2.18 Chemical Bonding: Ionic, Covalent and Metallic: Test Pack

AQA 8464 · Calculator allowed · about 40 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 This question checks three key terms used throughout this topic.

(a) Define an 'ionic bond'. **(1)**

(b) Define a 'covalent bond'. **(1)**

(c) Define 'delocalised electrons'. **(1)**

(Total for Question 1 is 3 marks)

2 Potassium and fluorine react together to form the ionic compound potassium fluoride, KF. A potassium atom has the electronic structure 2,8,8,1. A fluorine atom has the electronic structure 2,7.

(a) Explain how a potassium atom forms a potassium ion, including the charge on the ion formed. **(2)**

(b) Explain how a fluorine atom forms a fluoride ion, including the charge on the ion formed. **(2)**

(Total for Question 2 is 4 marks)

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3 The formula of an ionic compound must balance the total positive charge with the total negative charge.

(a) Aluminium ions, Al^{3+}, and sulfide ions, S^{2-}, form the ionic compound aluminium sulfide. Deduce the formula of aluminium sulfide, showing that the charges balance. **(3)**

(b) Potassium ions, K^{+}, and oxide ions, O^{2-}, form the ionic compound potassium oxide. Deduce the formula of potassium oxide. **(2)**

(Total for Question 3 is 5 marks)

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4 Required practical: Priya tests whether solid lead bromide, molten lead bromide, and an aqueous solution of sodium chloride conduct electricity, using a circuit containing a bulb and two graphite electrodes.

(a) State whether solid lead bromide would conduct electricity, and explain your answer in terms of its structure. **(2)**

(b) Explain why molten lead bromide does conduct electricity. **(2)**

(c) State one similarity in why molten lead bromide and aqueous sodium chloride solution both conduct electricity. **(1)**

(Total for Question 4 is 5 marks)

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5 Compound R has the formula Ca_3N_2. A nitride ion has charge N^{3-}.

(a) State the general rule that determines the ratio of ions in the formula of an ionic compound. **(1)**

(b) Use this rule and the formula Ca_3N_2 to calculate the charge on a calcium ion. Show your working. **(3)**

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(Total for Question 5 is 4 marks)

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6 An electrician notes that solid copper wire conducts electricity, but solid calcium oxide (also a giant lattice structure) does not conduct electricity unless it is melted.

(a) Explain why solid copper conducts electricity. **(2)**

(b) Explain why solid calcium oxide does not conduct electricity, even though it is also a giant lattice structure. **(2)**

(c) State what must happen to solid calcium oxide for it to be able to conduct electricity. **(1)**

(Total for Question 6 is 5 marks)

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7 Magnesium oxide, MgO, has a melting point of 2852°C. Sodium chloride, NaCl, has a melting point of 801°C. Both are ionic compounds with giant lattice structures.

(a) State the type of structure both compounds have. **(1)**

(b) Higher tier only. Explain why magnesium oxide has a much higher melting point than sodium chloride. **(3)**

(Total for Question 7 is 4 marks)

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Mark scheme · 2.18 Chemical Bonding: Ionic, Covalent and Metallic: Test Pack

Question 1

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

(a) Answer: The strong electrostatic force of attraction between oppositely charged ions.

(b) a shared pair of electrons between two (non-metal) atoms, oe **B1**

(b) Answer: A shared pair of electrons between two atoms.

(c) outer-shell electrons from metal atoms that are free to move throughout the whole metallic structure, not fixed to one atom, oe **B1**

(c) Answer: Outer-shell electrons from metal atoms that are free to move throughout the whole structure.

Question 2

(a) the potassium atom loses its 1 outer-shell electron, oe **M1**

(a) forming a K^+ ion with a full outer shell (electronic structure 2,8,8), oe **A1**

(a) Answer: The potassium atom loses its 1 outer-shell electron, forming a K^+ ion with a full outer shell.

(b) the fluorine atom gains 1 electron (the electron lost by potassium), oe **M1**

(b) forming an F^- ion with a full outer shell (electronic structure 2,8), oe **A1**

(b) Answer: The fluorine atom gains 1 electron, forming an F^- ion with a full outer shell.

Question 3

(a) identifies that 2 aluminium ions and 3 sulfide ions are needed **M1**

(a) shows total charge balances: 2 x (3+) = 6+ and 3 x (2-) = 6- **M1**

(a) Al_2S_3 cao **A1**

(a) Answer: Al_2S_3

(b) identifies that 2 potassium ions are needed to balance 1 oxide ion **M1**

(b) K_2O cao **A1**

(b) Answer: K_2O

Question 4

(a) does not conduct electricity **B1**

(a) the ions are held in fixed positions in the giant ionic lattice and cannot move to carry charge, oe **B1**

(a) Answer: Solid lead bromide does not conduct electricity, because its ions are held in fixed positions in the lattice and cannot move to carry charge.

(b) when lead bromide melts, the giant ionic lattice breaks down and the ions are free to move, oe **M1**

(b) the mobile (free-moving) ions can now carry electrical charge through the liquid, oe **A1**

(b) Answer: Melting breaks down the lattice, freeing the ions to move, and these mobile ions can carry electrical charge.

(c) both contain ions that are free to move (mobile) and can carry electrical charge, oe **B1**

(c) Answer: Both contain free-moving (mobile) ions that can carry electrical charge.

Question 5

(a) the total positive charge must equal (balance) the total negative charge, oe **B1**

(a) Answer: The total positive charge must balance the total negative charge.

(b) total negative charge from 2 nitride ions: 2 x (3-) = 6- **M1**

(b) total positive charge must also be 6+, shared equally between 3 calcium ions **M1**

(b) charge on each calcium ion = 6 / 3 = 2+ (i.e. Ca^{2+}) cao **A1**

(b) Answer: 2+ (Ca^{2+})

Question 6

(a) metallic bonding consists of a lattice of positive metal ions surrounded by a 'sea' of delocalised (free) electrons, oe **M1**

(a) these delocalised electrons are free to move throughout the whole structure, carrying charge, even in the solid state, oe **A1**

(a) Answer: Copper has a lattice of positive ions surrounded by delocalised electrons, which are free to move throughout the solid and carry charge.

(b) in ionic calcium oxide, the ions are held in fixed positions by strong electrostatic forces and cannot move, oe **M1**

(b) there are no delocalised (mobile) charged particles able to move through the solid lattice to carry a current, oe **A1**

(b) Answer: In calcium oxide the ions are held in fixed positions by strong electrostatic forces, so there are no mobile charged particles free to carry a current.

(c) it must be melted (or dissolved in water), so its ions become free to move, oe **B1**

(c) Answer: It must be melted, or dissolved in water, so the ions become free to move.

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Question 7

(a) giant ionic lattice (structure) **B1**

(a) Answer: Giant ionic lattice.

(b) the ions in magnesium oxide (Mg^{2+} and O^{2-}) have a greater charge than the ions in sodium chloride (Na^{+} and Cl^{-}), oe **M1**

(b) greater ionic charge produces stronger electrostatic forces of attraction between the oppositely charged ions in the lattice, oe **M1**

(b) so more (thermal) energy is needed to overcome these stronger forces and melt magnesium oxide, giving it a higher melting point, oe **A1**

(b) Answer: Magnesium oxide's ions (Mg^{2+} and O^{2-}) carry a greater charge than sodium chloride's (Na^{+} and Cl^{-}), producing stronger electrostatic forces in the lattice, so more energy is needed to melt it.

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