CHEMISTRY 11 – ENERGY CHANGES IN CHEMICAL REACTIONS WORKSHEET

1) You can think of the reaction $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O + 891$ kJ as occurring in two steps. (The reaction **does not** go this way, but it is convenient to pretend.)

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

   (a) Does step 1 absorb or give off energy? **(1 mark)**

   Since this step involves the **breaking of bonds** in the reactants to form the products, energy must have been **absorbed**.

   (b) Does step 2 absorb or give off energy? **(1 mark)**

   Since this step involves the **formation of new bonds** between the reactants to form the products, energy must have been **given off**.

   (c) Since the overall reaction is exothermic, which step involves more energy? **(1 mark)**

   Since the overall reaction is exothermic, more energy must have been given off then absorbed, therefore **step 2** involves more energy

2) Is the burning of wood exothermic or endothermic? **(1 mark)**

   Exothermic since heat is produced.

3) Is the melting of sugar exothermic or endothermic? **(1 mark)**

   Endothermic since energy is absorbed by the sugar in order to melt.

4) 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? **(2 marks)**

   If the beaker is releasing heat, energy is being produced therefore the chemicals in the beaker are **losing energy**. This type of reaction is **exothermic**, since the energy is leaving the system and going into the surroundings.

5) Which contain more energy in an endothermic reaction: the reactants or products? **(1 mark)**

   Since endothermic reactions involve energy being absorbed from the surroundings, the **products** contain more energy.

6) In an exothermic reaction, do you have to add or remove energy in order to allow products to form? **(1 mark)**

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

7) Is $\Delta H > 0$ or $\Delta H < 0$ for an endothermic reaction? Is $\Delta H > 0$ or $\Delta H < 0$ for an exothermic reaction? **(2 marks)**

   Endothermic reactions have a $\Delta H > 0$, while exothermic reactions have a $\Delta H < 0$.

8) Rewrite the following reactions including the energy term. **(4 marks)**

a) $2\ NO_{(g)} + O_{2\ (g)} \rightarrow 2\ NO_{2\ (g)}$ $\Delta H = +112$ kJ

$2\ NO_{(g)} + O_{2\ (g)} + 112\ kJ \rightarrow 2\ NO_{2\ (g)}$

b) $C_{(s)} + O_{2\ (g)} \rightarrow CO_{2\ (g)}$ $\Delta H = -394$ kJ

$C_{(s)} + O_{2\ (g)} \rightarrow CO_{2\ (g)} + 394\ kJ$

c) $CaO_{(s)} + 3\ C_{(s)} \rightarrow CaC_{2\ (s)} + CO_{(g)}$ $\Delta H = +464.8$ kJ

$CaO_{(s)} + 3\ C_{(s)} + 464.8\ kJ \rightarrow CaC_{2\ (s)} + CO_{(g)}$

d) $CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2\ (aq)}$ $\Delta H = -65.2$ kJ

$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2\ (aq)} + 65.2\ kJ$

9) Determine the ΔH for the following reactions and state whether the reaction is endothermic or exothermic. **(4 marks)**

a) $CH_{4\ (g)} + 2\ O_{2\ (g)} \rightarrow CO_{2\ (g)} + 2\ H_2O_{(l)} + 890.3$ kJ

$\Delta H = -890.3$ kJ exothermic

b) $2\ Na_2O_{2\ (s)} + 2\ H_2O_{(l)} + 287.0\ kJ \rightarrow 4\ NaOH_{(aq)} + O_{2\ (g)}$

$\Delta H = +287.0$ kJ endothermic

c) $2\ H_{2\ (g)} + O_{2\ (g)} \rightarrow 2\ H_2O_{(l)} + 572$ kJ

$\Delta H = -572$ kJ exothermic

d) $28\ kJ + H_{2\ (g)} + I_{2\ (g)} \rightarrow 2\ HI_{(g)}$

$\Delta H = +28$ kJ endothermic

10) When carbon monoxide and nitrogen dioxide react, 234 kJ is released. Which of the following correctly represent this reaction? **(2 marks)**

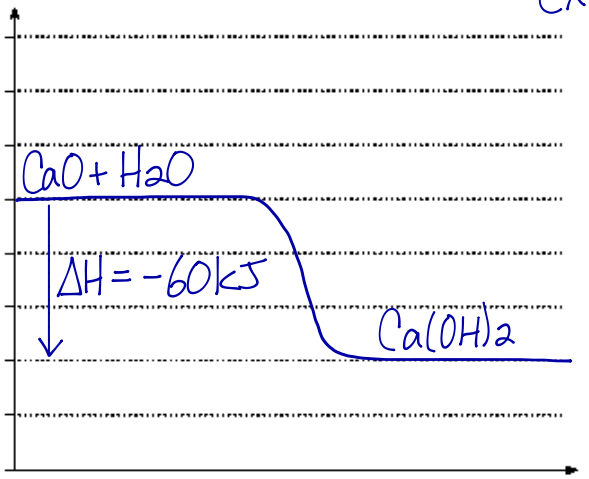
I	$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g) + 234\ kJ$
II	$CO(g) + NO_2(g) + 234\ kJ \rightarrow CO_2(g) + NO(g)$
III	$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g) \quad \Delta H = +234\ kJ$
IV	$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g) \quad \Delta H = -234\ kJ$

234 kJ of energy being released is an exothermic reaction, which is represented correctly by equations I & IV

11) Consider the following reaction:

$$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2\,(aq)} \qquad \Delta H = -60.0\ kJ$$

Draw the energy diagram for the above reaction. **(2 marks)** ΔH is negative ∴ exothermic ∴ curve down



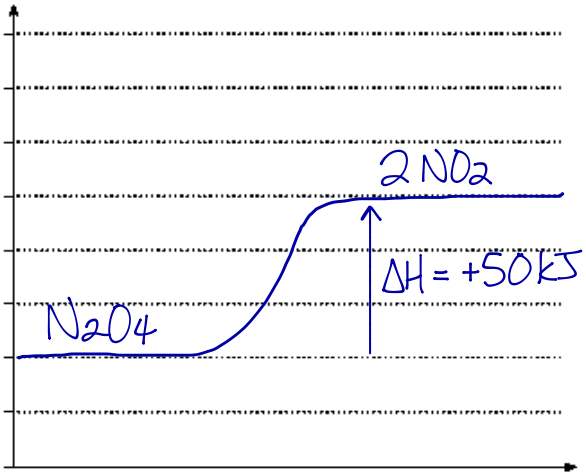
Energy

Progress of the reaction

12) Consider the following reaction: ΔH on left side ∴ endothermic ∴ curve up

$$N_2O_{4\,(g)} + 50.0\ kJ \rightarrow 2\ NO_{2\,(g)}$$

Draw the energy diagram for the above reaction. **(2 marks)**



Energy

Progress of the reaction