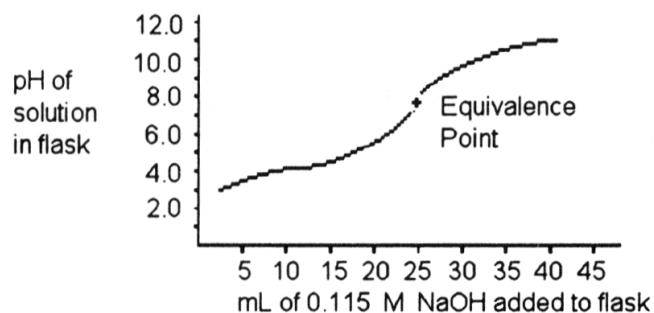


# 1052-2nd Chem Exam-1060517(A)

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

Please use this titration curve to answer the following two questions.



Indicator	pK <sub>a</sub>
methyl orange	3.46
methyl red	5.00
bromocresol purple	6.12
bromthymol blue	7.10
thymol blue	8.90
phenolphthalein	9.10

- 1) A 25.0 mL sample of a solution of a monoprotic acid is titrated with a 0.115 M NaOH solution. The titration curve above was obtained. Which of the following indicators would be best for this titration?
- bromocresol purple
  - bromthymol blue
  - phenolphthalein
  - methyl red
  - thymol blue

Answer: B

- 2) A 25.0 mL sample of a solution of a monoprotic acid is titrated with a 0.115 M NaOH solution. The titration curve above was obtained. The concentration of the monoprotic acid is about \_\_\_\_\_ mol/L.
- 0.115
  - 25.0
  - 0.100
  - 0.0600
  - 0.240

Answer: A

- 3) Which one of the following pairs cannot be mixed together to form a buffer solution?
- $C_5H_5N$ ,  $C_5H_5NHCl$
  - $NaClO$ ,  $HNO_3$
  - $NH_2CH_3$ ,  $HCl$
  - $HC_2H_3O_2$ ,  $NaOH$  ( $C_2H_3O_2^-$  = acetate)
  - $KOH$ ,  $HI$

Answer: E

- 4) What change will be caused by addition of a small amount of HCl to a solution containing fluoride ions and hydrogen fluoride?
- The concentration of hydronium ions will increase significantly.
  - The concentration of fluoride ions will increase as will the concentration of hydronium ions.
  - The concentration of fluoride ion will decrease and the concentration of hydrogen fluoride will increase.
  - The fluoride ions will precipitate out of solution as its acid salt.
  - The concentration of hydrogen fluoride will decrease and the concentration of fluoride ions will increase.

Answer: C

- 5) Of the following solutions, which has the greatest buffering capacity?
- A) 0.087 M  $\text{NH}_3$  and 0.088 M  $\text{NH}_4\text{Cl}$
  - B) 0.234 M  $\text{NH}_3$  and 0.100 M  $\text{NH}_4\text{Cl}$
  - C) 0.100 M  $\text{NH}_3$  and 0.455 M  $\text{NH}_4\text{Cl}$
  - D) 0.543 M  $\text{NH}_3$  and 0.555 M  $\text{NH}_4\text{Cl}$
  - E) They are all buffer solutions and would all have the same capacity.

Answer: D

- 6) Which below best describe(s) the behavior of an amphoteric hydroxide in water?
- A) With conc. aq.  $\text{NaOH}$ , its clear solution forms a precipitate.
  - B) With conc. aq.  $\text{NaOH}$ , its suspension dissolves.
  - C) With both conc. aq.  $\text{NaOH}$  and conc. aq.  $\text{HCl}$ , its suspension dissolves.
  - D) With conc. aq.  $\text{HCl}$ , its suspension dissolves.
  - E) With conc. aq.  $\text{HCl}$ , its clear solution forms a precipitate.

Answer: C

- 7) A 25.0 mL sample of 0.723 M  $\text{HClO}_4$  is titrated with a 0.273 M  $\text{KOH}$  solution. The  $\text{H}_3\text{O}^+$  concentration after the addition of 0.00 mL of  $\text{KOH}$  is \_\_\_\_\_ M.
- A) 0.0181
  - B) 0.430
  - C) 0.273
  - D) 0.723
  - E) none of the above

Answer: D

Please use this table to answer the following four questions.

