

1. The solubility of melamine,  $C_3H_6N_6$ , in water is 3.1 g/L at 20°C. How many mols of the element nitrogen are there in a liter of melamine solution that is saturated with that amount of melamine?

$$\text{mol. wt.} = 3(12.011) + 6(1.0079) + 6(14.007) = 126.1 \text{ g/mol} \quad (3)$$

$$3.1 \text{ g melamine} \rightarrow \frac{3.1 \text{ g}}{126.1 \text{ g/mol}} = 0.0246 \text{ mol melamine} \quad (3)$$

$$6 \text{ N per melamine} \quad (6)$$

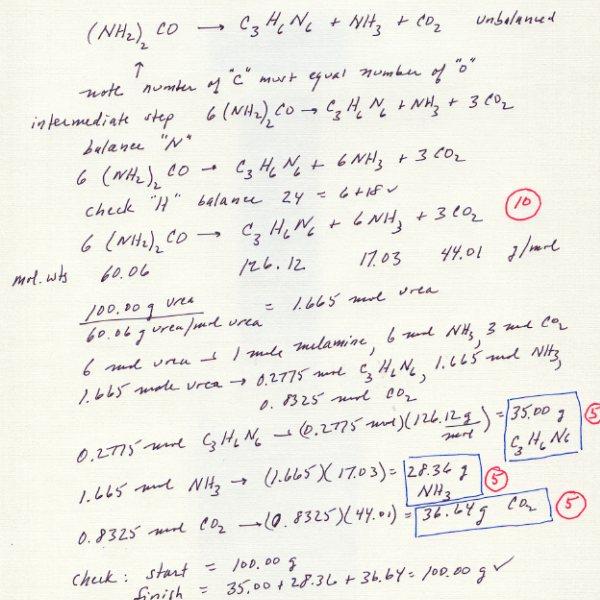
$$\rightarrow 6(0.0246) \text{ mol N} = 0.148 \text{ mol N} \quad (15)$$

How many g of nitrogen does this correspond to?

$$(0.148 \text{ mol N}) \rightarrow (0.148 \text{ mol})(14.007 \frac{\text{g}}{\text{mol}})$$

$$= 2.07 \text{ g N} \quad (10)$$

2. Melamine,  $C_3H_6N_6$ , has been in the news the past several weeks as a toxic substance illegally used to raise the nitrogen content of milk and other products in China. It is prepared as a product from urea ( $NH_2)_2CO$  as the only starting material. The other chemicals produced in the reaction besides melamine itself are ammonia,  $NH_3$ , and carbon dioxide,  $CO_2$ . If exactly 100.00 g of urea are allowed to react completely, how many g of what final substances remain when the reaction has ended? (Show all work.)



3. You have 200.00 grams of a mixture of manganese ores pyrolusite ( $MnO_2$ ) and hausmannite ( $Mn_3O_4$ ). The mixture is converted to metallic manganese (Mn) by heating with carbon (C) to produce carbon dioxide as a waste product. When you are finished and isolate the pure manganese metal, it has a mass of 136.40 grams. What is the percent by mass of the original mixture that is pyrolusite? (You can verify your answer by working backwards.)

A mixture problem!

$$x = \text{g of } MnO_2 \quad (\text{mol. wt.} = 86.94 \text{ g/mol})$$

$$200.00 - x = \text{g of } Mn_3O_4 \quad (\text{mol. wt.} = 228.81 \text{ g/mol})$$

$$MnO_2 + C \rightarrow Mn + CO_2 \quad (5)$$

$$MnO_2 \xrightarrow{86.94} \frac{x}{86.94} \text{ mol} \rightarrow \frac{x}{86.94} \text{ mol Mn}$$

$$= \frac{x}{86.94} (54.94) \text{ g Mn} = 0.6319x \text{ g Mn} \quad (10)$$

$$Mn_3O_4 + 3C \rightarrow 3Mn + 2CO_2$$

$$Mn_3O_4 \xrightarrow{228.81} \frac{200-x}{228.81} \text{ mol} \rightarrow 3 \left( \frac{200-x}{228.81} \right) \text{ mol Mn}$$

$$\rightarrow 3 \left( \frac{200-x}{228.81} \right) 54.94 \text{ g Mn} = (144.07 - 0.7203x) \text{ g Mn} \quad (5)$$

$$Mn \quad 136.40 \text{ g} = (0.6319x + 144.07 - 0.7203x) \text{ g}$$

$$0.0884x = 7.67$$

$$x = 86.76 \quad (3)$$

$$MnO_2 \text{ is } \frac{86.76}{200.00} (100\%) = 43.4\% \text{ of total} \quad (25)$$

4. Oil of wintergreen is a natural product of many species of plants. Recent indications are that it is a defense against plant-eating insects functioning to attract other insects that feed on the harmful ones. Chemical analysis by mass shows it to be C 63.154%, H 5.300%, and O 31.546%. What is the empirical formula for this substance consistent with the precision of the analysis? (Show all steps.)

Assume you have 100.000 g of compound

$$63.154 \text{ g C} \rightarrow \frac{63.154 \text{ g C}}{12.011 \text{ g C/mol C}} = 5.258 \text{ mol C} \quad (5)$$

$$5.300 \text{ g H} \rightarrow \frac{5.300 \text{ g}}{1.0079 \text{ g/mol}} = 5.258 \text{ mol H} \quad (5)$$

$$31.546 \text{ g O} \rightarrow \frac{31.546 \text{ g}}{15.999 \text{ g/mol}} = 1.972 \text{ mol O} \quad (5)$$

mol is a number

C : H : O = 5.258 : 5.258 : 1.972

Divide by 1.972 (seeking integers)

C : H : O = 2.666 : 2.666 : 1

Note 2.666 = 2 2/3

Multiply by 3

C : H : O → 7.998 : 7.998 : 3

= 8 : 8 : 3

