ENERGY CHANGES MARKING SCHEME

1. **1989 Q2 P1**
   - Reaction is exothermic
   - Vanadium (v) oxide

2. **1990 Q15 P1**

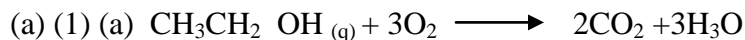   (a)   Reasons, both dissolution of KOH and neutralization by HCL are taking place

   Moles of HCL = 100×1 = 0.1 moles
   0.1 moles of HCL gives 0.05 mole of Hydrogen gas
   Volume of Hydrogen = 24×0.05
   $$= 2.96$$

   (b) $H_2 = H_1 = H_3$

3. **1990 Q23 P1**

   Specific heat capacity = 4.2 ×40×31.1-24.21)
   $$= 4.2 \times 40 \times 6.9 = 159.25 Kj/mol$$
   Molar heat of neutralization   = 1159.2×1000
   $$10000 \times 20 \times 1$$
   $$= 57.91 kj/mol$$

4. **1990 Q27 P1**

   (a) (1) (a) $CH_3CH_2\ OH_{(q)} + 3O_2 \longrightarrow 2CO_2 + 3H_3O$

   (ii) I   Heat absorbed = 4.2 ×500×60 =126.0kj
       II   R.F.M. of ethanol = 46
           5g of ethanol gives 126.0kj
       46g of ethanol gives = 46×126   5
           $$= 1159.2 K5mo^{-1}$$

   (b) (i) $CH_3CH_2OH \longrightarrow CH_3CH_2CHOH \longrightarrow CH_3OH$
       1490 $\longrightarrow$ 110 $\longrightarrow$ 710
       For $CH_3CH_2CH_2CH_2OH \longrightarrow$ 1490 + 390 = 1880 +330
       1870 $\longrightarrow$ 1910
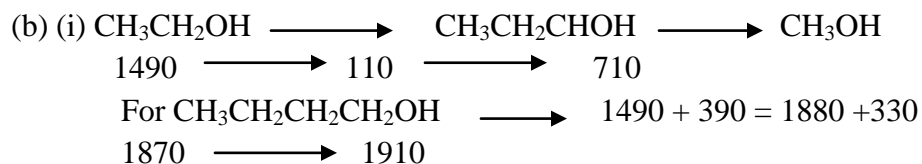
   Extrapolation   graph value
   $$= 1880 \pm 10$$
   $$= 1870- 1890$$

(ii) (I) For every CH2 increase by a constant as the number of carbon atoms increase there is a constant increase in enthalpy of combustion

(II) the higer the RMF the higher the enthalpy

(c) (i) I Enthalpy of hydration

II Enthalpy of solution

(iii)$\Delta H3 = \Delta H + \Delta H$

$= (2237 - 2378)Kj$

$= 141kj$

5. 1991 Q5 P1

(i) $C_{(S)} + 2H_2 (g) \longrightarrow CH_4 (S)$

(ii) $\Delta H = -393.5 + 2(-2285.8) - (-890.4)$

$= 74KJ/ mol$ (Accept kj only)
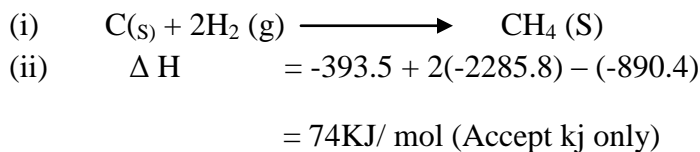
6. 1992 Q4 P1

R .F.M of $CH_3 OH = (12+4+16) = Heat = \dfrac{93.5 \times 32}{4} = 748kj/ Mole$

7. 1992 Q10 P1

H- H $\longrightarrow$ 2H, H = +435

CL-CL $\longrightarrow$ CL, H = +243
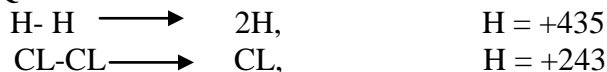
Δ 2H + 2CL $\longrightarrow$ 2(H-Cl) +2 × (-431)

