**AP chem**

**Text: chapters 4, 21, & more**

**Review - 2**

(Reactions)

Name: __________________

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**1. Precipitation**

-sodium iodide reacts with lead nitrate

\[ \text{I}^- + \text{Pb}^{2+} \rightarrow \text{PbI}_2 \]

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**2. Acid base**

-vinegar reacts with sodium hydroxide

\[ \text{CH}_3\text{CO}_2\text{H} + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{CO}_2^- \]

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**3. Combustion**

-C$_2$H$_6$S is burned in air

\[ 2 \text{C}_2\text{H}_6\text{S} + 9 \text{O}_2 \rightarrow 4 \text{CO}_2 + 6 \text{H}_2\text{O} + 2 \text{SO}_2 \]

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**4. Simple redox (single replacement)**

-solid tin reacts with copper(II) nitrate solution

\[ \text{Sn} + \text{Cu}^{2+} \rightarrow \text{Sn}^{2+} + \text{Cu} \]

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**5. Decomposition**

-potassium chloride is heated vigorously

\[ 2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2 \]

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**6. Synthesis**

-sulfur trioxide is bubbled through water

\[ \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 \]

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**7. Advanced redox**

-to iron(II) in acid is added potassium permanganate

\[ 5 \text{Fe}^{2+} + 8 \text{H}^- + \text{MnO}_4^- \rightarrow 5 \text{Fe}^{3+} + \text{Mn}^{2+} + 4 \text{H}_2\text{O} \]

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**8. Complex ion formation**

-excess hydroxide is added to aluminum sulfate

\[ \text{Al}^{3+} + 4 \text{OH}^- \rightarrow \text{Al}(	ext{OH})_4^- \]

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**PROBLEMS**

1. Which of the following best represents the balanced net ionic equation for the reaction of lead(II) carbonate with concentrated hydrochloric acid?

   a. \( \text{PbCO}_3 + 2\text{H}^+ + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   b. \( \text{PbCO}_3 + \text{H}_2\text{O} + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   c. \( \text{PbCO}_3 + 2\text{H}^+ \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   d. \( \text{PbCO}_3 + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   e. \( \text{Pb}^{2+} + \text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)

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5. Which of the following best represents the balanced net ionic equation for the reaction of lead(II) carbonate with concentrated hydrochloric acid?

   a. \( \text{Pb}^{2+} + 2\text{H}^+ + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   b. \( \text{Pb}^{2+} + 2\text{H}^+ + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   c. \( \text{Pb}^{2+} + 2\text{H}^+ \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   d. \( \text{Pb}^{2+} + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)
   e. \( \text{Pb}^{2+} + 2\text{H}^+ + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)

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6. A sample of copper metal is reacted with dilute nitric acid in the absence of air. After the reaction, what are the final products present in solution?

   a. \( \text{Cu(NO}_3)_2, \text{H}_2\text{O} \)
   b. \( \text{Cu(NO}_3)_3, \text{NO}, \text{and H}_2\text{O} \)
   c. \( \text{Cu(NO}_3)_2, \text{NO}, \text{and H}_2\text{O} \)
   d. \( \text{Cu(NO}_3)_3, \text{H}_2\text{O}, \text{and H}_2 \)
   e. \( \text{Cu(NO}_3)_2, \text{NO}, \text{and H}_2 \)

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7. Which is the correct net ionic equation for the reaction of acetic acid with potassium hydroxide?

   a. \( \text{HC}_2\text{H}_3\text{O}_2 + \text{OH}^- \rightarrow \text{C}_2\text{H}_3\text{O}_2^- + \text{H}_2\text{O} \)
   b. \( \text{HC}_2\text{H}_3\text{O}_2 + \text{K}^+ \rightarrow \text{C}_2\text{H}_3\text{O}_2^- + \text{H}_2\text{O} \)
   c. \( \text{HC}_2\text{H}_3\text{O}_2 + \text{KOH} \rightarrow \text{C}_2\text{H}_3\text{O}_2^- + \text{H}_2\text{O} \)
   d. \( \text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} \)
   e. \( \text{C}_2\text{H}_3\text{O}_2^- + \text{KOH} \rightarrow \text{C}_2\text{H}_3\text{O}_2^- + \text{H}_2\text{O} \)

