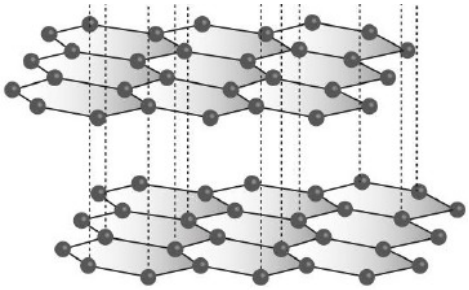
1. Look at the diagram.

It shows a structure of carbon.



Which structure of carbon is shown in the diagram?

A diamond
B fullerene
C graphene
D graphite

Your answer ☐

[1]

2. Which row in the table shows the correct results for an ionic compound?

	Solid compound	Compound dissolved in water	Molten compound
A	conducts	does not conduct	conducts
B	conducts	conducts	conducts
C	conducts	conducts	does not conduct
D	does not conduct	conducts	conducts

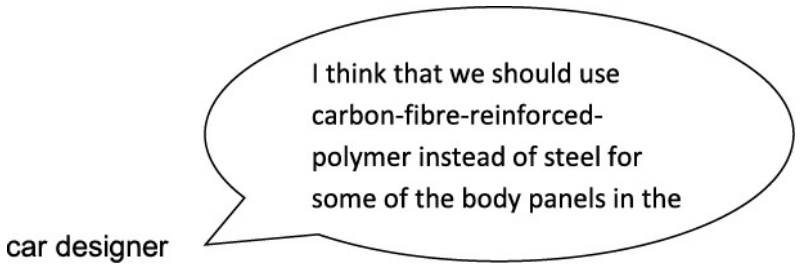
Your answer ☐

[1]

3. Look at the table of data.

Material	Strength (arbitrary units)	Resistance to corrosion	Density (g/cm^3)	Electrical conductivity	Cost (£ per tonne)
Aluminium	222	Good	2.8	Very good	750
Titanium alloy	850	Good	4.4	Good	8000
Carbon-fibre-reinforced-polymer	2457	Good	1.5	Very good	10000
Steel	254	Poor	7.8	Good	65
PVC	69	Good	1.3	Poor	490

A car designer is discussing the material to use in a new car.



Discuss the arguments for and against the use of carbon-fibre-reinforced-polymer instead of steel for car body panels.

Use information from the table.

---

[3]

4. A very large metal structure called ‘The Orbit’ was built for the London Olympics.

Look at the picture of ‘The Orbit’.

The table shows information about some metals that could be used to make ‘The Orbit’.

Metal	Melting point in °C	Relative strength (very strong = 10and weak = 1)	Density in g/cm^3	Corrosion	Relative electrical conductivity (good = 10 and poor = 1)
A	1700	8	7.4	corrodes very slowly	7
B	232	3	9.4	corrodes rapidly	4
C	2010	9	3.2	corrodes very slowly	3

Explain, with reasons, which metal, **A**, **B** or **C**, from the table would be best to make ‘The Orbit’.

--- **[2]**

5. A very large metal structure called ‘The Orbit’ was built for the London Olympics.

Look at the picture of ‘The Orbit’.

The table shows information about some metals that could be used to make ‘The Orbit’.

Metal	Melting point in °C	Relative strength (very strong = 10 and weak = 1)	Density in g / cm^3	Corrosion	Relative electrical conductivity (good = 10 and poor = 1)
A	1700	8	7.4	corrodes quite rapidly	7
B	232	3	9.4	corrodes rapidly	4
C	2010	9	3.2	corrodes very slowly	3

Suggest the properties needed for the metal used to make ‘The Orbit’.

Explain, with reasons, which metal, **A**, **B** or **C**, from the table would be best.

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

[6]

6. This question is about allotropes of carbon.

Diamond is one allotrope of carbon.

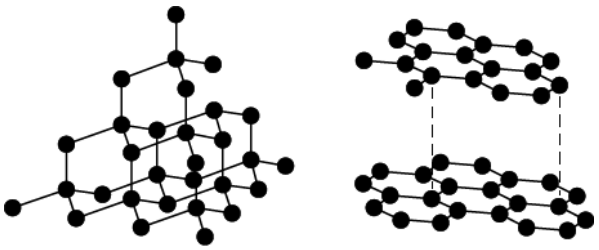
Diamond is used in jewellery.

Explain why.

---

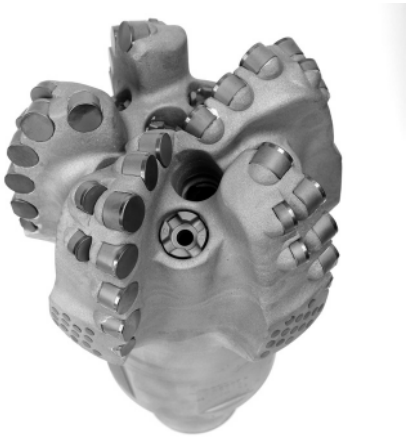
[1]

