

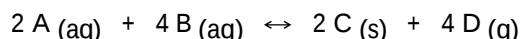
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) Zn(OH)_2 is amphoteric. In which of the following solutions would the solubility of Zn(OH)_2 be lowest?

A) pure water B) 1 M NH_3 C) 1 M NaOH D) 1 M ZnCl_2 E) 1 M HCl

Answer: D

- 2) For the following reaction, what is the value of K_{eq} ?



$[\text{A}] = 1.19$

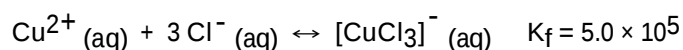
$[\text{B}] = 0.720$

$[\text{D}] = 0.880$

A) 1.58 B) 6.00×10^{-1} C) 3.56×10^{-1} D) 1.03 E) 6.35×10^{-1}

Answer: A

- 3) Which of the following statements is true concerning the following equilibrium?



A) Addition of AgNO_3 would increase the amount of free copper ions in solution.

B) Addition of KNO_3 would decrease the amount of complex ions in solution.

C) Addition of KCl would increase the amount of Cu^{2+} in solution.

D) Addition of KCl to the system would precipitate more $[\text{CuCl}_3]^{2-}$.

E) Addition of CuSO_4 to the system would precipitate more $[\text{CuCl}_3]^{2-}$.

Answer: A

- 4) To a solution with $[\text{Pb}^{2+}] = 0.0010 \text{ M}$ is added sufficient potassium sulfate to make the $[\text{SO}_4^{2-}] = 0.0011 \text{ M}$.

What percentage of the Pb^{2+} remains in solution? ($K_{\text{sp}} \text{ PbSO}_4 = 7.1 \times 10^{-8}$)

A) 6.5 B) 22 C) 6.5×10^{-2} D) 6.5×10^{-5} E) 93.5

Answer: A

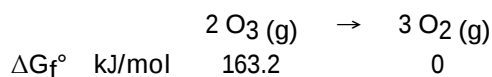
- 5) The Arrhenius equation is $k = A e^{-(E_a / RT)}$

The slope of a plot of $\ln k$ vs. $1/T$ is equal to:

A) A B) E_a C) $-k$ D) k E) $-E_a/R$

Answer: E

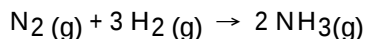
- 6) Consider the following data and calculate ΔG° , in kJ, for the following reaction at 25°C .



A) -163.2 B) 489.6 C) 163.2 D) -326.4 E) 326.4

Answer: D

7) For the reaction:



$\Delta H^\circ = -92.2 \text{ kJ}$ and $K_p = 6.8 \times 10^5$ at 25°C . Determine the temperature ($^\circ\text{C}$) at which $K_p = 2.5 \times 10^3$.

- A) 18 B) 46 C) 351 D) -14 E) 78

Answer: E

8) What is the $[\text{CH}_3\text{COOH}]$ (aq) in a solution made by dissolving 0.500 mol acetic acid in 1.00 L water? $K_a = 1.8 \times 10^{-5}$

- A) 0.500 M B) 0.003 M C) 0.503 M D) 0.0009 M E) 0.497 M

Answer: E

9) What is the pH of a solution containing 0.00044 moles H^+ per liter?

- A) 1.0 B) 3.4 C) 0.00044 D) 3.7 E) -3.4

Answer: B

10) A certain first-order reaction $\text{A} \rightarrow \text{B}$ is 25% complete in 42 min at 25°C . What is the half-life of the reaction?

- A) 101 min B) 42 min C) 21 min D) 120 min E) 84 min

Answer: A

11) Would a precipitate be observed if equal volumes of a 0.040 M AgNO_3 solution and a 0.030 M NaNO_2 solution are mixed? ($K_{sp} \text{ AgNO}_2 = 6.0 \times 10^{-4}$)

- A) Yes, because $Q_{ip} > K_{sp}$.
B) No, because $Q_{ip} < K_{sp}$.
C) No, because $Q_{ip} = K_{sp}$.
D) Yes, because $Q_{ip} < K_{sp}$.
E) No, because $Q_{ip} > K_{sp}$.

Answer: B

12) For which of the following processes would the entropy change be positive?

