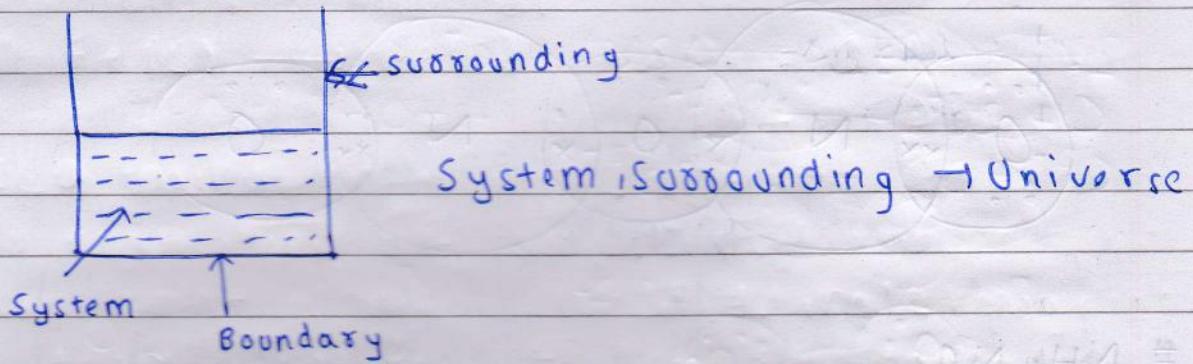


ENTHALPY CHANGE



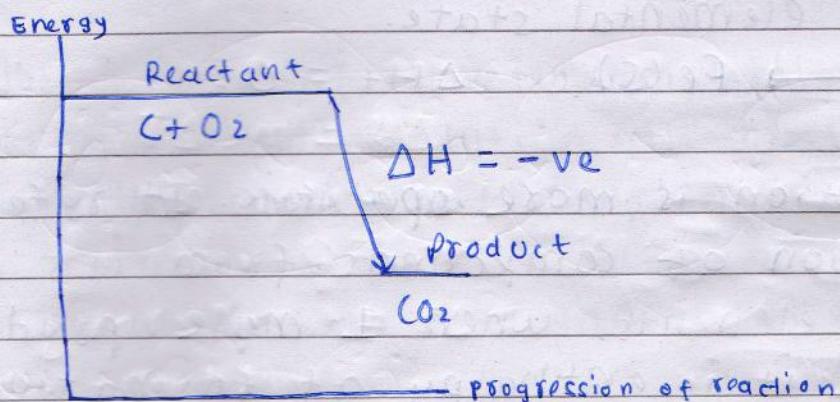
In this closed system, entropy always increases as suggested by the second law of thermodynamics.

- Open system is not closed with lid and can be subjected to external influence.
- Closed system is closed with lid and external influence won't be there.
 - # In open sys. energy exchange takes place between system & surrounding
 - # In closed sys. energy exchange takes place inside system. and with surrounding.
 - # In open sys. matter exchange is also a high possibility and takes place but this isn't possible in closed sys.
- Isolated system is like a system where no energy and/or matter exchange is possible between system and surrounding. Things in vacuum experience this. An example is a thermos flask.

Exothermic - When heat is released

Endothermic - When heat is absorbed.

Energy profile diagram



Exothermic reaction

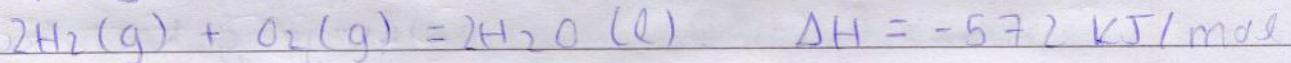
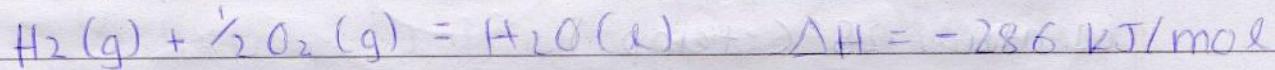
$\Delta H < 0$

Everything in the universe wants to attain stability by losing energy.

In the above case heat change is negative.

This ΔH is very high for Kerosene petrol but negative.

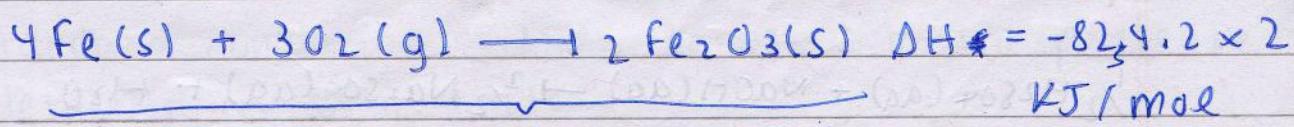
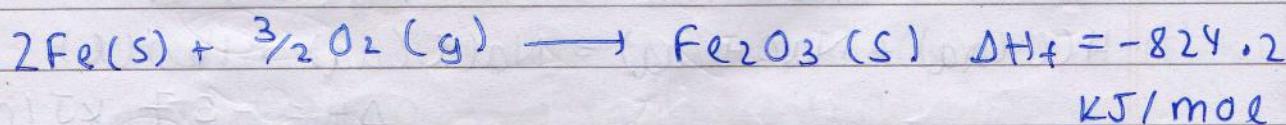
Enthalpy change of reaction



The ΔH are the enthalpy changes.

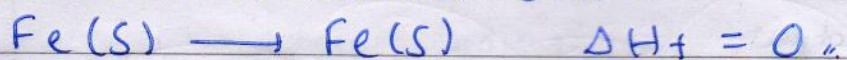
Second ΔH is $2 \times$ first ΔH . It is because in first case there is one mole of product but in second product is 2 moles.

Enthalpy change of formation ΔH_f



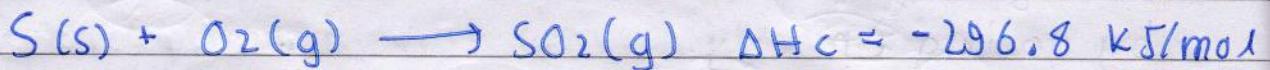
This is Enthalpy change of reaction.

Enthalpy change for formation is 0 for no reaction in elemental state.

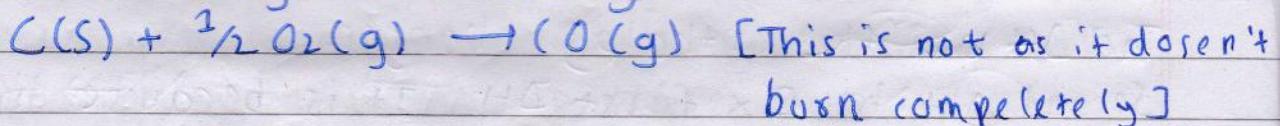


ECO formation is more specific. It refers to formation of compounds from its constituent elements. When 1 mole product is formed, it is enthalpy of formation.

Enthalpy change of combustion.

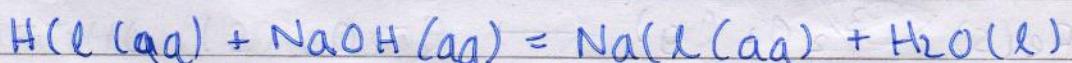


When 1 mole of substance is completely burnt, then the heat change is called enthalpy of combustion under standard condition (1 atm, 25°C temp.)



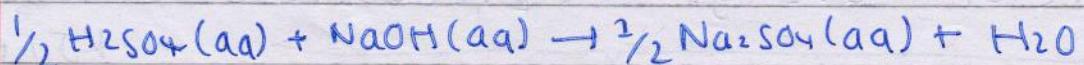
(CO can again combine with $\frac{1}{2}\text{O}_2$ to form CO_2 , thus there is incomplete combustion.

