PRACTICE EXAM 18: 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 systems engineering review, solve $2x - 3 = 4$ for x.

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

2. For a process-reliability analysis, what is the area of a circle with radius 2.5 m?

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

3. While validating an operating parameter, evaluate $f(x) = 3x^2 + 2x - 5$ at $x = 3$.

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

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

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

5. For an engineering economics decision, find the determinant of the matrix [[6, 1], [1, 3]].

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

6. During a systems engineering review, solve $7x - 8 = 4$ for x.

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

7. For a process-reliability analysis, what is the area of a circle with radius 5 m?

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

8. While validating an operating parameter, evaluate $f(x) = 3x^2 + 2x - 5$ at $x = 8$.

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

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

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

10. For an engineering economics decision, find the determinant of the matrix [[11, 1], [1, 3]].

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

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

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

12. For a process-reliability analysis, a component fails with probability 0.25. What is the probability it does not fail?

A. 0.94
B. 0.25

C. 0.75
D. 0.06

13. While validating an operating parameter, for a binomial variable with n = 7 and p = 0.40, what is the expected value?

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

14. In a project-risk 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 engineering economics decision, what is the arithmetic mean of [6, 8, 10, 12]?

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

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

A. 0.45
B. 0.80
C. 0.20

D. 0.55

17. For a process-reliability analysis, for a binomial variable with n = 11 and p = 0.40, what is the expected value?

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

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

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

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

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

20. For an engineering economics 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 systems engineering review, a solution has $[H^+]$ = 3.16e-05 mol/L. What is its pH?

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

22. For a process-reliability analysis, what mass of water corresponds to 5 mol if its molar mass is 18.015 g/mol?

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

23. While validating an operating parameter, 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 project-risk assessment, which device converts a physical quantity into a usable electrical signal?

A. A relief valve
B. A transducer
C. A flywheel

D. A heat exchanger

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

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

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

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

27. For a process-reliability analysis, 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 validating an operating parameter, 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. 0.00391 V
D. 0.00781 V

29. In a project-risk assessment, an engineer discovers a design condition posing an imminent danger to the public. What is the engineer’s primary ethical obligation?

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

30. For an engineering economics decision, an engineer is asked to approve calculations prepared outside the engineer’s area of competence. What is the proper response?

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

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

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

32. For a process-reliability analysis, when presenting an engineering report, which practice best supports professional integrity?

A. Omit unfavorable results

B. Guarantee outcomes beyond available evidence

C. State relevant assumptions and limitations clearly

D. Present estimates as exact measurements

33. While validating an operating parameter, an engineer reviews a former employer's confidential design data. When may the engineer disclose it?

A. Whenever the information is technically interesting

B. When authorized or legally required

C. After leaving the employer

D. Whenever it improves a competing proposal

34. In a project-risk assessment, which action best addresses a potential conflict of interest before accepting an assignment?

A. Conceal it unless financial harm occurs

B. Transfer it informally to a coworker

C. Proceed because technical work is objective

D. Disclose the conflict to affected parties

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

A. Enter briefly without monitoring

B. Test the atmosphere and establish required controls

C. Disable ventilation to avoid turbulence

D. Rely only on odor detection

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

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

37. For a process-reliability analysis, what is the first hierarchy-of-controls preference for a serious workplace hazard?

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

38. While validating an operating parameter, which instrument is appropriate for checking oxygen concentration before confined-space entry?

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

39. In a project-risk assessment, what is the principal purpose of lockout/tagout?

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

40. For an engineering economics decision, for a small energized electrical fire, which extinguisher characteristic is required?

A. Nonconductive agent suitable for Class C hazards
B. Combustible metal powder only
C. Pressurized water stream
D. Conductive foam only

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

A. General warning signage
B. Longer work shifts
C. Administrative record retention
D. Local exhaust ventilation

42. For a process-reliability analysis, what future amount results from investing $1,000 for 3 years at 5% annual compound interest?

A. $863.84
B. $1,150.00
C. $1,157.63
D. $1,000.15

43. While validating an operating parameter, 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. 1000.00 units
C. 700.00 units
D. 411.76 units

44. In a project-risk 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 engineering economics 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. $2,500.30
D. $3,350.24

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

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

47. For a process-reliability analysis, 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 validating an operating parameter, a 100-N force acts 30° above the positive x-axis. What is its x-component?

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

49. In a project-risk 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 engineering economics 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 systems engineering 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. 80 N
D. 139 N

52. For a process-reliability analysis, 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. 210 N
C. 70 N
D. 280 N

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

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

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

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

55. For an engineering economics 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 systems engineering review, a 580-N block rests on a horizontal surface with coefficient of static friction 0.30. What is the maximum static friction?

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

57. For a process-reliability analysis, a 280-N force acts 30° above the positive x-axis. What is its x-component?

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

58. While validating an operating parameter, a particle starts at 2 m/s and accelerates uniformly at 3 m/s² 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 project-risk assessment, what net force accelerates a 6-kg mass at 2 m/s²?

