YAKEEN NEET 2.0

2026

Thermodynamics & Thermochemistry

Physical Chemistry | **Lecture -9**

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Topics to be covered

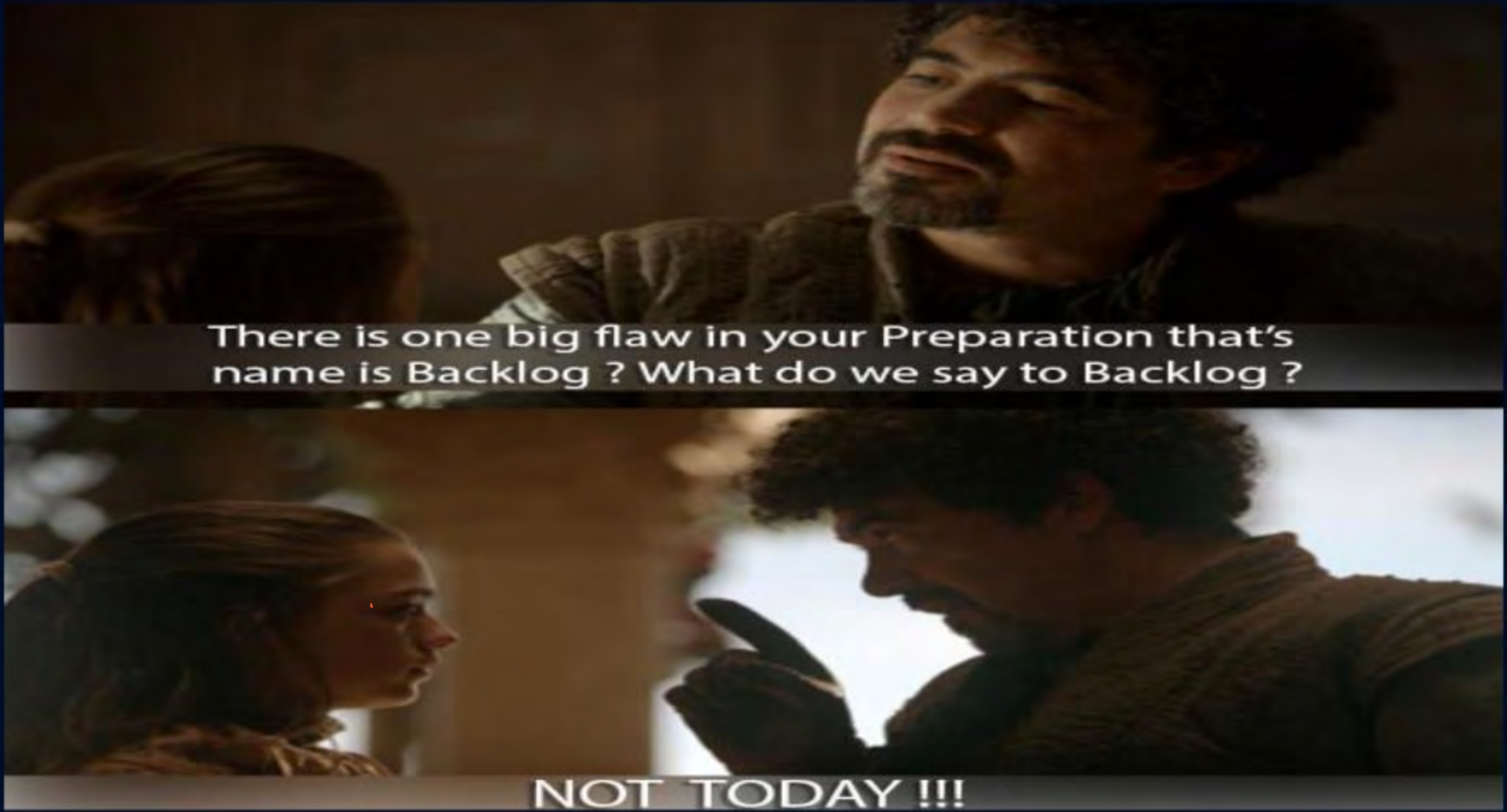
1. ~~Modics Test~~, Revision of Last Class
2. Different Types of Enthalpies Part-03
3. Magarmach Practice Questions, Home work from Modules,

Rules to Attend Class

1. Always sit in a peaceful environment with headphone and be ready with your copy and pen.
2. Never ever attend a class from in between or don't join a live class in the middle of the chapter.
3. Make sure to revise the last class before attending the next class & always complete your Magarmach Practice Questions.
4. Never ever engage in chat whether live or recorded on the topic which is not being discussed in current class as by doing so u can be blocked by the admin team or your subscription can be cancelled.