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8. Which of the following is the correct net ionic equation for the addition of aqueous ammonia to a precipitate of silver chloride?

   a. \( \text{AgCl} + 4\text{NH}_3 \rightarrow [\text{Ag(NH}_3]_4]^+ + \text{Cl}^- \)
   b. \( \text{AgCl} + 2\text{NH}_4^+ \rightarrow [\text{Ag(NH}_3]_2]^2+ + \text{Cl}^- \)
   c. \( \text{AgCl} + \text{NH}_4^+ + \text{NH}_4\text{Cl} \)
   d. \( \text{AgCl} + \text{NH}_3 \rightarrow \text{Ag}^+ + \text{NH}_4\text{Cl} \)
   e. \( \text{AgCl} + 2\text{NH}_3 \rightarrow [\text{Ag(NH}_3]_2]^2+ + \text{Cl}^- \)

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9. Which is a false statement?

   a. The solution is acidic.
   b. The gas is hydrogen.

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c. The potassium compound is water-soluble.
d. The potassium compound will react with hydrochloric acid.
e. A solution of the potassium compound will form a precipitate when added to an FeCl₃ solution.

10. A sample is tested for the presence of the Hg₂⁺ ion. This ion, along with others, may be precipitated with the chloride ion. If Hg₂⁺ is present in the chloride precipitate, a black color will form upon treatment with aqueous ammonia. The balanced net ionic equation for the formation of this black color is:
   a. Hg₂Cl₂ + 2NH₃ + 2H₂O → 2Hg + 2NH₄⁺ + 2Cl⁻ + 2OH⁻
   b. Hg₂Cl₂ + 2NH₃ → 2Hg + 2NH₄Cl
   c. Hg₂Cl₂ + 2NH₄⁺ + 2H₂O → 2Hg + 2NH₄Cl + 2OH⁻
   d. Hg₂Cl₂ + NH₄⁺ → 2Hg + NH₄Cl
   e. Hg₂Cl₂ + 2NH₃ → Hg + HgNH₂Cl₂ + NH₄⁺ + Cl⁻

11. Which solid is not soluble in water, but is soluble in dilute nitric acid?
   a. NaOH
   b. BaCO₃
   c. AgCl
   d. (NH₄)₂PO₄
   e. FeCl₂

12. What is the minimum number of moles of Pb(NO₃)₂ that must be added to 0.10 L of a solution that is 1.0 M in MgCl₂ and 1.0 M in KCl?
   a. 1.0 moles
   b. 0.20 moles
   c. 0.50 moles
   d. 0.15 moles
   e. 0.30 moles

13. When 50.0 mL of 1.0 M AgNO₃ is added to 50.0 mL of 0.50 M HCl, AgCl precipitates. After the reaction is complete, what is the concentration of silver ions in the solution?
   a. 0.50 M
   b. 0.0 M
   c. 1.0 M
   d. 0.25 M
   e. 0.75 M

14. A student mixes 50.0 mL of 0.10 M Pb(NO₃)₂ solution with 50.0 mL of 0.10 M KCl. A white precipitate forms, and the concentration of the chloride ion becomes very small. Which list places the concentrations of the remaining ions in order of decreasing concentration?
   a. [NO₃⁻] > [Pb²⁺] > [K⁺]
   b. [NO₃⁻] > [K⁺] > [Pb²⁺]
   c. [K⁺] > [NO₃⁻] > [Pb²⁺]
   d. [Pb²⁺] > [NO₃⁻] > [K⁺]
   e. [Pb²⁺] > [K⁺] > [NO₃⁻]

15. A solution is prepared for qualitative analysis. The solution contains: Co²⁺, Pb²⁺, and Al³⁺. Which of the following will cause no observation?
   a. Dilute NH₃(aq) is added.
   b. Dilute K₂CrO₄(aq) is added.
   c. Dilute HNO₃(aq) is added.
   d. Dilute K₂S(aq) is added.
   e. Dilute HCl(aq) is added.