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

60. For an engineering economics 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 systems engineering review, a particle starts at 5 m/s and accelerates uniformly at 3 m/s² for 4 s. What is its final speed?

A. 13 m/s

B. 44 m/s

C. 17 m/s

D. 12 m/s

62. For a process-reliability analysis, 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 validating an operating parameter, an object moves at 15 m/s in a circular path of radius 5 m. What is its centripetal acceleration?

A. 6 m/s²

B. 45 m/s²

C. 1.12e+03 m/s²

D. 3 m/s²

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

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

65. For an engineering economics 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 systems engineering 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. 1.62e+03 m/s^2
C. 3.6 m/s^2
D. 64.8 m/s^2

67. For a process-reliability analysis, 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 validating an operating parameter, a 2-m bar elongates 0.0011 m. What is its axial strain?

A. 0.055000

B. 1818.181818
C. 0.000550
D. 0.002200

69. In a project-risk 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. 120 MPa
C. 3.33e+08 MPa
D. 60 MPa

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

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

71. During a systems engineering 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 a process-reliability analysis, within the elastic range, a material has E = 200,000 MPa and strain 0.00075. What is the stress?

A. 150 MPa

B. 3.75e-09 MPa
C. 2.67e+08 MPa
D. 75 MPa

73. While validating an operating parameter, 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 project-risk 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 engineering economics 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. 180 MPa
C. 90 MPa
D. 2.22e+08 MPa

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

A. Hardness

B. Specific heat

C. Ductility

D. Thermal conductivity

77. For a process-reliability analysis, what commonly happens to the strength and ductility of a cold-worked metal?

A. Both remain unchanged

B. Both strength and ductility increase

C. Strength decreases while ductility increases

D. Strength increases while ductility decreases

78. While validating an operating parameter, 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 project-risk assessment, why is galvanic corrosion promoted when dissimilar metals are electrically connected in an electrolyte?

A. A potential difference drives electrochemical current

B. Both metals become perfect insulators

C. Mechanical stress becomes zero

D. The electrolyte removes all ions

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

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

81. During a systems engineering review, what is creep?

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

82. For a process-reliability analysis, 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. 150 m^3/s
B. 0.06 m^3/s
C. 60 m^3/s
D. 0.00667 m^3/s

83. While validating an operating parameter, 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. 24.5 Pa
D. 2.45e+04 Pa

84. In a project-risk 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. 1.1e+05
C. 2.2e+06
D. 110

85. For an engineering economics 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. 9.2 m/s
B. 4.6 m/s
C. 0.575 m/s
D. 1.15 m/s

86. During a systems engineering 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. 0.072 m^3/s
D. 0.008 m^3/s

87. For a process-reliability analysis, 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. 4.41e+04 Pa
C. 2.18e+03 Pa
D. 44.1 Pa

88. While validating an operating parameter, for water with $\rho = 1000$ kg/m^3 and $\mu = 0.001$ Pa·s flowing at 2.6 m/s in a 0.05-m pipe, what is Reynolds number?

A. 131

B. 130

C. 2.6e+06

D. 1.3e+05

89. In a project-risk 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. 10.8 m/s

B. 1.35 m/s

C. 5.4 m/s

D. 0.675 m/s

90. For an engineering economics 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. 0.00933 m^3/s

B. 107 m^3/s

C. 0.084 m^3/s

D. 84 m^3/s

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

A. 6.38e+04 Pa

B. 6.5e+03 Pa

C. 1.51e+03 Pa

D. 63.8 Pa

92. For a process-reliability analysis, 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. 150
B. 3e+06
C. 1.5e+05
D. 151

93. While validating an operating parameter, 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. 6.2 m/s
C. 0.775 m/s
D. 12.4 m/s

94. In a project-risk 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. 0.096 m^3/s
C. 96 m^3/s
D. 93.8 m^3/s

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

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

96. During a systems engineering 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 a process-reliability analysis, a device operates at 12 V and draws 2 A. What electrical power does it consume?

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

98. While validating an operating parameter, 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 project-risk assessment, what is the equivalent resistance of 8 Ω and 10 Ω connected in series?

A. 2 Ω
B. 80 Ω
C. 18 Ω
D. 4.44 Ω

100. For an engineering economics 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 systems engineering 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 a process-reliability analysis, heat transfer is 520 W through 2 m² with a 25 K temperature difference. What is the overall heat-transfer coefficient?

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

103. While validating an operating parameter, a heat engine receives 1100 kJ and produces 320 kJ of work. What is its thermal efficiency?