Rules to Attend Class

5. Try to make maximum notes during the class if something is left then u can use the notes pdf after the class to complete the remaining class.
6. Always ask your doubts in doubt section to get answer from faculty. Before asking any doubt please check whether same doubt has been asked by someone or not.


There is one big flaw in your Preparation that's name is Backlog ? What do we say to Backlog ?
NOT TODAY !!!

Revision of Last Class

$\Delta H_{\text{Hydrogenation}}$ | $\Delta H_{\text{Hydration}}$ | $\Delta H_{\text{solution}}$ | $\Delta H_{\text{ionisation}}$

$\Delta H_{\underline{\text{A.T.}}}$ | ΔH_{fusion} | ΔH_{vap} | $\Delta H_{\underline{\text{sub}}}$

<u>B.E.</u> | $\Delta H_{\text{atomisation}}$

QUESTION

The enthalpy of atomization of $PH_3(g)$ is +954 kJ/mol and that of P_2H_4 is +1.488 MJ/mol. The bond energy of the P–P bond is

(A) 318 kJ/mol

(B) 372 kJ/mol

(C) 216 kJ/mol

(D) 534 kJ/mol

$1PH_3(g) \longrightarrow 1P(g) + 3H(g)$ $\quad \Delta H = 954\ kJ/mol = 954\times10^{3}\ J/mol$

$1P_2H_4(g) \longrightarrow 2P(g) + 4H(g)$ $\quad \Delta H = 1.488\ MJ/mol = 1.488\times10^{6}\ J/mol = 1488\times10^{3}\ J/mol$

$\Delta H = 954\ KJ = 3\times B.E_{P-H} - 0$

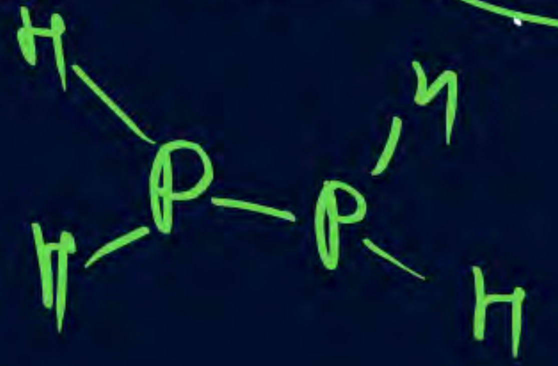
$B.E_{P-H} = \frac{954}{3} = 318$

$\Delta H = 4\times B.E_{P-H} + 1\times B.E_{P-P} - 0$

$1488 = \underline{4\times 318} + 1\times B.E_{P-P}$

$1488 - 1272 = B.E_{P-P}$

$216 = B.E_{P-P}$



QUESTION – (AIIMS 2015)

The enthalpy changes for the following processes are listed below:

$Cl_2(g) \rightarrow 2Cl(g)$, 242.3 kJ mol^{-1}

$I_2(g) \rightarrow 2I(g)$, 151.0 kJ mol^{-1}

$ICl(g) \rightarrow I(g) + Cl(g)$, 211.3 kJ mol^{-1}

$I_2(s) \rightarrow I_2(g)$, 62.76 kJ mol^{-1}

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for ICl(g) is:

(A) +16.8 kJ mol^{-1}

(B) +244.8 kJ mol^{-1}

(C) –14.6 kJ mol^{-1}

(D) –16.8 kJ mol^{-1}

$\frac{1}{2} I_2(s) + \frac{1}{2} Cl_2(g) \longrightarrow 1\, ICl(g) \quad \Delta H = ?$

$\Delta H_1 = \frac{1}{2} \Delta H_{sub}$

ΔH_2

$\frac{1}{2} I_2(g) + \frac{1}{2} Cl_2(g)$

$$\Delta H = \Delta H_1 + \Delta H_2$$

$$= \frac{1}{2} \times 62.76 + \left[\frac{1}{2} \times 151 + \frac{1}{2} \times 242.3 - (1 \times 211.3)\right]$$

$$= 31.38 + [75.5 + 121.15 - 211.3]$$

$$\approx 16.8$$

QUESTION – (AIIMS 2012)

$A \nmid A$

$x \quad x \quad \frac{x}{2}$

AB, A_2 and B_2 are diatomic molecules. If the bond enthalpies of A_2, AB and B_2 are in the ratio 1 : 1 : 0.5 and enthalpy of formation of AB from A_2 and B_2 is – 100 kJ mol^{-1}. What is the bond energy of A_2 ?

