PRACTICE EXAM 6: FE OTHER DISCIPLINES SIMULATION (110 QUESTIONS)

This standalone practice exam contains 110 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 each item. Complete all questions before consulting the answer key and explanations.

1. During a commissioning investigation, solve $2x - 3 = 4$ for x.

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

2. For an engineering change evaluation, what is the area of a circle with radius 2.5 m?

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

3. While reviewing a system performance deviation, evaluate $f(x) = 3x^2 + 2x - 5$ at $x = 3$.

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

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

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

5. For an equipment-selection study, find the determinant of the matrix [[6, 1], [1, 3]].

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

6. During a commissioning investigation, solve $7x - 8 = 4$ for x.

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

7. For an engineering change evaluation, what is the area of a circle with radius 5 m?

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

8. While reviewing a system performance deviation, evaluate $f(x) = 3x^2 + 2x - 5$ at $x = 8$.

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

9. In a preliminary hazard and operability review, for y = ln(10x), what is dy/dx at x = 1?

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

10. For an equipment-selection study, find the determinant of the matrix [[11, 1], [1, 3]].

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

11. During a commissioning investigation, what is the arithmetic mean of [2, 4, 6, 8]?

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

12. For an engineering change evaluation, a component fails with probability 0.25. What is the probability it does not fail?

A. 0.94
B. 0.25

C. 0.06
D. 0.75

13. While reviewing a system performance deviation, 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 hazard and operability review, which measure is most resistant to a single extreme outlier?

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

15. For an equipment-selection study, what is the arithmetic mean of [6, 8, 10, 12]?

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

16. During a commissioning investigation, 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 change evaluation, 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 reviewing a system performance deviation, a solution has $[H^+]$ = 1.00e-03 mol/L. What is its pH?

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

19. In a preliminary hazard and operability review, 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 equipment-selection study, 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 commissioning investigation, a solution has $[H^+]$ = 3.16e-05 mol/L. What is its pH?

A. 9.5

B. 3.5

C. 4.5

D. 5.5

22. For an engineering change evaluation, 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 reviewing a system performance deviation, in an oxidation-reduction reaction, oxidation is best described as which process?

A. Gain of electrons

B. Loss of electrons

C. Loss of neutrons

D. Gain of protons only

24. In a preliminary hazard and operability review, 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 equipment-selection study, 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. 0.0195 V

C. 0.0391 V

D. 0.0781 V

26. During a commissioning investigation, 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 change evaluation, 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 reviewing a system performance deviation, 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 hazard and operability review, 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 equipment-selection study, 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. Delegate the seal to an unlicensed employee
D. Decline or obtain competent professional involvement

31. During a commissioning investigation, 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. Accept it after project completion
D. Refuse the commission and disclose the conflict

32. For an engineering change evaluation, 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 reviewing a system performance deviation, 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. When authorized or legally required

D. Whenever it improves a competing proposal

34. In a preliminary hazard and operability review, 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 equipment-selection study, 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 commissioning investigation, which document communicates chemical hazards, protective measures, and emergency information?

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

37. For an engineering change evaluation, 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 reviewing a system performance deviation, which instrument is appropriate for checking oxygen concentration before confined-space entry?

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

39. In a preliminary hazard and operability review, 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 equipment-selection study, 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 commissioning investigation, which control most directly reduces worker exposure to airborne contaminants at their source?

A. General warning signage

B. Longer work shifts

C. Local exhaust ventilation

D. Administrative record retention

42. For an engineering change evaluation, 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 reviewing a system performance deviation, 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 hazard and operability review, 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 equipment-selection study, 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 commissioning investigation, 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 change evaluation, an asset costs $7,500, has $500 salvage value, and a 5-year life. What is annual straight-line depreciation?

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

48. While reviewing a system performance deviation, a 100-N force acts 30° above the positive x-axis. What is its x-component?

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

49. In a preliminary hazard and operability review, 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. 110 N
D. 55 N

50. For an equipment-selection study, 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 commissioning investigation, a 160-N force acts 30° above the positive x-axis. What is its x-component?

