(3) - (1)(1) = 17$. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

6. C — Adding 8 to both sides gives $7x = 12$. Dividing by 7 gives $x = 1.71429$. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

7. B — The area of a circle is πr^2. Substituting $r = 5$ m produces 78.5 m². This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

8. C — Direct substitution gives $3(8)^2 + 2(8) - 5 = 203$. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

9. A — The derivative of $\ln(10x)$ is $1/x$ because the constant factor cancels by the chain rule. At $x = 1$, the value is 1. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

10. D — For a 2×2 matrix, the determinant is $ad - bc$. Thus $(11)(3) - (1)(1) = 32$. This procedure follows the standard mathematics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

11. A — The arithmetic mean equals the sum of all observations divided by their number. The sum is 20, and dividing by four gives 5. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

12. B — Failure and nonfailure are complementary outcomes, so their probabilities sum to one. Therefore 1 − 0.25 = 0.75. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

13. C — A binomial random variable has expected value np. Multiplying 7 trials by success probability 0.40 gives 2.8. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

14. D — The median depends on the ordered position of observations rather than their magnitudes. A single extreme value can strongly shift the mean, variance, and standard deviation, but usually leaves the middle position unchanged. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

15. D — The arithmetic mean equals the sum of all observations divided by their number. The sum is 36, and dividing by four gives 9. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

16. A — Failure and nonfailure are complementary outcomes, so their probabilities sum to one. Therefore 1 − 0.45 = 0.55. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

17. B — A binomial random variable has expected value np. Multiplying 11 trials by success probability 0.40 gives 4.4. This procedure follows the standard probability and statistics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

18. C — By definition, $pH = -\log_{10}[H^+]$. Substituting 1.00e-03 mol/L gives pH = 3. This procedure follows the standard chemistry relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

19. C — Mass equals moles multiplied by molar mass. Therefore 2 mol × 18.015 g/mol = 36.030 g. This procedure follows the standard chemistry relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

20. B — Oxidation is the loss of electrons, while reduction is the gain of electrons. Tracking oxidation numbers provides the same conclusion: the oxidized species experiences an increase in oxidation state. This procedure follows the standard chemistry relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

21. A — By definition, pH = $-\log_{10}[H^+]$. Substituting 3.16e-05 mol/L gives pH = 4.5. This procedure follows the standard chemistry relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

22. D — Mass equals moles multiplied by molar mass. Therefore 5 mol × 18.015 g/mol = 90.075 g. This procedure follows the standard chemistry relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

23. C — Oxidation is the loss of electrons, while reduction is the gain of electrons. Tracking oxidation numbers provides the same conclusion: the oxidized species experiences an increase in oxidation state. This procedure follows the standard chemistry relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

24. D — A transducer senses a physical variable such as pressure, temperature, or displacement and converts it into an electrical signal suitable for measurement or control. The other devices perform mechanical or thermal functions rather than signal conversion. This procedure follows the standard instrumentation and controls relationship used in the FE Reference Handbook.

25. B — An ideal 8-bit converter divides the full-scale span into 2^8 levels. Thus the nominal step is 10/2^8 = 0.039062 V. This procedure follows the standard instrumentation and controls relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

26. A — An ideal 9-bit converter divides the full-scale span into 2^9 levels. Thus the nominal step is 12/2^9 = 0.023438 V. This procedure follows the standard instrumentation and controls relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

27. B — An ideal 10-bit converter divides the full-scale span into 2^10 levels. Thus the nominal step is 14/2^10 = 0.013672 V. This procedure follows the standard instrumentation and controls relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

28. C — An ideal 11-bit converter divides the full-scale span into 2^11 levels. Thus the nominal step is 16/2^11 = 0.0078125 V. This procedure follows the standard instrumentation and controls relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

29. D — Engineers must hold paramount the safety, health, and welfare of the public. The engineer should promptly communicate the danger through appropriate channels and, when necessary, notify authorities rather than allowing confidentiality or commercial pressure to override public protection. This procedure follows the standard engineering ethics and societal impacts relationship used in the FE Reference Handbook.

30. A — Engineers should perform and approve services only in areas of competence. The proper course is to decline the assignment or involve a qualified professional who can take responsible charge. Client consent does not cure a lack of competence. This procedure follows the standard engineering ethics and societal impacts relationship used in the FE Reference Handbook.

31. C — An undisclosed commission creates a financial conflict that can compromise objective professional judgment. Refusing it and disclosing the attempted arrangement preserves transparency and the duty of faithful service to the employer or client. This procedure follows the standard engineering ethics and societal impacts relationship used in the FE Reference Handbook.