(A) 200 kJ mol^{-1}

(B) 100 kJ mol^{-1}

(C) 300 kJ mol^{-1}

(D) 400 kJ mol^{-1}

$\frac{1}{2}A_2(g) + \frac{1}{2}B_2(g) \longrightarrow 1AB(g) \quad \Delta H = -100\ KJ$

$\Delta H = -100 = \frac{1}{2} \times x + \frac{1}{2} \times \frac{x}{2} - 1 \times x$

$= \frac{x}{2} + \frac{x}{4} - x$

$= \frac{2x + x - 4x}{4} = +\frac{x}{4} = +100$

$x = 400\ KJ$

QUESTION

The heats of combustion of carbon and carbon monoxide are –393.5 and –283.5 kJ mol^{-1}, respectively. The heat of formation (in kJ) of carbon monoxide per mole is

(A) 676.5

(B) – 676.5

(C) – 110.5

(D) 110.5

① $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ KJ

② $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$ $\Delta H = -283.5$ KJ

$1C(\text{graphite}) + \frac{1}{2}O_2(g) \rightarrow 1CO(g)$

eq. ① – eq. ②

$1C(\text{graphite}) + \frac{1}{2}O_2 + \cancel{CO_2(g)} \rightarrow \cancel{CO_2(g)} + CO(g) + \cancel{\frac{1}{2}O_2}$

$\Delta H = -393.5 - (-283.5)$
$= -393.5 + 283.5$
$= -110.5$

QUESTION

$C_6H_6(l)$

The combustion of benzene (*l*) gives $CO_2(g)$ and $H_2O(l)$. Given that heat of combustion of benzene at constant volume is –3263.9 kJ mol^{-1} at 25°C; heat of combustion (in kJ mol^{-1}) of benzene at constant pressure will be ($R = 8.314\ JK^{-1}\ mol^{-1}$)

$q_V = \Delta U = -3263.9\ kJ/mol$ $\quad T = 298\ K$

$q_p = \Delta H = ?$

$1C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$

$\Delta n_g = 6 - \frac{15}{2}$

$= -\frac{3}{2}$

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta H = -3263900 - \frac{3}{2} \times 8.314 \times 298$

A. 4152.6

B. –452.46

C. 3260

D. –3267.6

QUESTION

The heat evolved in the combustion of glucose $C_6H_{12}O_6$ is -680 kcal/mol. The mass of CO_2 produced, when 170 kcal of heat is evolved in the combustion of glucose is

(A) 45 g

(B) 66 g

(C) 11 g

(D) 44 g

$\Delta H_{comb} = -680$ Kcal/mol

$M_{CO_2} = 44$

$C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l)$

680 Kcal $\rightarrow 6 \times 44 = 264$ g

170 Kcal $\longrightarrow \frac{264}{680} \times 170 = 66$ g

Calorific Value of Fuel

① heat evolved by Combustion of 1g of fuel.

② High Calorific value

∴ Better fuel.

QUESTION

M 16g 28g 30g

Enthalpies of combustion of CH_4, C_2H_4 and C_2H_6 are –890, –1411 and –1560 kJ/mole, respectively. Which has the highest fuel value (heat produced per gram of the fuel)

Calorific Value

highest Calorific Value.

A CH_4 $\quad \frac{+890}{16} > 50 \approx 55 \text{ or } 56$

B C_2H_6 $\quad + \frac{1411}{28} \approx 50$

C C_2H_4 $\quad + \frac{1560}{30} = 52$

D All are same

QUESTION

For a specific work, on an average a person requires 5615 kJ of energy. How many kilograms of glucose must be consumed if all the required energy has to be derived from glucose only? ΔH for combustion of glucose is –2808 kJ mol^{-1}

A 0.720 kg

B 0.36 kg

C 0.18 kg

D 1.0 kg

1 mol Glucose Comb. energy = 2808 KJ

2808 KJ glucose = 1 mole = 180 g

5615 ~ ?

$= \frac{180 \times 5615}{2808}$

$= 360 g$

$= \frac{360}{1000} = 0.36 Kg$

QUESTION

Combustion.

