

CAIE Chemistry A-level

Topic 5 - Chemical Energetics

Flashcards

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In terms of energy, what happens when a chemical reaction occurs?



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- Energy changes occur, generally in the form of thermal energy.
- The energy change is either endothermic or exothermic.



What is an endothermic reaction?



What is an endothermic reaction?

- A reaction in which energy is taken in from the surroundings. The temperature of the surroundings decreases.
- Positive enthalpy change.
- More energy is used to break bonds than is released in making bonds.



What is an exothermic reaction?



What is an exothermic reaction?

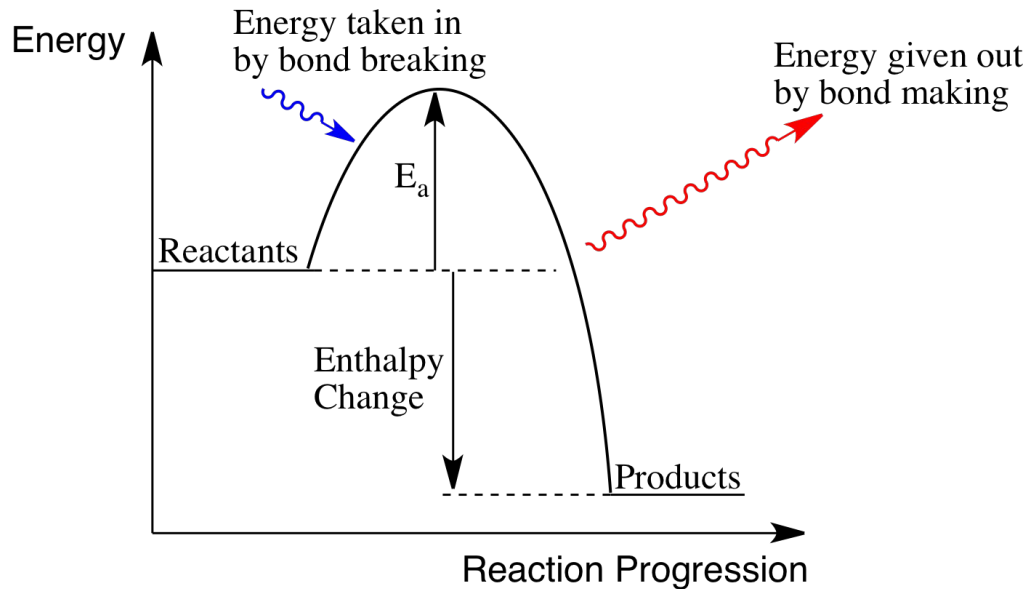
- A reaction in which energy is given out to the surroundings. The temperature of the surroundings increases.
- Negative enthalpy change.
- More energy is released making bonds than is used to break bonds.



Draw an enthalpy level diagram for an exothermic reaction



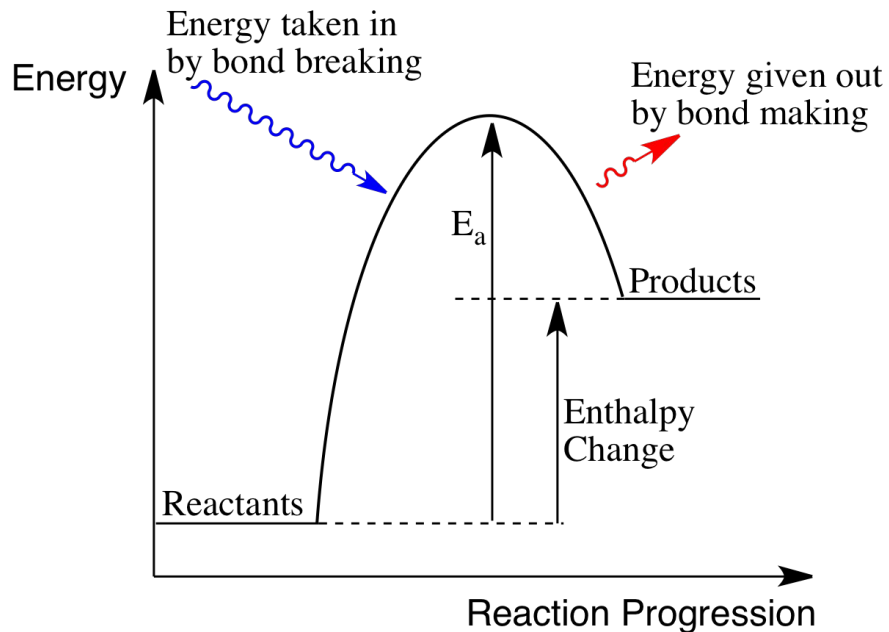
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Draw an enthalpy level diagram for an endothermic reaction