Δ H reaction $= -863 + 435 +243$

$= -184KJ$

8. 1993 Q2 P1

Mole gives 369 $1^1/_5 = 0.2$ moles 4Ne $\dfrac{0.2 \times 369}{5} = 339$

0r

Fe(s) $\longrightarrow$ Fe (g) H = 15.4 + 354 = 369.4kj

56(g) gives 369.4 kj

Heat produced by 11.2 g $= \dfrac{11.2 \times 369.3}{56}$

$= 73.9kj$

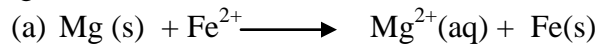**9. 1993 Q4 P1**

$\Delta H(-4036 -364) \Delta H = 771-770 = kj$

10. 1993 Q10 P1

Yield would increase; reasons-reaction is endothermic.

11. **1994 Q11 P1**

389-100 = -289kj or + 22 + -311 = 289kj

12. **1994 Q18 P1**

(a) $Mg_{(s)} + Fe^{2+} \longrightarrow Mg^{2+}(aq) + Fe(s)$

(b) Heat change = 100g $\times 6.0^0C \times$ g-1 = 2520j

14. **1995 Q26 P1**

Enthalpy of neutralization between $CH_3 CaOH_{(aq)}$ and $NaOH_{(aq)}$ is lower than that between $HCl_{(aq)}$ and NaOH because $CH_3 CaOH_{(aq)}$ is a weak acid which does not dissociate fully in water thus some of heat produced is used for dissociation fully dissociated and partially dissociated. (2 marks)
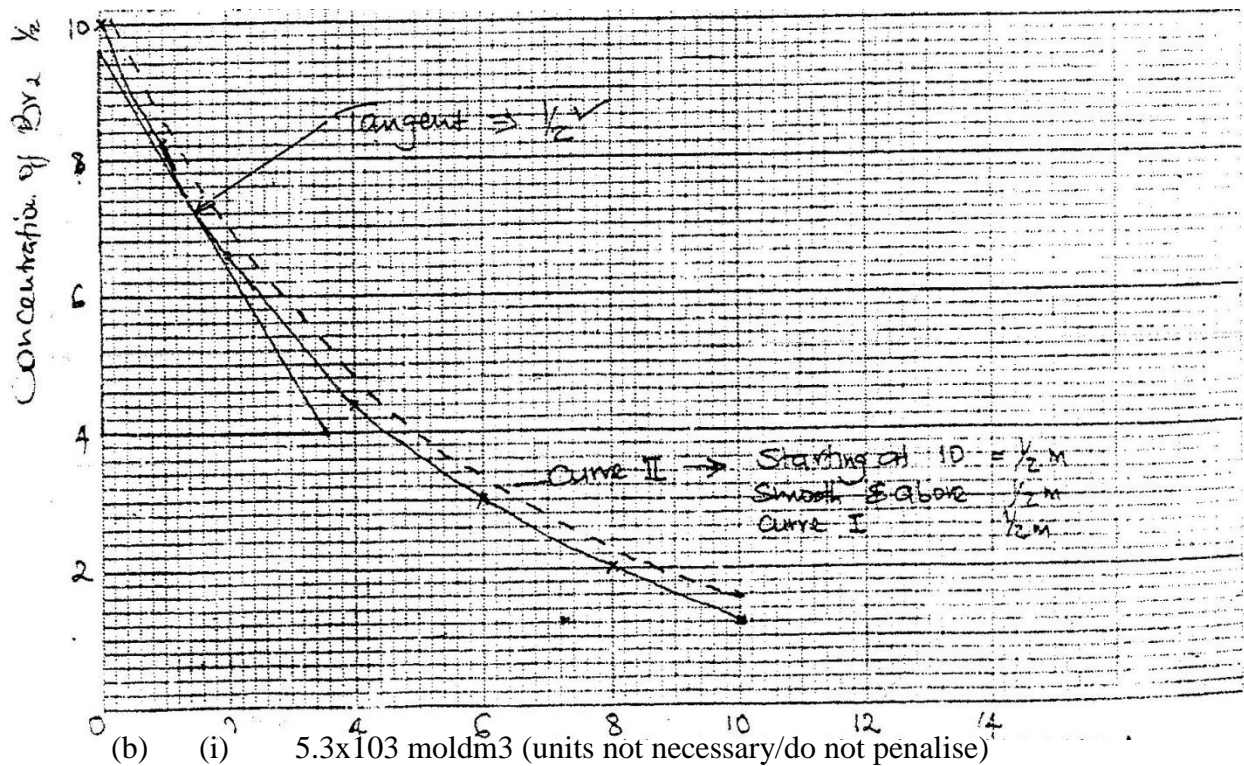
15. **1996 Q19 P1**

