Structure and Bonding 6 Marks - Can you apply your knowledge to answer these EXPLANATION questions?

Q1.

Explain the difference in the ability of solid sodium chloride and molten sodium chloride to conduct electricity in terms of their structures.

(6

Q2.

* Chlorine, Cl_2, is a simple molecular, covalent substance.

Diamond is a giant molecular, covalent substance.
Sodium chloride is an ionic substance.
Zinc is metallic.

As a result of their different structures these substances have the following different properties.

- Solid chlorine has a very low melting point but diamond, sodium chloride and zinc have high melting points.
- Diamond and sodium chloride have different solubilities in water.

In terms of the structure and bonding of these substances, explain these properties.

(6)

Q3.

* Sodium chloride and water have very different properties.

Sodium chloride is an ionic substance.
It is a crystalline solid at room temperature.
It has a high melting point.
It conducts electricity when molten or in aqueous solution.

Water is a covalent substance.
It is a liquid at room temperature.
It is a very poor conductor of electricity.

Explain these properties of sodium chloride and water in terms of the particles present and the forces between them.

(6)

Q4

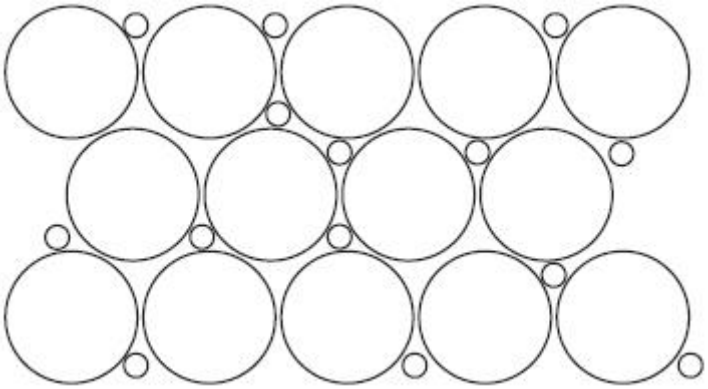
Methane is a gas at room temperature.
It exists as molecules, CH_4.
Methane has a low boiling point.
It does not conduct electricity.

Explain, in terms of the nature of its molecules and the forces between its molecules, why methane has a low boiling point and does not conduct electricity.

(6)

Q6.

* The diagram shows the structure of a metal.



Use the diagram to describe the structure of a metal and to explain why metals are malleable and conduct electricity.

(6)

Q7.

* Methane is a gas at room temperature.
It exists as molecules, CH_4.
Methane has a low boiling point.
It does not conduct electricity.

Explain, in terms of the nature of its molecules and the forces between its molecules, why methane has a low boiling point and does not conduct electricity.

(6)

Mark Scheme

Q1.

		Indicative Content	Mark
	*	A description including some of the following points **solid** regular arrangement/ lattice (of ions) sodium/Na^+ ions chloride /Cl^- ions (held together by) strong (ionic) bonds strong (electrostatic) forces of attraction between oppositely charged ions / positive and negatively charged ions closely packed together (when solid) does not conduct because ions cannot move **molten** heat energy overcomes/breaks (strong ionic) bonds strong (electrostatic) forces of attraction between oppositely charged ions / positive and negatively charged ions ions can move (therefore) conducts when molten	(6)
Level	0	No rewardable content	

l		
1	1 - 2	• a limited explanation e • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple explanation • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• a detailed explanation • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q2.