720 kJ

The enthalpy change involved in the oxidation of glucose is –2880 kJ mol. Twenty five per cent of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk 1 km, what is the maximum distance that a person will be able to walk after eating 120 g of glucose?

(A) 19.2 km

(B) 9.6 km

(C) 2.4 km

(D) 4.8 km

$\Delta H_{comb} = -2880$ kJ/mol

1 mol $\Rightarrow$ 2880

energy available for work $= \frac{25}{10\cancel{0}} \times 288\cancel{0}$

180 g glucose $= 720$ kJ/mol

120 g " $= \frac{\cancel{720}^{240}}{\cancel{180}_{3}} \times \cancel{120}$ ② $= 480$ kJ

$\frac{2}{\cancel{3}} \times \cancel{720}^{240} = 480$ kJ

4.8 KM

100 kJ → 1 km

480 kJ → $\frac{1}{10\cancel{0}} \times 48\cancel{0}$

$= 4.8$ km

QUESTION

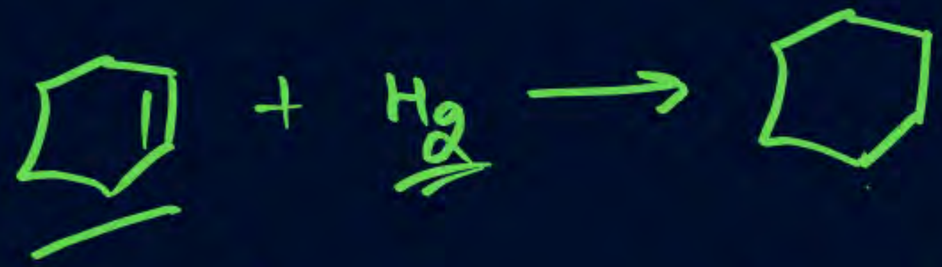
The enthalpy of combustion at 25°C of $H_2(g)$, cyclohexane(l) and cyclohexene(l) are –241, –3920 and –3800 kJ mol, respectively. The enthalpy of hydrogenation of cyclohexene(l) is

(A) –121 kJ/mol

(B) +121 kJ/mol

(C) –242 kJ/mol

(D) +242 kJ/mol



$$\Delta H = [1 \times -3800 + 1 \times -241] - [1 \times -3920]$$

$$= -4041 + 3920$$

$$= -121 \text{ KJ/mol}$$

QUESTION

Enthalpies of solution of $BaCl_2(s)$ and $BaCl_2 \cdot 2H_2O(s)$ are –20.6 kJ/mol and 8.8 kJ/mol, respectively. ΔH hydration of $BaCl_2(s)$ to $BaCl_2 \cdot 2H_2O(s)$ is

(A) –29.4 kJ

(B) –11.8 kJ

(C) 29.6 kJ

(D) 11.8 kJ

$BaCl_2(s) + H_2O(l) \longrightarrow BaCl_2(aq.) \quad \Delta H_1 = -20.6\ kJ$

$BaCl_2 \cdot 2H_2O(s) + '' \longrightarrow BaCl_2(aq.) \quad \Delta H_2 = 8.8\ kJ$

$BaCl_2(s) + H_2O(l) \longrightarrow BaCl_2 \cdot 2H_2O(s)$

eq.(1) – eq.(2) $\Rightarrow \Delta H = -20.6 - 8.8$

$= -29.4\ kJ$

QUESTION

Study the following thermochemical data. $1H_2 + S + 2O_2 \longrightarrow 1H_2SO_4$

$S + O_2 \rightarrow SO_2$; (1) $\Delta H = -298.2$ kJ

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$; (2) $\Delta H = -98.2$ Kj

$SO_3 + H_2O \rightarrow H_2SO_4$; (3) $\Delta H = -130.2$ kJ

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$; (4) $\Delta H = -287.3$ kJ

eq.(1) + eq.(3) + eq.(4) + eq.(2)

The enthalpy of formation of H_2SO_4 at 298 K will be:

(A) –433.7 kJ

(B) –650.3 kJ

(C) +320.5 kJ

(D) –813.9 kJ

$$S + \frac{3}{2}O_2 + \cancel{SO_3} + \cancel{H_2O} + H_2 + \cancel{SO_2} + \frac{1}{2}O_2 \longrightarrow \cancel{SO_2} + H_2SO_4 + \cancel{H_2O} + \cancel{SO_3}$$

$$S + 2O_2 + 1H_2 \longrightarrow 1H_2SO_4$$

$$\Delta H = -298.2 - 98.2 - 130.2 - 287.3 = -813.9 \text{ KJ/mol}$$

Resonance Energy (R.E.)

