STAWA SET 11

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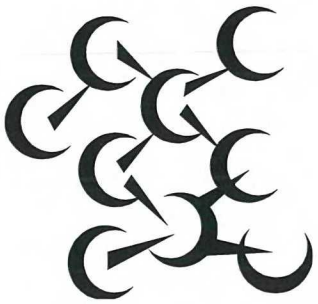


1. The equation for the combustion of butane is:

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

Calculate the number of moles of:
(a) CO_2 produced in the combustion of 1.00 moles of C_4H_{10}
(b) H_2O produced in the combustion of 3.00 moles of C_4H_{10}
(c) O_2 consumed in the combustion of 0.600 moles of C_4H_{10}

2. 0.0300 moles of magnesium oxide is completely dissolved in nitric acid to form a solution of magnesium nitrate.

$$MgO + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$$

or $$MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)$$

Calculate the number of moles and masses of:
(a) nitric acid required, and
(b) magnesium nitrate formed.

3. When silver nitrate solution is added to a solution of calcium chloride, a white precipitate of silver chloride is produced.

$$CaCl_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgCl$$

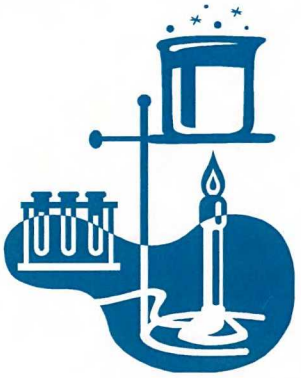
or $$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

If 0.200 moles of silver chloride is formed, calculate the number of moles and masses of:
(a) silver nitrate required,
(b) calcium chloride required, and
(c) calcium nitrate formed in solution.

4. A sample of copper(II) oxide was dissolved in sulfuric acid and the solution evaporated to dryness to yield 3.14 g of $CuSO_4.5H_2O$.

$$CuO + H_2SO_4 + 4H_2O \rightarrow CuSO_4.5H_2O$$

(a) Calculate the mass of sulfuric acid required.
(b) Calculate the moles of copper(II) oxide dissolved.



5. Write a balanced equation for the decomposition of potassium chlorate ($KClO_3$) into potassium chloride and oxygen gas by heating. How many moles of oxygen would be formed from the decomposition of 0.800 mol of $KClO_3$?

6. Write a balanced equation for the decomposition of mercury(II) oxide into mercury and oxygen gas (O_2). What mass of oxygen would be formed from the decomposition of 0.240 mol of mercury(II) oxide?

7. Excess nitric acid was added to 3.00 g of calcium carbonate.

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

or $$CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$$

Calculate the masses of:
(a) nitric acid consumed,
(b) carbon dioxide produced, and
(c) calcium nitrate formed in solution.

8. Sulfuric acid solution containing 20.0 g of pure H_2SO_4 was added to 6.08 g of magnesium to produce hydrogen gas.

$$Mg(s) + H_2SO_4(aq) + 7H_2O \rightarrow H_2(g) + MgSO_4.7H_2O(s)$$

(a) Identify the limiting reactant.
(b) What mass of hydrogen is produced?
(c) What mass of magnesium sulfate crystals ($MgSO_4.7H_2O$) would be obtained if the solution was evaporated to dryness?

9. 1.600 g of sodium hydroxide is added to a solution containing 1.472 g of H_2SO_4.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

or $$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

(a) Identify the limiting reactant.
(b) Calculate the mass of sodium sulfate formed in solution.
(c) Calculate the mass of unused reactant remaining in solution.

10. The overall reaction for the manufacture of superphosphate is:

$$Ca_3(PO_4)_2 + 4H_3PO_4 \rightarrow 3Ca(H_2PO_4)_2$$

25.0 tonnes of calcium phosphate ($Ca_3(PO_4)_2$) is heated with 30.0 tonnes of phosphoric acid (H_3PO_4). What mass of calcium dihydrogenphosphate $Ca(H_2PO_4)_2$ is formed?

11. When 7.20 g of impure anhydrous sodium carbonate was treated with excess dilute hydrochloric acid, 2.94 g of carbon dioxide was produced.

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

or $$Na_2CO_3(s) + 2H^+(aq) \rightarrow 2Na^+(aq) + H_2O(l) + CO_2(g)$$

Calculate the percentage purity of the sodium carbonate.

