51 - MC = 31

60.5/68 89%

# It's a Heat Wave

[69 Marks]

## Communication [8 marks] 8 wow!

1. The energy involved in the process $H_2O(g) \rightarrow H_2O(l)$ could be described as a molar enthalpy of condensation. Write the appropriate symbol for the molar enthalpy that would be associated with each of the following reactions. [3 marks]

3

(a) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2 + 4H_2O(l)$ $\Delta H_{combustion}$ ✓

(b) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$ $\Delta H_{neutralization}$ ✓

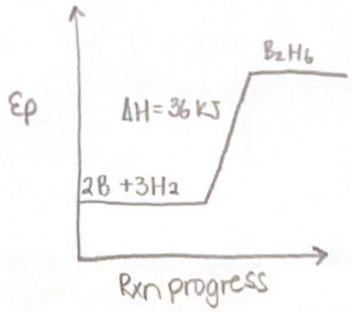
(c) $6C(s) + 3H_2(g) \rightarrow C_6H_6(l)$ $\Delta H_{formation}$ ✓

2. Draw a completely labeled potential energy diagram to represent the formation of diborane ($B_2H_6$) from its elements ($\Delta H° = 36$ kJ/mol). [5 marks]

$2B + 3H_2 \longrightarrow B_2H_6$

$\Delta H° = 36 \frac{kJ}{mol}$

5




## Making Connections [6 marks] 6 wow! x2

3. Explain how water's high specific heat helps guard against swings in the body's core temperature as the outside temperature fluctuates. [3 marks]

3

Water has a high specific heat capacity of 4.184 $\frac{J}{g \cdot °C}$ so it takes lots of energy to increase 1g of water by 1°C. When the outside temp changes, and for example is hotter than your body temp it will take time to increase your body temp. And opposite for if the outside temp is colder than your body temp. Homeostasis plays a role in maintaining our bodies temp.

4. If the same amount of heat were added to individual 1.00 g samples of water, methanol (2.918 J/g°C) and aluminum (0.900 J/g°C), which substance would undergo the greatest temperature change? Explain fully. [3 marks]

3

water

① $m = 1.00g$

$c = 4.184 \frac{J}{g \cdot °C}$

$q = 100J$

$\Delta T = ?$

$q = mc\Delta T$

$100J = (1.00g)(4.184 \frac{J}{g \cdot °C})(\Delta T)$

$23.900573613 °C = \Delta T$

$23.9°C = \Delta T$

q = fixed # = 100 J

∴ Aluminum would have the greatest temp. change

methanol

② $m = 1.00g$

$c = 2.918 \frac{J}{g \cdot °C}$

$q = 100J$

$\Delta T = ?$

$q = mc\Delta T$

$100J = (1.00g)(2.918 \frac{J}{g \cdot °C})(\Delta T)$

$34.270047978°C = \Delta T$

$34.3°C = \Delta T$

greatest temp. change

aluminum

③ $m = 1.00g$

$c = 0.900 \frac{J}{g \cdot °C}$

$q = 100J$

$\Delta T = ?$

$q = mc\Delta T$

$100J = (1.00g)(0.900 \frac{J}{g \cdot °C})(\Delta T)$

$111.111111111°C = \Delta T$

$111.1°C = \Delta T$

## Inquiry [16 marks] (8)

5. A lab tech adds 43.1 mL of concentrated 11.6 M hydrochloric acid to water to form 500.0 mL of dilute … temperature of the solution changes from 19.2°C to 21.8°C. Calculate the molar enthalpy of dilution of … acid. [7 marks]

V = 43.1 mL, C = 11.6 M } $HCl_{(aq)}$

$V_T = 500.0 mL$

$T_1 = 19.2°C$, $T_2 = 21.8°C$ ] $T_2 - T_1 = \Delta T$, $2.6°C = \Delta T$

$\Delta H_{dil} = ?$

$n = CV$
$= (11.6M)(0.0431L)$
$= 0.49996 mol$
$= 0.491 mol$

$q = mc\Delta T$
$= (500g)(4.184 \frac{J}{g°C})(2.6°C)$
$= 5439.2 J$
$= 5.4 kJ$

$\Delta H = \frac{q}{n}$

$\Delta H = \frac{5.4 kJ}{0.491 mol}$

$\Delta H = 10.87927034 \frac{kJ}{mol}$

$\Delta H = 10.9 kJ/mol$ (SD)

