OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



MARK SCHEME

C2.3 PROPERTIES OF MATERIALS

SCORE	PERCENTAGE
/179	%

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Question			Answer/Indicative content	Marks	Guidance
1		i	To allow a comparison between with and without the added substance (1)	1	
		ii	Idea that the rate of reaction will change if concentration is changed (1)	1	It is a fair test is not sufficient **ALLOW** if concentration is increased the rate of reaction is increased **ALLOW** to ensure there are the same number of acid particles present / same number of acid particles per unit volume
		iii	Copper Because the reaction is faster (1) There is no change in appearance (1)	2	**No** marks for copper on its own If substance other than copper given then 0 marks for the question
		iv	Measure mass of catalyst before and after (1)	1	
		v	(Relative rate) between above 1 and below 10 because of smaller surface area / less exposed particles / less collisions (2)	2	**No** marks for the prediction on its own **No** marks for whole question if prediction incorrect
			Total	**7**	
2			D	1	
			Total	**1**	
3			D	1	
			Total	**1**	
4			B	1	
			Total	**1**	
5	a		**graphite** – has a layered structure (1) electrons can move / electrons between layers or delocalised (1) **diamond** – no free electrons or ions (1)	3	
	b		it can bond to itself (and make chains and rings) (1)	1	
	c		liquid (1) liquid above –114 °C and does not boil until 78 °C (1)	2	

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Question			Answer/Indicative content	Marks	Guidance
			Total	6	
6	a		strong electrostatic force of attraction between ions (1) must be broken to melt sodium chloride (1)	2	
	b		weak intermolecular forces / weak forces between molecules (1) easily broken (1)	2	
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
7		i	To allow a comparison between with and without the added substance (1)	1	
		ii	Idea that the rate of reaction will change if concentration is changed (1)	1	It is a fair test is not sufficient **ALLOW** if concentration is increased the rate of reaction is increased **ALLOW** to ensure there are the same number of acid particles present / same number of acid particles per unit volume
		iii	Copper Because the reaction is faster (1) There is no change in appearance (1)	2	**No** marks for copper on its own If substance other than copper given then 0 marks for the question
		iv	Measure mass of catalyst before and after (1)	1	
		v	(Relative rate) between above 1 and below 10 because of smaller surface area / less exposed particles / less collisions (2)	2	**No** marks for the prediction on its own **No** marks for whole question if prediction incorrect
			Total	**7**	
8			A	1	
			Total	**1**	
9			C	1	
			Total	**1**	
10			Idea that thermometer should remain in reaction mixture for temperature at end (1) otherwise temperature at end will be inaccurate (1)	2	**ALLOW** do not stir with thermometer (1) as it is fragile (1) **ALLOW** lag the beaker (1) to reduce energy loss (1)
			Total	**4**	
11	a		During this reaction, the oxidising agent is **oxygen** and the reducing agent is **magnesium** (1)	1	
	b		$2Mg(s)$ (1) + $O_2(g)$ (1) $\longrightarrow$ $2MgO(s)$	2	
			Total	**8**	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>12</td><td></td><td></td><td>Mass of fuel needed to boil water (g) = energy needed to boil water (J) / energy per gram

= 63000 / 50000 (1)

= 1.2 g (1)