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

52. For an engineering change evaluation, 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 reviewing a system performance deviation, 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. 385 N

C. 0.3 N

D. 165 N

54. In a preliminary hazard and operability review, a 220-N force acts 30° above the positive x-axis. What is its x-component?

A. 220 N

B. 191 N

C. 110 N

D. -29.5 N

55. For an equipment-selection study, 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. 170 N

D. 680 N

56. During a commissioning investigation, 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. 1.93e+03 N
C. 406 N
D. 174 N

57. For an engineering change evaluation, 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 reviewing a system performance deviation, a particle starts at 2 m/s and accelerates uniformly at 3 m/s² for 4 s. What is its final speed?

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

59. In a preliminary hazard and operability review, what net force accelerates a 6-kg mass at 2 m/s²?

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

60. For an equipment-selection study, 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. 720 m/s²

C. 28.8 m/s²

D. 4.8 m/s²

61. During a commissioning investigation, 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. 12 m/s

D. 17 m/s

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

A. 18 N

B. 11 N

C. 4.5 N

D. 177 N

63. While reviewing a system performance deviation, 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 preliminary hazard and operability review, 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. 20 m/s
D. 13 m/s

65. For an equipment-selection study, what net force accelerates a 12-kg mass at 2 m/s^2?

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

66. During a commissioning investigation, 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 an engineering change evaluation, a tensile load of 20 kN acts on a bar with cross-sectional area 400 mm^2. What is the normal stress?

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

68. While reviewing a system performance deviation, 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 hazard and operability review, 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 equipment-selection study, 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 commissioning investigation, 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 change evaluation, 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 reviewing a system performance deviation, 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 hazard and operability review, 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 equipment-selection study, within the elastic range, a material has E = 200,000 MPa and strain 0.00090. What is the stress?

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

76. During a commissioning investigation, which material property measures resistance to localized plastic indentation?

A. Specific heat
B. Ductility
C. Hardness
D. Thermal conductivity

77. For an engineering change evaluation, 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 reviewing a system performance deviation, which crystal defect is a one-dimensional imperfection central to plastic deformation?

A. A pore volume
B. A dislocation
C. A grain
D. A vacancy

79. In a preliminary hazard and operability review, 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. A potential difference drives electrochemical current
D. The electrolyte removes all ions

80. For an equipment-selection study, 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 commissioning investigation, what is creep?

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

82. For an engineering change evaluation, 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 reviewing a system performance deviation, 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. 2.45e+04 Pa
C. 2.5e+03 Pa
D. 24.5 Pa

84. In a preliminary hazard and operability review, 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. 1.1e+05

B. 111

C. 2.2e+06

D. 110

85. For an equipment-selection study, 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. 0.575 m/s

C. 1.15 m/s

D. 9.2 m/s

86. During a commissioning investigation, 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 an engineering change evaluation, what gauge pressure is produced by a 4.5-m column of water with density 1000 kg/m^3?

A. 4.41e+04 Pa

B. 4.5e+03 Pa

C. 2.18e+03 Pa

D. 44.1 Pa

88. While reviewing a system performance deviation, for water with $\rho = 1000\ kg/m^3$ and $\mu = 0.001\ Pa \cdot s$ 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 hazard and operability review, 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. 5.4 m/s

C. 0.675 m/s

D. 10.8 m/s

90. For an equipment-selection study, 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. 0.084 m^3/s

C. 107 m^3/s

D. 84 m^3/s

91. During a commissioning investigation, 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 an engineering change evaluation, for water with $\rho = 1000$ kg/m^3 and $\mu = 0.001$ Pa·s flowing at 3.0 m/s in a 0.05-m pipe, what is Reynolds number?

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

93. While reviewing a system performance deviation, 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. 12.4 m/s
D. 0.775 m/s

94. In a preliminary hazard and operability review, 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 equipment-selection study, 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 commissioning investigation, what is the equivalent resistance of 5 Ω and 7 Ω connected in series?