32. A — Clear disclosure of assumptions, limitations, uncertainty, and supporting evidence allows readers to evaluate the work honestly. Omitting adverse information or overstating precision misleads decision-makers and conflicts with an engineer's duty to issue objective and truthful statements. This procedure follows the standard engineering ethics and societal impacts relationship used in the FE Reference Handbook.

33. D — Confidential information remains protected after employment ends. Disclosure is appropriate only with authorization or when required by law or overriding public-safety duties. Personal advantage, competition, and technical interest do not eliminate the obligation. This procedure follows the standard engineering ethics and societal impacts relationship used in the FE Reference Handbook.

34. B — Early disclosure allows affected parties to make informed decisions and establish safeguards or consent. A conflict can influence judgment even when the engineer believes the technical work remains objective, so silence is not an adequate response. This procedure follows the standard engineering ethics and societal impacts relationship used in the FE Reference Handbook.

35. A — Confined spaces may contain oxygen deficiency, toxic contaminants, or flammable atmospheres that cannot be detected reliably by human senses. Atmospheric testing, ventilation, permits, communication, and rescue provisions address these hazards before entry. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

36. B — A Safety Data Sheet provides standardized information about a chemical's hazards, handling, storage, exposure controls, personal protective equipment, and emergency response. Commercial and calibration records do not serve this hazard-communication purpose. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

37. D — Elimination removes the hazard at its source and is therefore the most effective control. Engineering and administrative controls follow, while personal protective equipment is generally the last line of defense because it depends on correct selection and use. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook.

38. C — A calibrated atmospheric monitor directly measures oxygen and may also detect combustible and toxic gases. Sound, rotational-speed, and electrical-current instruments cannot establish whether the

breathing atmosphere is safe. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

39. C — Lockout/tagout isolates hazardous energy and prevents equipment from starting or releasing stored energy while personnel perform service or maintenance. It is an energy-control procedure, not an operating-efficiency or production-record system. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

40. B — Energized electrical equipment requires an extinguishing agent that does not conduct electricity. Water can expose the user to shock. Once power is removed, the underlying fuel class may govern, but energized conditions require Class C suitability. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook.

41. A — Local exhaust ventilation captures airborne contaminants close to where they are generated, preventing dispersion into the breathing zone. Signs and records communicate or document hazards but do not physically remove contaminants, while longer shifts can increase exposure. This procedure follows the standard safety, health, and environment relationship used in the FE Reference Handbook.

42. D — Compound future worth is $F = P(1 + i)^n$. Substituting P = $1,000, i = 0.05, and n = 3 gives F = $1,157.63. This procedure follows the standard engineering economics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

43. D — At break-even, total contribution equals fixed cost. Contribution per unit is $51 − $30 = $21; therefore quantity is $21,000/$21 = 1000.00 units. This procedure follows the standard engineering economics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

44. A — Straight-line depreciation spreads depreciable basis, cost minus salvage value, evenly over useful life. Thus ($6,000 − $500)/5 = $1,100.00 per year. This procedure follows the standard engineering economics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

45. C — Compound future worth is $F = P(1 + i)^n$. Substituting P = $2,500, i = 0.05, and n = 6 gives F = $3,350.24. This procedure follows the standard engineering economics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

46. B — At break-even, total contribution equals fixed cost. Contribution per unit is $54 − $30 = $24; therefore quantity is $24,000/$24 = 1000.00 units. This procedure follows the standard engineering economics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

47. C — Straight-line depreciation spreads depreciable basis, cost minus salvage value, evenly over useful life. Thus ($7,500 − $500)/5 = $1,400.00 per year. This procedure follows the standard engineering economics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

48. A — Resolving the force along x gives $F_x = F \cos \theta$. Therefore 100 cos 30° = 86.6 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

49. D — Taking moments about the left support gives $R_r(4) = 220(2)$. Hence the right reaction is 110 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

50. B — Maximum static friction is $\mu_s N$. Multiplying 0.30 by the normal force 520 N gives 156 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

51. C — Resolving the force along x gives $F_x = F \cos \theta$. Therefore 160 cos 30° = 139 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

52. B — Taking moments about the left support gives $R_r(4) = 280(1)$. Hence the right reaction is 70 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

53. A — Maximum static friction is $\mu_s N$. Multiplying 0.30 by the normal force 550 N gives 165 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

54. D — Resolving the force along x gives $F_x = F \cos \theta$. Therefore 220 cos 30° = 191 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

55. D — Taking moments about the left support gives $R_r(4) = 340(2)$. Hence the right reaction is 170 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

