MahaScience9

CLASS 9 SCIENCE · MAHARASHTRA STATE BOARD

CHAPTER 14

Substances in Common Use

Chapter Notes

1. Important salts in daily life

A **salt** is formed when an acid reacts with a base. Many salts are used every day at home, in farms, hospitals and industries.

1.1 Sodium chloride (NaCl), common salt

Obtained by evaporating **sea water** in salt pans, and from rock salt mines. It is a white, crystalline, neutral salt, soluble in water, with a high melting point (801 °C).

Uses: in food and for preserving fish, meat and pickles; as a raw material for making sodium hydroxide, chlorine, hydrogen, baking soda, washing soda and bleaching powder.

Electrolysis of sodium chloride: passing electricity through it gives different products in different forms:

Form of NaCl	Products
Fused (molten) salt	Sodium metal at the cathode, chlorine gas at the anode
Saturated brine (concentrated solution)	Chlorine at the anode, hydrogen at the cathode, **sodium hydroxide** left in solution (chlor-alkali process)
Dilute solution	Mainly the water breaks down: hydrogen at the cathode, oxygen at the anode

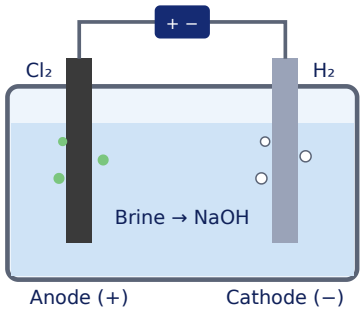


Fig. 14.1 Electrolysis of brine

$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2\uparrow + H_2\uparrow$

1.2 Bleaching powder ($CaOCl_2$), calcium oxychloride

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$ (chlorine passed over dry slaked lime)

- A white powder with a strong **smell of chlorine**. It smells because it reacts with carbon dioxide in the air and slowly gives off chlorine: $CaOCl_2 + CO_2 \rightarrow CaCO_3 + Cl_2$.
- **Uses:** disinfecting drinking water and swimming pools; bleaching cotton, linen and wood pulp in the paper industry; cleaning and making chloroform.

1.3 Baking soda ($NaHCO_3$), sodium bicarbonate

Chemical name: **sodium hydrogen carbonate (sodium bicarbonate)**. Made from NaCl, water, CO_2 and ammonia: $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$.

- On heating, it gives CO_2, which makes cakes, dhokla and bread soft and spongy: $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2\uparrow$.

- **Uses:** baking powder (baking soda + a mild acid such as tartaric acid); **antacid** to relieve acidity; in soda–acid fire extinguishers.

1.4 Washing soda ($Na_2CO_3 \cdot 10H_2O$), sodium carbonate

Each formula unit has **10 molecules of water of crystallization**. Baking soda is heated to get sodium carbonate, which is crystallized from water to get washing soda.

- **Softening hard water:** well water often contains calcium and magnesium salts, which make it hard. Washing soda turns them into insoluble carbonates that settle down, so the water becomes soft: $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$.
- **Uses:** washing clothes; softening water; making glass, soap and paper.

1.5 Crystalline salts and water of crystallization

Some salts contain a **fixed number of water molecules** in their crystals. This water is called **water of crystallization**. It gives crystals their shape and sometimes their colour. On heating, the water is lost and the crystals break into powder. For example, blue copper sulphate turns white.

Salt	Formula	Use
Washing soda	$Na_2CO_3 \cdot 10H_2O$	Washing, softening water
Blue vitriol (copper sulphate)	$CuSO_4 \cdot 5H_2O$	Fungicide (Bordeaux mixture), testing water
Green vitriol (ferrous sulphate)	$FeSO_4 \cdot 7H_2O$	Making inks and dyes; iron supplements
Potash alum (turti)	$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$	Purifying water; stops bleeding from small cuts
Gypsum	$CaSO_4 \cdot 2H_2O$	Plaster of Paris, cement, fertilizer
Epsom salt	$MgSO_4 \cdot 7H_2O$	Medicine, bath salts

2. Soap

Soap is the sodium or potassium salt of long-chain **fatty acids**. It is made by heating oil or fat with sodium hydroxide. This process is called **saponification**, and glycerol is formed as a by-product.

How soap cleans: a soap molecule has a water-loving (**hydrophilic**) head and an oil-loving (**hydrophobic**) tail. The tails stick to oily dirt and the heads face the water, forming balls called **micelles** that are washed away.

Soap in hard water: calcium and magnesium ions in hard water react with soap to form an **insoluble, sticky precipitate (scum)**, so soap does not lather and is wasted. Detergents work even in hard water.