Standard enthalpy change of neutralization ΔH_n^{θ}



$$\Delta H = -57 \text{ kJ/mol}$$

Enthalpy change when 1 mole of water is produced from acid-base reaction.



$$\Delta H = -57 \text{ kJ/mol}$$

Standard enthalpy change of solution ΔH_{sol}

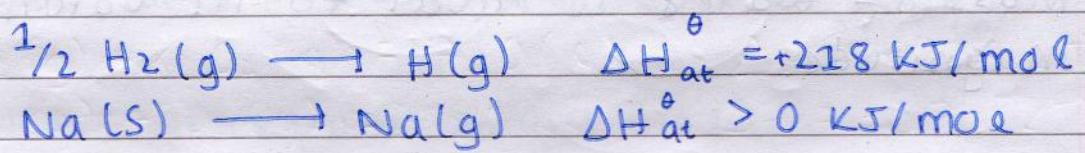
When 1 mole of solute is completely dissolved to form a dilute solution, the heat change is enthalpy change of solution.



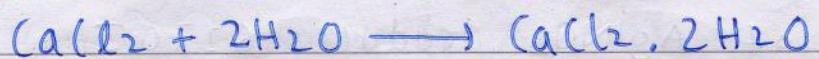
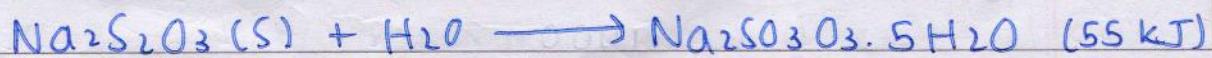
Enthalpy change when 1 mole of solute dissolves with 2L of water or 5L of water is same.

Standard enthalpy change of atomization $\Delta H_{\text{at}}^{\theta}$

When 1 mole of gaseous atoms is formed from its element under standard condition.

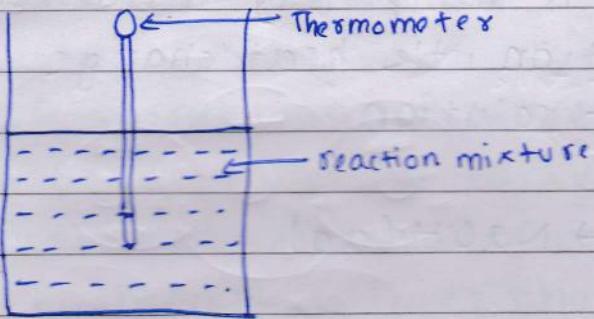
# Standard enthalpy change of hydration of an anhydrous salt $\Delta H_{\text{hydr}}^{\theta}$

When 1 mole of hydrated salt is formed from one mole of anhydrous salt under standard conditions.



Standard condition: 25°C temp., 1 atm pressure, elements in solid state

Measuring enthalpy changes



$$\Delta H = m.c.\Delta T$$

m = mass of reaction mix.

c = specific heat capacity

ΔT = temp. change

= final temp - initial temp

If process is exothermic, temperature will rise,
if endothermic temperature will drop in the
surrounding.

We can also refer to m as mass of water.

In this, specific heat capacity is heat
required to raise temp. of 1 g liquid by 1°C .
Mass of water is equal to its volume in
magnitude.



100cm^3 100cm^3

0.5 mol/dm^3 0.5 mol/dm^3

$$\Delta T = 7.5^\circ\text{C}$$

$$\Delta H_r = ?$$

$$\Delta H = -m c \Delta t = -200 \times 4.18 \times 7.5 = -6270 \text{ J}$$

$$\text{AgNO}_3 = 0.5 \times \frac{100}{1000} = 0.05 \text{ mol} = \text{KCl}$$

0.05 mol of AgNO_3 produces 6270 J
Then 1 mol produces 125400 J

$$\therefore \Delta H_r = -125.4 \text{ kJ}$$



$200 \text{ cm}^3 \quad 200 \text{ cm}^3$

$0.5 \text{ mol/dm}^3 \quad 0.5 \text{ mol/dm}^3$

$\Delta T = 8^\circ\text{C}$

$$\Delta H = -mc\Delta t = -400 \times 4.18 \times 8 = -13376 \text{ J.}$$

$$\text{AgNO}_3 = 0.5 \times \frac{200}{1000} = 0.1 \text{ mol} = \text{KCl}$$

$$\therefore \Delta H_r = -\frac{13376}{0.1} = -133760 \text{ J} = -133.76 \text{ kJ mol}^{-1}$$



$200 \text{ cm}^3 \quad 200 \text{ cm}^3$

$0.5 \text{ mol/dm}^3 \quad 0.25 \text{ mol/dm}^3$

$\Delta T = 8^\circ\text{C}$

$$\Delta H = -mc\Delta t = -400 \times 4.18 \times 8 = -13376 \text{ J.}$$

$$\text{AgNO}_3 = 0.5 \times \frac{200}{1000} = 0.1 \text{ mol}$$

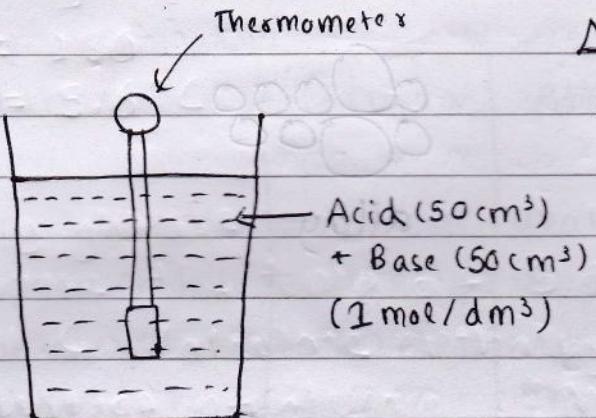
$$\text{KCl} = 0.25 \times \frac{200}{1000} = 0.05 \text{ mol}$$

only 0.05 mol will react.

$$\therefore \Delta H_r = -\frac{13376}{0.05} = -267.5 \text{ kJ.}$$

Here KCl is limiting agent as it doesn't allow for full reaction of AgNO_3 .

Measuring enthalpy change of neutralization



$$\Delta T = 6.5^\circ\text{C}$$

$$\Delta H = -mc\Delta T$$

$$= -100 \times 4.18 \times 6.5$$

$$= -2717 \text{ J} \text{..}$$

(1 mol/dm³)

$$n(\text{acid}) = \frac{1 \times 50}{1000} = 0.05 \text{ mol} = n(\text{base})$$

$$\Delta H_r = -2.7 \text{ kJ} \text{..}$$

0.05 mol of H₂O gives 2717 J of heat.

$$1 \text{ mol gives } \frac{2717}{0.05} = 54 \text{ kJ} \text{..}$$

$$\therefore \Delta H_n = -54 \text{ kJ} \text{..}$$



100 cm³ 100 cm³

0.05 0.05

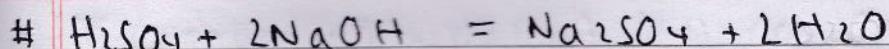
$$\Delta H_n = ?$$

$$\Delta T = 5.5^\circ\text{C}$$

$$\Delta H = -mc\Delta t = -100 \times 4.18 \times 5.5 = -4598 \text{ J} \text{..}$$

$$n(\text{HCl}) = 0.05 \times \frac{100}{1000} = 0.005 \text{ mol} = n(\text{NaOH})$$

$$\therefore \Delta H_n = -919 \text{ kJ} \text{..}$$



$$100 \text{ cm}^3 \quad 100 \text{ cm}^3$$

$$0.05 \text{ M} \quad 0.05 \text{ M}$$

$$\Delta T = 6^\circ\text{C}$$

$$\Delta H_n = ? \quad \Delta H_f = ?$$

$$\cancel{200} \quad 2 \quad -5040 \text{ J}$$

$$\Delta H = -mc\Delta T = -200 \times 4.18 \times 6 = -5016 \text{ J} \quad -3762 \text{ J}$$

$$\therefore \Delta H_f = -5.016 \text{ KJ} \quad -3.7 \text{ KJ}$$

$$\frac{n(\text{H}_2\text{SO}_4)}{n(\text{NaOH})} = \frac{1}{2}, \quad n(\text{H}_2\text{SO}_4) = \frac{1}{2}n(\text{NaOH})$$