Since 3 g in burner, this is enough propane / AW (1)</td><td>3</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>13</td><td></td><td></td><td>idea that does not show arrangement in space / is 2-dimensional only (1)
bond angles are incorrect (1)</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>14</td><td>a</td><td></td><td><table>
<tr><th>Particle</th><th>Atomic number</th><th>Mass number</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th><th>Electronic structure</th></tr>
<tr><td>A</td><td>11</td><td>23</td><td>11</td><td>12</td><td>11</td><td>2.8.1</td></tr>
<tr><td>B</td><td>9</td><td>19</td><td>9</td><td>10</td><td>9</td><td>2.7</td></tr>
<tr><td>C</td><td>17</td><td>37</td><td>17</td><td>20</td><td>17</td><td>2.8.7</td></tr>
<tr><td>D</td><td>13</td><td>27</td><td>13</td><td>14</td><td>10</td><td>2.8</td></tr>
</table></td><td>4</td><td>one mark scored for each correct line</td></tr>
<tr><td></td><td>b</td><td></td><td>particle A – one electron in outer shell or energy level (1)
particle D – has more protons than electrons (1)</td><td>2</td><td></td></tr>
<tr><td></td><td>c</td><td></td><td>group 7 (1) as 7 electrons in outer shell (1)
period 3 (1) as 3 shells occupied (1)</td><td>4</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>8</td><td></td></tr>
<tr><td>15</td><td></td><td></td><td>liquid (1)
liquid above –114 °C and does not boil until 78 °C (1)</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
16		i	**x** = 3 **y** = 8 **z** = 3 **all** correct (1)	1	Examiner's Comments Most candidates deduced the values for x, y and z in the formula.
		ii	contains oxygen / does not contain carbon and hydrogen only (1)	1	**allow** has O in the formula / contains three elements (1) **allow** C and H for carbon and hydrogen (1) **not** contains an oxygen **molecule** (in the formula) **not** is not a **mixture** of carbon and hydrogen only **not** does not contain carbon and hydrogen **molecules** or **compounds** only **not** does not contain carbon and hydro only Examiner's Comments Most candidates explained that glycerol is not a hydrocarbon as it contains an oxygen atom or does not contain carbon and hydrogen only. When candidates did not gain credit it was usually because they referred to glycerol containing 'oxygen molecules' or 'not only containing carbon and hydrogen *molecules*'.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
17	a	i	contains a (carbon-carbon) double bond (1)	1	**allow** has a C = C in its formula (1) **allow** (has a) double bonded carbon (1) **Examiner's Comments** Identified the double bond as indicated that the fat was unsaturated. The chemical test for unsaturation.
		ii ii	bromine (water) (1) goes (from brown to) colourless / is decolourised (1)	2	**allow** Br_2 (1) **not** bromide this marking point is **dependent** on correct reagent or bromide **allow** colour fades (1) **allow** any colour from orange-red, orange, brown-red, brown for colour of bromine (1) **ignore** clear **not** if wrong starting colour of bromine is given **not** discoloured **Examiner's Comments** Was not well known by candidates. A common misconception was to burn the fat.
	b		**any two from:** (making) biodiesel (1) (making) margarine (1) (making) soap (1)	2	**allow** butter / cooking oil / cooking for **one** mark **ignore** used in foods **Examiner's Comments** Large scale uses of fats were not well known. Examiners frequently saw answers about ‘providing energy’ or ‘keeping us warm’.

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Question			Answer/Indicative content	Marks	Guidance
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
18	a		ester (1)	1	**allow** other ways of indicating correct answer e.g. ticks or answer circled but answer line takes precedence **Examiner's Comments** This question was about fats. Many candidates gave the answer as alkenes rather than esters.
	b		$C_3H_8O_3$ (1)	1	**allow** any order of atoms **ignore** $C_3H_5(OH)_3$ etc. **Examiner's Comments** This question was about fats. Many candidates could write a formula from the displayed formula but often it was a partial structural formula e.g. $C_3H_5(OH)_3$ rather than the molecular formula.
	c	i	contains a (carbon-carbon) double bond (1)	1	**allow** has a C=C in its formula allow (has a) double bonded carbon **Examiner's Comments** This question was about fats. Candidates often referred to the presence of a double bond. In this example this was sufficient since the structure shown in the stem only had a carbon-carbon double bond.

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Question			Answer/Indicative content	Marks	Guidance
		ii	bromine (water) (1) goes (from brown to) colourless / is decolourised (1)	2	**allow** Br_2 **not** bromide this marking point is **dependent** on correct reagent or bromide **allow** colour fades **allow** any colour from orange-red, orange, brown-red, brown for colour of bromine **ignore** clear **not** if wrong starting colour of bromine is given **not** discoloured **Examiner's Comments** This question was about fats. The chemical test for unsaturation was well known and some candidates gave both the test and result and some explanation in terms of the dibromo compound formed.
	d		react with hydrogen (1) **and any one of** nickel (catalyst) (1) use of high pressure (1) use of an **unsaturated fat** or oil (1)	2	**allow** hydrogenation **not** hydrated **allow** any quoted pressure above atmospheric pressure / under pressure **allow** use of a fat with a C=C bond **ignore** reference to temperature **Examiner's Comments** This question was about fats. Candidates often could not recall how margarine was manufactured and gave answers that referred to making emulsions or even pasteurisation. The best answers appreciated that there was a hydrogenation reaction and mentioned either one or both of the use of a nickel catalyst and a high pressure.

