

Answer **all** the questions.

1. Crude oil can be separated in the laboratory into fractions which have different boiling points.

Look at the table. It shows possible relationships between:

- boiling point
- number of carbon atoms in the molecule
- size of intermolecular forces.

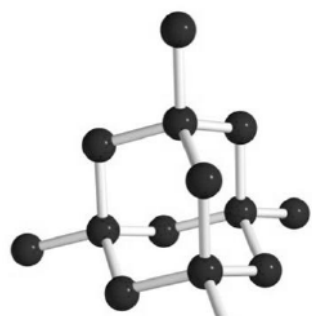
Which letter represents the correct relationship between the boiling point, number of carbon atoms and size of intermolecular forces?

	Boiling point	Number of carbon atoms in the molecule	Size of intermolecular forces
A	high	more than 50	small
B	low	more than 50	large
C	high	less than 20	large
D	low	less than 20	small

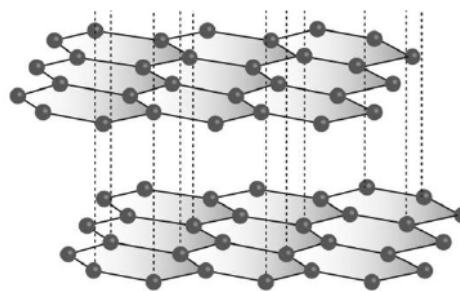
Your answer

[1]

2. The diagrams show the structures of two forms of carbon.



diamond



graphite

Graphite is a good conductor of electricity.

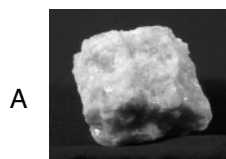
Diamond does not conduct electricity.

Use ideas about structure and bonding in diamond and graphite to explain these observations.

[3]

3. Look at the diagrams.

Which diagram shows a solid with the **largest** surface area to volume ratio?



Your answer

[1]

4. Ethanol contains carbon.

Look at some information about ethanol.

Melting point = -114°C

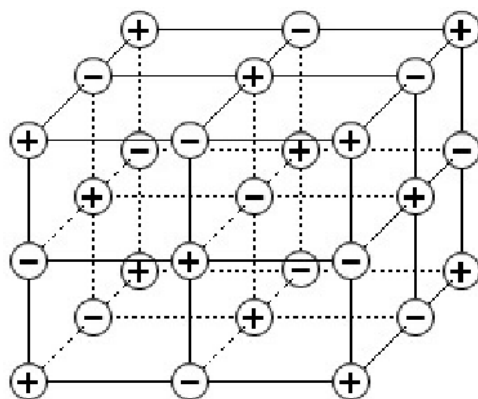
Boiling point = 78°C

Predict the state of ethanol at 25°C . How can you tell?

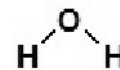
----- [2]

5(a). Look at the diagrams.

They show the structures of two compounds.



sodium chloride



water

Sodium chloride has a melting point of 801°C.

Use the structure of sodium chloride to explain why.

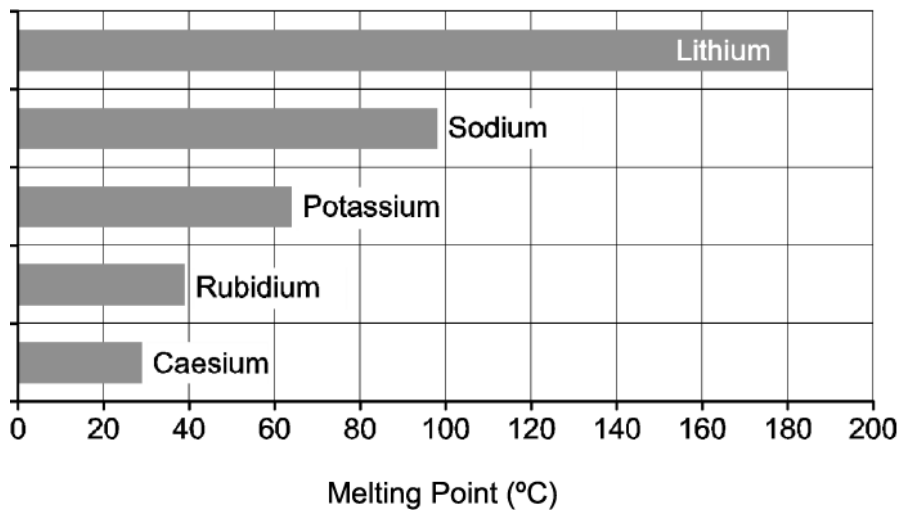
[2]

(b). Water has a low melting point and boiling point.