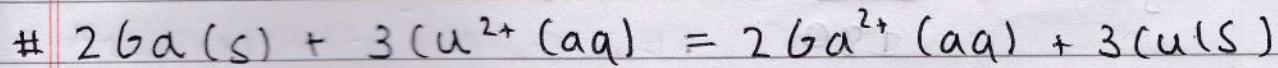
$$n(\text{H}_2\text{SO}_4) = 0.05 \times \frac{200}{1000} = 0.005 \text{ mol} = n(\text{NaOH})$$

$$= 0.0025 \text{ mol}$$

$$\approx 0.0025 \text{ mol}$$

~~0.025~~ mol of water gives ~~-5016~~ ⁴⁰ J of energy

$$\therefore \Delta H_n = -501.6 \text{ KJ}, -2000 \text{ KJ}, -2006 \text{ KJ}, -2016 \text{ KJ}, -1008 \text{ KJ}$$



excess

$$250 \text{ cm}^3$$

$$10 \text{ g}$$

$$\Delta H = \Delta T = 14.2^\circ\text{C}$$

$$C = 4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1} \quad \Delta H_f = ?$$

$$\Delta H = -mc\Delta T = -510 \times 4.2 \times 14.2 = 30 -14910 \text{ J}$$

$$n(3\text{Cu}^{2+}) = 0.2 \times \frac{250}{1000} = 0.05 \text{ mol}$$

$$n(\text{Cu}^{2+}) = \frac{1}{60} \text{ mol}$$

$$\therefore \Delta H_f = -14910 \times 60 = -894.6 \text{ KJ}$$

Burning of glucose

$$m = 2\text{ g} \quad C =$$

$$M_f = 180$$

$$\Delta T = 5.6^\circ\text{C}$$

1.8 g glucose was completely burnt. Heat produced to raise the temp of 5 dm³ of water by 1.34 °C. (calculate enthalpy change of combustion of glucose. [M_f = 180; C = 4.2 J g⁻¹ °C⁻¹])

$$Q = -mc\Delta T = -1.8 \times 4.2 \times 1.34 = -10.23 \text{ J}, -28140 \text{ J}$$

$$\therefore Q = -28140 \text{ KJ}$$

$$n(\text{glucose}) = \frac{1.8}{180} = 0.01 \text{ mol}$$

~~Hess's law~~

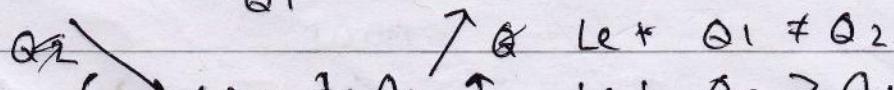
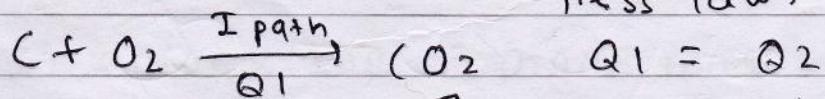
Hess law

→ Based off of conservation of energy



→ The total energy change for a chemical reaction is always the same irrespective of the path it follows.

Hess law:

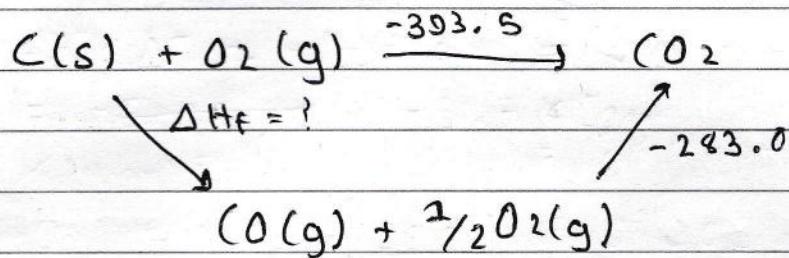
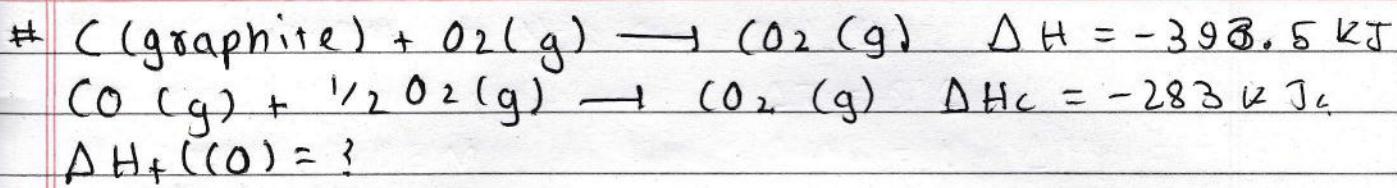


$$\text{Let } Q_2 > Q_1$$

$Q_2 - Q_1 = \text{heat given to surrounding}$

$\therefore Q_1 = Q_2$ is a must.

II path
Q₂

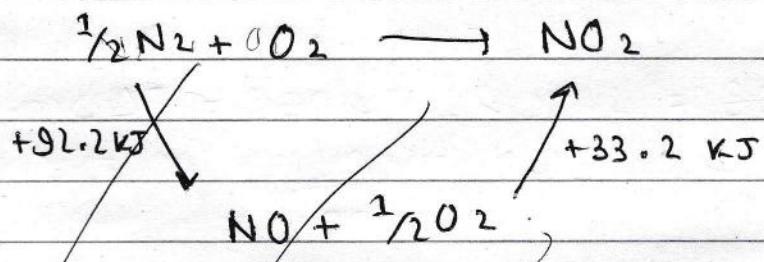
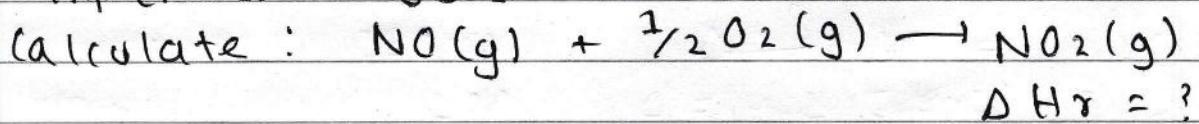


$$\Delta H_f = -393.5 - -283.0$$

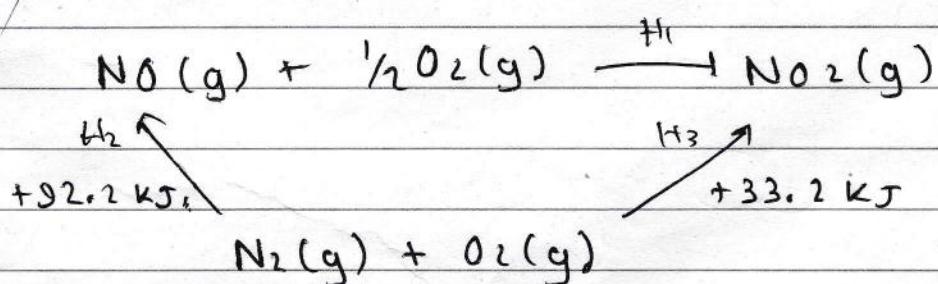
$$\therefore \Delta H_f = -110.5 \text{ kJ}$$