$O=C=O$

MIT

① 1 mole non R.S. $\longrightarrow$ 1 mole R.S. $\Delta H = R.E.$

$1\,CO_2(g) \longrightarrow 1\,CO_2(g)$ $\Delta H = R.E.$

non R.S. $\qquad$ R.S.

② R.E is in (−)ve as energy is released

③ In Chem. eq^n → R.S. is written.

④ B.E. formula → non R.S.

⑤ $R.E. = \underbrace{\Delta H}_{\text{jo aana chahiye}} - \underbrace{\Delta H}_{\text{jo aaya hai}}$

Q/

$$1\,C(\text{graphite}) + O_2(g) \xrightarrow{\Delta H} \underline{CO_2(g)}$$

R·S·

$\Delta H_1 = \Delta H_{sublimation}$

$\Delta H_3 = R \cdot E \cdot$

C(g)

C(g)

$$\underline{1\,C(g)} + 1\,O_2(g) \xrightarrow{\Delta H_2} CO_2(g)$$

non R·S·

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

$$= \Delta H_{\text{sublimation of } C(\text{graphite})} + \left[1\times 0 + 1\times B\cdot E_{O=O} - 2\times B\cdot E_{C=O}\right] + R\cdot E\cdot \text{ of } CO_2(g)$$

Q. $1CH_4(g) + 2O_2(g) \longrightarrow 1CO_2(g) + 2H_2O(l)$

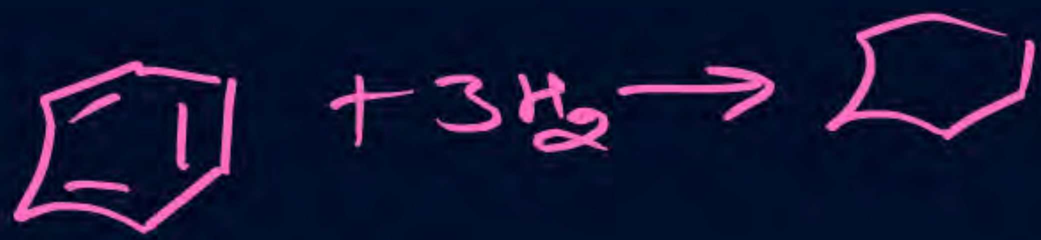
R.S.

$1CO_2(g) + 2H_2O(g) \longrightarrow 1CO_2(g) + 2H_2O(g)$

R.S.

non R.S.

$\Delta H = -x\ KJ$



$\Delta H = -3x\ KJ$

$\Delta H = -y\ KJ$

Benzene

$$R.E. = -3x - (-y)$$
$$= (y - 3x)\ KJ$$

QUESTION

Calculate the magnitude of resonance energy of CO_2 from the following data (in kJ/mol).

Bond energies: $C = O = 539.0$, $O = O = 498.0$

Heat of sublimation of $C(s) = 718.0$

Heat of combustion of $C(s) = -393.0$

A. ~~-29.4 kJ~~

B. ~~-11.8 kJ~~

C. 29.6 kJ

D. 11.8 kJ

$1C(\text{graphite}) + 1O_2(g) \longrightarrow 1CO_2(g)$ $\Delta H = -393$ KJ

R.S.

R.E.

$\Delta H_1 = \Delta H_{sub} = 718$

$1C(g) + 1O_2(g) \xrightarrow{\Delta H_2} CO_2(g)$

non R.S.

$\Delta H = -393 = \Delta H_1 + \Delta H_2 + \Delta H_3$

$-393 = 718 + [1 \times 498 - 2 \times 539] + R.E.$

$-R.E = 718 - 580 + 393$

$= 1111 - 580$

$R.E = |-531|$

$= 531$

QUESTION – (AIPMT 2006)