Explain why.

[2]

6. The bar chart shows some information about the melting points of Group 1 elements.



What are the melting points of rubidium and caesium?

	Melting point of rubidium (°C)	Melting point of caesium (°C)
A	39	29
B	40	25
C	29	41
D	41	25

Your answer

[1]

7(a). This Gore-Tex[®] jacket is both waterproof and breathable.



Gore-Tex[®] is made from a layer of nylon that is laminated with a PTFE polymer membrane.

Use ideas about the structure of Gore-Tex[®] to explain why it is both waterproof and breathable.

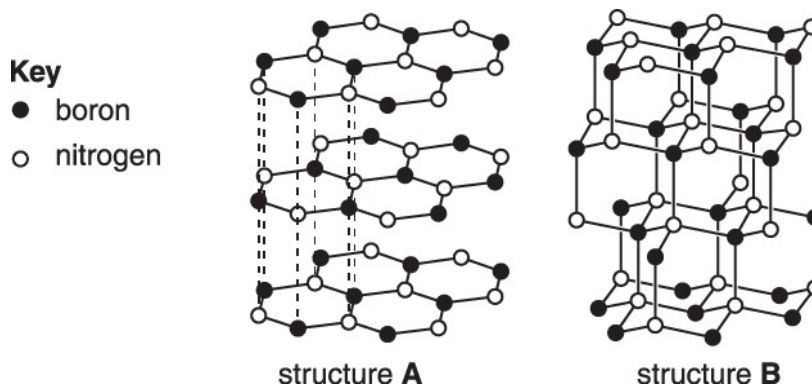
[2]

(b). Suggest **one** advantage of a Gore-Tex[®] jacket over one made from only nylon.

[1]

8(a). Boron nitride, BN, exists in two physical forms.

The structures of these forms are shown below.



These two forms of boron nitride resemble graphite and diamond, the two allotropes of carbon.

Boron nitride, with structure **A**, is slippery.

Explain why, in terms of structure and bonding.

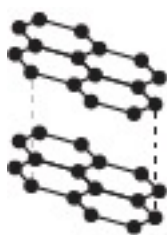
[2]

(b). Boron nitride, with structure **B**, has a very high melting point.

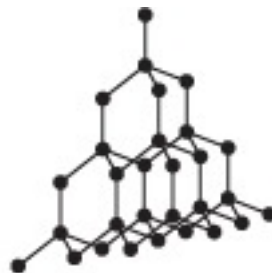
Explain why, in terms of structure and bonding.

[2]

9(a). Diamond and graphite are two forms of carbon.



graphite



diamond

One of the physical properties of diamond is that it is colourless.

Describe some of the **other** physical properties of diamond.

[2]

(b). Graphite is used to make the electrodes for electrolysis.

Explain why.

[1]

10. Copper is a metal.

One property of metals is that they are good conductors of heat.

Write down **two** other properties of metals.

[2]

11. Sodium chloride is an ionic compound.

Carbon dioxide is a covalent compound.

Look at the table.

	Sodium chloride	Carbon dioxide
Formula	NaCl	CO ₂
Type of particles present	ions	-----
Melting point	-----	low

(i) Complete the table.

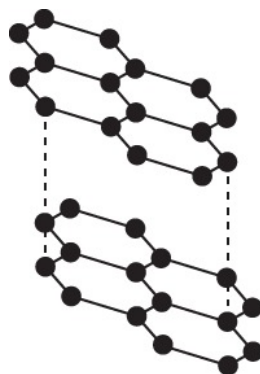
[2]

(ii) Carbon dioxide has a low melting point.

Explain why, using ideas about forces.

[1]

12. Graphite is one of the allotropes of carbon.



Graphite is used as an electrode in electrolysis.

This is because it conducts electricity and has a high melting point.

