Answers to Further Questions
in GCSE Chemistry for You (5th Edition)

On the following pages we show the Answers and Mark Schemes for the Further Questions on Structure and Bonding.

The answers have been prepared by an Examiner using the mark schemes published by each Examination Board.

For the Student:

⦁ It is very important that you are able to answer the questions on your own, using your own knowledge of Chemistry.
  So it is important that you have a go at the questions first, and then afterwards you can check your answers using these pages.
  If you get a question wrong, try to work out where you have made an error. Discuss it with your teacher if you are not sure.

⦁ Be aware that in some answers the mark is for the idea in your own words (not necessarily the exact words shown), whereas in other answers the number and unit must be exactly correct.

For the Teacher:

⦁ You will find these sheets useful when marking the students’ homework, or when going over the Further Questions in class.
  The Answer Sheet will also enable you to assess how much work is involved in answering the questions when planning how much homework to set.

⦁ The PDFs are available for you to hand out to the students if you wish (perhaps as part of a Revision Programme).
  As with all mark schemes there may be alternative credit-worthy statements for qualitative answers (for the idea) and this may need to be explained to your students. Quantitative answers, however, are generally more prescriptive and your students may need to be encouraged to show the exact numerical value and the appropriate unit.

Lawrie Ryan
1. **Ionic compounds**

(a) (i) 1 mark for 11; (ii) 1 mark for 17; (iii) 1 mark for neutron.

(b) (i) 1 mark for the idea that it loses one electron; (ii) 1 mark for the idea that there is no change.

(c) 1 mark for idea.

(d) 1 mark for each of the following ideas: a sodium atom has only one electron to lose and an atom of chlorine has only one electron to gain; so only one chloride ion forms for each sodium ion formed OR sodium ion has charge +1, chloride ion has charge −1; so equal numbers of ions in compound.

(e) 1 mark for each of the following ideas: a chlorine molecule is a held together by strong covalent bonds/chlorine is made up of small molecules; but there are weak forces between chlorine molecules; sodium chloride is a giant ionic structure; the ions are held together by strong forces of attraction between oppositely charged ions.

**Total 12 marks**

2. (a) 1 mark for each lithium atom loses an electron.

(b) 1 mark for each fluorine atom gains an electron.

(c) 1 mark for the idea that they are held together by strong forces of attraction between oppositely charged ions.

(d) 1 mark for idea.

(e) 1 mark for each of the following ideas: ionic compounds form giant ionic lattices; with strong forces between the oppositely charged ions.

**Total 6 marks**

3. 1 mark for B (gain an electron).

**Total 1 mark**

4. 1 mark for each of the following ideas: in Group 1 an atom has one electron in its outer shell which it loses to become an ion; in Group 2 an atom has two electrons in its outer shell which it loses to become an ion.

**Total 2 marks**

5. (a) (i) 1 mark each for: 9 protons; 10 neutrons.

(ii) 1 mark for 9 electrons.

6. (a) 1 mark for each of the following ideas: the calcium atom loses two electrons (or forms a 2+ ion or achieves an electronic structure of 2,8,8); the oxygen atom gains two electrons (or forms a 2− ion or achieves an electronic structure of 2,8).

(b) 1 mark for each of the following ideas: the ions are held together by strong forces; of attraction between oppositely charged ions.

(c) 1 mark for each of the following ideas: melt it; so that the ions are free to move.

**Total 6 marks**

7. (a) (i) 1 mark for the idea that the atom has one more electron than the ion; (ii) 1 mark for the idea that the ion has one more electron than the atom; (iii) 1 mark for idea.

(b) (i) 1 mark for the idea that the sodium ions and chloride ions are held by ionic bonds at opposite corners of a cube; (ii) 1 mark for each of the following ideas: ionic compounds form giant ionic lattices; with strong forces between the oppositely charged ions.

(iii) 1 mark for each of the following ideas: in the solid the ions are held together; and cannot move to conduct electricity.

(iv) 1 mark for each of the following ideas: melting breaks the bonds between the ions; so the ions are free to move.

