

O Level Combined Chemistry Structured

Chemical Bonding Test 2.0

Q1

Draw dot-and-cross diagrams to show the bonding in carbon dioxide and sodium oxide. Show only the outer shell electrons.

carbon dioxide

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sodium oxide

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[6]

Q2

- (a) (i) Draw 'dot and cross' diagrams to show the arrangement of electrons in carbon dioxide and water.
Show only valence electrons.
[Proton numbers: H, 1; C, 6; O, 8]

water:

- (ii) Briefly describe how the bonds are formed in a water molecule, using the 'dot and cross' diagram drawn in (a)(i).

.....
.....
.....[2]

- (iii) An isotope of carbon, ^{13}C , also forms a compound with oxygen.

Explain why the chemical compound formed has the same chemical formula as carbon dioxide.

.....
.....[1]

- (b) List three differences between the physical properties of covalent molecules and ionic compounds.

.....
.....
.....
.....[3]

Q3

- (b) Sulfur forms simple molecules which have a relative molecular mass of 256.

Suggest the formula of a sulfur molecule.

..... [1]

- (c) Sulfur reacts with hydrogen to form hydrogen sulfide, H_2S .

- (i) Draw the 'dot-and-cross' diagram to show the bonding in a molecule of hydrogen sulfide, showing the outer shell electrons.

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- (ii) State one physical property of hydrogen sulfide.

[2]

.....[1]

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Q4

Table 1.1 shows the melting points, boiling points and electrical conductivities of the five substances A to E.

Table 1.1

substance	melting point / °C	boiling point / °C	electrical conductivity	
			at room temperature	when dissolved in water
A	113	444	does not conduct	does not dissolve
B	0	100	very poor	very poor
C	803	1465	does not conduct	good
D	-5 to -10	102 to 105	good	good
E	-85	-60	does not conduct	does not dissolve

(a) Which substance is a gas at room temperature?

..... [1]

(b) Which two substances are liquids at room temperature?

..... [1]

(c) Which substance is an ionic compound?

..... [1]

(d) (i) Which substance is impure?

..... [1]

(ii) Explain your choice of answer for (d)(i).

..... [1]

Q5

Fig. 3.1 shows how the outer shell electrons are arranged in compound F.

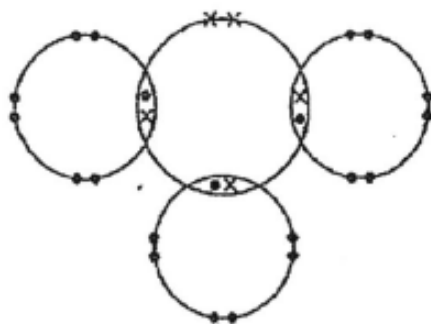


Fig. 3.1

(a) Put ticks (✓) in the boxes to show whether the following statements about compound F are true or false. [2]

	true	false
It is an unsaturated hydrocarbon		
It could be ammonia, NH ₃		
It is a halogen compound.		
It conducts electricity when molten.		

(b) Draw a dot-and-cross diagram to show the electronic structure of magnesium chloride. Show only the valence electrons. [Atomic numbers: Mg, 12; Cl: 17]

[2]

(c) Magnesium chloride has a much higher boiling point than compound F. Use your knowledge of the bonding in magnesium chloride and compound F to explain the difference in boiling point.

.....

.....

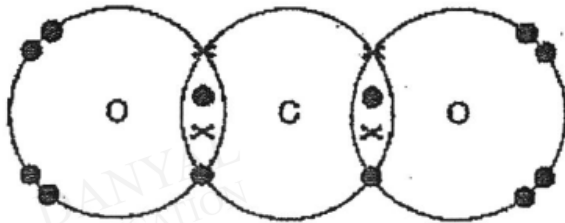
.....

.....[2]

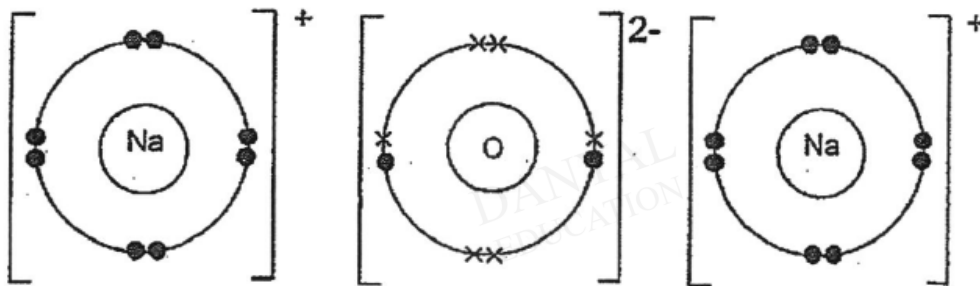
Answers

Chemical Bonding Test 2.0

Q1

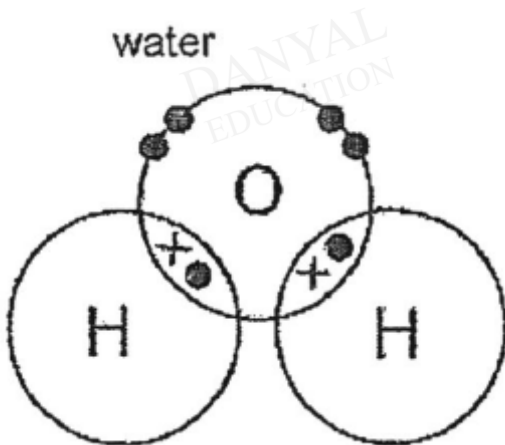


Correct number of electrons for carbon – 1m
Correct number of electrons for oxygen-1m
Covalent diagram-1m



