# Redox Equilibrium

## Oxidation

Gain of oxygen, loss of hydrogen, LOSS of electrons, increase in oxidation number.

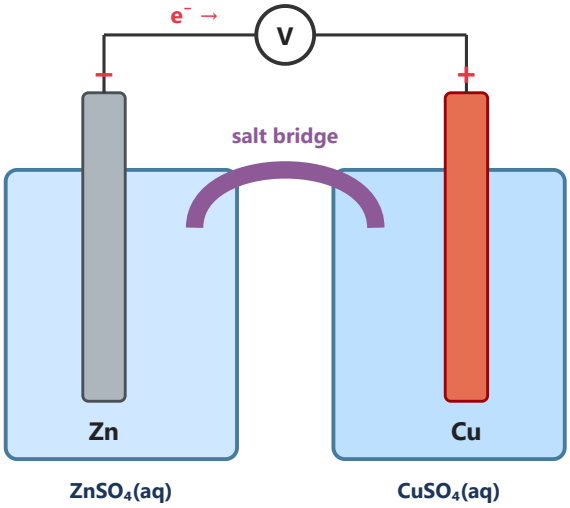
## Reduction

Loss of oxygen, gain of hydrogen, GAIN of electrons, decrease in oxidation number.

## Agents

Oxidising agent is reduced (e.g. $Cl_2$, $KMnO_4$). Reducing agent is oxidised (e.g. Zn, $Fe^{2+}$).

## Voltaic (Daniell) cell




Negative terminal (Zn, more electropositive):
$Zn \rightarrow Zn^{2+} + 2e^-$ (OXIDATION)
Positive terminal (Cu):
$Cu^{2+} + 2e^- \rightarrow Cu$ (REDUCTION)
$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$ $E°cell = 1.10$ V

## Electrolysis

Electricity breaks a compound. Anode: oxidation. Cathode: reduction. In water: ion choice depends on E°, concentration, electrode.

## Rusting

Iron + oxygen + water → $Fe_2O_3 \cdot xH_2O$. Stop it: paint, galvanise (Zn), or a sacrificial metal.

## Extracting metals

Iron: reduce ore with carbon (blast furnace). Aluminium: electrolysis of molten $Al_2O_3$.

### FORMULA / KEY TERMS

- OIL RIG: Oxidation Is Loss, Reduction Is Gain (of electrons)
- $E°cell = E°(\text{positive terminal}) - E°(\text{negative terminal})$
- More negative E° → stronger reducing agent
- Sum of oxidation numbers in a compound = 0

### COMMON MISTAKE

❌ "The oxidising agent is the substance that is oxidised."

✅ The oxidising agent makes the OTHER substance oxidised; it is itself REDUCED.

### QUICK CHECK (worked answers at the back, page 17)

1. Zinc is added to copper(II) sulphate solution. Which substance is oxidised? Write the half-equation.
2. $E°(Zn^{2+}/Zn) = -0.76$ V and $E°(Cu^{2+}/Cu) = +0.34$ V. Find the cell voltage.
3. Why are zinc blocks fixed to steel ship hulls?

# Thermochemistry

## Heat of precipitation

Heat change when 1 mol of precipitate forms from its ions.

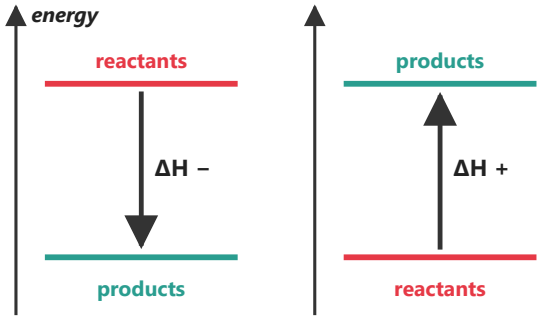
## Heat of displacement

Heat change when 1 mol of metal is displaced from its salt solution.

## Heat of neutralisation

Strong acid + strong alkali: −57 kJ per mol of water. Weak acid: less (energy used to ionise).

## Energy level diagrams




Exothermic: combustion, neutralisation, respiration, metal + acid
Endothermic: photosynthesis, dissolving $NH_4Cl$, thermal decomposition of $CaCO_3$
Bond BREAKING takes in energy
Bond MAKING gives out energy

## Heat of combustion

1 mol of fuel burnt completely in oxygen. More carbon atoms → more heat.

## Fuel value

Energy per gram of fuel (kJ $g^{-1}$). Choose a fuel by value, cost, and pollution.

## Assumptions

Density of solution = 1 g $cm^{-3}$, c = 4.2 J $g^{-1}$ $°C^{-1}$, no heat lost.

