Assignment #3 Physics 346

Due 4:30 pm **Friday** February 3, 2012

Use Phys 346 drop box located at entrance to Physics Dept. off main floor of AQ.

1. It is often claimed that electric cars are impractical because the electricity would have to be provided by burning fossil fuels. Let's assume a typical car in North America consumes 70 kWhr of chemical energy to drive 100 km. Existing electric cars can achieve approximately 20 kWh of electric energy per 100 km. Suppose that instead of burning the gasoline in a car, we burn it in a power plant with a conversion efficency of 45%. How much chemical energy from gasoline is required to drive the electric car 100 km? Note that burning gasoline in fossil plants makes no sense: it would be better to burn the crude oil directly and eliminate the energy cost of refining the gasoline. This would achieve even greater efficiencies.

2. BC annual natural gas consumption for residential space heating is approximately 2×10^9 cubic meters. The state of the art chemical conversion efficiency for a household furnace is around 97%. The heat of combustion for natural gas is approximately 39 MJ/m^3. Calculate the heat in kWh delivered to the houses of BC based on 97% efficient furnaces. Suppose we delivered the same amount of heat using electric powered heat pumps with a COP of 3.5.*

   (a) How much electrical energy would be required in kWh?

   (b) If this power were derived from natural gas power plants with a conversion efficiency of 45%, how much natural gas would be required in cubic meters?

   (c) What fraction of the current gas consumption does this represent?

   *Note: COP for a residential heat pump is defined as $|Q_H|/|W|$. For a fridge it is $|Q|_C/|W|$.

3. According to the BC hydro website, hydro generates 43,000 gigawatt hours of electricity each year. Calculate how many tons of CO_2 would be released into the air annually if BC generated this power by burning anthracite coal with an energy content of 27 MJ/kg. Assume that the coal is burned in fossil fuel power plants with a thermodynamic efficiency of 40%. To estimate the CO_2 produced assume that the coal is pure carbon and that the chemical reaction is $C+O_2 \rightarrow CO_2$. (Consult the periodic table for atomic mass information).

4. Questions from Chapter 4 of your text: # 10, 11, 14, 16