**Total 10 marks**

8. 1 mark each for:

(a) FeSO₄

(b) Fe₂O₃

**Total 2 marks**
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9 (a) 1 mark for \(2Na + Cl_2 \rightarrow 2NaCl\)  
(b) 1 mark for \(Na \rightarrow Na^+ + e^-\)  
or \(Na - e^- \rightarrow Na^+\)  
**Total 2 marks**

10 (a) 1 mark for 2+  
(b) 1 mark for each of the following ideas: each atom loses; 2 electrons.  
**Total 3 marks**

11 (a) 1 mark for each of the following ideas:  
(i) a substance containing only one type of atom / atoms with the same atomic number (or number of protons)  
(ii) a substance containing more than one type of atom / element.  
(b) 1 mark for each of the following labelled features shown on the diagram:  
magnesium 2 electrons in the inner shell, 8 in the middle shell, 2 in the outer shell;  
chlorine 2 electrons in the inner shell, 8 in the middle shell, 7 in the outer shell.  
(c) 1 mark for each of the following ideas:  
the magnesium atom loses 2 electrons; from its outer shell;  
each chlorine atom gains 1 electron; to its outer shell.  
(d) 1 mark for each of the following ideas: there are strong forces of attraction; between oppositely charged ions.  
**Total 10 marks**

12 (a) 1 mark for A.  
(b) 1 mark for each of the following ideas: it has a high melting point; it conducts electricity when melted, but not when solid.  
**Total 3 marks**

▶ Covalent bonding

13 1 mark for each of the following ideas: a carbon atom has 4 electrons in its outer shell and each hydrogen atom has 1 electron in its outer shell;  
each hydrogen atom shares its electron with one of the outer electrons in the carbon atom;  
hydrogen achieves the electronic structure of helium and carbon achieves the electronic structure of neon.  
**Total 3 marks**

14 (a) 1 mark for covalent.  
(b) 1 mark for each of the following ideas: each chlorine atom shares one of its outer electrons; with one of the outer electrons of the carbon atom.  
**Total 3 marks**

15 1 mark for D.  
**Total 1 mark**

16 1 mark for each of the following labelled features shown on the diagram:  
two fluorine atoms with outer shells overlapping; each sharing one outer electron with the other.  
**Total 2 marks**

17 1 mark for each of the following labelled features shown on the diagrams:  
hydrogen atom with one electron in its outer shell, oxygen atom with six electrons in its outer shell,  
nitrogen atom with 5 electrons in its outer shell; water molecule showing 2 hydrogen atoms sharing their electron with one of the outer oxygen electrons;  
ammonia molecule with three hydrogen atoms sharing their electron with one of the outer nitrogen electrons;  
idea that in both molecules the number of electrons, including shared electrons, in the outer shell of each atom, results in it being full.  
**Total 4 marks**

18 (a) 1 mark for covalent.  
(b) 1 mark for the idea that the atoms share pairs of electrons.  
(c) 1 mark for each of the following ideas: it has a low boiling / melting point; it does not conduct electricity.  
(d) 1 mark for each of the following labelled features shown on the diagram:  
chlorine atoms with 2 electrons in the inner shell, 8 in the middle shell and 7 in the outer shell;  
hydrogen atom with 1 electron in the shell;  
chlorine and oxygen atoms;  
electron of hydrogen shared with one outer chlorine electron.  
**Total 7 marks**

19 (a) 1 mark for each of the following labelled features shown on the diagram:  
outer shell of each of the two chlorine atoms contains 7 electrons and outer shell of oxygen atom contains 6 electrons; a shared pair of electrons between each chlorine atom and the oxygen atom.  
(b) 1 mark for each of the following ideas: strong covalent bonds between the chlorine and oxygen atoms; but only weak forces between the molecules.  
**Total 4 marks**

20 (a) 1 mark for electrons.
(b) 1 mark for covalent.
(c) 1 mark for each of the following ideas:
  gas; there are strong covalent bonds between the chlorine and hydrogen atoms within each molecule; but only weak forces between the molecules.
Total 5 marks

