—/63 = %

Name:_____

SCH 4U Thermodynamics Test

1. For each of the following, label with a + or a - where a + indicated an endothermic reaction (i.e. $\Delta H = +$) and a - indicates an exothermic reaction (i.e. $\Delta H = -$). Do not guess, wrong will be subtracted from right.

a) __−__ a rotting onion is slowly consumed by special rotting onion bacteria

b) __−__ formation of dew overnight

c) __+__ formation of hydrogen cyanide from the elements hydrogen, carbon and nitrogen in their natural state at 25 °C and 1 atm pressure

d) __+__ boiling water produces water vapour

e) __+__ spontaneous levitation of an entire class of chemistry students

/10

f) __−__ zinc and oxygen combine in a combustion reaction to form a common oxide of zinc

(12)

g) __+__ mixing ammonium nitrate and water is a common reaction used in cold packs (reduces temperature in case of injury)

h) __+__ irradiation of stable atoms produces unstable isotopes capable of spontaneous radiative decay processes

i) __+__ electricity can be used to separate water molecules into it component elements through electrolysis

j) __+__ slow steady growth of a tree is a result of metabolic processes with in the tree

2. Using the table found in your text book, determine the heat of reaction for the decomposition of potassium chlorate.

$$2KClO_3(s) \Rightarrow 2KCl(s) + 3O_2(g) \quad \Delta H = ?$$ ✓

(12)

$\Delta H = [2\Delta H^\circ_{KCl(s)} + 3\Delta H^\circ_{O_2(g)}] - [\Delta H^\circ_{KClO_3(s)}]$ ✓

$\Delta H = [2(-436.7\,kJ) + 3(0)] - [-397.7\,kJ]$ ✓

$\Delta H = -475.7\,kJ$ ✓

/4

/14

3. Determine the volume of water in L that can be warmed from 15 °C to 70 °C, by the combustion of 500 g of cyclopropane (C_3H_6)

$$C_3H_6(g) + \tfrac{9}{2}O_2(g) \rightarrow 3CO_2(g) + 3H_2O(l) \quad \Delta H = ?$$

$$\Delta H = [3\Delta H^\circ_{CO_2(g)} + 3\Delta H^\circ_{H_2O(l)}] - [\Delta H^\circ_{C_3H_6(g)} + \tfrac{9}{2}\Delta H^\circ_{O_2(g)}]$$

$$\Delta H = [3(-393.5\,kJ) + 3(-285.8\,kJ)] - [+17.8\,kJ + \tfrac{9}{2}(0)]$$

$$\Delta H = -2055.7\,kJ$$

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$$Q = -\Delta H$$

$$Q = -(-2055.7\,kJ)$$

$$Q = 2055.7\,kJ/mol\ C_3H_6$$

$$500g \times \frac{1mol}{42.09g} \times \frac{2055.7\,kJ}{1mol} = 24420\,kJ$$

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$Q = 24420\,kJ \rightarrow 2.442 \times 10^7\,J$

$m = ?$

$c = 4.184\,J/g\,^\circ C$

$\Delta T = 70 - 15 = 55^\circ C$

$$Q = mc\Delta T$$

$$m = \frac{Q}{c\Delta T}$$

$$m = \frac{2.442 \times 10^7\,J}{4.184\,J/g^\circ C \times 55^\circ C}$$

$$m = 106119\,g$$

for H_2O $106119g \rightarrow 106119mL \rightarrow 106.119L$

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4. Using Hess' Law, determine the heat of formation of acetamide (CH_3CONH_2) from the following information:

① the oxidation of ethyl alcohol produces acetic acid

$C_2H_5OH(l) + \frac{1}{2}O_2(g) \Rightarrow CH_3COOH(l) + H_2O \quad \Delta H° = -197.6$ kJ

② ethane can be formed from the addition of hydrogen to ethene

$C_2H_4(g) + H_2(g) \Rightarrow C_2H_6(g) \quad \Delta H° = -136.3$ kJ

③ addition of water to ethene produces ethane

$C_2H_4(g) + H_2O(l) \Rightarrow C_2H_5OH(l) \quad \Delta H° = -287.7$ kJ

④ acetic acid plus ammonia forms acetamide plus water

$CH_3COOH(l) + NH_3(g) \Rightarrow CH_3CONH_2(s) + H_2O(l) \quad \Delta H° = 139.5$ kJ