a) The energy change that takes place when one mole of the compound is formed from its constituents elements in their state

b) 3 x-286 = 2 x-394-(277)

858 + 788+ 277 = 11369 kjmol

16. **1997 Q20 P1**

a)

(b) (i) 5.3x103 moldm3 (units not necessary/do not penalise)

Change in conc. = (9.6 -4) x 103 = 5.6 x 103

Change in time = 3.7-0 =3.7 min

Rate of reaction $\underline{5.6}$ = 1.51 x 103

3.7

(c)   At high concentration the rate of reaction is high because the more particles in solution collide at high frequency.

(d)   At lower temps; the particles have less K.e / frequency of collision is reduced/ few particles/ less activation energy.
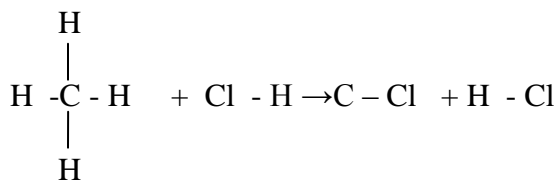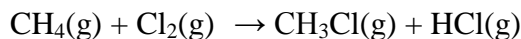
17.   1997 Q20 P1

ΔH =   500 x 9 x 4.2
ΔH =   18900J
     18900J produced by $\underline{0.6 \text{ x } 38000}$
                                  18900
                             = 12.06

18.   1998 Q16 P1

(a) ΔH_1 – Bond breaking/ activation Energy

        ΔH_3 – Energy evolved during reaction

(b)   - $\Delta H_3 = \Delta H_1 + \Delta H_2$

$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

$$\begin{array}{c} H \\ | \\ H - C - H \\ | \\ H \end{array} + Cl - H \rightarrow C - Cl + H - Cl$$

$\underline{414 + 244}$ = $\underline{326 + 431}$
BBE   658   BFE   757

ΔHd =   BBE – BFE = 658 – 758 = -99KJ
ALT 2
4(414) + 244 = 3(414) + 326 + 431
BBE 1900 – 1999 = -99KJ

19.   1999 Q15 P1

Hp (products) – Hr (reactants)
(i)   1207-(-394 – 365) = -1207 + 394 – 635 = 178kj
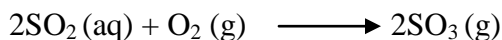   2 marks with –ve sign but 1 without
        OR
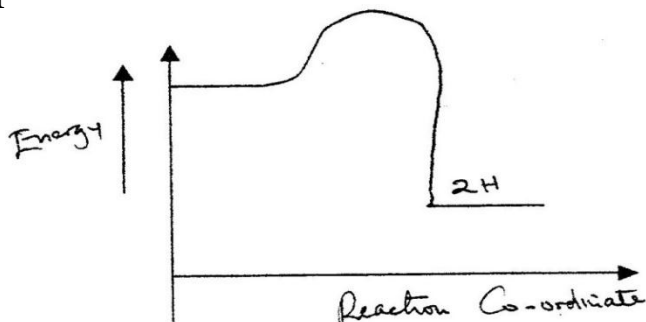   394 + 635 = 1029
                    = -1207 + 1029
                    = -178kj or any other acceptable method