- A) $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{aq})$
B) $\text{Hg}(\text{l}) (45^\circ\text{C}) \rightarrow \text{Hg}(\text{l}) (25^\circ\text{C})$
C) $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$
D) $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$
E) $\text{He}(\text{g}) (1 \text{ atm}) \rightarrow \text{He}(\text{g}) (10 \text{ atm})$

Answer: A

13) Determine the pH of a 0.15 M H_2NNH_2 solution. K_b for H_2NNH_2 is 8.5×10^{-7} .

- A) 13.00 B) 9.52 C) 10.55 D) 10.97 E) 3.45

Answer: C

14) Which of the following equilibrium constants indicates a reaction that is spontaneous at room temperature?

- A) $K_{eq} = 6.4 \times 10^{-9}$
- B) $K_{eq} = 5.9 \times 10^{-8}$
- C) $K_{eq} = 2.3 \times 10^{-1}$
- D) $K_{eq} = 1.1 \times 10^2$
- E) $K_{eq} = 8.1 \times 10^{-9}$

Answer: D

15) What is the pH of a solution prepared by dissolving 0.025 mol $Ba(OH)_2$ in water to give 455 mL of solution?

- A) 1.26
- B) 12.74
- C) 12.40
- D) 13.04
- E) 1.60

Answer: D

16) What is the correct K_{sp} expression for Ag_2CrO_4 ?

- A) $[Ag^+]^2 [CrO_4^{2-}]$
- B) $2[Ag^+]^2 [CrO_4^{2-}]$
- C) $[Ag^+] [CrO_4^{2-}]^2$
- D) $[2 Ag^+] [CrO_4^{2-}]$
- E) $[Ag^+]^2 [Cr^{3+}] [O^{2-}]^4$

Answer: A

17) Calculate ΔG° , in kJ, at 350.°C for the reaction:

		2 NO ₂ (g)	→	N ₂ O ₄ (g)
ΔH_f°	kJ/mol	33.18		9.16
ΔS	J/mol·K	240.1		304.3

- A) -4.01×10^4
- B) 1.10×10^5
- C) 52.4
- D) -97.2
- E) 4.37

Answer: C

18) Which of the following variables are NOT needed to solve the van't Hoff equation?

- A) universal gas constant
- B) temperature
- C) equilibrium constant
- D) enthalpy
- E) entropy

Answer: E

19) A 4.08 g sample of phenol, C_6H_5OH , is dissolved in 0.250 L of water at 25°C, and its pH is found to be 5.38. What is the K_a of phenol?

- A) 2.5×10^{-9}
- B) 1.0×10^{-10}
- C) 5.8×10^{-5}
- D) 2.5×10^{-10}
- E) 1.8×10^{-5}

Answer: B

20) What is the value of K_a for an acid if $[H_3O^+] = 0.13\text{ M}$, $[A^-] = 0.820\text{ M}$, and $[HA] = 2.00\text{ M}$ at equilibrium?

- A) 0.54 B) 0.48 C) 19 D) 0.053 E) 0.21

Answer: D

21) What is K_b for an acid whose $K_a = 0.000051$?

- A) -5.1×10^{-5} B) 2.0×10^{-3} C) 3.9×10^4 D) 2.0×10^4 E) 2.0×10^{-10}

Answer: E

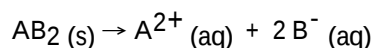
22) Calculate the $[CH_3COO^-]$ in a solution that is $0.50\text{ M } CH_3COOH$ and $0.25\text{ M } HCl$.

($K_a\text{ } CH_3COOH = 1.8 \times 10^{-5}$)

- A) 0.50 B) 3.0×10^{-3} C) 3.7×10^{-3} D) 3.6×10^{-5} E) 0.25

Answer: D

23) What is the molar solubility of a salt with $K_{sp} = 1.63 \times 10^{-17}$?



- A) 2.54×10^{-6} B) 1.60×10^{-6} C) 6.35×10^{-7} D) 4.04×10^{-9} E) 2.01×10^{-6}

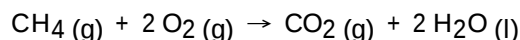
Answer: B

24) For a certain reaction, the enthalpy change is 600 kJ and the entropy change is 250 J/K . What is the free energy change, in kJ , at 400 K ?

- A) 1.00×10^5 B) 850 C) 568 D) 500 E) 200

Answer: D

25) The following reaction is spontaneous at room temperature.



The reverse reaction

- A) is faster than the forward reaction.
B) is spontaneous.
C) is not spontaneous.
D) is exothermic.
E) has a larger equilibrium constant, K_p .

