## EVE 290

Introduction to Environmental Engineering

## HW \#4 <br> (These aren't from our text)

1. 

Suppose total world energy consumption of fossil fuels, equal to $3 \times 10^{17} \mathrm{~kJ} / \mathrm{yr}$, were to be obtained entirely by combustion of petroleum with the approximate chemical formula $\mathrm{C}_{2} \mathrm{H}_{3}$. Combustion of petroleum releases about $43 \times 10^{3} \mathrm{~kJ} / \mathrm{kg}$.
(a) Estimate the emissions of $\mathrm{CO}_{2}$ per year
(b) What is the ratio of grams of $C$ emitted per unit of energy for petroleum vs. methane? Use the results of the example problem completed in class.
2.

Water is frequently disinfected with chlorine gas, forming hypochlorous acid (HOCl), which partially ionizes to hypochlorite and hydrogen ions as follows:

$$
\mathrm{HOCl} \leftrightarrow \mathrm{H}^{+}+\mathrm{OCl}^{-} \quad \text { with equilibrium constant } \mathrm{K}=2.9 \times 10^{-8}
$$

The amount of [ HOCl ], the desired disinfectant, depends on the pH . Find the fraction that is hypochlorous acid, that is

$$
\frac{[\mathrm{HOCl}]}{[\mathrm{HOCl}]+\left[\mathrm{OCl}^{-}\right]}
$$

as a function of pH . What would the hypochlorous fraction be for $\mathrm{pH}=6.8$ and 10?

## 3

Hydrogen sulfide $\left(\mathrm{H}_{2} \mathrm{~S}\right)$ is an odorous gas that can be stripped from solution in a process similar to that described in the classroom example for ammonia. The reaction is

$$
\mathrm{H}_{2} \mathrm{~S} \leftrightarrow H^{+}+\mathrm{HS}^{-} \quad \text { with K }=0.86 \times 10^{-7}
$$

Find the hydrogen sulfide fraction at pH 6 and pH 8 .
4.

Suppose the gas above the soda in a bottle of soft drink is pure $\mathrm{CO}_{2}$ at a pressure of 2 atm . Calculate $\left[\mathrm{CO}_{2}\right]$ at $25^{\circ} \mathrm{C}$.