20. **1999 Q6d P2**

$$2SO_2 \text{ (aq)} + O_2 \text{ (g)} \longrightarrow 2SO_3 \text{ (g)}$$

(i)   A reaction where heat is lost to the surroundings

(ii)   Lower (1) through by the principal, the yield is expected to increase, the rate of reaction is lower (I) because the reacting molecules have lower kinetic energy (I)

21. **2000 Q24 P1**
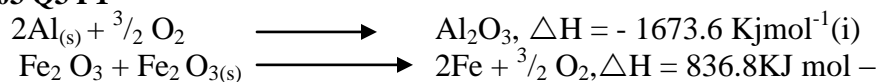

22. **2001 Q2 P1**

Experiment II. At a high temperature the particles have more energy, hence rate of high energy collisions increase.
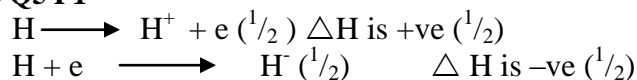
23. **2002 Q13 P1**

(a) Lattice energy (a)

(b) Let the heat be H_3

$H_{3-} - 701 = 15$ (l)

$H_3 = 686$ kJ mol -1   (2 marks)

24. **2003 Q3 P1**

$$2Al_{(s)} + {}^3/_2 \, O_2 \longrightarrow Al_2O_3, \triangle H = - 1673.6 \text{ Kjmol}^{-1}(i)$$

$$Fe_2 O_3 + Fe_2 O_{3(s)} \longrightarrow 2Fe + {}^3/_2 \, O_2, \triangle H = 836.8 \text{KJ mol} -$$

25. . **2003 Q5 P1**

$$H \longrightarrow H^+ + e \, ({}^1/_2) \, \triangle H \text{ is } +ve \, ({}^1/_2)$$

$$H + e \longrightarrow H^- \, ({}^1/_2) \qquad \triangle H \text{ is } -ve \, ({}^1/_2)$$

26. **2004 Q5 P1**

Moles of $BaCl_2$=600 x 1 = 0.6

Heat change when 0.6 moles of $BaCl_2$ are used = 17.7 x 0.6 (½) = 10.62KJ

1500 x 4$\triangle$T = 10.62 (1)   1.5 x 4.2 x$_\triangle$ T   10.62

$\triangle$T= $\underline{10.62}$

1500x4.2   or $_\triangle$ $\underline{10.62}$

1.5 x 4.2

= 1.68570+

= 1.7   1.6857 or 1.7
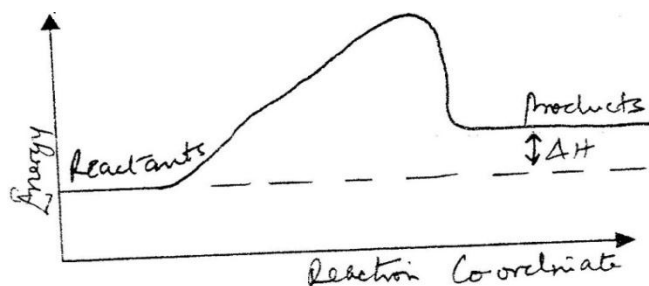
27. . **2004 Q9 P1**

Working out the differences between any two consecutive alcohols (1) . There is a constant increase in mass caused by constant addition of CH_2

OR

This is a homologous series in a constant increase in mass.   (3 marks)

28. **2004 Q25 P1**

a)

d)   Endothermic (1) products are at a higher energy level than the reactants.(1)

29. **2005 Q13 P1**

From the equation:
1 mole of metane produces 890kj
Hence 890 Kj = 24 litres
111.25 KJ   = 111.25 x 24 litres
                        = 3 litres

30. **2005 Q19 P1**

a)   Molar heat of fusion
b) $-\Delta H^3$ process to exothermic (heat given out to the surrounding)

31. **2006 Q9 P1**

a)   Mass

- Pale yellow intensifies.
- Forward reaction is exothermic
- Lowering temperature shifts the equilibrium to the right.   (1 ½ marks)

b)

- Pale yellow intensified
- Reducing the volume of syringe.
- Increases the pressure
- The equilibrium shifts to the rights.