7. Look at the diagrams. They show the structures of diamond and graphite.



diamond graphite

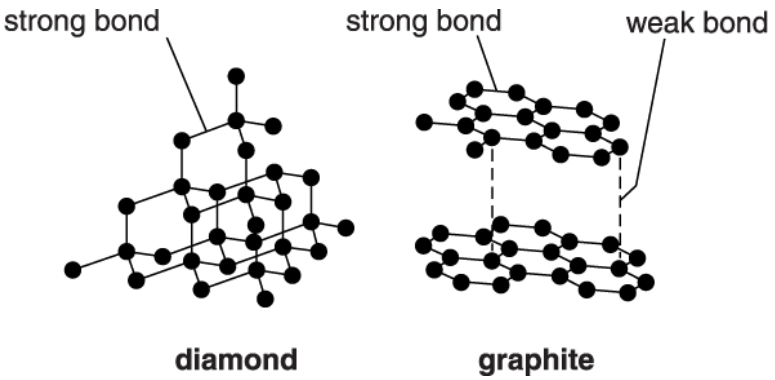
Diamond is used in cutting tools.



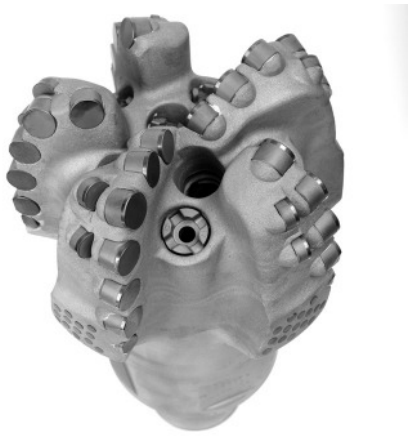
Explain why.

[1]

8(a). Look at the diagrams. They show the structures of diamond and graphite.



Diamond is used in cutting tools.



Explain why.

---

[2]

(b). Graphite is slippery.

Explain why.

---

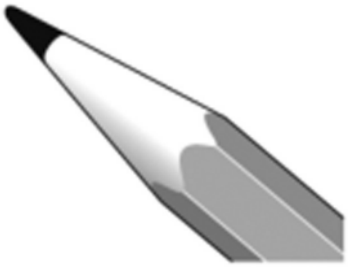
[1]

9. Diamonds are used in jewellery.

One physical property of diamond is that it is colourless.

Graphite is used in pencil leads.

One physical property of graphite is that it is slippery.



Diamond and graphite have some physical properties in common.

Write down **two** of these properties.

---

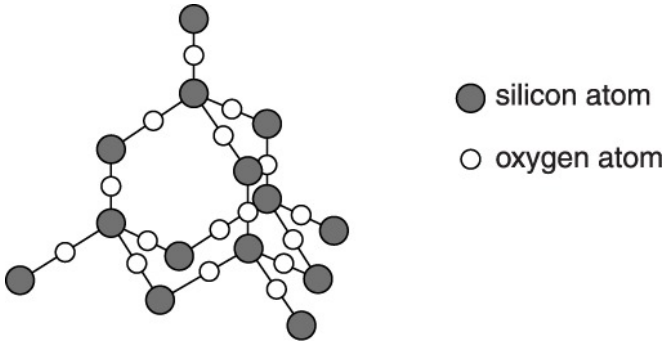
[2]

10(a) Both diamond and graphite have **giant molecular structures.**

.

Silicon dioxide also has a giant molecular structure.

Look at the structure of silicon dioxide.



Explain, using ideas about structure and bonding, why silicon dioxide has a high melting point.

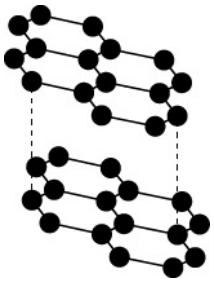
---

[2]

(b). Graphite is another allotrope of carbon.

Graphite is used in pencil leads.

Look at the structure of graphite.



Explain, using ideas about structure and bonding, why graphite is used in pencil leads.

---

[2]

11(a) Computer touch screens are made using the metal indium or using carbon fibre.

.

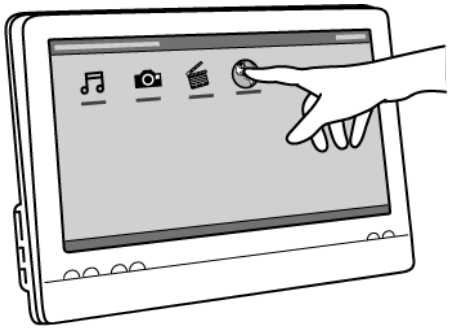


Table 1 shows the strength and the density (the mass of 1 cm^3) of these two materials.

Table 1

Material	Strength in MPa	Density in grams per cm^3
carbon fibre	1600	2.1
indium	262	7.3

Write about how suitable these two materials are for making the touch screens of tablet computers.

---

[2]

(b). In 2004 a new material called graphene was made.

It is made from graphite.

Graphene is a single sheet of carbon atoms that is one atom thick.

(i) A sheet of graphene is 8.0×10^{-8} cm thick.

What is the area of a sheet made with 1 cm^3 of graphene?

Put a tick (✓) in the box next to the correct answer.

8.0×10^{8} cm^2 ☐

1.3×10^{7} cm^2 ☐

1.3×10^{-7} cm^2 ☐

8.0×10^{-8} cm^2 ☐

[1]

(ii) Table 2 contains some information about indium and graphite.

