

**4 • Solution Stoichiometry****PRACTICE TEST**

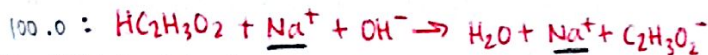
1. On the basis of the solubility rules, which of the following is insoluble?  
 a)  $K_2O$                       d)  $(NH_4)_2SO_4$   
 b)  $Na_2CO_3$                   e)  $Ba(C_2H_3O_2)_2$   
 c)  $PbS$  *(s) for insoluble*
2. In a double replacement reaction, formation of which of the following does not necessarily lead to a chemical change?  
 a)  $HC_2H_3O_2$                   d)  $H_2S$   
 b)  $AgCl$  *(s)*                  e)  $NaCl$   
 c)  $CO_2$  *(g)*                  *You need a precipitate, a gas, water, or a weak electrolyte.*
3. Reaction of an acid with a carbonate (such as  $CaCO_3$ ) always results in the formation of  
 a)  $O_2$                           d)  $O_3$   
 b)  $C$  (diamond)              e)  $CO_2$  and  $H_2O$   
 c)  $CH_4$   
*acid +  $CO_3^{2-} \rightarrow H_2CO_3 \rightarrow CO_2(g) + H_2O(l)$*
4. Which of the following is incorrect?  
 a) all salts containing  $NH_4^+$  are soluble.  
 b) all salts containing  $NO_3^-$  are soluble.  
 c) all fluorides are soluble. *(except  $CBS-PM$ )*  
 d) all sulfates (except those of  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ , and  $Pb^{2+}$ ) are soluble.  
 e) most hydroxides are insoluble, except those of  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ , the alkali metals and  $NH_4^+$ .
5. One of the gases shown below is NOT usually formed in a double replacement reaction. Which one?  *$AX + BY \rightarrow BX + AY$*   
 a)  $N_2$                           d)  $NH_3$   
 b)  $CO_2$                         e)  $H_2S$   
 c)  $SO_2$
6. Write the balanced molecular equation for the reaction of washing soda,  $Na_2CO_3$  and vinegar,  $HC_2H_3O_2$ .  
 $Na_2CO_3(aq) + 2HC_2H_3O_2(aq) \rightarrow 2NaC_2H_3O_2(aq) + H_2O(l) + CO_2(g)$
7. The net ionic equation for the above reaction is:  
 $CO_3^{2-}(aq) + 2HC_2H_3O_2(aq) \rightarrow 2C_2H_3O_2^-(aq) + H_2O(l) + CO_2(g)$
8. How many moles of  $H^+$  are associated with the acid,  $H_2SO_3$ , during neutralization?  
 a) 0      b) 1      c) 2      d) 3
9. How many moles  $Al_2O_3$  are needed to neutralize 1 mole of  $HCl$ ?  
 a)  $1/3$                           d) 6  
 b)  $2/3$                         e) 12  
 c) 2                              f)  $1/6$   
 $1 Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O(l)$
10. Write the net reaction that will occur when solid ammonium carbonate is added to a solution of hydrosulfuric acid.  
 $(NH_4)_2CO_3(s) + H_2S(aq) \rightarrow (NH_4)_2S(aq) + H_2O(l) + CO_2(g)$   
 $2NH_4^+(aq) + S^{2-}(aq)$

11. When  $\text{H}_2\text{SO}_4$  and  $\text{Ba}(\text{OH})_2$  are reacted in a double replacement reaction, one of the products of the reaction is...

- a)  $\text{H}_2$                       d)  $\text{BaH}_2$   
**b)  $\text{H}_2\text{O}$**                       e)  $\text{SO}_2$   
 c)  $\text{BaS}$                        *$\text{BaSO}_4$  is the other*

12. In the double replacement reaction between the weak acid,  $\text{HC}_2\text{H}_3\text{O}_2$  and strong base,  $\text{NaOH}$ , which ion(s) are spectator ions?

- a)  $\text{Na}^+$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$       d)  $\text{H}^+$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$   
 b)  $\text{Na}^+$ ,  $\text{OH}^-$               **e)  $\text{Na}^+$  only**  
 c)  $\text{OH}^-$  only



13. Which of the following is a base?

- a)  $\text{KOH}$**                       d)  $\text{CH}_3\text{OH}$  *not  $\text{OH}^-$  (alcohol)*  
 b)  $\text{C}_2\text{H}_5\text{OH}$  *not  $\text{OH}^-$  (alcohol)*      e)  $\text{CO}_2$   
 c)  $\text{Br}^-$

14. Which of the following is a strong acid?

- a)  $\text{H}_2\text{CO}_3$  *weak*              **d)  $\text{HClO}_3$**   
 b)  $\text{HF}$  *weak*                  **e)  $\text{HNO}_3$**   
 c)  $\text{H}_3\text{PO}_4$  *weak*              *oops, 2 answers.*

15. Which of the following is an acid in aqueous solutions?

- a)  $\text{H}_2\text{CO}_3$**   *$\text{H}^+\text{X}^-$*       d)  $\text{H}_2\text{O}$  *neutral*  
 b)  $\text{Al}_2\text{O}_3$                       e)  $\text{BaO}$   
 c)  $\text{CH}_4$  *neutral*

16.  $\text{SO}_2$  turns into which acid in solution?