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
<tr><td>19</td><td></td><td>i</td><td>
<table>
<tr><th>Alloy</th><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td>A</td><td>low density / high strength</td><td>high cost</td></tr>
<tr><td>B</td><td>high strength</td><td>high density</td></tr>
<tr><td>C</td><td>high strength / low cost</td><td>high density</td></tr>
<tr><td>D</td><td>low density / low cost</td><td>low strength</td></tr>
</table>
all eight cells in table correct (3)
</td><td>3</td><td>five, six or seven correct (2)

three or four correct (1)

allow AW eg cheap / expensive / strong / weak / dense / lightweight
ignore light / heavy

ignore medium cost in relation to B
ignore answers which merely quote numbers from the table

<u>Examiner's Comments</u>

This question was about alloys.

Most candidates successfully evaluated the advantages and disadvantages of the four alloys for making aeroplane wings in part (i). Marks were lost most commonly for writing ‘heavy’ instead of high density, or putting high density in the advantages boxes / low density in the disadvantages boxes.</td></tr>
<tr><td></td><td></td><td>ii</td><td>A (1)</td><td>1</td><td><u>Examiner's Comments</u>

This question was about alloys.

In part (ii) C was a common incorrect choice.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
20	a		(because) holes in membrane are too small to let (liquid) water droplets through (1) (but) holes are large enough to let water **vapour** to pass through (1)	2	**allow** rain for (liquid) water droplets (1) **ignore** water molecules or water particles **not** water for water vapour **not** just sweat **allow** big enough to let sweat or water **evaporate** (1) **allow** the (liquid) water droplets do not pass through but water **vapour** does (2) Examiner's Comments This question focused on Gore-Tex®. Good responses to this question identified that the holes in the polymer membrane are too small to let water droplets through but are large enough to let water vapour pass through. When candidates failed to gain credit it was usually because they referred to water, water molecules or sweat rather than water droplets and water vapour.
	b		Gore-tex® is breathable but nylon is not / nylon is only waterproof / nylon is not breathable (1)	1	assume unqualified answer refer to Gore-tex® **allow** description of breathable ie allows sweat / water vapour to pass through if term breathable is not used Examiner's Comments This question focused on Gore-Tex®. Candidates were told in the question that Gore-Tex® is breathable. In order, therefore, to gain credit here it was necessary to compare Gore-Tex® to nylon, which many candidates failed to do.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
21	a		weak forces between the layers (1) which are easy to break (so layers can slide over each other) (1)	2	**allow** van der Waals' forces between layers / weak intermolecular forces **not** weak covalent bonds between layers **Examiner's Comments** This question assessed the ability of candidates to use their knowledge of diamond and graphite and apply it to the two different forms of boron nitride. Candidates often recognised the weak bonds between layers, but did not then state that this bond was easy to break.
	b		large number of strong (covalent) bonds (1) needs lots of energy to break / AW (1)	2	**allow** giant molecular structure or giant covalent structure / large number of strong bonds (between atoms) **allow** heat for energy but **ignore** high temperature **any mention of intermolecular bonds / forces scores 0** **Examiner's Comments** Candidates did not always appreciate the importance of the giant structure, or that there are many strong covalent bonds that need to be broken.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
22	a		**any two from:** hard (1) does not conduct electricity (1) (good) conductor of heat (1) high melting point (1) insoluble in water (1) shiny / lustrous (1) transparent (1)	2	**ignore** hard to break or cut **ignore** strong **Examiner's Comments** A number of candidates scored 1 mark on this question with 2 marks being less common. Whereas 'hard' was a correct response, 'hard to break' and 'strong' were common incorrect responses.
	b		conducts electricity (1)	1	**ignore** it is a good conductor **allow** it is inert / has a high melting point (1) **allow** it is insoluble in water (1) **Examiner's Comments** About a third of candidates gained this mark, usually for stating that graphite is a good conductor of electricity. Responses such as 'inert' or 'insoluble in water' were also acceptable.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
23			**any two from**: high melting point (1) high boiling point (1) conducts electricity (1) ductile / can be drawn into wires (1) malleable / can be worked into shape (1) sonorous / make a ringing noise when hit (1) lustrous / shiny (1) hard (1) high density (1) high tensile strength / strong (1)	2	**allow** can be hammered into shape (1) **ignore** bendy / flexible **allow** dense (1) **ignore** durable / tough / hardwearing / long lasting Examiner's Comments Most candidates scored on this question. 'Strong' and 'hard' were popular correct answers.
			Total	2	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>24</td><td></td><td>i</td><td>molecules (1)

high (1)</td><td>2</td><td>
<table>
<tr><th></th><th>Sodium chloride</th><th>Carbon dioxide</th></tr>
<tr><td>Formula</td><td>NaCl</td><td>CO_2</td></tr>
<tr><td>Type of particles present</td><td>ions</td><td>molecules</td></tr>
<tr><td>Melting point</td><td>high</td><td>low</td></tr>
</table>

