

1.1		max 2 for incorrect reference to particles or bonds		AO1 5.2.3.1
	covalent bonds		1	
	giant structure / macromolecule	allow each C has 4 bonds allow giant covalent structure for 2 marks allow giant ionic / lattice structure for 1 mark ignore lattice	1	
	lots of <u>energy</u> needed to break / overcome	allow disrupt structure ignore heat and high temperature if no other marks awarded allow 1 mark for strong / many bonds	1	

1.2		max 2 for incorrect reference to particles or bonds		AO1 5.2.2.3
	dissolved (in water) or aqueous	allow in solution	1	
	molten / liquid		1	
	so ions are mobile or free moving		1	

1.3	<u>delocalised</u> electrons (from outer shell) (free to) move energy transferred (through structure)	max 2 for incorrect reference to particles or bonds ignore conducts thermal energy ignore electricity if no other mark awarded allow 1 mark for ions / atoms vibrate	1 1 1	AO1 5.2.1.5 5.2.2.8
Total			9	

2.1		max 2 marks for incorrect reference to bonding or structure or particles		AO1 5.2.2.3
	(giant) lattice	allow giant structure	1	
	ionic		1	
	strong bonds or strong electrostatic forces	do not accept strong intermolecular forces / bonds	1	
	large amounts of energy needed to overcome	ignore heat	1	
Total			9	

3.1		allow free electrons for delocalised electrons		AO1 4.2.3.2
	each carbon / atom forms 3 (covalent) bonds		1	
	one electron per carbon / atom is delocalised		1	
	(so) these electrons carry charge through the graphite or (so) these electrons move through the structure	ignore carry current / electricity	1	
		if no other mark scored, allow 1 mark for delocalised / free electrons		

4.1	hydrogen chloride is made of small molecules	allow hydrogen chloride is simple molecular	1	AO1 4.1.2.6 4.2.1.4 4.2.2.4
	(so hydrogen chloride) has weak intermolecular forces	do not accept reference to bonds breaking unless applied to intermolecular bonds	1	
	(intermolecular forces) require little energy to overcome		1	

5.1	metal chlorides are usually ionic	allow titanium chloride is ionic	1	AO1 4.1.2.6 4.1.3.1 4.2.1.2 4.2.2.3 4.2.2.4
	(so)(metal chlorides) are solid at room temperature or (so)(metal chlorides) have high melting points	allow titanium chloride for metal chlorides	1	
	(because) they have strong (electrostatic) forces between the ions or (but) must be a small molecule or covalent	ignore strong ionic bonds allow molecular allow alternative approach: titanium chloride must be covalent or has small molecules (1) with weak forces between molecules do not accept bonds unless intermolecular bonds(1) (but) metal chlorides are usually ionic (1)	1	

6.1	weak forces between the molecules or weak intermolecular forces	allow weak intermolecular bonds do not accept incorrect references to covalent bonds	1	AO1 AO3 5.1.2.6 5.2.2.4
	(so) little energy required to overcome / break the forces between molecules or (so) little energy required to overcome / break the intermolecular forces	allow (so) little energy required to separate the molecules allow (so) little energy required to overcome / break the intermolecular bonds ignore less energy	1	

7.1	Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 AO2
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	

Indicative content

	sodium chloride	hydrogen chloride
differences in bonding	ionic	covalent
	metal & non-metal	two non-metals
	transferring electrons	sharing electrons
	ions (Na^+ and Cl^-)	molecules
	charged particles	neutral or no overall charge
differences in structure	giant structure or lattice	small / simple / discrete molecules
	electrostatic	intermolecular forces
	(electrostatic forces) are strong	(intermolecular forces) are weak
	act in all directions	random or between the molecules
	regular	irregular / random
similarities in bonding	full shells or stability	full shells or stability
	(transferring) electrons	(sharing) electrons
	strong bonds	strong (covalent) bonds
similarities in structure	(electrostatic) forces	(intermolecular) forces

ignore properties eg melting points, conduct electricity

to access level 2 there must be a comparison of the structure **and** bonding **and** magnitude of both sodium chloride **and** hydrogen chloride.

8.1		nanotube ignore throughout for through ignore current / electricity for charge		
Question	Answers		Mark	AO / Spec. Ref.

