Board Exam Desk

Chemical Engineering Reviewer

Chemical Engineering Licensure Examination | PRC | 120 original questions

2026 Edition | Updated November 2026

Original board-style practice questions with an answer key.

Practice questions

Physical and Chemical Principles

1. How many grams of NaOH (molar mass about 40.00 g/mol) are needed to prepare 250 mL of a 0.40 M solution?

A. 16.00 g
B. 10.00 g
C. 1.60 g
D. 4.00 g

2. How many moles of an ideal gas occupy 15.0 L at 2.50 atm and 35 °C?

A. 13.057 mol
B. 0.0146 mol
C. 1.483 mol
D. 1.673 mol

3. What is the pH of a 0.020 M HCl solution at 25 °C?

A. 12.30
B. 0.85
C. 1.70
D. 2.70

4. What is the pH of 0.10 M acetic acid (Ka = 1.8 × 10■■)?

A. 1.00
B. 2.87
C. 4.74
D. 5.74

5. A buffer contains 0.30 M NH■ and 0.20 M NH■Cl (Kb of NH■ = 1.8 × 10■■). What is its pH?

A. 9.43
B. 9.08
C. 4.57
D. 9.26

6. The Ksp of CaF■ is 3.9 × 10■^{11}. What is its molar solubility in pure water?

A. 6.24 × 10■■ M
B. 3.39 × 10■■ M
C. 2.69 × 10■■ M
D. 2.14 × 10■■ M

7. A current of 3.00 A is passed through a CuSO■ solution for 45.0 minutes. What mass of copper is deposited?

A. 5.335 g
B. 2.667 g
C. 1.334 g
D. 0.0445 g

8. For a Zn-Cu galvanic cell (E° = 1.10 V) with [Zn²■] = 1.0 M and [Cu²■] = 0.010 M at 25 °C, what is the cell potential?

A. 1.159 V
B. 1.041 V
C. 0.982 V
D. 1.085 V

9. A first-order reaction is 75% complete in 40 minutes. What is its half-life?

A. 30 min
B. 20 min
C. 10 min
D. 15 min

10. The rate constant of a reaction doubles when temperature rises from 300 K to 310 K. What is the activation energy?

A. 23.3 kJ/mol
B. 154.6 kJ/mol
C. 53.6 kJ/mol
D. 0.058 kJ/mol

11. 1.5 mol of a nonvolatile, nonelectrolyte solute is dissolved in 18 mol of water. If pure water has a vapor pressure of 23.8 mmHg, what is the vapor pressure of the solution?

A. 21.97 mmHg
B. 1.83 mmHg
C. 21.82 mmHg
D. 25.78 mmHg

12. What is the freezing point of a solution made by dissolving 12.0 g of urea (60.06 g/mol) in 250 g of water? (Kf = 1.86 °C·kg/mol)

A. –0.37 °C
B. –2.97 °C
C. –1.49 °C
D. –1.42 °C

13. What is the osmotic pressure of a 0.050 M aqueous glucose solution at 25 °C?

A. 0.103 atm
B. 1.22 atm
C. 2.45 atm
D. 123.9 atm

14. Under identical conditions, how many times faster does H■ effuse than O■?

A. 15.87
B. 0.251
C. 2.82
D. 3.98

15. Using ΔHf° values CH■(g) = −74.8, CO■(g) = −393.5 and H■O(l) = −285.8 kJ/mol, what is ΔH° for CH■ + 2O■ → CO■ + 2H■O(l)?

A. −604.5 kJ
B. −1039.9 kJ
C. −890.3 kJ
D. −754.1 kJ

16. How much heat is absorbed by 150 g of water when it warms from 22.0 °C to 31.5 °C? (c = 4.184 J/g·°C)

A. 5.96 kJ
B. 1.43 kJ
C. 19.77 kJ
D. 13.81 kJ

17. Which quantum number mainly determines the shape of an atomic orbital?

A. Principal quantum number, n
B. Azimuthal quantum number, l
C. Magnetic quantum number, m■
D. Spin quantum number, m■

18. What is the hybridization of each carbon atom in ethyne (C■H■)?

A. sp
B. sp^2
C. sp^3
D. sp^3d

19. For N■(g) + 3H■(g) ■ 2NH■(g), what happens when total pressure is increased by compression at constant temperature?

A. Equilibrium shifts toward N■ and H■
B. Equilibrium shifts toward NH■
C. The equilibrium constant increases
D. No shift occurs at all

20. Acid-catalyzed hydration of propene gives mainly which product?

A. 2-Propanol
B. 1-Propanol
C. Propanal
D. Propanoic acid

21. Heating a carboxylic acid with an alcohol in the presence of an acid catalyst produces which class of compound?

A. An ether
B. An aldehyde
C. An amide
D. An ester

22. How many structural isomers have the molecular formula C■H■■?

A. 2
B. 4
C. 3
D. 5

23. Which statement correctly describes an SN2 reaction?

A. Rate depends on the substrate concentration only
B. It proceeds through a carbocation intermediate
C. It gives retention of configuration
D. Rate depends on both substrate and nucleophile

24. Benzene most characteristically undergoes which type of reaction?

A. Electrophilic addition across C=C
B. Nucleophilic aromatic addition
C. Free-radical polymerization
D. Electrophilic aromatic substitution

25. A 25.00 mL sample of H■SO■ requires 32.40 mL of 0.1050 M NaOH to reach the equivalence point. What is the molarity of the acid?