16. Chlorine gas is bubbled through a colorless solution and the solution turns reddish. Adding a little methylene chloride to the solution extracts the color into the methylene chloride layer. Which of the following ions may be present in the original solution?
   a. Cl⁻
   b. I⁻
   c. SO₄²⁻
   d. Na⁺
   e. Br⁻

17. The addition of concentrated NaOH(aq) to a 1.0 M (NH₄)₂SO₄ solution will result in which of the following observations?
   a. The solution becomes neutral.
   b. The formation of a brown precipitate takes place.
   c. Nothing happens because the two solutions are immiscible.
   d. The odor of ammonia will be detected.
   e. An odorless gas forms and bubbles out of the mixture.

18. Which of the following solutions will give a yellow precipitate when a 0.10 M Na₂CrO₄ solution is added to a 0.1 M solution of the ion listed?
   a. K⁺(aq)
   b. Pb²⁺(aq)
   c. NO₃⁻(aq)
   d. OH⁻(aq)
   e. NH₄⁺(aq)

FREE-RESPONSE

19. Answer all of the following questions. Each question will have two parts—writing the balanced chemical equation and answering a question about the reaction. Coefficients in the balanced chemical equation must be in the lowest whole-number ratio. Do not include formulas for substances that remain unchanged during the reaction. Unless otherwise noted, assume all the reactions occur in aqueous solution. If a substance is extensively ionized and therefore present as ions in solution, write its formula as ions. EX: Hydrochloric acid is added to lead(II) nitrate solution. Pb²⁺ + 2Cl⁻ → PbCl₂

   a. Excess sodium hydroxide is added to an aluminum sulfate solution. Which species behaves as a Lewis acid in the reaction? Explain.

   b. An acidified iron(II) sulfate solution is added to a potassium permanganate solution. Describe the color change occurring as the reaction proceeds.

   c. Dichlorine heptaoxide is mixed with water. What is the oxidation number of the chlorine atom in the product?

   d. Metallic strontium is added to warm water. If phenolphthalein indicator is added to the resulting solution, what would be the color of the solution? Explain.

   e. Solid manganese(IV) oxide is added to concentrated hydrochloric acid. What is the oxidation number of the species being oxidized before and after the reaction takes place?

   f. A lead(II) nitrate solution is mixed with ammonium sulfate solution. Which ions are spectator ions in this reaction?

19. a. 4OH⁻ + Al³⁺ → Al(OH)₄⁻; Aluminum ion is the Lewis acid because it accepts a pair of electrons from hydroxide.
   b. 5Fe²⁺ + 8H⁺ + MnO₄⁻ → 5Fe³⁺ + Mn²⁺ + 4H₂O; The purple color of the permanganate ion slowly disappears as the reaction proceeds.
   c. Cl₂O₃ + H₂O → 2H⁺ + 2ClO₂⁻; The oxidation number of the chlorine in the perchlorate ion is +7.
   d. Sr + 2H₂O → Sr²⁺ + 2OH⁻ + H₂; The resulting solution is basic owing to the presence of the hydroxide ion. Phenolphthalein is pink in base, so the solution would be pink.
   e. MnO₂ + 4H⁺ + 2Cl⁻ → Mn²⁺ + Cl₂ + 2H₂O; Chlorine is being oxidized from -1 in the chloride ion to 0 in diatomic chlorine gas.
   f. Pb²⁺ + SO₄²⁻ → PbSO₄; The spectator ions are the nitrate ions and the ammonium ions.