

(1) Which salt if added to the solution will decrease the ionization of HClO_2 ?

- a) NaCl
 - b) KCl
 - c) KClO_2
 - d) NaClO_4
 - e) Na_2SO_4
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(2) Which mixture can function as a buffer?

- a) HCl and KCl
 - b) H_2SO_4 and K_2SO_4
 - c) NaOH and NaCl
 - d) H_2O and HCl
 - e) $\text{HC}_2\text{H}_3\text{O}_2$ and $\text{NaC}_2\text{H}_3\text{O}_2$
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(3) The Henderson-Hasselbalch equation is:

- a) $[H^+] = K_a + \frac{[base]}{[acid]}$
 - b) $pH = pK_a - \log\left(\frac{[base]}{[acid]}\right)$
 - c) $pH = pK_a + \log\left(\frac{[base]}{[acid]}\right)$
 - d) $pH = pK_a + \log\left(\frac{[acid]}{[base]}\right)$
 - e) $pH = \log\left(\frac{[acid]}{[base]}\right)$
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(4) What is the ratio of HCO_3^- to H_2CO_3 in blood of pH 7.4 ($K_a = 4.3 \times 10^{-7}$ for H_2CO_3)?

- a) 2.1
 - b) 3.8
 - c) 10.8
 - d) -1.4
 - e) 5.4
- $pH = pK_a + \log\left(\frac{[base]}{[acid]}\right)$ $\frac{[base]}{[acid]} = 10^{pH - pK_a} = 10^{7.4 - 6.33} = 10^{1.033} = 10.8$
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(5) The definition of an equivalence point is as follows:

- a) the point at which stoichiometrically equivalent quantities of acid and base have brought together
- b) pH is always 7.0 regardless of the strengths of the acid or base
- c) the acid and base solutions have precisely the same concentration
- d) pH is greater than 7.0
- e) pH is smaller than 7.0

(6) Consider the titration of 25.0 mL of 0.270 M HClO_4 with 0.270 M KOH. The concentration of H^+ before any KOH is added is ___ M

** strong acid*

- a) 0.57
- b) 1.00×10^{-7}
- c) 0.72
- d) 2.81×10^{-13}
- e) 0.27

$$[\text{H}^+] = [\text{HClO}_4] = 0.270 \text{ M}$$

(7) Consider the titration of 25.0 mL of 0.270 M HClO_4 with 0.270 M KOH. The concentration of H^+ after addition of 25.0 mL of KOH is ___ M

*we are at the equivalence point
+ strong acid & strong base titration*

- a) 0.57
- b) 1.00×10^{-7}
- c) 0.72
- d) 2.81×10^{-13}
- e) 0.27

(8) Consider the titration of 50.0 mL of 0.200 M hydrozoic acid (HN_3) ($K_a = 2.6 \times 10^{-5}$) with 0.200 M NaOH. The pH of the solution before any NaOH is added is ___.

- a) 2.64
- b) 8.79
- c) 12.21
- d) 4.59
- e) 7.00

$$\text{HN}_3(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{N}_3^-(\text{aq})$$
$$0.200 - x \qquad x \qquad x$$
$$K_a = \frac{[\text{H}^+][\text{N}_3^-]}{[\text{HN}_3]} = \frac{x^2}{0.200 - x} = \frac{x^2}{0.200} = 2.6 \times 10^{-5}$$
$$x = 2.28 \times 10^{-3} \text{ ; } \text{pH} = 2.64$$

(9) Consider the titration of 50.0 mL of 0.200 M hydrozoic acid (HN_3) ($K_a = 2.6 \times 10^{-5}$) with 0.200 M NaOH. Calculate the pH of the solution after addition of 50.0 mL of NaOH solution.

we are at the equivalence point

$$\text{N}_3^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HN}_3^-(\text{aq}) + \text{OH}^-(\text{aq})$$
$$0.100 - x \qquad x \qquad x$$

- a) 2.64
- b) 8.79
- c) 12.21
- d) 4.59
- e) 7.00

$$K_b = \frac{[\text{HN}_3][\text{OH}^-]}{[\text{N}_3^-]} = \frac{x^2}{0.100 - x} = \frac{K_w}{K_a} = 3.85 \times 10^{-10}$$
$$x^2 = 0.1 \times 3.85 \times 10^{-10} \text{ ; } x = 6.20 \times 10^{-6} \text{ ; } \text{pOH} = 5.21$$
$$\text{pH} = 14.00 - 5.21 = 8.79$$

(10) Given the following table of K_{sp} values, determine which compound listed has the smallest solubility.

