1092-2nd Midterm Exam _05/19/21_(A)

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

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

   Answer: C

2) Which one of the following is a Brønsted-Lowry base?
   A) HNO_2
   B) CH_3COOH
   C) HF
   D) $(CH_3)_3N$
   E) none of the above

   Answer: D

3) The conjugate base of HPO_4^{2-} is _____.
   A) $H_2PO_4^-$
   B) PO_4^{3-}
   C) H_2PO_4
   D) H_3PO_4
   E) none of the above

   Answer: B

4) Calculate the pH of a 0.500 M aqueous solution of NH_3. The K_b of NH_3 is 1.77×10^{-5}.
   A) 2.53 B) 8.95 C) 11.77 D) 2.23 E) 11.47

   Answer: E

5) The K_a for some acid HA is 7.0×10^{-4}. What is the pH of a 0.15 M aqueous solution prepared by the salt NaA?
   A) 5.83 B) 0.82 C) 1.17 D) 5.01 E) 8.17

   Answer: E

6) The pH of a 0.25 M aqueous solution of hydrofluoric acid, HF, at 25.0 °C is 2.03. What is the value of K_a for HF?
   A) 3.6×10^{-4}
   B) 2.0×10^{-9}
   C) 1.1×10^{-9}
   D) 6.0×10^{-5}
   E) none of the above

   Answer: A

7) The acid-dissociation constants of sulfurous acid (H_2SO_3) are $K_{a1} = 1.7 \times 10^{-2}$ and $K_{a2} = 6.4 \times 10^{-8}$ at 25.0 °C. Calculate the pH of a 0.163 M aqueous solution of sulfurous acid.

A) 1.28 B) 6.21 C) 4.53 D) 1.93 E) 1.86

Answer: A

8) Calculate the percent ionization of formic acid (HCO_2H) in a solution that is 0.152 M in formic acid. The K_a of formic acid is 1.8×10^{-4}.

A) 3.44 B) 8.44 C) 0.0180 D) 2.74×10^{-5} E) 0.581

Answer: A

9) In which of the following aqueous solutions does the weak acid exhibit the highest percentage ionization?

A) 0.01 M H_2CO_3 ($K_a = 4.5 \times 10^{-7}$)

B) 0.01 M HOCl ($K_a = 3.5 \times 10^{-8}$)

C) 0.01 M HCN ($K_a = 6.2 \times 10^{-10}$)

D) 0.01 M $HC_3H_5O_2$ ($K_a = 1.3 \times 10^{-5}$)

E) 0.01 M H_2SO_3 ($K_a = 1.4 \times 10^{-2}$)

Answer: E

10) Of the following substances, an aqueous solution of _____ will form <u>basic</u> solutions.

NH_4Br $Pb(NO_3)_2$ K_2CO_3 NaF

A) K_2CO_3, NH_4Br

B) NH_4Br only

C) NaF, K_2CO_3

D) NaF only

E) NH_4Br, $Pb(NO_3)_2$

Answer: C

11) For which salt should the aqueous solubility be most sensitive to pH?

A) MgI_2 B) $MgCl_2$ C) MgF_2 D) $Mg(NO_3)_2$ E) $MgBr_2$

Answer: C

12) Which of the following acids will be the strongest?

A) H_2SeO_4 B) H_2SO_4 C) HSO_3^- D) HSO_4^- E) H_2SO_3

Answer: B

13) A solution containing which one of the following pairs of substances will be a buffer solution?

A) KBr, HBr

B) NaI, HI

C) CsF, HF

D) RbCl, HCl

E) none of the above

Answer: C

14) What change will be caused by addition of a small amount of HCl to a solution containing0.1 M fluoride ions and 0.1 M hydrogen fluoride?

A) The concentration of hydronium ions will increase significantly.
B) The concentration of fluoride ions will increase as will the concentration of hydronium ions.
C) The concentration of fluoride ion will decrease and the concentration of hydrogen fluoride will increase.
D) The fluoride ions will precipitate out of solution as its acid salt.
E) The concentration of hydrogen fluoride will decrease and the concentration of fluoride ions will increase.

Answer: C

15) Which solution would have the greatest buffering capacity?

A) 1.15 M HF and 0.624 M NaF
B) 0.574 M HF and 0.312 M NaF
C) 0.287 M HF and 0.156 M NaF
D) 0.189 M HF and 0.103 M NaF
E) They are all buffer solutions and would all have the same capacity.