Examiner's Comments

Many candidates appreciated that the melting point of sodium chloride was high but could not name the particles present in carbon dioxide. Many candidates wrote atoms, ions or electrons and only a very small proportion of candidates gave the correct particle, a molecule.</td></tr>
<tr><td></td><td></td><td>ii</td><td>weak forces between molecules / weak intermolecular forces (1)</td><td>1</td><td>allow weak forces between particles, but not weak forces between ions or between atoms
allow weak intermolecular bonds / weak bonds between molecules

not weak intermolecular forces between atoms / weak covalent bonds

weak forces and weak bonds on their own are not sufficient

Examiner's Comments

Many candidates appreciated that the low melting point of carbon dioxide was due to a weak force but a significant proportion had this as a weak force between atoms rather than between molecules. The best answers referred to weak intermolecular forces.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
</table>

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Question			Answer/Indicative content	Marks	Guidance
25			experiments **1** and **3** show that as time doubles mass (of copper made) doubles (1) experiments **3** and **4** show that as the current quadruples, the mass also quadruples (1) **OR** experiments **1** and **2** show that as current doubles mass (of copper made) doubles (1)	2	**allow** reference to the correct data in the table to identify which experiments they are using **allow** when the time doubles and the current stays the same the mass doubles **allow** when the current doubles and the time stays the same the mass doubles **allow** if no other marks awarded then as time and current increase the mass (of copper) increases for one mark **Examiner's Comments** In this evaluation question many candidates could use the data to show that as current increases so does the mass and as the time increases so does the mass but were less confident at explaining why this indicated direct proportionality. Only the best answers referred to the experiment numbers in their explanations. Candidates did not always choose sets of experiments where only one variable changed and as a result did not justify the patterns they were describing.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
26	a		slippery / layers can slide over one another (1) (black / grey so) can be seen on the paper (1)	2	**allow** weak forces (of attraction) or weak bonds between layers (1) **allow** leaves mark on the paper / comes off onto the paper (1) **Examiner's Comments** Good responses to this question explained the suitability of graphite for making pencils in terms of the layers in the structure sliding over one another so that the graphite leaves a mark which can be seen on the paper. A common omission was not to describe the slippery / layered structure.
	b	i	has free electrons / mobile electrons / electrons that can move / delocalised electrons (1)	1	**not** has free ions **ignore** has spare electrons **Examiner's Comments** Most candidates explained the electrical conductivity of graphite in terms of free or delocalised electrons.
		ii	idea of a giant structure / has **many** covalent bonds (1) idea that strong bonds need to be broken / bonds need lots of energy to break (1)	2	**not** ionic bonds / (strong) intermolecular forces / bonds between carbon molecules – 0 marks for the question **allow** bonds are difficult to break (1) **allow many** strong covalent bonds are broken for 2 marks **Examiner's Comments** Many candidates appreciated that graphite contains strong bonds that need to be broken. The second mark for the idea of graphite having a giant structure or many covalent bonds was, however, rarely awarded. Candidates who failed to gain credit often described graphite as having strong intermolecular forces or bonds.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
27	a		absorbs or takes in energy (in the light) (1) (then) releases or emits energy (in the dark) (1)	2	**allow** stores energy from light in the day (1) **allow** light instead of energy **not** reference to radioactive emissions **Examiner's Comments** Most candidates were able to use ideas about absorbing energy in the light, and then releasing the energy in the dark, to explain why phosphorescent pigments glow in the dark.
	b		reacts with oxygen / it is oxidised (1)	1	**Examiner's Comments** Many candidates correctly described the oxidation of the oil. Candidates who failed to gain credit usually merely repeated information from the stem of the question.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
28	a		allotropes (1)	1	**allow** allotropy (1) **allow** giant structures or giant molecules (1) **Examiner's Comments** 'Isotopes' was a common error in this question.
	b		graphene only contains strong (carbon to carbon) covalent bonds (1) graphite contains weak forces or bonds between the layers (of carbon atoms) (1)	2	**allow graphene only allows strong bonds between atoms (1)** **not** strong ionic bonds / strong intermolecular forces **allow** van der Waals' forces between layers or (weak) intermolecular forces (1) **not** weak covalent bonds between layers **ignore** graphite has layers held loosely together **Examiner's Comments** Candidates often recognised that graphite has weak forces between the layers. To gain the second mark candidates needed to compare graphite to graphene, which contains only one layer of carbon atoms and therefore only contains strong covalent bonds.
