

**I. Multiple Choice**

**20**

- |      |       |       |       |
|------|-------|-------|-------|
| 1. A | 6. B  | 11. A | 16. B |
| 2. A | 7. B  | 12. C | 17. A |
| 3. C | 8. B  | 13. D | 18. C |
| 4. C | 9. A  | 14. B | 19. D |
| 5. B | 10. D | 15. B | 20. B |

**II. Short Answer**

**35**

1. Calculate the concentration (molarity) of a solution prepared by dissolving 12.00 grams of potassium chloride, KCl, in water, for a total solution volume of 250.0 mL. **3**

***Molar mass of KCl = 74.6 g/mol***

$$M = \frac{\text{mol}}{\text{L}} = \frac{12.0 \text{ g}}{1} \times \frac{\text{mol}}{74.6 \text{ g}} \times \frac{1}{0.250 \text{ L}} = 0.643 \text{ M}$$

2. Calculate the mass of AgNO<sub>3</sub> required to make 200 mL of 0.40 M silver nitrate solution. **3**

***Molar mass of AgNO<sub>3</sub> is 169.9 g/mol***

$$g = \frac{169.9 \text{ g}}{\text{mol}} \times \frac{0.40 \text{ mol}}{1} \times \frac{0.200 \text{ L}}{1} = 13.6 \text{ g}$$

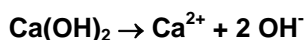
3. What volume of a 1.44 M solution of potassium sulfide ( $K_2S$ ) contains 113.0 g of  $K_2S$ ? 3

**Molar mass of  $K_2S = 110.3 \text{ g/mol}$**

$$L = \frac{L}{1.44 \text{ mol}} \times \frac{\text{mol}}{110.3 \text{ g}} \times \frac{113.0 \text{ g}}{1} = 0.712 \text{ L}$$

4. A solution is prepared by adding enough water to 5.88 g of calcium hydroxide,  $Ca(OH)_2$  to make a solution volume of 0.750 L.

- a) Write a balanced equation for the dissociation reaction. 1



- b) Calculate the concentration of the calcium hydroxide solution. 3

$$M = \frac{\text{mol}}{L} = \frac{5.88 \text{ g}}{1} \times \frac{\text{mol}}{74.1 \text{ g}} \times \frac{1}{0.750 \text{ L}} = 0.106 \text{ M}$$

- c) Determine the concentration of the calcium ions,  $Ca^{2+}$ , and hydroxide ions,  $OH^-$ . 2

$$[Ca^{2+}] = [Ca(OH)_2] = 0.106 \text{ M}$$

$$[OH^-] = 2 \times [Ca(OH)_2] = 0.212$$

5. What volume of a 2.00 M NaOH stock solution would you require in order to prepare 250 mL of a 0.600 M NaOH solution? 3

$$M_1V_1 = M_2V_2$$

$$(2.0 \frac{\text{mol}}{L})(V_1) = (0.600 \frac{\text{mol}}{L})(0.250 \text{ L})$$

$$V_1 = 0.075 \text{ L or } 75 \text{ mL}$$

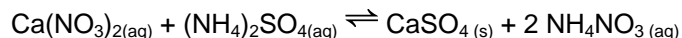
6. A contaminated sample of water contains 325 ppm of lead ions,  $Pb^{2+}$ . Calculate the concentration of lead ions in  $\text{mol} \cdot L^{-1}$ . Show all work. 2

**Molar mass of Pb = 207.2 g/mol**

$$\frac{\text{mol}}{L} = \frac{325 \text{ g}}{10^6 \text{ g}} = \frac{325 \text{ g}}{10^6 \text{ mL}} = \frac{325 \text{ g}}{10^3 \text{ L}} \times \frac{\text{mol}}{207.2 \text{ g}} = \frac{325 \text{ mol}}{2.07 \times 10^5 \text{ L}} = 1.57 \times 10^{-3} \text{ M}$$

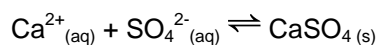
7. A calcium nitrate solution,  $\text{Ca}(\text{NO}_3)_2$ , is mixed with an ammonium sulfate solution,  $(\text{NH}_4)_2\text{SO}_4$ .

