Enthalpy Change Chemistry Questions with Solutions

Q1. If the activation energy is equal for both forward and backward reactions, then
(a) $\Delta H = 0$
(b) $\Delta G = 0$
(c) $\Delta S = 0$
(d) $\Delta H = \Delta G = \Delta S = 0$
Answer: (a) If the activation energy is equal for both forward and backward reactions, then ΔH should be zero.

Q2. The change in enthalpy of a system is equivalent to the heat absorbed by the system at a
(a) Constant temperature
(b) Constant pressure
(c) Constant volume
(d) None of the above
Answer: (b) The change in enthalpy of a system is equivalent to the heat absorbed by the system at a constant pressure.

Q3. The change in enthalpy of an exothermic reaction is
(a) Always positive
(b) Always negative
(c) Can either be positive or negative
(d) None of the above
Answer: (b) The change in enthalpy of an exothermic reaction is always negative.

Q4. If the heat is transmitted to a system at a steady pressure. In that case, the enthalpy of the system will
(a) Increase
(b) Decrease
(c) First increase then decrease
(d) First decrease then increase
Answer: (a) If the heat is transmitted to a system at a steady pressure, the enthalpy of the system will increase.

Q5. The change in enthalpy when 1 mole of the compound is formed under standard conditions is known as
(a) Standard enthalpy of neutralisation
(b) Standard enthalpy of formation

(c) Standard enthalpy of combustion
(d) None of the above
Answer: (b) The change in enthalpy when 1 mole of the compound is formed under standard conditions is known as standard enthalpy of formation.

Q6. What is enthalpy?
Answer: Enthalpy is a thermodynamic parameter that gauges the total heat present in a thermodynamic system where the pressure is regular. It is equivalent to the sum of the internal energy and the product of the pressure and volume of a thermodynamic system.

$$H = E + PV$$

Q7. What are the various factors that affect the enthalpy of an atom?
Answer: Enthalpy is a thermodynamic parameter that gauges the total heat present in a thermodynamic system where the pressure is regular. Various factors that affect the enthalpy of an atom are mentioned below.
1. Amount of reactant and product.
2. Physical State of Reactants and Products.
3. Allotropic Modification
4. Temperature and Pressure

Q8. What is the enthalpy change?
Answer: The enthalpy change of an atom is defined as the amount of heat absorbed or evolved in a reaction carried out at a steady pressure.

Q9. Calculate the enthalpy change for the following reaction:
$CH_4\ (g) + 2\ O_2\ (g) \longrightarrow CO_2\ (g) + 2\ H_2O\ (l)$
Given that enthalpies of formation of CH_4, CO_2 and H_2O are 74.8 kJ $mol^{-1,}$ − 393.5 kJ $mol^{-1,}$ and − 286 kJ $mol^{-1,}$ respectively.

Answer: Enthalpy of formation of CH_4 = 74.8 kJ $mol^{-1,}$
Enthalpy of formation of CO_2 = − 393.5 kJ mol^{-1}
Enthalpy of formation of H_2O = − 286 kJ mol^{-1}
Enthalpy change = $\Delta H^{o}_{PRODUCTS} - \Delta H^{o}_{REATANTS}$
Enthalpy change = $(\Delta H^{o}_{CO2} + \Delta H^{o}_{H2O}) - (\Delta H^{o}_{CH4} + 2\ \Delta H^{o}_{O2})$
Enthalpy change = (− 393.5 kJ mol^{-1} + − 286 kJ mol^{-1}) - (74.8 kJ mol^{-1} + 2 x 0)
Enthalpy change = - 890.7 kJ mol^{-1}

Q10. Calculate the enthalpy of formation of OH^- ions at 25° C from the following thermochemical data.
$H_2O\ (l) \rightarrow H^+\ (aq) + OH^-\ (aq)$; ΔH^O = 57.3 kJ
$H_2 + ½\ O_2\ (g) \rightarrow H_2O\ (l)$; ΔH^O = - 285.9 kJ
Answer: Foremost, we will add first two-equation.

H_2 (g) + ½ O_2 (g) → H^+ (aq) + OH^- (aq); Δ H^O = 57.3 kJ - 285.9 kJ = - 228.6 kJ.
Hence, Δ H^O = - 228.6 kJ = 0 + Δ H_f^O (OH^- (aq)) - (0+0), since, by convention, Δ H_f^O [H^+(aq)] = 0,
Hence, Δ H_f^O [OH^- (aq)] = - 228.6 kJ.

Q11. The enthalpy of combustion of glucose $C_6H_{12}O_6$ (s) is - 2816 kJ mol^{-1} at 25° C. Calculate Δ H_f^O $C_6H_{12}O_6$. The H_f^O values for CO_2 (g) and H_2O (l) are - 393.5 and - 285.9 kJ mol^{-1}, respectively.
Answer: $C_6H_{12}O_6$ (s) + 6 O_2 (g) → 6 CO_2 (g) + 6 H_2O (l); Δ H^O = - 2816 kJ.
Since Δ H = ∑ Δ H_f^O (products) - ∑ Δ H_f^O (reactants), we find that
- 2816 kJ = (6 X 393.5 kJ mol^{-1}) + (6 X - 285.9 kJ mol^{-1}) - Δ H_f^O ($C_6H_{12}O_6$) - 6 Δ H_f^O (O_2)
We know that, Δ H_f^O (O_2) = 0
So, Δ H_f^O ($C_6H_{12}O_6$) = - 1260.4 kJ mol^{-1}.