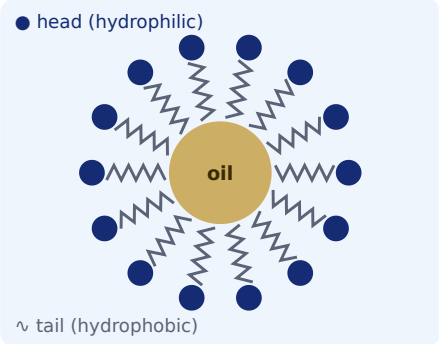


Fig. 14.2 A micelle traps oily dirt

3. Radioactivity

In **1896**, **Henri Becquerel** found that uranium salts give out invisible rays. **Marie and Pierre Curie** later discovered the radioactive elements polonium and radium. The **spontaneous emission of**

radiation from the nucleus of an atom is called **radioactivity**, and such elements are called radioactive elements.

Unstable nucleus: a nucleus is unstable when it has **too many neutrons compared with protons** (neutron-to-proton ratio above about 1.5), or when the atomic number is **more than 83**. Such nuclei break down by giving out radiation until they become stable.

Ray	Nature	Charge	Penetrating power	Stopped by
Alpha (α)	Helium nuclei (2 protons + 2 neutrons)	+2	Lowest; ionizing power highest	A sheet of paper
Beta (β)	Fast-moving electrons	−1	About 100 times more than α	A few mm of aluminium
Gamma (γ)	Electromagnetic waves (like light, very high energy)	0	Highest	Thick lead or concrete

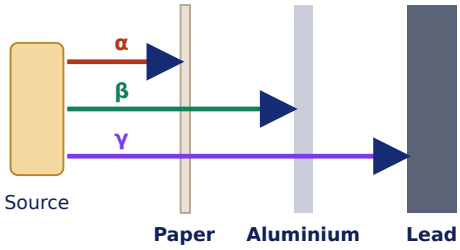


Fig. 14.3 Penetrating power of α, β and γ rays

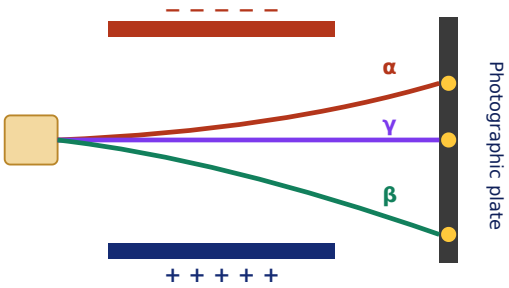


Fig. 14.4 Three marks on the plate in an electric field

Three marks on the photographic plate: in an electric field, positive **α rays bend towards the negative plate**, negative **β rays bend more, towards the positive plate** (they are much lighter), and **γ rays go straight** because they have no charge. So the plate shows three separate marks.

USES OF RADIOACTIVE ISOTOPES

- **Medicine:** iodine-131 to treat **hyperthyroidism** and thyroid problems; cobalt-60 to treat cancer; sterilizing surgical instruments.
- **Agriculture:** phosphorus-32 to study how plants take up fertilizer; developing better seed varieties; preserving food.
- **Industry:** detecting leaks in pipelines and cracks in welded joints; measuring the thickness of sheets; smoke detectors.
- **Research:** carbon-14 dating to find the age of fossils and old objects.

HARMFUL EFFECTS OF RADIATION

- Damages living cells and DNA; can cause cancer, skin burns, blood diseases and birth defects in future generations.
- Nuclear accidents, such as Chernobyl (1986) and Fukushima (2011), spread radiation over large areas.
- Radioactive materials must be handled with lead shields and protective clothing, and stored and disposed of safely.

4. Chemical substances in day-to-day life

4.1 Food colours and essences

Natural food colours come from plants: turmeric (yellow), saffron, beetroot (red), spinach (green) and caramel (brown). **Artificial (synthetic) food colours**, such as tartrazine and sunset yellow, and **artificial essences** (flavours such as vanilla, pineapple and rose) are added to sweets, cold drinks, ice-cream and jellies.

Harmful effects of artificial food colours: allergies, skin rashes, asthma, headaches and hyperactivity in children; long-term use may damage the liver and kidneys and some colours are linked to cancer. Only colours permitted by food-safety rules, in small amounts, should be used.

4.2 Dyes and artificial colours

Dyes are used to colour cloth, hair, leather, paper and food. Natural dyes come from plants (henna, indigo, turmeric, flowers); synthetic dyes are made from chemicals. **Harmful effects of artificial dyes:** skin allergies, eye irritation and breathing problems; dye waste from factories pollutes rivers.

ECO-FRIENDLY COLOURS FOR RANG PANCHAMI / HOLI

Use colours made from **palash (tesu) and marigold flowers, turmeric, beetroot, henna and sandalwood**. They are safe for skin, eyes and hair, wash off easily, and do not pollute water or soil, unlike chemical colours that may contain lead, mercury or chromium compounds.