- a. Write a **balanced** equation for this reaction. You must indicate the physical state of all participants. This will include predicting any precipitates that might form.



- b. Write the **net ionic equation** for this reaction.

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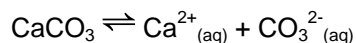


8. Write the equations for the reactions that occur when each of the following electrolytes is dissolved in water AND the solubility product expressions

Compound	Balanced Dissociation Equation	$K_{\text{sp}}$ Expression
$\text{Ba}(\text{OH})_2$	$\text{Ba}(\text{OH})_{2(\text{s})} \rightleftharpoons \text{Ba}^{2+}_{(\text{aq})} + 2 \text{OH}^{-}_{(\text{aq})}$	$K_{\text{sp}} = [\text{Ba}^{2+}][\text{OH}^{-}]^2$
$\text{Na}_2\text{CO}_3$	$\text{Na}_2\text{CO}_{3(\text{s})} \rightleftharpoons 2 \text{Na}^{+}_{(\text{aq})} + \text{CO}_3^{2-}_{(\text{aq})}$	$K_{\text{sp}} = [\text{Na}^{+}]^2[\text{CO}_3^{2-}]$

9. At a certain temperature a saturated solution of calcium carbonate,  $\text{CaCO}_3$ , has a concentration of  $7.1 \times 10^{-5} \text{ mol} \cdot \text{L}^{-1}$ . Calculate the value of  $K_{\text{sp}}$  of calcium carbonate.

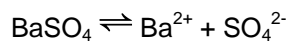
3



$$[\text{CaCO}_3] = [\text{Ca}^{2+}] = [\text{CO}_3^{2-}] = 7.1 \times 10^{-5} \text{ M}$$

$$K_{\text{sp}} = [\text{Ca}^{2+}][\text{CO}_3^{2-}] = (7.1 \times 10^{-5})(7.1 \times 10^{-5}) = 5.04 \times 10^{-9}$$

10. Calculate the concentrations of barium ions,  $\text{Ba}^{2+}$ , and sulfate ions,  $\text{SO}_4^{2-}$ , in a saturated aqueous solution of barium sulfate,  $\text{BaSO}_4$ , in which the value of  $K_{\text{sp}}$  is  $1.1 \times 10^{-10}$ .



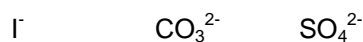
$$[\text{BaSO}_4] = [\text{Ba}^{2+}] = [\text{SO}_4^{2-}] = x$$

$$K_{\text{sp}} = [\text{Ba}^{2+}] [\text{SO}_4^{2-}]$$

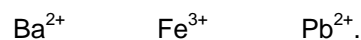
$$1.1 \times 10^{-10} = x^2$$

$$x = [\text{Ba}^{2+}] = [\text{SO}_4^{2-}] = 1.05 \times 10^{-5} \text{ M}$$

11. You are given a solution that contains the following anions



You wish to separate these ions by causing one, and only one, ion to precipitate out of solution at a time. In order to do so you are provided with the following cations in solution (all are nitrate compounds):



In what order should you add these solutions in order to remove one anion at a time from the original solution, by precipitation? Give the formulas of the three precipitates that you will be forming.

4

	$\text{I}^-$	$\text{CO}_3^{2-}$	$\text{SO}_4^{2-}$
$\text{Ba}^{2+}$	sol	ppt	ppt
$\text{Fe}^{3+}$	sol	ppt	sol
$\text{Pb}^{2+}$	ppt	ppt	ppt

First add  $\text{Fe}^{3+}$  to form the precipitate  $\text{Fe}_2(\text{CO}_3)_3$

Second add  $\text{Ba}^{2+}$  to form the precipitate  $\text{BaSO}_4$

Third add  $\text{Pb}^{2+}$  to form the precipitate  $\text{PbI}_2$