A. 0.1361 M
B. 0.0810 M
C. 0.0680 M
D. 0.0340 M

26. A 0.5000 g sample is treated so that all its sulfur precipitates as 0.6120 g of BaSO■ (233.39 g/mol). What is the percent sulfur in the sample?

A. 50.38%
B. 72.02%
C. 8.41%
D. 16.81%

27. A solution in a 1.00 cm cell has absorbance 0.452 at a wavelength where ε = 1.25 × 10■ L/mol·cm. What is its concentration?

A. 1.81 × 10■■ M
B. 7.23 × 10■■ M
C. 3.62 × 10■■ M
D. 2.77 × 10■ M

28. Which substance is commonly used as a primary standard for standardizing NaOH solutions?

A. Sodium carbonate solution
B. Concentrated hydrochloric acid
C. Potassium hydrogen phthalate
D. Potassium permanganate

29. Replicate analyses gave 10.2, 10.5, 10.1 and 10.4 mg/L. What is the sample standard deviation?

A. 0.158 mg/L
B. 0.183 mg/L
C. 0.0333 mg/L
D. 0.400 mg/L

30. A liquid with ΔHvap = 32.0 kJ/mol has a vapor pressure of 100 mmHg at 300 K. Estimate its vapor pressure at 330 K.

A. 1467 mmHg
B. 110 mmHg
C. 100.1 mmHg
D. 321 mmHg

31. A reaction has ΔH° = −92.2 kJ and ΔS° = −198.7 J/K. What is ΔG° at 298 K?

A. −33.0 kJ
B. −151.4 kJ
C. +33.0 kJ
D. −87.2 kJ

32. A reaction has ΔG° = −10.0 kJ/mol at 25 °C. What is its equilibrium constant?

A. 56.5
B. 0.0177
C. 1.0040
D. 4.03

33. According to the third law of thermodynamics, the entropy of a perfect crystalline substance at 0 K is:

A. Equal to its enthalpy
B. Zero
C. At its maximum value
D. Equal to R ln 2

34. Which of the following is an intensive property?

A. Density
B. Mass
C. Volume
D. Total enthalpy

35. In the van der Waals equation, the constant a corrects for:

A. The finite volume of molecules
B. Quantum effects at low temperature
C. Dissociation of gas molecules
D. Attractive forces between molecules

36. A radioisotope has a half-life of 5.0 days. How much of an 80.0 mg sample remains after 18 days?

A. 6.60 mg
B. 10.00 mg
C. 2.19 mg
D. 5.00 mg

37. A compound contains 54.5% C, 9.15% H and 36.3% O by mass. What is its empirical formula?

A. CH■O
B. C■H■O
C. C■H■O
D. C■H■O

38. 10.0 g of H■ reacts with 64.0 g of O■ to form water. What maximum mass of water can form?

A. 89.4 g
B. 74.0 g
C. 72.1 g
D. 36.0 g

39. Which intermolecular force is chiefly responsible for the unusually high boiling point of water?

A. London dispersion forces
B. Hydrogen bonding
C. Ion-dipole attraction
D. Covalent network bonding

40. Colligative properties of a dilute solution depend primarily on:

A. The chemical identity of the solute
B. The number of solute particles
C. The molar mass of the solvent only
D. The color and odor of the solute

Chemical Engineering Principles

41. An evaporator concentrates 1000 kg/h of a 10 wt% NaCl solution to 25 wt%. How much water is evaporated?

A. 400 kg/h
B. 600 kg/h
C. 150 kg/h
D. 750 kg/h

42. 200 kg of a 30 wt% sugar solution is mixed with 300 kg of a 50 wt% sugar solution. What is the sugar content of the mixture?

A. 42 wt%
B. 40 wt%
C. 38 wt%
D. 45 wt%

43. Propane is burned with 20% excess air. How many kmol of air are supplied per kmol of propane?

A. 23.81 kmol
B. 6.00 kmol
C. 28.57 kmol
D. 19.05 kmol

44. Methane burns completely with 10% excess air. What is the mole percent CO■ in the wet flue gas?

A. 10.55%
B. 9.50%
C. 8.71%
D. 18.52%

45. A reactor is fed 100 mol of A; 80 mol of A react, producing 60 mol of desired product B (A → B) and the rest going to by-product. What is the fractional yield of B based on A consumed?

A. 0.75
B. 0.60
C. 0.80
D. 0.48

46. Air at 101.325 kPa contains water vapor at a partial pressure of 2.5 kPa. What is its absolute humidity?

A. 0.0157 kg water/kg dry air
B. 0.0153 kg water/kg dry air
C. 0.0253 kg water/kg dry air
D. 0.0247 kg water/kg dry air

47. Two moles of an ideal gas expand reversibly and isothermally at 350 K from 10 L to 40 L. How much work does the gas do?

A. 3.50 kJ
B. 4.03 kJ
C. 23.28 kJ
D. 8.07 kJ

48. Air ($\gamma = 1.4$) is compressed reversibly and adiabatically from 100 kPa and 300 K to 800 kPa. What is the final temperature?

A. 543.4 K
B. 689.2 K
C. 2400.0 K
D. 1324.9 K

49. What is the coefficient of performance of a Carnot refrigerator operating between −10 °C and 35 °C?

A. 6.85
B. 0.146
C. 5.85
D. 0.286

50. A throttling process across a valve, with negligible heat transfer and kinetic energy change, is best described as:

A. Isentropic
B. Isothermal
C. Isochoric
D. Isenthalpic

51. For a pure ideal gas, the fugacity is equal to:

A. Its partial molar volume
B. Its pressure
C. Zero at all conditions
D. Its vapor pressure

52. Water ($\rho = 998$ kg/m³, $\mu = 1.0 \times 10^{-3}$ Pa·s) flows at 1.5 m/s in a pipe of 50 mm inside diameter. What is the Reynolds number?