12. The equation for the reaction of manganese dioxide with hot concentrated hydrochloric acid is:

$$MnO_2(s) + 4HCl(aq) \rightarrow Cl_2(g) + MnCl_2(aq) + 2H_2O(l)$$

or $$MnO_2(s) + 4H^+(aq) + 2Cl^-(aq) \rightarrow Cl_2(g) + Mn^{2+}(aq) + 2H_2O(l)$$

When 3.52 g of impure manganese dioxide was treated with excess hydrochloric acid, 2.84 g of chlorine was evolved. Calculate the percentage purity of the manganese dioxide.

13. A load of quarried limestone contains 92.0% $CaCO_3$, the remainder being silica (SiO_2). The limestone is to be heated to form quicklime (CaO)

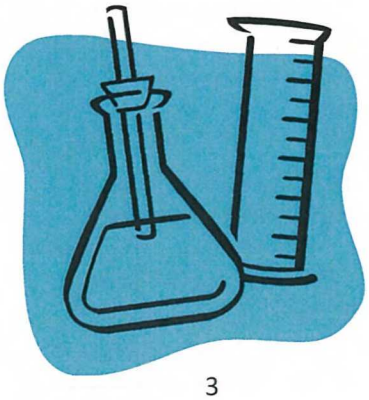
$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(a) What mass of quicklime could be produced by heating 500.0 kg of the limestone?
(b) What mass of carbon dioxide would be produced?

14. Sulfuric acid can be manufactured from iron pyrites according to the following sequence of reactions:

$$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$$
$$2SO_2 + O_2 \rightarrow 2SO_3$$
$$SO_3 + H_2O \rightarrow H_2SO_4$$

(a) Calculate the mass of sulfuric acid which could be obtained from 1.00 kg of pure iron pyrites.
(b) If the iron pyrites is only 85.0% pure, what mass of sulfuric acid could be produced from 1.00 kg of impure ore?



15. Sodium carbonate is commonly manufactured by the Solvay Process which involves the following reactions:

$$NH_3 + H_2O + CO_2 \rightarrow NH_4HCO_3$$
$$NH_4HCO_3 + NaCl \rightarrow NH_4Cl + NaHCO_3$$
$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$
$$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$$

Calculate the masses of ammonia and sodium chloride required to produce 200.0 kg of pure sodium carbonate decahydrate.

16. A 0.7941 g sample of cast iron was heated in oxygen to convert the carbon it contained to carbon dioxide. The carbon dioxide produced was absorbed in potassium hydroxide solution to form potassium hydrogencarbonate.

$$C(s) + O_2(g) \rightarrow CO_2(g)$$
$$CO_2(g) + KOH(aq) \rightarrow KHCO_3(aq)$$

If the mass of the potassium hydroxide solution increased by 0.0732 g, calculate the percentage of carbon in the cast iron.

17. Some potassium chlorate was decomposed to produce oxygen gas. This oxygen gas reacted to form a layer of oxide ions on the surface of a sheet of clean magnesium.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

How many oxygen molecules were formed in the decomposition, if the sheet of magnesium increased in mass by 0.124 mg?

Set 11 **SOLUTIONS**

1. (a) 4.00 mol
   (b) 15.0 mol
   (c) 3.90 mol

2. (a) 6.00×10^{-2} mol HNO_3, 3.78 g HNO_3
   (b) 3.00×10^{-2} mol $Mg(NO_3)_2$, 4.45 g $Mg(NO_3)_2$

3. (a) 2.00×10^{-1} mol $AgNO_3$, 34.0 g $AgNO_3$
   (b) 1.00×10^{-1} mol $CaCl_2$, 11.1 g $CaCl_2$
   (c) 1.00×10^{-1} mol $Ca(NO_3)_2$, 16.4 g $Ca(NO_3)_2$

4. (a) 1.23 g
   (b) 1.26×10^{-2} mol

5. $2KClO_3 \rightarrow 2KCl + 3O_2$, 1.20 mol

6. $2HgO \rightarrow 2Hg + O_2$, 3.84 g

7. (a) 3.78 g
   (b) 1.32 g
   (c) 4.92 g

8. (a) H_2SO_4
   (b) 4.08×10^{-1} g
   (c) 50.2 g

9. (a) H_2SO_4
   (b) 2.13 g
   (c) 4.00×10^{-1} g NaOH

10. 53.8 tonne

11. 98.4 % pure

12. 98.8% pure

13. (a) 2.58×10^5 g
    (b) 2.02×10^5 g

14. (a) 1.64×10^3 g
    (b) 1.39×10^3 g

15. 2.38×10^4 g NH_3
    8.18×10^4 g NaCl

16. 2.51% C

17. 2.33×10^{18} oxygen molecules