$\Delta H_f(NO) = +92.2 \text{ kJ}$

$$\Delta H_f(NO_2) = +33.2 \text{ kJ}$$



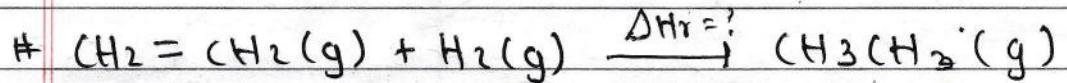
$$\Delta H_r = 92.2 + 33.2 = 125.4 \text{ kJ}$$



$$H_3 = H_1 + H_2$$

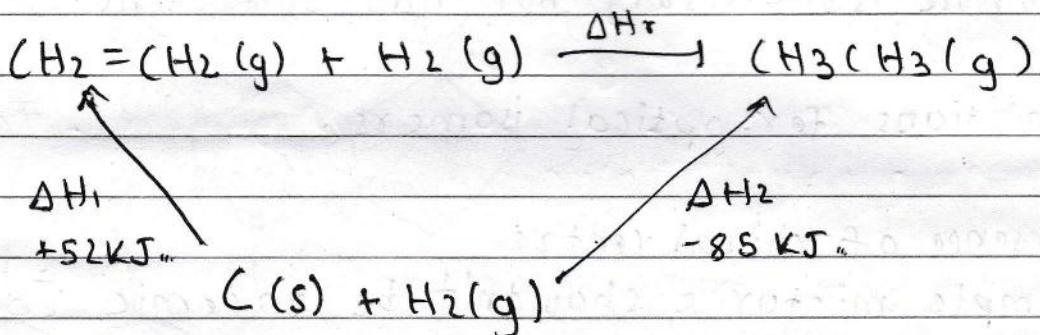
$$\therefore H_2 = -59 \text{ kJ}$$

THERMODYNAMICS . . .



given :- $\Delta H_f^\circ (\text{CH}_2 = \text{CH}_2) = +52 \text{ KJ}^\circ \text{m}^{-1}$,

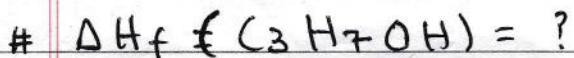
$$\Delta H_f^\circ ((\text{H}_3\text{C}\text{H}_2)) = -85 \text{ KJ}^\circ \text{m}^{-1}$$



$$\Delta H_1 + \Delta H_2 = \Delta H_r$$

$$\text{or } \Delta H_r = -85 - 52$$

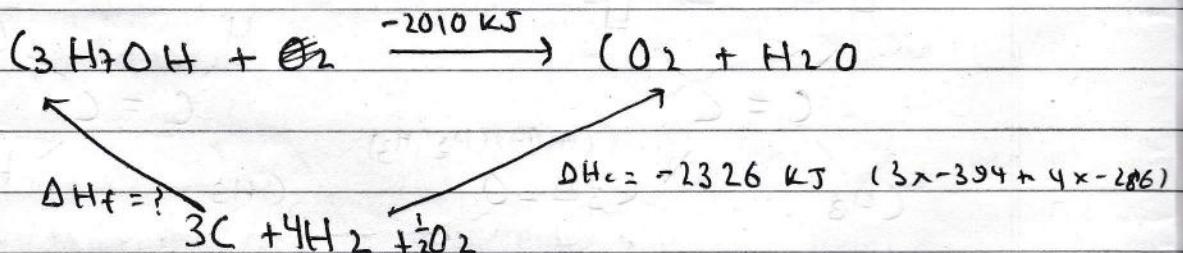
$$\therefore \Delta H_r = -137 \text{ KJ}^\circ \text{m}^{-1}$$



$$\Delta H_c^\circ ((\text{C}_3\text{H}_7\text{OH})) = -2010 \text{ KJ}^\circ \text{m}^{-1} \quad (\text{L})$$

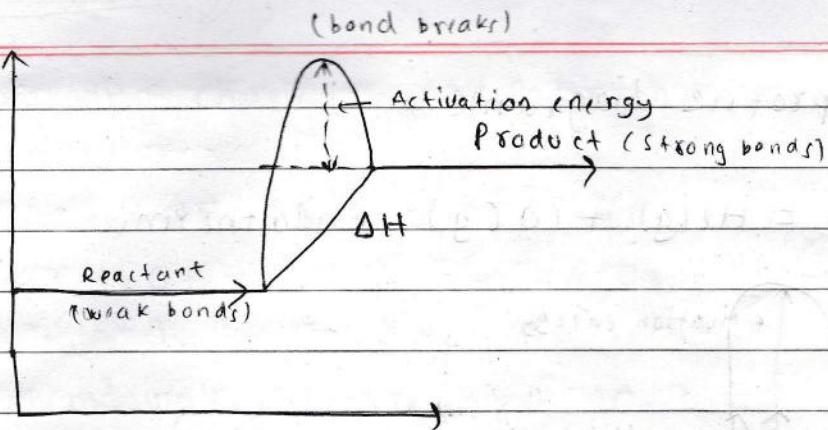
$$\Delta H_c^\circ (\text{C(s)}) = -394 \text{ KJ}^\circ \text{m}^{-1}$$

$$\Delta H_c^\circ (\text{H}_2(\text{g})) = -286 \text{ KJ}^\circ \text{m}^{-1}$$

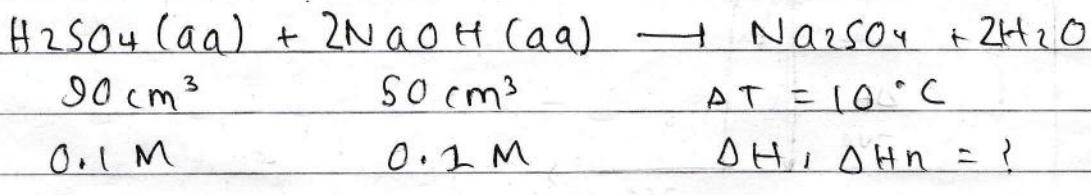
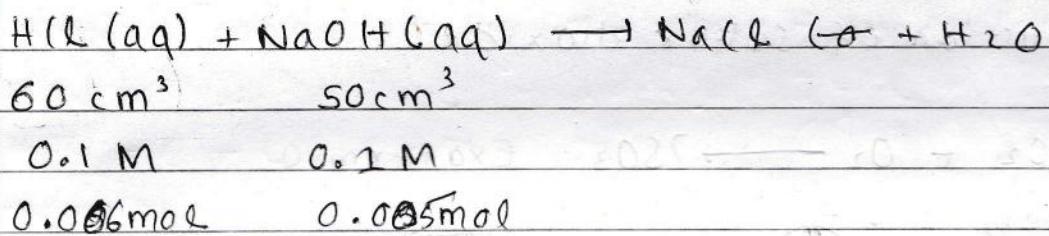


$$\Delta H_f^\circ - 2010 = -2326$$

$$\therefore \Delta H_f^\circ = -3626 - 326 \text{ KJ}^\circ \text{m}^{-1}$$



0.005 mol H₂O gives 4200 J, so, 1 mol gives :
4200 J energy ∴ ΔH_n = -840 KJ..
 0.005



