

## Hess Law Of Constant Heat Summation Chemistry Questions with Solutions

**Q-1:** Which of the following are Hess's Law applications?

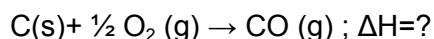
- a) Enthalpy of Formation Calculations
- b) Enthalpy Change Prediction
- c) Enthalpy of Allotropic Transformation Calculations
- d) All of the above

**Answer: d)** All of the above

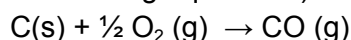
**Q-2:** Calculate the enthalpy of formation of carbon monoxide (CO) from the following data:

- i)  $C(s) + O_2(g) \rightarrow CO_2(g)$  ;  $\Delta H = -393.3 \text{ kJ/mol}$
- ii)  $CO + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$  ;  $\Delta H = -282.8 \text{ kJ/mol}$

**Answer:** We aim at



Subtracting equation ii) from i), we get



Therefore,  $\Delta H = -393.3 - (-282.8) \text{ kJ/mol} = -110.5 \text{ kJ/mol}$

**Q-3:** The thermite reaction used for welding of metals involves the reaction



What is  $\Delta H^\circ$  at  $25^\circ\text{C}$  for this reaction? Given that the standard heats of formation of  $Al_2O_3$  and  $Fe_2O_3$  are  $-1675.7 \text{ kJ}$  and  $-828.4 \text{ kJ/mol}$  respectively.

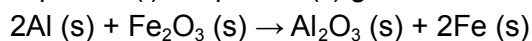
**Answer:** We are given

- i)  $2Al(s) + \frac{3}{2} O_2(g) \rightarrow Al_2O_3(s)$  ;  $\Delta H = -1675.7 \text{ kJ/mol}$
- ii)  $2Fe(s) + \frac{3}{2} O_2(g) \rightarrow Fe_2O_3(s)$  ;  $\Delta H = -828.4 \text{ kJ/mol}$

We aim at



Equation (i) - Equation (ii) gives



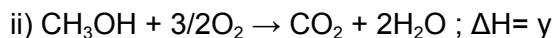
$\Delta H = -1675.7 - (-828.4) \text{ kJ/mol} = -847.3 \text{ kJ/mol}$

**Q-4:**  $\text{CH}_4 + \frac{1}{2}\text{O}_2 \rightarrow \text{CH}_3\text{OH}$  has a negative enthalpy. Which of the following relationships is correct if the enthalpy of combustion of  $\text{CH}_4$  and  $\text{CH}_3\text{OH}$  is  $z$  and  $y$ , respectively?

- a)  $z > y$
- b)  $z < y$
- c)  $z = y$
- d) Information insufficient

**Answer: b)  $z < y$**

Explanation:



(i)-(ii) gives the required equation, that is,  $\text{CH}_4 + \frac{1}{2}\text{O}_2 \rightarrow \text{CH}_3\text{OH}$

Thus, for the given reaction,  $\Delta H = z - y = -ve$

This implies,  $z < y$ .

**Q-5:** Hess' Law states that the total amount of heat evolved or absorbed is independent of

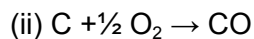
- a) The nature of the initial reactants,
- b) The nature of the final products.
- c) The path taken,
- d) All of the above

**Answer: c)** Hess' Law states that the total amount of heat evolved or absorbed is independent of the path taken.

**Q-6:** How are thermochemical equations advantageous in Hess law?

**Answer:** Because thermochemical equations can be treated as algebraic equations that can be added, subtracted, multiplied, or divided. As a result, they are advantageous in Hess's law.

**Q-7:** If for (i)  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$



(iii)  $\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$  the heats of reaction are  $Q$ ,  $-12$  and  $-4$  respectively. Then  $Q = \underline{\hspace{2cm}}$ .

- a)  $-2$
- b)  $2$
- c)  $-22$
- d)  $-16$

**Answer: d)  $-16$**

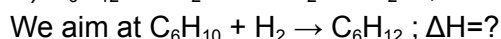
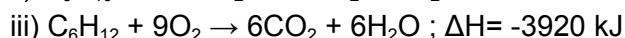
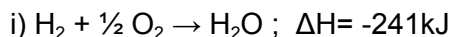
Explanation: Adding equation ii) and iii) gives the required equation i) for which we have to calculate  $Q$ . Thus,  $Q = -12 - 4 = -16$ .

**Q-8:** Calculate the change in enthalpy for the reaction  $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ , if heat of formation for  $\text{H}_2\text{O}_2$  and  $\text{H}_2\text{O}$  are  $-190 \text{ kJ/mol}$  and  $-286 \text{ kJ/mol}$  respectively.

**Answer:**  $\Delta H^\circ_{\text{(reaction)}} = [2\Delta H^\circ_f(\text{H}_2\text{O}) + \Delta H^\circ_f(\text{O}_2)] - [2\Delta H^\circ_f(\text{H}_2\text{O}_2)] = [2(-286) + (0)] - [2(-190)] = -192 \text{ kJ}$ .

**Q-9:** The standard enthalpy of combustion at  $25^\circ\text{C}$  of hydrogen, cyclohexene and cyclohexane are  $-241$ ,  $-3800$  and  $-3920 \text{ kJ/mol}$  respectively. Calculate the heat of hydrogenation for cyclohexene.