	c		**any two from:** (diamond) has a high melting point (1) (diamond) is very hard (1)	2	**ignore** other properties from the table **allow** (diamond) is a good thermal conductor (1) **Examiner's Comments** Most candidates correctly interpreted the data in the table and explained that diamond is used to make cutting tools because it is hard and has a high melting point.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
29			**any two from** high melting point (1) high boiling point (1) does not conduct electricity (1) does not dissolve in water (1) colourless (1) good thermal conductor (1) hard / does not scratch easily (1)	2	**allow** clear / transparent **ignore** does not corrode **ignore** strong / tough ?Examiner's Comments ?? This question was about the properties of diamond. The idea that diamond was hard was well known but a common misconception was that diamond is strong. Other correct properties given by candidates included high melting point, insoluble in water and clear or transparent.
			Total	2	
30			preservative / flavouring (1)	1	**allow** road salt / gritting roads / table salt / used to make chlorine / making sodium hydroxide / making hydrogen in food is **not** sufficient Examiner's Comments This question was about sodium chloride (salt). Some candidates just referred to sodium chloride being used in food without explaining why it was used. Only a small proportion of candidates referred to treating icy roads.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
31			density increases / gets bigger / gets larger (1) any value between 0.77 and 0.84 (1)	2	**ignore** density gets heavier **allow** ORA if the trend is fully described ?Examiner's Comments?? Candidates often recognised the pattern of increasing density from the table but some were not able to predict the density of icosane. Those candidates that made a prediction often gave values between 0.79 to 0.84 g/cm^3.
			Total	**2**	
32	a		carbon (1)	1	**allow** C **Examiner's Comments** This part was found to be challenging.
	b		**any three from:** diamond has a high melting point (1) lustrous (1) colourless (1) does not conduct electricity (1) insoluble in water (1) transparent (1)	3	**ignore** strong / rare / expensive **allow** shiny **allow** clear **Examiner's Comments** This part was found to be challenging. Most candidates gave a list of uses of diamond, not its properties.
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
33	a		slippery (1)	1	**allow** weak bonds or forces **between layers** (1) **allow layers** can slide over each other (1) Examiner's Comments Most candidates correctly stated that graphite is slippery. When candidates did not gain credit it was usually because they referred to 'weak covalent bonds between layers' or referred to 'weak intermolecular forces' without reference to layers.
	b		has delocalised electrons / free electrons / electrons can move (1)	1	**ignore** spare electrons **not** ions can move Examiner's Comments The majority of candidates correctly explained that graphite conducts electricity because it has delocalised or free electrons. Candidates who did not gain this mark usually suggested that ions or atoms move.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
34			Level 3 Explains why the polymer has a low melting point in terms of intermolecular forces AND gives two suitable properties, with reasons, for the polymer Quality of communication does not impede communication of science at this level. (5 – 6 marks) Level 2 Explains why the polymer has a low melting point in terms of intermolecular forces OR gives two suitable properties, with reasons, for the polymer Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) Level 1 Attempts to explain why the polymer has a low melting point in terms of intermolecular forces OR gives one suitable property, with a reason, for the polymer OR gives two suitable properties Quality of communication impedes communication of the science at this level. (1 – 2 marks) Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A* Indicative scientific points at level 3 must include: • weak intermolecular forces between polymer molecules • does not need much energy to overcome or break the intermolecular forces do not allow break covalent bonds Suitable properties may include: • insoluble in water or waterproof so drink does not leak out • unreactive so it doesn't react with the contents or doesn't break down • flexible or bendy so can be made into different shapes • non-biodegradable so it will not decompose while still in use • non-toxic so drink does not get contaminated • low density or lightweight so that the bottle isn't heavy (to carry or transport) • strong so it contains the pressure or doesn't break when dropped ignore rigid / can be recycled / transparent Use the L1, L2, L3 annotations in Scoris. Do not use ticks. <u>Examiner's Comments</u> This 6 mark question was targeted at all grades up to, and including, grade A* and discriminated well. At level 3 (5 – 6 marks) all aspects of the question needed to be addressed and candidates were required to explain why the polymer has a low melting point and suggest and explain two other properties that make it suitable for use as a fizzy drinks bottle. When candidates did not gain full credit it was

