Exothermic and Endothermic Reactions

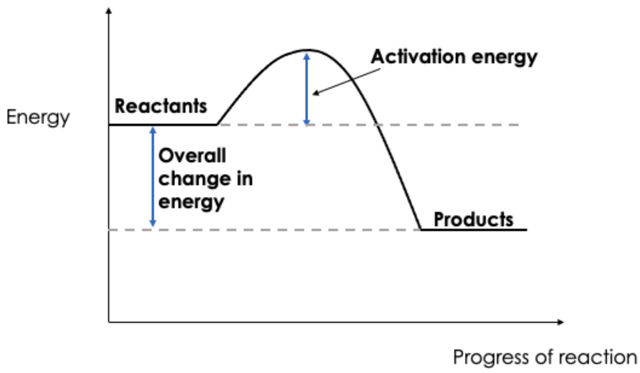
1. A **chemical reaction** involves the formation of a **new substance**.
2. **Mass** is **conserved** in a chemical reaction.
3. Chemical equations must be **balanced** because atoms are not created or destroyed in a chemical reaction.
4. **Energy** is **conserved** in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place.
5. An **exothermic reaction** is one that transfers energy **to the surroundings** so the **temperature** of the surroundings **increases**.
6. Exothermic reactions include combustion, many oxidation reactions and neutralisation.
7. Everyday uses of exothermic reactions include self-heating cans and hand warmers.
8. An **endothermic** reaction is one that takes in energy **from the surroundings** so the **temperature** of the surroundings **decreases**.
9. Endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate.
10. Some sports injury packs are based on endothermic reactions.
11. Photosynthesis is represented by the equation:

carbon dioxide + water → glucose + oxygen

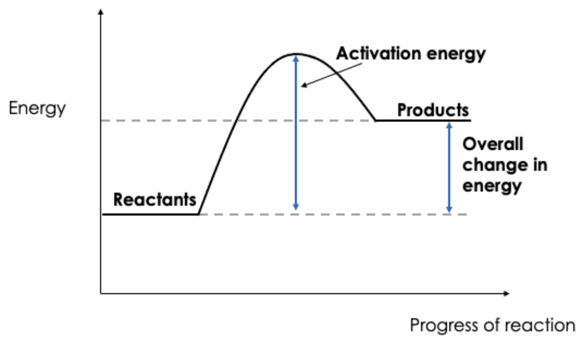
12. **Photosynthesis** is an **endothermic** reaction in which energy is transferred from the environment to the chloroplasts by light.
13. **Respiration** is an **exothermic** reaction that is continuously occurring in living cells.
14. The energy transferred during respiration supplies all the energy needed for living processes.

Energy in Chemical Reactions

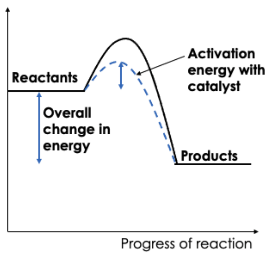
15. Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy.
16. The **minimum amount** of **energy** that particles must have to react is called the **activation energy**.
17. Energy needs to be supplied before a fuel burns.
18. Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.
19. The reaction profile for an **exothermic** reaction is:

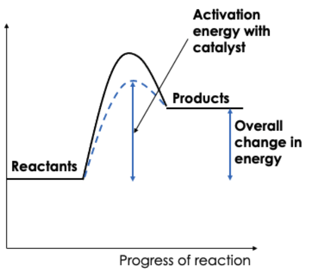


20. The reaction profile for an **endothermic** reaction is:



21. The use of a **catalyst decreases** the **activation energy** required for the reaction to occur.





22. If a reaction **transfers energy** to the surroundings the **product** molecules must have **less energy** than the **reactants**, by the amount transferred.
23. The temperature change of chemical reactions can be investigated, using reactions such as acids + metals, acids + alkalis or acids + metal carbonates
24. The greater the temperature change, the more energy is released or absorbed

Bond Energy (HT only)

25. *During a chemical reaction energy must be **supplied** to **break bonds** in the **reactants** and energy is **released** when **bonds** in the products are **formed**.*
26. *The energy needed to break bonds and the energy released when bonds are formed can be calculated from **bond energies**.*
27. *The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the **overall energy change** of the reaction.*
28. *In an **exothermic** reaction, the **energy released** from forming new bonds is **greater** than the **energy needed** to break existing bonds.*
29. *In an **endothermic** reaction, the **energy needed** to break existing bonds is **greater** than the **energy released** from forming new bonds.*
30. *Bond energies can be used to calculate the energy transferred in reactions.*

Percentage Yield and Atom Economy (Chemistry only)

31. Atoms are not gained or lost in a chemical reaction but it is not always possible to obtain the theoretical amount of a product.
32. This can be because:
    - the reaction does not go to completion because it is a **reversible** reaction
    - some of the product is lost when **separated** from the reaction mixture
    - some of the reactants **react differently** to the expected reaction
33. The amount of product obtained is called the **yield**.
34. The percentage yield is a measure of how much yield is **actually obtained** compared to how much yield should **theoretically** be **obtained**.
35. The equation to calculate percentage yield is:

$$\%\ \text{yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

36. Atom economy can also be called atom utilisation.
37. Atom economy is a measure of the amount of the starting materials that end up as useful products.

38. It is important economically and for sustainable development reasons to use chemical reactions with high atom economy.
39. Percentage atom economy is calculated using:

$$\% \text{ atom economy} = \frac{\text{Mr of desired product}}{\text{Total Mr of reactants}} \times 100$$

Cells, Batteries and Fuel Cells (Chemistry only)

40. Cells contain chemicals which **react** to **produce electricity**.
41. The **voltage** produced by a cell is dependent upon a number of factors including the **type** of **electrode** and **electrolyte**.
42. A simple cell can be made by connecting two different metals in contact with an electrolyte.
43. The **greater** the **difference** in **reactivity** of the metals used for the electrodes, the **greater** the **voltage**.
44. Batteries consist of two or more cells connected together in series to provide a greater voltage.
45. In **non-rechargeable** cells and batteries the chemical reactions stop when one of the **reactants** has been **used up**.
46. Alkaline batteries are non-rechargeable.
47. **Rechargeable** cells and batteries can be recharged because the **chemical reactions** are **reversed** when an **external electrical current** is supplied.
48. Fuel cells are supplied by an external source of fuel (e.g. hydrogen) and oxygen or air.
49. The fuel is **oxidised electrochemically** within the fuel cell to produce a potential difference.
50. The overall reaction in a hydrogen fuel is:

    hydrogen + oxygen → water
51. The balanced symbol equation for the reaction is:

    $2H_2 + O_2 \rightarrow 2H_2O$

52. *The half equation for the reaction at the negative electrode is:*

    $2H_2 \rightarrow 4H^+ + 4e^-$

53. *The half equation for the reaction at the positive electrode is:*

    $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

54. Hydrogen fuel cells offer a potential alternative to rechargeable cells and batteries.
55. Hydrogen fuel cells and rechargeable chemical cells both have advantages and disadvantages.