Answer: A

16) The K_a of some weak acid HA is 1.76×10^{-5}. The pH of a buffer prepared by combining 15.0 mL of 1.00 M A^- and 50.0 mL of 1.00 M HA is _____.

A) 0.851 B) 1.705 C) 3.406 D) 4.232 E) 2.383

Answer: D

17) 1.A 25.0 mL sample of 0.150 M acetic acid is titrated with a 0.150 M NaOH solution. What is the pH at the equivalence point? The K_a of acetic acid is 1.8×10^{-5}.

A) 11.74 B) 9.26 C) 8.81 D) 7.00 E) 4.74

Answer: C

18) A 50.0 mL sample of an aqueous H_2SO_4 solution is titrated with a 0.375 M NaOH solution. The complete neutralization is reached with 62.5 mL of the base. The concentration of H_2SO_4 is _____ M.

A) 0.469 B) 0.300 C) 0.938 D) 0.234 E) 0.150

Answer: D

19) Use the information below to answer the question below:
methyl orange: red at pH < 3.1: orange at pH 3.1-4.4
litmus: red at pH < 4.5: purple at pH 4.5-8.3: blue above pH 8.3
thymol blue: yellow at pH < 8.0: green at pH 8.0-9.6: blue above pH 9.6
trinitrobenzene: colorless at pH < 12: yellow at pH 12.0-1: orange above pH 14.0
Which of the pH indicators from the list above would be most appropriate for the titration of 0.30 M acetic acid ($K_a = 1.8 \times 10^{-5}$) with 0.15 M sodium hydroxide?

A) litmus
B) trinitrobenzene
C) thymol blue
D) methyl orange
E) Both thymol blue and trinitrobenzene can be used.

Answer: C

20) A solution contains 1.0×10^{-2} M Ag^+ and 2.0×10^{-2} M Pb^{2+}. When the concentration of Cl^- is 2×10^{-5} M, is precipitation observed? (AgCl $K_{sp} = 1.8 \times 10^{-10}$, $PbCl_2$ $K_{sp} = 1.7 \times 10^{-5}$)

A) only AgCl
B) only $PbCl_2$
C) both AgCl and $PbCl_2$
D) no precipitate

Answer: A

21) Which one of the following is <u>not</u> amphoteric?

A) $Ca(OH)_2$ B) $Cr(OH)_3$ C) $Zn(OH)_2$ D) $Sn(OH)_2$ E) $Al(OH)_3$

Answer: A

22) The molar solubility of _____ is not affected by the pH of the solution.

A) Na_3PO_4 B) MnS C) $AlCl_3$ D) NaF E) KNO_3

Answer: E

23) The solubility of manganese (II) hydroxide ($Mn(OH)_2$) is 2.2×10^{-5} M. What is the K_{sp} of $Mn(OH)_2$?

A) 4.8×10^{-10} B) 4.3×10^{-14} C) 2.2×10^{-5} D) 1.1×10^{-14} E) 2.1×10^{-14}

Answer: B

24) Which compound listed below has the smallest molar solubility in water?

A) CaF_2 ($K_{sp} = 3.9 \times 10^{-11}$)
B) $Cd(OH)_2$ ($K_{sp} = 2.5 \times 10^{-14}$)
C) AgI ($K_{sp} = 8.3 \times 10^{-17}$)
D) $ZnCO_3$ ($K_{sp} = 1.4 \times 10^{-11}$)
E) $CdCO_3$ ($K_{sp} = 5.2 \times 10^{-12}$)

Answer: C

25) In which of the following aqueous solutions would you expect $PbCl_2$ to have the lowest solubility? (The K_{sp} of $PbCl_2$ is $1.7 \times \times 10^{-5}$)

A) 0.020 M $Pb(NO_3)_2$
B) pure water
C) 0.020 M KCl
D) 0.020 M $BaCl_2$
E) 0.020 M NaCl

Answer: D

26) The thermodynamic quantity that expresses the extent of randomness in a system is _____.

A) heat flow
B) bond energy
C) enthalpy
D) internal energy
E) entropy

Answer: E

27) Place the following in order of increasing entropy at 298 K.