21 (a) 1 mark for each of the following ideas:
  carbon dioxide – simple molecular structure with covalent bonding; because it has a low boiling point and is a poor conductor of electricity;
  silicon dioxide – giant covalent molecule; because it has a high melting point and is a poor conductor of electricity.
(b) 1 mark for each of the following labelled features shown on the diagram:
  4 outer electrons in one silicon atom;
  7 outer electrons in each of;
  4 chlorine atoms;
  4 shared pairs of electrons, each between a chlorine atom and the silicon atom.
Total 8 marks

22 1 mark for each of the following ideas:
  hydrogen atom with one electron in its outer shell, oxygen atom with six electrons in its outer shell,
  chlorine atom with 7 electrons in its outer shell; water molecule showing 2 hydrogen atoms sharing their electron with one of the outer oxygen electrons;
  hydrogen chloride molecule with one hydrogen atoms sharing its electron with one of the outer chlorine electrons.
Total 3 marks

23 (a) 1 mark each for:
  covalent bonding;
  the outer shells of 2 fluorine atoms overlap with the outer shell of an oxygen atom;
  each area of overlap contains a pair of electrons.
(b) 1 mark for each of the following ideas:
  strong covalent bonds between the fluorine and oxygen atoms; but only weak forces between the molecules.
Total 5 marks

24 (a) 1 mark for each of the following ideas:
  covalent bonds between carbon atoms; in a structure of many atoms / in a crystal.

25 1 mark for each of any four of the following ideas:
  giant structure / macromolecule; each silicon atom is joined to four other silicon atoms; by covalent bonds; which are strong bonds / need a lot of energy to break them; a large number of bonds need to be broken.
Total 4 marks

26 (a) (i) 1 mark for each of the following ideas:
  they are both made of carbon atoms; they both have covalent bonds;
(ii) 1 mark for each of the following ideas:
  diamond is a giant structure / diamond has all atoms interconnected by bonds; fullerene is made of molecules OR in diamond each carbon atom is bonded to 4 others, in buckminsterfullerene each carbon atom is bonded to 3 others.
(b) 1 mark for each of the following ideas:
  covalent bonds are very strong / covalent bonds need a lot of energy to break them; all bonds in diamond are covalent; fullerene has covalent bonds in molecules; but has weaker intermolecular forces / has weaker bonds between molecules.
Total 8 marks

27 (a) 1 mark for each of the following ideas:
  the electrical conductivity of single walled nanotubes is similar to that of metals; by spacing and controlling the size of the tubes they can behave as semiconductors, similar to silicon;
  catalysts atoms or molecules can be attached to the outside of nanotubes; because the nanotubes are so small, they have a very large surface area which gives a very large area of contact for the catalyst.
(b) 1 mark for each of the following ideas:
  they will deliver the drug straight to the tumour;
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and not release it elsewhere in the body; allowing much smaller doses of the drug to be used.

**Total** 7 marks

28 1 mark for **C** (form the same products when burnt).

**Total** 1 mark

29 1 mark for **B** (consists of layers that slide over one another).

**Total** 1 mark

30 1 mark for each of the following ideas:
in **graphite** the carbon atoms form three covalent bonds and there are therefore delocalised electrons which can move and conduct electricity; **there are no delocalised electrons in a diamond molecule** because each carbon atom forms four covalent bonds in a rigid structure.

**Total** 2 marks

31 (a) (i) 1 mark for carbon.
(ii) 1 mark for diamond.
(b) 1 mark for each of the following labelled features shown on the diagram:
carbon atoms arranged in hexagonal lattice; layers of atoms shown.
(c) 1 mark for the idea that there are weak forces between the layers, so it is quite easy to rub off a layer of carbon.

**Total** 5 marks

**Metals and structures**

32 1 mark each for ideas such as
(a) coins – it is malleable.
(b) pipes – it does not corrode easily.
(c) saucepans – it is a good conductor of heat.

**Total** 3 marks

33 (a) 1 mark for each of the following ideas:
they are giant structures; composed of atoms (or positive ions); held together by a ‘sea’ of delocalised electrons.
(b) 1 mark for each of the following ideas:
the delocalised electrons donated by each atom; can move.

**Total** 5 marks

34 (a) (i) 1 mark for titanium;
(ii) 1 mark for has highest melting point so will not melt when white hot / has highest electrical resistivity so will heat to white hot more easily.