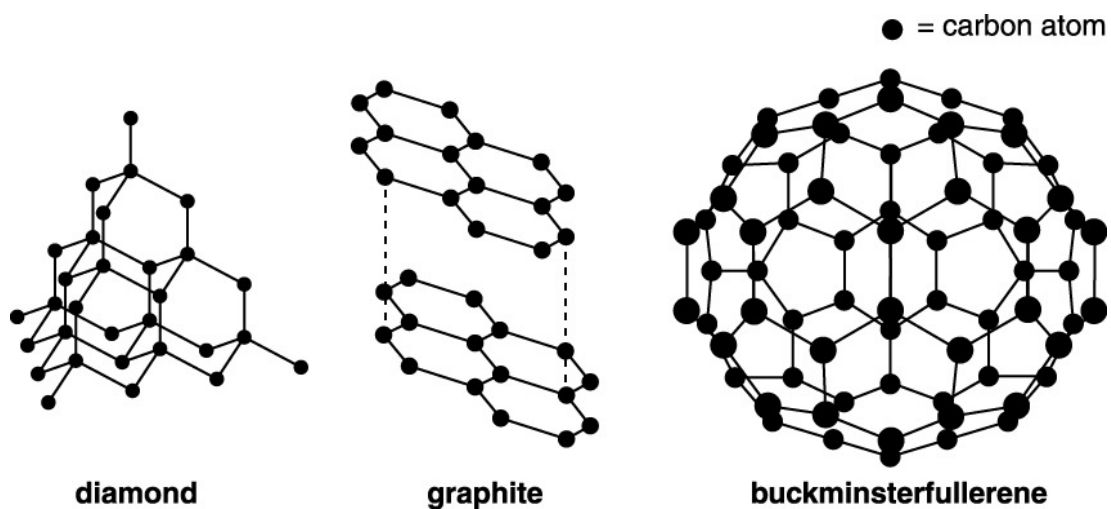
(i) Explain why graphite can conduct electricity. Use the diagram to help you.

----- [1]

(ii) Explain why graphite has a high melting point. Use the diagram to help you.

----- [2]

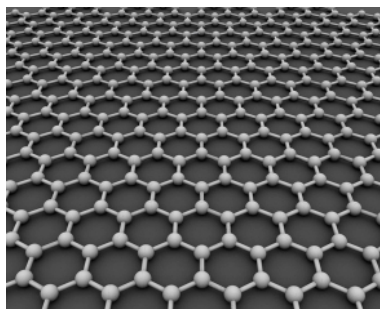
13(a). Carbon can exist in different solid forms.



What is the name given to these three forms?

----- [1]

(b). Look at the diagram.



It shows the structure of a new solid form of carbon called graphene.

Graphene contains **one layer** of carbon atoms.

Graphene is made from graphite.

Graphene is harder than graphite.

Explain, using ideas about structure and bonding, why **graphene is hard** and **graphite is slippery**.

[2]

(c). Diamond and graphite have different properties and different uses.

Look at the table.

It shows some information about the properties of diamond and graphite.

Property	Diamond	Graphite
State at room temperature	solid	solid
Appearance at room temperature	transparent	black
Melting point	very high	very high
Hardness	very hard	soft
Electrical conductivity	does not conduct	good conductor

Diamond is used to make cutting tools.



The picture shows a drill bit with diamonds on its end.

This drill is used to cut through rock.

Explain why diamond is used to make cutting tools.

Use the table to help you.

[2]

14. Diamond is a form of carbon.



Diamonds are used in jewellery because they are lustrous (shiny).

Write about two **other** properties of diamond.

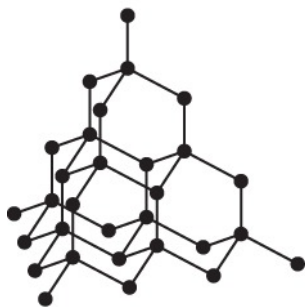
[2]

15. This question is about sodium chloride (salt).

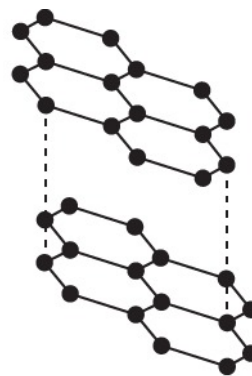
Write down one **use** of sodium chloride.

[1]

16(a). This question is about diamond and graphite.



diamond



graphite

Diamond and graphite are made of the same element.

Which element?