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Question			Answer/Indicative content	Marks	Guidance
					usually because they gave properties of the plastic which were not relevant or did not fully explain the low melting point of the polymer in terms of weak intermolecular forces between polymer molecules that do not need much energy to overcome. A common misconception was that the low melting point resulted from the polymer only having single covalent bonds or not having many covalent bonds.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
35	a		diamond (1)	1	Examiner's Comments Many candidates recognised diamond.
	b		any two from: high melting point (1) high boiling point (1) grey / black (1) conducts electricity (1) insoluble in water (1) lustrous / shiny (1) opaque (1)	2	ignore dark not dull not flexible ignore strong / hard Examiner's Comments Candidates often gave one property of graphite but were less likely to give two properties. Candidates that referred to graphite as strong or hard were not given credit. The most common correct properties were that graphite had a high melting point and conducts electricity but all the other properties in the mark scheme were seen by the examiners. Some candidates referred to the presence of layers or the idea of weak intermolecular forces between the layers. Since these are not properties of graphite they were not given credit in the mark scheme.
	c		idea that can cage medicine, drug or chemical inside the fullerene (1)	1	ignore spherical in shape Examiner's Comments The use of fullerenes as a drug delivery system was not well known by candidates. Most candidates did not appreciate that the drug molecule could be trapped inside the fullerene.

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Question			Answer/Indicative content	Marks	Guidance
			Total	4	
36			D ✓	1(AO1.1)	Examiner's Comments  Misconception A and B were common misconceptions in this question.
			Total	1	
37			A ✓	1(AO1.1)	
			Total	1	
38			C ✓	1(AO2.1)	
			Total	1	

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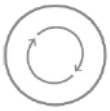
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Question			Answer/Indicative content	Marks	Guidance
39	a		Could be breathed in / Idea of absorbed by skin / Idea of absorbed into bloodstream / Take a long time to break down in the environment ✓	1(AO2.1)	**ALLOW** cannot see so may leave (areas of) skin unprotected **ALLOW** idea that we don't know the **long term** risks **IGNORE** idea that they are not fully understood / there could be side effects / idea that they may react with or irritate skin / harmful to humans Examiner's Comments Good responses to this question either described specific risks of nanoparticles (e.g. can be breathed in or the idea of absorption through skin or into the bloodstream) or stated that we do not yet know the long-term risks of nanoparticles. Answers that did not gain credit were often too vague, e.g. the idea that they are not fully understood or there could be side effects or they may be harmful to humans.

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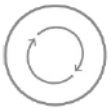
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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.12 OR 0.12:1 OR 1:8.3 award 4 marks	4	Units not needed
			Surface area = $6 \times 50^2 = 15000$ ✓	(AO3 × 2.2)	ALLOW surface area = 1.5×10^4 nm^2
			Volume = $50^3 = 125000$ ✓		ALLOW volume = 1.25×10^5 nm^3
			Surface area / volume ratio = 15000 ÷ 125000 ✓		ALLOW ECF from incorrect surface area and / or volume
			= 0.12 or 0.12:1 or 1:8.3 ✓	(AO1.2)	ALLOW any simplified ratio consistent with 0.12:1 eg 3:25 or 1.5:12.5 for 4 marks DO NOT ALLOW ratio wrong way round eg 1:0.12 Examiner's Comments Many candidates calculated the surface area of the cube as 2,500nm^2, failing to multiply this answer by 6. Examiners gave 'error carried forward' so candidates making this mistake were still able to gain 3 marks.  AfL It is worth centres stressing to candidates that the award of 'error carried forward' is only possible when an answer is clearly set out.