32. **2006 Q28 P1**

a) $\triangle H_1 =$ Lattice energy
    $\triangle H_2 =$ Hydration energy   (2 marks)
b) $\triangle H_3 = \triangle H_2$ (1 mark)

33. **2006 Q2a P2**

    a) (i)   The blue colour of solution fades. Brown solid is deposited because the coloured copper ions are discharged to form copper.   (3 marks)

        (ii)   Heat Change
                 25 x 4.2 x 18 =   1890 Joules   (2 marks)

        (iii)   Moles of M_g used $= \dfrac{0.15}{24} = 0.00625$

                0.00625   =   1890 Joules

                  1 mole   = $\dfrac{1890}{0.00625}$

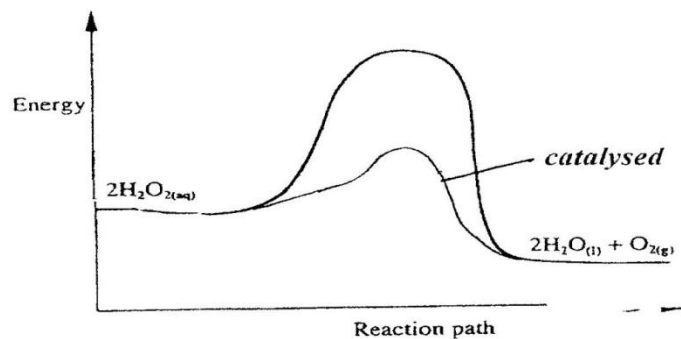   =   -302.4Kj mol-1   (2 marks)

        (iv) $Mg_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + CU_{(s)}$ (l)   (1 mark)

        (v)
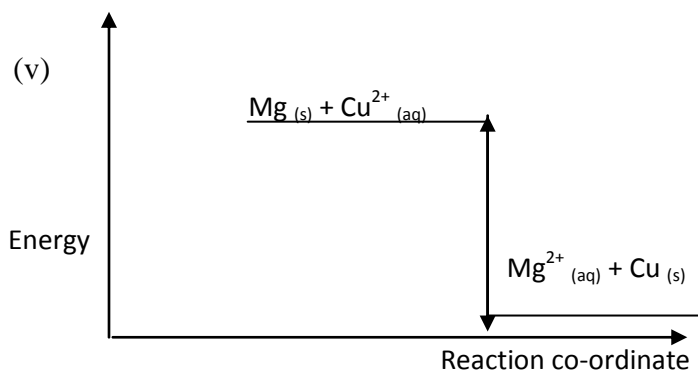
  b) Zinc is higher than copper in the reactivity series of zinc is more reactive than copper or zinc will dissolve in the solution leading to weakening of the container or Redox reaction will take place.   (2 marks)

34. **2007 Q27 P1**

35. 2007 Q1 P2

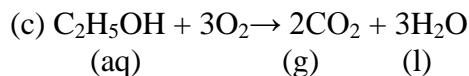   (a) The type of flame produced
          - Amount of heat produced
        (b) (i) Heat produced $= MC\Delta T$
             $\Delta T = 46.5 = 25 = 21.5^0C$
             $\Delta H = 450 \times 21.5 = 40635$ Joules

