Problem 2.7

In this problem, we start to see some of the problem solving techniques that are important when you are learning new material. We will describe the steps that it takes to solve the problem and our thought processes that we used to solve the problem.

Problem Statement:
A supersonic aircraft consumes 5320 imperial gallons of kerosene/hour of flight and flies an average of 14 hours/day. It takes roughly seven tons of crude oil to produce one tone of kerosene. The density of kerosene is 0.965 g/cm^3. How many planes would it take to consume the entire annual world production of 4.02 x 10^9 metric tons of crude oil?

Steps:

1) Read the problem to get a sense of what it is telling you.

2) Read the problem again and write down all the information:

5320 gallons/hr
14 hr/day
7tons oil/1 ton kerosene
density kerosene = 0.965 g/cm^3
4.02 x 10^9 tons oil/yr

3) Start solving the problem:

$$\frac{5320\ \text{gal}}{\text{hr}} \left| \frac{14\ \text{hr}}{\text{day}} \right. = \frac{74480\ \text{gal}}{\text{day}}$$

} This operation got rid of hours from the problem

Now I got stuck. After doing some thinking, it occurred to me that I can calculate the total amount of kerosene produced annually:

$$4.02 \times 10^9 \frac{\text{tons oil}}{\text{year}} \left| \frac{1\ \text{ton kerosene}}{7\ \text{tons oil}} \right. = 5.74 \times 10^8 \frac{\text{tons kerosene produced}}{\text{year}}$$

Now, I can use the density of kerosene to convert from volume to mass. But first I need to convert the density from g/cm^3 to g/gal:

$$\frac{0.965\ \text{g}}{\text{cm}^3} \left| \frac{10^6\ \text{cm}^3}{220.83\ \text{gal}} \right. = 4.36 \times 10^3 \frac{\text{g}}{\text{gal}}$$

Now combine other units to get:

$$4.36 \times 10^3 \frac{\text{g}}{\text{gal}} \left| \frac{74480\ \text{gal}}{\text{day}} \right. = 3.24 \times 10^8 \frac{\text{g}}{\text{day}}$$

Now, also convert:

$$3.24 \times 10^8 \frac{\text{g}}{\text{day}} \left| \frac{1\ \text{kg}}{1000\ \text{g}} \right| \frac{1\ \text{ton}}{1000\text{kg}} \left| \frac{365\ \text{day}}{\text{yr}} \right. = 1.18 \times 10^5 \frac{\text{tons needed}}{\text{plane yr}}$$

So,

$$5.74 \times 10^8 \frac{\text{ton produced}}{\text{yr}} \left| \frac{\text{plane yr}}{1.18 \times 10^5\ \text{ton}} \right. = \boxed{4864\ \text{planes}}$$

In hindsight, I can now look at this problem to see what it was really all about.

This problem really concentrated on two major aspects for beginning problem solvers. The first issue was to test to see if I could read a complex problem statement and try to understand what the problem was all about. The second issue was to see if I understand unit conversions. Without knowing how to write down all the important information and without being able to use unit conversions, I would not have been able to solve this problem. I will make a note to myself that concepts important from this material are:
1) reading a complex problem statement correctly
2) being able to use unit conversions