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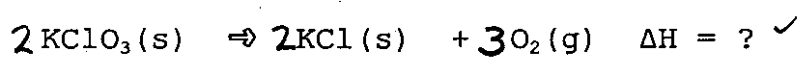
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Name: \_\_\_\_\_

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
  - f) - zinc and oxygen combine in a combustion reaction to form a common oxide of zinc
  - 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 its component elements through electrolysis
  - j) + slow steady growth of a tree is a result of metabolic processes within the tree

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



$$\Delta H = [2\Delta H^\circ_{\text{KCl}(\text{s})} + 3\Delta H^\circ_{\text{O}_2(\text{g})}] - [\Delta H^\circ_{\text{KClO}_3(\text{s})}] \checkmark$$

$$\Delta H = [2(-436.7 \text{ kJ}) + 3(0)] - [-397.7 \text{ kJ}] \checkmark$$

$$\Delta H = -475.7 \text{ kJ} \checkmark$$

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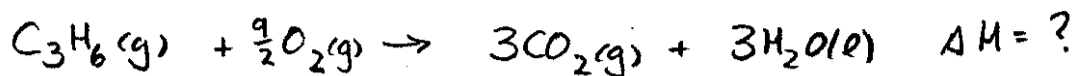
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3. Determine the volume of water in L that can be warmed from 15 °C to 70 °C, by the combustion of 500 g of cyclopropane (C<sub>3</sub>H<sub>6</sub>)



$$\Delta H = [3\Delta H^\circ_{\text{CO}_2(\text{g})} + 3\Delta H^\circ_{\text{H}_2\text{O}(\text{l})}] - [\Delta H^\circ_{\text{C}_3\text{H}_6(\text{g})} + \frac{9}{2}\Delta H^\circ_{\text{O}_2(\text{g})}]$$

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

$$\Delta H = -2055.7\text{kJ}$$

$$Q = -\Delta H$$

$$Q = -(-2055.7\text{kJ})$$

$$Q = 2055.7\text{kJ/mol C}_3\text{H}_6$$

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

$$Q = 24420\text{kJ} \rightarrow 2.442 \times 10^7\text{J}$$

$$m = ?$$

$$c = 4.184\text{J/g}^\circ\text{C}$$

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

$$Q = mc\Delta T$$

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

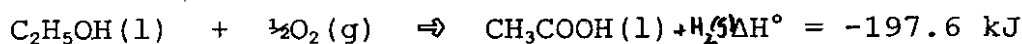
$$m = \frac{2.442 \times 10^7\text{J}}{4.184\text{J/g}^\circ\text{C} \times 55^\circ\text{C}}$$

$$m = 106119\text{g}$$

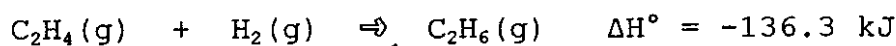
$$\text{for H}_2\text{O } 106119\text{g} \rightarrow 106119\text{mL} \rightarrow 106.119\text{L}$$

4. Using Hess' Law, determine the heat of formation of acetamide ( $\text{CH}_3\text{CONH}_2$ ) from the following information:

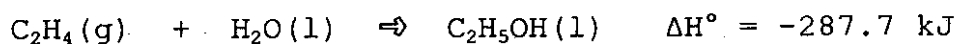
① the oxidation of ethyl alcohol produces acetic acid



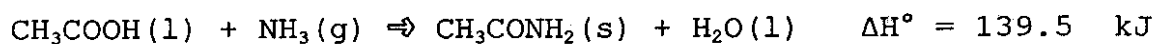
② ethane can be formed from the addition of hydrogen to ethene



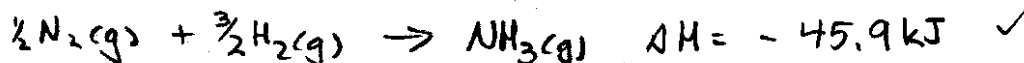
③ addition of water to ethene produces ethanol



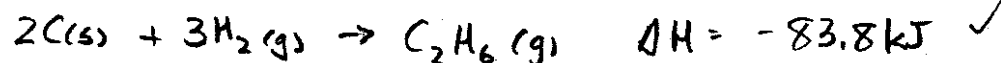
④ acetic acid plus ammonia forms acetamide plus water