A. 7.48×10^{4}
B. 3.74×10^{4}
C. 7.48×10^{4}
D. 7.49×10^{3}

53. Water flows at 2.0 m/s through 100 m of 0.10 m diameter pipe. With a Darcy friction factor of 0.020, what is the head loss?

A. 8.15 m
B. 2.04 m
C. 16.31 m
D. 4.08 m

54. For fully developed laminar flow in a circular pipe at Re = 1600, what is the Darcy friction factor?

A. 0.010
B. 0.020
C. 0.064
D. 0.040

55. Neglecting losses, what is the discharge velocity of water from a small orifice 5.0 m below the free surface of a large open tank?

A. 7.00 m/s
B. 98.1 m/s
C. 4.95 m/s
D. 9.90 m/s

56. A pump delivers 0.020 m³/s of water (ρ = 1000 kg/m³) against a total head of 30 m with 70% efficiency. What is the shaft power required?

A. 5.89 kW
B. 4.12 kW
C. 8.41 kW
D. 0.857 kW

57. By the pump affinity laws, if the speed of a centrifugal pump is doubled, the power required becomes:

A. 2 times the original
B. 4 times the original
C. 16 times the original
D. 8 times the original

58. A 0.20 m thick wall (k = 0.80 W/m·K) has an area of 10 m² and a temperature difference of 30 °C across it. What is the steady conduction heat rate?

A. 120 W
B. 48 W
C. 1200 W
D. 6000 W

59. A furnace wall has 0.20 m of brick (k = 0.70 W/m·K) and 0.05 m of insulation (k = 0.05 W/m·K). The faces are at 500 °C and 50 °C. What is the heat flux?

A. 1575 W/m²
B. 450 W/m²
C. 2025 W/m²
D. 350 W/m²

60. In a counterflow exchanger, the hot fluid cools from 150 °C to 90 °C while the cold fluid heats from 30 °C to 70 °C. What is the LMTD?

A. 55.8 °C
B. 69.5 °C
C. 70.0 °C
D. 60.0 °C

61. A gray surface with emissivity 0.80 is at 1000 K. What is its emissive power? (σ = 5.67 × 10■■ W/m²·K■)

A. 56.7 kW/m²
B. 45.4 kW/m²
C. 70.9 kW/m²
D. 12.7 kW/m²

62. Cooling water (2.0 kg/s, cp = 4.18 kJ/kg·K) is heated from 20 °C to 60 °C by oil (4.0 kg/s, cp = 2.0 kJ/kg·K) entering at 150 °C. What is the oil outlet temperature?

A. 108.2 °C
B. 66.4 °C
C. 41.8 °C
D. 191.8 °C

63. The Schmidt number is the ratio of:

A. Momentum diffusivity to mass diffusivity
B. Thermal diffusivity to mass diffusivity
C. Momentum diffusivity to thermal diffusivity
D. Convective to diffusive mass transfer

64. A binary column has a constant relative volatility of 2.5. Using the Fenske equation, what is the minimum number of theoretical stages for xD = 0.95 and xB = 0.05?

A. 3.21
B. 2.79
C. 6.43
D. 7.43

65. On a McCabe-Thiele diagram, the q-line for a feed entering as saturated liquid is:

A. Horizontal
B. Inclined at 45°
C. Vertical
D. Coincident with the y-axis

66. A column is fed 100 kmol/h of a 40 mol% benzene mixture. The distillate is 95 mol% and the bottoms 5 mol% benzene. What is the distillate rate?

A. 61.11 kmol/h
B. 38.89 kmol/h
C. 40.00 kmol/h
D. 42.11 kmol/h

67. A column operates at reflux ratio R = 3 with distillate composition xD = 0.90. What is the y-intercept of the rectifying operating line?

A. 0.300
B. 0.225
C. 0.900
D. 0.675

68. A gas has a Henry's law constant of 50 atm (per mole fraction) in water. What equilibrium liquid mole fraction corresponds to a gas partial pressure of 0.50 atm?

A. 25.0
B. 0.0100
C. 0.0200
D. 0.0050

69. A first-order liquid reaction (k = 0.25 min■¹) is run in a CSTR at 10 L/min. What reactor volume gives 80% conversion?

A. 64.4 L
B. 160 L
C. 32.0 L
D. 200 L

70. A first-order reaction with k = 0.050 min■¹ is carried out in an isothermal batch reactor. How long does it take to reach 90% conversion?

A. 180.0 min
B. 46.1 min
C. 18.0 min
D. 20.0 min

71. If the half-life of a reaction is independent of the initial reactant concentration, the reaction is:

A. Zero order
B. First order
C. Second order
D. Third order

72. A liquid of 40 mol% benzene and 60 mol% toluene is at its bubble point where P°(benzene) = 180 kPa and P°(toluene) = 70 kPa. Assuming Raoult's law, what is the benzene mole fraction in the vapor?

A. 0.632
B. 0.400
C. 0.368
D. 0.288

73. For a first-order process with time constant τ, the response to a step input reaches what fraction of its final change at t = τ?