∴ the molar enthalpy of hydrochloric acid would be 10.9 kJ/mol

6. As an alternative to combustion, coal gas can undergo a process called methanation.

$3H_2(g) + CO(g) \rightarrow CH_4(g) + H_2O(g) \quad \Delta H = ?$

Determine the enthalpy change involved in the reaction of $3.00 \times 10^2$ g of carbon monoxide in this methanation reaction, using the following reference equations and enthalpy changes. [9 marks]

1) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ ) $\Delta H_1° = -483.6$ kJ
2) $2C(s) + O_2(g) \rightarrow 2CO(g)$ ) $\Delta H_2° = -221.0$ kJ
3) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\Delta H_3° = -802.7$ kJ
4) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H_4° = -393.5$ kJ

1) $3H_{2(g)} + \frac{3}{2}O_{2(g)} \rightarrow 3H_2O_{(g)}$ $\Delta H_1° = -725.4$ kJ
2) $CO_{(g)} \rightarrow \frac{1}{2}O_{2(g)} + C_{(s)}$ $\Delta H_2° = 110.5$ kJ
3) $2H_2O_{(g)} + CO_{2(g)} \rightarrow CH_{4(g)} + 2O_{2(g)}$ $\Delta H_3° = 802.7$ kJ
4) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H_4° = -393.5$ kJ

$3H_{2(g)} + CO_{(g)} \rightarrow CH_{4(g)} + H_2O_{(g)} \quad \Delta H°_{rxn} = -205.7$ kJ

$q = ?$
$\Delta H°_{rxn} = -205.7 kJ$
$m_{CO} = 300g$
$M_{CO} = 28.0101 g/mol$

$n = \frac{m}{M} = \frac{300g}{28.0101 g/mol}$
$= 10.71042231 mol$
$= 10.7 mol_2$

$\Delta H = \frac{q}{n}$

$-205.7 \frac{kJ}{mol} = \frac{q}{10.7 mol}$

$-2203.133869 kJ = q$

$-2203 kJ = q$ (SD)

115 + 19 = 303 +1

## Knowledge & Understanding [12 + 27 = 39 marks]

3. A 10.2 kg sample of a radioactive isotope is analyzed after 18 hours and only 187.5 g of the original isotope remains. What is the half life of this isotope, in days? [5 marks]

$m_1 = 10.2\,kg = 10{,}200\,g$

$t = 18\,h$

$m_2 = 187.5\,g$

$t_{h1} = ?$

$m_2 = m_1 \left(\frac{1}{2}\right)^{\frac{t}{t_{h1}}}$

$187.5 = 10200 \left(\frac{1}{2}\right)^{\frac{18}{t_{h1}}}$

$\log\left(\frac{187.5}{10200}\right) = \frac{18}{t_{h1}} \log(0.5)$

$3.122000091 = t_{h1}$

$\frac{3.122000091}{24}$

$0.13008333 7 = t_{h1}$

$0.13\ days = t_{h1}$

5. ∴ the half life of the isotope would be around 0.13 days

7. The standard enthalpy of combustion of liquid cyclohexane to carbon dioxide and liquid water is -3824 kJ/mol. What is the standard enthalpy of formation of cyclohexane? [7 marks]

↳ $C_6H_{12}$

$C_6H_{12(\ell)} + 9O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(\ell)} \quad \Delta H = -3824\ kJ/mol$

$\Delta H = ?$

$9(\emptyset)$ ↳ $\emptyset$

$6(-393.5)$ ↳ $-2361\ kJ$

$6(-285.85)$ ↳ $-1715.1\ kJ$

+ x rep. the standard enthalpy of $C_6H_{12}$

$\Delta H^\circ_{rxn} = \Sigma \Delta H_f^\circ(P) - \Sigma \Delta H_f^\circ(R)$

$3824 = [-1715.1 - 2361] - [\emptyset - x]$

$3824 = -4076.1 + x$

$-3824 + 4076.1 = +x$

$252.1\ kJ = x$

∴ The standard enthalpy of formation of cyclohexane ($C_6H_{12}$) would be 252.1 kJ

SD

6.5

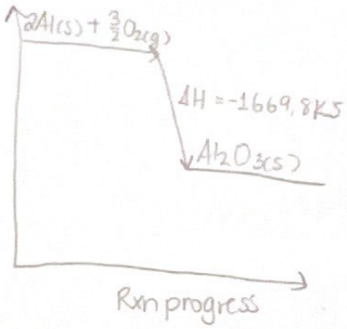
...ue-fan because it acts like displacement, only the beginning and ...ter, nothing else. Hess Law connection is if we can go in one step it's the ...as writing it in multiple steps (Σ). (only care about start + end).

