ENSCI 524B – Assignment #2 Solutions
Photochemical Reactions

8.12 Indicate whether the following halocarbons are CFCs, HCFCs, HFCs, or halons, and give their designation numbers:

(a) C_3HF_7
- ✓ C_3HF_7 is an HFC, or hydrofluorocarbon, designation number $HFC-227$

(b) $C_2FH_3Cl_2$
- ✓ $C_2FH_3Cl_2$ is an HCFC, or hydrochlorofluorocarbon, designation number $HCFC-141$

(c) $C_2F_4Cl_2$
- ✓ $C_2F_4Cl_2$ is a CFC, or chlorofluorocarbon, designation number $CFC-114$

(d) CF_3Br
- ✓ CF_3Br is a halon, designation number $H-1301$

8.13 Write chemical formulas for the following:

(a) $HCFC-225$
- ✓ The chemical formula for $HCFC-225$ is $C_3HF_5Cl_2$

(b) $HFC-32$
- ✓ The chemical formula for $HFC-32$ is CH_2F_2

(c) $H-1301$
- ✓ The chemical formula for $H-1301$ is CF_3Br

(d) $CFC-114$
- ✓ The chemical formula for $CFC-114$ is $C_2F_4Cl_2$

8.36 The photon energy required to cause the following reaction to occur is $306\frac{kj}{mol}$. What is the maximum wavelength that the photon can have (you might want to refer back to Example 2.6)?

$$NO_2 + h\nu \rightarrow NO + O$$

✓ $\lambda_m \leq \frac{1.19\times10^{-4}\left(kJ\cdot\frac{m}{mol}\right)}{\Delta H^0\left(\frac{kJ}{mol}\right)} = \frac{1.19\times10^{-4}\left(kJ\cdot\frac{m}{mol}\right)}{306\left(\frac{kJ}{mol}\right)} = 3.89\times10^{-7}m = 389\,nm$

8.37 Photodissociation of oxygen requires $495\frac{kJ}{mol}$. What maximum wavelength can the photon have to drive this reaction (refer to Example 2.6)?

$$O_2 + h\nu \rightarrow O + O$$

✓ $\lambda_m \leq \frac{1.19\times10^{-4}\left(kJ\cdot\frac{m}{mol}\right)}{\Delta H^0\left(\frac{kJ}{mol}\right)} = \frac{1.19\times10^{-4}\left(kJ\cdot\frac{m}{mol}\right)}{495\left(\frac{kJ}{mol}\right)} = 2.40\times10^{-7}m = 240\,nm$

In reality, wavelengths of up to 290 nm can achieve this reaction, important in the stratosphere to make ozone.

9.6 Assuming that Figure 9-4 represents the relationship between NO_x, VOC, and O_3 concentrations for an urban area, determine the percent reduction or increase in the ozone concentration for the following strategies. The concentration of VOCs is $1.2\ ppmC$ and the concentration of NO_x is 0.08 ppm. Assume that a reduction in the VOC and NO_x emissions is equivalent to the reduction in the concentration of these pollutants. (a) Reduce NO_x emissions by 75 percent while holding VOCs constant, (b) Reduce VOC emissions by 75 percent while holding NO_x constant, (c) Reduce NO_x and VOCs by 75 percent.

(a) Reduce NO_x emissions by 75 percent while holding VOCs constant
- ✓ With NO_x concentration decreased from 0.08 ppm to 0.02 ppm and the VOC concentration held constant at $1.2\ ppmC$, we would see a decrease in O_3 concentration from 0.27 ppm to 0.11 ppm which is a 59% reduction in ozone concentration.

(b) Reduce VOC emissions by 75 percent while holding NO_x constant
- ✓ With VOC concentration decreased from $1.2\ ppmC$ to $0.3\ ppmC$ and the NO_x concentration held constant at 0.08 ppm, we would see a decrease in O_3 concentration from 0.27 ppm to 0.13 ppm which is a 52% reduction in ozone concentration.

(c) Reduce NO_x and VOCs by 75 percent
- ✓ With NO_x concentration decreased from 0.08 ppm to 0.02 ppm and the VOC concentration decreased from $1.2\ ppmC$ to $0.3\ ppmC$, we would see a decrease in O_3 concentration from 0.27 ppm to 0.09 ppm which is a 67% reduction in ozone concentration.

It is to be expected that values calculated will vary as reading these graphs is challenging for accurate readings. Your % removals could easily be 5% or more lower or higher.