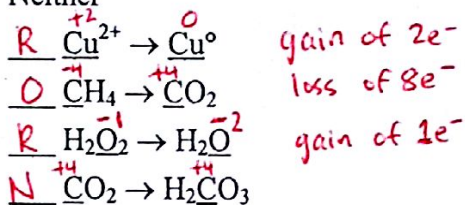
- a)  $\text{HNO}_3$                       d)  $\text{H}_2\text{S}$   
**b)  $\text{H}_2\text{SO}_3$**                       e)  $\text{HNO}_2$   
 c)  $\text{H}_2\text{SO}_4$                        *$\frac{\text{SO}_2 + \text{H}_2\text{O}}{\text{H}_2\text{SO}_3}$*

17. What is the oxidation number of C in  $\text{CO}_3^{2-}$ ?

- a) +6                              d) +1       *$x + 3(-2) = -2$*   
**b) +4**                              e) -1       *$x = +4$*   
 c) +2

18. What is the oxidation number of Br in  $\text{KBrO}_4$ ?  
 a) +1    b) -1    c) +5    **d) +7**    e) +8

19. For each change below, label the change of the underlined element as Oxidation, Reduction, or Neither



20. How many milliliters of 0.123 M  $\text{NaOH}$  solution contain 25.0 g of  $\text{NaOH}$  (molar mass = 40.00 g/mol)?

- a) 5.08 mL                      d) 625 mL  
 b) 50.8 mL                      **e) 5080 mL**  
 c) 508 mL

*$25.0 \text{ g NaOH} \times \frac{1 \text{ mol NaOH}}{40.00 \text{ g}} \times \frac{1000 \text{ mL}}{0.123 \text{ mol NaOH}} =$*

21. If you need 1.00 L of 0.125 M  $\text{H}_2\text{SO}_4$ , how would you prepare this solution?

- a) Add 950. mL of water to 50.0 mL of 3.00 M  $\text{H}_2\text{SO}_4$ .  
 b) Add 500. mL of water to 500. mL of 0.500 M  $\text{H}_2\text{SO}_4$ .  
 c) Add 750 mL of water to 250 mL of 0.375 M  $\text{H}_2\text{SO}_4$ .  
 d) Dilute 36.0 mL of 1.25 M  $\text{H}_2\text{SO}_4$  to a volume of 1.00 L.  
**e) Dilute 20.8 mL of 6.00 M  $\text{H}_2\text{SO}_4$  to a volume of 1.00 L.**

*$M_1V_1 = M_2V_2$   
 test each answer!  $\rightarrow$   $(6.00 \text{ M})(20.8 \text{ mL}) = (0.125 \text{ M})(1.00 \text{ L})$*

22. What is the ion concentration in a 0.12 M solution of  $\text{BaCl}_2$ ?

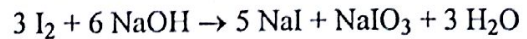
- a)  $[\text{Ba}^{2+}] = 0.12 \text{ M}$  and  $[\text{Cl}^-] = 0.12 \text{ M}$ .  
 b)  $[\text{Ba}^{2+}] = 0.12 \text{ M}$  and  $[\text{Cl}^-] = 0.060 \text{ M}$ .  
**c)  $[\text{Ba}^{2+}] = 0.12 \text{ M}$  and  $[\text{Cl}^-] = 0.24 \text{ M}$ .**  
 d)  $[\text{Ba}^{2+}] = 0.060 \text{ M}$  and  $[\text{Cl}^-] = 0.060 \text{ M}$ .  
 e)  $[\text{Ba}^+] = 0.12 \text{ M}$  and  $[\text{Cl}_2^-] = 0.12 \text{ M}$ .

23. What is the molarity of the solution that results when 60.0 g NaOH is added to enough water to make 500. mL solution?

- a) 1.33 M                      d) 8.0 M  
 b) 12.0 M                    e) 1.50 M

c) 3.00 M      $M = \frac{\text{moles NaOH}}{\text{Liters solution}} = \frac{(60.0 \text{ g NaOH} \times \frac{1 \text{ mol}}{40.0 \text{ g}})}{0.500 \text{ L}} =$

27. What volume of 0.150 M NaOH is needed to react completely with 3.45 g iodine according to the equation:



- a) 181 mL                      d) 2.04 mL  
 b) 45.3 mL                    e) 1.02 mL  
 c) 4.08 mL

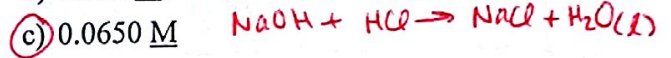
24. What is the molarity of the solution that results when 45.0 g HCl is dissolved in enough water to make 250. mL solution?