Ne Xe He Ar Kr

A) Ar < Ne < Xe < Kr < He
B) He < Ne < Ar < Kr < Xe
C) Xe < Kr < Ar < Ne < He
D) He < Kr < Ne < Ar < Xe
E) Ar < He < Ar < Ne < Kr

Answer: B

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

Answer: E

29) ΔS is positive for the reaction _____.
A) $HCl\ (g) + NH_3\ (g) \rightarrow NH_4Cl\ (s)$
B) $Pb^{2+}\ (aq) + 2Cl^-\ (aq) \rightarrow PbCl_2\ (s)$
C) $CO_2\ (g) \rightarrow CO_2\ (s)$
D) $2\ Ca\ (s) + O_2\ (g) \rightarrow 2\ CaO\ (s)$
E) $2\ KClO_3\ (s) \rightarrow 2KCl\ (s) + 3\ O_2\ (g)$

Answer: E

30) For an isothermal process, the entropy change of the surroundings is given by the equation:
A) $\Delta S = -q_{sys} / T$
B) $\Delta S = -q_{sys}\ T$
C) $\Delta S = q_{sys}\ T$
D) $\Delta S = -q\ \ln T$
E) $\Delta S = q\ \ln T$

Answer: A

31) Of the following, only _____ is <u>not</u> a state function.
A) H B) S C) q D) E E) T

Answer: C

32) For the reaction

$$C_2H_6\ (g) \rightarrow C_2H_4\ (g) + H_2\ (g)$$

$\Delta H°$ is +137 kJ/mol and $\Delta S°$ is +120 J/K · mol. This reaction is _____.
A) nonspontaneous at all temperatures
B) spontaneous at all temperatures
C) spontaneous only at low temperature
D) spontaneous only at high temperature

Answer: D

33) What is the value of $\Delta S°$ for the formation of $POCl_3$ from its constituent elements,?

$P_2\,(g) + O_2\,(g) + 3Cl_2\,(g) \rightarrow 2POCl_3\,(g)$

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

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	S° (J/K-mol)
Cl_2 (g)	0	0	222.96
O_2 (g)	0	0	205.0
P_2 (g)	144.3	103.7	218.1
$POCl_3$ (g)	-542.2	-502.5	325

A) +321.0 B) -771.0 C) +771.0 D) -442.0 E) -321.0

Answer: D

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

Answer: C

35) Which one of the following statements is true about the equilibrium constant for a reaction if $\Delta G°$ for the reaction is negative?
A) $K < 1$
B) $K = 0$
C) $K = 1$
D) $K > 1$
E) More information is needed.

Answer: D

36) The standard Gibbs free energy of formation of _____ is zero.

(a) H_2O (l)
(b) Fe (s)
(c) I_2 (s)

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

Answer: D

37) Calculate ΔG_{rxn} at 298 K under the conditions shown below for the following reaction. (R: 8.314 J/mol · K)

$3\ O_2(g) \rightarrow 2\ O_3(g)$ $\Delta G° = +326$ kJ

$P(O_2) = 0.41$ atm, $P(O_3) = 5.2$ atm

A) +341 kJ B) +332 kJ C) -109 kJ D) +17.8 kJ E) -47.4 kJ

Answer: A

38) The Gibbs energy change for a reaction is -298 kJ. The reaction is therefore:

A) endothermic
B) exothermic
C) nonspontaneous
D) irreversible
E) spontaneous

Answer: E

39) Which of the following reactions will have the largest equilibrium constant (K) at 298 K?

A) $2\ Hg(g) + O_2(g) \rightarrow 2\ HgO(s)$ $\Delta G° = -180.8$ kJ
B) $Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$ $\Delta G° = -28.0$ kJ
C) $3\ O_2(g) \rightarrow 2\ O_3(g)$ $\Delta G° = +326$ kJ
D) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ $\Delta G° = +131.1$ kJ
E) It is not possible to determine without more information.

Answer: A

40) Given the thermodynamic data in the table below, calculate the equilibrium constant (at 298 K) for the reaction: (R: 8.314 J/mol · K)

$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$

Substance	$\Delta H_f°$ (kJ/mol)	S° (J/mol · K)
SO_2 (g)	-297	249
O_2 (g)	0	205
SO_3 (g)	-395	256

A) 2.40×10^{24}
B) 1.06
C) 3.82×10^{23}
D) 1.95
E) More data are needed.

Answer: A