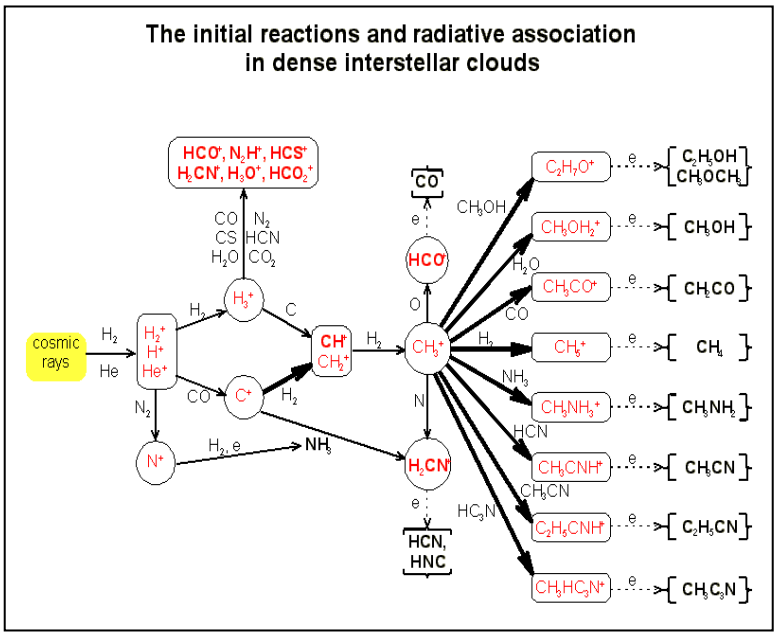

Because molecules and atoms come in 'integer' packages, the ratios of various molecules or atoms in a compound are often expressible in simple fractions. Adding compounds together can often lead to interesting mixtures in which the proportions of the various molecules involve mixed numbers.

The figure shows some of the ways in which molecules are synthesized in interstellar clouds. (Courtesy D. Smith and P. Spanel, "Ions in the Terrestrial Atmosphere and in Interstellar Clouds", *Mass Spectrometry Reviews*, v.14, pp. 255-278.)

In the problems below, do not use a calculator and state all answers as simple fractions or integers.

Problem 1 - <u>What makes your car go</u>: When 2 molecules of gasoline (ethane) are combined with 7 molecules of oxygen you get 4 molecules of carbon dioxide and 6 molecules of water.

A) What is the ratio of ethane molecules to water molecules?
B) What is the ratio of oxygen molecules to carbon dioxide molecules?
C) If you wanted to 'burn' 50 molecules of ethane, how many molecules of water result?
D) If you wanted to create 50 molecules of carbon dioxide, how many ethane molecules would you have to burn?

Problem 2 - <u>How plants create glucose from air and water:</u> Six molecules of carbon dioxide combine with 6 molecules of water to create one molecule of glucose and 6 molecules of oxygen.

A) What is the ratio of glucose molecules to water molecules?
B) What is the ratio of oxygen molecules to the total number of carbon dioxide and water molecules?
C) If you wanted to create 120 glucose molecules, how many water molecules are needed?
D) If you had 100 molecules of carbon dioxide, what is the largest number of glucose molecules you could produce?

Answer Key

Problem 1 - What makes your car go: When 2 molecules of gasoline (ethane) are combined with 7 molecules of oxygen you get 4 molecules of carbon dioxide and 6 molecules of water.

A) In this reaction, 2 molecules of ethane yield 6 molecules of water, so the ratio is 2/6 or 1/3.
B) 7 oxygen molecules and 4 carbon dioxide molecules yield the ratio 7/4

C) The reaction says that 2 molecules of ethane burn to make 6 molecules of water. If you start with 50 molecules of ethane, then you have the proportion:

$$\frac{50 \text{ ethane}}{2 \text{ ethane}} = \frac{x\text{-water}}{6 \text{ -water}} \quad \text{so} \quad X = 25 \times 6 = 150 \text{ water molecules.}$$

D) Use the proportion:

$$\frac{50 \text{ Carbon Dioxide}}{4 \text{ carbon dioxide}} = \frac{X \text{ ethane}}{2 \text{ ethane}} \quad \text{so} \quad X = 2 \times (50/4) = 25 \text{ molecules ethane}$$

Problem 2 - How plants create glucose from air and water: Six molecules of carbon dioxide combine with 6 molecules of water to create one molecule of glucose and 6 molecules of oxygen.
A) What is the ratio of glucose molecules to water molecules?
B) What is the ratio of oxygen molecules to the total number of carbon dioxide and water molecules?
C) If you wanted to create 120 glucose molecules, how many water molecules are needed?
D) If you had 100 molecules of carbon dioxide, what is the largest number of glucose molecules you could produce?

A) Glucose molecules /water molecules = 1 / 6

B) Oxygen molecules / (carbon dioxide + water) = 6 / (6 + 6) = 6/12 = 1/2

C)

$$\frac{120 \text{ glucose}}{1 \text{ glucose}} = \frac{X \text{ water}}{6 \text{ water}} \quad \text{so} \quad X = 6 \times 120 = 720 \text{ water molecules}$$

D)

$$\frac{100 \text{ carbon dioxide}}{6 \text{ carbon dioxide}} = \frac{X \text{ glucose}}{1 \text{ glucose}} \quad \text{so} \quad X = 100/6 \text{ molecules.}$$

The problem asks for the largest number that can be made, so we cannot include fractions in the answer. We need to find the largest multiple of '6' that does not exceed '100'. This is 96 so that 6 x 16 = 96. That means we can get no more than 16 glucose molecules by starting with 100 carbon dioxide molecules. (Note that 100/6 = 16.666 so '16' is the largest integer).