----- [1]

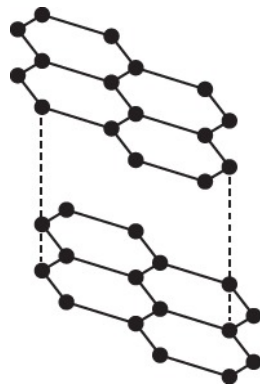
(b). One property of diamond is that it is very hard.

Diamond is used to make cutting tools.

Write about some other properties of diamond.

----- [3]

17. Graphite is a form of carbon.



Graphite is used as a lubricant.

Write down **one** property of graphite that explains why it is used as a lubricant.

----- [1]

18. Stowmarket Synthetics make a polymer that is used to make bottles for fizzy drinks.



The polymer they use has a low melting point.

Suggest, with reasons, **two other** properties of the polymer that make it suitable for use as a bottle for fizzy drinks.

Use a simple model of the structure of the polymer to explain why it has a low melting point.

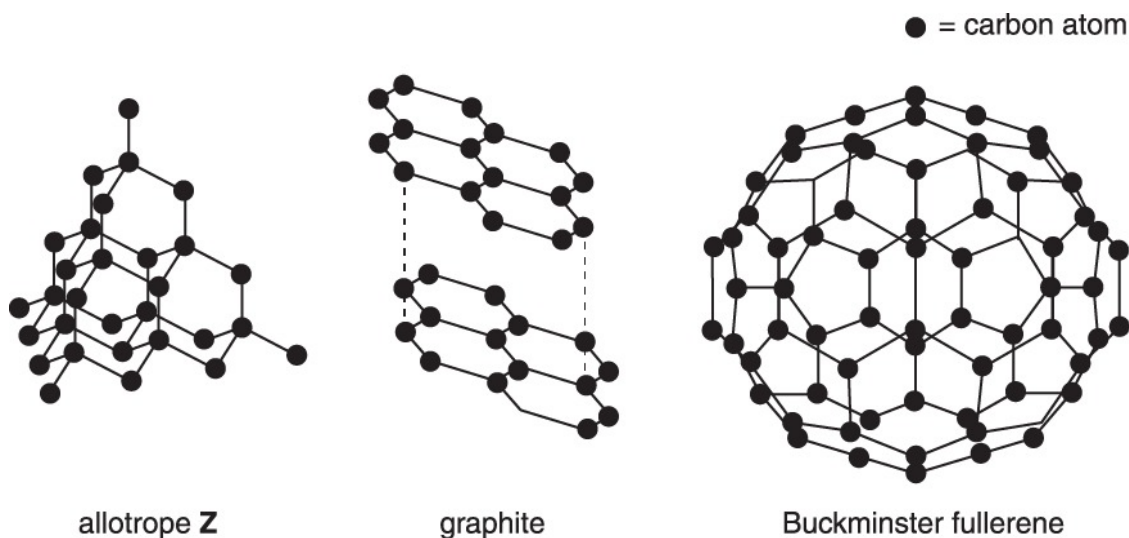


The quality of written communication will be assessed in your answer to this question.

[6]

19(a). This question is about carbon.

Look at the structures of the three allotropes of carbon.



What is the name of allotope Z?

----- [1]

(b). One property of graphite is that it is slippery.

Write about two **other** properties of graphite.

----- [2]

(c). Fullerenes can be used in new drug delivery systems for patients who are ill in hospitals.

Explain why fullerenes can be used.