Name	Formula	$K_{\text{sp}}$
Cadmium carbonate	$\text{CdCO}_3$	$5.2 \times 10^{-12}$
Cadmium hydroxide	$\text{Cd}(\text{OH})_2$	$2.5 \times 10^{-14}$
Calcium fluoride	$\text{CaF}_2$	$3.9 \times 10^{-11}$
Silver iodide	$\text{AgI}$	$8.3 \times 10^{-17}$
Zinc carbonate	$\text{ZnCO}_3$	$1.4 \times 10^{-11}$

- 8) Which compound listed below has the greatest molar solubility in water?
- A)  $\text{CaF}_2$       B)  $\text{CdCO}_3$       C)  $\text{ZnCO}_3$       D)  $\text{Cd}(\text{OH})_2$       E)  $\text{AgI}$

Answer: A

- 9) Which compound listed below has the smallest molar solubility in water?
- A)  $\text{AgI}$       B)  $\text{Cd}(\text{OH})_2$       C)  $\text{CaF}_2$       D)  $\text{ZnCO}_3$       E)  $\text{CdCO}_3$

Answer: A

- 10) What is the concentration of iodide ions in a saturated solution of silver iodide?  
A)  $9.1 \times 10^{-9}$       B)  $1.4 \times 10^{-8}$       C)  $3.0 \times 10^{-10}$       D)  $3.8 \times 10^{-11}$       E)  $3.5 \times 10^{-9}$

Answer: A

- 11) In which of the following aqueous solutions would you expect AgI to have the highest solubility?  
A) 0.050 M BaI<sub>2</sub>  
B) 0.050 M KI  
C) 0.010 M AgNO<sub>3</sub>  
D) pure water  
E) 0.050 M NaI

Answer: D

- 12) The pH of a solution that contains 0.800 M acetic acid ( $K_a = 1.76 \times 10^{-5}$ ) and 0.172 M sodium acetate is \_\_\_\_\_.  
A) 8.578      B) 9.913      C) 5.422      D) 8.370      E) 4.087

Answer: E

- 13) A solution of NaF is added dropwise to a solution that is 0.0122 M in Ba<sup>2+</sup>. When the concentration of F<sup>-</sup> exceeds \_\_\_\_\_ M, BaF<sub>2</sub> will precipitate. Neglect volume changes. For BaF<sub>2</sub>,  $K_{sp} = 1.7 \times 10^{-6}$ .  
A)  $1.2 \times 10^{-2}$       B)  $7.0 \times 10^{-5}$       C)  $2.1 \times 10^{-8}$       D)  $3.0 \times 10^{-3}$       E)  $1.4 \times 10^{-4}$

Answer: A

- 14) The  $K_b$  of ammonia is  $1.76 \times 10^{-5}$ . The pH of a buffer prepared by combining 50.0 mL of 1.00 M ammonia and 45.0 mL of 1.00 M ammonium nitrate is \_\_\_\_\_.  
A) 9.291  
B) 4.632  
C) 9.372  
D) 4.742  
E) none of the above

Answer: A

- 15) According to the Arrhenius concept, an acid is a substance that \_\_\_\_\_.  
A) tastes bitter  
B) is capable of accepting one or more H<sup>+</sup>  
C) causes an increase in the concentration of H<sup>+</sup> in aqueous solutions  
D) reacts with the solvent to form the cation formed by autoionization of that solvent  
E) can accept a pair of electrons to form a coordinate covalent bond

Answer: C

- 16) A Brønsted-Lowry acid is defined as a substance that \_\_\_\_\_.
- A) acts as a proton acceptor
  - B) acts as a proton donor
  - C) decreases  $[H^+]$  when placed in  $H_2O$
  - D) increases  $K_a$  when placed in  $H_2O$
  - E) increases  $[OH^-]$  when placed in  $H_2O$

Answer: B

- 17) Using the data in the table, which of the conjugate bases below is the strongest base?

Acid	$K_a$
HOAc	$1.8 \times 10^{-5}$
$HC_7H_5O_2$	$6.3 \times 10^{-5}$
$HNO_2$	$4.5 \times 10^{-4}$
HF	$6.8 \times 10^{-4}$

- A)  $OAc^-$
- B)  $F^-$
- C)  $C_7H_5O_2^-$
- D)  $NO_2^-$
- E)  $OAc^-$  and  $C_7H_5O_2^-$

Answer: A

- 18) Which solution will be the most basic?
- A) 0.10 M  $H_2O$
  - B) 0.10 M  $CH_3OH$
  - C) 0.10 M KOH
  - D) 0.10 M  $Ba(OH)_2$
  - E) All solutions have equal basicity.

Answer: D

- 19) Which of the following ions will act as a weak base in water?
- A)  $Cl^-$
  - B)  $ClO^-$
  - C)  $NO_3^-$
  - D)  $OH^-$
  - E) None of the above will act as a weak base in water.