(b) (i) 1 mark for each of the following ideas:
it has delocalised electrons (‘sea’ of electrons); which can move;
(ii) 1 mark for each of five of the following ideas:
its density; if it is too heavy, too much tension will be exerted on insulators etc.; its electrical conductivity; high resistivity will result in large energy transfer to the surroundings; its resistance to corrosion; protecting it from weather would be expensive; its cost – in relation to other benefits or disadvantages in its use.

**Total** 9 marks

35 (a) (i) 1 mark each for three of the following ideas:
stainless steel and aluminium both resist corrosion from oxygen well – giving a longer lasting body; aluminium is much less dense than either of the steels and would therefore lead to better fuel economy; stainless steel has much the highest tensile strength leading to greater safety; stainless steel is the best, but its high cost might mitigate against use at the lower end of the market.

(ii) 1 mark each for three of the following ideas:
stainless steel would best resist the acid gases in the exhaust fumes; the low melting point of aluminium makes it unsuitable for use with hot exhaust gases; carbon steel has by far the lowest cost, but would not last as long as the other metals in the presence of acidic exhaust gases; stainless steel is best and could be used here in spite of its high cost because of the much smaller amount of metal needed to produce an exhaust pipe.

(b) 1 mark for each of the following ideas:
in a pure metal the atoms are all the same size which allows layers of metal atoms to slide over each other; different sized atoms prevent some movement of layers of atoms; the more difficult it is for the atoms to move past each other, the harder the metal.

**Total** 9 marks

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36 (a) 1 mark for each of the following ideas:
- there are many delocalised electrons;
- metal atoms form positive ions;
- the attraction between the negative electrons and positive metal ions holds the metal together;
- no specific bonds exist between adjacent atoms / ions;
- atoms / ions can slide over each other, allowing the metal to bend.

(b) 1 mark for each of the following ideas:
- some of the electrons are free to move;
- these electrons carry the electric current;
- from left to right across the period the number of delocalised electrons increases;
- because the elements have more electrons in their outer shells to donate into the ‘sea’ of electrons.

Total 9 marks

37 1 mark each for:
(a) B;  
(b) D;  
(c) C;  
(d) A;  
(e) E.

Total 5 marks

38 1 mark each for:
(a) B  
(b) D  
(c) C  
(d) A.

Total 4 marks

39 1 mark for B (share electrons).

Total 1 mark

40 (a) 1 mark each for:
- CCl₄  
- MgCl₂

(b) 1 mark each for:
- carbon chloride – small, covalent molecule / simple molecular;  
- magnesium chloride – giant ionic structure.

Total 4 marks

41 1 mark each for:
(a) D  
(b) E  
(c) B  
(d) C.

Total 4 marks

42 (a) 1 mark each for:
(i) B  
(ii) C.

(b) 1 mark for the idea, shown on the diagram, that the ions are close together, but irregularly arranged.

Total 4 marks

43 (a) 1 mark for sulfur dioxide and carbon dioxide and nitrogen dioxide.
(b) 1 mark for calcium fluoride and sodium oxide and potassium chloride.

Total 2 marks

44 (a) (i) 1 mark for each of the following labelled features shown on the diagram:
- regular arrangement of metal atoms / ions;
- metal atoms / ions all the same size;
- free electrons in between atoms / ions.

(ii) 1 mark for either of the following ideas:
- no specific bonds exist between adjacent atoms / ions;
- atoms / ions can slide over each other, allowing the metal to be pulled into a wire.

(b) 1 mark for each of the following ideas:
- that solid magnesium chloride does not conduct electricity / its ions are fixed in position;
- but when molten the ions are free to move.

(c) (i) 1 mark for each of the following labelled features shown on the diagram:
- magnesium ion with 2 electrons in the first shell and 8 electrons in the outer shell;
- oxygen ion with 2 electrons in the first shell and 8 electrons in the outer shell;
- magnesium ion with 2+ charge and oxide ion with 2– charge.

(ii) 1 mark for the idea that it is a giant ionic compound therefore has a high melting point.

Total 10 marks

Questions 45–48
1 mark each for:
45 D (giant metallic);  
46 A (simple molecular);  
47 C (giant ionic);  
48 A (simple molecular).

Total 4 marks