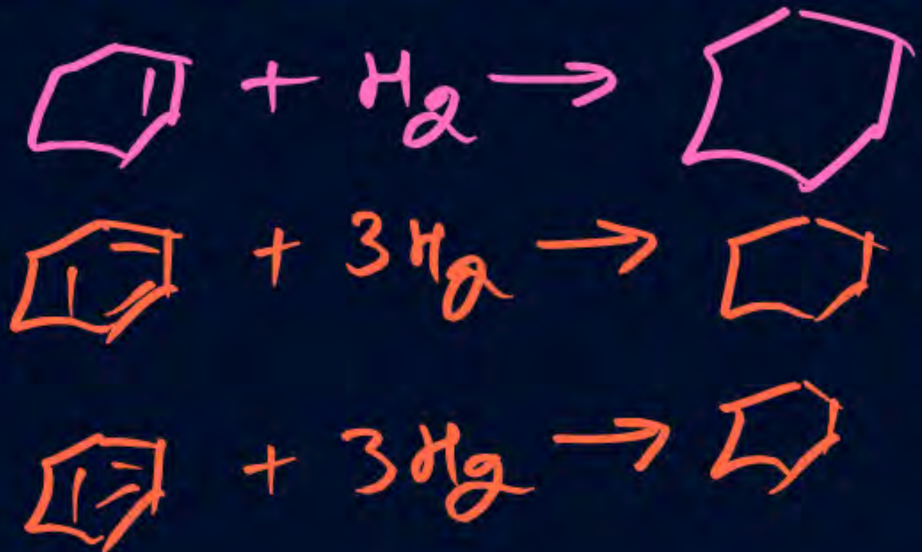
The enthalpy of hydrogenation of cyclohexene is –119.5 kJ mol^{-1}. If resonance energy of benzene is –150.4 kJ mol^{-1}, its enthalpy of hydrogenation would be:

(A) – 208.1 kJ mol^{-1}

(B) – 269.9 kJ mol^{-1}

(C) – 358.5 kJ mol^{-1}

(D) – 508.9 kJ mol^{-1}



$\Delta H = -119.5$ KJ/mol

$\Delta H = -3 \times 119.5 = -358.5$ KJ

$\Delta H^{Hyd.}_{Benzene} = ?$

$R.E._{Benzene} = -150.4 \text{ KJ} = -358.5 - \Delta H_{Hyd.\ Benzene}$

$\Delta H_{Hyd} = -358.5 + 150.4 = -208.1$

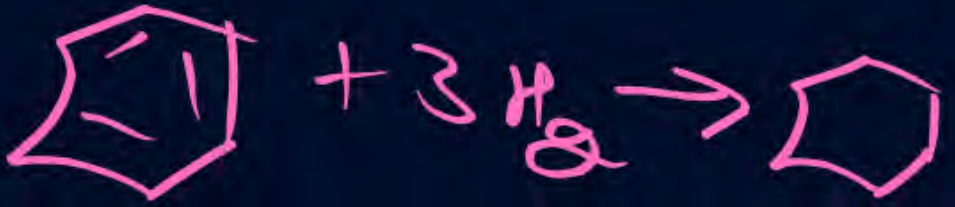
Q. 

$\Delta H = -49.8$ KCal/mol.

Benzene

R.E. Benzene $= -36$ KCal $=$ $\Delta H_{Hyd.}$ jo aana chahiye $-$ ΔH jo aaya hai

$\Delta H = x$



$\Delta H = \Delta H$ jo aana chahiye $= 3x$

$-36 = \Delta H_{Hyd} - (-49.8)$

$-49.8 - 36 = \Delta H_{Hyd.}$

$-85.8 = \Delta H_{Hyd.} = 3x$

$\Delta H = \dfrac{-85.8}{3}$

$= -28.6$

Q.

 $+ 3H_2 \longrightarrow$  $\Delta H = -51$ KCal/mol.

Benzene

 $+ 2H_2 \longrightarrow$  $\Delta H = -58$ KCal/mol.

 $+ H_2 \longrightarrow$  $\Delta H = -29$ KCal/mol.

 $+ 3H_2$

$\downarrow$

 $\Delta H = -29 \times 3$

$= -87$

$\downarrow$

jo aana chahiye

R.E. Benzene $= -87 - (-51) = -36$

Enthalpy of Neutralisation

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QUESTION

If CH_3COOH (1 mole) is completely neutralized by NaOH and heat evolved is 55 kJ/mol. Find enthalpy of ionisation of CH_3COOH?

A) –29.4 kJ

B) –11.8 kJ

C) 29.6 kJ

D) 11.8 kJ

QUESTION

If 1 gram eq. of H_2SO_4 is completely neutralized by aq. KOH (excess). Find Enthalpy change for process?

QUESTION

The enthalpy change for the reaction, $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$ is -57 kJ. Predict the value of the enthalpy change in the following reaction.