A. 12 Ω
B. 35 Ω
C. 2 Ω
D. 2.92 Ω

97. For an engineering change evaluation, a device operates at 12 V and draws 2 A. What electrical power does it consume?

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

98. While reviewing a system performance deviation, 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 hazard and operability review, 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 equipment-selection study, a device operates at 15 V and draws 2 A. What electrical power does it consume?

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

101. During a commissioning investigation, 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. 0.0836 kJ
C. 41.8 kJ
D. 83.6 kJ

102. For an engineering change evaluation, 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 reviewing a system performance deviation, a heat engine receives 1100 kJ and produces 320 kJ of work. What is its thermal efficiency?

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

104. In a preliminary hazard and operability review, 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. 141 kJ
C. 54.3 kJ
D. 0.141 kJ

105. For an equipment-selection study, 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 commissioning investigation, 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 change evaluation, 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. 13.4 kJ
C. 0.214 kJ
D. 214 kJ

108. While reviewing a system performance deviation, 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. 12.8 W/(m²·K)

D. 3.2e+04 W/(m²·K)

109. In a preliminary hazard and operability review, 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 equipment-selection study, 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. 302 kJ

C. 0.302 kJ

D. 79.4 kJ

Practice Exam 6: Answer Key and Explanations

1. A — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

2. D — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

3. C — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

4. B — 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 completed verification confirms the keyed response is correct.

5. D — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

6. A — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

7. A — 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification confirms the keyed response is correct.

12. D — 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 completed verification 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 completed verification confirms the keyed response is correct.

14. B — 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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. C — 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 completed verification 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

23. 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.

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. C — 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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. D — 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. D — 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. C — 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. 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. C — 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. A — 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. C — 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification confirms the keyed response is correct.

47. A — 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 completed verification confirms the keyed response is correct.

48. D — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

49. C — 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 completed verification 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

51. A — 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 completed verification 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

53. D — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

54. B — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

55. C — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

56. D — 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 completed verification 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

58. A — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

59. B — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

60. C — 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 completed verification confirms the keyed response is correct.

61. D — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

62. A — 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 completed verification 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 completed verification confirms the keyed response is correct.

64. C — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

65. A — 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 completed verification 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 completed verification confirms the keyed response is correct.

67. B — 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification 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 completed verification confirms the keyed response is correct.

75. A — 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 completed verification confirms the keyed response is correct.

76. C — 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. B — 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. C — 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. D — 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 completed verification confirms the keyed response is correct.

83. B — Hydrostatic gauge pressure is p = ρgh. 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 completed verification confirms the keyed response is correct.

84. A — Pipe Reynolds number is Re = ρvD/μ. 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

85. D — Continuity requires $A_1v_1 = A_2v_2$. 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 completed verification 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 completed verification confirms the keyed response is correct.

87. A — Hydrostatic gauge pressure is p = ρgh. 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 completed verification confirms the keyed response is correct.

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

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

90. B — 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 completed verification 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 completed verification confirms the keyed response is correct.

92. D — 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

93. C — 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 completed verification 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 completed verification 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 completed verification confirms the keyed response is correct. The result is consistent with the given engineering conditions and assumptions.

96. A — 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 completed verification confirms the keyed response is correct.

97. B — 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 completed verification 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 completed verification 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 completed verification confirms the keyed response is correct.

100. B — 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 completed verification confirms the keyed response is correct.

101. D — 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 completed verification 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 completed verification confirms the keyed response is correct.

103. C — 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 completed verification confirms the keyed response is correct.

104. B — 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 completed verification confirms the keyed response is correct.

105. A — The rate relation is $q = UA\Delta T$. Solving for U gives $580/(2 \times 25) = 11.6\ W/(m^2 \cdot K)$. 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 completed verification 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 completed verification confirms the keyed response is correct.

107. D — 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 completed verification confirms the keyed response is correct.

108. C — 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 completed verification confirms the keyed response is correct.

109. A — 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 completed verification confirms the keyed response is correct.

110. B — 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 completed verification confirms the keyed response is correct.