### FORMULA / KEY TERMS

- Q = mcθ (m = total mass of solution)
- ΔH = −Q ÷ n (exothermic: negative sign)
- Fuel value = heat released ÷ mass of fuel
- 1 kJ = 1000 J

### COMMON MISTAKE

❌ "In an endothermic reaction the temperature of the mixture rises."

✅ It FALLS: the reaction takes heat from the solution, so the thermometer reading drops.

### QUICK CHECK (worked answers at the back, page 17)

1. 50 $cm^3$ of 1.0 mol $dm^{-3}$ HCl + 50 $cm^3$ of 1.0 mol $dm^{-3}$ NaOH: temperature rises 6.5 °C. Find ΔH.
2. Why is the heat of neutralisation of ethanoic acid less than that of HCl?
3. Give one example of an endothermic process.

CHEMISTRY · FORM 5 · CHAPTER 4

# Polymers

### Polymer

A long chain molecule made of many repeating units (monomers).

### Addition

Monomers with C=C join; nothing is lost. n $CH_2$=$CH_2$ → (–$CH_2$–$CH_2$–)$_n$

### Condensation

Monomers join and lose a small molecule (water). Nylon, polyester, proteins.

| Polymer | Monomer | Use |
|---|---|---|
| **Polythene** | ethene | plastic bags, bottles |
| **PVC** | chloroethene | water pipes, cable cover |
| **Polypropene** | propene | ropes, crates |
| **Natural rubber** | isoprene | tyres, gloves |
| **Starch** | glucose | food store in plants |
| **Protein** | amino acids | muscles, enzymes |

### Latex

Acid makes latex coagulate ($H^+$ neutralises the negative protein layer). Ammonia keeps it liquid.

### Vulcanisation

Heat rubber with sulphur: cross-links. Stronger, more elastic, heat-resistant.

### Plastic waste

Non-biodegradable. Reduce, reuse, recycle; biodegradable polymers.

### 📐 FORMULA / KEY TERMS

- n (monomer) → (polymer)$_n$
- Thermoplastic: softens when heated, can be reshaped
- Thermoset: sets hard, does not melt again
- Elastomer: stretches and returns (rubber)

### ⚠️ COMMON MISTAKE

❌ "Polythene has a double bond because it is made from ethene."

✅ The C=C opens up during polymerisation. Polythene is SATURATED.

### ✍️ QUICK CHECK (worked answers at the back, page 17)

1. Name the monomer of PVC.
2. Why is ammonia solution added to fresh latex?
3. Give two advantages of vulcanised rubber.

CHEMISTRY · FORM 5 · CHAPTER 5

# Consumer and Industrial Chemistry

## Oils and fats

Unsaturated oils + $H_2$ (nickel, 180°C) → saturated margarine (hydrogenation).

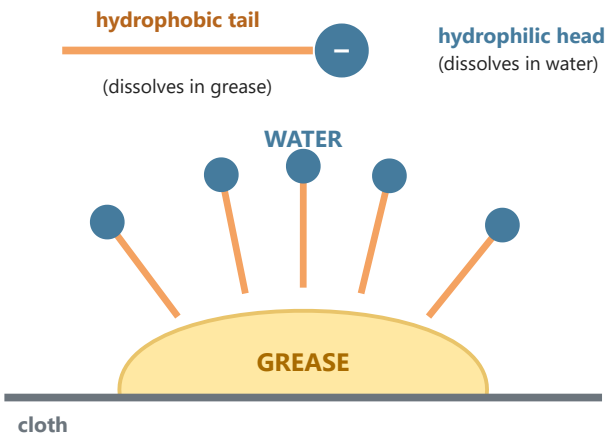
## Saponification

Fat/oil + concentrated NaOH, boiled → soap + glycerol.

## Soap vs detergent

Soap forms scum in hard water ($Ca^{2+}$, $Mg^{2+}$). Detergent still works in hard water.

## How soap removes grease




1. Tails go into the grease, heads stay in water
2. Scrubbing lifts the grease off the cloth
3. Grease breaks into small drops (emulsified)
4. Negative heads repel each other: drops do not join again, they rinse away

## Food additives

Preservatives, antioxidants, flavourings, stabilisers, thickeners, dyes.

## Medicines

Analgesics (pain), antibiotics (bacteria: finish the course), psychotherapeutic drugs.

## Nanotechnology

Materials 1–100 nm: stronger, lighter; used in sunscreen, electronics, medicine.

### FORMULA / KEY TERMS

- Fat + NaOH → sodium salt of fatty acid (soap) + glycerol
- Soap: hydrophobic tail + hydrophilic head
- Green chemistry: less waste, safer chemicals
- Antioxidant (e.g. ascorbic acid) stops oxidation of oils

### COMMON MISTAKE

❌ "Soap cleans well in hard water."

✅ In hard water soap reacts with $Ca^{2+}$/$Mg^{2+}$ to form insoluble scum, so it lathers poorly. Use a detergent.