8.2	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 4.2.2.7 4.2.3.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • wood is the least dense so lightest to use • aluminium is the most dense so will make the racket too heavy • carbon nanotube is the strongest so least likely to break • wood / aluminium are too weak so the racket will break more easily • carbon nanotube is the stiffest so least likely to bend out of shape • wood / aluminium are not very stiff so could bend out of shape • justified conclusion		

8.3	$= 4.0 \times 10^4 \text{ (nm}^2\text{)}$	allow correct calculation using incorrectly calculated value of area of one face from step 1 allow $4.0344 \times 10^4 \text{ (nm}^2\text{)}$ correctly rounded to 1 or more significant figures allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area	1	
	any one from:	allow converse statements about fine particles	1	AO3 4.2.4.2

8.4	any one from: • less can be used (for the same effect) • greater surface area (to volume ratio)	ignore nanoparticles are smaller	1	
total			10	

9.1	(so) little energy is needed to overcome the intermolecular forces	allow (so) little energy is needed to break the intermolecular bonds allow (so) little energy is needed to separate the molecules do not accept references to breaking covalent bonds	1	
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10.1	(delocalised) electron(s)		1	AO1
	ion(s)		1	AO2
	(delocalised) electron(s)		1	AO1
				5.2.2.3 5.2.2.8 5.2.3.2
Total			9	

11.1	weak	allow weaker	1	AO1 5.2.2.4

11.2	4		1	AO1 5.2.3.1

11.3	any two from: • (very) hard • (very) high melting point • does not conduct electricity	allow strong allow high thermal conductivity ignore shiny	2	AO1 5.2.3.1
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11.4	graphite	allow graphene	1	AO1 5.2.2.6
	silicon dioxide	allow silica	1	
		allow silicon		
		allow polymer(s) or allow (named) polymer(s)		
		allow fullerene or allow carbon nanotubes		
		ignore buckminsterfullerene		
Total			8	

12.1	the boiling point increases as the number of (carbon) atoms increases (because the weak) intermolecular forces increase or (because the weak) forces between the molecules increase (and these intermolecular forces increase) as the size of the molecules increases	max 2 marks for incorrect reference to particles / bonds allow converse	1 1 1	AO1 AO2 AO3 5.2.2.4 5.7.1.3
		MPS dependent on correct		

13.1	poly(ethene)		1	AO2
	water		1	4.2.1.4 4.2.2.4 4.2.2.5

13.2	Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 4.2.1.2 4.2.1.3 4.2.1.4
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	
	Indicative content • (both) carbon dioxide and silicon dioxide are made up of atoms • (but) magnesium oxide is made up of ions • (both) silicon dioxide and magnesium oxide are giant structures • (but) carbon dioxide is small molecules • with weak intermolecular forces • all three compounds have strong bonds • (both) carbon dioxide and silicon dioxide are formed from two non-metals • (so) bonds formed are covalent • (so) electron (pairs) are shared (between atoms) • (but) magnesium oxide is formed from a metal and a non-metal • (so) bonds in magnesium oxide are ionic • (so) electrons are transferred • from magnesium to oxygen • two electrons are transferred • bonds in silicon dioxide are single bonds • (where) each silicon forms four bonds • (and) each oxygen forms two bonds • (but) in carbon dioxide the bonds are double bonds • (where) carbon forms two double bonds • (and) oxygen forms one double bond ignore properties e.g. melting point, electrical conductivity		
Total			8

14.1	(boiling point) increases (down the table / group)		1	AO1 4.1.2.6 4.2.2.1 4.2.2.4
	(because) the relative formula / molecular mass increases or (because) the size of the molecule increases		1	
	(so) the intermolecular forces increase (in strength)	allow (so) the forces between molecules increase (in strength)	1	
	(so) more energy is needed to overcome the intermolecular forces	allow (so) more energy is needed to separate the molecules do not accept a reference to breaking bonds unless specifically between molecules	1	

15.1	C ₆₀		1	AO1 5.2.3.3

15.2	(graphite has) delocalised electrons (so the delocalised electrons) carry electrical charge through the structure		1 1	AO1 5.2.3.2

15.3	carbon atoms have different sizes to iron atoms / ions		1	AO1 5.2.2.7
	(so carbon atoms) distort the layers of iron atoms / ions		1	
	(therefore) the layers cannot slide		1	

16.1	Level 2: Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4–6	AO3
	Level 1: Relevant features are identified and differences noted.	1–3	AO1 AO2
	No relevant content	0	
	Indicative content - methane has 1 carbon atom, hexane has 6 - methane has 4 hydrogen atoms, hexane has 14 - both contain C – H bonds - only hexane contains C – C bonds - both are hydrocarbons - hexane has a higher melting point than methane (or converse) - hexane has a higher boiling point than methane (or converse) - methane is a gas at room temperature - hexane is a liquid at room temperature - both are small molecules - hexane has larger molecules than methane - weak forces between molecules - forces between hexane molecules stronger than between methane molecules - hexane is more viscous than methane - both are flammable - methane is more flammable than hexane (or converse) - possible products of combustion from both are: carbon, carbon monoxide, carbon dioxide, water - neither conduct electricity		5.2.2.4 5.7.1.1 5.7.1.3

17.1	spherical	allow ball-shaped ignore round / circular	1	AO1 4.2.3.3
Question	Answers	Extra information	Mark	AO / Spec. Ref.