(ii) Moles of ethanol $= \dfrac{1.5}{46} = 0.0326$

Molar heat $= \dfrac{40635}{0.0326} = 1246472.392$ Joules

(c) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
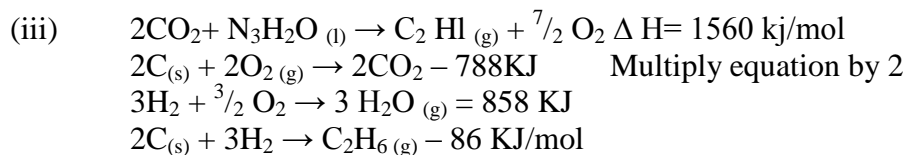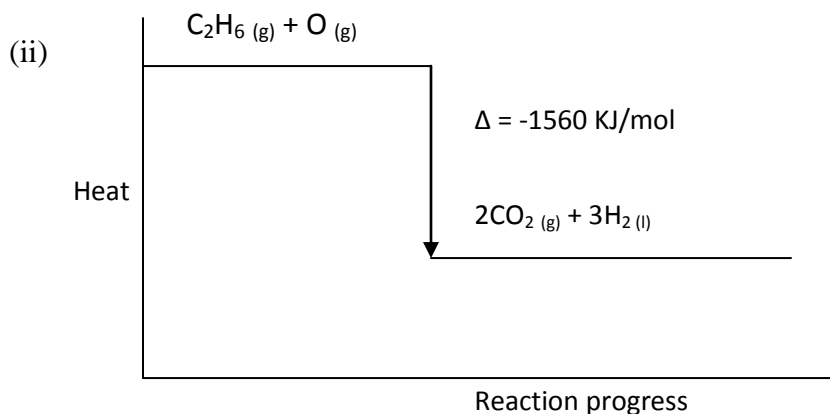$\quad$ (aq) $\qquad$ (g) $\qquad$ (l)

(d) - Heat less by radiation, conduction and convectional current
$\quad$ - Experimental errors when reading thermometer

36. $\quad$ **2008 Q7 P2**

(a) The heat change when mole of substance is formed from its constituent elements.

(b) (i) $\quad$ Heat of combustion of hydrogen
$\qquad$ Heat of formation of water stream

(ii)

$C_2H_{6\,(g)} + O_{(g)}$

$\Delta = -1560$ KJ/mol

$2CO_{2\,(g)} + 3H_{2\,(l)}$

Heat

Reaction progress

(iii) $\quad$ $2CO_2 + N_3H_2O_{(l)} \rightarrow C_2\,HI_{(g)} + \dfrac{7}{2}O_2 \;\Delta H = 1560$ kj/mol
$\qquad$ $2C_{(s)} + 2O_{2\,(g)} \rightarrow 2CO_2 - 788KJ \qquad$ Multiply equation by 2
$\qquad$ $3H_2 + \dfrac{3}{2}O_2 \rightarrow 3\,H_2O_{(g)} = 858$ KJ
$\qquad$ $2C_{(s)} + 3H_2 \rightarrow C_2H_{6\,(g)} - 86$ KJ/mol

(iv) $\quad$ Heat produced $= \dfrac{500 \times 21.5 \times 4.3}{1000}$
$\qquad\qquad\qquad = 45.\,15$ KJ

II $\qquad$ Moles of ethane $\qquad = \dfrac{\text{Answer I}}{1560}$

$\qquad\qquad \dfrac{45..15}{1560}$
$\qquad\qquad = 0.02894 \times 39$
$\qquad\qquad = 0.868$

37. $\quad$ **2009 Q9 P1**

(a) Heat change when one mole of a solute dissolve in excess of the solvent (l)
$\quad$ (i) $\Delta H_1 = + 733$ kj Mol -1 Until no further Δ in temperature
$\qquad$ $\Delta H_2 = 406$ kJ mol -1 / Infinitely dilute solution
$\qquad$ $\Delta H_3 = 335$ kJ mol -1