Table 2

	World reserves in tonnes	World use in tonnes per year

indium	5 700	640
graphite	71 000 000	1 100 000

If **indium** is used at the present rate it will run out.

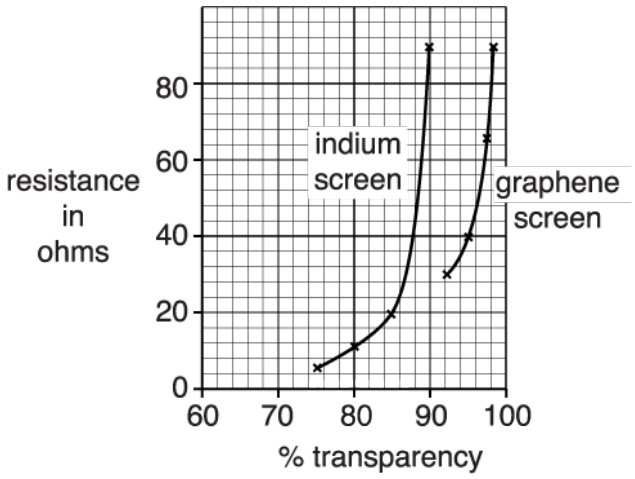
Use the data to work out how long it will last.

answer _____ years [1]

(iii) Computer touch screens need to be transparent and have a low electrical resistance.

Look at the graph.

It shows the range of transparency and resistance for screens made using graphene and screens made using indium.



A screen will not work if it has a resistance greater than 30 ohms.

What does the graph tell you about the use of **indium** for touch screens?

_____

_____

_____ [2]

(c). Scientists think the discovery of graphene is important.

Table 3 shows some more information about graphene.

Table 3

Strength in MPa	Density in grams per cm^3
5000	1.0

Evaluate the use of graphene for making touch screens.

Use Table 3 and information from all parts of the question in your answer.

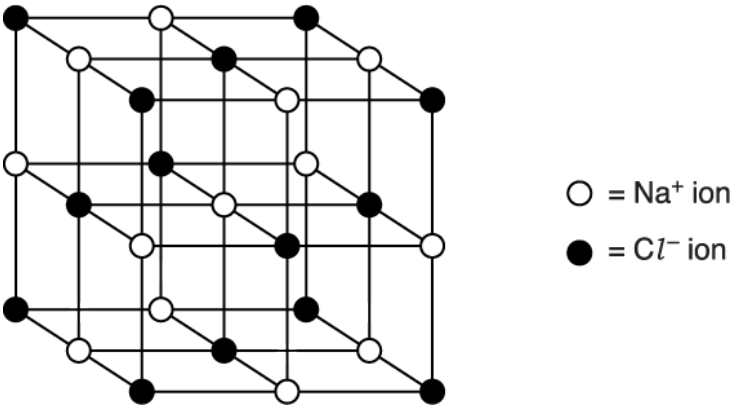
[4]

12(a) Sodium chloride is an ionic compound.

.

Sodium chloride is made of sodium ions, Na^+, and chloride ions, Cl^-.

Look at the diagram of part of the structure of sodium chloride.



How many Cl^- ions surround each Na^+ ion?

Choose from **2**, **4**, **6** or **8**.

answer _____ [1]

(b). Magnesium oxide is an ionic compound.

It has a similar structure to sodium chloride.

Both sodium chloride and magnesium oxide have a high melting point.

(i) Explain why sodium chloride has a high melting point.

---[1]

(ii) The melting point of magnesium oxide is higher than that of sodium chloride.

Explain why.

---[2]

13. Iron has a high melting point and is a good conductor of electricity.

Explain **both** of these properties of iron.

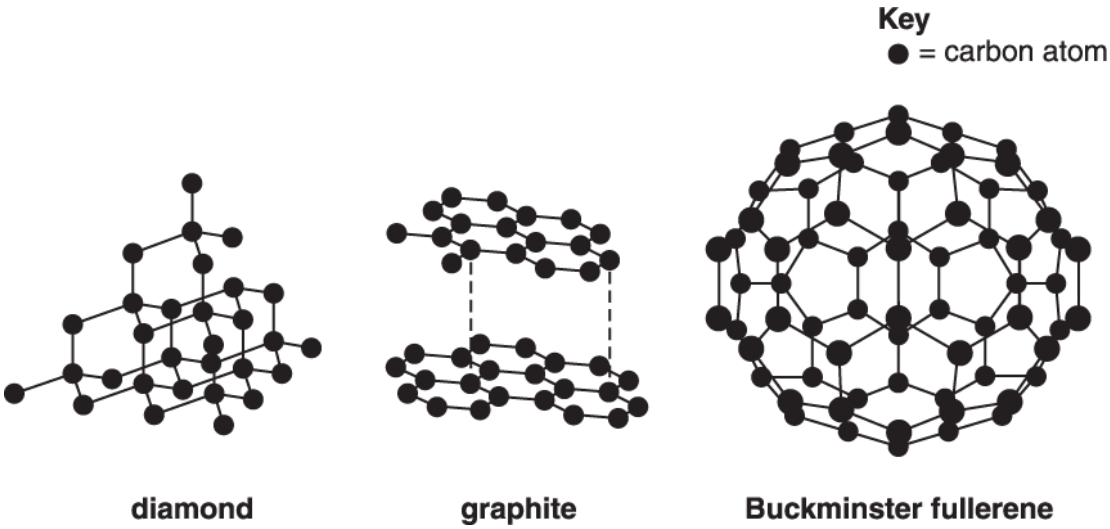
Use ideas about structure and bonding.