17.2	any one from: • drug delivery (round the body) • hydrogen storage • anti-oxidants • reduction of bacterial growth • catalysts • (cylindrical fullerenes for) strengthening materials • (spherical fullerenes for) lubricants		1	AO1 4.2.3.3
Question	Answers	Extra information	Mark	AO / Spec. Ref.

17.3	the intermolecular forces are weak		1	AO1 4.2.2.1 4.2.2.4
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Question	Answers	Mark	AO/ Spec. Ref

17.4	Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.2.2.6 4.2.3.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • bonds are covalent • giant / macromolecular structure • three (covalent) bonds per carbon atom - or - only three electrons per carbon atom used in (covalent) bonds • so one electron per carbon atom (is delocalised) • these delocalised electrons • can move through the structure • carrying (electrical) charge • so graphite conducts electricity • layered structure • of (interlocking) hexagonal rings • with weak (intermolecular) forces between layers - or - no (covalent) bonds between layers • so the layers can slide over each other • so graphite is soft and slippery		
Total			11

18.1	giant structure	allow (giant ionic) lattice	1	AO1 4.2.1.3 4.2.2.1 4.2.2.3
	(with) strong (electrostatic) forces of attraction between (oppositely charged) ions		1	
	(so) large amounts of energy are needed to break the bonds / forces	allow (so) large amounts of energy are needed to separate the ions	1	
Total			16	

19.1	C		1	AO3 4.2.2.7 4.2.2.8
Question	Answers	Extra information	Mark	AO / Spec. Ref.

19.2	(in an alloy) the atoms are of different sizes (so) the layers (of atoms in an alloy) are distorted (so in an alloy) the layers slide over each other less easily (than in a pure metal)		1 1 1	AO1 4.2.2.7
Question	Answers	Extra information	Mark	AO / Spec. Ref.

20.1	(the) molecules increase in size going down the group	allow converse explanation in terms of decreasing melting point allow atoms increase in size going down the group allow increase in number of electron shells going down group	1	AO3
	(so the) forces between the molecules increase or (so the) intermolecular forces increase		1	AO1
	(so the) melting points increase going down the group or (so the) melting points increase with increasing relative atomic mass	allow (so) more energy is needed to separate the molecules	1	AO1 5.1.2.6 5.2.2.4
Question	Answers	Extra information	Mark	AO / Spec. Ref.

21.1	fullerene	allow (carbon) nanotube do not accept Buckminsterfullerene	1	AO1 5.2.3.3
Question	Answers	Extra information	Mark	AO / Spec. Ref.

21.2	any one from: • conducts heat • conducts electricity • very high length to diameter ratio	allow large surface area to volume ratio allow high tensile strength allow can trap other molecules / atoms / ions	1	AO2 5.2.3.3
Question	Answers	Extra information	Mark	AO / Spec. Ref.

21.3	other metal atoms have different sizes to aluminium atoms		1	AO1 5.2.2.7
	(so) the layers of aluminium atoms are distorted		1	
	(so) the layers cannot slide	allow (so) the atoms cannot slide over each other	1	
	(which) makes the alloy harder	allow (which) makes the alloy stronger	1	

21.4	covalent bonds (between atoms) in the chain		1	AO1 5.2.2.5
	intermolecular forces between the chains		1	
	covalent bonds are strong and intermolecular forces are weak		1	
otal Question 5			9	

22.1	delocalised electrons	allow free electrons	1	AO1 5.2.2.8
	carry (electrical) charge through the metal / sodium	ignore throughout for through ignore current / electricity MP2 is dependent upon MP1	1	
Question	Answers	Extra information	Mark	AO / Spec. Ref.

22.2	(conducts electricity) when liquid / molten or (conducts electricity) in (aqueous) solution	allow (conducts electricity) when dissolved in water	1	AO1 5.2.2.3
	(because) <u>ions</u>		1	
	(ions) are free to move or (ions) allow charge to flow		1	
total Question 7			17	

23.1	delocalised electrons	allow free electrons	1	AO1 4.2.1.5 4.2.2.8
	(the electrons) carry (electrical) charge	ignore current / electricity for charge	1	
	(the electrons move) through the metal / aluminium / structure	ignore throughout for through	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.