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⑤ formation of ammonia gas ($NH_3(g)$) (use text book)

$\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g) \quad \Delta H = -45.9$ kJ ✓

⑥ formation of ethane gas ($C_2H_6(g)$) (use text book)

$2C(s) + 3H_2(g) \rightarrow C_2H_6(g) \quad \Delta H = -83.8$ kJ ✓

⑦ formation of water ($H_2O(l)$) (use text book)

don't need!! → $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l) \quad \Delta H = -285.8$ kJ

Find $2C(s) + \frac{5}{2}H_2(g) + \frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3CONH_2(s)$ ✓✓

④ ~~$CH_3COOH(l)$~~ + ~~$NH_3(g)$~~ → $CH_3CONH_2(s) + H_2O(l)$ ✓ $\Delta H = 139.5$kJ

① ~~$C_2H_5OH(l)$~~ + $\frac{1}{2}O_2(g)$ → ~~$CH_3COOH(l)$~~ + ~~$H_2(g)$~~ ✓ $\Delta H = -197.6$kJ

③ ~~$C_2H_4(g)$~~ + ~~$H_2O(l)$~~ → ~~$C_2H_5OH(l)$~~ ✓ $\Delta H = -287.7$kJ

reverse ② ~~$C_2H_6(g)$~~ → ~~$C_2H_4(g)$~~ + ~~$H_2(g)$~~ ✓ $\Delta H = 136.3$kJ

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⑥ $2C(s) + 3H_2(g)$ → ~~$C_2H_6(g)$~~ ✓ $\Delta H = -83.8$kJ

⑤ $\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$ → ~~$NH_3(g)$~~ ✓ $\Delta H = -45.9$kJ

$2C(s) + \frac{5}{2}H_2(g) + \frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3CONH_2(s)$ ✓

$\Delta H = -339.2$kJ ✓

✓✓ easy to follow

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5. What mass of pentane ($C_5H_{12}(l)$) must be combusted in order to convert 1 kg of ice at 0 °C to water at 40 °C. Use information from your text book found on page 800, 799 and 307.

$Q_1 = ?$

$L_F = \frac{6.03\ kJ}{1\ mol} \times \frac{1\ mol}{18.02\ g} = \frac{0.3346\ kJ}{1\ g}$

$m = 1\ kg \rightarrow 1000\ g$

$Q_1 = L_F m$

$Q_1 = \frac{0.3346\ kJ}{1\ g} \times 1000\ g$

$Q_1 = 334.6\ kJ$

(12)

$Q_2 = ?$

$m = 1\ kg \rightarrow 1000\ g$

$c = 4.184\ J/g°C$

$\Delta T = 40 - 0 = 40°C$

$Q_2 = mc\Delta T$

$Q_2 = 1000\ g \times 4.184\ J/g°C \times 40°C$

$Q_2 = 167360\ J$

$Q_2 = 167.36\ kJ$

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$Q_T = Q_1 + Q_2$

$Q_T = 334.6\ kJ + 167.36\ kJ$

$Q_T = 501.99\ kJ$

$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l) \quad \Delta H = ?$

$\Delta H = [5\Delta H^\circ_{CO_2(g)} + 6\Delta H^\circ_{H_2O(l)}] - [\Delta H^\circ_{C_5H_{12}(l)} + 8\Delta H^\circ_{O_2(g)}]$

$\Delta H = [5(-393.5\ kJ) + 6(-285.8\ kJ)] - [(-173.5\ kJ) + 8(0)]$

$\Delta H = -3508.8\ kJ$

$Q = -\Delta H$

$Q = 3508.8\ kJ/mol\ C_5H_{12}$

$501.99\ kJ \times \frac{1\ mol\ C_5H_{12}}{3508.8\ kJ} \times \frac{72.17\ g\ C_5H_{12}}{1\ mol\ C_5H_{12}} = 10.325\ g\ C_5H_{12}$

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