Separate Science (Chemistry) Unit 2 Bonding structure and properties of matter – mark scheme

Foundation

Question number	Description	Marks	Page number
4.2.1 Chemical bonds, ionic covalent and metallic			
1	Identifying bonding type from diagrams multiple choice, (4.4.3 electrolysis gap fills, and statement/reason box matching)	10	3
5	State symbol for oxygen at room temperature, percentage by mass from a pie chart, calculating a mean from a results table to 3 significant figures , completing dot and cross diagram for H_2O, bonding gap fill, (4.2.2 comparing boiling points of molecule gap fill using relative sizes from a diagram)	10	4
4.2.2 How bonding and structure are related to the properties of substances			
2	Ratio of metal atoms in an alloy diagram, multiple choice based on calculated ratio, electron structure of silicon multiple choice, identifying bonding in silicon dioxide from diagram, identifying number of atoms bonding in diagram, state symbol for silicon dioxide at room temperature.	8	6
4	Reading values from a graph, completing bar graph for metals in an alloy, ratio calculation of metals in alloy based on values read from graph, defining alloy, reason why alloys are used rather than pure metals, metallic metals multiple choice.		7

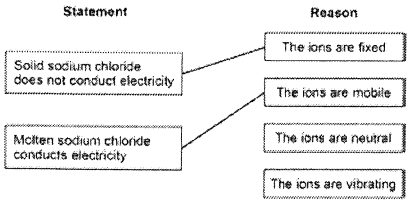
Common content

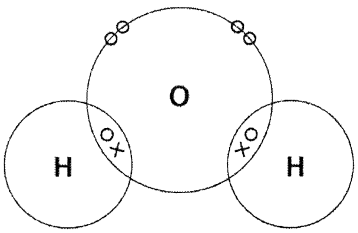
Question number	Description	Marks	Page number
4.2.1 Chemical bonds, ionic covalent and metallic			
2	(4.2.1 comparing electronic structure of sodium an chlorine, positions in periodic table are given), describing electron transfer when sodium and chlorine react (4.5.1 completing reaction profile for exothermic reaction)	8	8

4.2.3 Structure and bonding of carbon			
9	Converting metres in standard form to nanometres, use of graphene multiple choice, suggest reason graphene more suitable than graphite for electronics, explain why graphite conducts electricity and is slippery (6 marks)	9	10
4.2.4 Bulk and surface properties of matter including nanoparticles			
3	Explain why carbon nanotubes conduct electricity, evaluate information in a table on the use of aluminium, carbon nanotube and wood for making badminton racket frames, calculating the surface are of a nanoparticle, suggesting reason it costs less to use nanoparticles that fine particle sin sun cream.	10	12

Higher

Question number	Description	Marks	Page number
4.2.1 Chemical bonds, ionic covalent and metallic			
7	Recall value of Avogadro constant, ratio calculation the mass of copper in g in 1kg of a sample when told 70ng of copper in 1g of sample answer in standard form, empirical formula of silicon dioxide from diagram, describe the structure and bonding in silicon dioxide	11	14
4.2.2 How bonding and structure are related to the properties of substances			
5	Explain conditions need for sodium chloride needed to conduct electricity, describe how sodium conducts thermal energy (question continued in 4.2.3)	3	15
4.2.3 Structure and bonding of carbon			
5	(Question continued form 4.2.3) explain why diamond has a high meting point	3	15