4.3 Deodorants

Deodorants reduce **body odour** caused by bacteria acting on sweat. They contain perfumes, antibacterial substances and often **aluminium compounds** (such as aluminium chlorohydrate) that reduce sweating. **Harmful effects:** skin irritation, itching and allergies; breathing trouble from sprays; some people react to the aluminium compounds. Use them in moderation, never on broken skin.

4.4 Teflon

Chemical name: **polytetrafluoroethylene (PTFE)**, a polymer of tetrafluoroethylene, $(–CF_2–CF_2–)_n$.

- **Properties:** very smooth and **non-stick**; not affected by heat up to about 300 °C or by chemicals; does not conduct electricity; repels water and oil.
- **Uses:** coating on **non-stick cookware**, insulation on electric wires, gaskets and pipes in industry, laboratory equipment.
- **Why Teflon coating is popular:** food does not stick or burn, less oil is needed, and utensils are easy to clean.

4.5 Powder coating

A dry powder (resin and colour pigment) is sprayed on a metal object with a special gun. The **powder particles are given an electric charge**, while the object is earthed, so the charged particles are **attracted to the metal and stick evenly** all over it, even in corners. The object is then heated in an oven, so the powder melts into a smooth, hard layer.

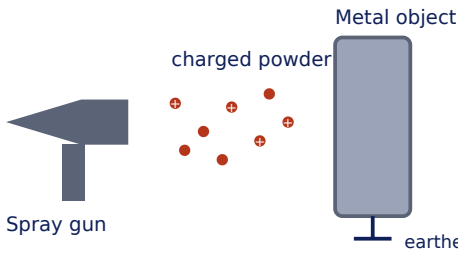


Fig. 14.5 Powder coating

Uses: vehicle parts, bicycles, refrigerators, washing machines, steel furniture and window frames. It is long-lasting, rust-proof and needs no harmful solvents.

4.6 Anodizing

Aluminium naturally has a very thin oxide layer. **Anodizing** makes this layer thicker by electrolysis. The aluminium article is made the **anode** in dilute sulphuric acid. **Oxygen is released at the anode** and combines with the aluminium surface to form a thick, hard layer of **aluminium oxide (Al_2O_3)**. That is why aluminium must be the anode. The layer can also be dyed in attractive colours.

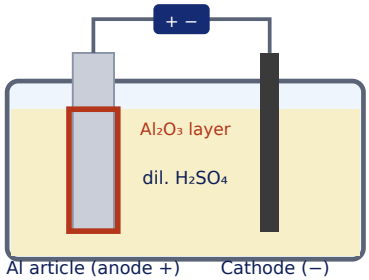


Fig. 14.6 Anodizing aluminium

Uses: pressure cookers and cooking pots, window and door frames, vehicle and aircraft parts. It protects against **corrosion** and scratches.

4.7 Ceramics

Ceramics are hard materials made by shaping clay or other inorganic, non-metallic materials and heating them to a very high temperature in a **kiln**. Examples: pottery, porcelain, bricks, tiles, sanitaryware and glass-like glazed articles.

- **Properties:** hard, brittle, resistant to heat and chemicals, do not rust, and are poor conductors of heat and electricity.
- **Uses:** crockery, tiles and wash basins; electrical insulators and spark plugs; dental crowns and bone implants; cutting tools.
- **Space shuttle tiles:** the outer surface of a space shuttle becomes extremely hot (over 1000 °C) as it re-enters the atmosphere. Special **silica ceramic tiles** withstand this heat and are very poor conductors of heat, so they protect the shuttle and the astronauts inside.

5. Important questions for the exam

1. Fill in the blanks: Washing soda has **10** molecules of water of crystallization. The chemical name of baking soda is **sodium bicarbonate**. **Iodine-131** is used to treat hyperthyroidism. The chemical name of Teflon is **polytetrafluoroethylene**.
2. Match: Saturated brine – NaOH (chlor-alkali); fused salt – sodium metal; $CaOCl_2$ – bleaching powder; $NaHCO_3$ – baking soda / antacid.
3. Write the formulas of bleaching powder ($CaOCl_2$), common salt ($NaCl$), baking soda ($NaHCO_3$) and washing soda ($Na_2CO_3 \cdot 10H_2O$).
4. Give scientific reasons: bleaching powder smells of chlorine; washing soda softens well water; soap forms a precipitate in hard water; powder particles are charged in powder coating; aluminium is the anode in anodizing.
5. What is radioactivity? When is a nucleus unstable? Write the properties of α, β and γ rays.
6. Write the uses of anodizing, powder coating, radioactive substances and ceramics.
7. Write the harmful effects of artificial dyes, artificial food colours, radiation and deodorants.