Review: Energy Changes, Rates of Reaction and Nuclear Energy

Questions 1 - 3

1. a) exothermic
   b) endothermic
   c) exothermic
   d) exothermic
   e) exothermic (in the forward direction)

2. $q = cm\Delta T$ = 4.1796 J/g°C x 500 g x 0.4 °C
   = 835.92 J = 0.8$\underline{3}$592 kJ
   # mol = 10 g x (1 mol / 16 g) = 0.6$\underline{2}$5
   kJ/mol = 0.8$\underline{3}$592 kJ/0.6$\underline{2}$5 mol= $\underline{1}$.3 kJ/mol

3. $2 Na(s) + C(s) + 1.5 O_2(g) \rightarrow Na_2CO_3(s)$
   $\Delta H^°_f$= -1131 kJ/mol

Questions 4 - 5

4. $2N_2 + 6O_2 + 2H_2 \rightarrow 4HNO_3$ -696.4
   $4HNO_3 \rightarrow 2N_2O_5 + 2H_2O$ 153.2
   $2H_2O \rightarrow 2H_2 + O_2$ 571.6
   $2N_2 + 5O_2 \rightarrow 2N_2O_5$ 28.4 kJ
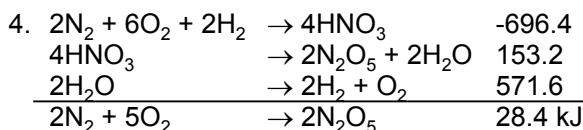
5. $\Delta H^°$
   = [$\Delta H^°$ of Na_2CO_3 + $\Delta H^°_f$ of H_2O + $\Delta H^°_f$ of CO_2]
      – [$\Delta H^°_f$ of $NaHCO_3$]
   = [1 mol (-1131kJ/mol) + 1 mol (-241.8 kJ/mol)
      + 1 mol (-393.5 kJ/mol)]
      – [2 mol (-947.7kJ/mol]
   = (-176$\underline{6}$.3 kJ) – (-1895.4 kJ)   = 12$\underline{9}$.1 kJ

Question 6 - 7

6.
   $N_2O_4(g)$
        ΔH = 9.67 kJ
   $N_2(g) + 2O_2(g)$

7.
   $N_2O + 1.5 O_2$
   ΔH = 81.57 kJ ΔH = 71.9 kJ
   N_2O_4
        ΔH = 9.67 kJ
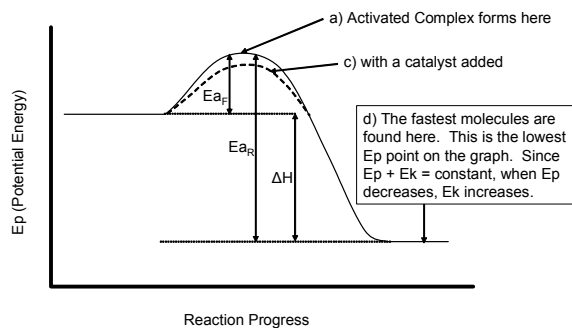 $N_2 + 2O_2$
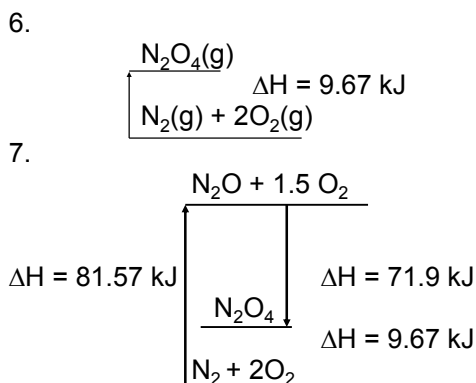
Question 8 - 9

8. M-B and Ek are the same (fraction or percent of molecules versus kinetic energy). Ep is potential energy versus path of reaction (similar to time over which the reaction occurs)

9.

Question 10

a) Activated Complex forms here

c) with a catalyst added

d) The fastest molecules are found here. This is the lowest Ep point on the graph. Since Ep + Ek = constant, when Ep decreases, Ek increases.

Ep (Potential Energy)

Reaction Progress
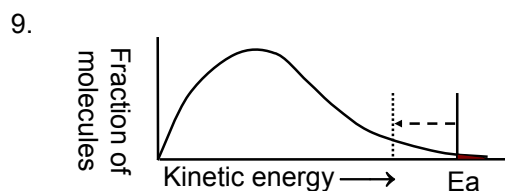
11. Chemicals in solution are spread out. Also, mixed aqueous solutions are homogeneous. Thus, reaction rates increase because the reactants have a better chance of meeting.

12. 1) Nature of reactants: different reactants will require different minimum kinetic energies. 2) The ability of reactants to meet: means more collisions per second. 3) Concentration of reactants: means a higher rate of collisions. 4) Temperature: high temperatures mean more collisions per unit time and more kinetic energy (more successful collisions). 5) Catalysts: these lower the energy required for a successful collision (by lowering Ea).

Question 13 - 14

13. Fusion: atomic nuclei or nucleons join. Fission: a nucleus splits into smaller nuclei. Radiation: the emission of EM energy or nuclear particles (similar to fission, except that smaller units are given off)

14. $^{228}_{90}Th \rightarrow {}^{4}_{2}He + {}^{224}_{88}Ra$
   $^{202}_{82}Pb + {}^{0}_{-1}e \rightarrow {}^{202}_{81}Tl$
   $^{140}_{56}Ba \rightarrow {}^{0}_{-1}e + {}^{140}_{57}La$
   $^{18}_{9}F \rightarrow {}^{0}_{1}e + {}^{18}_{8}O$