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	ionic		1	AO1 5.2.1.3
01.2	a molecule		1	AO1 5.2.1.4
01.3	a fullerene		1	AO1 5.2.3.3
01.4	covalent		1	AO1 5.2.3.2
01.5	1		1	AO1 5.2.3.2
01.6	solid		1	AO1 5.2.2.8
01.7	electrons		1	AO1 5.2.2.8
01.8	dissolved		1	AO1 5.2.2.3
01.9		do **not** accept if more than 1 line from 1 box	1 1	AO1 5.2.2.3
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(g)	allow g ignore formulae	1	AO1 5.2.2.2
05.2	40 (%)		1	AO2 5.1.1.1
05.3		an answer of 3.94 (g) scores **3** marks		AO2 5.3.1.3
	$\frac{3.76 + 3.98 + 4.09}{3}$ **or** $\frac{11.83}{3}$		1	
	= 3.943(333333333333333333)		1	
	= 3.94 (g)	allow a correctly written answer to 3 significant figures from an incorrectly calculated mean	1	
05.4		allow combination of circles, dots, crosses or $e^{(-)}$		AO1 5.2.1.4
	one shared pair in each overlap	do **not** accept extra electron(s) on outer shell of hydrogen	1	
	4 non-bonding electrons in outer shell of oxygen	ignore any inner shell electrons	1	
		 diagram scores 2 marks		

05.5	covalent		1	AO1 5.2.2.1 5.2.2.4

05.6	higher (than) stronger (than between oxygen molecules)		1 1	AO2 5.2.2.4

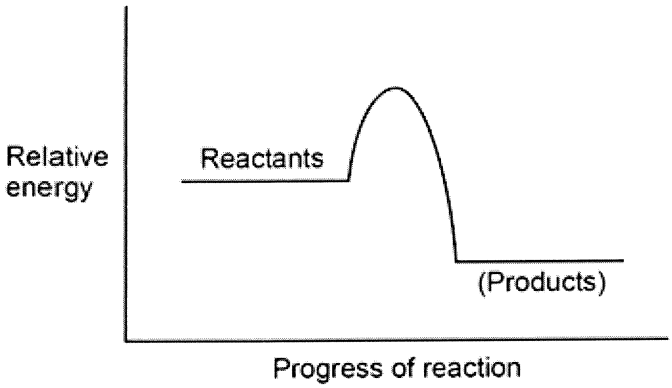
Total			**10**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	9 : 1	must be in this order allow 18 : 2	1	AO2 4.6.2.7
02.2	an alloy		1	AO1 4.6.2.7
02.3	7×10^{-8} kg		1	AO2 4.6.2
02.4	2,8,4		1	AO2 4.5.1.1
02.5	covalent strong		1 1	AO1 4.6.2.4 4.6.2.5
02.6	2		1	AO2 4.6.2.4 4.6.2.5
02.7	(s)		1	AO2 4.5.2.1 4.6.2.5
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	iron = 60 (g) **and** nickel = 6 (g)	both required for a mark	1	AO2 4.6.2.7
04.2	14 (g) bar drawn at 14 g	allow ecf from question **04.1** allow an incorrectly calculated value for mass of chromium correctly drawn allow a tolerance of ± half a small square	1 1	AO2 4.6.2.7
04.3	600 (g)	allow ecf from question **04.1**	1	AO2 4.6.2.7
04.4	mixture of metals	allow a mixture of elements with at least one being a metal	1	AO1 4.6.2.7
04.5	alloys are harder	allow alloys are stronger allow alloys can be designed for specific purposes allow alloys are corrosion resistant ignore references to cost, reactivity	1	AO1 4.6.2.7
04.6	cobalt		1	AO1 4.6.3.2
04.7	permanent		1	AO1 4.6.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(difference) sodium has one and chlorine has seven electrons in outer level / shell **or** number of electrons	number of electrons must be correct if quoted	1	AO2 5.1.1.7 5.1.2.1
	(similarity) both have three / same number of levels / shells **or** have electrons in third level / shell **or** both have incomplete (outer) levels / shells	allow both have 2 electrons in inner shell **or** both have 8 electrons in second shell **or** both are one electron away from full outer level / shell	1	
02.2		allow marks from suitable diagram(s)		AO1 5.2.1.2
	sodium (atom) loses	allow moves / transfers for loses do **not** accept sodium ion loses	1	
	one (outer shell electron)		1	
	chlorine (atom) gains	do **not** accept chloride	1	
	one (electron)		1	
		transfer of 1 electron from chlorine to sodium **max 2** marks reference to sharing **or** covalent bonding **max 3** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3		ignore labels any curve / line going up and then down products line below reactants allow curve to start / finish anywhere along reactant / product lines	1 1	AO1 5.5.1.2
Total			**8**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	0.34 nm		1	AO2 4.8.1.1
09.2	in composites		1	AO1 4.8.1.1
09.3	(graphene) any **one** from: • better conductor (of electricity) • allows greater miniaturisation of electronic circuits • stronger • harder • more flexible	must be comparative allow converse for graphite allow thinner	1	AO3 4.8.1.1