Question number		Indicative content	Mark
QWC	*	An explanation including some of the following points **chlorine** • weak intermolecular forces / weak forces between molecules • requires little energy • to separate molecules **diamond** • strong covalent bonds between all atoms • each atom bonded to four carbon atoms • requires lots of energy • to break all bonds / separate atoms **sodium chloride** • electrostatic forces of attraction between oppositely charged ions • giant ionic lattice • requires lots of energy • to separate ions **zinc** • electrostatic forces of attraction between oppositely charged metal ions and delocalised electrons • giant (metallic) lattice • requires lots of energy • to separate metal ions **solubility** • diamond does not dissolve • sodium chloride dissolves in water • water separates ions of sodium chloride / group 1 salts are soluble • water does not separate the atoms in diamond	(6)

Level	0	No rewardable content
1	1 – 2	• a limited explanation e.g. explains link between bonding between particles and melting point for one substance OR explains solubility of diamond or sodium chloride • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 – 4	• a simple explanation e.g. explains link between bonding between particles and melting point for more than one substance OR explains solubility of diamond and sodium chloride OR explains link between bonding between particles and melting point for one substance and explains solubility of diamond or sodium chloride • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 – 6	• a detailed explanation e.g. explains link between bonding between particles and melting point for more than two substances OR explains link between bonding between particles and melting point for one substance and explains solubility of diamond and sodium chloride OR explains link between bonding between particles and melting point for more than one substance and explains solubility of diamond or sodium chloride • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q3.

Question Number		Indicative Content	Mark
QWC	*	An explanation including some of the following points **Sodium chloride** • contains {charged particles/ ions} • contains Na^+ and Cl^- • (regular) giant structure/lattice (hence crystalline) • strong (electrostatic) forces (of attraction) between {ions/particles}/ strong bonds between {ions/particles}/strong ionic bonds • a lot of (heat) energy is needed to separate the {ions/particles}/ a lot of (heat) energy is needed to {overcome/ break } the {forces/ bonds/ lattice} (hence high melting point) • {ions/ charged particles} free to move (so it conducts electricity) when molten/ dissolved in water **Water** • covalent bonds between (hydrogen and oxygen) atoms/ (pair of) electrons shared between atoms • contains molecules • H_2O • simple molecular/ simple covalent • weak intermolecular forces/ weak {forces/ bonds} between {molecules/ particles} • not much energy needed to separate the {molecules/ particles}/ not much energy is needed to break the {forces/ bonds between particles} (hence liquid at room temperature) • does not contain any charged particles/ ions/ {delocalised/ free} electrons (hence does not conduct electricity)	**(6)**

Level	0	No rewardable content
1	1 - 2	• a limited explanation of one or two points e.g. water contains molecules. • the answer communicates ideas using simple language and uses limited scientific terminology. • spelling, punctuation and grammar are used with limited accuracy.
2	3 - 4	• a simple explanation of at least three points from sodium chloride or water OR a combination of three or four points from sodium chloride and water e.g. sodium chloride contains ions and water contains H_2O molecules. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately. • spelling, punctuation and grammar are used with some accuracy.
3	5 - 6	• a detailed explanation of at least five points, including at least one point from sodium chloride **and** at least one point from water e.g. sodium chloride contains ions held together by strong forces and it has a high melting point as lot of energy is needed to separate the ions, water contains molecules and has a low melting point as there are weak forces between the molecules • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately. • spelling, punctuation and grammar are used with few errors.

Q4.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	A description including carbon (1) atom(s) (1)		**(2)**

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	covalent Ignore giant molecular		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	fractional distillation (2)	distillation fractionation	**(2)**

Question Number	Answer	Acceptable answers	Mark
(c)	**A** 0.25		**(1)**

Question Number		Indicative Content	Mark
QWC	*** (d)**	A description/explanation including some of the following points content could be shown in diagram(s) **practical procedure** • ignite magnesium /put magnesium in (Bunsen) flame • use of tongs/crucible / tube or gas jar of {oxygen/air} • lift lid (to let air in)- if crucible used • magnesium burns/oxidises/exothermic reaction • (bright) white {flame/light} • white powder/ash/solid formed **bonding** • magnesium atoms have 2 electrons in the outer shell • magnesium atoms {lose/transfer} electrons • form Mg^{2+}/ions with positive charge • oxygen atoms have 6 electrons in the outer shell • oxygen atoms gain electrons • forms O^{2-}/ions with negative charge • {8 electrons in /full/complete} outer shell • two electrons transferred/gained/lost • ions with opposite charges attract each other/ Mg^{2+} attracts O^{2-} ions	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. magnesium burns / magnesium atoms lose electrons • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description e.g. magnesium burns with a white flame / magnesium forms positive ions and oxygen forms negative ions • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description including the experiment and bonding e.g. magnesium burns with a white flame, magnesium atoms give their 2 outer electrons to oxygen atoms • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

(Total for Question = 12 marks)

Q5.