---[2]

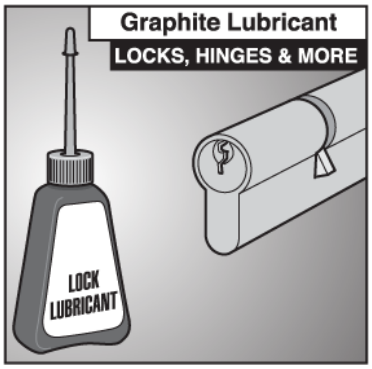
14(a) Look at the diagrams.

.

They show the structures of diamond, graphite and Buckminster fullerene.



Graphite is used in lubricants.



Use the structure of graphite to explain why.

---

[1]

(b). Diamond, graphite and Buckminster fullerene are **allotropes** of carbon.

Explain what is meant by allotropes.

---

[1]

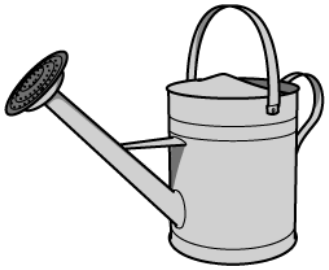
15(a) The properties of four metals are shown in the table.

.

Look at the table.

Metal	Melting point in °C	Density in g / cm^3	Reaction with water
W	1540	7.9	rusts rapidly
X	98	1.0	reacts violently
Y	660	2.7	no visible reaction
Z	840	1.6	slowly reacts

Oskar's grandad wants to buy Oskar a new watering can.



Which metal, **W**, **X**, **Y** or **Z** would be best to use to make the watering can?

Write down **one** reason for your answer.

---

[2]

(b). The table shows some properties of metals.

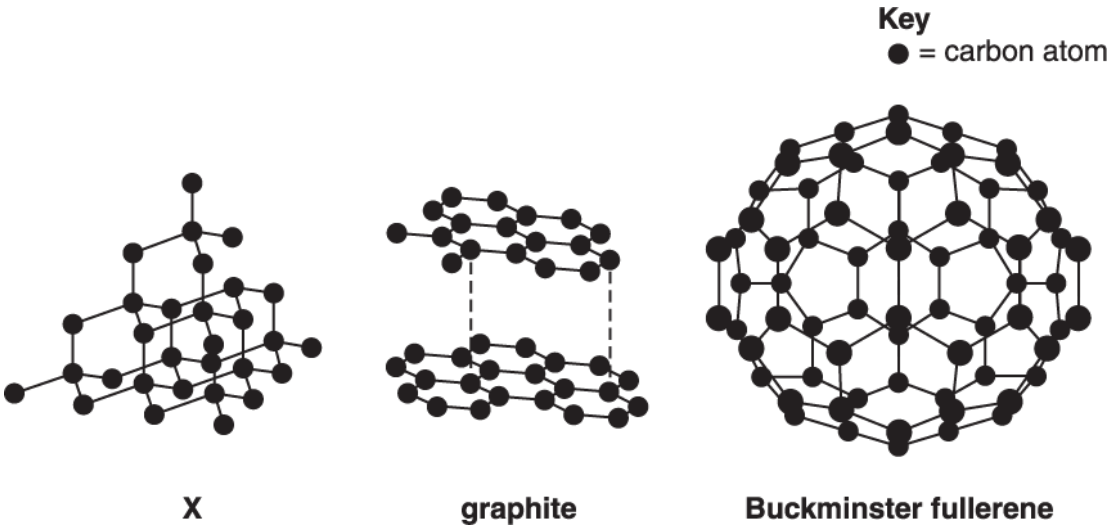
Write down **three other** properties of metals.

---

[3]

16. This question is about different forms of carbon.

Look at the diagrams. They show three different forms of carbon.



Ball-shaped fullerenes can be used in new drug delivery systems.