Draw an enthalpy level diagram for an endothermic reaction



What is activation energy?



What is activation energy?

The minimum amount of energy required to start a reaction between two colliding particles.



What are standard conditions?



What are standard conditions?

- Pressure: 101 kPa (or 100 kPa) or 1 atm
- Temperature: 298 K or 25°C
- Solution concentrations: 1 mol dm⁻³



Define the standard enthalpy change of reaction, $\Delta_r H^\theta$



Define the standard enthalpy change of reaction, $\Delta_r H^\theta$

The enthalpy change that accompanies a reaction in the molar quantities expressed in an equation under standard conditions, with all reactants and products in their standard states.



Define the standard enthalpy change of formation, $\Delta_f H^\theta$



Define the standard enthalpy change of formation, $\Delta_f H^\theta$

The enthalpy change that occurs when one mole of product is formed from its constituent elements under standard conditions, with all reactants and products in their standard states.



Define the standard enthalpy change of combustion, $\Delta_c H^\theta$



Define the standard enthalpy change of combustion, $\Delta_c H^\theta$

The enthalpy change that occurs when one mole of a compound completely reacts with oxygen under standard conditions with all reactants and products in their standard states.



Define the standard enthalpy change of neutralisation, $\Delta_{\text{neut}} H^\theta$



Define the standard enthalpy change of neutralisation,
 $\Delta_{\text{neut}} H^\theta$

The enthalpy change that occurs when one mole of water is formed in a neutralisation reaction under standard conditions.



How do you experimentally calculate enthalpy change of a reaction?



How do you experimentally calculate enthalpy change of a reaction?

$$q = mc\Delta T$$

m - mass of the solution that changes temperature ($1\text{g} = 1\text{cm}^3$)

c - specific heat capacity (usually of water)

ΔT - temperature change

q - heat energy evolved (joules)

- Divide q (in kJ) by the number of moles of the limiting reactant.
- Add a sign to show whether ΔH_r^\ominus is exothermic (-) or endothermic (+).



What is Hess' law?

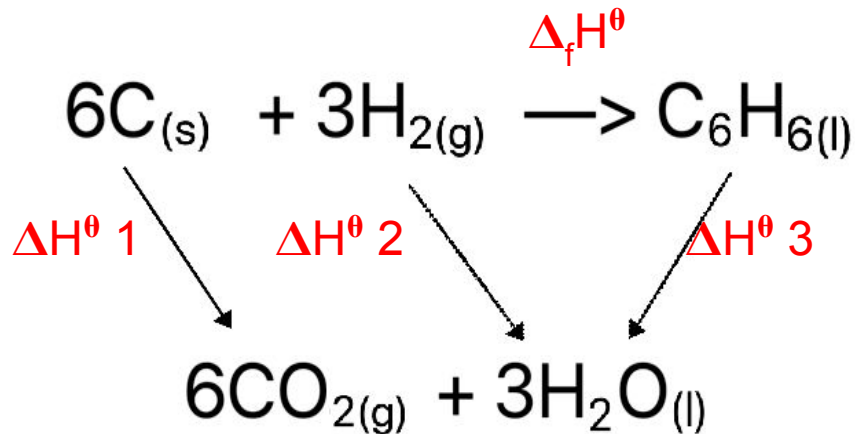


What is Hess' law?