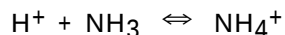
Answer: C

26) "Milk of magnesia" antacid has a pH of 10.25. What is the $[OH^-]$ in this solution?

- A) 1.8×10^{-4} B) 5.6×10^{-11} C) 1.8×10^{10} D) 1.8 E) 3.75

Answer: A

27) Identify the Lewis Base in the following equation.



- A) H^+
- B) NH_3
- C) H_2O
- D) NH_4^+
- E) not an acid-base reaction

Answer: A

28) Which of the following compounds would be predicted to most closely follow Trouton's Rule?

- A) $\text{HOCH}_2(\text{CH}_2)_6\text{CH}_2\text{OH}$
- B) $\text{CH}_3(\text{CH}_2)_8\text{CH}_3$
- C) $\text{CH}_3(\text{CH}_2)_8\text{CH}_2\text{OCH}_3$
- D) $\text{CH}_3(\text{CH}_2)_6\text{CH}_2\text{OH}$
- E) $\text{CH}_3\text{O}(\text{CH}_2)_6\text{CH}_2\text{OH}$

Answer: B

29) How many grams of NH_4Cl must be added to 0.250 L of 0.375 M NH_3 to produce a buffer solution with pH = 9.45? ($K_b(\text{NH}_3) = 1.8 \times 10^{-5}$)

- A) 13
- B) 3.2
- C) 1.0
- D) 0.80
- E) 170

Answer: B

30) What is the molar solubility of PbI_2 in a solution that contains 0.30 M KI ? ($K_{sp} = 7.9 \times 10^{-9}$)

- A) 7.9×10^{-7}
- B) 1.3×10^{-8}
- C) 2.6×10^{-8}
- D) 2.4×10^{-9}
- E) 8.8×10^{-8}

Answer: E

31) At 50°C, the solubility of silver chloride, AgCl , is 5.2×10^{-4} g/100 mL. Calculate the K_{sp} at this temperature.

- A) 1.8×10^{-10}
- B) 1.3×10^{-9}
- C) 1.0×10^{-8}
- D) 7.6×10^8
- E) 4.0×10^{-5}

Answer: B

32) What is the $[\text{H}_3\text{O}^+]$ in a 0.020 M $\text{Ca}(\text{OH})_2$?

- A) 2.5×10^{-13}
- B) 0
- C) 12.60
- D) 5×10^{-13}
- E) 1.0×10^{-7}

Answer: A

33) What is the K_{sp} expression for magnesium phosphate, $\text{Mg}_3(\text{PO}_4)_2$?

- A) $K_{sp} = [\text{Mg}_2^+]^3 [\text{PO}_4^{3-}]$
- B) $K_{sp} = [\text{Mg}_2^+]^3 [\text{PO}_4^{3-}]^2 / [\text{Mg}_3(\text{PO}_4)_2]$
- C) $K_{sp} = [\text{Mg}^{2+}] [\text{PO}_4^{3-}]$
- D) $K_{sp} = [\text{Mg}^{2+}]^3 [\text{PO}_4^{3-}]^2$
- E) $K_{sp} = [\text{Mg}_2^+]^2 [\text{PO}_4^{3-}]^3$

Answer: D

34) A pH meter reads 4.48. What is the $[H_3O^+]$ in the solution?

- A) 7.00 B) 9.52 C) 3.0×10^{-10} D) 3.3×10^{-5} E) 3.0×10^4

Answer: D

35) What is the maximum molar concentration of magnesium ion in a solution of pH = 11.00?

($K_{sp} Mg(OH)_2 = 1.8 \times 10^{-11}$)

- A) 1.8×10^{-11} B) 1.8×10^{-8} C) 1.7×10^{-4} D) 2.6×10^{-4} E) 1.8×10^{-5}

Answer: E

36) Calculate the concentration of free Ag^+ in a solution containing 0.10 M Ag^+ and 0.30 M $S_2O_3^{2-}$.

($K_f (Ag(S_2O_3)_2^-) = 1.7 \times 10^{13}$)

- A) 1.7×10^{-14} M
B) 1.2×10^{14} M
C) 0.2 M
D) 2.9×10^{-14} M
E) 8.5×10^{13} M

Answer: D

37) What molarity of pyridine, C_5H_5N , is required to produce an aqueous solution with pH = 9.35?