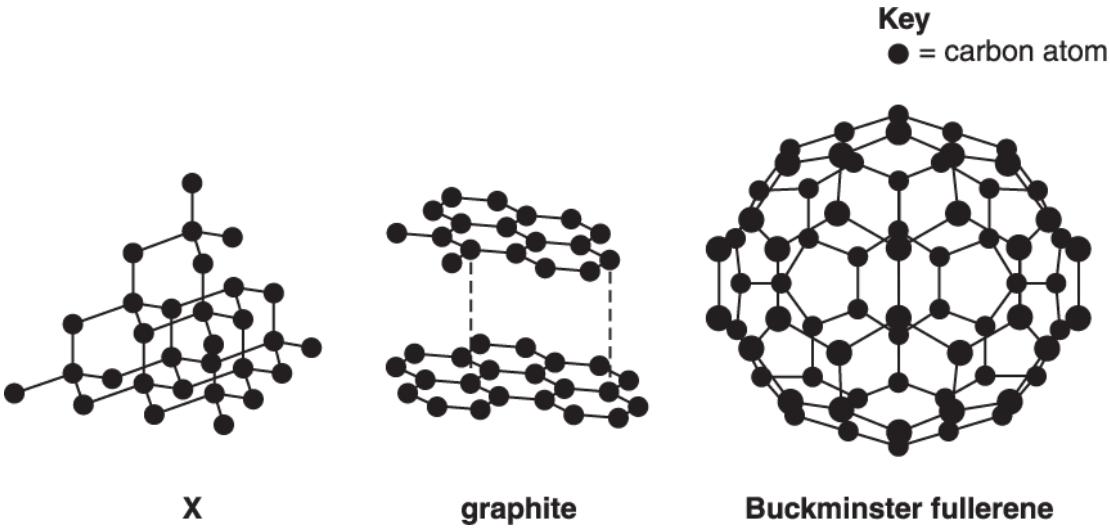
Explain why.

---

[2]

17. This question is about different forms of carbon.

Look at the diagrams. They show three different forms of carbon.



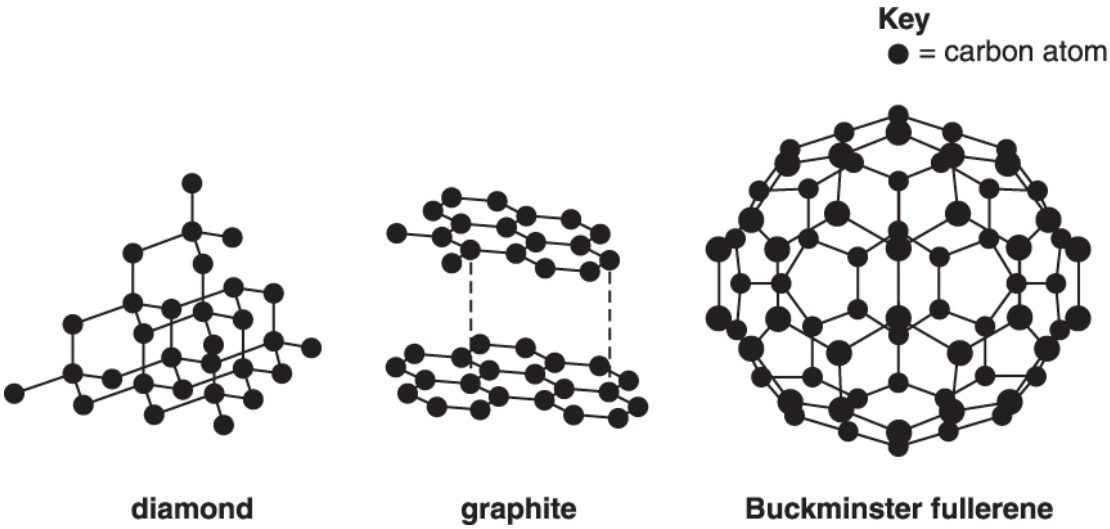
Write down the name of the form of carbon labelled **X**.

---

[1]

18. Look at the diagrams.

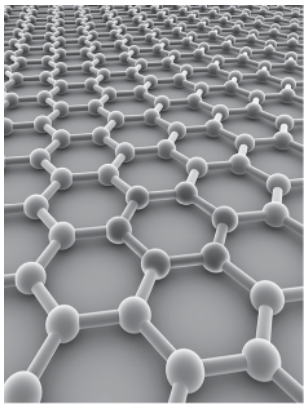
They show the structures of diamond, graphite and Buckminster fullerene.



Graphene is another allotrope of carbon.

The carbon atoms in graphene are arranged in a regular hexagon pattern, similar to graphite.

Graphene is different to graphite because it only has one layer of carbon atoms.



Scientists are developing graphene batteries that re-charge very quickly.

A mobile phone powered by a graphene battery could charge in only 5 seconds.

Graphite and graphene both conduct electricity.

Suggest why graphene conducts electricity.

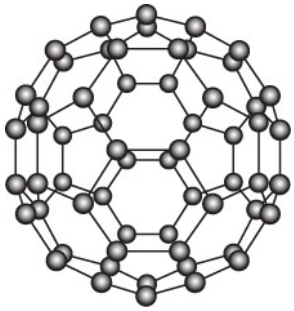
---

[2]

19. This question is about different forms of carbon.

Another form of carbon was first made in a laboratory over 25 years ago.

Look at this form of carbon.



Write down the **name** of this form of carbon.

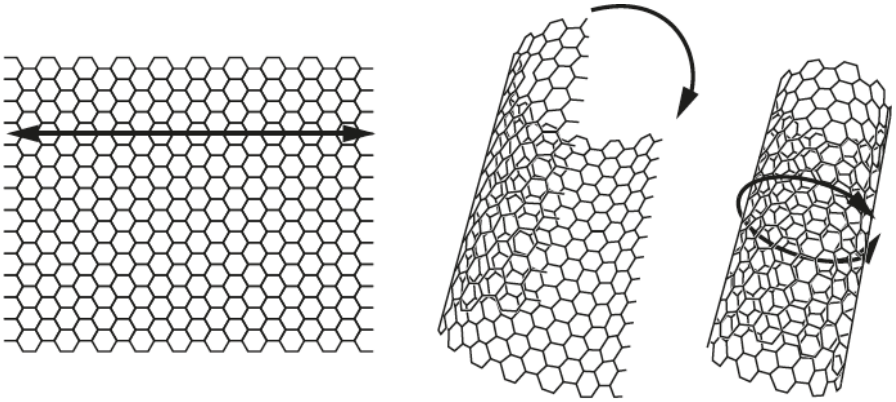
---

[1]

20(a) Carbon nanotubes are a new material.

.

The diagrams show how a graphene sheet can form a nanotube.



Nanotubes are more than 100 times stronger than iron.

Explain why nanotubes are so strong. Use ideas about bonding.

--- [2]

(b). Carbon nanotubes and iron have very similar electrical conductivities.

Look at some other properties of carbon nanotubes and iron.

Material	Density (g / cm^3)	Melting point (°C)
Carbon nanotubes	1.6	3500
Iron	7.9	1538

(i) Calculate how many times more dense iron is than carbon nanotubes.

Answer = ---------- [2]

(ii) Explain why iron is more dense than carbon nanotubes.

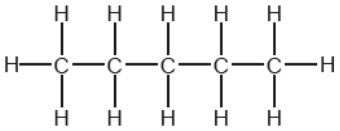
---[1]

(iii) Suggest a reason why carbon nanotubes have a higher melting point than iron.

---[1]

21.

The molecule below has a simple molecular structure. It has a boiling point of 36.1 °C.



Explain why the molecule has a low boiling point.

---[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			D	1	
			Total	**1**	
2			D	1	
			Total	**1**	
3			*Against* Carbon-fibre-reinforced-polymer very expensive (so only used in luxury cars) (1) *For* **Any two from** Carbon-fibre-reinforced-polymer stronger than steel/ORA (1) Carbon-fibre-reinforced-polymer lower density / ORA (1) Carbon-fibre-reinforced-polymer has better corrosion resistance / ORA (1)	3	Must have an argument for and against for full marks. **ALLOW** carbon-fibre-reinforced-polymer would be no good for crumple zones **ALLOW** carbon-fibre-reinforced-polymer's lower density will result in better fuel economy
			Total	**3**	
4			**C** because **any two from** is strong (1) does not corrode (easily) / corrodes (very) slowly (1) low density (1)	2	**no** marks for **C** on its own but if **C** is not chosen = no marks **ignore** references to melting points / conductivity **ignore** light **allow** lightweight **Examiner's Comments** The majority of candidates gave metal C and then listed all the properties.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
5			[Level 3] Applies understanding of the relationship between property and use of a material to give two properties needed by the metal AND identifies metal C with two reasons Quality of written communication does not impede communication of the science at this level (5 – 6 marks) [Level 2] Applies understanding of the relationship between property and use of a material to give two properties needed by the metal OR identifies metal C with a reason Quality of written communication partly impedes communication of the science at this level (3 – 4 marks) [Level 1] Applies understanding of the relationship between property and use of a material to give one property needed by the metal OR identifies C as a suitable metal (without a reason) Quality of written 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 C. Indicative scientific points at all could include: • Metal must be strong • Metal must not corrode or rust • Metal must be malleable • Metal must not be brittle Reasons: Metal C • idea that has highest relative strength / is very strong • idea that corrodes slowest / is slow to corrode ignore idea that metal C is the least corrosive ignore other properties Use the L1, L2, L3 annotations in scoris; do not use ticks. Examiner's Comments This six mark question was, in general, very well answered. However there was evidence that candidates had not read the question carefully. The question was in two parts, firstly to identify the properties necessary for the metal to make 'The Orbit' and secondly to identify with reasons which metal was most suitable from the list provided. Most candidates ignored the first part and went on to answer the second part correctly. Several candidates included all the properties rather than being selective and omitting melting point and electrical conductivity which have little relevance to the structure. Only those candidates who answered both parts were able to score full marks.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
6			any one from: lustrous (1) colourless (1) clear (1) transparent (1)	1	 **allow** shiny **allow** sparkly / glistens **ignore** cost / hard Examiner's Comments Candidates were able to explain why diamond is used for jewellery with lustrous and shiny being the most popular properties.
			Total	1	
7			any one from: hard (1) high melting point (1)	1	 **allow** hard wearing / it can't be scratched **ignore** durable / hard to break / good at cutting things **ignore** strong / sharp / dense **allow** it will not melt as an extra marking point **allow** (good) thermal conductor Examiner's Comments To get marks for this question, candidates needed to identify a property of diamond that would be useful in cutting tools. Answers such as 'strong' and 'sharp' did not get marks.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
8	a		hard (1) high melting point (1)	2	**allow** hard wearing / it can't be scratched **ignore** durable **/** hard to break / good at cutting things **ignore** strong / sharp / dense **allow** it will not melt **as an extra marking point** **allow** (good) thermal conductor **Examiner's Comments** Many candidates described diamond as 'strong' rather than 'hard'. Others referred to 'hard to break', although a number achieved both marking points. Many made references to strong covalent bonds, without applying this to the question.
	b		weak bonds between layers / layers can slide over each other (1)	1	**allow** references to weak (intermolecular) forces between layers **not** (weak) covalent bonds between layers **allow** sheets for layers / plates for layers **Examiner's Comments** The majority of candidates were not clear on the structure of graphite and made references to weak bonds between strong bonds or weak covalent bonds. There was a clear divide between those who knew exactly what was right and those who were trying to make something of the diagram.
			Total	3	
9			**any two from:** high melting point (1) insoluble in water (1) lustrous or shiny (1)	2	**allow** solid **Examiner's Comments** This question was not particularly well answered. Some common incorrect responses included strong, hard, sharp, found underground. Shiny was the most common scoring response.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
10	a		strong covalent bonds (1) lots of energy needed to break the bonds (1)	2	strong bonds **not** sufficient covalent on its own **not** sufficient **allow** covalent bonds are strong **not** giant ionic or giant metallic **not** intermolecular forces **allow** lots of heat needed to break the bonds **ignore** harder to break bonds **ignore** more heat needed to break bonds **ignore** high temperature **not** lots of energy needed to break ionic or metallic bonds **Examiner's Comments** This answer required candidates to write about strong covalent bonds and lots of energy needed to break these strong covalent bonds. Many candidates wrote about bonds but were not specific about them being strong covalent bonds. They also wrote about needing more energy to break them but not about the need for lots of energy.
	b		weak (intermolecular) forces between **layers** (can easily be broken) (1) **layers** can slide over each other (1)	2	**allow** has van der Waals forces between layers / weak bonds between layers **but** weak intermolecular forces on its own is not sufficient **allow** IMF for intermolecular or VDW for van der Waals forces **not** weak covalent bonds **allow** layers are slippery / **layers** rub off onto paper **Examiner's Comments** Candidates were usually awarded one mark for describing that graphite exists in layers and that these layers can slide over each other and onto the paper. Fewer candidates were able to describe the weak intermolecular forces between these layers. Many thought that the bonds were covalent or that the weak bonds were between atoms in the same layer.
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
11	a		carbon fibre is strong(er) so screen (it) is less likely to break (1) carbon fibre has low(er) density so computer (it) will be light (1)	2	**allow** ORA throughout **ignore** carbon fibre is light **allow** lightweight **if no other mark awarded allow** carbon fibre / computer is strong(er) and has low(er) density (1) Examiner's Comments There was the common confusion between density and weight in the answers here. A number of candidates also thought that touch screens should be as dense as possible to resist poking.
	b	i	1.3×10^7 (1) ☐ √ ☐ ☐	1	Examiner's Comments This question was designed to be challenging and did indeed prove so. Candidates found the standard form difficult to cope with and there were few correct answers.
		ii	8 / 9 (years) (1)	1	**allow** 8.9 / 8.91 / 8.906 etc Examiner's Comments This was a much more accessible calculation and was well-answered by most.

