Chemistry 11

Name: Key
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Percent Purity

1. Consider the reaction of magnesium hydroxide with phosphoric acid:

$$\underline{3}\ Mg(OH)_2 + \underline{2}\ H_3PO_4 \rightarrow \underline{\quad}\ Mg_3(PO_4)_2 + \underline{6}\ H_2O$$

impure / sample — pure makes pure!

Calculate the mass of $Mg(OH)_2$ needed to make 127 g of $Mg_3(PO_4)_2$. Assume the $Mg(OH)_2$ is 88.5% pure.

$$127\,g\,Mg_3(PO_4)_2 \times \frac{1\,mol\,Mg_3(PO_4)_2}{262.87\,g\,Mg_3(PO_4)_2} \times \frac{3\,mol\,Mg(OH)_2}{1\,mol\,Mg_3(PO_4)_2} \times \frac{58.33\,g\,Mg(OH)_2}{1\,mol\,Mg(OH)_2} = 84.5\,g \text{ pure } Mg(OH)_2$$

$$\%\text{ Purity} = \frac{\text{pure}}{\text{sample}} \times 100\% \rightarrow 88.5\% = \frac{84.5\,g}{x} \times 100\% \rightarrow \boxed{x = 95.5\,g \text{ sample } Mg(OH)_2}$$

2. Consider the reaction:

$$\underline{4}\ KO_2 + \underline{2}\ CO_2 \rightarrow \underline{2}\ K_2CO_3 + \underline{3}\ O_2$$

impure — pure makes pure!

a. A 30.0 g sample of KO_2 is 59.3% pure. What mass of K_2CO_3 can the sample produce?

$$\%\text{ Purity} = \frac{\text{pure}}{\text{sample}} \times 100\% \rightarrow 59.3\% = \frac{x}{30.0\,g\,KO_2} \times 100\% \rightarrow x = 17.8\,g \text{ pure } KO_2$$

$$17.8\,g \text{ pure } KO_2 \times \frac{1\,mol\,KO_2}{71.10\,g\,KO_2} \times \frac{2\,mol\,K_2CO_3}{4\,mol\,KO_2} \times \frac{138.21\,g\,K_2CO_3}{1\,mol\,K_2CO_3} = \boxed{17.3\,g \text{ pure } K_2CO_3}$$

sample — pure

b. Another sample of KO_2 with a mass of 150.0 g is reacted so as to produce 89.7 g of K_2CO_3. What is the percentage purity of KO_2?

$$89.7\,g \text{ pure } K_2CO_3 \times \frac{1\,mol\,K_2CO_3}{138.12\,g\,K_2CO_3} \times \frac{4\,mol\,KO_2}{2\,mol\,K_2CO_3} \times \frac{71.10\,g\,KO_2}{1\,mol\,KO_2} = 92.3\,g \text{ pure } KO_2$$

$$\%\text{ Purity} = \frac{\text{pure}}{\text{sample}} \times 100\% \rightarrow \frac{92.3\,g}{150.0\,g} \times 100\% \rightarrow \boxed{61.5\%\ KO_2}$$

sample

3. If 72.1 g of FeO produces 12.9 g of pure Fe according to the reaction:

$$\underline{2}\ FeO + \underline{2}\ C + \underline{\quad}\ O_2 \rightarrow \underline{2}\ Fe + \underline{2}\ CO_2$$

What is the percentage purity of the FeO used?

$$12.9\,g \text{ pure } Fe \times \frac{1\,mol\,Fe}{55.85\,g\,Fe} \times \frac{2\,mol\,FeO}{2\,mol\,Fe} \times \frac{71.85\,g\,FeO}{1\,mol\,FeO} = 16.6\,g \text{ pure } FeO$$

$$\%\text{ purity} = \frac{\text{pure}}{\text{sample}} \times 100\% \rightarrow \frac{16.6\,g\,FeO}{72.1\,g\,FeO} \times 100\% = \boxed{23.0\%\ FeO}$$

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Percent Yield

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4. Potassium chlorate decomposes to form potassium chloride and oxygen gas.
   a. What is the balanced reaction?

$$2\ KClO_3 \rightarrow 2\ KCl + 3O_2$$

5.95 g ; ? g → theoretical

   b. When 5.95 g of potassium chlorate decomposes, 1.45 g of oxygen gas is given off. Calculate the percentage yield of oxygen.

↳ actual

$$5.95\,g\,KClO_3 \times \frac{1\,mol\,KClO_3}{122.55\,g\,KClO_3} \times \frac{3\,mol\,O_2}{2\,mol\,KClO_3} \times \frac{32.00\,g\,O_2}{1\,mol\,O_2} = 2.33\,g\,O_2 \leftarrow \text{theoretical}$$

$$\%\ yield = \frac{actual}{theoretical} \times 100\% = \frac{1.45\,g\,O_2}{2.33\,g\,O_2} \times 100\% = \boxed{62.2\%\ O_2}$$

5. When 50.0 g of iron metal is reacted with copper (II) sulfate, 43.0 g of copper metal is recovered.

↳ actual

   a. What is the balanced reaction?

$$Fe + CuSO_4 \rightarrow Cu + FeSO_4$$

50.0 g ; ? g → theoretical

   b. Determine the percentage yield of copper.

$$50.0\,g\,Fe \times \frac{1\,mol\,Fe}{55.85\,g\,Fe} \times \frac{1\,mol\,Cu}{1\,mol\,Fe} \times \frac{63.55\,g\,Cu}{1\,mol\,Cu} = 56.9\,g\,Cu$$

$$\%\ yield = \frac{actual}{theoretical} \times 100\% = \frac{43.0\,g\,Cu}{56.9\,g\,Cu} \times 100\% = \boxed{75.6\%\ Cu}$$

6. Consider the following reaction:

★ 2 possible reactants! Which one is limiting?

$$\_\_\ C_3H_8 + \underline{5}\ O_2 \rightarrow \underline{3}\ CO_2 + \underline{4}\ H_2O$$

19.0 g ; 32.0 g ; ? g → theoretical

32.0 g of oxygen reacts with 19.0 g of C_3H_8. The experiment gives 2.00 g H_2O. What is the % yield?

← actual

We have to try both reactants... :)

$$19.0\,g\,C_3H_8 \times \frac{1\,mol\,C_3H_8}{44.11\,g\,C_3H_8} \times \frac{4\,mol\,H_2O}{1\,mol\,C_3H_8} \times \frac{18.02\,g\,H_2O}{1\,mol\,H_2O} = \cancel{31.0\,g\,H_2O}$$ excess

$$32.0\,g\,O_2 \times \frac{1\,mol\,O_2}{32.00\,g\,O_2} \times \frac{4\,mol\,H_2O}{5\,mol\,O_2} \times \frac{18.02\,g\,H_2O}{1\,mol\,H_2O} = 14.4\,g\,H_2O$$ limiting!

↑ theoretical

$$\%\ yield = \frac{actual}{theoretical} \times 100\% = \frac{2.00\,g\,H_2O}{14.4\,g\,H_2O} \times 100\% = \boxed{13.9\%\ H_2O}$$

1. 95.5 g $Mg(OH)_2$ 2a. 17.3 g KO_2 2b. 61.5% KO_2 3. 23.0% FeO 4a. $2KClO_3 \rightarrow 2KCl + 3O_2$ 4b. 62.2% O_2 5a. $Fe + CuSO_4 \rightarrow Cu + FeSO_4$ 5b. 75.6% Cu 6. 13.9% H_2O