ENERGY CHANGES IN CHEMICAL REACTIONS

EXERCISES: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

68. You can think of the above reaction as occuring in two steps. (The reaction DOES NOT go this way, but it is convenient to pretend.)

    Step 1: $CH_4 + 2O_2 \longrightarrow C + 4H + 4O$ (the reactants are broken down to individual atoms)
    Step 2: $C + 4H + 4O \longrightarrow CO_2 + 2H_2O$ (the individual atoms are assembled into products)

    (a) Does step 1 absorb or give off energy?
    (b) Does step 2 absorb or give off energy?
    (c) Since the overall reaction is exothermic, which step involves more energy: step 1 or step 2?

69. The energy needed to break an H–Cl bond is 432 kJ: $HCl + 432\ kJ \longrightarrow H + Cl$. How many kilojoules of energy are given off in the reaction: $H + Cl \longrightarrow HCl + \_\_\ kJ$? Why?

70. Is the burning of wood exothermic or endothermic?

71. Is the melting of sugar exothermic or endothermic?

72. A beaker becomes warm when a reaction occurs in it. Are the chemicals in the beaker gaining or losing energy? Is the reaction endothermic or exothermic?

73. Which contain more energy in an endothermic reaction: the reactants or products?

74. In an exothermic reaction, do you have to add or remove energy in order to allow products to form?

75. Is $\Delta H > 0$ or $\Delta H < 0$ for an endothermic reaction? Is $\Delta H > 0$ or $\Delta H < 0$ for an exothermic reaction?

76. Draw an energy diagram having $\Delta H = +25$ kJ.

77. Draw an energy diagram having $\Delta H = -50$ kJ.

78. $\Delta H = -50$ kJ for the reaction: $F \longrightarrow G$. Re–write this equation to show the 50 kJ properly on the reactant or product side.

79. If a reaction absorbs 30 kJ of heat, what is ΔH for the reaction?

80. If $P \longrightarrow Q + 25$ kJ, what is ΔH for the reaction? Which have more energy, the reactants or products?

Answers

68. (a) Step 1 absorbs energy to break bonds.
    (b) Step 2 gives off energy as bonds are made.
    (c) Step 2 gives off more energy than step 1 absorbs.

69. $H + Cl \longrightarrow HCl + 432\ kJ$. The two reactions are exact opposites of each other, including the heat term.

70. Exothermic; heat is produced

71. Endothermic; heat is absorbed by the sugar in order to melt

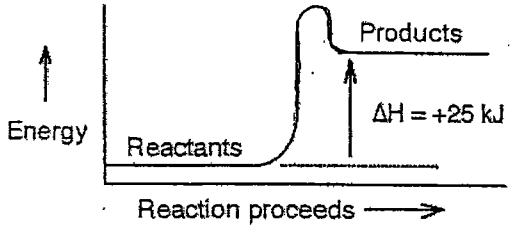
72. Chemicals are **losing** energy to the surrounding beaker. The reaction is exothermic.

73. Products. The reactants gain energy and become high energy products.

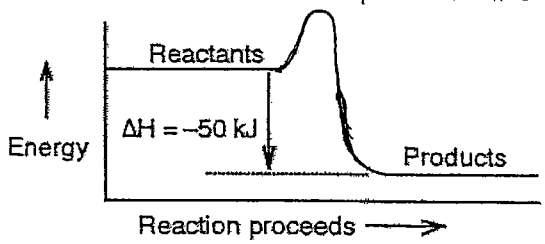
74. Energy is removed from reactants as lower energy products are formed.

75. Since $H_{REACTANTS} < H_{PRODUCTS}$; then $\Delta H = H_{PRODUCTS} - H_{REACTANTS} > 0$ for an endothermic reaction.
    Since $H_{REACTANTS} > H_{PRODUCTS}$; then $\Delta H = H_{PRODUCTS} - H_{REACTANTS} < 0$ for an exothermic reaction.

76. The actual energies of the reactants and products are not important; only the energy difference matters.



77. Again; only the energy difference of the reactants and products matters.



78. $F \longrightarrow G + 50\ kJ$

79. $\Delta H = +30\ kJ$

80. $\Delta H = -25\ kJ$; the reactants have more energy.