A. 63.2%
B. 50.0%
C. 86.5%
D. 95.0%

74. A process has transfer function G(s) = 5/(10s + 1). What is the final steady-state change in output for a step input of magnitude 2?

A. 2.5
B. 5
C. 0.5
D. 10

75. Rittinger's law of crushing states that the energy required for size reduction is proportional to:

A. The volume of the feed particles
B. The logarithm of the size ratio
C. The square root of feed size
D. The new surface area created

76. Estimate the Stokes terminal velocity of a 50 μm sphere (ρp = 2650 kg/m³) settling in water (ρ = 1000 kg/m³, μ = 1.0 × 10■³ Pa·s).

A. 5.62 × 10■■ m/s
B. 2.25 × 10■³ m/s
C. 3.61 × 10■³ m/s
D. 2.29 × 10■■ m/s

77. 100 kg of a wet solid containing 40% moisture (wet basis) is dried to 10% moisture (wet basis). How much water is removed?

A. 30.0 kg
B. 36.0 kg
C. 40.0 kg
D. 33.3 kg

78. In evaporator operation, steam economy is defined as:

A. Mass of steam per mass of feed
B. Heat transferred per unit area
C. Mass of water evaporated per mass of steam
D. Mass of product per mass of steam

79. A 50 t/day plant cost PHP 20 million. Using the six-tenths rule, estimate the cost of a similar 150 t/day plant.

A. PHP 60.0 million
B. PHP 34.6 million
C. PHP 31.0 million
D. PHP 38.7 million

80. For an air-water system, the wet-bulb temperature equals the dry-bulb temperature when the air is:

A. Completely dry
B. Saturated with water vapor
C. Heated above its dew point
D. At exactly 50% humidity

General Engineering

81. PHP 100,000 is deposited at 6% interest compounded annually. What is its value after 5 years?

A. PHP 133,822.56
B. PHP 130,000.00
C. PHP 134,685.50
D. PHP 134,985.88

82. What is the effective annual interest rate for a nominal 12% compounded monthly?

A. 12.00%
B. 12.55%
C. 12.75%
D. 12.68%

83. What is the present worth of PHP 50,000 received at the end of each year for 10 years if money is worth 8% per year?

A. PHP 500,000.00
B. PHP 231,596.74
C. PHP 335,504.07
D. PHP 724,328.12

84. Equipment costs PHP 1,200,000 with a salvage value of PHP 200,000 after 8 years. Using straight-line depreciation, what is the book value after 3 years?

A. PHP 750,000
B. PHP 900,000
C. PHP 625,000
D. PHP 825,000

85. An asset costing PHP 500,000 has a 5-year life. Using the double-declining-balance method, what is the first-year depreciation?

A. PHP 100,000
B. PHP 166,667
C. PHP 200,000
D. PHP 250,000

86. Equipment costing PHP 900,000 has a salvage value of PHP 100,000 after 4 years. Using sum-of-years'-digits, what is the first-year depreciation?

A. PHP 200,000
B. PHP 450,000
C. PHP 320,000
D. PHP 240,000

87. A product sells for PHP 150 per unit with a variable cost of PHP 90 per unit. Fixed costs are PHP 2.4 million per year. What is the break-even volume?

A. 16,000 units
B. 40,000 units
C. 26,667 units
D. 10,000 units

88. What is the maximum area of a rectangle that can be enclosed by 80 m of fencing?

A. 1600 m²
B. 800 m²
C. 400 m²
D. 300 m²

89. What is the area bounded by $y = x^2$, the x-axis and the lines $x = 0$ and $x = 3$?

A. 27
B. 18
C. 6
D. 9

90. A quantity obeys $dy/dt = -0.2y$ with $y(0) = 50$. What is y at t = 5?

A. 30.33
B. 135.91
C. 25.00
D. 18.39

91. Two fair dice are rolled. What is the probability that the sum is 7?

A. 1/6
B. 1/12
C. 7/36
D. 1/9

92. In how many ways can a committee of 3 be chosen from 8 people?

A. 56
B. 336
C. 24
D. 512

93. What is the determinant of the matrix with rows (1, 2, 3), (0, 4, 5) and (1, 0, 6)?

A. 22
B. 2
C. 46
D. −22

94. What is the product $(3 + 4i)(1 - 2i)$?

A. $11 - 2i$
B. $11 + 2i$
C. $-5 - 2i$
D. $3 - 8i$

95. What is the perpendicular distance from the point (3, 4) to the line $3x + 4y - 10 = 0$?

A. 5
B. 15
C. 3
D. 2

96. What is the sum of the first 50 positive odd integers?

A. 2550
B. 2500
C. 1275
D. 2450

97. What is the Laplace transform of e^(−3t)?

A. 1/(s − 3)
B. 3/(s + 3)
C. s/(s + 3)
D. 1/(s + 3)

98. A projectile is launched at 20 m/s at 45° above level ground. Neglecting air resistance, what is its horizontal range?