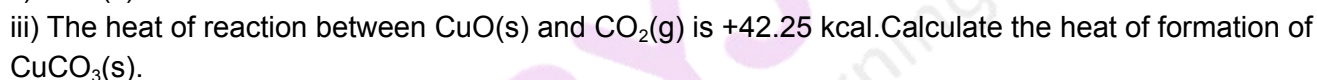
**Answer:**



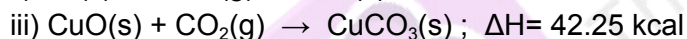
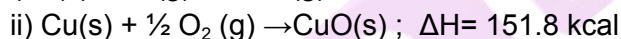
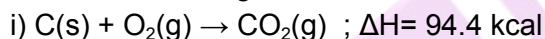
Equation (i) + Equation (ii) - Equation (iii) gives the required result.

Thus,  $\Delta H = -241 + (-3800) - (-3920) = -121 \text{ kJ}$

**Q-10:** The heat of formation of



**Answer:** We are given



We aim at



Eqn(i) + Eqn(ii) + Eqn(iii) gives the required result.

$\Delta H = 94.4 + 151.8 + 42.25 = 288.45 \text{ kcal}$ .

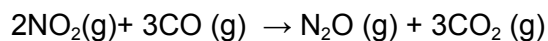
**Q-11:** What is the name of the law that states that the total enthalpy change in a chemical reaction remains constant at the same temperature?

**Answer:** Hess's Law of constant heat summation.

**Q-12:** What do you mean by a thermochemical equation? Can we use fractional coefficients in such an equation?

**Answer:** A thermochemical equation is one in which a balanced chemical equation not only indicates the quantities of the different reactants and products but also the amount of heat evolved or absorbed. Yes, a thermochemical equation can be written using fractional coefficients.

**Q-13:**  $\Delta H^\circ_f$  of  $\text{CO}_2(\text{g})$ ,  $\text{CO}(\text{g})$ ,  $\text{N}_2\text{O}(\text{g})$  and  $\text{NO}_2(\text{g})$  in  $\text{kJ/mol}$  are respectively  $-393$ ,  $-110$ ,  $-81$  and  $-34$ . Calculate  $\Delta H$  in  $\text{kJ}$  for the following reaction.



**Answer:**  $\Delta H^\circ_{(\text{reaction})} = [\Delta H^\circ_f(\text{N}_2\text{O}) + 3\Delta H^\circ_f(\text{CO}_2)] - [3(\Delta H^\circ_f(\text{CO}) + 2(\Delta H^\circ_f(\text{NO}_2))]$

On substituting values, we get

$$\Delta H^\circ_{(\text{reaction})} = [-81 + 3(-393)] - [3(-110) + 2(-34)] = -836 \text{ kJ}$$

**Q-14:** What is the basis of Hess's Law?

**Answer:** Hess' law is based on the fact that enthalpy is a state function, which means that enthalpy change depends only on the initial and final states and not on the path taken.

**Q-15:** What is the significance of bond enthalpy?

**Answer:** One important significance of a bond enthalpy is in calculating the enthalpy of atom formation.

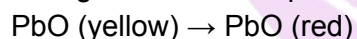
## Practice Questions on Hess Law Of Constant Heat Summation

**Q-1:** Hess's Law is concerned with the

- a) Entropy of the System
- b) Heat change of the Reaction
- c) Kinetic Rate of Reaction
- d) Thermodynamics of the Reaction

**Answer:** b) Hess's Law is concerned with the heat changes for the reactions.

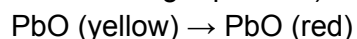
**Q-2:** There are two crystalline forms of PbO: one yellow and one red. These two forms have standard enthalpies of formation of -217.3 and -219.0 kJ per mol, respectively. Determine the enthalpy change during the solid-solid phase transition.



**Answer:**

- i)  $\text{Pb}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{PbO}(\text{yellow})$  ;  $\Delta H = -217.3 \text{ kJ/mol}$
- ii)  $\text{Pb}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{PbO}(\text{red})$  ;  $\Delta H = -219.0 \text{ kJ/mol}$

On reversing equation i) and adding it to equation ii) gives

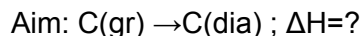
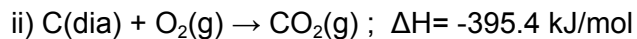


Therefore,  $\Delta H = +217.3 \text{ kJ/mol} - 219.0 \text{ kJ/mol} = -1.7 \text{ kJ/mol}$

**Q-3:** Graphite and diamond have combustion enthalpies of 393.5 and 395.4 kJ, respectively. Calculate the enthalpy change associated with the 1 mole of graphite transformed into diamond.

**Answer:** The combustion reactions of graphite and diamond are given below respectively:

- i)  $\text{C}(\text{gr}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$  ;  $\Delta H = -393.5 \text{ kJ/mol}$



On reversing equation ii) and adding it to first we get  
 $C(\text{gr}) \rightarrow C(\text{dia})$

$$\Delta H = (-393.5 + 395.4) \text{ kJ/mol} = 1.9 \text{ kJ/mol}$$

**Q-4:** Why is the Hess law significant?

**Answer:** Hess law is significant because it can calculate heat changes for reactions that cannot be determined experimentally.

**Q-5:** According to Hess's law, a chemical reaction is independent of the path taken by chemical reactions while maintaining the same \_\_\_\_\_.

- (a) Initial and Final Conditions
- (b) Only the initial conditions
- (c) Only the final conditions
- (d) Temperature

**Answer: a)** According to Hess's law, a chemical reaction is independent of the path taken by chemical reactions while maintaining the same initial and final conditions.