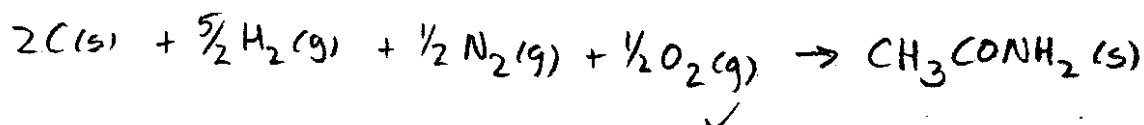
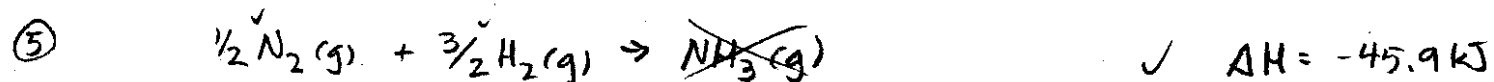
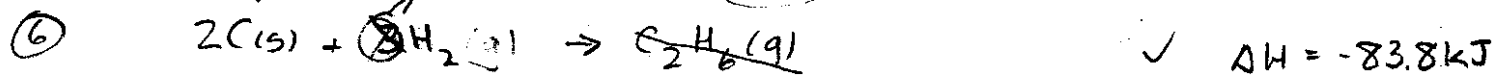
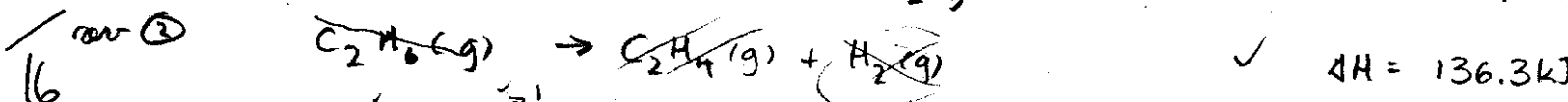
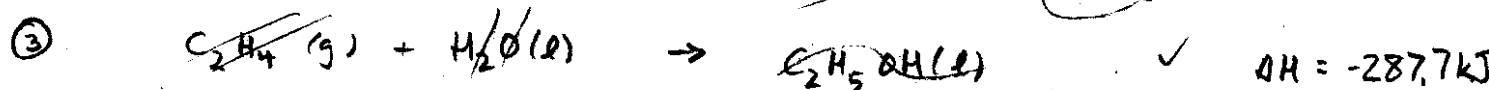
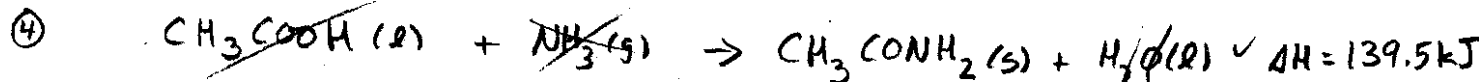
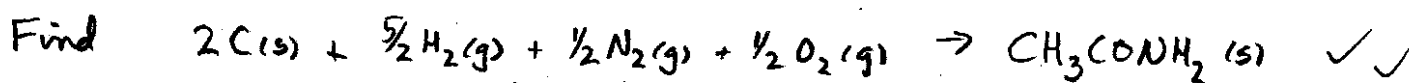
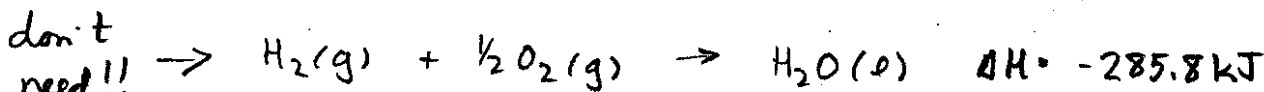
⑤ formation of ammonia gas ( $\text{NH}_3(g)$ ) (use text book)



⑥ formation of ethane gas ( $\text{C}_2\text{H}_6(g)$ ) (use text book)



⑦ formation of water ( $\text{H}_2\text{O}(l)$ ) (use text book)



$$\Delta H = -339.2 \text{ kJ}$$

✓ easy to follow

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

$$\checkmark Q_1 = ?$$

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

$$m = 1 \text{ kg} \rightarrow 1000 \text{ g}$$

$$Q_1 = L_F m$$

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

$$Q_1 = 334.6 \text{ kJ} \checkmark$$

$$\checkmark Q_2 = ?$$

$$m = 1 \text{ kg} \rightarrow 1000 \text{ g}$$

$$c = 4.184 \text{ J/g}^\circ C$$

$$\Delta T = 40 - 0 = 40^\circ C$$

$$Q_2 = mc \Delta T \checkmark$$

$$Q_2 = 1000 \text{ g} \times 4.184 \text{ J/g}^\circ C \times 40^\circ C$$

$$Q_2 = 167360 \text{ J} \checkmark$$

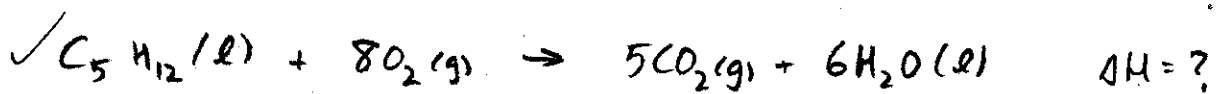
$$Q_2 = 167.36 \text{ kJ} \checkmark$$

(12)

$$\checkmark Q_T = Q_1 + Q_2$$

$$Q_T = 334.6 \text{ kJ} + 167.36 \text{ kJ}$$

$$\checkmark Q_T = 501.99 \text{ kJ}$$



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

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

$$\checkmark \Delta H = -3508.8 \text{ kJ}$$

$$\checkmark Q = -\Delta H$$

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

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

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