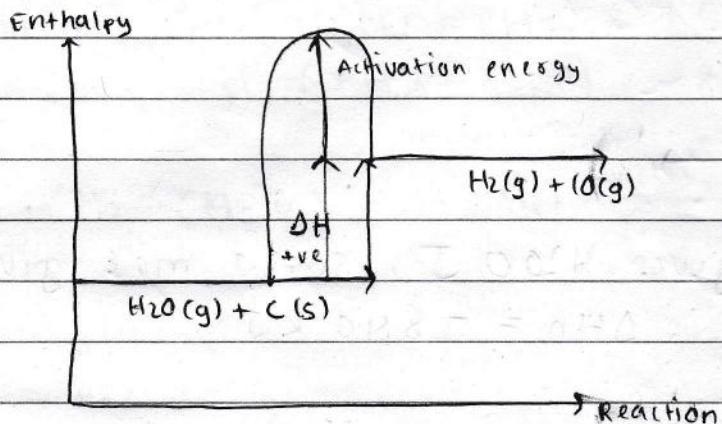
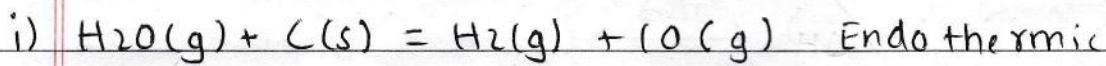
0.0025 mol reacts, 0.0065 mol does not (65 cm³)

$$\therefore \Delta H = -mc\Delta T = -75 \times 4.2 \times 10 = -3150 \text{ J..}$$

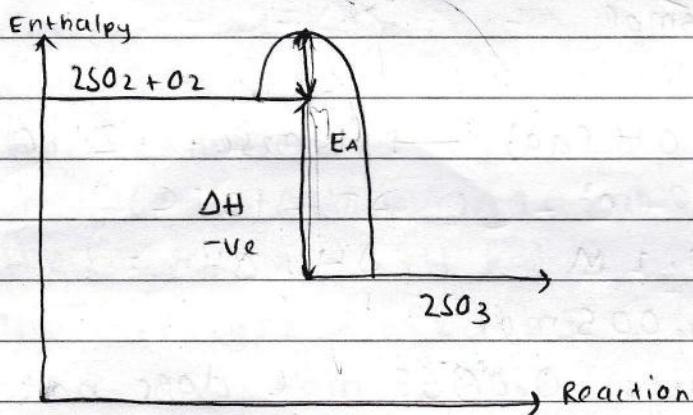
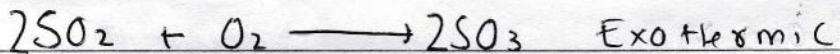
0.0025 mol H₂O gives 3150 J

$$\therefore \Delta H_n = -3150 / 0.0025 = -1260 \text{ KJ..} = -630 \text{ KJ}$$

Draw energy profile diagrams.



ii) Combustion of sulfur dioxide



Enthalpy change of neutralization ΔH_n^θ



50cm^3 50cm^3 $T_1 = 21.3^\circ\text{C}$ $T_2 = 27.8^\circ\text{C}$
 1M 1M $\Delta T = 6.5^\circ\text{C}$

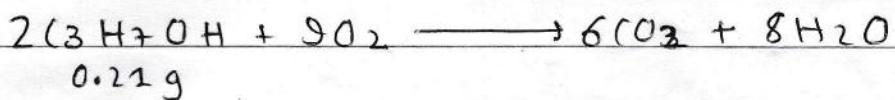
$$\Delta H = -mc\Delta T = -100 \times 4.2 \times 6.5 = -2730 \text{ J..}$$

$$\text{No. of moles (H}_2\text{O)} = 50 \times \frac{1}{1000} = 0.05 \text{ mole}$$

0.05 mole H_2O gives 2730 J energy

$$\therefore \Delta H_n^\theta = -54.6 \text{ KJ..}$$

Enthalpy change of combustion ΔH_c°



100 cm³ water heated by 10.7 °C

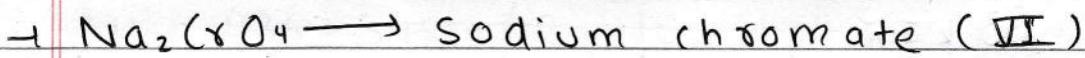
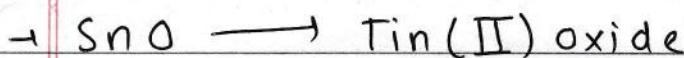
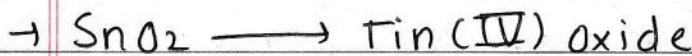
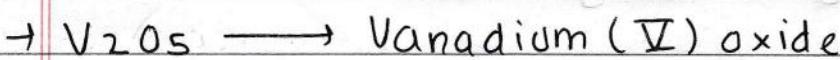
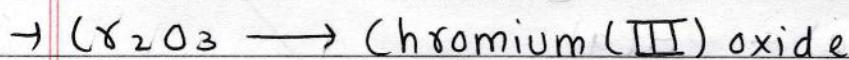
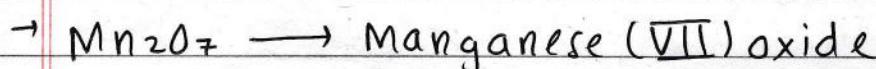
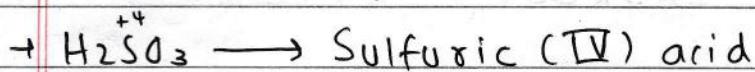
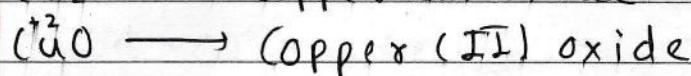
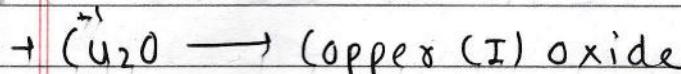
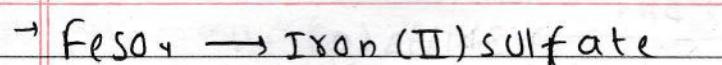
$$\textcircled{Q} \quad \Delta H = -mc\Delta T = -100 \times 4.2 \times 10.7 = -4494 \text{ J.}$$

2
1 mol propanol give

$$1 \text{ mol propanol} = 60 \text{ g.}$$

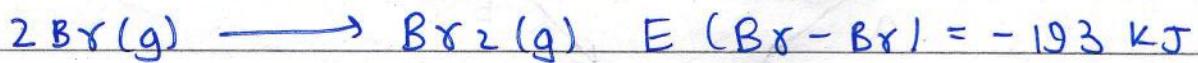
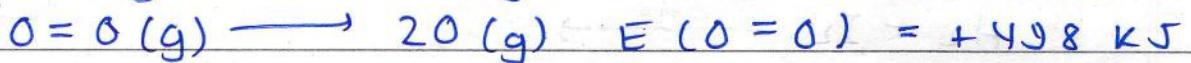
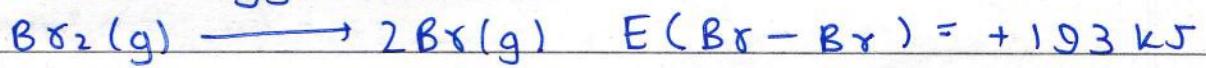
$$0.0035 \text{ mol propanol} = 0.21 \text{ g.} = -4494 \text{ J.}$$

$$\therefore \Delta H_c^\circ = -1284 \text{ KJ.}$$



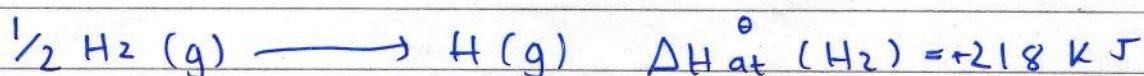
Bond energy and enthalpy changes

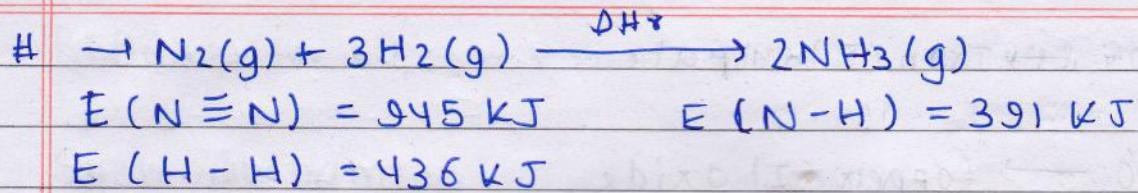
Bond energy:



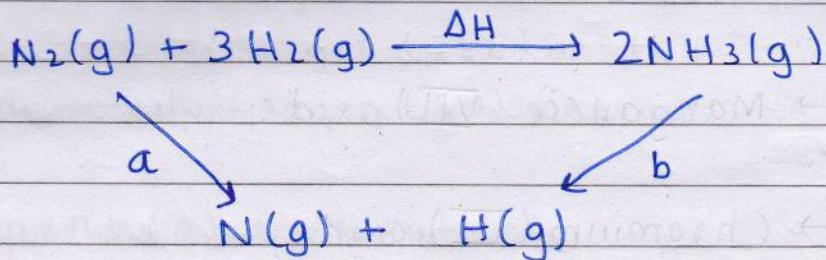
Enthalpy change of atomization

When one mole of gaseous atom is formed from its element.





$$\Delta H^\circ = 945 + 3 \times 436 - 2 \times 3 \times 391 = -93 \text{ kJ}_{\text{..}}$$



$$a = \Delta H + b$$

$$\text{or } \Delta H = a - b$$

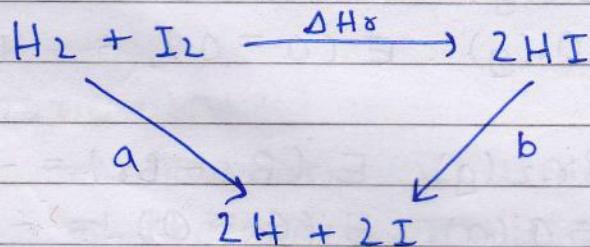
$$\text{g. } \Delta H = 945 + 3 \times 436 - 2 \times 3 \times 391$$

$$\therefore \Delta H = -93 \text{ kJ}_{\text{..}}$$

$E(\text{H}-\text{H}) = 436 \text{ kJ}$

$$E(\text{I}-\text{I}) = 151 \text{ kJ}$$

$$E(\text{H}-\text{I}) = 299 \text{ kJ}$$

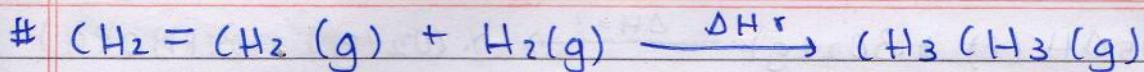


$$a = \Delta H + b$$

$$\text{g. } \Delta H = a - b$$

$$\text{g. } \Delta H = 436 + 151 - 2 \times 299$$

$$\therefore \Delta H = -11 \text{ kJ}_{\text{..}}$$

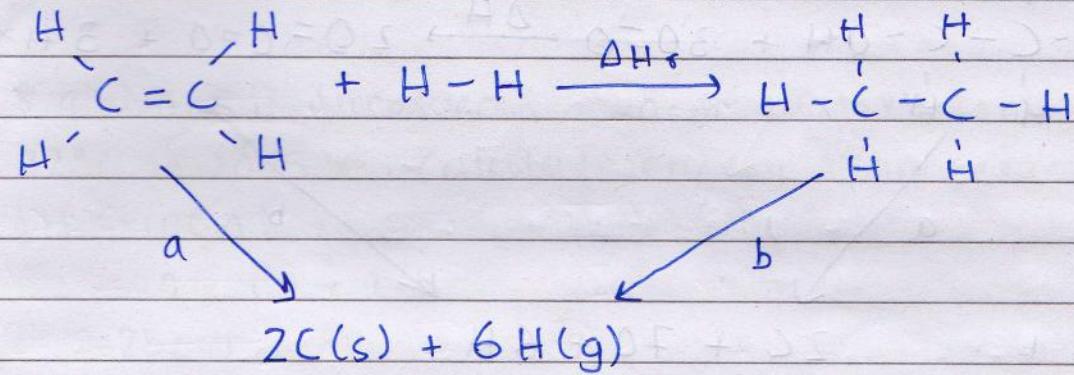


$$E(\text{C-H}) = 416 \text{ kJ}$$

$$E(\text{C=C}) = 612 \text{ kJ}$$

$$E(\text{C-C}) = 348 \text{ kJ}$$

$$E(\text{H-H}) = 436 \text{ kJ}$$



$$\Delta H = a - b$$

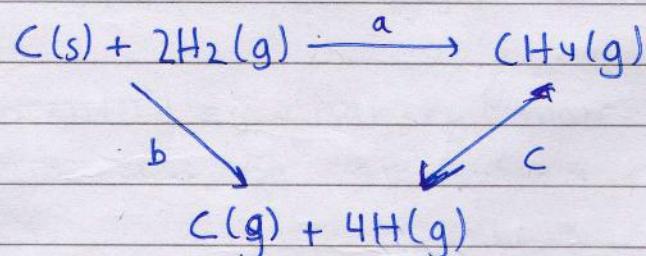
$$\begin{aligned} a. \quad \Delta H &= 436 + 348 - (2 \times 416 - 348) \quad (612 + 4 \times 416 + 436) - (348 + 6 \times 436) \\ \therefore \quad \Delta H &= 300 \text{ kJ} - 136 \text{ kJ} = -132 \text{ kJ} \end{aligned}$$

¶ $E(\text{C-H}) = ?$

$$\Delta H_f^\circ (\text{CH}_4) = -74.8 \text{ kJ}$$

$$\Delta H_{\text{at}}^\circ (\frac{1}{2}\text{H}_2) = +218 \text{ kJ}$$

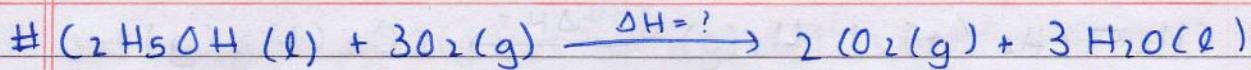
$$\Delta H_{\text{at}}^\circ (\text{C(graphite)}) = +716.7 \text{ kJ}$$



$$b = a + c$$

$$a. \quad 716.7 + 4 \times 218 = -74.8 + 4E(\text{C-H})$$

$$\therefore E(\text{C-H}) = +415.9 \text{ kJ}$$



$$\varepsilon(C-C) = +347 \text{ kJ}$$

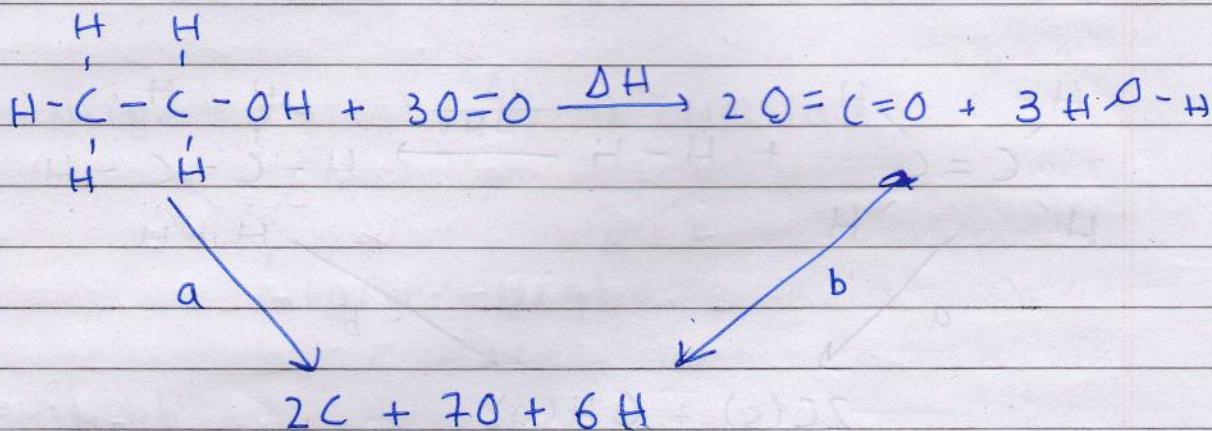
$$\varepsilon(C-H) = +410 \text{ kJ}$$

$$\varepsilon(C=O) = +805 \text{ kJ}$$

$$\varepsilon(C-O) = +336 \text{ kJ}$$

$$\varepsilon(O=O) = +496 \text{ kJ}$$

$$\varepsilon(O-H) = +465 \text{ kJ}$$



$$a = \Delta H + b$$

$$\therefore \Delta H = a - b$$

$$\therefore \Delta H = (347 + 3 \times 496 + 5 \times 410 + 465 + 336) - (4 \times 805 + 6 \times 465)$$

$$\therefore \Delta H = -1324 \text{ kJ}$$

3)

