

AP Chemistry Quarter 3 Exam Review

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

- _____ 1. What is the pH of an aqueous solution at 25°C in which $[\text{OH}^-]$ is 0.0025 M?
- 2.25
 - 11.40
 - +11.40
 - 2.60
 - +2.60
- _____ 2. All species below have Lewis dot diagrams that illustrate the octet rule EXCEPT
- NO_2
 - N_2
 - NH_3
 - NH_4^{+1}
 - NO_3^{-1}
- _____ 3. Which sample contains the greatest number of nitrogen atoms? (All measurements taken at 1 atm and 273 K)
- 0.20 moles $\text{N}_2\text{O}_4(\text{g})$
 - 40 g $\text{NH}_3(\text{g})$
 - 0.40 moles $\text{N}_2(\text{g})$
 - 40 L $\text{NO}_2(\text{g})$
 - 80 g $\text{N}_2\text{O}_4(\text{g})$
- _____ 4. $10 \text{ HI} + 2 \text{ KMnO}_4 + 3 \text{ H}_2\text{SO}_4 \rightarrow 5 \text{ I}_2 + 2 \text{ MnSO}_4 + \text{K}_2\text{SO}_4 + 8 \text{ H}_2\text{O}$
55. According to the balanced equation above, how many moles of HI would be necessary to produce 2.5 mol of I_2 , starting with 4.0 mol of KMnO_4 and 3.0 mol of H_2SO_4 ?
- 2.5
 - 10
 - 20
 - 8.0
 - 5.0
- _____ 5. Rate = $k[\text{X}]$
For the reaction whose rate law is given above, a plot of which of the following is a straight line?
- $[\text{X}]$ versus 1/time
 - $\log [\text{X}]$ versus 1/time
 - $\log [\text{X}]$ versus time
 - $1/[\text{X}]$ versus time
 - $[\text{X}]$ versus time
- _____ 6. Which of these alkaline earth metal oxides has the greatest percent by mass oxygen?
- magnesium oxide
 - calcium oxide
 - barium oxide
 - strontium oxide
 - beryllium oxide

- _____ 7. $4 \text{HCl(g)} + \text{O}_2\text{(g)} \rightleftharpoons 2 \text{Cl}_2\text{(g)} + 2 \text{H}_2\text{O(g)}$
Equal numbers of moles of HCl and O_2 in a closed system are allowed to reach equilibrium as represented by the equation above. Which of the following must be true at equilibrium?
I. $[\text{HCl}]$ must be less than $[\text{Cl}_2]$.
II. $[\text{O}_2]$ must be greater than $[\text{HCl}]$.
III. $[\text{Cl}_2]$ must equal $[\text{H}_2\text{O}]$.
- a. I only
b. I and III only
c. II and III only
d. II only
e. I, II, and III
- _____ 8. $1s^2 2s^2 2p^6 3s^2 3p^3$
Atoms of an element, X, have the electronic configuration shown above. The compound most likely formed with magnesium, Mg, is
- a. Mg_2X
b. MgX
c. MgX_3
d. Mg_3X_2
e. MgX_2
- _____ 9. The shape of the IO_3^{-1} ion is best described as
- a. trigonal pyramidal
b. tetrahedral
c. trigonal planar
d. T-shaped
e. see-saw
- _____ 10. The bond angles about the carbon atom in the formaldehyde molecule, $\text{H}_2\text{C}=\text{O}$, are about:
- a. 109°
b. 180°
c. 120°
d. 60°
e. 90°
- _____ 11. Relatively slow rates of chemical reaction are associated with which of the following?
- a. High temperature
b. High concentration of reactants
c. Low activation energy
d. The presence of a catalyst
e. Strong bonds in reactant molecules
- _____ 12. Which of the following forms oxides that are common air pollutants and that yield acidic solution in water?
- a. Mg
b. Mn
c. F
d. Ar
e. S

- _____ 13. In a basic solution, _____.
- $[\text{H}_3\text{O}^+] > [\text{OH}^-]$
 - $[\text{OH}^-] > 7.00$
 - $[\text{H}_3\text{O}^+] = 0$
 - $[\text{H}_3\text{O}^+] < [\text{OH}^-]$
 - $[\text{H}_3\text{O}^+] = [\text{OH}^-]$

_____ 14.

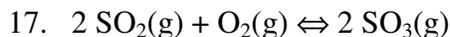
Step 1) $\text{N}_2\text{H}_2\text{O}_2 \rightleftharpoons \text{N}_2\text{HO}_2^- + \text{H}^+$	(fast equilibrium)
Step 2) $\text{N}_2\text{HO}_2^- \rightarrow \text{N}_2\text{O} + \text{OH}^-$	(slow)
Step 3) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$	(fast)

Nitramide, $\text{N}_2\text{H}_2\text{O}_2$, decomposes slowly in aqueous solution. This decomposition is believed to occur according to the reaction mechanism above. The rate law for the decomposition of nitramide that is consistent with this mechanism is given by which of the following?