Q12. Calculate the enthalpy of combustion of methane at 25° C and 1 atm pressure.
Given that Δ H_f^O (CO_2) = - 393.5 kJ mol^{-1}, Δ H_f^O (H_2O) = - 285.9 kJ mol^{-1} and Δ H_f^O (CH_4) = -74.8 kJ mol^{-1}.
Answer: The combustion of methane is referenced as
CH_4 (g) + 2 O_2 (g) → CO_2 (g) + 2 H_2O
Δ H^o = Δ H_f^o (CO_2) + 2 Δ H_f^o (H_2O) - Δ H_f^o (CH_4) - 0
Δ H^o = (- 393.5 kJ mol^{-1}) + 2 X (- 285.9 kJ mol^{-1}) - (- 74.8 kJ mol^{-1})
Δ H^o = - 890.5 kJ mol^{-1}.
Thus, the enthalpy of combustion of methane at 25° C and 1 atm pressure = - 890.5 kJ mol^{-1}.

Q13. One mole of a non-ideal gas undergoes a state change from (2 atm, 3 L, 95 K) to (4 atm, 5 L, 245 K) with a change of internal energy, Δ U = 30 L atm. What is the difference in enthalpy (Δ H)?
Answer: Change in enthalpy = Δ H = Δ U + Δ (PV)
Change in enthalpy = Δ H = Δ U + (P_2V_2 - P_1V_1)
Change in enthalpy = Δ H = 30 + (20 - 6)
Change in enthalpy = Δ H = 44 L atm.

Q14. The reaction of cyanamide NH_2CN (s) with dioxygen was carried out in a bomb calorimeter, and △ U was found to be − 742.7 kJ mol^{-1} at 298 K.
NH_2CN (g) + 23 O_2 (g) → N_2 (g) + CO_2 (g) + H_2O (l)
Calculate the enthalpy change for the reaction at 298 K?
Answer: For the given reaction, Δ n = 1 + 1 − 1.5 = 0.5.
Moreover, Δ H = Δ U + Δn_g RT
Δ H = − 742.7 + 0.5 X 8.314 X 10^{-3} X 298
Δ H = − 742.7 + 1.2
Δ H = − 741.5 kJ $mole^{-1}$.

Q15. The combustion of one mole of benzene occurs at 298 K, and 1 atm after combustion, CO_2 (g) and H_2O (l) are produced, and 3267.0 KJ of heat is liberated. Calculate the standard enthalpy of

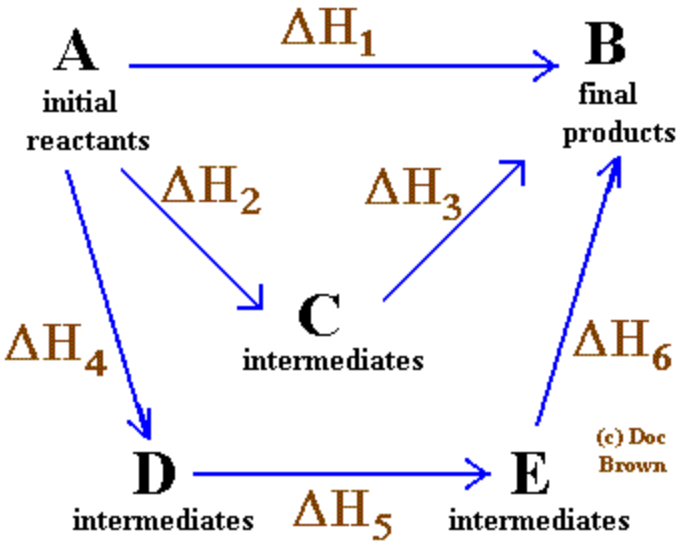
formulation ΔH_f of benzene. Given the standard enthalpy of formation of CO_2 (g) and H_2O (l) are -393.5 KJ $mole^{-1}$ and - 285.83 KJ $mole^{-1}$.
Answer: Reaction: $C_6H_6 + 15/2\ O_2 \rightarrow 6\ CO_2 + 3\ H_2O$, $\Delta H_{rxn} = -3267$ KJKJ $mole^{-1}$

$\Delta H_{rxn} = 6\ \Delta H_f\ CO_2 + 3\ \Delta H_f\ H_2O - \Delta H_f\ C_6H_6$
ΔH_f (Benzene) = 6 X (− 393.5) + 3 X (− 285.8) + 3267
ΔH_f (Benzene) = − 3218.49 + 3267
ΔH_f (Benzene) = 48.51 KJ.