A. 20.4 m
B. 81.5 m
C. 35.3 m
D. 40.8 m

99. A 6 m simply supported beam carries a 12 kN point load 2 m from the left support. What is the left reaction?

A. 4 kN
B. 8 kN
C. 6 kN
D. 12 kN

100. A block slides down a 30° incline with a kinetic friction coefficient of 0.20. What is its acceleration?

A. 4.91 m/s²
B. 3.21 m/s²
C. 6.60 m/s²
D. 2.94 m/s²

101. A 1200 kg car moving at 20 m/s is stopped by a constant braking force of 6000 N. What is the stopping distance?

A. 80 m
B. 20 m
C. 40 m
D. 4 m

102. A 20 mm diameter rod carries an axial tensile load of 50 kN. What is the normal stress?

A. 159.2 MPa
B. 39.8 MPa
C. 125.0 MPa
D. 636.6 MPa

103. A 2.0 m steel rod (E = 200 GPa) with a 300 mm² cross section carries 60 kN in tension. What is its elongation?

A. 2.00 mm
B. 0.20 mm
C. 20.00 mm
D. 1.00 mm

104. A 10 m steel rail (α = 12 × 10■■ /°C) undergoes a temperature rise of 40 °C. How much does it lengthen if unrestrained?

A. 4.8 mm
B. 0.48 mm
C. 48 mm
D. 2.4 mm

105. How many atoms belong to one face-centered cubic (FCC) unit cell?

A. 2
B. 6
C. 4
D. 8

106. Galvanizing protects steel from corrosion mainly because zinc:

A. Is more noble than iron in seawater
B. Forms an inert ceramic layer on steel
C. Raises the hardness of the steel surface
D. Corrodes preferentially as a sacrificial anode

107. In the iron-carbon system, the hard and brittle intermetallic compound Fe■C is called:

A. Ferrite
B. Austenite
C. Cementite
D. Martensite

108. A 10 mL wastewater sample is diluted to 300 mL in a BOD bottle. Dissolved oxygen falls from 8.5 to 3.2 mg/L in 5 days. What is the BOD■?

A. 159 mg/L
B. 5.3 mg/L
C. 53 mg/L
D. 1590 mg/L

109. Convert 50 ppm (by volume) of SO■ to mg/m³ at 25 °C and 1 atm (molar volume 24.45 L/mol).

A. 19.1 mg/m³
B. 142.9 mg/m³
C. 131.0 mg/m³
D. 3203 mg/m³

110. The lower flammability limit of a fuel vapor in air is:

A. The lowest temperature at which the fuel self-ignites
B. The maximum fuel concentration that can still burn
C. The lowest pressure at which the fuel will boil
D. The minimum fuel concentration that can propagate a flame

111. Which hazard analysis technique systematically applies guide words such as 'no', 'more' and 'reverse' to process parameters?

A. Fault tree analysis (FTA)
B. Hazard and operability study (HAZOP)
C. Failure modes and effects analysis
D. Job safety analysis (JSA)

112. Applying one Newton-Raphson iteration to $f(x) = x^2 - 5$ starting from $x_■ = 2$ gives $x_■$ equal to:

A. 2.25
B. 2.50
C. 2.236
D. 1.75

113. Using the trapezoidal rule with two equal intervals, estimate $\int_{■}^{2} x^3\,dx$.

A. 5
B. 4
C. 6
D. 4.5

114. What is the limit of (sin 3x)/x as x approaches 0?

A. 0
B. 3
C. 1
D. 1/3

115. A facility costs PHP 1,000,000 initially and PHP 30,000 per year to maintain forever. At 6% interest, what is its capitalized cost?

A. PHP 1,500,000
B. PHP 1,030,000
C. PHP 500,000
D. PHP 1,300,000

116. A PHP 800,000 heat-recovery unit saves PHP 160,000 per year in fuel. Ignoring interest, what is the simple payback period?

A. 5.0 years
B. 0.2 years
C. 4.0 years
D. 6.0 years

117. A shaft transmits 15 kW at 1200 rpm. What torque does it carry?

A. 12.5 N·m
B. 750 N·m
C. 1194 N·m
D. 119.4 N·m

118. Solve for x: 2^x = 50.

A. 1.699
B. 25.000
C. 5.644
D. 3.912

119. If 2x + 3y = 12 and x – y = 1, what is the value of x?

A. 2
B. 4
C. 1.8
D. 3

120. What is the population standard deviation of the data 2, 4, 4, 4, 5, 5, 7, 9?

A. 2.14
B. 4.00
C. 2.00
D. 1.50

Answer key

Chemical Engineering

1. D. 4.00 g

mass = M × V × MW = 0.40 mol/L × 0.250 L × 40.00 g/mol = 4.00 g.

2. C. 1.483 mol

n = PV/RT = (2.50)(15.0)/(0.08206 × 308.15) = 1.483 mol; temperature must be in kelvin.

3. C. 1.70

HCl is a strong acid, so [H■] = 0.020 M and pH = –log(0.020) = 1.70.

4. B. 2.87

[H■] ≈ √(Ka·C) = √(1.8 × 10■■) = 1.342e-03 M, so pH = 2.87.

5. A. 9.43

pOH = pKb + log([NH■■]/[NH■]) = 4.74 + log(0.20/0.30) = 4.57; pH = 14 – pOH = 9.43.

6. D. 2.14 × 10■■ M

Ksp = s(2s)² = 4s³, so s = (3.9 × 10■¹¹/4)^(1/3) = 2.14 × 10■■ M.

7. B. 2.667 g

m = ItM/(nF) = (3.00)(2700 s)(63.546)/(2 × 96485) = 2.667 g.

8. B. 1.041 V

E = E° – (0.05916/n) log([Zn²■]/[Cu²■]) = 1.10 – (0.05916/2)(2) = 1.041 V.

9. B. 20 min

75% completion equals two half-lives for first-order kinetics (100 → 50 → 25%), so t½ = 40/2 = 20 min.