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Question			Answer/Indicative content	Marks	Guidance
	c	i	Nanoparticles have diameter between 1 - 100 (nm) / idea that (diameter of) DNA is more than 1 (nm) but less than 100 (nm) ✓ Water (molecule) is too small / 0.27 (nm) is less than 1 (nm) / idea that 0.27 (nm) is not in range 1 – 100 (nm) ✓	2(AO1.1)	**ALLOW** has at least one dimension on the nanoscale Examiner's Comments Good responses to this question stated that nanoparticles have a diameter between 1 – 100nm but a water molecule is too small. Lower ability candidates tended to focus on the fact that DNA is a polymer and water is a simple or small molecule, without reference to the size of nanoparticles. Examiners also saw the idea that water is made of 3 atoms but DNA is made of many atoms.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3100 award 2 marks 100000 ÷ 32 ✓ = 3100 (2 significant figures) ✓	2(AO2.2)	**ALLOW** 3125 for 1 mark **ALLOW** 0.00032 for 1 mark (correct sig figs from incorrect working out, ie 32 ÷ 100000) Examiner's Comments  AfL Centres should stress to candidates that if they are asked to give their answer to a specific number of significant figures, they can only score full marks by doing so. Many candidates scored only 1 mark for giving the answer 3125.
			Total	9	
40			B	1 (AO2.1)	Examiner's Comments Candidates found the unit conversion very difficult. All responses seen, A being the most common.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
41	a	i	Buckminsterfullerene / bucky ball ✓	1 (AO1.1)	ALLOW C_{60} IGNORE fullerene Examiner's Comments Candidates found this very difficult and a significant number omitted the question. Common non-creditworthy responses included: fullerene, graphene, carbon, giant covalent.
		ii	Has many atoms joined together (by covalent bonds) ✓ Arranged in a repeating pattern ✓	2 (AO1.1)	ALLOW all atoms joined together / each/every C atom joined together DO NOT ALLOW imf Examiner's Comments Candidates found this extremely difficult with few gaining credit and a significant number omitted the question. Discussion of bond strength, four bonds, layers, large and intermolecular forces were seen alongside a range of guesses.
	b	i	Many strong (covalent) bonds ✓ A lot of energy needed to break the bonds ✓	2 (AO1.1)	ALLOW each/every C bonded to 4 C atoms (ie network idea) / many bonds / network of bonds / bonds throughout structure ✓ strong (covalent) bonds ✓ DO NOT ALLOW IMF/ionic Examiner's Comments Candidates found this difficult. Higher ability candidates knew that the bonds were strong but few appreciated the concept of a high number of the strong bonds giving it hardness.

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Question			Answer/Indicative content	Marks	Guidance
		ii	Layers slide over each other / weak forces between the layers ✓	1 (AO1.1)	IGNORE IMF Examiner's Comments Higher ability candidates gained credit. Non-creditworthy responses included: layered structure, carbon atoms move, intermolecular forces between the layers, weak covalent bonds between layers and weak bonding.
	c		Any two from: Conducts electricity because touchscreens need to be able to conduct electricity ✓ High strength so screen does not break when dropped/ so doesn't wear off / rub off / crack from pressure of fingers ✓ Transparent so can see light through the display ✓	2 (AO3.2a)	ALLOW doesn't break easily ALLOW can see work/can see through it Examiner's Comments Many candidates gained at least partial credit, usually for the transparency of the screen so that the display could be seen. Some candidates listed the properties from the table with no application to the touch screen.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
42	a		Could be breathed in / Idea of absorbed by skin / Idea of absorbed into bloodstream / Take a long time to break down in the environment ✓	1 (AO2.1)	ALLOW cannot see so may leave (areas of) skin unprotected ALLOW idea that we don't know the **long term** risks IGNORE idea that they are not fully understood / there could be side effects / idea that they may react with skin / harmful to humans <u>Examiner's Comments</u> Higher ability candidates appreciated that the smallness of the nanoparticles means they are easily absorbed into the bloodstream or body. Many thought they would irritate or react with the skin without appreciating that they could not be sold where this true. Side effects, particles too small to cover the skin and non-understanding of nanoparticles were common non-creditworthy responses.

