2.5 Covalent Bonding: Simple Molecules and Giant Structures: 30-minute Pack

Total Marks

EDEXCEL 4CH1 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 P is a simple molecular substance. A laboratory records that it is a gas at room temperature, has a low boiling point and does not conduct electricity. Explain its low boiling point in terms of its particles and forces.

(Total for Question 1 is 2 marks)

2 A solid sample identified as diamond melts only at a very high temperature. Explain its high melting point using the particles and bonds in diamond.

(Total for Question 2 is 1 mark)

3 Draw dot-and-cross diagrams showing the bonding in methane (CH_4) and in ammonia (NH_3). For each molecule state the number of covalent bonds and the number of lone pairs on the central atom.

(Total for Question 3 is 3 marks)

4 A sample of silicon dioxide is heated strongly, but it remains solid until a very high temperature. Explain why much energy is needed to melt it.

(Total for Question 4 is 2 marks)

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5 Draw dot-and-cross diagrams to show the double covalent bonding in a molecule of oxygen (O_2) and the bonding in carbon dioxide (CO_2). For each molecule indicate the total number of shared electron pairs.

(Total for Question 5 is 3 marks)

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6 Draw a dot-and-cross diagram for nitrogen gas, N_2, showing the triple bond between the two nitrogen atoms. State how many electrons are shared in total in the bond and how many lone pairs each nitrogen atom has after bonding.

(Total for Question 6 is 2 marks)

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7 Each substance is either simple molecular or giant covalent. Substance X melts at -78 degrees C and does not conduct electricity. Substance Y melts above 1000 degrees C and also does not conduct electricity. Compare the structures of X and Y and explain their different melting points.

(Total for Question 7 is 3 marks)

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8 Explain why silicon dioxide (SiO_2) is a solid with a very high melting point and does not conduct electricity, whereas carbon dioxide (CO_2) is a gas at room temperature. Refer to bonding and structure for both substances in your answer.

(Total for Question 8 is 4 marks)

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9 Describe the bonding and structure of graphite and explain two properties of graphite that arise from that structure, referring to the bonding and layers in your explanation.

(Total for Question 9 is 4 marks)

10 A student is given one sample of each of four solids: graphite, diamond, silicon dioxide and a simple molecular substance. The observations are: A is soft and conducts electricity; B is very hard and does not conduct; C has a very high melting point and does not conduct; D melts at a low temperature and does not conduct. Match each solid to graphite, diamond, silicon dioxide or a simple molecular substance, and explain the melting-point evidence for C and D.

(Total for Question 10 is 3 marks)

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Mark scheme · 2.5 Covalent Bonding: Simple Molecules and Giant Structures: 30-minute Pack

Question 1

P is made of small, separate molecules. **B1**

Weak intermolecular forces between the molecules require little energy to overcome. **B1**

Answer: P consists of small separate molecules with weak intermolecular forces between them, so little energy is needed to separate the molecules.

Question 2

Diamond has a giant covalent structure with strong covalent bonds throughout, requiring much energy to break. **B1**

Answer: Diamond has strong covalent bonds throughout its giant structure, requiring much energy to break.

Question 3

methane diagram with C sharing four electrons with four H atoms **B1**

ammonia diagram with N sharing three electrons with three H atoms and one lone pair on N **B1**

states number of covalent bonds and lone pairs: CH_4 has 4 bonds and 0 lone pairs on C; NH_3 has 3 bonds and 1 lone pair on N **B1**

Answer: CH_4: carbon shares four electrons with four H atoms (4 covalent bonds) and carbon has 0 lone pairs. NH_3: nitrogen shares three electrons with three H atoms (3 covalent bonds) and has 1 lone pair.

Question 4

Silicon dioxide has a giant covalent structure with many strong covalent bonds throughout. **B1**

Many of these bonds must be overcome, requiring a large energy input. **B1**

Answer: Silicon dioxide has a giant covalent network with many strong bonds throughout, and much energy is needed to overcome them.

Question 5

O_2 diagram showing two bonding pairs between the two O atoms (a double bond) and two lone pairs on each O **B1**

CO_2 diagram linear O=C=O with two double bonds, each O with two lone pairs **B1**

states total shared pairs: O_2 has 2 shared pairs, CO_2 has 4 shared pairs (two per C=O) **B1**

Answer: O_2: two shared pairs between O atoms (double bond), total 2 shared pairs. CO_2: O=C=O with two double bonds, total 4 shared pairs (2 for each C=O).

Question 6

diagram shows three bonding pairs between the two N atoms (a triple bond) **B1**

states that 6 electrons are shared in the triple bond and that each N has one lone pair remaining **B1**

Answer: N_2: three shared pairs (6 electrons) between the two N atoms; each nitrogen retains one lone pair.

Question 7

X is consistent with a simple molecular substance, with weak forces between molecules. **B1**

Y is consistent with a giant covalent structure, with strong covalent bonds throughout. **B1**

Little energy is needed to separate X's molecules, whereas much energy is needed to overcome bonds throughout Y. **B1**

Answer: X is simple molecular with weak intermolecular forces; Y is giant covalent with strong bonds throughout. Separating X's molecules takes little energy, while overcoming bonds in Y takes much more energy.

Question 8

states that SiO_2 has a giant covalent structure where each Si is bonded to four O atoms in a continuous network **B1**

explains that strong covalent bonds throughout the giant lattice require large energy to break, giving a very high melting point **B1**

states that SiO_2 has no free charged particles to move so it does not conduct electricity **B1**

contrasts CO_2 as simple molecular with discrete CO_2 molecules with weak intermolecular forces so it is a gas at room temperature **B1**

Answer: SiO_2 is giant covalent: a continuous network of strong Si-O covalent bonds which need a lot of energy to break, so it is a hard solid with a very high melting point and it does not conduct because there are no mobile charged particles. CO_2 is made of separate linear molecules held by weak intermolecular forces, so little energy is needed to separate them and CO_2 is a gas at room temperature.

Question 9

describes graphite as layers of hexagonally arranged carbon atoms with strong covalent bonds within layers **B1**

states that each carbon has three bonds and there is a delocalised electron per carbon **B1**

explains that layers can slide over each other because of weak forces between layers, accounting for graphite being slippery and useful as a lubricant or pencil lead **B1**

explains that delocalised electrons allow graphite to conduct electricity along the layers **B1**

Answer: Graphite consists of layers of carbon atoms bonded covalently in hexagons; each carbon is bonded to three others and there are delocalised electrons. Weak forces between layers allow them to slide, making graphite slippery, and the delocalised electrons make graphite a good conductor of electricity along the layers.

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Question 10

A is graphite and B is diamond. **B1**

C is silicon dioxide and D is a simple molecular substance. **B1**

C's giant covalent structure has strong bonds throughout, while D's molecules are held together by weak intermolecular forces, explaining the contrasting melting points. **B1**

Answer: A: graphite; B: diamond; C: silicon dioxide; D: a simple molecular substance. C has strong covalent bonds throughout its giant structure, while weak intermolecular forces between D's molecules account for its low melting point.

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