79%

It's a Heat Wave

[69 Marks]

50/69 72%

Communication [8 marks] 5

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]

1

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

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

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

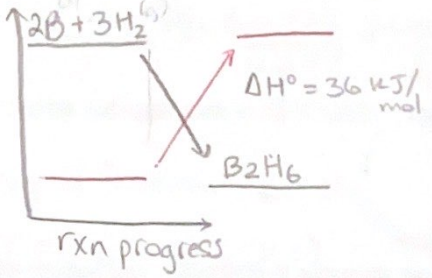
2. Draw a completely labeled potential energy diagram to represent the formation of diborane (B_2H_6) from its elements ($\Delta H° = 36$ kJ/mol). [5 marks]

$\Delta H_{formation}$

don't switch exothermic reaction sign; endothermic

4

$2B + 3H_2 \rightarrow B_2H_6$ $\Delta H° = 36 \frac{kJ}{mol}$



Making Connections [6 marks] 6 wow!

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

= Since water's h.s.h.c. is 4.184 J/g °C, it takes a lot of heat to raise the temperature of 1g of water by 1°C. In our bodies, if the temp. changes outside, and becomes warmer than your body temp., the water in your body won't warm up as fast and raise your temp, giving you fever. Water's h.s.h.c. helps maintain homeostasis.

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

Aluminum would because it has the lowest specific heat capacity

If $m = 1g$, $\Delta T = ?$, q = fixed #, say 100, and $c = 4.184 (H_2O)$, 2.918 (Methanol), 0.900 (Al)

then $q = m\Delta Tc$

$100 = 1(\Delta T)(4.184)$

$\Delta T = \frac{100}{4.184}, \frac{100}{2.918}, \frac{100}{0.900}$ → of the 3, the highest ΔT would be Al

H_2O methanol Al

Inquiry [16 marks]

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

→ final volume

$q = m\Delta T c \rightarrow q = (500)(2.6)(4.184)$

$q = 5439.2\,J$

$C = 11.6\,M$

$v/m = 500\,mL \rightarrow 500\,g$

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

$\Delta H_{dilution} = ?$

sp. h. C. $(c) = 4.184\,J/g \cdot °C$

$\Delta H = \frac{q}{n}$ $\quad c = \frac{n}{v}$

$c = \frac{n}{v}$

$11.6 = \frac{n}{0.500\,L}$ $\quad .005 \times 10^2$

$n = 5.8\ mol$

$\Delta H = \frac{q}{n} = \frac{5439.2}{5.8}$

$= 937.79\ kJ/mol$

$\therefore \Delta H_{dil.} = -940\ kJ/mol$

5

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

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

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

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

$3H_2(g) + \frac{3}{2}O_2(g) \rightarrow \frac{1}{2}H_2O(g)$ $\quad \Delta H_1° = -483.6\,kJ / 2 = -241.8\,kJ \times 3 = -725.4$

$CO(g) \rightarrow \frac{1}{2}C(s) + \frac{1}{2}O_2(g)$ $\quad \Delta H_2° = +221.0\,kJ / 2 = 110.5\ kJ$

$2H_2O(g) + CO_2(g) \rightarrow 2O_2(g) + CH_4(g)$ $\quad \Delta H_3° = +802.7\ kJ$

$\frac{1}{2}C(s) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H_4° = -393.5\,kJ$

5

$3H_2(g) + CO(g) \longrightarrow CH_4(g) + H_2O(g) \qquad \Delta H = -205.7\,kJ$

$\frac{3 \times 10^2}{M_{CO}} = n$

$q = ?$

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

$-205.7 = \frac{q}{n}$

te solution. The
of hydrochloric

12 + 17 = (29)

ledge & Understanding [12 + 27 = 39 marks]

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]

5

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

$m_1 = 10.2\,kg \rightarrow \times 1000 = 10200\,g$

$t = 18$ hours $\rightarrow 18/24 \rightarrow 0.75$ days

$m_2 = 187.5\,g$

$t_{1/2} = ?$

$\rightarrow 187.5 = 10200\left(\frac{1}{2}\right)^{0.75/t_{1/2}}$

$\frac{187.5}{10200} = \left(\frac{1}{2}\right)^{0.75/t_{1/2}}$

$\log 0.018 = \frac{0.75}{t_{1/2}} \log\left(\frac{1}{2}\right)$

$\frac{\log 0.018}{\log 0.5} = \frac{0.75}{t_{1/2}}$

$\therefore, t_{1/2} = 0.13$ 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]

Let x represent enthalpy of formation of cyclohexane

$C_6H_{12}(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

$x = ?$ kJ/mol $\quad 0$ kJ/mol $\quad -393.5$ kJ/mol $\quad -285.85$ kJ/mol

$\Delta H = -3824\,kJ/mol$

$\Sigma \Delta H_f^\circ(P) - \Sigma \Delta H_f^\circ(R)$

7

$-3824 = [(-393.5 \times 6) + (-285.85 \times 6)] - [x + (9 \times 0)]$

$-3824 = [(-2361) + (-1715.1)] - [x]$

$-3824 = -4076.1 - x$

$-3824 + 4076.1 = x$

$252.1 = -x$

$x = -252.1$

$\therefore, \Delta H_f^\circ$ for cyclohexane is -252.1 kJ/mol