4)

5)

7/11

EXERCISE

1) Temp. of 75 cm^3 water rises from 23°C to 54°C

$$\Delta H = -mc\Delta T$$

$$= -75 \times 4.2 \times 31$$

$$= -9765 \text{ J} \text{..}$$

ΔH

2) 8 g NaCl is dissolved in 40 cm^3 water. Temp falls from 22°C to 20.5°C . calculate energy transferred.

$$\Delta H = -mc\Delta T$$

$$= -40 \times 4.2 \times 1.5$$

$$= -252 \text{ J} \text{..}$$

3) 50 cm^3 NaOH to 50 cm^3 HCl. Both solutions were at 18°C and change to 33°C . How much energy is released.

$$\Delta H = -mc\Delta T$$

$$= -100 \times 4.2 \times 15$$

$$= -6300 \text{ J} \text{..}$$

465)

4) Why is enthalpy change of neutralization of H_2SO_4 not the standard enthalpy change of neutralization in KJ mol^{-1} .

Because in enthalpy change, ^{refers to} mole formation is of optionat. water in acid base reaction.

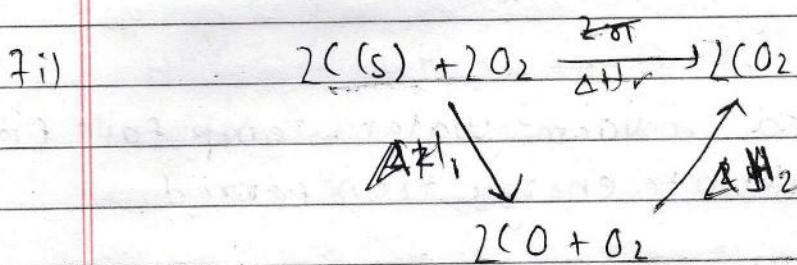
5) A student added 10 g (0.25 mol) of NaOH to 40 cm^3 water to make conc solution. All NaOH dissolved. Student recorded and concluded that results would give an accurate value for standard enthalpy change of solution. Give two reasons why student is wrong.

Because for standard ^{enthalpy change}, ^{dissolved} one mole to be formed, and diluting doesn't make concentrated.

6) $\Delta H^\circ_f [C_2H_5OH]$ by calorimetry = -870 kJ mol^{-1} .

Data value = $-1367 \text{ kJ mol}^{-1}$

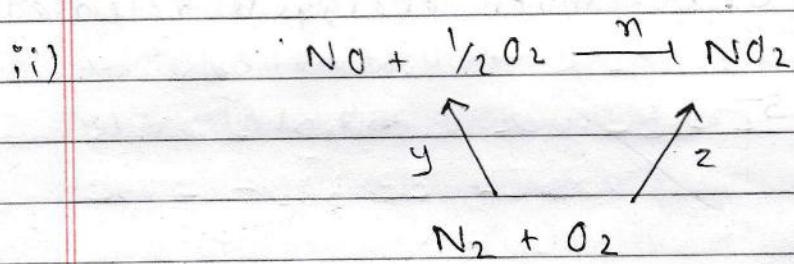
→ Because in calorimetry it's difficult to burn one mole which is a large amount of C_2H_5OH . and also container is heated. Not in isolated system.



$$2n = 2z + 2y$$

$$\therefore n - y = z$$

$$\therefore \Delta H = -110.5 \text{ kJ mol}^{-1}$$



$$z = y + n$$

$$\therefore n = 2 - y$$

$$\therefore \Delta H = -59 \text{ kJ mol}^{-1}$$

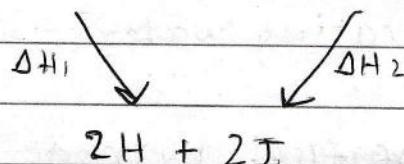
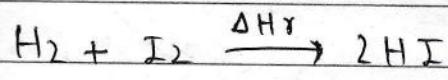
6a) Define avg. bond energy.

→ The average amount of energy required to form/break a bond is avg. bond energy.

✓ 23/3/2022

b) Use avg. bond energies to find enthalpy change.

$$\begin{aligned}\epsilon(H-H) &= +436 \text{ kJ mol}^{-1} & \epsilon(H-I) &= +299 \text{ kJ mol}^{-1} \\ \epsilon(I-I) &= +151 \text{ kJ mol}^{-1}\end{aligned}$$



$$\Delta H_r = \Delta H_1 + \Delta H_2$$

$$\therefore \Delta H_r = \Delta H_1 - \Delta H_2$$

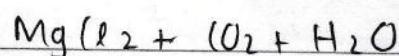
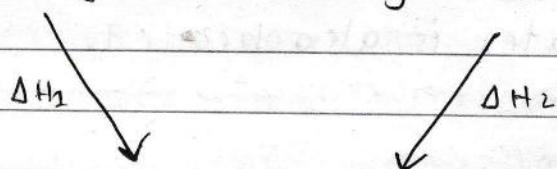
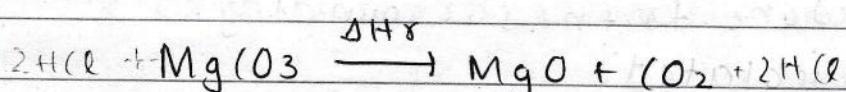
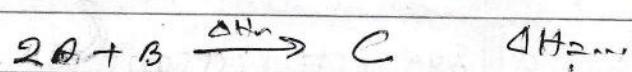
$$\therefore \Delta H_r = (436 + 151) - (2 \times 299)$$

$$\therefore \Delta H_r = -11 \text{ kJ mol}^{-1}$$

7a) Define standard enthalpy change of reaction.

→ It is defined as the heat change that takes place when one mole of products are formed in a standard reaction.

b) Find ΔH_r .



$$\Delta H_r = \Delta H_1 + \Delta H_2$$

$$\therefore \Delta H_r = \Delta H_1 - \Delta H_2 \dots$$

Q1 Calculate energy that went into heating the water.

$$\Delta H = -mc\Delta T$$

$$= -250 \times 4.2 \times (43 - 20)$$

$$= -250 \times 4.2 \times 23$$

$$= -24.15 \text{ kJ}$$

$\therefore 24.15 \text{ kJ}$ went into heating water.

b) calculate no. of moles of fuel burned.

$$\text{mass of fuel burnt} = 248.8 - 245.9 = 2.9 \text{ g}$$

$$M [(\text{H}_3\text{O}\text{H})] = 12 + 3 + 16 + 1 = 32 \text{ g mol}^{-1}$$

$$\therefore n = \frac{m}{M} = \frac{2.9}{32} = 0.0906 \text{ moles}$$

c) calculate value for enthalpy change of combustion of methanol.