Question			Answer/Indicative content	Marks	Guidance
		iii	**any two from:** can be used because resistance can be less than 30 **Ω** (1) at 30 **Ω** / maximum transparency for screens is 87% (1) can give lower resistance but it is not very transparent (1) less transparent than graphene (1)	2	**allow** can be used because it can be less than 30 **Ω** **allow** maximum is 86 - 88% **allow** as resistance decreases, transparency decreases ORA **ignore** less transparent / low transparency unless qualified Examiner's Comments A number of candidates stated correctly that an indium screen could work as the resistance could be low enough but far fewer followed this up with the fact that the transparency would be quite low.
	c		**any four from:** strong(er) (1) low(er) density (than carbon fibre or indium) (1) **graphite** will not run out for a long time (1) graphite not run out for 64.5 years (1) it has a high transparency (1) **but** it has a high transparency for its resistance / for a low resistance (2)	4	**ignore** light / **allow** lightweight **ignore** lots of graphene left / **it** will not run out **allow** any value in range 60 -70 Examiner's Comments Candidates did quite well at bringing together information from all parts of the question but again imprecision cost some, with references to graphene being light or confusion between graphite and graphene.
			Total	**10**	

Question			Answer/Indicative content	Marks	Guidance
12	a		6 (1)	1	more than one answer = 0 Examiner's Comments ??Very few candidates gave the correct answer of six, with four being the most common error. It seemed that the majority of candidates only counted the atoms in one plane.
	b	i	strong attraction between positive and negative ion (1)	1	**not** strong covalent bond, strong metallic bond / intermolecular forces or references to molecules **allow** strong ionic bond / ions have strong bonds **ignore** strong bonds unless qualified **allow** it takes a lot of heat energy to break or overcome the ionic bonds Examiner's Comments ??Few candidates correctly referred to the strength of ionic bonds and again there were many incorrect references to covalent and intermolecular bonding.