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

(A) -57 kJ

(B) -76 kJ

(C) -114 kJ

(D) -200 kJ

Bomb Calorimeter

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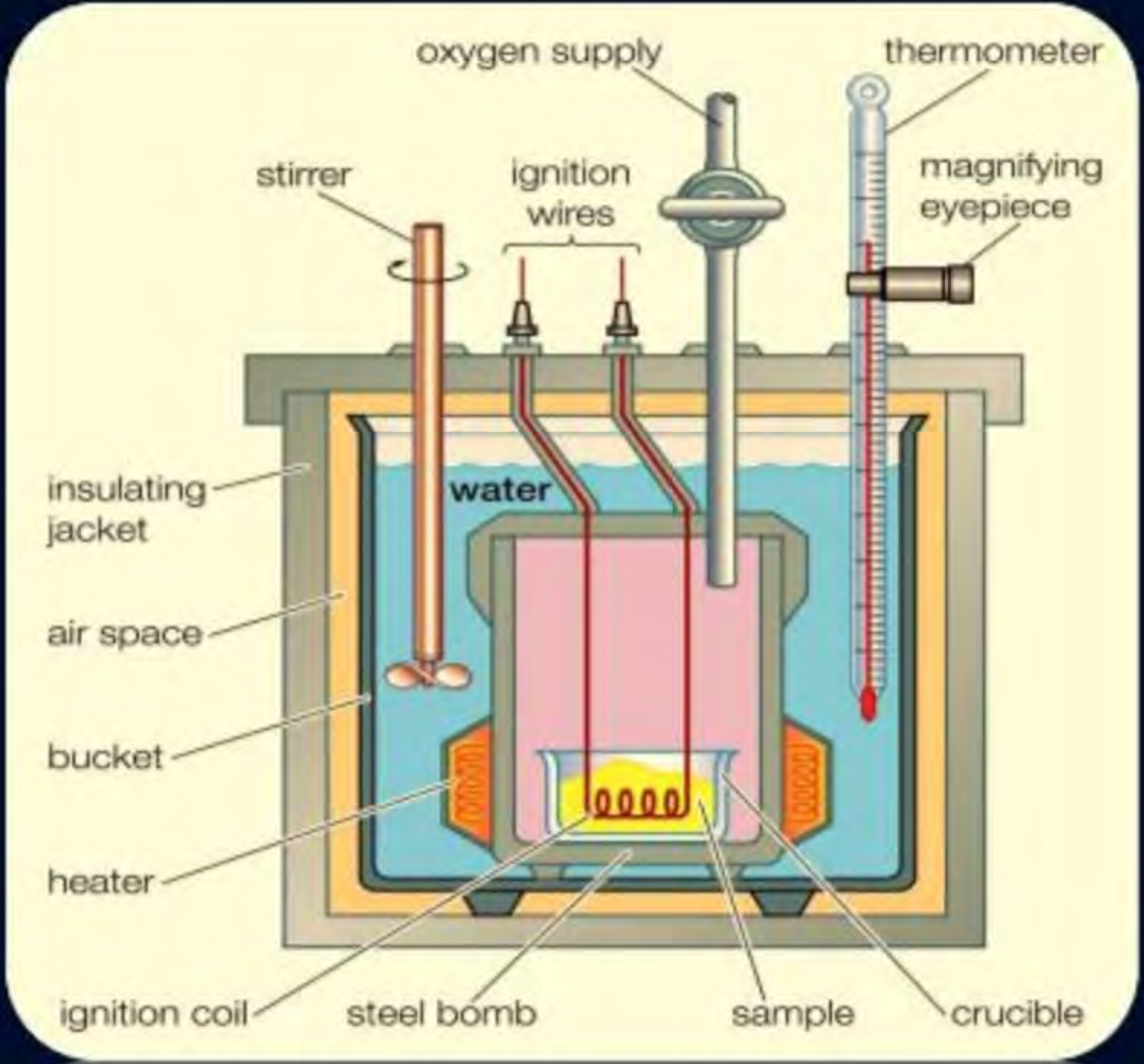


QUESTION

Stearic acid $[C_3(CH_2)_{16}CO_2H]$ is a fatty acid, the part of fat that stores most of the energy. 1 g of stearic acid was burned in a bomb calorimeter. The bomb has a heat capacity of 652 J/C. If the temp of 500 g water (c = 4.18 J/g C) rose from 25.0 to 39.3°C, how much heat was released when stearic acid was burned ? {given: $C_p(H_2O) = 4.18$ J/g °C}

Home work from modules

Prarambh → 51, 52, 53, 56, 57, 58, 59, 60, 61, 63, 64
65, 66, 67, 68, 69.