- Rate = $k [\text{N}_2\text{H}_2\text{O}_2] [\text{H}^+]$
- Rate = $k [\text{N}_2\text{H}_2\text{O}_2] [\text{OH}^-]$
- Rate = $\frac{k[\text{N}_2\text{H}_2\text{O}_2]}{[\text{N}_2\text{HO}_2^{-1}]}$
- Rate = $k [\text{N}_2\text{H}_2\text{O}_2]$
- Rate = $\frac{k[\text{N}_2\text{H}_2\text{O}_2]}{[\text{H}^+]}$

- _____ 15. What is the pOH of a 0.015 M solution of barium hydroxide?
- 1.82
 - 10.35
 - 12.18
 - 1.52
 - 12.48

- _____ 16. Select the molecule among the following that has a dipole moment.
- SeO_3
 - BeCl_2
 - SF_4
 - CO_2
 - XeF_4



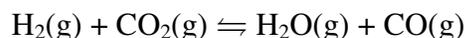
When 0.40 mole of SO_2 and 0.60 mole of O_2 are placed in an evacuated 1.00-liter flask, the reaction represented above occurs. After the reactants and the product reach equilibrium and the initial temperature is restored, the flask is found to contain 0.30 mole of SO_3 . Based on these results, the expression for the equilibrium constant, K_c , of the reaction is

- a. $\frac{(0.30)^2}{(0.45)(0.10)^2}$
 b. $(0.30) / [(0.60)(0.40)]$
 c. $(0.30) / [(0.45)(0.10)]$
 d. $\frac{(0.30)^2}{(0.60)(0.40)^2}$
 e. $\frac{2(0.30)}{(0.45)(2 \times 0.10)}$

Problem

18. Show how added acid and base is neutralized by a hypobromous acid/sodium hypobromite buffer system.

19. The equilibrium constant for the reaction



is 4.2 at 1650°C. Initially 0.80 moles of H_2 , 0.80 moles of CO_2 , 2.0 moles of H_2O , and 3.0 moles of CO are injected into a 5.00 L flask. Calculate the equilibrium concentrations of all species.

20. Draw the resonance structures and predict the best representation of the electrons due to formal charge for CNO^- .

21. For a hypothetical chemical reaction that has the stoichiometry $2 \text{X} + \text{Y} \rightarrow \text{Z}$, the following initial rate data were obtained. All the measurements were made at the same temperature.

Initial Rate of Formation of Z, $\text{mol L}^{-1} \text{sec}^{-1}$	Initial $[\text{X}]_0$, mol L^{-1}	Initial $[\text{Y}]_0$, mol L^{-1}
7.0×10^{-4}	0.20	0.10
1.4×10^{-3}	0.40	0.20
2.8×10^{-3}	0.40	0.40
4.2×10^{-3}	0.60	0.60

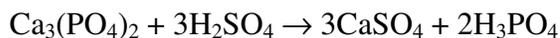
(a) Give the rate law for this reaction from the data above

(b) Calculate the specific rate constant for this reaction and specify its units.

- (c) How long must the reaction proceed to produce a concentration of Z equal to 0.20 molar, if the initial reaction concentrations are $[X]_0 = 0.80$ molar, $[Y]_0 = 0.60$ molar, and $[Z]_0 = 0$ molar?
- (d) Select from the mechanisms below the one most consistent with the observed data, and explain your choice. In these mechanisms M and N are reaction intermediates. (NB - the words fast and slow are placed above the reaction arrow on the original test.)

(1)	(2)	(3)
$X + Y \xrightarrow{\text{slow}} M$	$X + X \xrightleftharpoons{\text{fast}} M$	$Y \xrightarrow{\text{slow}} M$
$X + M \xrightarrow{\text{fast}} Z$	$Y + M \xrightarrow{\text{slow}} Z$	$M + X \xrightarrow{\text{fast}} N$
		$N + X \xrightarrow{\text{fast}} Z$

22. Calculate the pH of a HF/NaF buffer solution in which the initial concentration of both the HF and NaF is 0.100 M.
23. What two substances are needed to make a buffer solution? Why?
24. One of the commercial uses of sulfuric acid is in the production of phosphoric acid and calcium sulfate. The phosphoric acid is used for fertilizer. The reaction is:



What mass of concentrated H_2SO_4 (98% by mass) must be used to react completely with 100.0 g of calcium phosphate?

25. Answer the following questions about $\text{BeC}_2\text{O}_4(s)$ and its hydrate.
- a) Calculate the mass percent of carbon in the hydrated form of the solid that has the formula $\text{BeC}_2\text{O}_4 \cdot 3 \text{H}_2\text{O}$
- b) When heated to $220.^\circ\text{C}$, $\text{BeC}_2\text{O}_4 \cdot 3 \text{H}_2\text{O}(s)$ dehydrates completely as represented below



If 3.21 g of $\text{BeC}_2\text{O}_4 \cdot 3 \text{H}_2\text{O}(s)$ is heated to $220.^\circ\text{C}$, calculate

- i) the mass of $\text{BeC}_2\text{O}_4(s)$ formed, and
- ii) the volume of the $\text{H}_2\text{O}(g)$ released, measured at $220.^\circ\text{C}$ and 735 mm Hg.

Essay

26. Using principles of chemical bonding and/or intermolecular forces, explain each of the following.

- (A) The normal boiling point of iodine, I_2 , is greater than the normal boiling point of chlorine.
- (B) Both Ag(s) and molten Ag are excellent conductors of electricity. However, silver nitrate, $AgNO_3$, is a good conductor only when melted or dissolved in water. As a solid, it is a poor conductor of electricity.
- (C) The normal boiling point of H_2O is higher than the normal boiling point of H_2S even though the molar mass of H_2O is lower.
- (D) Arsenic, As, reacts with the metal sodium Na, to form Na_3As . Arsenic reacts with the nonmetal chlorine, Cl_2 , to form $AsCl_3$.

27. CF_4 XeF_4 ClF_3

- (a) Draw a Lewis electron-dot structure for each of the molecules above and identify the shape of each.
- (b) Use the valence shell electron-pair repulsion (VSEPR) model to explain the geometry of each of these molecules.