- a) 4.94 M                      d) 1.80 M  
 b) 4.50 M                    e) 1.46 M  
 c) 3.24 M

$M = \frac{\text{moles HCl}}{\text{Liters sol'n}} = \frac{(45.0 \text{ g HCl} \times \frac{1 \text{ mol}}{36.46 \text{ g}})}{0.250 \text{ L}} =$

28. What is the concentration of an NaOH solution if it takes 16.25 mL of a 0.100 M HCl solution to titrate 25.00 mL of the NaOH solution?

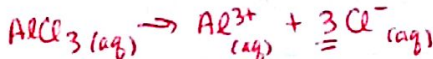
- a) 0.0165 M                      d) 0.100 M  
 b) 0.151 M                      e) 0.413 M



25. What is the concentration of Cl<sup>-</sup> ion in 0.60 M AlCl<sub>3</sub> solution?

$[\text{Cl}^-] = 3(0.60 \text{ M}) = 1.8 \text{ M}$

- a) 1.8 M                      d) 0.30 M  
 b) 0.60 M                    e) 0.10 M  
 c) 0.20 M

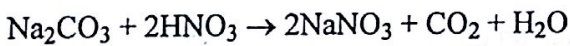


29. A 4.00 M solution of H<sub>3</sub>PO<sub>4</sub> will contain \_\_\_ g of H<sub>3</sub>PO<sub>4</sub> in 0.250 L of solution.

- a) 196 g                      d) 24.0 g  
 b) 98.0 g                      e) 12.0 g  
 c) 49.0 g

$0.250 \text{ L} \times \frac{4.00 \text{ mol}}{1 \text{ liter}} \times \frac{98.00 \text{ g H}_3\text{PO}_4}{1 \text{ mol}} = 98.0 \text{ g}$

30. How many grams of Na<sub>2</sub>CO<sub>3</sub> (molar mass = 106.0 g/mol) are required for complete reaction with 25.0 mL of 0.155 M HNO<sub>3</sub>?



- a) 0.122 g                      d) 20.5 g  
 b) 0.205 g                    e) 205 g  
 c) 0.410 g

$\frac{0.155 \text{ mol}}{1000 \text{ mL}} \times 25.0 \text{ mL} \times \frac{1 \text{ mol Na}_2\text{CO}_3}{2 \text{ mol HNO}_3} \times \frac{106.0 \text{ g Na}_2\text{CO}_3}{1 \text{ mol Na}_2\text{CO}_3} = 0.205 \text{ g}$

to find moles HNO<sub>3</sub>                      to find moles Na<sub>2</sub>CO<sub>3</sub>                      to find grams Na<sub>2</sub>CO<sub>3</sub>

27.)  $3.45 \text{ g I}_2 \times \frac{1 \text{ mol I}_2}{253.8 \text{ g I}_2} \times \frac{6 \text{ mol NaOH}}{3 \text{ mol I}_2} \times \frac{1000 \text{ mL}}{0.150 \text{ mol NaOH}} = 181.245 \text{ mL}$

to find moles I<sub>2</sub> (m.m.)                      to find moles NaOH (Stoich.)                      use M to find mL

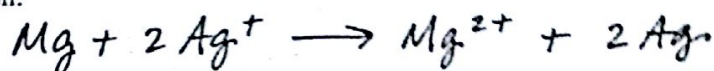
**4 • Solution Stoichiometry****PRACTICE FRQ**

For each of the following reactions, in part (i) write a balanced equation for the reaction and in part (ii) answer the question about the reaction. In part (i), coefficients should be in terms of lowest whole numbers. Assume that solutions are aqueous unless otherwise indicated. Represent substances in solutions as ions if the substances are extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction. You may use empty space at the bottom of the page for scratch work, but only equations that are written in the answer boxes provided will be graded.

**EXAMPLE:**

A strip of magnesium metal is added to a solution of silver(I) nitrate.

(i) Balanced equation:

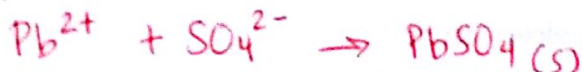


(ii) Which substance is oxidized in the reaction?

Mg is oxidized.

- a) Solutions of lead(II) nitrate and sulfuric acid are mixed.

(i) Balanced equation:



(ii) If the reaction mixture is filtered, what substance will end up in the filter?

The solid PbSO<sub>4</sub> will be on the filter.

- b) A strip of magnesium metal is placed in a solution of iron(II) chloride.

(i) Balanced equation:



(ii) Which chemical is the oxidizing agent?

FeCl<sub>2</sub> is the oxidizing agent since Fe<sup>2+</sup> is being reduced.