2 **a** 0°C **b** 100°C

3 **a** Gas **b** Solid

c Liquid

4 **a** Oxygen **b** Nitrogen

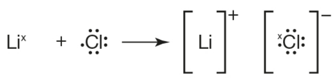
c Oxygen **d** Oxygen

Ions and ionic bonding

1 Magnesium is a metal which is found in group **2** of the periodic table. This means it has **2** electrons in its outer shell. When it reacts, it loses **2** electrons and forms an ion with a **2**$^+$ charge. Fluorine is a non-metal which is found in group **7** of the periodic table. When it reacts, it **gains** 1 electron to form an ion with a **1**$^-$ charge. When magnesium reacts with fluorine, it forms magnesium fluoride which has the formula **MgF_2**.

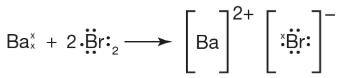
2 Potassium chloride, KCl; Magnesium oxide, MgO; Magnesium chloride, $MgCl_2$; Aluminium fluoride, AlF_3.

3 **a** Formula = LiCl



(correct ion; correct formula)

b Formula = $BaBr_2$



(correct ion; correct formula)

The structure and properties of ionic compounds

1 High melting points; Conduct electricity when molten or in solution; Made of ions.

2 **a** B **b** A **c** C

3 Ionic bonds are formed when **metals** react with **non-metals**. Atoms either lose or gain **electrons** to become positive or negative particles called ions. The ions are held together in a giant ionic **lattice** by strong **electrostatic** forces of attraction acting in all **directions**.

4 Level 1 (marks 1–2)

KI is ionic/made of ions/consists of a giant ionic lattice.

KI will have a high melting point *or* will conduct electricity when molten or in solution.

Level 2 (marks 3–4)

KI will have a high melting point because the ions are strongly attracted together/lots of energy is needed to break the strong ionic bonds *or*

KI will conduct electricity when molten or in solution/dissolved because the ions are free to move.

Level 3 (marks 5–6)

KI will have a high melting point because the ions are strongly attracted together/lots of energy is needed to break the strong ionic bonds *and*

KI will conduct electricity when molten or in solution/dissolved because the ions are free to move *and*

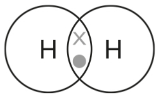
KI will not conduct electricity when solid as the ions do not move/are in fixed positions.

Covalent bonds and simple molecules

1 NH_3; Water.

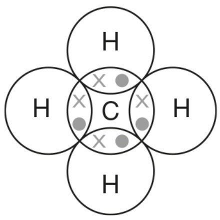
2 **a** and **b**

Hydrogen



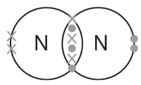
Formula: H_2

Methane



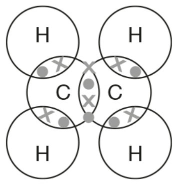
Formula: CH_4

3 **a**



b Covalent bond – triple bond

4 **a**



(each single bond; correct double bond)

b Covalent bonds – 4 × single and 1 × double

Diamond, graphite and graphene

1 **a** A **b** C

2 **a** Strong covalent bonds; large amounts of energy needed to overcome/break covalent bonds.

b Each carbon is bonded to 4 other carbon atoms; covalent bonds are very strong.

c Both have delocalised electrons; both conduct electricity.

3 **a** Does not have delocalised electrons. (do not allow free/mobile ions).

b High melting/boiling points hard. (due to no delocalised electrons).

Fullerenes and polymers

1 **a** D **b** C

c A **d** B

2 **a** Hollow/spherical

b Large surface area

3 **a** Covalent

b
- Polyethene is a bigger molecule so has larger intermolecular forces;
- More energy needed to overcome these intermolecular forces;
- Increases the melting point;
- Allow reverse argument.

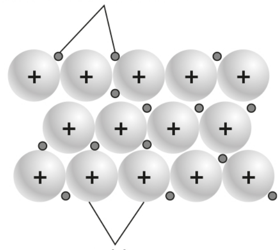
Giant metallic structures and alloys

1 Metals are **giant** structures. The atoms are arranged in **layers**.

The outer shell electrons become detached from the rest of the atom and are said to be **delocalised**. This means they are free to move throughout the whole metal.

Metallic bonding is strong because of the **electrostatic** attraction between the positive metal ions and the electrons.

2 **free electrons** from outer shells of metal atoms



metal ions

Giant structure; Positive metal ions drawn and labelled; Delocalised electrons drawn and labelled; Electrons can carry charge throughout the metal.

3 **a** Strong electrostatic attraction between positive metal ions and delocalised electrons; Lots of energy needed to overcome the strong attraction.

b Carbon/different sized atoms distort the regular lattice; Layers cannot slide over each other.

Nanoparticles

1 1–100 nm

2 **a** 8.6×10^{-8} m

b 1.46×10^{-8} m

c 1.58×10^{-7} m

d 8.2×10^{-9} m

e c– because the value is > 100 nm (both points needed)

3 **a**
- Surface area = $5^2 \times 6$ = 150 nm^2; [units not needed]
- Volume = 5^3 = 125 nm^3;
- SA:volume ratio = 150/125 = 1.2.

b As length of the side increases, ratio increases; by a factor of 10.