04-05 Chemical Bonding and Materials

Set B **Answer key**

A Multiple choice

6 MARKS

1 **D** one atom of oxygen receives two electrons from an atom of X [1]

In XO, the ions are X^{2+} and O^{2-}. Oxygen gains two electrons from the metal.

2 **C** potassium [1]

K^+ is 2.8.8 with three shells. O^{2-}, F^- and Mg^{2+} are all 2.8, with two shells.

3 **B** PQ_2 [1]

P loses 2 electrons to form P^{2+}. Q gains 1 electron to form Q^-. Two Q^- balance one P^{2+}, so the formula is PQ_2.

4 **D** electrons only [1]

Only the delocalised electrons move. The positive ions stay in the lattice.

5 **B** 1 and 4 [1]

Only the electrons are mobile, so statement 2 is wrong. Iron has metallic bonding, not ionic bonding, so statement 3 is wrong.

6 **B** The zinc atoms prevent layers of copper atoms from slipping over each other easily. [1]

Zinc atoms are a different size from copper atoms, so they disrupt the orderly layers. A larger force is then needed to make the layers slide.

B Structured questions

34 MARKS

7 **(a)** Carbon has 4 valence electrons and prefers to share electrons rather than transfer electrons to form a bond. [1]

(b)(i) The higher the relative electron movement speed, the higher the electrical conductivity. [1]

(ii)

Each carbon atom in SWCNT is bonded to three others. [1]

Each carbon atom in diamond is bonded to four others. [1]

So SWCNT has one delocalised electron per carbon atom that can conduct electricity, but diamond has none. [1]

(c)(i)

Any two of the following: it is soluble in organic solvents, it has a low electrical conductivity of 0.00001 S per cm, it has a low melting point of 600 °C. [2]

(ii)

C_{60} [1]

(d)

SWCNT (single-walled carbon nanotube). No mark is given for the name alone.

It has the highest electrical conductivity of all the carbon allotropes. [1]

It is also flexible. [1]

8 **(a)**

Any one: high melting point, insoluble in water (but soluble in organic solvent), conducts electricity, brittle or slippery. [1]

(b)

Comparison: both buckyball and graphite have each carbon atom covalently bonded to 3 other carbon atoms, with 1 unbonded electron that is delocalised, free-moving and mobile.

Prediction: buckyball can conduct electricity. [1] [1]

9 **(a)**

Correct shared electron pairs: the oxygen atom shares one pair with each chlorine atom, making two single bonds. [1]

Correct unshared electrons: oxygen has 2 lone pairs and each chlorine atom has 3 lone pairs, so every atom has an octet. [1]

(b)

(i) False [1]

(ii) True [1]

(iii) False [1]

Aluminium chloride has a low melting point, so it is made of simple molecules with no ions to carry current.

10 **(a)**

A sodium ion with the electronic arrangement 2.8 and a hydride ion with 2 electrons, all shown, each in square brackets. [1]

The correct charges, + on sodium and – on hydrogen, outside the brackets. [1]

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Pure ethanedioic acid contains only molecules with no charge, so there are no mobile charged particles. [1]

In water, the acid forms mobile ions, which are charge carriers. [1]

12 **(a)**

5065 [1]

(b)

Low carbon steel has the highest malleability, so it can be easily moulded into the shapes of car bodies. [1]

High carbon steel has the highest tensile strength, so it can support the weight of the suspension bridge without breaking. [1]

(c)(i)

High carbon steel [1]

(ii)

It has more carbon atoms, which are a different size from iron atoms. [1]

They disrupt the orderly arrangement of the atoms more. [1]

A greater force is needed to slide the layers of atoms over one another. [1]

The idea of "more" must be present, or a maximum of 2 marks is given.

13

Flerovium has a giant metallic structure and oxygen has a simple molecular structure. [1]

Flerovium has a higher melting point than oxygen, because more energy is needed. [1]

This is to overcome the strong electrostatic forces of attraction between the positive metal ions and the sea of delocalised electrons in flerovium, compared with the weak intermolecular forces between the molecules in oxygen. [1]

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The correct electrons: Ca^{2+} with no outer electrons shown and O^{2-} with 8 outer electrons.

The correct charges and ratio: one Ca^{2+} to one O^{2-}, in square brackets. [1] [1]