(ii) Molar heat of solution

Must be correct $(733 - (+ 406 + 335 = 733 - 406 - 335)$

$= -8$ kJ Mol -1   (3 marks)
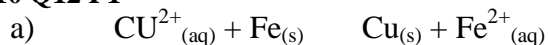
38.   2010 Q10 P1

a) Enthalpy of formation of hydrogen peroxide or enthalpy of formation

(b) $\Delta H_1 + \Delta H_3 = \Delta H_2 \implies \Delta H_2 = \Delta H_2 - \Delta H_1$

$= - 285.8 - (-187.8) = 187.8 - 285.8 = - 98$ kJmol^{-1}

39.   2010 Q12 P1

a) $CU^{2+}_{(aq)} + Fe_{(s)} \quad Cu_{(s)} + Fe^{2+}_{(aq)}$
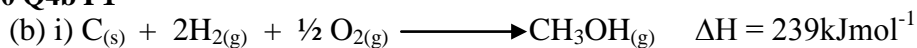
(b)$\Delta H = MC\Delta T; \quad = 75.0 \times 4.2 \times 5.6 = - 1764.5$

Moles of Cu $= \dfrac{5.83}{63.5} = 0.0918$

$\Delta H/mol = \dfrac{1764}{0.0918} \quad = -19215J$ (must have a –ve sign)

$= - 19.2$kJmol^{-1}

40.   2010 Q4b P1

(b) i) $C_{(s)} + 2H_{2(g)} + \tfrac{1}{2} O_{2(g)} \longrightarrow CH_3OH_{(g)} \quad \Delta H = 239$kJmol^{-1}
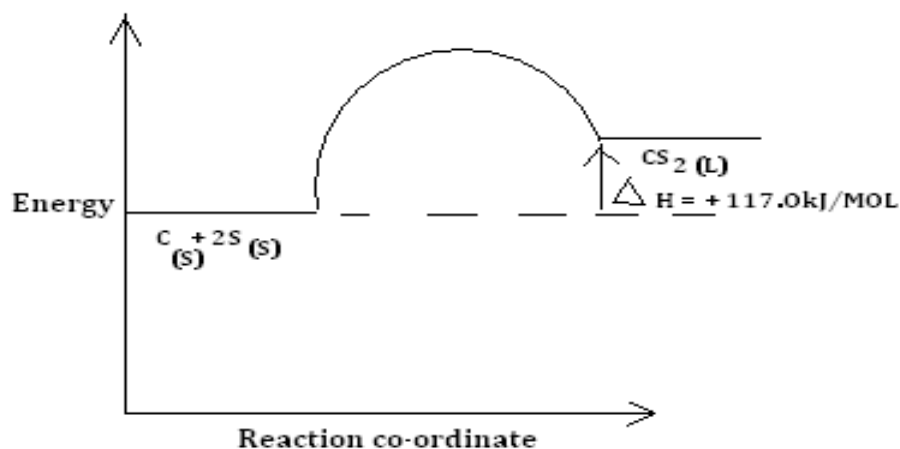
ii)

(I)   Yield increases

Equilibrium shifts to the right

(II)   .

iii) Enthalpy of formation of CO was not included.

41.   2011 Q4b P1

$C_{(s)} + 2S_{(s)} \longrightarrow CS_{2\,(l)} \qquad H = {}^+117.0$kJmol
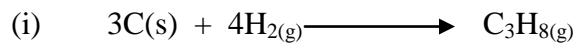

42.   2011 Q7 P2

(a) Amount of heat liberated / energy change when one mole of substance is burnt in

excess oxygen .

(b) Heat absorbed/ evolved in a chemical change is the same regardless of the route taken.

(i) $3C(s) + 4H_{2(g)} \longrightarrow C_3H_{8(g)}$

(c)
- Cost
- Availability
- Easy of transportation
- Storage
- Effect on environment

(d)
- Ethanoic acid is a weak acid some heat is used to ionize before neutralization occurs.
- Ethanoic acid decomposes partially than another one.

43.   2012 Q17 P1

(a) Heat of reaction / heat change / enthalpy of reaction or molar heat of reaction.

(b) using a catalyst

A catalyst lowers /reduces the activation energy