----- [1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			D	1	
			Total	1	
2			graphite – has a layered structure (1) electrons can move / electrons between layers or delocalised (1) diamond – no free electrons or ions (1)	3	
			Total	3	
3			B	1	
			Total	1	
4			liquid (1) liquid above $-114\text{ }^{\circ}\text{C}$ and does not boil until $78\text{ }^{\circ}\text{C}$ (1)	2	
			Total	2	
5	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	
6			A	1	
			Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
7	a	<p>(because) holes in membrane are too small to let (liquid) water droplets through (1)</p> <p>(but) holes are large enough to let water vapour to pass through (1)</p>	2	<p>allow rain for (liquid) water droplets (1) ignore water molecules or water particles</p> <p>not water for water vapour not just sweat allow big enough to let sweat or water evaporate (1)</p> <p>allow the (liquid) water droplets do not pass through but water vapour does (2)</p> <p><u>Examiner's Comments</u></p> <p>This question focused on Gore-Tex[®].</p> <p>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.</p>
	b	<p>Gore-tex[®] is breathable but nylon is not / nylon is only waterproof / nylon is not breathable (1)</p>	1	<p>assume unqualified answer refer to Gore-tex[®]</p> <p>allow description of breathable ie allows sweat / water vapour to pass through if term breathable is not used</p> <p><u>Examiner's Comments</u></p> <p>This question focused on Gore-Tex[®].</p> <p>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.</p>
		Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
8	a	<p>weak forces between the layers (1)</p> <p>which are easy to break (so layers can slide over each other) (1)</p>	2	<p>allow van der Waals' forces between layers / weak intermolecular forces not weak covalent bonds between layers</p> <p>Examiner's Comments</p> <p>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.</p> <p>Candidates often recognised the weak bonds between layers, but did not then state that this bond was easy to break.</p>
	b	<p>large number of strong (covalent) bonds (1)</p> <p>needs lots of energy to break / AW (1)</p>	2	<p>allow giant molecular structure or giant covalent structure / large number of strong bonds (between atoms) allow heat for energy but ignore high temperature</p> <p>any mention of intermolecular bonds / forces scores 0</p> <p>Examiner's Comments</p> <p>Candidates did not always appreciate the importance of the giant structure, or that there are many strong covalent bonds that need to be broken.</p>
		Total	4	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
9	a	<p>any two from: hard (1)</p> <p>does not conduct electricity (1) (good) conductor of heat (1) high melting point (1) insoluble in water (1) shiny / lustrous (1) transparent (1)</p>	2	<p>ignore hard to break or cut ignore strong</p> <p>Examiner's Comments</p> <p>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.</p>
	b	conducts electricity (1)	1	<p>ignore it is a good conductor allow it is inert / has a high melting point (1) allow it is insoluble in water (1)</p> <p>Examiner's Comments</p> <p>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.</p>
		Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
10		<p>any two from:</p> <p>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)</p> <p>sonorous / make a ringing noise when hit (1) lustrous / shiny (1) hard (1) high density (1) high tensile strength / strong (1)</p>	2	<p>allow can be hammered into shape (1) ignore bendy / flexible</p> <p>allow dense (1)</p> <p>ignore durable / tough / hardwearing / long lasting</p> <p><u>Examiner's Comments</u></p> <p>Most candidates scored on this question. 'Strong' and 'hard' were popular correct answers.</p>
		Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance												
11		i	molecules (1) high (1)	2	<table border="1" style="width: 100%; border-collapse: collapse; margin-bottom: 10px;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 35%; text-align: center;">Sodium chloride</th> <th style="width: 35%; text-align: center;">Carbon dioxide</th> </tr> </thead> <tbody> <tr> <td>Formula</td> <td style="text-align: center;">NaCl/</td> <td style="text-align: center;">CO₂</td> </tr> <tr> <td>Type of particles present</td> <td style="text-align: center;">ions</td> <td style="text-align: center;">molecules</td> </tr> <tr> <td>Melting point</td> <td style="text-align: center;">high</td> <td style="text-align: center;">low</td> </tr> </tbody> </table> <p>Examiner's Comments</p> <p>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.</p>		Sodium chloride	Carbon dioxide	Formula	NaCl/	CO ₂	Type of particles present	ions	molecules	Melting point	high	low
	Sodium chloride	Carbon dioxide															
Formula	NaCl/	CO ₂															
Type of particles present	ions	molecules															
Melting point	high	low															
		ii	weak forces between molecules / weak intermolecular forces (1)	1	<p>allow weak forces between particles, but not weak forces between ions or between atoms</p> <p>allow weak intermolecular bonds / weak bonds between molecules</p> <p>not weak intermolecular forces between atoms / weak covalent bonds</p> <p>weak forces and weak bonds on their own are not sufficient</p> <p>Examiner's Comments</p> <p>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.</p>												
Total				3													

