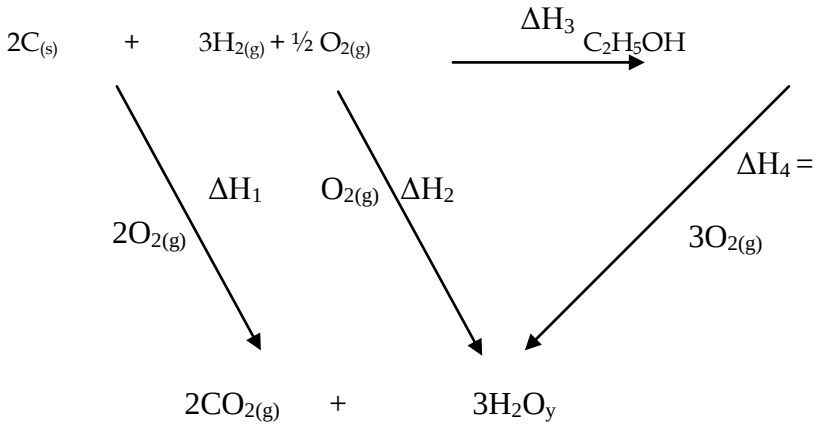
ENERGY CHANGES IN CHEMICAL REACTIONS

MARKING SCHEME

1. From the energy cycle diagram:-



$\Delta H_1 + \Delta H_2 = \Delta H_3 + \Delta H_4$ ✓ 1

Then

$\Delta H_3 = \Delta H_1 + \Delta H_2 - \Delta H_4$

$\Delta H_3 = (2 \times -394) + (3 \times -286) - (-277)$ ✓ 1

$= -788 + 853 - -277$

$= -788 - 853 + 277$

$\Delta H_3 = -1646 + 277 = -1369$

$\Delta H_3 = -1369\ KJMOI^{-1}$ ✓ 1

2.

Bonds Broken	
2 C - H	
2 Cl - Cl ✓ ½	
Bonds formed	
2 C - Cl	
2 H - Cl ✓ ½	

ΔHv = Energy in Bonds Broken - Energy in Bonds Formed ✓

$\Delta Hv = [(2 \times 414) + (2 \times 244)] - [(2 \times 326) + (2 \times 431)]$

$\Delta Hv = (828 + 488) - (652 + 862)$ ½

$\Delta Hv = 1316 - 1514$ ½ m

$\Delta Hv = -198 KJMol^{-1}$ ✓ 1mk

3.(a) $50 \times 4.2 \times (26 - 23) J = 630\ J$ (1mk)

(b)

$\frac{25}{100} \times 0.5\ mols\ \ H^{+}_{(aq)}\ \ give\ \ 630\,J$ $\frac{1}{2}mk$

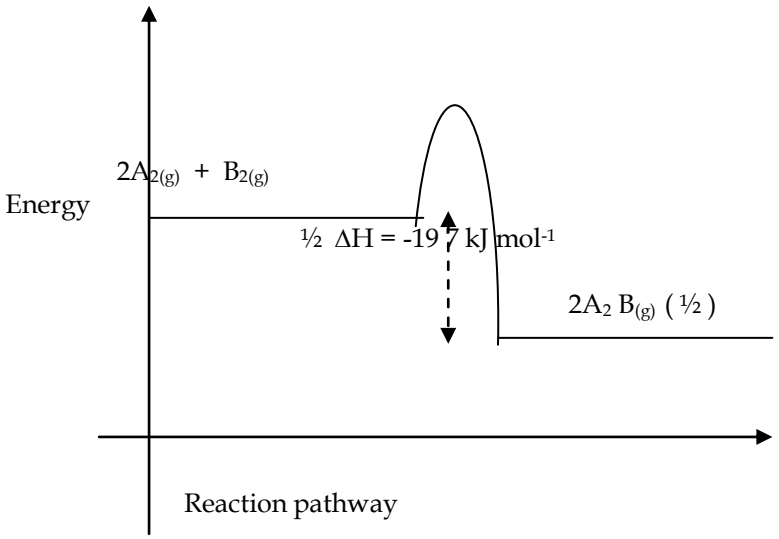
$\therefore 1\ mole\ of\ \ each \equiv \frac{1}{0.0125} \times\ 630\,J\ =\ 50400\,J$ $1mk$

$= 50.4\,KJmol^{-1}$

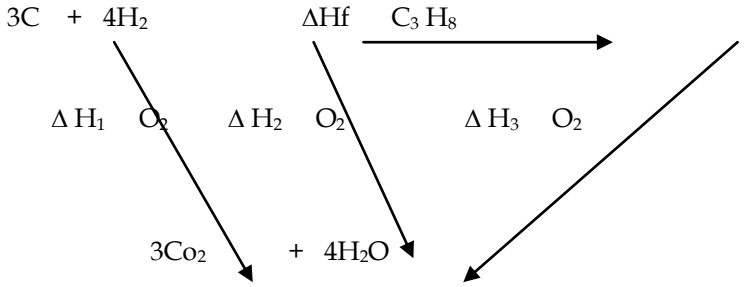
$\Delta H_{neut} = -50.4\,kjmol^{-1}$ $\frac{1}{2}mk$

4. a) i) Increasing the pressure (1)

ii) Descreasing the temperature (1)



5.