### QUICK CHECK (worked answers at the back, page 17)

1. Name the process that makes soap and the alkali used.
2. Why must a patient finish the whole course of antibiotics?
3. Name the additive group of each: (a) sodium benzoate (b) ascorbic acid.

# Worked Answers (2/2)

### Form 4 Chapter 8: Manufactured Substances in Industry

1. Tin atoms are a different size from copper atoms; they disrupt the orderly layers so the layers cannot slide easily.
2. It has a low coefficient of expansion, so it resists cracking on sudden heating/cooling, and it resists chemicals.
3. Concrete and steel bars. Advantage: strong under both compression and tension (good for bridges, tall buildings).

### Form 5 Chapter 1: Redox Equilibrium

1. Zinc is oxidised: $Zn \rightarrow Zn^{2+} + 2e^-$ ($Cu^{2+}$ is reduced to Cu).
2. E°cell = +0.34 − (−0.76) = 1.10 V.
3. Zinc is more electropositive than iron, so zinc corrodes (is oxidised) instead of the iron: sacrificial protection.

### Form 5 Chapter 2: Carbon Compounds

1. Propanol; alcohol series.
2. Butane (straight chain) and 2-methylpropane (branched).
3. Ethyl ethanoate ($CH_3COOC_2H_5$).

### Form 5 Chapter 3: Thermochemistry

1. Q = 100 × 4.2 × 6.5 = 2730 J. n($H_2O$) = 1.0 × 0.05 = 0.05 mol. ΔH = −2730 ÷ 0.05 = −54 600 J = −54.6 kJ $mol^{-1}$.
2. Ethanoic acid is weak and only partly ionised; some heat is used to ionise it fully during the reaction, so less heat is released.
3. Any one: dissolving ammonium chloride/nitrate in water; photosynthesis; thermal decomposition of calcium carbonate.

### Form 5 Chapter 4: Polymers

1. Chloroethene (vinyl chloride), $CH_2$=CHCl.
2. $OH^-$ ions neutralise any acid made by bacteria, so the rubber particles stay negatively charged, repel each other, and the latex does not coagulate.
3. Any two: more elastic; stronger/harder; more resistant to heat; resists oxidation; does not become sticky.

### Form 5 Chapter 5: Consumer and Industrial Chemistry

1. Saponification; sodium hydroxide (or potassium hydroxide).
2. To kill ALL the bacteria; stopping early lets resistant bacteria survive and multiply.
3. (a) Preservative. (b) Antioxidant.

# Key Terms: English – Bahasa Melayu (2/2)

Form 5. Use the English words in your DLP answers; the BM words help when you read BM books or past papers.

| English | Bahasa Melayu |
|---|---|
| **oxidation** | pengoksidaan |
| **reduction** | penurunan |
| **redox reaction** | tindak balas redoks |
| **oxidising agent** | agen pengoksidaan |
| **reducing agent** | agen penurunan |
| **oxidation number** | nombor pengoksidaan |
| **electrolysis** | elektrolisis |
| **electrolyte** | elektrolit |
| **anode** | anod |
| **cathode** | katod |
| **voltaic cell** | sel kimia / sel volta |
| **salt bridge** | titian garam |
| **standard electrode potential** | keupayaan elektrod piawai |
| **rusting** | pengaratan |
| **sacrificial protection** | perlindungan korban |
| **hydrocarbon** | hidrokarbon |
| **homologous series** | siri homolog |
| **alkane** | alkana |
| **alkene** | alkena |
| **alcohol** | alkohol |
| **carboxylic acid** | asid karboksilik |
| **ester** | ester |
| **isomer** | isomer |
| **saturated** | tepu |
| **unsaturated** | tak tepu |
| **combustion** | pembakaran |
| **fermentation** | penapaian |
| **esterification** | pengesteran |
| **exothermic** | eksotermik |
| **endothermic** | endotermik |
| **heat of reaction** | haba tindak balas |
| **heat of neutralisation** | haba peneutralan |
| **heat of combustion** | haba pembakaran |
| **fuel value** | nilai bahan api |
| **energy level diagram** | gambar rajah aras tenaga |
| **polymer** | polimer |
| **monomer** | monomer |
| **addition polymerisation** | pempolimeran penambahan |
| **condensation polymerisation** | pempolimeran kondensasi |
| **latex** | lateks |
| **vulcanisation** | pemvulkanan |
| **coagulation** | penggumpalan |
| **elastomer** | elastomer |
| **saponification** | saponifikasi |
| **detergent** | detergen |
| **hard water** | air liat |
| **food additive** | bahan tambah makanan |
| **preservative** | pengawet |
| **antioxidant** | pengantioksida |
| **nanotechnology** | nanoteknologi |

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- Fizik: modul PhysiXplosion T4 + Magnatron T5 dengan skema jawapan
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