	Answer	Acceptable answers	Mark
(a)(i)	covalent		**(1)**
(a)(ii)	HCl	ClH ignore subscript 1 after either or both atoms ignore any working	**(1)**
(a)(iii)	C has a low boiling point		**(1)**
(b)	$H_2 + F_2 \rightarrow 2\ HF$ correct formulae on correct sides of equation (1) balancing correct formulae (1)	accept = for → multiples reject f for F and h for H BUT allow mark for balancing completely correct equation but reversed scores 1 mark	**(2)**

		Indicative Content	Mark
	***(c)**	A description including some of the following points **molecules** si mple / small molecule separate / discrete molecules covalent bonds (between atoms in molecule) displayed structure for CH_4 weak forces between molecules **properties** to boil need to separate molecules little energy needed (as weak forces between molecules) therefore low boiling point to be able to conduct must have charged particles which must be free to move no charged particles present no	**(6)**

		delocalised /free electrons / no ions present all electrons are in covalent bonds therefore does not conduct electricity / cannot carry current	
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. methane is a simple / small molecule e.g. weak forces between molecules • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description e.g. methane is a simple / small molecule with weak forces between molecules (so low boiling point) e.g. it is covalent / there are no charged particles (ions or free electrons) to move and carry the current • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description e.g. methane is a simple / small molecule with weak forces between molecules (so low boiling point) AND any mention of lack of charged particles e.g. does not conduct electricity because it is covalent /there are no charged particles (ions or free electrons) to move and carry the current AND any mention of separate molecules or weak forces between them • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Q6.

Question Number		Indicative Content	Mark
QWC	*	A description / explanation including some of the following points **CREDIT CAN BE GIVEN FOR LABELS/ANNOTATIONS ON DIAGRAM** **Structure of a metal** • positive ions/cations/atoms • in regular arrangement/lattice • delocalised/sea of electrons **Metals are malleable** • malleable means can be bent/hammered into shape because • rows/sheets/layers of ions/ atoms • slide over each other • electrons fill spaces **Metals conduct electricity** • free electrons • (electrons) can move/flow • through structure • (electrons) transfer charge	**(6)**

Level	**0**	No rewardable content
1	**1 - 2**	• a limited description eg a limited description of one of structure, malleability, and conduction • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description eg a limited description of **two** from structure, malleability and conduction **OR** an explanation of **one** of structure, malleability and conduction • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed description eg a description of all three of structure, malleability, and conduction **OR** a detailed explanation of one of them and a limited description of another • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q7.

		Indicative Content	Mark
	*	A description including some of the following points **molecules** simple / small molecule separate / discrete molecules covalent bonds (between atoms in molecule) displayed structure for CH_4 weak forces between molecules **properties** to boil need to separate molecules little energy needed (as weak forces between molecules) therefore low boiling point to be able to conduct must have charged particles which must be free to move no charged particles present no delocalised /free electrons / no ions present all electrons are in covalent bonds therefore does not conduct electricity / cannot carry current	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. methane is a simple / small molecule e.g. weak forces between molecules • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**		

		• a simple description e.g. methane is a simple / small molecule with weak forces between molecules (so low boiling point) e.g. it is covalent / there are no charged particles (ions or free electrons) to move and carry the current • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed description e.g. methane is a simple / small molecule with weak forces between molecules (so low boiling point) AND any mention of lack of charged particles e.g. does not conduct electricity because it is covalent /there are no charged particles (ions or free electrons) to move and carry the current AND any mention of separate molecules or weak forces between them • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors