Assignment 3 Solutions

From "Chemistry in Context" (E-reserve) Chapter 4: #7, 9, 10, 13, 25, 27, 41, 53.

7. 1.20×10^7 kJ

9. b. ΔH = -43 kJ/mol. The reaction is exothermic.

   c. No, many of the C-H bonds stay in tact in the reaction, and they would appear on both sides of the equation. Thus, they cancel out and can be omitted from the calculation.

10. a. exothermic

    b. endothermic

    c. endothermic

    d. exothermic

13. a. -106 kJ/mol, exothermic

    b. -146 kJ/mol, exothermic

    c. -1 kJ/mol, slightly exothermic

25. Energy is never created or destroyed, so the total energy in the universe is constant. However, the energy may not be in useful form. As we use energy to do work and power our lives, we transform it from useful forms (e.g. fossil fuels) to non-useful forms (heat, friction). Hence, there can be an energy crisis when there is not enough energy readily available in useful forms.

27. a. The heats of combustion of octane and butane are 5450 kJ/mol and 2859 kJ/mol, respectively. On a per mass basis, however, these are 47.8 kJ/g and 49.3 kJ/g. Octane is a bigger molecule containing more atoms and more bonds, hence it has a higher heat of combustion per molecule (or per mole). On a per gram basis, however, the two are nearly equal. In fact, butane has a slightly higher heat of combustion per gram. Mass is the important measure when transporting and buying or selling energy sources, and this calculation shows there's no great advantage to large molecules over smaller ones.

    b. There is a trend toward smaller heat of combustion per gram with increasing size of the molecule, so we would expect the heat of combustion per gram of candle wax to be smaller than that of octane. The heat of combustion per mol of candle wax, however, would be larger than that of octane.

41. In general, the heat of combustion of oxygenated fuels is lower than the heat of combustion of non-oxygenated fuels. The heat of combustion of MTBE is -3167 kJ/mol or -35.9 kJ/g. (Note ΔH for the reaction is -6334 kJ, but this is for combustion of 2 moles of MTBE, since in the balanced combustion reaction MTBE has a coefficient of 2. Hence, we must divide by 2 to get the heat of combustion per mole of MTBE.)

53. n-octane and isooctane have the same heat of combustion because they have the same number and type of bonds. The bonds are simply arranged differently in the two molecules.