CHEMISTRY 11 AP – ENERGY CHANGES IN CHEMICAL REACTIONS WORKSHEET

1) Indicate whether each of the following changes is endothermic or exothermic.

(a) Barbecuing a steak — Endothermic

(b) Freezing a tray full of water to make ice — Exothermic

(c) Neutralizing an acid spill with baking soda — Exothermic

(d) Making a grilled cheese sandwich — Endothermic

(e) Condensing water on a mirror — Exothermic

2) 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

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

3) 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

4) 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

5) Given the following ΔH values, write a balanced thermochemical equation and an equation using ΔH notation with the smallest possible whole number coefficients for each of the following changes:

(a) $\Delta H_{combustion}$ of $C_2H_{6\,(g)} = -1428.5$ kJ/mol

$$kJ = 2\,mol\,C_2H_6 \times \frac{-1428.5\,kJ}{1\,mol\,C_2H_6} = -2857\,kJ$$

$$2\,C_2H_{6(g)} + 7O_{2(g)} \longrightarrow 4CO_{2(g)} + 6H_2O_{(l)} + 2857\,kJ$$

$$2\,C_2H_{6(g)} + 7O_{2(g)} \longrightarrow 4CO_{2(g)} + 6H_2O_{(l)} \quad \Delta H = -2857\,kJ$$

(b) $\Delta H_{decomposition}$ of $NH_{3\,(g)} = +46.1$ kJ/mol

$$kJ = 2\,mol\,NH_3 \times \frac{+46.1\,kJ}{1\,mol\,NH_3} = +92.2\,kJ$$

$$92.2\,kJ + 2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)}$$

$$2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)} \quad \Delta H = +92.2\,kJ$$

(c) $\Delta H_{formation}$ of $HBr_{(g)} = -36.1$ kJ/mol

$$kJ = 2\,mol\,HBr \times \frac{-36.1\,kJ}{1\,mol\,HBr} = -72.2\,kJ$$

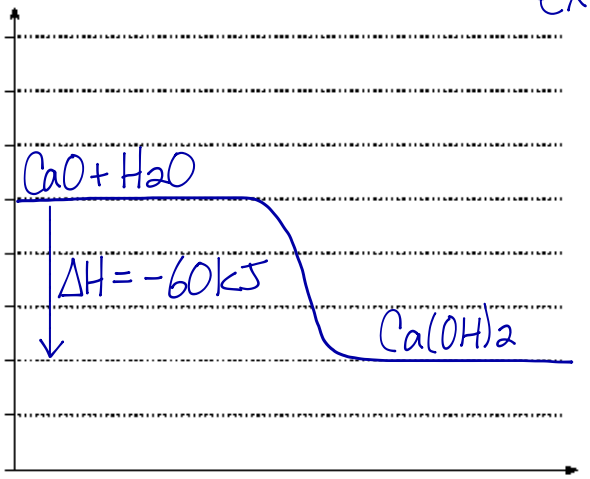
$$H_{2(g)} + Br_{2(g)} \longrightarrow 2HBr_{(g)} + 72.2\,kJ$$

$$H_{2(g)} + Br_{2(g)} \longrightarrow 2HBr_{(g)} \quad \Delta H = -72.2\,kJ$$

6) 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



7) 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)**