3.7 Comparing bonding and properties

Table C3.10 summarises information related to metallic, covalent and ionic bonds.

Table C3.10 Metallic, covalent and ionic bonds

Ionic bond	Covalent bond	Metallic bond
Formed by the attraction between one atom that has lost electrons and another atom that has gained electrons.	Formed by the mutual sharing of electrons between the same or different elements	Formed by the attraction between metal cations and a sea of mobile electrons
Strong because of electrostatic force of attraction	Fairly strong bond because the electron pair is strongly attracted by two nuclei	Strong because of the simultaneous attraction of the electrons by a large number of metal cations
Non-directional	Directional	Non-directional

EXPERIMENT 3.2

COMPARING DIFFERENT TYPES OF SUBSTANCES

Solids can be divided into four categories on the basis of their properties. Solids can be metallic, ionic, covalent molecular and covalent network. The property of electrical conductivity effectively distinguishes between metallic, ionic and covalent solids. To distinguish between covalent molecular and covalent network types, melting point must be considered.

In this experiment, you will classify a number of substances on the basis of their ability to conduct electricity in the solid, molten and/or aqueous states.

Note: Because of the amount of equipment and time involved, this experiment is best done by rotating through stations, each of which tests the properties of one substance.

Aim

To classify substances according to their physical properties

Materials

All stations

- Power pack, kit for measuring conductivity (Stations 1–5 need 2 kits)

Stations 1 and 2

- 2 crucibles with lids, Bunsen burner, tripod, pipe clay triangle
- Station 1 – sodium hydroxide pellets (enough to half-fill 2 crucibles)
- Station 2 – silver nitrate crystals (enough to half-fill 2 crucibles). Platinum electrodes work better at this station because of contamination of the electrodes in silver nitrate.

Stations 3–5

- 2 crucibles with lids, hot plate
- Station 3 – candle wax (enough to half-fill 2 crucibles)
- Station 4 – sulfur (enough to half-fill 2 crucibles). Place this station in a fume cupboard.
- Station 5 – camphor or naphthalene (enough to half-fill 2 crucibles). Place this station in a fume cupboard.

Stations 6–12

- 100 mL beaker
- Station 6 – 50 mL of distilled water
- Station 7 – 50 mL of kerosene
- Station 8 – 50 mL of ethanol
- Station 9 – 50 mL of 0.1 mol L^{-1} sucrose solution
- Station 10 – 50 mL of 0.1 mol L^{-1} sodium chloride solution
- Station 11 – 50 mL of 0.1 mol L^{-1} sodium hydroxide solution
- Station 12 – 50 mL of 0.1 mol L^{-1} hydrochloric acid solution

Station 13

- 1 piece each of copper sheet, tin foil, aluminium foil and quartz

What are the risks in doing this experiment?	How can you manage these risks to stay safe?
Hydrochloric acid and sodium hydroxide are corrosive.	Wear safety glasses, gloves and protective clothing. Take care when pouring. Clean up spills immediately; if spilt on skin, wash affected area with plenty of water and notify your teacher immediately.
Silver nitrate is toxic.	Wear appropriate safety gear. Dispose of in chemical waste jar provided.
Substances may spit out of heated crucible.	Wear appropriate safety gear; use tongs.
Sulfur and naphthalene are irritants to eyes, nose and throat.	Work in a fume cupboard. Do not breathe in the fumes.
Kerosene is flammable and can be an irritant.	Place kerosene well away from Bunsen burners and hotplates. Work in a well-ventilated area; do not breath the fumes.

In your write-up, add any more risks you can think of, as well as ways to manage them.

Procedure

1. At all stations, start the power pack at 2 V. If you get a reading, then record it. If not, turn the voltage up one step at a time until you get a reading or until you get to a maximum of 6 V. Record the result, either a current reading or no current.
2. At stations 1 and 2, place one of the crucibles on the tripod and heat it with a blue flame until it melts. Turn the Bunsen burner to a very low flame or off. Use one of the conductivity kits to test the molten substance. Use the other kit to test the solid in the other crucible. If the electrodes in the molten substance are covered in solid, then the solid will need to be melted before testing the conductivity.
3. At stations 3–5, there is a chance of the substance catching fire. If it does, place the lid on the crucible to put it out. Heat the crucible on the hot plate until the substance melts. Use one of the conductivity kits to test the molten substance. Use the other kit to test the solid in the other crucible.
4. At stations 6–12, dip the conductivity kit into the solution and record the result.
5. At station 13, place the electrodes against each sample.

Results

Record your results in a table similar to the following table.

Chemical	State	Conductivity	Classification

Analysing the results

What, pattern if any, is there to the conductivity results?

Discussion

Use theory to identify the types of bonding in each of the substances tested. Compare your results with the theoretical classifications and suggest any reasons for differences.

Conclusion

What generalisations can you make about particles in substances and conductivity?