Some More Challenging Stoichiometry Questions p69b

1. Methanol, CH_3OH, and ethanol, C_2H_5OH, can be used as fuel for a burner. The following diagrams show the energy released during the combustion of one mole of each substance.

   If you burn one mole of methanol you will release 730 kJ
   If you burn one mole of ethanol you will release 1370 kJ

   Which of the two combustion reactions illustrated above releases the most energy when 1 g of substance is burned?

   1 g CH_3OH (mole/ 32 g) = 0.03125 moles CH_3OH
   1 g C_2H_5OH (mole/ 46 g) = 0.0217moles C_2H_5OH

   Methanol : 730 kJ/mole (0.03125 moles CH_3OH) = 22.81 kJ
   Ethanol: 1370 kJ(0.0217moles C_2H_5OH) = 29.72 kJ

2. While you are running, your body requires 2500 kJ/hr. It has been determined that 60% of this energy requirement is provided by the combustion of glucose ($C_6H_{12}O_6$) metabolized in your body.
   The equation for the combustion of glucose is:

   $$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 2816\ kJ$$

   How many grams of glucose will be metabolized during a two-hour run?

   You need 2500 kJ/hr (2 hr) = 5000 kJ

   60%:
   0.60(5000 kJ) = 3000 kJ will come from glucose

   1 mole/2816kJ* (3000 kJ) = 1.06 moles of glucose

   1.06 moles $C_6H_{12}O_6$ (180 g/mole) =190.8 g

3. Patrick wonders which gas he should choose for a gas fireplace for his country cottage. He is hesitating between propane (C_3H_8) and butane (C_4H_{10}).

   The combustion equations are:

   $$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O + 2233\ kJ$$
   $$2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O + 5306\ kJ$$

Knowing that the containers of gas are 5 kg each:

A) Which gas provides the most energy?

B) Which gas produces less carbon dioxide?

A) 5000 g (1 mole C_3H_8 /44 g) = 113.63 moles C_3H_8

2233 kJ /mole (113.63 moles C_3H_8) = 253 735.79 kJ

5000 g (1 mole C_4H_{10} **/58 g) = 86.2 moles C_4H_{10}**

5306 kJ /2 moles (86.2 moles C_4H_{10}) = 228 688 kJ ; propane releases more.

B)

5000 g (1 mole C_3H_8 /44 g) = 113.63 moles C_3H_8

113.63 moles C_3H_8 (3 CO_2/ C_3H_8) = 340.89 moles of CO_2

5000 g (1 mole C_4H_{10} **/58 g) = 86.2 moles C_4H_{10}**

86.2 moles C_4H_{10} (8 CO_2/2 moles C_4H_{10}**) = 344.8 moles CO_2 ; butane produces more ; propane produces less**

4. Gasoline (octane), C_8H_{18}, has a density of 703 g/L. Knowing that a car has a gas consumption of 6.0 L/100 km on a highway, how many moles of carbon dioxide are produced by the car after travelling 200 km on the highway? (Don't forget to write a balanced equation)

200 km(6 L/ 100km) = 12 L

12 L (703 g/L) = 8436 g of gasoline have to be burnt

8436 g of gasoline(mole/114 g) = 74 moles

74 moles C_8H_{18} (8 CO_2/ 1 C_8H_{18}) = 592 moles