23.2	ionic		1	AO1 4.2.1.1
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24.1	giant structure	allow macromolecular allow (giant) lattice	1	AO1 4.2.3.1
	covalent (bonds)		1	
	four bonds per carbon / atom		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.

24.2	(covalent) bonds are strong		1	AO1
	(and many covalent) bonds must be broken		1	4.2.2.1 4.2.2.6 4.2.3.1
	(so) a lot of energy is required		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.

24.3	fullerene		1	AO1 4.2.3.3
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24.4	any one from: • (C₇₀ is) hollow • (C₇₀ is) unreactive • (C₇₀ is) not toxic • (C₇₀ has) a large surface area to volume ratio	ignore references to ease of movement around the body allow (C ₇₀) acts as a cage allow (C ₇₀) traps the drug	1	AO3 4.2.3.3
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Question	Answers	Extra information	Mark	AO / Spec. Ref.

25.1	ions are not free to move		1	AO1 5.2.2.3 5.4.3.1
Question	Answers	Extra information	Mark	AO / Spec. Ref.

26.1	fullerenes and graphene		1	AO1 5.2.3.3
Question	Answers	Extra information	Mark	AO / Spec. Ref.

26.2	delocalised electrons		1	AO1
	(which) move through the structure		1	5.2.1.5 5.2.2.8
	(and) transfer energy		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.

26.3	strong (electrostatic) forces of attraction		1	AO1 5.2.1.3 5.2.2.3
	(between the) oppositely charged ions		1	
	(so) large amounts of energy needed to break the many / strong bonds / forces	allow (so) large amounts of energy needed to break the bonds / forces in all directions allow (so) large amounts of energy needed to break the bonds in the lattice	1	

26.4	small molecules	allow simple molecules	1	AO1 5.2.1.4 5.2.2.4
	(with) weak forces between the molecules or (with) weak intermolecular forces	allow (with) weak intermolecular bonds do not accept incorrect references to covalent bonds	1	
	(so) little energy required to overcome / break the forces between molecules or (so) little energy required to overcome / break the intermolecular forces	allow (so) little energy required to separate the molecules allow (so) little energy required to overcome / break the intermolecular bonds ignore less energy	1	
otal Question 7			10	

27.1	(methane) methane has (much) smaller molecules (so) has weaker intermolecular forces (so the intermolecular forces) need less energy to overcome (so) the boiling / melting point is lower (and methane is a gas) OR (poly(ethene)) poly(ethene) has (much) larger molecules (1) (so) has stronger intermolecular forces (1) (so the intermolecular forces) need more energy to break (1) (so) the melting / boiling point is higher (and poly(ethene) is a solid) (1)	do not accept reference to weak(er) covalent bonds do not accept reference to breaking covalent bonds do not accept reference to weak(er) covalent bonds do not accept reference to breaking covalent bonds	1 1 1 1	AO1 4.2.2.4 4.2.2.5
Total Question 4				12

28.1	Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3 4.2.2.7 4.2.2.8 4.4.1.2
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content relevant points - silver is the best electrical conductor - aluminium is the least dense - aluminium is the least expensive - copper is a better conductor than aluminium or copper is almost as good a conductor as silver - copper is much less expensive than silver - overhead power cables need a low density metal - wiring in homes needs to be affordable - printed circuit boards only require small amounts of material judgements - use aluminium for overhead wires because of aluminium's low density and/or lower cost - use copper for domestic wiring because copper is a very good conductor and not too expensive - use silver only for small uses such as circuit boards due to high cost - copper is a good compromise between electrical conductivity and cost		

28.2	(metals have) delocalised electrons		1	AO1 4.2.1.5 4.2.2.8
	the electrons carry (electrical) charge	ignore current / electricity for charge	1	
	the electrons move through the structure / metal	ignore throughout for through	1	
Question	Answers	Extra information	Mark	AO / Spec. Ref.

28.3	in alloys different sized atoms distort the layers / structure (so) the movement of (delocalised) electrons is restricted		1 1	AO3 4.2.2.7 4.2.2.8
Total Question 6			9	

29.1	(nanoparticles) any two from: • have a higher surface area to volume ratio • less (material) needed (for the same effect) • more light gets through	allow converse arguments for fine particles allow a thinner coating is needed	2	AO3 4.2.4.2
Question	Answers	Extra information	Mark	AO / Spec. Ref.