Answer: B

20) Of the compounds below, a 0.1 M aqueous solution of \_\_\_\_\_ will have the highest pH.

- A) NaClO,  $K_a$  of HClO =  $3.2 \times 10^{-8}$
- B) KCN,  $K_a$  of HCN =  $4.0 \times 10^{-10}$
- C) NaHS,  $K_b$  of  $\text{HS}^-$  =  $1.8 \times 10^{-7}$
- D)  $\text{NH}_4\text{NO}_3$ ,  $K_b$  of  $\text{NH}_3$  =  $1.8 \times 10^{-5}$
- E) NaOAc,  $K_a$  of HOAc =  $1.8 \times 10^{-5}$

Answer: B

21) Calculate the concentration (in M) of hydronium ions in a solution at 25.0 °C with a pOH of 4.223.

- A)  $5.98 \times 10^{-5}$
- B)  $1.00 \times 10^{-7}$
- C)  $1.67 \times 10^4$
- D)  $5.99 \times 10^{-19}$
- E)  $1.67 \times 10^{-10}$

Answer: E

22) The conjugate base of  $\text{H}_2\text{PO}_4^-$  is \_\_\_\_\_.

- A)  $\text{H}_2\text{PO}_4$
- B)  $\text{HPO}_4^{2-}$
- C)  $\text{PO}_4^{3-}$
- D)  $\text{H}_3\text{PO}_4$
- E) none of the above

Answer: B

23)  $K_a$  for HCN is  $4.9 \times 10^{-10}$ . What is the pH of a 0.068 M aqueous solution of sodium cyanide?

- A) 2.96
- B) 11.07
- C) 13.24
- D) 0.74
- E) 7.00

Answer: B

24) The  $K_a$  of hypochlorous acid (HClO) is  $3.00 \times 10^{-8}$ . What is the pH at 25.0 °C of an aqueous solution that is 0.0200 M in HClO?

- A) -9.22
- B) +4.61
- C) -2.45
- D) +2.45
- E) +9.22

Answer: B

25) The pH of a 0.55 M aqueous solution ammonia,  $\text{NH}_3$ , at 25.0 °C is 11.50. What is the value of  $K_b$  for  $\text{NH}_3$ ?

- A)  $6.0 \times 10^{-5}$
- B)  $1.1 \times 10^{-9}$
- C)  $1.8 \times 10^{-5}$
- D)  $2.0 \times 10^{-9}$
- E) none of the above

Answer: C

26) The acid-dissociation constants of phosphoric acid ( $\text{H}_3\text{PO}_4$ ) are  $K_{a1} = 7.5 \times 10^{-3}$ ,  $K_{a2} = 6.2 \times 10^{-8}$ , and  $K_{a3} = 4.2 \times 10^{-13}$  at 25.0 °C. What is the pH of a 2.5 M aqueous solution of phosphoric acid?

- A) 0.86
- B) 0.13
- C) 1.82
- D) 2.51
- E) 0.40

Answer: A

- 27) A reaction that is spontaneous as written \_\_\_\_\_.
- A) is very rapid
  - B) is also spontaneous in the reverse direction
  - C) will proceed without outside intervention
  - D) is very slow
  - E) has an equilibrium position that lies far to the left

Answer: C

- 28) Which of the following statements is true?
- A) Processes that are spontaneous in one direction are spontaneous in the opposite direction.
  - B) Spontaneity can depend on the temperature.
  - C) Processes are spontaneous because they occur at an observable rate.
  - D) All of the statements are true.

Answer: B

- 29) Which one of the following processes produces a decrease of the entropy of the system?
- A) boiling of alcohol
  - B) explosion of nitroglycerine
  - C) sublimation of naphthalene
  - D) dissolving sodium chloride in water
  - E) dissolving oxygen in water

Answer: E

- 30) Given the following table of thermodynamic data,

Substance	$\Delta H_f^\circ$ (kJ/mol)	$S^\circ$ (J/mol · K)
TiCl <sub>4</sub> (g)	-763.2	354.9
TiCl <sub>4</sub> (l)	-804.2	221.9

complete the following sentence. The vaporization of TiCl<sub>4</sub> is \_\_\_\_\_.