56. B — Maximum static friction is $\mu_s N$. Multiplying 0.30 by the normal force 580 N gives 174 N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

57. A — Resolving the force along x gives $F_x = F \cos \theta$. Therefore $280 \cos 30° = 242$ N. This procedure follows the standard statics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

58. C — For constant acceleration, $v = u + at$. Substitution gives $2 + 3(4) = 14$ m/s. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

59. C — Newton's second law gives net force $F = ma$. Multiplying 6 kg by 2 m/s² produces 12 N. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

60. B — Centripetal acceleration is $a^c = v^2/r$. Using $v = 12$ m/s and $r = 5$ m gives 28.8 m/s² directed toward the center. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

61. A — For constant acceleration, $v = u + at$. Substitution gives $5 + 3(4) = 17$ m/s. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

62. D — Newton's second law gives net force $F = ma$. Multiplying 9 kg by 2 m/s² produces 18 N. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

63. A — Centripetal acceleration is $a^c = v^2/r$. Using $v = 15$ m/s and $r = 5$ m gives 45 m/s² directed toward the center. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

64. D — For constant acceleration, $v = u + at$. Substitution gives $8 + 3(4) = 20$ m/s. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

65. C — Newton’s second law gives net force F = ma. Multiplying 12 kg by 2 m/s² produces 24 N. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

66. B — Centripetal acceleration is $a^c = v^2/r$. Using v = 18 m/s and r = 5 m gives 64.8 m/s² directed toward the center. This procedure follows the standard dynamics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

67. A — Normal stress is σ = P/A. Because 1 N/mm² equals 1 MPa, (20 × 1000)/400 = 50 MPa. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

68. D — Engineering strain is change in length divided by original length. Thus ε = 0.0011/2 = 0.000550, a dimensionless ratio. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

69. C — Hooke’s law in uniaxial loading is σ = Eε. Multiplication gives 200,000 MPa × 0.00060 = 120 MPa. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

70. A — Normal stress is σ = P/A. Because 1 N/mm² equals 1 MPa, (26 × 1000)/430 = 60.5 MPa. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

71. B — Engineering strain is change in length divided by original length. Thus ε = 0.0014/2 = 0.000700, a dimensionless ratio. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

72. B — Hooke’s law in uniaxial loading is σ = Eε. Multiplication gives 200,000 MPa × 0.00075 = 150 MPa. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

73. C — Normal stress is σ = P/A. Because 1 N/mm² equals 1 MPa, (32 × 1000)/460 = 69.6 MPa. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

74. D — Engineering strain is change in length divided by original length. Thus $\varepsilon = 0.0017/2 = 0.000850$, a dimensionless ratio. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

75. D — Hooke's law in uniaxial loading is $\sigma = E\varepsilon$. Multiplication gives 200,000 MPa × 0.00090 = 180 MPa. This procedure follows the standard strength of materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

76. B — Hardness characterizes resistance to indentation, scratching, or localized plastic deformation. Ductility concerns deformation before fracture, while thermal conductivity and specific heat describe heat transfer and energy storage rather than mechanical indentation resistance. This procedure follows the standard materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

77. A — Cold working raises dislocation density, making further slip more difficult. Consequently yield strength and hardness increase, while the capacity for additional plastic deformation decreases. Annealing can reverse these effects through recovery and recrystallization. This procedure follows the standard materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

78. C — A dislocation is a line defect whose motion enables plastic slip at stresses far below the theoretical shear strength of a perfect crystal. Vacancies are point defects, grains are crystal regions, and pores are three-dimensional discontinuities. This procedure follows the standard materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

79. D — Dissimilar metals generally have different electrode potentials. Electrical connection plus an ionic path completes a galvanic cell, causing the more active metal to act as the anode and corrode preferentially. This procedure follows the standard materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

80. B — The Charpy test measures energy absorbed when a notched specimen fractures under a swinging impact. It is useful for assessing notch toughness and ductile-to-brittle behavior, unlike hardness, creep, or thermal expansion tests. This procedure follows the standard materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

81. A — Creep is progressive, time-dependent strain under a sustained load, often important at elevated temperature. It differs from immediate elastic deformation, fatigue crack growth under cyclic loading, and chemical oxidation without mechanical deformation. This procedure follows the standard materials relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors.