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12		i	has free electrons / mobile electrons / electrons that can move / delocalised electrons (1)	1	<p>not has free ions</p> <p>ignore has spare electrons</p> <p>Examiner's Comments</p> <p>Most candidates explained the electrical conductivity of graphite in terms of free or delocalised electrons.</p>
		ii	<p>idea of a giant structure / has many covalent bonds (1)</p> <p>idea that strong bonds need to be broken / bonds need lots of energy to break (1)</p>	2	<p>not ionic bonds / (strong) intermolecular forces / bonds between carbon molecules – 0 marks for the question</p> <p>allow bonds are difficult to break (1)</p> <p>allow many strong covalent bonds are broken for 2 marks</p> <p>Examiner's Comments</p> <p>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.</p>
			Total	3	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
13	a	allotropes (1)	1	<p>allow allotropy (1) allow giant structures or giant molecules (1)</p> <p>Examiner's Comments</p> <p>'Isotopes' was a common error in this question.</p>
	b	<p>graphene only contains strong (carbon to carbon) covalent bonds (1)</p> <p>graphite contains weak forces or bonds between the layers (of carbon atoms) (1)</p>	2	<p>allow graphene only allows strong bonds between atoms (1) not strong ionic bonds / strong intermolecular forces</p> <p>allow van der Waals' forces between layers or (weak) intermolecular forces (1) not weak covalent bonds between layers</p> <p>ignore graphite has layers held loosely together</p> <p>Examiner's Comments</p> <p>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.</p>
	c	<p>any two from:</p> <p>(diamond) has a high melting point (1)</p> <p>(diamond) is very hard (1)</p>	2	<p>ignore other properties from the table</p> <p>allow (diamond) is a good thermal conductor (1)</p> <p>Examiner's Comments</p> <p>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.</p>
		Total	5	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
14		<p>any two from</p> <p>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)</p>	2	<p>allow clear / transparent</p> <p>ignore does not corrode ignore strong / tough</p> <p>?Examiner's Comments ??</p> <p>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.</p>
		Total	2	
15		<p>preservative / flavouring (1)</p>	1	<p>allow road salt / gritting roads / table salt / used to make chlorine / making sodium hydroxide / making hydrogen</p> <p>in food is not sufficient</p> <p>Examiner's Comments</p> <p>This question was about sodium chloride (salt).</p> <p>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.</p>
		Total	1	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
16	a	carbon (1)	1	<p>allow C</p> <p>Examiner's Comments</p> <p>This part was found to be challenging.</p>
	b	<p>any three from:</p> <p>diamond has a high melting point (1)</p> <p>lustrous (1)</p> <p>colourless (1)</p> <p>does not conduct electricity (1)</p> <p>insoluble in water (1)</p> <p>transparent (1)</p>	3	<p>ignore strong / rare / expensive</p> <p>allow shiny</p> <p>allow clear</p> <p>Examiner's Comments</p> <p>This part was found to be challenging. Most candidates gave a list of uses of diamond, not its properties.</p>
		Total	4	
17		slippery (1)	1	<p>allow weak bonds or forces between layers (1)</p> <p>allow layers can slide over each other (1)</p> <p>Examiner's Comments</p> <p>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.</p>
		Total	1	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
18	<p>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)</p> <p>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)</p> <p>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)</p> <p>Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A*</p> <p>Indicative scientific points at level 3 must include:</p> <ul style="list-style-type: none"> • weak intermolecular forces between polymer molecules • does not need much energy to overcome or break the intermolecular forces <p>do not allow break covalent bonds</p> <p>Suitable properties may include:</p> <ul style="list-style-type: none"> • 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 <p>ignore rigid / can be recycled / transparent</p> <p>Use the L1, L2, L3 annotations in Scoris. Do not use ticks.</p> <p><u>Examiner's Comments</u></p> <p>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</p>

Mark Scheme

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	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
19	a	diamond (1)	1	<p>Examiner's Comments</p> <p>Many candidates recognised diamond.</p>
	b	<p>any two from:</p> <p>high melting point (1)</p> <p>high boiling point (1)</p> <p>grey / black (1)</p> <p>conducts electricity (1)</p> <p>insoluble in water (1)</p> <p>lustrous / shiny (1)</p> <p>opaque (1)</p>	2	<p>ignore dark</p> <p>not dull</p> <p>not flexible</p> <p>ignore strong / hard</p> <p>Examiner's Comments</p> <p>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.</p>
	c	idea that can cage medicine, drug or chemical inside the fullerene (1)	1	<p>ignore spherical in shape</p> <p>Examiner's Comments</p> <p>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.</p>

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			Total
4			