$\Delta H_f = \Delta H_1 + \Delta H_2 - \Delta H_3$

$= 3(-395.5) + 4(-285.9) - (-2220)$ (1)

$= 1180.5 + -1143.6 + 2220$ (1)

$= -104.1kJ\ mol^{-1}$ (1)

6

6a)	Bonds broken Cl – Cl and C – H (242 + 412) = ✓½ + 654 Bonds formed C –Cl and H – Cl 338 + 431 = -759✓½ Enthalpy change Δh = + 654 – 769✓½ =- 115 kJ mol –✓½
b)	u – v light // sunlight // photocatalysis✓

7. Heat change = McΔT

$$= \frac{400cm^3}{1000} \; x \frac{kg}{cm^3} \; x \; \frac{4.2kJ}{kg \; x \; K} \; x \; (87-22)K$$ ½✓

= 0.4 x 4.2 x 65 kJ

= 109.2 kJ✓½

Molar mass of ethanol (C_2H_5OH)

= (2 x 12) + (6 x 1) + (1 x 16)

= 46✓½

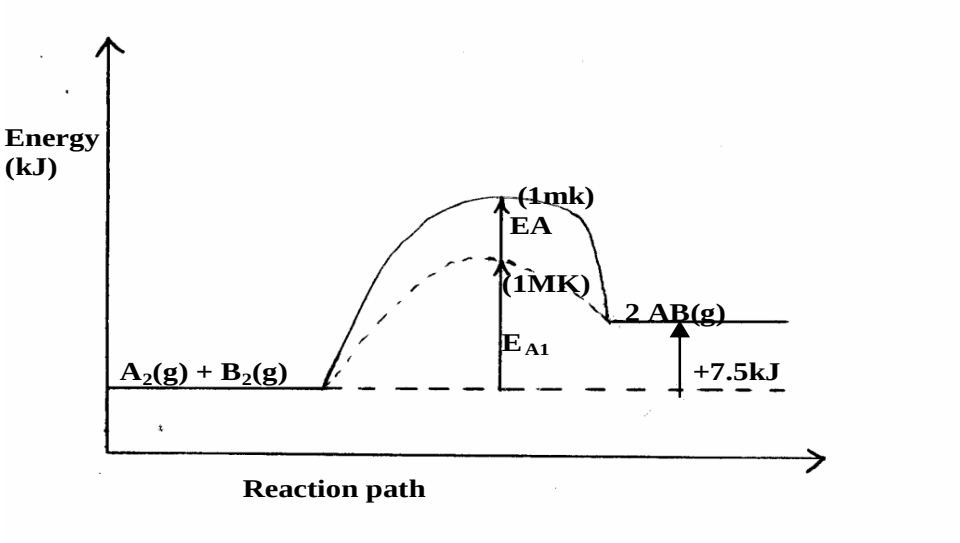
If 10g give 109.2kJ

46g gives $\frac{46}{10} \; x \; 109.2kJ$ ✓½

= 502.32kJ

∴ Molar heat of combustion of ethanol is – 502.32kJmol^{-1}✓1

8. (a)



$$2Al_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Al_2O_{3(s)} \qquad \Delta H_f = -1590KJ \qquad (i)$$

(b) $Cr_2O_3 \rightarrow 2Cr_{(s)} + \frac{3}{2}O_{3(s)} \qquad \Delta H_f = +1134KJ \qquad (ii)$

$(i)+(ii) \quad 2Al_{(s)} + Cr_2O_3 \longrightarrow Al_2O_{3(s)} + 2Cr_{(s)} \qquad \Delta H_f = -456KJ$

$\Delta H\ reaction = -456KJ$ (1*marks*)

(c) (i) Mass determined just before ethanol was ignited at the wick and after. It is put off having raised the temperature of water. (1mark)

(ii) $\Delta T = (28.0 - 23.5)^0 C = 4.5^0 C$ (½ mark)

$200 \times 4.2 \times 4.5J = 3780J$ (½ mark)

(iii) - The ethanol burnt completely as reflected by the mass decease

- All the heat evolved was used in heating the water & there was no heat loss.

(iv) $CH_3CH_2OH = 12+3+12+2+16+1 = 46$ (½ mark)

$0.2g$ *burnt gave* $3780J$

$\therefore 46g$ " $\frac{3780 \times 46}{0.2} J = 869400J$ (1mark) =869.4KJ

$\Delta H_c(CH_3CH_2OH_{(l)}) = -869.4KJ\ mol^{-1}$ (½ marks)

Penalise full if wrong units e.g. KJ instead of KJ and if expression doesn't have negative sign.

(v)

$$CH_3CH_2OH_{(l)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)} \qquad \Delta H = -1368 KJmol^{-1}$$

No mark if ΔH value missing

(1 mark)

9. a) Mixture ✓1

Compound✓1

b) Hydrogen gas ✓1

Iron fillings in the mixture✓1 reacted with dil. HCl to form hydrogen gas.

Accept equation for explanation

c) $2\,HCl_{(aq)} + FeS_{(S)} \longrightarrow FeCl_{2(aq)} + H_2S_{(g)}$ ✓1

d) i) To minise heat loss✓1

ii) To completely displace the Cu^{2+}✓1

iii) - The solution turned from blue to green.

- A brown solid formed at the base of the container.

iv) $\Delta T = 31.5 - 21.5 = 10$

$24 \times 4.2 \times 10$ ✓ ½ = 1050 ✓ ½

Moles of Cu^{2+}

$1000cm^3 \equiv 0.2$

$25 \equiv \frac{25 \times 0.2}{1000} = 0.0005$ moles

0.005 moles ≡ 1050J ✓ ½

1 mole ≡ $\frac{1050}{0.005}$ ✓ ½ = -210000Jmol

= $-210kJMol^{-1}$ ✓ ½

v) $Cu^{2+}_{(aq)} + Fe_{(s)} \longrightarrow Fe^{2+} + Cu_{(s)}$ = $-210kJmol^{-1}$