Question	Answers	Mark	AO / Spec. Ref.
09.4	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.6.2.4 4.6.2.5 4.8.1.1 4.8.2.6
	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 **Structure and bonding** • giant structure / lattice • of carbon atoms • in layers • of hexagonal rings • covalent (bonds) • strong (covalent) bonds • where each (carbon) atom bonded to three other (carbon) atoms • one electron on each atom is delocalised • delocalised / free electrons **Explanation for conductivity** • delocalised / free electrons • (which) carry charge through the structure **or** • (which) move through the structure **Explanation for graphite being slippery** • layers free to slide over each other • (because) no covalent bonds between layers **or** (because) only weak (intermolecular) forces between layers		

Total			9

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	contain delocalised electrons (so) electrons can move through the structure / nanotube	allow contain free electrons allow (so) electrons can carry charge through the structure / nanotube ignore throughout for through ignore current / electricity for charge	1 1	AO1 4.2.3.3

Question	Answers	Mark	AO / Spec. Ref.
03.2	**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		

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		an answer of 4.0 x 10^4 (nm^2) scores **3** marks an answer of 40344 (nm^2) scores **2** marks		AO2 4.2.4.1
	(82^2 =) 6724 (nm^2)		1	
	(6 x 6724 =) 40344 (nm^2)	allow 40344 (nm^2) correctly rounded to any number of significant figures allow correct calculation using incorrectly calculated value of area of one face from step 1	1	
	= 4.0 x 10^4 (nm^2)	allow 4.0344 x 10^4 (nm^2) 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	
03.4	any **one** from: • less can be used (for the same effect) • greater surface area (to volume ratio)	allow converse statements about fine particles ignore nanoparticles are smaller	1	AO3 4.2.4.2
Total			**10**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	atoms in the alloy are different sizes		1	AO1 4.6.2.7
	(so) structure / layers distorted		1	
	(therefore) it is (more) difficult for layers / atoms to slide over each other		1	
07.2	8.86 : 1.00		1	AO2 4.5.2.4
07.3	6.02×10^{23} per mole		1	AO1 4.5.2.4
07.4		an answer of $7(.0) \times 10^{-5}$ (g) scores **2** marks an answer of 0.00007 **or** 7×10^{-8} (g) scores **1** mark		AO2 4.5.2.4
	$70 \times 10^{-9} \times 1000$	allow 70×10^{-6}	1	
	$= 7.0 \times 10^{-5}$ (g)		1	
07.5	SiO_2		1	AO2 4.6.2.4 4.6.2.5
07.6		a maximum of **2** marks if reference made to incorrect bonding		AO1 4.6.2.4 4.6.2.5
	any **three** from: • giant structure • covalent (bonds) • strong bonds • each silicon atom bonded to four oxygen atoms **or** each oxygen atom bonded to two silicon atoms	allow lattice ignore forces	3	
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		**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 energy needed to break / overcome	allow disrupt structure ignore heat and high temperature	1	
		if no other marks awarded allow **1** mark for strong / many bonds		
05.2		**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	
05.3		**max 2** for incorrect reference to particles or bonds		AO1 5.2.1.5 5.2.2.8
	delocalised electrons (from outer shell)		1	
	(free to) move		1	
	energy transferred (through structure)	ignore conducts thermal energy ignore electricity	1	
		if no other mark awarded allow **1** mark for ions / atoms vibrate		
Total			**9**	