10. C. 53.6 kJ/mol

Ea = R ln(k■/k■)/(1/T■ – 1/T■) = 8.314 × ln2/(1/300 – 1/310) = 53.6 kJ/mol.

11. A. 21.97 mmHg

Raoult's law: P = x(water)·P° = (18/19.5)(23.8) = 21.97 mmHg.

12. C. –1.49 °C

m = (12.0/60.06)/0.250 = 0.799 mol/kg; ΔTf = 1.86 × 0.799 = 1.49 °C, so Tf = –1.49 °C.

13. B. 1.22 atm

π = MRT = (0.050)(0.08206)(298.15) = 1.22 atm; glucose does not dissociate (i = 1).

14. D. 3.98

Graham's law: rate(H■)/rate(O■) = √(M(O■)/M(H■)) = √(32.00/2.016) = 3.98.

15. C. –890.3 kJ

ΔH° = ΣΔHf(products) – ΣΔHf(reactants) = [–393.5 + 2(–285.8)] – (–74.8) = -890.3 kJ.

16. A. 5.96 kJ

q = mcΔT = 150 × 4.184 × 9.5 = 5962 J = 5.96 kJ.

17. B. Azimuthal quantum number, l

The azimuthal (angular momentum) quantum number l defines the subshell type (s, p, d, f) and hence orbital shape.

18. A. sp

Each carbon in ethyne forms a triple bond and one C-H bond, giving two electron domains and linear sp hybridization.

19. B. Equilibrium shifts toward NH■

Compression favors the side with fewer gas moles (2 versus 4), so more NH■ forms; K itself depends only on temperature.

20. A. 2-Propanol

By Markovnikov's rule the H adds to the CH■ carbon and OH to the more substituted carbon, giving 2-propanol.

21. D. An ester

Fischer esterification condenses RCOOH and R'OH into the ester RCOOR' with release of water.

22. C. 3

C■H■■ exists as n-pentane, 2-methylbutane and 2,2-dimethylpropane, so there are three structural isomers.

23. D. Rate depends on both substrate and nucleophile

SN2 is a single concerted step with backside attack, so rate = k[substrate][nucleophile] and configuration is inverted.

24. D. Electrophilic aromatic substitution

Substitution preserves the stable aromatic π system, so benzene favors electrophilic substitution over addition.

25. C. 0.0680 M

H■SO■ + 2NaOH: mol acid = (0.03240 × 0.1050)/2 = 0.001701 mol; M = that/0.02500 L = 0.0680 M.

26. D. 16.81%

%S = (0.6120 × 32.06/233.39)/0.5000 × 100 = 16.81%.

27. C. 3.62 × 10■■ M

Beer-Lambert law: c = A/(εb) = 0.452/(1.25 × 10■ × 1.00) = 3.62 × 10■■ M.

28. C. Potassium hydrogen phthalate

KHP is a stable, nonhygroscopic, high-purity monoprotic acid of high molar mass, ideal for standardizing bases.

29. B. 0.183 mg/L

Mean = 10.30; s = √[Σ(x – x■)²/(n – 1)] = √(0.10/3) = 0.183 mg/L.

30. D. 321 mmHg

Clausius-Clapeyron: ln(P■/P■) = (ΔHvap/R)(1/T■ – 1/T■) = 1.166, so P■ = 100e^1.166 = 321 mmHg.

31. A. –33.0 kJ

ΔG° = ΔH° – TΔS° = –92.2 – (298)(–0.1987) = -33.0 kJ.

32. A. 56.5

K = exp(–ΔG°/RT) = exp(10000/(8.314 × 298.15)) = 56.5.

33. B. Zero

The third law sets the entropy of a perfect crystal at absolute zero to zero, providing a reference for absolute entropies.

34. A. Density

Density does not depend on the amount of material, whereas mass, volume and total enthalpy scale with system size.

35. D. Attractive forces between molecules

The a/V² term accounts for intermolecular attraction lowering the pressure; b corrects for molecular volume.

36. A. 6.60 mg

m = m■(1/2)^(t/t½) = 80.0 × (0.5)^(3.6) = 6.60 mg.

37. B. C■H■O

Mole ratios C:H:O = 4.54:9.08:2.27; dividing by 2.27 gives 2:4:1, so C■H■O.

38. C. 72.1 g

O■ (2.00 mol) is limiting versus H■ (4.96 mol); 2H■ + O■ → 2H■O gives 4.00 mol H■O = 72.1 g.

39. B. Hydrogen bonding

O-H groups form strong hydrogen bonds between water molecules, raising its boiling point well above similar hydrides.

40. B. The number of solute particles

Vapor-pressure lowering, boiling-point elevation, freezing-point depression and osmotic pressure depend on particle concentration.

41. B. 600 kg/h

Salt balance: 0.10(1000) = 0.25P, so P = 400 kg/h; water evaporated = 1000 – 400 = 600 kg/h.

42. A. 42 wt%

x = (0.30 × 200 + 0.50 × 300)/500 = 210/500 = 42 wt%.

43. C. 28.57 kmol

C■H■ + 5O■ → 3CO■ + 4H■O; theoretical air = 5/0.21 = 23.81 kmol, × 1.20 = 28.57 kmol.

44. C. 8.71%

Per mol CH■: CO■ 1, H■O 2, O■ 0.2, N■ 8.276; total 11.476 mol, so CO■ = 8.71%.

45. A. 0.75

Yield based on consumption = mol B formed/mol A reacted = 60/80 = 0.75.