Compound	K_{sp}	Handwritten Calculation
$CdCO_3$	5.2×10^{-12}	$x^2 = K_{sp}$; $x = 2.28 \times 10^{-6}$
$Cd(OH)_2$	2.5×10^{-14}	$x(2x)^2 = 4x^3 = K_{sp}$; $x = 1.84 \times 10^{-5}$
AgI	8.3×10^{-17}	$x^2 = K_{sp}$; $x = 9.1 \times 10^{-9}$
$Fe(OH)_3$	4×10^{-38}	$x(3x)^3 = 27x^4 = K_{sp}$; $x = 1.97 \times 10^{-10}$
$ZnCO_3$	1.4×10^{-11}	$x^2 = K_{sp}$; $x = 3.74 \times 10^{-6}$

- a) $CdCO_3$
 - b) $Cd(OH)_2$
 - c) AgI
 - d) $Fe(OH)_3$
 - e) $ZnCO_3$
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(11) Of the substances below, _____ will decrease the solubility of $AgCl$ in a saturated solution

- a) $NaNO_3$
 - b) H_2O_2
 - c) HNO_3
 - d) $Pb(NO_3)_2$
 - e) $NaCl$
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(12) The layer of the atmosphere that contains our weather is called the _____

- a) mesosphere
 - b) stratosphere
 - c) thermosphere
 - d) troposphere
 - e) tropopause
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(13) Ozone is

- a) O
- b) O_2
- c) O_4
- d) O_3
- e) H_2O_2

(14) CFC stands for

- a) chlorinated freon compound
 - b) carbofluoro compound
 - c) carbonated fluorine compound
 - d) caustic fluorine carbohydrate
 - e) chlorofluorocarbon
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(15) ___ is used in treating water for a public water system?

- a) NaCl
 - b) Cl_2
 - c) HCl
 - d) HClO
 - e) HClO_4
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(16) A reaction that is spontaneous, _____

- a) will be very rapid as written
 - b) will proceed as written without outside intervention
 - c) is also spontaneous in the reverse direction
 - d) has an equilibrium position that lies very far to the left
 - e) will occur very slowly
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(17) Of the following, only _____ is not a state function.

- a) E
 - b) H
 - c) w
 - d) S
 - e) G
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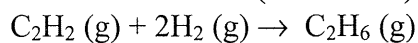
(18) A system that cannot exchange either matter or energy with its surroundings is called an _____ system.

- a) adiabatic
- b) isolated
- c) isothermal
- d) isobaric
- e) isotonic

(19) Given the following table of thermodynamic data,

Substance	S°
C_2H_2 (g)	201 J/mol-K
C_2H_6 (g)	230 J/mol-K
H_2 (g)	131 J/mol-K

Determine the ΔS° (in J/mol-K) for the reaction:



- a) 233
- b) -102
- c) +233
- d) +112
- e) +201

$$\Delta S^\circ = S_{C_2H_6}^\circ - S_{C_2H_2}^\circ - 2S_{H_2}^\circ = -233 \text{ J/mol-K}$$

(20) What can be said about a chemical reaction that has a free energy (ΔG) zero?

- a) it is at absolute zero
- b) its entropy is zero
- c) it is at equilibrium
- d) the reaction is complete
- e) the reaction is very fast

(21) The standard free energy of formation of _____ is zero

- a) H_2O (l)
- b) H_2O (s)
- c) O (g)
- d) O_2 (g)
- e) H_2SO_4 (l)

(22) The third law of thermodynamics states that:

- a) the entropy of a pure crystalline substance at absolute zero ($T=0$ K) is zero
- b) the entropy of a pure crystalline substance is always more than zero
- c) the entropy of a pure crystalline substance is negative
- d) the entropy of a pure crystalline substance is increasing with temperature
- e) the entropy is a state function

(23) If the ΔG for a reaction is greater than zero, then _____.

- a) $Q > K$
- b) $Q = K$
- c) $Q < K$
- d) $K = 1$
- e) $Q = 0$

(24) The equilibrium constant for a reaction is 0.48 at 25°C. What is the value of ΔG° (kJ/mol) at this temperature?

- a) 1.8
- b) -4.2
- c) 1.5×10^2
- d) 4.2
- e) more information is needed

$$\Delta G^\circ = -RT \ln K = -8.314 \times 298 \times (-0.733) = 1816 \text{ J/mol} = 1.8 \text{ kJ/mol}$$

(25) For a certain chemical reaction, $\Delta H^\circ = -35.4$ kJ/mol and $\Delta S^\circ = -85.5$ J/K-mol. The reaction is _____ at 298 K.

- a) spontaneous
- b) nonspontaneous
- c) at the equilibrium
- d) very slow
- e) very fast

$$\begin{aligned} \Delta G^\circ &= \Delta H^\circ - T \Delta S^\circ = \\ &= -35.4 \text{ kJ/mol} - \frac{298 \text{ K} (-85.5 \text{ J/K-mol}) (1 \text{ kJ})}{1000 \text{ J}} = \\ &= -35.4 \text{ kJ/mol} + 25.5 \text{ kJ/mol} = -9.9 \text{ kJ/mol} \end{aligned}$$