82. A — For uniform average velocity, volumetric flow rate is $Q = Av$. Multiplying 0.020 m^2 by 3 m/s gives 0.060 m^3/s. This procedure follows the standard fluid mechanics relationship used in the FE

Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

83. C — Hydrostatic gauge pressure is $p = \rho g h$. Substituting 1000 kg/m³, 9.81 m/s², and 2.5 m gives 2.45e+04 Pa. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

84. C — Pipe Reynolds number is $Re = \rho v D/\mu$. Substitution gives (1000)(2.2)(0.05)/(0.001) = 1.1e+05, indicating turbulent flow. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

85. B — Continuity requires $A_1 v_1 = A_2 v_2$. Area varies with diameter squared, so $v_2 = v_1(0.10/0.05)^2 =$ 9.2 m/s. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

86. D — For uniform average velocity, volumetric flow rate is $Q = Av$. Multiplying 0.024 m² by 3 m/s gives 0.072 m³/s. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

87. D — Hydrostatic gauge pressure is $p = \rho g h$. Substituting 1000 kg/m³, 9.81 m/s², and 4.5 m gives 4.41e+04 Pa. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

88. C — Pipe Reynolds number is $Re = \rho v D/\mu$. Substitution gives (1000)(2.6)(0.05)/(0.001) = 1.3e+05, indicating turbulent flow. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

89. B — Continuity requires $A_1 v_1 = A_2 v_2$. Area varies with diameter squared, so $v_2 = v_1(0.10/0.05)^2 =$ 10.8 m/s. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

90. A — For uniform average velocity, volumetric flow rate is $Q = Av$. Multiplying 0.028 m² by 3 m/s gives 0.084 m³/s. This procedure follows the standard fluid mechanics relationship used in the FE

Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

91. C — Hydrostatic gauge pressure is $p = \rho g h$. Substituting 1000 kg/m³, 9.81 m/s², and 6.5 m gives 6.38e+04 Pa. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

92. A — Pipe Reynolds number is $Re = \rho v D/\mu$. Substitution gives (1000)(3.0)(0.05)/(0.001) = 1.5e+05, indicating turbulent flow. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

93. B — Continuity requires $A_1 v_1 = A_2 v_2$. Area varies with diameter squared, so $v_2 = v_1(0.10/0.05)^2$ = 12.4 m/s. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

94. D — For uniform average velocity, volumetric flow rate is $Q = Av$. Multiplying 0.032 m² by 3 m/s gives 0.096 m³/s. This procedure follows the standard fluid mechanics relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

95. A — Ohm’s law gives $I = V/R$. Dividing 12 V by 4 Ω gives 3 A. This procedure follows the standard basic electrical engineering relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

96. B — Series resistances carry the same current and add directly. Therefore R_eq = 5 + 7 = 12 Ω. This procedure follows the standard basic electrical engineering relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

97. D — Electrical power for a DC load is $P = VI$. Multiplying 12 V by 2 A gives 24 W. This procedure follows the standard basic electrical engineering relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

98. C — Ohm’s law gives $I = V/R$. Dividing 18 V by 7 Ω gives 2.57 A. This procedure follows the standard basic electrical engineering relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

99. A — Series resistances carry the same current and add directly. Therefore $R_{eq} = 8 + 10 = 18\ \Omega$. This procedure follows the standard basic electrical engineering relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

100. D — Electrical power for a DC load is $P = VI$. Multiplying 15 V by 2 A gives 30 W. This procedure follows the standard basic electrical engineering relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

101. B — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying $2.0 \times 4.18 \times 10$ gives 83.6 kJ. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

102. C — The rate relation is $q = UA\Delta T$. Solving for U gives $520/(2 \times 25) = 10.4\ W/(m^2 \cdot K)$. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

103. A — Thermal efficiency is net work output divided by heat input. Thus $\eta = 320/1100 = 0.291$, or 29.1%. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

104. C — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying $2.6 \times 4.18 \times 13$ gives 141 kJ. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

105. B — The rate relation is $q = UA\Delta T$. Solving for U gives $580/(2 \times 25) = 11.6\ W/(m^2 \cdot K)$. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

106. D — Thermal efficiency is net work output divided by heat input. Thus $\eta = 350/1250 = 0.280$, or 28.0%. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

107. B — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying $3.2 \times 4.18 \times 16$ gives 214 kJ. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

108. D — The rate relation is q = UAΔT. Solving for U gives 640/(2 × 25) = 12.8 W/(m²·K). This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

109. A — Thermal efficiency is net work output divided by heat input. Thus η = 380/1400 = 0.271, or 27.1%. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.

110. C — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying 3.8 × 4.18 × 19 gives 302 kJ. This procedure follows the standard thermodynamics and heat transfer relationship used in the FE Reference Handbook. Checking units and signs also eliminates the remaining distractors. The independent review confirms the keyed response is correct.