- A) nonspontaneous at all temperatures
- B) spontaneous at all temperatures
- C) spontaneous at low temperature and nonspontaneous at high temperature
- D) nonspontaneous at low temperature and spontaneous at high temperature
- E) not enough information given to draw a conclusion

Answer: D

- 31)  $\Delta S$  is positive for the reaction \_\_\_\_\_.
- A)  $2\text{SO}_3(\text{g}) \rightarrow 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$
  - B)  $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
  - C)  $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$
  - D)  $\text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{s})$
  - E)  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$

Answer: A

32) For an isothermal process, the entropy change of the surroundings is given by the equation:

- A)  $\Delta S = -q_{\text{sys}} / T$
- B)  $\Delta S = q_{\text{sys}} T$
- C)  $\Delta S = q \ln T$
- D)  $\Delta S = -q \ln T$
- E)  $\Delta S = -q_{\text{sys}} T$

Answer: A

33) A reaction that is not spontaneous at low temperature can become spontaneous at high temperature if  $\Delta H$  is \_\_\_\_\_ and  $\Delta S$  is \_\_\_\_\_.

- A) +, +
- B) -, -
- C) +, -
- D) -, +
- E) +, 0

Answer: A

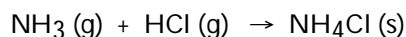
34) The standard Gibbs free energy of formation of \_\_\_\_\_ is zero.

- (a)  $\text{H}_2\text{O} (\text{l})$
- (b)  $\text{Fe} (\text{s})$
- (c)  $\text{I}_2 (\text{s})$

- A) (a) only
- B) (b) only
- C) (c) only
- D) (b) and (c)
- E) (a), (b), and (c)

Answer: D

35) Consider the reaction:



Given the following table of thermodynamic data at 298 K:

Substance	$\Delta H_f^\circ$ (kJ/mol)	$S^\circ$ (J/K · mol)
$\text{NH}_3 (\text{g})$	-46.19	192.5
$\text{HCl} (\text{g})$	-92.30	186.69
$\text{NH}_4\text{Cl} (\text{s})$	-314.4	94.6

The value of K for the reaction at 25 °C is \_\_\_\_\_.

- A)  $1.4 \times 10^8$
- B) 150
- C)  $1.1 \times 10^{-16}$
- D)  $8.4 \times 10^4$
- E)  $9.3 \times 10^{15}$

Answer: E

36) Which one of the following processes produces a decrease in the entropy of the system?

- A) dissolution of LiOH(s) in water
- B) freezing of Fe(l) into Fe(s)
- C) melting ice to form water
- D) mixing of two gases into one container
- E) evaporation of liquid ethanol into gaseous ethanol

Answer: B

37) For a given reaction,  $\Delta H = +22.2 \text{ kJ/mol}$  and  $\Delta S = +81.1 \text{ J/K}\cdot\text{mol}$ . The reaction is spontaneous \_\_\_\_\_.

Assume that  $\Delta H$  and  $\Delta S$  do not vary with temperature.

- A) at all temperatures
- B)  $T < 250 \text{ K}$
- C)  $250 \text{ K} < T < 274 \text{ K}$
- D)  $274 \text{ K} < T$

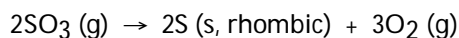
Answer: D

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C)

Substance	$\Delta H^\circ_f$ (kJ/mol)	$\Delta G^\circ_f$ (kJ/mol)	S (J/K·mol)
Oxygen			
O <sub>2</sub> (g)	0	0	205.0
H <sub>2</sub> O (l)	-285.83	-237.13	69.91
Sulfur			
S (s, rhombic)	0	0	31.88
SO <sub>2</sub> (g)	-269.9	-300.4	248.5
SO <sub>3</sub> (g)	-395.2	-370.4	256.2

38) The value of  $\Delta S^\circ$  for the decomposition of gaseous sulfur trioxide to solid elemental sulfur and gaseous oxygen,

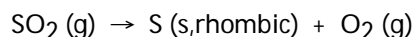


is \_\_\_\_\_ J/K · mol.

- A) +166.4
- B) +19.3
- C) -19.3
- D) +493.1
- E) -493.1

Answer: A

39) The value of  $\Delta H^\circ$  for the decomposition of gaseous sulfur dioxide to solid elemental sulfur and gaseous oxygen,



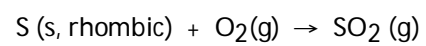
is \_\_\_\_\_ kJ/mol.

- A) +269.9
- B) 0.0
- C) -269.9
- D) +135.0
- E) -135.90

Answer: A



40) What is the equilibrium constant  $K_{eq}$  for the oxidation of solid elemental sulfur to gaseous sulfur dioxide?



- A)  $4.54 \times 10^{52}$       B) 1.129      C) 0.886      D)  $2.20 \times 10^{-53}$       E) -300.4
- Answer: A