($K_b = 1.7 \times 10^{-9}$)

- A) 2.2×10^{-5} B) 2.97 C) 0.29 D) 3.6×10^{-5} E) 1.3×10^4

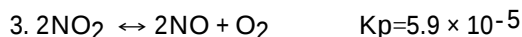
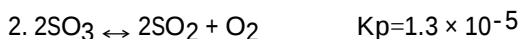
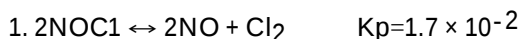
Answer: C

38) Calculate the pH after 10.0 mL of 0.40 M HCl is added to 20.0 mL of 0.50 M NaOH.

- A) 7.00 B) 0.40 C) 13.70 D) 13.30 E) 0.30

Answer: D

39) The following reactions occur at 500°K. Arrange them in order of increasing tendency to proceed to completion (least → greatest tendency).



- A) $1 < 2 < 3$ B) $2 < 1 < 3$ C) $2 < 3 < 1$ D) $3 < 1 < 2$ E) $3 < 2 < 1$

Answer: C

40) Which process is accompanied by a decrease in entropy for the system?

- A) sodium chloride dissolves
B) dry ice sublimates
C) ethanol condenses
D) wax melts
E) water evaporates

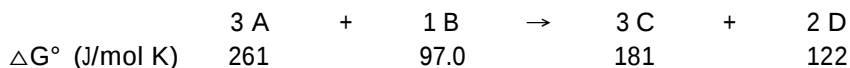
Answer: C

41) The metal center in a complex ion is

- A) a Lewis base.
- B) a Bronsted- Lowry base.
- C) a ligand.
- D) a Lewis acid.
- E) insoluble in the solvent.

Answer: D

42) Given the values of ΔG° shown below, determine the value of ΔG° for the reaction.



- A) 93.0
- B) 1670
- C) -55.0
- D) 101
- E) -93.0

Answer: E

43) What is the ionization constant of a weak acid with $pK_a = 8.00$?

- A) 1.0×10^{-8}
- B) 1.0×10^8
- C) -9.0×10^{-1}
- D) 1.0×10^{-6}
- E) -2.1

Answer: A

44) Calculate the molar solubility of PbI_2 . ($K_{sp} = 7.1 \times 10^{-9}$)

- A) 8.4×10^{-5}
- B) 1.2×10^{-3}
- C) 1.5×10^{-3}
- D) 1.9×10^{-3}
- E) 4.8×10^{-3}

Answer: B

45) What is the pH of a 0.700 M solution of CH_3COONa ? $K_b = 5.6 \times 10^{-10}$

- A) 4.70
- B) 10.80
- C) 9.30
- D) 11.55
- E) 18.70

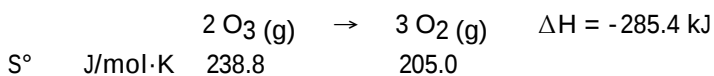
Answer: C

46) Calculate the pH after 10.0 mL of 0.40 M $NaOH$ is added to 20.0 mL of 0.50 M HCl .

- A) 0.70
- B) 13.30
- C) 13.70
- D) 7.00
- E) 0.30

Answer: A

47) Consider the following data and calculate ΔG° , in kJ, at $110^\circ C$ for the following reaction.



- A) -232.8
- B) -5.29×10^4
- C) -300.5
- D) -1.54×10^4
- E) -338.0

Answer: E

48) If 125 mL of 0.015 M $BaCl_2$ is mixed with 75 mL of 0.0010 M Na_2SO_4 , will a precipitate form?

($K_{sp} BaSO_4 = 1.1 \times 10^{-10}$)

- A) No, because $Q_{ip} < K_{sp}$.
- B) No, because $Q_{ip} = K_{sp}$.
- C) Yes, because $Q_{ip} > K_{sp}$.
- D) No, because $Q_{ip} > K_{sp}$.
- E) Yes, because $Q_{ip} < K_{sp}$.

Answer: C

49) Use Trouton's rule to estimate the normal boiling point of hexane, in °C, given that at this temperature $\Delta H_{\text{vap}} = 29.8 \text{ kJ/mol}$.

A) 45

B) 70

C) 343

D) 2.9

E) 34

Answer: B

50) The conjugate acid of HPO_4^{2-} is

A) H_2PO_4^-

B) H_3PO_4

C) PO_4^{3-}

D) $\text{H}_2\text{PO}_4^{2-}$

E) none of these

Answer: A