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

104. In a project-risk 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. 0.141 kJ

D. 141 kJ

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

A. 11.6 W/(m²·K)

B. 2.9e+04 W/(m²·K)

C. 290 W/(m²·K)

D. 23.2 W/(m²·K)

106. During a systems engineering 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. 28.0%

D. 72.0%

107. For a process-reliability analysis, 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 validating an operating parameter, heat transfer is 640 W through 2 m² with a 25 K temperature difference. What is the overall heat-transfer coefficient?

A. 12.8 W/(m²·K)
B. 25.6 W/(m²·K)
C. 320 W/(m²·K)
D. 3.2e+04 W/(m²·K)

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

A. 368.4%
B. 37.3%
C. 72.9%
D. 27.1%

110. For an engineering economics 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 18: Answer Key and Explanations

1. B — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

2. C — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

3. A — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

4. D — 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 systems review confirms the keyed response is correct.

5. C — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

6. B — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

7. C — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

8. A — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

9. D — 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 systems review confirms the keyed response is correct.

10. B — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

11. B — 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 systems review confirms the keyed response is correct.

12. C — 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 systems review confirms the keyed response is correct.

13. A — 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 systems 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. A — 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 systems review confirms the keyed response is correct.

16. D — 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 systems review confirms the keyed response is correct.

17. C — 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 systems review confirms the keyed response is correct.

18. B — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

19. A — 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 systems 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. D — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

22. C — 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 systems 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. B — 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. A — 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 systems review confirms the keyed response is correct.

26. D — 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 systems 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 systems review confirms the keyed response is correct.

28. D — 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 systems review confirms the keyed response is correct.

29. A — 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. C — 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. A — 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. C — 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. B — 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. D — 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. B — 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. A — 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. C — 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. D — 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. B — 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. A — 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. D — 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. C — 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 systems review confirms the keyed response is correct.

43. B — 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 systems 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 systems review confirms the keyed response is correct.

45. D — 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 systems review confirms the keyed response is correct.

46. A — 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 systems 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 systems review confirms the keyed response is correct.

48. C — 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 systems 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 systems 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

51. D — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

52. C — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

53. B — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

54. A — 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 systems 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

56. A — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

57. B — 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 systems 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

59. A — 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 systems 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 systems review confirms the keyed response is correct.

61. C — 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 systems 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

63. B — 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 systems review confirms the keyed response is correct.

64. A — 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 systems 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

66. D — 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 systems 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 systems review confirms the keyed response is correct.

68. C — 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 systems review confirms the keyed response is correct.

69. B — 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 systems review confirms the keyed response is correct.

70. D — 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 systems 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 systems review confirms the keyed response is correct.

72. A — 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 systems 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 systems 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 systems review confirms the keyed response is correct.

75. B — 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 systems review confirms the keyed response is correct.

76. A — 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. D — 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. A — 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. D — 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. C — 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. B — 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 systems review confirms the keyed response is correct.

83. D — 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 systems review confirms the keyed response is correct.

84. B — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

85. A — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

86. C — 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 systems review confirms the keyed response is correct.

87. B — 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 systems review confirms the keyed response is correct.

88. D — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

89. A — 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

90. C — 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 systems review confirms the keyed response is correct.

91. A — Hydrostatic gauge pressure is p = ρgh. 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 systems review confirms the keyed response is correct.

92. C — Pipe Reynolds number is Re = ρvD/μ. 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

93. D — Continuity requires $A_1v_1 = A_2v_2$. 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

94. B — 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 systems review confirms the keyed response is correct.

95. D — 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 systems 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 systems review confirms the keyed response is correct.

97. A — 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 systems 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 systems review confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

99. C — Series resistances carry the same current and add directly. Therefore R_eq = 8 + 10 = 18 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 systems 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 systems review confirms the keyed response is correct.

101. B — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying 2.0 × 4.18 × 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 systems review confirms the keyed response is correct.

102. A — The rate relation is $q = UA\Delta T$. Solving for U gives $520/(2 \times 25) = 10.4$ 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 systems review confirms the keyed response is correct.

103. B — 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 systems review confirms the keyed response is correct.

104. D — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying 2.6 × 4.18 × 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 systems review confirms the keyed response is correct.

105. A — The rate relation is $q = UA\Delta T$. Solving for U gives $580/(2 \times 25) = 11.6$ 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 systems review confirms the keyed response is correct.

106. C — 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 systems review confirms the keyed response is correct.

107. B — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying 3.2 × 4.18 × 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 systems review confirms the keyed response is correct.

108. A — The rate relation is $q = UA\Delta T$. Solving for U gives $640/(2 \times 25) = 12.8$ 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 systems review confirms the keyed response is correct.

109. D — Thermal efficiency is net work output divided by heat input. Thus $\eta = 380/1400 = 0.271$, 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 systems review confirms the keyed response is correct.

110. C — For sensible heating with constant specific heat, $Q = mc_p\Delta T$. Multiplying $3.8 \times 4.18 \times 19$ 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 systems review confirms the keyed response is correct.