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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.12 OR 0.12:1 or 1:8.3 award 4 marks Surface area = $6 \times 50^2 = 15000$ ✓ Volume = $50^3 = 125000$ ✓ Surface area / volume ratio = 15000 ÷ 125000 ✓ = 0.12 or 0.12:1 or 1:8.3 ✓	4 (AO3 × 2.2) (AO1.2)	Units not needed ALLOW surface area = 1.5×10^4 nm^2 ALLOW volume = 1.25×10^5 nm^3 ALLOW ECF from incorrect surface area and/or volume ALLOW any ratio that simplifies to 0.12:1 eg 3:25 or 1.5:12.5 for 4 marks DO NOT ALLOW ratio wrong way round eg 1:0.12 Examiner's Comments Higher ability candidates calculated both correctly and determined a ratio. Common errors included calculating the surface area for one face only and missing 0's on the volume. Most showed the steps of their working and many then scored follow through marks for using their values to determine a ratio. A significant number omitted the question.
	c	i	Nanoparticles have diameter between 1 nm – 100 nm / idea that (diameter of) DNA is more than 1 nm but less than 100 nm ✓ Water (molecule) is too small / 0.27 nm is less than 1 nm / idea that 0.27 nm is not in range 1 nm – 100 nm ✓	2 (AO 1.1)	ALLOW has at least one dimension on the nanoscale Examiner's Comments Higher ability students appreciated that a water molecule is too small to be a nanoparticle but very few candidates discussed the dimensions of a nanoparticle. Many omitted the question. Incorrect responses included: water molecules cannot be found on their own, DNA can be seen but water molecules can't and water being a liquid.

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Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3100 award 2 marks 100000 ÷ 32 ✓ = 3100 (2 significant figures) ✓	2 (AO2.2)	 ALLOW 3125 for 1 mark ALLOW 0.00032 for 1 mark (correct sig figs from incorrect working out, ie 32 ÷ 100000) <u>Examiner's Comments</u> More able candidates calculated the value correctly, but many did not give their answer to 2 significant figures.
			Total	9	
43			D	1 (AO1.1)	
			Total	1	
44			B	1 (AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
45	a	i	A **AND** D ✓	1 (AO3.1a)	
		ii	**Any two from:** Conducts electricity in molten state ✓ Does not conduct electricity in solid state ✓ High melting point ✓	2 (AO3.2b)	ALLOW dissolve in water
	b	i	Add water (and stir) ✓ Filtration ✓ **B** collects on filter paper ✓	3 (AO3.3a 1.2 3.3a)	
		ii	Distillation **OR** evaporation **OR** heating ✓ Removes water **OR** dries C **OR** removes some water and leave to crystalise ✓	2 (AO1.2 3.3a)	**ALLOW** boiling
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
46	a	i	ionic✓ oppositely charged ions✓	2 (AO1.1)	**ALLOW** oppositely charged particles / has + and – particles **IGNORE** contains anions and cations (in diagram) **IGNORE** oppositely charged atoms / molecules **DO NOT ALLOW** positive nucleus and negative electrons **Mark independently**
		ii	**Any two from:** Idea of many strong ✓ covalent bonds ✓ (which) require a lot of energy to break ✓	2 (AO1.1)	**Reference to intermolecular forces / bonds / molecular forces scores 0 for question** **ALLOW** many covalent bonds break at high temperatures for 2 marks **ALLOW** idea that each atom has 4 strong covalent bonds for 2 marks **ALLOW** giant covalent structure for 1 mark
		iii	No delocalised electrons / no sea of electron / no mobile charge carriers / ions / electrons structure contains atoms ✓	1 (AO1.1)	**IGNORE** just free electrons
	b		Layers / metal ions ✓ slide over each other ✓	2 (AO1.1)	**IGNORE** metal atoms / electrons **Mark independently**
			Total	**7**	
47			D ✓	1 (AO1.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
48			A ✓	1 (AO1.1)	
			Total	**1**	
49	a	i	Ionic ✓ oppositely charged ions ✓	2 (AO1.1)	**ALLOW** oppositely charged particles / has + and - particles **IGNORE** contains anions and cations (in diagram) **IGNORE** oppositely charged atoms / molecules **DO NOT ALLOW** positive nucleus and negative electrons **Mark independently**
		ii	**Any two from:** Idea of many strong ✓ covalent bonds ✓ (which) require a lot of energy to break ✓	2 (AO1.1)	**Reference to intermolecular forces / bonds / molecular forces scores 0 for question** **ALLOW** many covalent bonds break at high temperatures for 2 marks **ALLOW** idea that each atom has 4 strong covalent bonds for 2 marks **ALLOW** giant covalent structure for 1 mark
		iii	No delocalised electrons / no sea of electrons / no mobile charge carriers / ions / electrons / structure contains atoms ✓	1 (AO1.1)	**IGNORE** just free electrons
	b		Layers / metal ions ✓ slide over each other ✓	2 (AO1.1)	**IGNORE** metal atoms / electrons **Mark independently**
			Total	**7**	

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