
Unless stated otherwise: (1) electromagnetic radiation is traveling in a vacuum, (2) solutions are aqueous, (3) temperature is 25 °C, (4) pressure is 1 atm, and (5) substances are in their standard state.

Questions 1–10 and 13 on the standardized exam and questions 41–44 below cover Exam 1 material.

41. The normal boiling point of methanol is 64.7 °C. What is the boiling point at 1.35 atm?
 $\Delta H_{\text{vap}} = 35.278 \text{ kJ/mol}$.

A. 51.0 °C

C. 73.0 °C

B. 60.3 °C

D. 84.2 °C

42. How much energy is required to heat a 75.0 g sample of ethanol at 35 °C to 110 °C?

Melting point = -114 °C

Boiling point = 78 °C

$\Delta H_{\text{fusion}} = 5.02 \text{ kJ/mol}$

$\Delta H_{\text{vaporization}} = 38.56 \text{ kJ/mol}$

$C_{s, \text{solid}} = 0.97 \text{ J/g}\cdot\text{K}$

$C_{s, \text{liquid}} = 2.3 \text{ J/g}\cdot\text{K}$

$C_{s, \text{gas}} = 1.88 \text{ J/g}\cdot\text{K}$

Molar mass of ethanol = 46.07 g/mol

A. 75.4 kJ

C. 74.7 kJ

B. 120 kJ

D. 82.9 kJ

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43. Palladium (Pd) has a face-centered cubic unit cell with density of 12.0 g/cm^3 . What is the **edge length** of a single unit cell?
- A. $1.73 \times 10^{-8} \text{ cm}$ C. $9.33 \times 10^{-9} \text{ cm}$
B. $3.89 \times 10^{-8} \text{ cm}$ D. $4.51 \times 10^{-7} \text{ cm}$

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44. What is the concentration, in molality, of a 12.3 M HCl solution? solution density = 1.19 g/mL , molar mass of HCl = 36.46 g/mol
- A. 16.6 m C. 8.35 m
B. 14.2 m D. 10.1 m

Questions 11, 12, 14–23 and 30 on the standardized exam and questions 45–46 below cover Exam 2 material.

45. What is the molar mass of an unknown non-electrolyte if a solution prepared from 5.0 g of the unknown in 75.0 g of benzene freezes at $4.1 \text{ }^\circ\text{C}$? The freezing point of pure benzene is $5.5 \text{ }^\circ\text{C}$ and K_f (benzene) = $5.12 \text{ }^\circ\text{C/m}$.
- A. $2.4 \times 10^2 \text{ g/mol}$ C. 83 g/mol
B. 78 g/mol D. $1.0 \times 10^2 \text{ g/mol}$
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49. The K_a values of four monoprotic acids are listed in the table below. Which solution will have the **lowest** pH?

Acid	K_a
HF	3.5×10^{-4}
$\text{HC}_7\text{H}_5\text{O}_2$	6.5×10^{-5}
HCN	4.9×10^{-10}

- A. 0.10 M $\text{HC}_7\text{H}_5\text{O}_2$ C. A mixture of 0.05 M HF and 0.05 M $\text{HC}_7\text{H}_5\text{O}_2$
B. 0.10 M HF D. A mixture of 0.10 M $\text{HC}_7\text{H}_5\text{O}_2$ and 0.10 M HCN
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50. What is the **percent ionization** of a 0.15 M $\text{HC}_3\text{H}_5\text{O}_3$ solution? $K_a(\text{HC}_3\text{H}_5\text{O}_3) = 1.4 \times 10^{-4}$
- A. 5.3% C. 2.0%
B. 0.94% D. 3.1%
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51. A solution is prepared by combining 100.0 mL of 0.500 M HI and 100.0 mL of 0.100 M CH_3COOH ($K_a = 1.8 \times 10^{-5}$). What is the pH of the resulting solution?
- A. 0.25 C. 0.22
B. 0.60 D. 0.52
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52. For aniline ($\text{C}_6\text{H}_5\text{NH}_2$), K_b is 3.9×10^{-10} . Select the correct values.

- A. $\text{p}K_b(\text{C}_6\text{H}_5\text{NH}_2) = 9.41$, $\text{p}K_a(\text{C}_6\text{H}_5\text{NH}_3^+) = 4.59$
- B. $\text{p}K_b(\text{C}_6\text{H}_5\text{NH}_2) = 1.79$, $\text{p}K_a(\text{C}_6\text{H}_5\text{NH}_3^+) = 12.21$
- C. $\text{p}K_b(\text{C}_6\text{H}_5\text{NH}_2) = 9.41$, $\text{p}K_a(\text{C}_6\text{H}_5\text{NH}_3^+) = 0.11$
- D. $\text{p}K_b(\text{C}_6\text{H}_5\text{NH}_2) = 12.21$, $\text{p}K_a(\text{C}_6\text{H}_5\text{NH}_3^+) = 1.79$

53. The pH of a 0.10 M solution is given for each of the following bases. Select the base with the **smallest** K_b value.

- A. pyridine, pH = 9.11
- B. hydroxylamine, pH = 9.52
- C. codeine, pH = 10.50
- D. The formula of the base must be known to determine the answer.

54. What is the pH of a 0.250 M NH_4Cl solution? $K_b(\text{NH}_3) = 1.76 \times 10^{-5}$.

- A. 11.34
 - B. 4.75
 - C. 4.92
 - D. 2.68
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55. Which substance can act as a Lewis base?



56. Calculate the pH of a buffer containing 0.250 M HClO_2 and 0.200 M KClO_2 .

$$K_a(\text{HClO}_2) = 1.1 \times 10^{-2}$$

A. 3.94

C. 1.86

B. 2.87

D. 0.65

57. Calculate the pH of a solution formed when 0.0025 moles of NaOH are added to 250.0 mL of a 0.20 M KClO /0.15M HClO buffer. $K_a(\text{HClO}) = 2.9 \times 10^{-8}$

A. 7.54

C. 7.68

B. 7.61

D. 7.71

Answer Key:

- 41. C
- 42. C
- 43. B
- 44. A
- 45. A
- 46. D
- 47. B
- 48. D
- 49. B
- 50. D
- 51. B
- 52. A
- 53. A
- 54. C
- 55. D
- 56. C
- 57. D
- 58. C
- 59. B
- 60. A