0.0906 moles gives 24.15 kJ

$$\therefore 1 \text{ mole gives} = 266.55 \text{ kJ} \quad [24.15 / 0.0906]$$

$$\therefore \Delta H = -266.55 \text{ kJ mol}^{-1}$$

d) Suggest reasons why this answer is much smaller.

→ Heat loss is done to the surrounding.

→ System isn't isolated.

→ Container heating water is also heated.

→ Standard conditions not met.



1. T

a)

→

b)

→

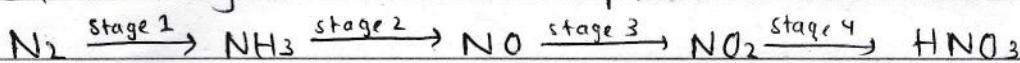
c)

→

d)

e)

1. The following reaction takes place:



a) Deduce the oxidation number of the nitrogen atom in each molecule.

$$\rightarrow 0, -3, +2, +4, +5$$

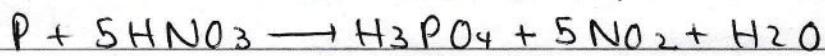
b) For each stage state whether oxidation or reduction has taken place.

\rightarrow Reduction in stage 1 as oxidation number decreases.
Oxidation in the other stages as oxidation number increases.

c) Give full systematic name for NO_2 .

\rightarrow Nitrogen (IV) oxide.

d) HNO_3 reacts with red phosphorus.



By referring to oxidation changes explain why this is a redox reaction.

\rightarrow Since oxidation number of phosphorus has increased from 0 to +5, it has oxidized. And since oxidation number of nitrogen has decreased from +5 to +4, it has reduced. As both oxidation and reduction have taken place, this is a redox reaction.

e) Explain why nitric acid is an oxidizing agent in this reaction.

\rightarrow It is because it gains the electrons of Phosphorus helping Phosphorus oxidize.

2. Calcium reacts with cold water to form Ca(OH)_2 & H_2 .

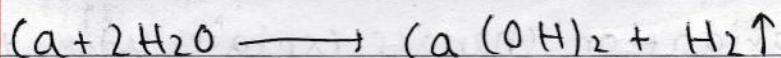
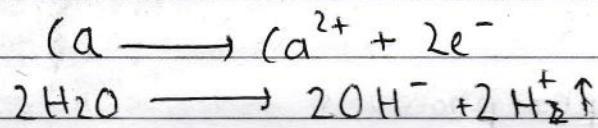
a) State the oxidation number of calcium in calcium metal and calcium hydroxide.

→ 0 and +2.

b) State oxidation number of hydrogen in water and hydrogen gas.

→ +1 and 0.

c) Write two half eq's to show reaction between water and calcium hydroxide to show the change from calcium to calcium ions and the change from water to hydroxide ions and hydrogen.



each
mixtural

ENTHALPY CHANGE

- 1) calculate energy transferred when temp of 75 cm^3 water rises from 23°C to 54°C .

$$\Delta H = -mc\Delta T$$

$$= -75 \times 4.2 \times (54 - 23)$$

$$= -9.76 \text{ kJ mol}^{-1}$$

9.76 kJ transferred

- 2) When 8 g NaCl is dissolved in 40 cm^3 water, temp. falls from 22°C to 20.5°C . calculate energy absorbed.

$$\Delta H = -mc\Delta T$$

$$= -40 \times 4.2 \times (20.5 - 22)$$

$$= +252 \text{ J mol}^{-1}$$

252 J absorbed.

- 3) A student added 50 cm^3 NaOH to 50 cm^3 HCl . Both solutions were at 18°C . When solutions mixed, temp. became 33°C . How much energy is released?

$$\Delta H = -mc\Delta T$$

$$= -100 \times 4.2 \times (33 - 18)$$

$$= -6.3 \text{ kJ mol}^{-1}$$

6.3 kJ released.

- 4) Explain why enthalpy change of neutralization of H_2SO_4 is not standard enthalpy change of neutralization in kJ mol^{-1} .

→ Because in standard enthalpy change of neutralization, one mole water is to be formed but in enthalpy change of neutralization one mole cannot or can't be formed. Also standard enthalpy change of neutralization requires standard condition of ~~RTP~~ while enthalpy change does not.

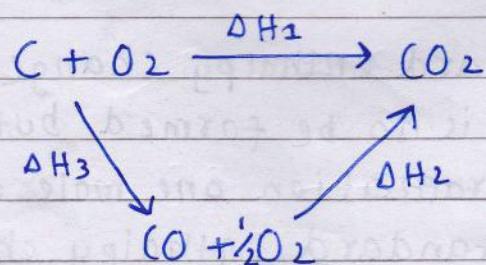
5) A student added 10g (0.25 mol) NaOH to 40cm³ water to make conc. solution. All NaOH dissolved. The student suggested that his results would give an accurate value for standard enthalpy change of solution. Give two reasons why student is incorrect.

→ Because to find standard enthalpy change of solution accurately, an infinitely dilute solution is to be formed while the student forms a concentrated solution. Also to get the most accurate value 1 mole is to be dissolved. It is difficult to maintain standard condition during reaction.

6) A student calculated standard enthalpy change of combustion ΔH_c° [2H₅O_H] by calorimetry as -870 kJ mol⁻¹. Data value is -1367 kJ mol⁻¹. Explain why there is a difference in values?

→ There is a difference because it is difficult to maintain standard condition of temp. and pressure during experiment, and experiment is not carried out in a isolated system.

7) Calculate ΔH_f° (O); when ΔH_c° (C) = -393.5 kJ and ΔH_i° (O(g)) = -283 kJ.

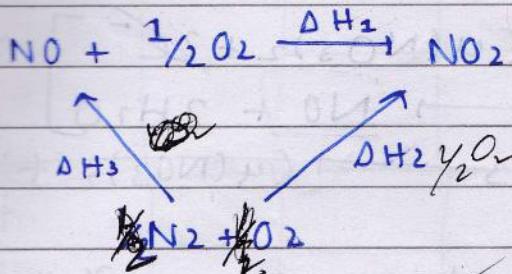
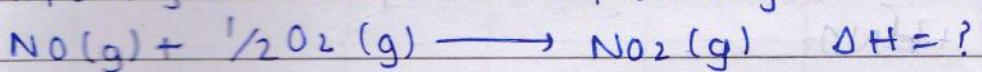


$$\Delta H_1 = \Delta H_3 + \Delta H_2$$

$$\text{or } -393.5 = \Delta H_3 - 283$$

$$\therefore \Delta H_3 = -110.5 \text{ kJ mol}^{-1}$$

8) $\Delta H_f(\text{NO(g)}) = +92.2 \text{ kJ}$, $\Delta H_f(\text{NO}_2\text{(g)}) = +33.2 \text{ kJ}$

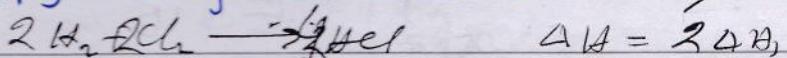


$$\Delta H_2 = \Delta H_3 + \Delta H_1$$

$$\therefore 33.2 = 92.2 + \Delta H_1$$

$$\therefore \Delta H_1 = -59 \text{ kJ mol}^{-1}$$

i) Enthalpy change of reaction : The amount of energy transferred when a standard reaction is carried out. is enthalpy change of reaction.



ii) Standard enthalpy change of formation : The heat change that takes place when one mole of a compound is formed from its constituent elements. (provided the reactants are in normal state.)

iii) Standard enthalpy change of combustion : The heat change that takes place when one mole of a substance is completely burnt.

iv) Standard enthalpy change of neutralization : The heat change that takes place when one mole of water is formed from an acid-base reaction.

v) Standard enthalpy change of solution : The heat change that takes place when one mole of a solute dissolves in an aqueous solution to form an infinitely dilute solution.