Chemistry / Environmental Studies L111
Environmental Concerns and Chemical Solutions
Professor Dransfield
Homework 5: Due March 8, 2007

#17. a. 4.26 μm = 4.26 x 10^{-6} m = λ

$$E = h\nu = h\frac{c}{\lambda} = 6.626x10^{-34}\,Js\frac{3.00x10^{8}\,m/s}{4.26x10^{-6}\,m} = 4.67x10^{-20}\,J$$

15.00 μm = 1.500 x 10^{-5} m = λ

$$E = h\nu = h\frac{c}{\lambda} = 6.626x10^{-34}\,Js\frac{3.00x10^{8}\,m/s}{1.500x10^{-5}\,m} = 1.33x10^{-20}\,J$$

b. The energy from the photon is absorbed, causing the molecule to vibrate, but the energy is eventually lost to friction as the molecule moves. As friction heats surrounding molecules, this is the same as being re-emitted as heat.

#24. a. One silver atom weighs 107.9 amu.
1 amu = 1.66 x 10^{-24} g

$$\frac{107.9amu}{1Ag\,atom}\times\frac{1.66\times10^{-24}g}{1amu} = \frac{1.79\times10^{-22}g}{1Ag\,atom}$$

So one silver atom weighs 1.79 x 10^{-22} g.

b. 10 trillion = 10 x 10^{12} = 10^{13}
So ten trillion silver atoms is 10^{13} Ag atoms

$$10^{13}Ag\ atoms\times\frac{1.79\times10^{-22}g}{1Ag\,atom} = 1.79\times10^{-9}g$$

And ten trillion silver atoms weigh 1.79 x 10^{-9} g.

c. If we have 5.00 x 10^{45} silver atoms, then

$$5.00\times10^{45}Ag\ atoms\times\frac{1.79\times10^{-22}g}{1Ag\,atom} = 8.95\times10^{23}g$$

And our 5.00 x 10^{45} silver atoms weigh 8.95 x 10^{23} g.

#25. The periodic table tells us that the molar mass of H is 1.008 g/mol,
the molar mass of O is 16.00 g/mol,
the molar mass of C is 12.01 g/mol,
the molar mass of Cl is 35.45 g/mol,
the molar mass of F is 19.00 g/mol,
and the molar mass of N is 14.01 g/mol.

a. H_2O has a molar mass of (1.008 + 1.008 + 16.00)g/mol or 18.016 g/mol.
b. CCl_2F_2 has a molar mass of (12.01 + 35.45 + 35.45 + 19.00 + 19.00) g/mol or 120.91 g/mol.

c. NO (5th edition) has a molar mass of (14.01 + 16.00) g/mol or 30.01 g/mol.
CO (4th edition) has a molar mass of 28.01 g/mol.

#40. a. $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

b. According to the balanced equation, 1 moles of ethanol will burn to produce 2 moles of carbon dioxide.

$$1 mol\, C_2H_5OH \times \frac{2 mol\, CO_2}{1 mol\, C_2H_5OH} = 2 mol\, CO_2$$

Numbers from balanced equation

c. According to the balanced equation, 10 moles of ethanol will burn completely only if we have 30 moles of oxygen.

$$10 mol\, C_2H_5OH \times \frac{3 mol\, O_2}{1 mol\, C_2H_5OH} = 30 mol\, O_2$$

#41. a. C_6H_{14} + 19/2 $O_2 \rightarrow$ 6 CO_2 + 7 H_2O
OR
2 C_6H_{14} + 19 $O_2 \rightarrow$ 12 CO_2 + 14 H_2O

b. C_8H_{18} + 25/2 $O_2 \rightarrow$ 8 CO_2 + 9 H_2O
OR
2 C_8H_{18} + 25 $O_2 \rightarrow$ 16 CO_2 + 18 H_2O

c. Octane produces more CO2 per mole than does hexane – 8 moles of CO2 per mole octane, as compared to 6 moles of CO2 per mole of hexane.

#42. The absorption of IR radiation does not destroy the molecule in any way. As long as the molecule remains in the troposphere it is able to absorb and re-emit IR radiation. The longer the molecule remains in the troposphere the more frequently it participates in the greenhouse effect, thus the more it is able to contribute to global warming.

#45. The molar mass of methane is 12.011 + (4 x 1.008) = 16.043 g/mol. Of this, 12.011 g is carbon. So, 12.011/16.043 = 74.9% of that mass is carbon. 74.9% x 73 million tons = 55 million tons of carbon.

#56. 1 SCF of CH_4 = 1196 mol CH_4 at 15.6˚C.

a. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

The balanced chemical reaction tells us that for every 1 mole of methane burned we are going to produce 1 mole of carbon dioxide. So when we burn 1 SCF of CH_4, which contains 1196 mol CH_4 then we are going to produce that exact same number of moles of CO_2. So 1196 mol of CO_2

will be produced by burning 1196 mol of CH_4. Mathematically, we can calculate this in the following manner:

$$1196\,mol\,CH_4 \times \frac{1\,mol\,CO_2}{1mol\,CH_4} = 1196\,mol\,CO_2$$

b. So now we've created 1196 moles of carbon dioxide, we know by looking at the periodic table that ONE mole of carbon dioxide has a mass of 44.01 grams. So every single one of the 1196b moles of carbon dioxide we have just produced weighs 44.01 grams, making for a total mass of carbon dioxide produced of (44.01*1196) 52,634 grams which is the same as 52.6 kg. Mathematically we can calculate this in the following manner.

$$1196\,mol\,CO_2 \times \frac{44.01g\,CO_2}{1mol\,CO_2} \times \frac{1kg}{1000\,g} = 52.64\,kg\,CO_2$$

c. In appendix 1 we learn that 1 metric ton (t) = 1000 kg so if we have 52.64 kg of carbon dioxide, dividing this number by 1000 tells us the number of metric tons of CO_2 we are producing.

$$52.64\,kg\,CO_2 \times \frac{1t}{1000\,kg} = 0.05264\,t\,CO_2$$

d. Appendix 1 also tells us that 1 metric ton (t) = 2200 lb, so multiplying the number of tons of CO_2 produced by 2200 will tell us the number of pounds of CO_2 produced by the burning of 1 standard cubic foot of natural gas.

$$0.05264\,t\,CO_2 \times \frac{2200\,lb}{1t} = 115.8\,lb\,CO_2$$

#58 a. There is clear correlation between the per capita GDP and the per capita CO_2. Richer countries emit MORE CO_2 per capita than poorer nations. This is presumably linked to richer nations having easier access to both the technology required for such consumption, but also easier access to the fuel itself.

b. This is a question with a very long answer. Some things you should consider: what is likely to happen to the GDP of developing nations? what would this likely cause in terms of CO_2 emissions? how does the "per capita" part play in, both now and in the future?