46. A. 0.0157 kg water/kg dry air

H = 0.622 p/(P – p) = 0.622 × 2.5/(101.325 – 2.5) = 0.0157 kg/kg dry air.

47. D. 8.07 kJ

W = nRT ln(V■/V■) = 2 × 8.314 × 350 × ln 4 = 8.07 kJ.

48. A. 543.4 K

T■ = T■(P■/P■)^((γ–1)/γ) = 300 × 8^0.2857 = 543.4 K.

49. C. 5.85

COP = T_L/(T_H – T_L) = 263.15/(308.15 – 263.15) = 5.85.

50. D. Isenthalpic

The steady-flow energy balance with Q = W = 0 and negligible ΔKE, ΔPE gives h■ = h■, the basis of Joule-Thomson expansion.

51. B. Its pressure

Fugacity is a corrected pressure; for an ideal gas the fugacity coefficient is 1, so f = P.

52. C. 7.48 × 10■

Re = ρvD/μ = 998 × 1.5 × 0.050/0.001 = 74,850, which is turbulent.

53. D. 4.08 m

hf = f(L/D)(v²/2g) = 0.020 × 1000 × 4/(2 × 9.81) = 4.08 m.

54. D. 0.040

For laminar flow f(Darcy) = 64/Re = 64/1600 = 0.040; the Fanning factor would be 16/Re = 0.010.

55. D. 9.90 m/s

Torricelli: v = √(2gh) = √(2 × 9.81 × 5.0) = 9.90 m/s.

56. C. 8.41 kW

P = ρgQH/η = 1000 × 9.81 × 0.020 × 30/0.70 = 8.41 kW.

57. D. 8 times the original

Q ∝ N, H ∝ N², and P ∝ N³, so doubling speed multiplies power by 2³ = 8.

58. C. 1200 W

Fourier's law: q = kAΔT/L = 0.80 × 10 × 30/0.20 = 1200 W.

59. D. 350 W/m²

Resistances in series: R = 0.20/0.70 + 0.05/0.05 = 1.2857 m²·K/W; q = 450/R = 350 W/m².

60. B. 69.5 °C

ΔT■ = 150 – 70 = 80, ΔT■ = 90 – 30 = 60; LMTD = (80 – 60)/ln(80/60) = 69.5 °C.

61. B. 45.4 kW/m²

E = εσT■ = 0.80 × 5.67 × 10■■ × (1000)■ = 45.4 kW/m².

62. A. 108.2 °C

Q = 2.0 × 4.18 × 40 = 334.4 kW; T_out = 150 – 334.4/(4.0 × 2.0) = 108.2 °C.

63. A. Momentum diffusivity to mass diffusivity

Sc = ν/D_AB = μ/(ρD_AB); the Lewis number is α/D and the Prandtl number is ν/α.

64. C. 6.43

Nmin = ln[(xD/(1–xD))((1–xB)/xB)]/ln α = ln(19 × 19)/ln 2.5 = 6.43.

65. C. Vertical

For saturated liquid q = 1, so the q-line slope q/(q – 1) is infinite and the line is vertical through x = zF.

66. B. 38.89 kmol/h

D = F(zF – xB)/(xD – xB) = 100(0.40 – 0.05)/(0.95 – 0.05) = 38.89 kmol/h.

67. B. 0.225

y = [R/(R + 1)]x + xD/(R + 1) = 0.75x + 0.90/4, so the intercept is 0.225.

68. B. 0.0100

Henry's law p = Hx gives x = 0.50/50 = 0.0100.

69. B. 160 L

τ = X/[k(1 – X)] = 0.80/(0.25 × 0.20) = 16 min; V = τv■ = 160 L.

70. B. 46.1 min

t = ln[1/(1 – X)]/k = ln 10/0.050 = 46.1 min.

71. B. First order

Only for first-order kinetics is t½ = ln 2/k, independent of initial concentration.

72. A. 0.632

P = 0.4(180) + 0.6(70) = 114 kPa; y = 72/114 = 0.632.

73. A. 63.2%

y(t)/y(∞) = 1 – e^(–t/τ); at t = τ this equals 1 – e■¹ = 0.632.

74. D. 10

By the final value theorem the steady-state change equals gain × step size = 5 × 2 = 10.

75. D. The new surface area created

Rittinger's law relates energy to new surface created (∝ 1/D■ – 1/D■); Kick's law uses the log of the size ratio.

76. B. 2.25 × 10■³ m/s

v = gD²(ρp – ρ)/(18μ) = 9.81 × (50 × 10■■)² × 1650/(18 × 0.001) = 2.25 × 10■³ m/s.

77. D. 33.3 kg

Dry solid = 60 kg; final mass = 60/0.90 = 66.7 kg; water removed = 100 – 66.7 = 33.3 kg.

78. C. Mass of water evaporated per mass of steam

Economy = kg vapor produced/kg live steam supplied; multiple-effect systems raise economy at the cost of capacity.

79. D. PHP 38.7 million

C■ = C■(Q■/Q■)^0.6 = 20 × 3^0.6 = PHP 38.7 million.

80. B. Saturated with water vapor

At 100% relative humidity no evaporation occurs from the wick, so there is no evaporative cooling and the readings coincide.

81. A. PHP 133,822.56

F = P(1 + i)■ = 100,000(1.06)■ = PHP 133,822.56.

82. D. 12.68%

i_eff = (1 + 0.12/12)¹² – 1 = 12.68%.

