

## *Problem set 1—due Monday, September 6*

1) Hydrogen has been suggested as an alternate fuel source for automobiles. Combustion of hydrogen produces 120 kJ/g hydrogen.

a) Calculate the mass of hydrogen which would give off as much energy during combustion as one liter (1000 ml) of gasoline. (hint—use Table 1.4 in Spiro, and assume the density of gasoline is about 0.65 g/ml)

b) Why is hydrogen an attractive alternative to petroleum-based fuels?

c) The main problem with hydrogen as automobile fuel is how to store it. Explain why storage of hydrogen is so difficult.

b) Hydrogen gas is absorbed by platinum metal (the hydrogen atoms actually bind reversibly to the platinum atoms to make a metal hydride). At room temperature and pressure, one cubic centimeter of platinum (which weighs about 21.5 grams) can contain up to 0.070 grams of hydrogen. Calculate the mass of platinum that would be needed to store the mass of hydrogen you calculated in part c. Now check the current price of platinum metal (try the financial pages of a newspaper, or online) and estimate the cost of this much platinum.

2) Answers should focus on the chemistry involved.

a) What is octane rating, why is it important, and how do gasoline formulators control the octane ratings of their products?

b) how do cars produce sulfur dioxide and nitrogen oxides?

c) why do diesel trucks emit so much black smoke?

d) In Table 1.4 in Spiro, the fuel energy content per gram of natural gas, petroleum, coal, ethanol, and cellulose are listed. What trend is observed, and what is the chemical reason for the trend?

e) what is smog?

3) Strain your imagination and posit that Congress passes a \$2/gallon gasoline (and diesel) tax in 2000; this would bring the average price of motor fuel to about \$3.50 per gallon, comparable to the price in Western Europe and Japan.

a) Estimate the anticipated revenue from this tax. State your assumptions and show all calculations.

b) Predict the impact of the tax on life in America.

- The impact will be different for people in different circumstances—be explicit about **which groups of Americans** your answers apply to! A list of groups and effects is fine, you don't have to write an essay. This answer should take about 1 page.