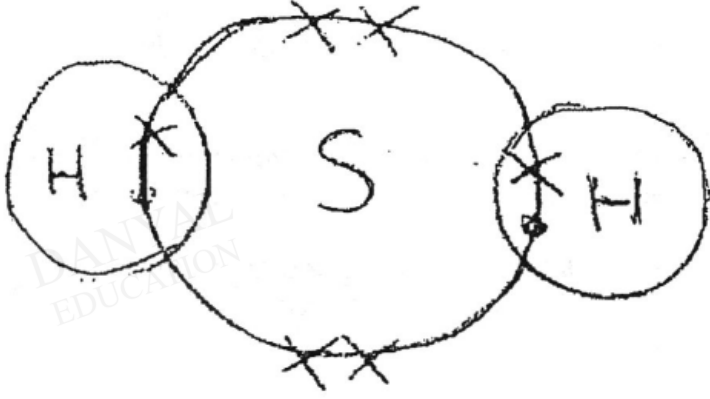
Correct sign - 1m 2 sodium atoms – 1m
Correct number of electrons – 1m

Q2



(a)(ii)	<p>Water molecules are formed by covalent bonds, where <u>oxygen atom shares one electron each with a hydrogen atom</u></p> <p>[MR: majority of students gave generic answers (covalent bonding, share electrons etc.) without reference to the water molecule. Many of them also did not state accurately how many electrons were shared between oxygen and each hydrogen atom]</p> <p>to form a <u>stable noble gas configuration</u>.</p> <p>[mark awarded here only if students show awareness of covalent compounds = sharing of electrons]</p> <p>[in general: many students started talking about the weak intermolecular forces of attraction between molecules, instead of referring to the 'dot and cross' diagram.]</p>	[1]
(a)(iii)	<p>Isotopes have <u>the same proton and electron number/same number of valence electrons</u> but different number of neutrons.</p> <p>[MR: many students only talked about the number of protons being the same or that they have similar chemical properties or stated the definition of isotopes only]</p>	[1]
(b)	<p>Ionic compounds have <u>high melting points</u>, while covalent compounds have <u>low melting points</u>.</p> <p>[MR: some students wrote about why the compounds have high melting/boiling points which was not necessary!]</p> <p>Ionic compounds are generally <u>soluble in water and insoluble in organic solvents</u>, while covalent compounds are generally <u>soluble in organic solvents and insoluble in water</u>.</p> <p>[MR: some students mixed up between ionic compound solubility and covalent compound solubility]</p> <p>[accept: soluble in water and insoluble in organic solvent, while covalent compound is opposite (meaning is same)]</p> <p>Ionic compounds can <u>conduct electricity in molten/liquid and aqueous states</u>, while covalent compounds <u>cannot conduct electricity in any state/non-conductors of electricity</u>.</p> <p>[MR: many students were not specific (e.g. ionic compounds conduct electricity while covalent compounds do not; conduct only in aqueous state etc.)]</p> <p>[In general: some students confused the physical properties with chemical properties (sharing/giving away electrons); some students also mixed up the physical properties with that of metals/non-metals (e.g. density, hard, ductile, malleable, solid at r.t.p etc.)]</p>	[1]

Q3

(b)	S ₈	[1]
(c)(i)	 <p>Key: x sulfur electron • hydrogen electron</p>	[1] for correct sharing of electron between S and H [1] for the 2 non-bonding electrons in S. Minus [1] if no key.
(c)(ii)	Low melting/boiling point; Cannot conduct electricity; Insoluble in water; Soluble in organic solvent	[1]

Q4

(a)	E	[1]
(b)	B & D	[1]
(c)	C	[1]
(d)	(i) D [1] (ii) <u>It melts and boils over a range of temperature.</u> [1] OR It does not have a fixed and sharp melting and boiling point. [1] **Reject : variable melting and boiling point or a range of melting and boiling point	[2]

Q5

(a)

	true	false
It is an unsaturated hydrocarbon		✓
It could be ammonia, NH ₃		✓
It is a halogen compound.	✓	
It conducts electricity when molten.		✓

[All correct – 2 marks; 1-3 correct – 1 mark; 0 correct – 0 mark]

(b)

For Mg²⁺ ion: [1]

- Correct charge of 2+
- Show 8 dots/ crosses

For Cl⁻ ion: [1]

- Correct charge of 1-
- Show 7 crosses and 1 dot (or vice versa)
- Show stoichiometric coefficient of 2 in front of ion

If all electron shells are drawn, deduct 1 mark throughout.

(c)

- Magnesium chloride is an ionic compound where oppositely charged ions are held at their fixed positions in a giant lattice structure by strong electrostatic forces of attraction;
- Compound F is a simple covalent molecule with weak intermolecular forces of attraction between its molecules;
- Much more energy/ heat is needed to overcome the stronger electrostatic forces of attraction in magnesium chloride, hence it has a higher boiling point.