Practise Questions on Enthalpy Change

Q1. What is Hess law? Explain the feasibility of Hess law with an example.

Answer: Hess law or Hess law of constant heat summation states that the amount of heat absorbed or evolved during the entire reaction is independent of the steps taken in the reaction.



Feasibility of Hess law:
Consider the formation of carbon dioxide. It can occur in two ways.
Method 1: Carbon reacts with oxygen to form carbon dioxide in a single step. It releases 94.3 kcals of heat.
$C + O_2 \rightarrow CO_2$ (ΔH = 94.3 kcal)
Method 2: Carbon reacts with oxygen to form carbon monoxide in the first step. It releases 26.0 kcals of heat.
$2\ C + O_2 \rightarrow 2\ CO$ (ΔH_1 = 26.0 kcal).

Carbon monoxide again reacts with oxygen to form carbon dioxide in the second step. It releases 68.3 kcals of heat.
$2\ CO + O_2 \rightarrow 2\ CO_2$ (ΔH_2 = 68.3 kcal)
Adding the enthalpy of method two, $\Delta H_T = \Delta H_1 + \Delta H_2 = 26.0 + 68.3 = 94.3$ kcal.
Thus, the net reaction enthalpy of both reactions is the same as that of single-step formation. So, the enthalpy of the reaction does not change on the path followed by the reactants.
Thus, Hess's law is verified.

Q2. Calculate the standard enthalpy of formation of methanol using the following data.
C (graphite) + O_2 (g) $\rightarrow$ CO_2 (g) ($\Delta H = -393$ kJmol^{-1})
CH_3OH (l) + 2 O_2 (g) $\rightarrow$ CO_2 (g) + 2 H_2O (l) ($\Delta H = -726$ kJmpl^{-1})
H_2 (g) + 2 O_2 (g) $\rightarrow$ H_2O (l) ($\Delta H = -286$ kJmol^{-1})

Answer: Reversing the equation 2.
CO_2 (g) + 2 H_2O (l) $\rightarrow$ CH_3OH (l) + 2 O_2 (g) ($\Delta H = +726$ kJmpl^{-1})
On reversing the reaction, the sign of ΔH also changes.
The second equation is
C (graphite) + O_2 (g) $\rightarrow$ CO_2 (g) ($\Delta H = -393$ kJmol^{-1}).
Multiply equation three by 2,
[H_2 (g) + 2 O_2 (g) $\rightarrow$ H_2O (l) ($\Delta H = -286$ kJmol^{-1})] X 2
2 H_2 (g) + 4 O_2 (g) $\rightarrow$ 2 H_2O (l) ($\Delta H = -286$ X 2= - 572 kJmol^{-1})
Add these three equations.
C (graphite) + 2 H_2 (g) + ½ O_2 (g) $\rightarrow$ CH_3OH (l)

Enthalpy of formation of $CH_3OH = \Delta H_T$
Enthalpy of formation of $CH_3OH = \Delta H_1 + \Delta H_2 + \Delta H_3$
Enthalpy of formation of CH_3OH = 726 - 393 - 572 kJmol^{-1}
Enthalpy of formation of CH_3OH = - 239 kJmol^{-1}

Q3. How will you differentiate between enthalpy from entropy?
Answer:

S. No.	Entropy	Enthalpy
1.	Entropy is a thermodynamic parameter that measures the system's thermal energy per unit temperature, which is elusive for doing useful work.	Enthalpy is a thermodynamic parameter that measures the total heat present in a thermodynamic system where the pressure is constant.
2.	Its unit is Joule K^{-1}.	Its unit is Joule mol^{-1}.
3.	It is denoted by the symbol S.	It is denoted by the symbol H.

4.	**It is the measurement of the randomness of molecules**	**It is the sum of internal energy and flows energy.**

Q4. How will you differentiate between extensive and intensive functions?
Answer:

S. No.	Extensive Function	Intensive Function
1.	**It depends on the mass.**	**It does not depend on the mass.**
2.	**Example: Length, Weight, Mass, and Volume**	**Example: Melting point, Boiling point, Freezing point, Colour, Lustre, Pressure, Density, Ductility, Conductivity, Odour, etc.**
3.	**It can not be used to determine the identity of a system.**	**It is used to determine the identity of a system.**
4.	**It can be computed.**	**It cannot be computed.**
5.	**It cannot be easily identified.**	**It can be easily identified.**

Q5. If the combustion of 1 g of graphite produces 20.7 kJ of heat. What will be the molar enthalpy change? What is the significance of the sign of enthalpy?
Answer: Molar enthalpy change of graphite = Enthalpy change of 1 g carbon X Molar mass of carbon
$\Delta H = -20.7 \text{ kJ } g^{-1} \text{ X } 12 \text{ g } mol^{-1}$
$\Delta H = -2.48 \text{ X } 10^{2} \text{ kJ } mol^{-1.}$

The negative sign of ΔH indicates that the reaction is exothermic in nature.