83. C. PHP 335,504.07

P = A[1 – (1 + i)■■]/i = 50,000[1 – 1.08■¹■]/0.08 = PHP 335,504.07.

84. D. PHP 825,000

Annual depreciation = (1,200,000 – 200,000)/8 = 125,000; BV■ = 1,200,000 – 3(125,000) = PHP 825,000.

85. C. PHP 200,000

DDB rate = 2/5 = 40%; first-year depreciation = 0.40 × 500,000 = PHP 200,000.

86. C. PHP 320,000

SYD = 1 + 2 + 3 + 4 = 10; D■ = (4/10)(900,000 – 100,000) = PHP 320,000.

87. B. 40,000 units

Break-even Q = fixed cost/(price – variable cost) = 2,400,000/60 = 40,000 units.

88. C. 400 m²

A = x(40 – x); dA/dx = 0 gives x = 20 m, a square, so A = 20 × 20 = 400 m².

89. D. 9

Area = ∫■³ x² dx = x³/3 from 0 to 3 = 27/3 = 9 square units.

90. D. 18.39

Solution y = 50e^(–0.2t); y(5) = 50e■¹ = 18.39.

91. A. 1/6

Six of the 36 equally likely outcomes give a sum of 7: 6/36 = 1/6.

92. A. 56

Order does not matter: C(8,3) = 8!/(3!5!) = 56; 336 is the permutation count.

93. A. 22

Expanding along row 1: 1(24 – 0) – 2(0 – 5) + 3(0 – 4) = 24 + 10 – 12 = 22.

94. A. 11 – 2i

(3 + 4i)(1 – 2i) = 3 – 6i + 4i – 8i² = 3 – 2i + 8 = 11 – 2i.

95. C. 3

d = |3(3) + 4(4) – 10|/√(3² + 4²) = 15/5 = 3.

96. B. 2500

The sum of the first n odd integers is n², so 50² = 2500.

97. D. 1/(s + 3)

L{e^(at)} = 1/(s – a); with a = –3 this gives 1/(s + 3).

98. D. 40.8 m

R = v² sin 2θ/g = 400 × 1/9.81 = 40.8 m.

99. B. 8 kN

Moments about the right support: R_L × 6 = 12 × 4, so R_L = 8 kN.

100. B. 3.21 m/s²

a = g(sin θ – μ cos θ) = 9.81(0.500 – 0.173) = 3.21 m/s².

101. C. 40 m

Work-energy: F·d = ½mv², so d = (0.5 × 1200 × 20²)/6000 = 40 m.

102. A. 159.2 MPa

σ = P/A = 50,000/(π × 0.010²) = 159.2 MPa.

103. A. 2.00 mm

δ = PL/(AE) = (60,000 × 2.0)/(300 × 10■■ × 200 × 10■) = 0.0020 m = 2.00 mm.

104. A. 4.8 mm

δ = αLΔT = 12 × 10■■ × 10 × 40 = 0.0048 m = 4.8 mm.

105. C. 4

FCC: 8 corners × 1/8 + 6 faces × 1/2 = 1 + 3 = 4 atoms per cell.

106. D. Corrodes preferentially as a sacrificial anode

Zinc is more active than iron, so it oxidizes first and cathodically protects exposed steel.

107. C. Cementite

Cementite is iron carbide (6.67 wt% C); ferrite and austenite are solid solutions and martensite is a metastable phase.

108. A. 159 mg/L

BOD■ = (D■ – D■)/P = (8.5 – 3.2)/(10/300) = 159 mg/L.

109. C. 131.0 mg/m³

mg/m³ = ppm × MW/24.45 = 50 × 64.06/24.45 = 131.0 mg/m³.

110. D. The minimum fuel concentration that can propagate a flame

Below the LFL the mixture is too lean to sustain flame propagation; auto-ignition temperature is a different property.

111. B. Hazard and operability study (HAZOP)

HAZOP studies each process node by combining guide words with parameters to find deviations, causes and consequences.

112. A. 2.25

$x_{■} = x_{■} – f(x_{■})/f'(x_{■}) = 2 – (4 – 5)/4 = 2.25$.

113. A. 5

h = 1: $T = (h/2)[f(0) + 2f(1) + f(2)] = 0.5(0 + 2 + 8) = 5$; the exact value is 4.

114. B. 3

$(\sin 3x)/x = 3 \times (\sin 3x)/(3x) \rightarrow 3 \times 1 = 3$.

115. A. PHP 1,500,000

Capitalized cost = first cost + A/i = 1,000,000 + 30,000/0.06 = PHP 1,500,000.

116. A. 5.0 years

Payback = investment/annual savings = 800,000/160,000 = 5.0 years.

117. D. 119.4 N·m

$T = P/\omega = 15{,}000/(2\pi \times 1200/60) = 119.4$ N·m.

118. C. 5.644

$x = \ln 50/\ln 2 = 3.912/0.693 = 5.644$.

119. D. 3

From $x = y + 1$: $2(y + 1) + 3y = 12$, so $y = 2$ and $x = 3$.

120. C. 2.00

Mean = 5; $\Sigma(x – 5)^2 = 32$; $\sigma = \sqrt{(32/8)} = 2.00$.

Topics to review

- Material and energy balances
- Thermodynamics and phase equilibria
- Transport, separations and reaction engineering
- Process design, safety and economics

Online question banks and study resources

Chemical Engineering - Pass Harbor (Question bank)

Official PRC board information

Current PRC exam programs

Independent study material prepared by Board Exam Desk.