quiz: II: thermodynamics

SCH4U_20018 - 2019_V2 **NAME: ____________**

Multiple Choice (7)

1. Which one of the following compounds would be expected to have the highest crystal lattice energy?

A. MgS B. MgO C. $CaSO_4$ D. $BaSO_4$

2. What is the correct equation for the lattice enthalpy of calcium sulphide?

A. $Ca^{+2}_{(g)} + S^{-2}_{(s)} \longrightarrow CaS_{(s)}$
B. $Ca^{+2}_{(g)} + S^{-2}_{(g)} \longrightarrow CaS_{(s)}$
C. $Ca^{+2}_{(g)} + S^{-2}_{(s)} \longrightarrow CaS_{(g)}$
D. $Ca_{(s)} + S_{(s)} \longrightarrow CaS_{(s)}$

3. Consider the following equation for the reaction of potassium with water:

$$2K_{(s)} + 2H_2O_{(l)} \longrightarrow 2\,KOH_{(aq)} + H_{2(g)} + 160\text{ kJ}$$

How much heat is released if 120 g of potassium metal reacts?

A. 52.1 kJ B. 246 kJ C. 280 kJ D. 491 kJ

4. The following equations show the oxidation of carbon and carbon monoxide to carbon dioxide.

$$C_{(s)} + O_{2\,(g)} \longrightarrow CO_{2\,(g)} \qquad \Delta H^0 = —x \text{ kJ mol}^{-1}$$
$$CO_{(g)} + \tfrac{1}{2}O_{2\,(g)} \longrightarrow CO_2 \qquad \Delta H^0 = —y \text{ kJ mol}^{-1}$$

What is the enthalpy change for the oxidation of carbon to carbon monoxide?

$$C_{(s)} + \tfrac{1}{2}O_{2\,(g)} \longrightarrow CO$$

A. $x + y$ B. $—x — y$ C. $y — x$ D. $x — y$

5. Consider the two reactions involving iron and oxygen.

$$2Fe_{(s)} + O_{2(g)} \rightarrow 2FeO_{(s)} \qquad \Delta H^{\ominus} = -544 \text{ kJ}$$
$$4Fe_{(s)} + 3O_{2(g)} \rightarrow 2Fe_2O_{3(s)} \qquad \Delta H^{\ominus} = -1648 \text{ kJ}$$

What is the enthalpy change, in kJ, for the reaction below?

$$4FeO_{(s)} + O_{2(g)} \rightarrow 2Fe_2O_{3(s)}$$

A. –1648 – 2(–544)
B. –544 – (–1648)
C. –1648 – 544
D. –1648 – 2(544)

6. Given the following two equations:

$$2C_{(s)} + 2H_{2\,(g)} \longrightarrow C_2H_{4\,(g)} \qquad \Delta H_1 = +52.3 \text{ kJ}$$
$$C_2H_{2\,(g)} + H_{2\,(g)} \longrightarrow C_2H_{4\,(g)} \qquad \Delta H_2 = -174.4 \text{ kJ}$$

What can be said about the value of ΔH_3 for the reaction below?

$$2C_{(s)} + H_{2\,(g)} \longrightarrow C_2H_{2\,(g)} \qquad \Delta H_3 = ?$$

A. ΔH_3 must be negative.
B. ΔH_3 must be a positive number smaller than 52.3 kJ.
C. ΔH_3 must be a positive number greater than 52.3 kJ.
D. ΔH_3 must be a greater number than all the stars in the milky way.

7. The heats of formation, ΔH_f^0, of NO_2 and N_2O_4 are + 33.2 kJ mol^{-1} and + 9.2 kJ mol^{-1} respectively. Calculate the enthalpy change for the reaction:

$$2\,NO_{2(g)} \longrightarrow N_2O_{4(g)}$$

A. -57.2 kJ B. -24.0 kJ C. 41.4 kJ D. 75.6 kJ

Multiple Choice Answers

1	2	3	4	5	6	7

PROBLEMS **(23)**

In order to receive full credit, the method used and the steps involved in arriving at your answer must be shown clearly. It is possible to receive partial credit but, without your supporting work, you may receive little credit. You must pay particular attention to significant figures and to units.

1. (a) Given the following equation:

$$4Fe_{(s)} + 3O_{2\,(g)} \longrightarrow 2Fe_2O_{3\,(e)} \qquad \Delta H = -3297.7 \text{ kJ}$$

How many grams of iron must be reacted to produce 742.5 kJ of energy? 3

mass: _____

(b) Use the above equation to determine the enthalpy change for the following reaction: 2

$$Fe_2O_{3\,(g)} \longrightarrow 2Fe_{(s)} + 3/2\ O_{2\,(g)} \qquad \Delta H = ???$$

energy: _____

2. (a) Define the term standard molar enthalpy change of formation, ΔH_f^0. 2

_____

_____

_____

b. One of the building blocks for proteins such as those in muscles and sinews is an amino acid called glycine, $C_2H_5NO_{2(s)}$. Write a thermochemical equation for the enthalpy of formation of glycine if the $\Delta H^0_f (C_2H_5NO_{2(s)}) = -1452 \text{ kJ mol}^{-1}$

2

_____

3. Mixing household cleaners can result in the production of hydrogen chloride gas ($HCl_{(g)}$). Not only is this gas dangerous in its own right, but it also reacts with oxygen to form chlorine gas and water vapour.

$$4\ HCl(g) + O_2(g) \longrightarrow 2\ Cl_2(g) + 2\ H_2O(g)$$

Determine the enthalpy change of this reaction, given the following equations. 3

$H_2(g) + Cl_2(g) \longrightarrow 2\ HCl\ (g)$ $\Delta H = -185$ kJ

$H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(l)$ $\Delta H = -285.8$ kJ

$H_2O\ (g) \longrightarrow H_2O(l)$ $\Delta H = -40.7$ kJ

enthalpy: ________________

4. The equation below shows the reaction between ammonia and fluorine:

$$NH_{3(g)} + 3F_{2\ (g)} \longrightarrow 3HF_{(g)} + NF_{3(g)}$$

(i) Use the standard molar enthalpy change of formation, ΔH_f^0, given in **Table I**, below to calculate the molar enthalpy change for the above reaction: 4

Table I

Compound	NH_3	HF	NF_3
ΔH_f^0 (kJ mol^{-1})	-46	-269	-119

enthalpy change: _______________

ii. State why the value for the ΔH^0_f for $F_{2(g)}$ is not given above. 1

5. a. Define the term standard molar enthalpy of neutralisation, $\Delta H^0_{neutralisation}$. 2

b. Write a net-ionic equation for the reaction of $HCl_{(aq)}$ with $NaOH_{(aq)}$ 1

c. Consider the net-ionic equation, **explain** in terms of bond-breaking and bond making if you expect the reaction to be an endothermic or an exothermic process. 1

d. Explain how the magnitude of the enthalpy would differ if the neutralization reaction was carried out using acetic acid, $CH_3COOH_{(aq)}$, instead of hydrochloric acid, with sodium hydroxide. 2