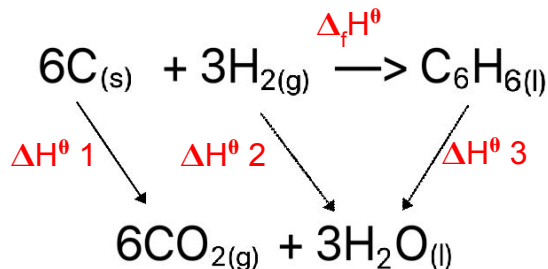
The enthalpy change of a reaction is independent of the route taken.



How can you use the Hess cycle below to indirectly determine enthalpy change?



How can you use a Hess cycle to indirectly determine enthalpy change?



- The enthalpy change for $\Delta_f H^\theta$ is equal to $\Delta H^\theta 1 + \Delta H^\theta 2 - \Delta H^\theta 3$.
- Make sure you multiply the enthalpy change by the stoichiometric ratio, i.e. $6 \times \Delta H^\theta 1$.
- Going in the direction of the arrow: add the value.
Going in the direction against the arrow: subtract the value.

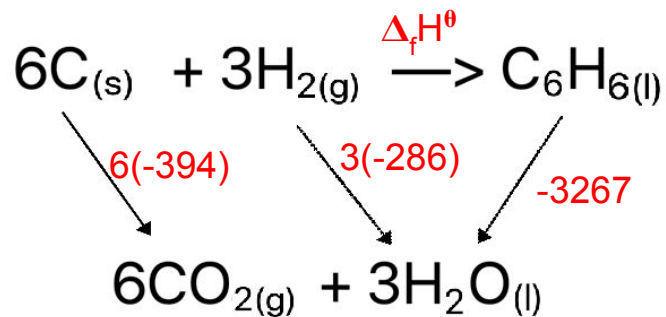


Calculate the enthalpy change of formation of $\text{C}_6\text{H}_6(\text{l})$ using the table below:

	$\Delta_c H^\theta / \text{kJ mol}^{-1}$
$\text{C}_6\text{H}_6(\text{l})$	-3267
$\text{C}_{(\text{s})}$	-394
$\text{H}_{2(\text{g})}$	-286



Calculate the enthalpy change of formation of $C_6H_6(l)$



$$\Delta_f H^\theta + (-3267) = 6(-394) + 3(-286)$$

$$\Delta_f H^\theta = 6(-394) + 3(-286) - (-3267)$$

$$= -2364 - 858 + 3267$$

$$= +45 \text{ kJ mol}^{-1}$$

	$\Delta_c H^\theta / \text{kJ mol}^{-1}$
$C_6H_6(l)$	-3267
$C_{(s)}$	-394
$H_{2(g)}$	-286



What is average bond enthalpy?



What is average bond enthalpy?

The average enthalpy change that occurs when one mole of gaseous covalent bonds are broken.



Calculate the enthalpy change of reaction for the equation below:

$$\text{CO(g)} + \text{H}_2\text{O(g)} \rightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$$

Bond	Average bond energy / kJ mol ⁻¹
C-O (carbon monoxide)	+1077
C=O	+805

Bond	Average bond energy / kJ mol ⁻¹
O-H	+464
H-H	+436



Calculate the enthalpy change of reaction for the equation below: $\text{CO(g)} + \text{H}_2\text{O(g)} \rightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$

ΔH = total energy needed to break bonds -
total energy made when forming bonds

$$\Delta H = +1077 + 2(+464) - (+436) - 2(+805)$$

$$\Delta H = +2005 - (+2046)$$

$$\Delta H = -41 \text{ kJ mol}^{-1}$$

(May use a Hess' Cycle instead)

Bond	Average bond energy / kJ mol^{-1}
C-O (carbon monoxide)	+1077
C=O	+805
O-H	+464
H-H	+436