$2Al_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Al_2O_{3(s)}$ $\Delta H = -1669.8 KJ$ ①

$\Delta H = -1669.8 KJ$ for 1 mole of $Al_2O_{3(s)}$ ②

$2Al_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Al_2O_{3(s)} + 1669.8 KJ$ ③

④




3. High specific heat because (show math)

4. $m_{H_2O} = ?$

$\Delta T = 72.5°C$

$n = 12.57 mol$ $(CH_3OH)$

$CH_3OH_{(l)} + \frac{3}{2}O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$

$-238.6$ $\quad \frac{2}{\emptyset}$ $\quad -393.5$ $\quad -241.8$

$\Delta H_{rxn} = \Sigma Hf°(P) - \Sigma Hf°(R)$

$= [-393.5 + 2(-241.8)] - [-238.6]$

$= -393.5 - 483.6 + 238.6$

$= -638.5 KJ/mol$

$\Delta H = \frac{q}{n}$

$-638.5 = \frac{q}{12.57 mol}$

$+8025.945 = q$

$+8025.945 = m(4.184)(72.5)$

$+26.5g = m$

5. ✓ $m_2 = m_1\left(\frac{1}{2}\right)^{\frac{t}{t_h}}$

$237.8g = 345.2g\left(\frac{1}{2}\right)^{\frac{125.25h}{t_h}}$

$\log\left(\frac{237.8}{345.2}\right) = \log(0.5)\cdot\frac{125.25}{t_h}$

$0.537683749 = \frac{125.25}{t_h}$

$232.94\ h = t_h$

$9.7\ days = t_h$

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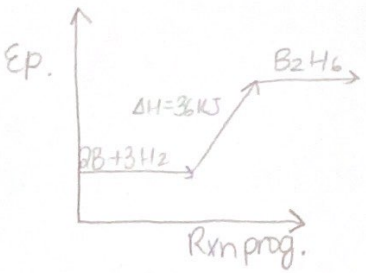
1. ✓ a) $\Delta H_{combustion}$ b) $\Delta H_{neutralization}$ c) $\Delta H_{formation}$

2. $2B + 3H_2 \rightarrow B_2H_6$

$\Delta H = 36\frac{kJ}{mol}$




✓ 3. Bc it takes a lot of heat to raise the temp. by 1° by 1g and so b/c of this it can maintain your temperature,

5. $V = 43.1\ mL_g$
$C = 11.6M\ (HCl)$
$V = 500.0\ mL_g$ (total)
$\Delta T = 2.6°C$
$\Delta H = ?$

$C = \frac{n}{V}$ $n = CV = (0.0431L)(11.6M)$
$= 0.49996\ mol$
$= 0.491\ mol$

$\Delta H = \frac{q}{n}$

$\Delta H = \frac{5.4kJ}{0.491mol}$

$q = mC\Delta T$

$q = (500.0g)(4184\ \frac{J}{g°C})(2.6°C)$ $\Delta H = 10.80\ kJ/mol$

$q = 5439.2J$

$q = 5.4kJ$

7.

$$C_6H_{12}{}_{(\ell)} + 9O_{2(g)} \longrightarrow 6CO_{2(g)} + 6H_2O_{(\ell)}$$

$C_6H_{12}$: $x$ $\quad$ $O_2$: $0$ $\quad$ $CO_2$: $-393.5$ $\quad$ $H_2O$: $-285.85$

$\Delta H = -3824\ KJ/mol$

$$\Delta H_{rxn} = \Sigma Hf^\circ(P) - \Sigma Hf^\circ(R)$$

$$-3824 = [6(-393.5) + 6(-285.85)] - [x]$$

(-2361 and -1715.1)

$$-3824 = -4076.1 - x$$

$$252.1 = -x$$

$$+252.1 = x$$