2.18 Chemical Bonding: Ionic, Covalent and Metallic: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Complete the table below to compare ionic, covalent and metallic bonding. For each bonding type, state (i) the particles that are joined by the bond and (ii) the force that holds them together.

Type of bonding	(i) Particles joined by the bond	(ii) Force holding them together
Ionic	?	?
Covalent	?	?
Metallic	?	?

(a) Complete the row for ionic bonding. **(2)**

(b) Complete the row for covalent bonding. **(2)**

(c) Complete the row for metallic bonding. **(2)**

(Total for Question 1 is 6 marks)

© Revision Library | revisionlibrary.co.uk

2 Figure 1 shows the outline of a dot-and-cross diagram for sodium chloride, before the electron transfer has been shown.

Figure 1



(a) Complete the dot-and-cross diagram in Figure 1 to show the ionic bonding in one formula unit of sodium chloride. Show the charge on each ion, and show outer-shell electrons only. **(3)**

(b) State the charge on the sodium ion and the charge on the chloride ion shown in your diagram. **(1)**

(c) Give one limitation of using a dot-and-cross diagram, like the one you completed in part (a), to represent the ionic bonding in sodium chloride. **(1)**

(Total for Question 2 is 5 marks)

© Revision Library | revisionlibrary.co.uk

3 Hydrogen and chlorine can each form simple covalent molecules.

(a) Draw a dot-and-cross diagram to show the covalent bonding in a molecule of hydrogen, H_2. Show outer-shell electrons only. **(2)**

(b) Draw a dot-and-cross diagram to show the covalent bonding in a molecule of hydrogen chloride, HCl. Show outer-shell electrons only. **(2)**

(Total for Question 3 is 4 marks)

---

4 This question checks some key words used throughout this topic.

(a) State what is meant by the term 'ion'. **(1)**

(b) Name the three types of strong chemical bonding studied in this topic. **(3)**

(Total for Question 4 is 4 marks)

© Revision Library | revisionlibrary.co.uk

5 When a metal atom forms metallic bonds, it releases its outer-shell electrons to become part of the delocalised sea of electrons.

(a) Using group numbers from the periodic table, state the number of electrons released to become delocalised electrons by one atom of each of the following metals: (i) sodium (Group 1) (ii) magnesium (Group 2) (iii) aluminium (Group 3). **(3)**

(Total for Question 5 is 3 marks)

---

6 Metals are good conductors of electricity, but substances made of small covalent molecules are not.

(a) Explain, in terms of bonding, why metals conduct electricity. **(2)**

(b) Suggest why a simple covalent substance, such as methane, does not conduct electricity. **(1)**

(Total for Question 6 is 3 marks)

© Revision Library | revisionlibrary.co.uk

Mark scheme · 2.18 Chemical Bonding: Ionic, Covalent and Metallic: 30-minute Pack

Question 1

(a) particles: oppositely charged ions (a positive ion and a negative ion) oe **B1**

(a) force: electrostatic force of attraction between the oppositely charged ions oe **B1**

(a) Answer: Particles: oppositely charged ions. Force: electrostatic attraction between the ions.

(b) particles: two (non-metal) atoms sharing a pair of electrons oe **B1**

(b) force: electrostatic attraction between the shared pair of electrons and both positive nuclei oe **B1**

(b) Answer: Particles: two atoms sharing a pair of electrons. Force: electrostatic attraction between the shared electrons and both nuclei.

(c) particles: positive metal ions and delocalised electrons oe **B1**

(c) force: electrostatic attraction between the positive ions and the delocalised (free) electrons oe **B1**

(c) Answer: Particles: positive metal ions and delocalised electrons. Force: electrostatic attraction between the ions and the delocalised electrons.

Question 2

(a) Na shown as [Na]+ with an empty outer shell (no dots or crosses) **B1**

(a) Cl shown as [Cl]- surrounded by 8 outer-shell electrons: 7 shown as one symbol (e.g. dots, its own original electrons) and 1 shown as a different symbol (a cross, transferred from sodium) **B1**

(a) both ions enclosed in square brackets with the correct charge (1+ and 1-) marked outside the brackets **B1**

(a) Answer: [Na]+ with an empty outer shell, and [Cl]- surrounded by 8 outer-shell electrons (7 shown as dots from chlorine's original outer shell, plus 1 shown as a cross transferred from sodium), each ion in square brackets with its charge shown outside.

(b) Na^+ = 1+ (or +1); Cl^- = 1- (or -1) cao **B1**

(b) Answer: Na^+ = 1+; Cl^- = 1-.

(c) any one valid limitation, e.g. it does not show the giant lattice structure / that millions of ions are arranged in a repeating 3D pattern (it only shows one ion pair); OR it does not show the relative sizes of the ions; OR it does not show the true 3D shape or arrangement oe **B1**

(c) Answer: It does not show the giant lattice structure of the real compound; the diagram shows only one Na^+ and one Cl^- ion, not the millions of ions arranged in a repeating 3D pattern.

Question 3

(a) one shared pair of electrons shown correctly between the two H atoms (one dot from one H, one cross from the other) **B1**

(a) each H atom shown with a full outer shell of 2 electrons (a duplet) as a result of sharing **B1**

(a) Answer: Two H atoms each contribute 1 electron to a single shared pair, shown as one dot and one cross between the two H symbols; each H then has a full outer shell of 2 electrons (a duplet).

(b) one shared pair of electrons shown correctly between H and Cl (one dot, one cross) **B1**

(b) chlorine's remaining 6 outer electrons shown correctly as 3 lone pairs, giving Cl a full outer shell of 8 **B1**

(b) Answer: H contributes 1 electron and Cl contributes 1 of its 7 outer electrons to form one shared pair; Cl also shows 3 lone pairs (6 non-bonding electrons); H ends with a duplet (2 electrons) and Cl ends with an octet (8 electrons).

Question 4

(a) an atom (or group of atoms) that has lost or gained one or more electrons and so has an overall electric charge oe **B1**

(a) Answer: An ion is an atom, or group of atoms, that has lost or gained electrons and so has an overall positive or negative charge.

(b) ionic bonding **B1**

(b) covalent bonding **B1**

(b) metallic bonding **B1**

(b) Answer: Ionic bonding, covalent bonding and metallic bonding.

Question 5

(a) sodium: 1 electron per atom **B1**

(a) magnesium: 2 electrons per atom **B1**

(a) aluminium: 3 electrons per atom **B1**

(a) Answer: Sodium releases 1 delocalised electron per atom (forming Na^+); magnesium releases 2 per atom (forming Mg^{2+}); aluminium releases 3 per atom (forming Al^{3+}).

Question 6

(a) metals contain delocalised electrons that are free to move throughout the whole structure **B1**

(a) when a voltage is applied, these delocalised electrons can flow through the metal, carrying charge and producing an electric current oe **B1**

(a) Answer: Metals contain delocalised electrons that are free to move through the whole structure. When a voltage is applied, these electrons can flow through the metal, carrying charge and producing an electric current.

(b) there are no free-moving charged particles (no delocalised electrons and no free ions) able to carry charge through the substance oe **B1**

(b) Answer: Simple covalent substances like methane have no free electrons or ions able to move and carry charge, so no current can flow.

© Revision Library | revisionlibrary.co.uk