Magarmach Practice Questions (MPQ)

QUESTION – (AIPMT 2011)

Enthalpy change for the reaction $4H(g) \rightarrow 2H_2(g)$ is -869 kJ. The dissociation energy of H–H bond is:

(A) -434.8 kJ

(B) -869.6 kJ

(C) $+434.8$ kJ

(D) $+217.4$ kJ

QUESTION – (AIPMT 2009)

From the following bond energies:

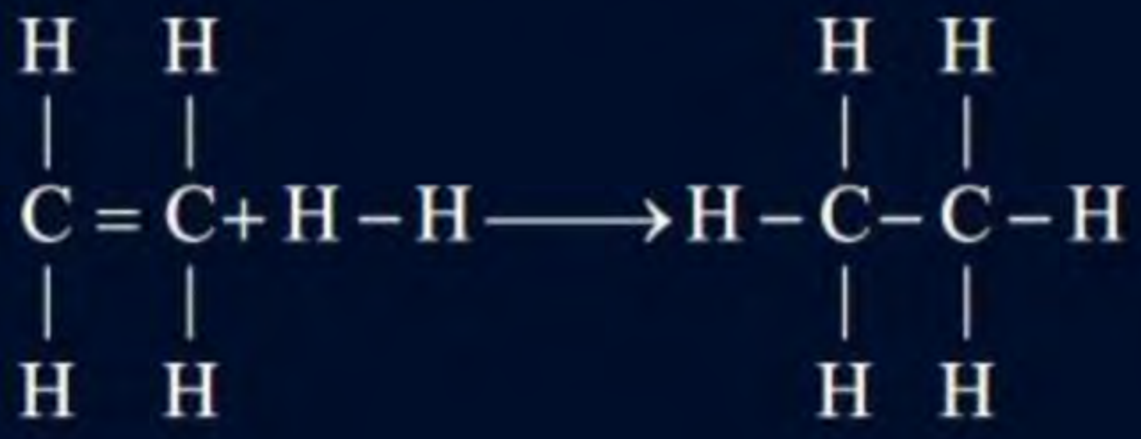
H – H bond energy: 431.37 kJ mol^{-1}

C – C bond energy: 336.49 kJ mol^{-1}

C = C bond energy: 606.10 kJ mol^{-1}

C – H bond energy: 410.50 kJ mol^{-1}

Enthalpy for the reaction, will be:



(A) – 243.6 kJ mol^{-1}

(B) –120.0 kJ mol^{-1}

(C) 553.0 kJ mol^{-1}

(D) 1523.6 kJ mol^{-1}

QUESTION

$C_2H_4 + H_2 \longrightarrow C_2H_6$

Find $\Delta H_{Hydrogenation}$ of ethene if:

$B.E_{C=C} = x$ kJ/mol; $B.E_{C-C} = y$ kJ/mol; $B.E_{H-H} = z$ kJ/mol; $B.E_{C-H} = w$ kJ/mol

QUESTION

The ΔH°_f for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are -393.5, -110.5 and -241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ mol^{-1}) for the reaction $CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$ is:

A) $+524.1$

B) $+41.2$

C) -262.5

D) -41.2

QUESTION

Given, $C_{(graphite)} + O_2(g) \rightarrow CO_2(g); \Delta_r H° = -393.5 \text{ kJ mol}^{-1}$

$H_2(g) \ \frac{1}{2} O_2(g) \rightarrow H_2O(l); \Delta_r H° = -285.8 \text{ kJ mol}^{-1}$

$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g); \Delta_r H° = +890.3 \text{ kJ mol}^{-1}$

Based on the above thermochemical equations, the value of $\Delta_r H°$ at 298 K for the reaction $C_{(graphite)} + 2H_2(g) \rightarrow CH_4(g)$ will be :

(A) $+ 78.8 \text{ kJ mol}^{-1}$

(B) $+ 144.0 \text{ kJ mol}^{-1}$

(C) $- 74.8 \text{ kJ mol}^{-1}$

(D) $- 144.0 \text{ kJ mol}^{-1}$

QUESTION

The enthalpy of hydrogenation of benzene is –51.0 kcal/mol. If enthalpy of hydrogenation of cyclohexene is –29 kcal/mol, respectively, then what is the resonance energy of benzene?

A. 29 kcal/mol

B. 36 kcal/mol

C. 58 kcal/mol

D. 7 kcal/mol

THANK YOU