Question			Answer/Indicative content	Marks	Guidance
		ii	**any two from** Mg^{2+} has a higher charge (than Na^{+}) (1) O^{2-} has a higher charge (than Cl^{-}) (1) greater attraction between ions (1)	2	**assume answers refer to magnesium oxide** **allow ora allow** Mg^{2+} is smaller (than Na^{+}) **not** atom **allow ora allow** O^{2-} is smaller (than Cl^{-}) **not** atom charge on ions in MgO greater than in NaCl (2) **not** strong covalent bond, strong metallic bond / intermolecular forces or references to molecules **allow** stronger ionic bonds **ignore** strong bonds unless qualified **if no other marks scored** then identifying Mg^{2+} **and** O^{2-} (1) Examiner's Comments ??This question was beyond most of the candidates and there were very few correct references to the charges on the ions.
			Total	**4**	
13			high melting point because strong attraction / strong (metallic) bonds / strong forces between metal ions and (delocalised) electrons (1) conducts electricity because electrons can move / it has free electrons / it has delocalised electrons (1)	2	**not** intermolecular forces / ionic bonds / covalent bonds **allow** positive atoms, cations, positive ions instead of metal ions **allow** lots of energy to break bonds / overcome attractions / forces / overcome electrostatic attractions **ignore** atoms **ignore** electromagnetic bonds Examiner's Comments Most candidates could correctly identify the free electrons as the reason for conductivity. However, the explanation for the high melting point were hampered by the same inaccuracies.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
14	a		(because it is) slippery (1)	1	**allow** weak forces between the layers or sheets (1) **allow** weak bonds between the layers or sheets (1) **not** weak covalent bonds **ignore** (inter)molecular **ignore** weak layers **allow** layers can **slide** over each other / sheets can **slide** over each other (1) **ignore** rub (off) Examiner's Comments About 50% of candidates gained this mark for answers about it being slippery or because layers can slide. A few candidates wrote about atoms slipping or sliding rather than layers of atoms sliding. A few also wrote about forces between atoms rather than between layers. A common misconception was that graphite is a good lubricant because it is a liquid.
	b		different structures of the same **element** **or** different structures of **carbon** (1)	1	**allow** different forms of the same **element** (1) **allow** different forms of **carbon** (1) **allow** different arrangement of carbon atoms (1) Examiner's Comments Candidates found it difficult to explain what is meant by allotropes. Many candidates thought they were different compounds or atoms having different forms or structures. A few candidates used ideas about protons and neutrons as the definition of an isotope in their answers.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
15	a		Y (1) does not react (with water) (1)	2	W, X or Z scores 0 for the question **allow** does not rust (1) Examiner's Comments Good responses selected metal Y as the best metal to make the watering can because it does not react with water. Candidates who chose one of the other metals did not gain credit for the question.
	b		**any three from:** **high** boiling point / solid **at room temperature** (1) (good) heat conductor (1) (good) electrical conductor (1) malleable / can be worked into sheets (1) ductile / can be made into wire (1) hard (1) strong (1) flexible / not brittle (1) shiny / lustrous (1)	3	**allow** chemical properties such as react with acids / forms basic oxides / form positive ions (1) **allow** (good) conductor for 1 mark, if neither heat nor electrical specified **allow** can be shaped (1) **ignore** strength unless qualified **allow** sonorous (1) **ignore** melting point / density / reaction with water / solid (unless qualified) / durable / hard wearing Examiner's Comments The mark scheme gave credit for a wide variety of properties of metals. Candidates who did not gain credit often wrote their answer in the form of questions, e.g. 'Is the metal strong?' and did not gain credit. Answers such as 'strength' also did not gain credit, as it was not clear if the candidate was referring to high or low strength.

Question			Answer/Indicative content	Marks	Guidance
			Total	5	
16			any two from: idea that fullerenes can act as (hollow) cages to trap other molecules (1) idea that fullerenes can carry drug (molecules) around the body (and deliver them to where they are needed) (1) large (internal) surface area (1)	2	**allow** store drugs inside the fullerene in the body **allow** transport drugs Examiner's Comments Not well-answered by the majority of candidates. There were very few correct responses for either marking point. The majority of candidates just repeated the question in their answers. . Better responses seen were ‘store drugs inside’, ‘enclose the drug’ and ‘transport the drugs’ but very rarely were two marking point put together.
			Total	2	
17			diamond (1)	1	Examiner's Comments Most candidates scored here, although spelling of ‘diamond’ was poor.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
18			(graphene conducts electricity is related to the presence of) electrons (1) **but** has mobile electrons / delocalised electrons / free electrons / moving electrons (2)	2	**ions, molecules or atoms moving scores 0 for the question** **ignore** reference to bonded electrons **maximum of 1 mark if electrons are positive** **allow** has spare electrons / has loose electrons (2) Examiner's Comments Where candidates gave the answer of 'electrons' they usually explained that these electrons were delocalised or free. Some candidates thought that graphene conducted electricity because it is a metal. Others thought that there was space for the electricity to flow between the layers or across the single layer.
			Total	2	
19			Buckminster fullerene	1	**allow phonetic spelling** **allow** buckyball **not** Buckminster or fullerene on their own Examiner's Comments ??This was frequently left blank. However, some did score even with the correct spelling. Some candidates realised that it was an allotrope of carbon.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
20	a		Covalent bonds identified in tubes ✓ Idea that **bonds** are (very) strong / there are many bonds / bonds take lots of energy to break ✓	2 (AO2 × 1.1)	**DO NOT ALLOW either mark for** reference to intermolecular forces or ionic bonding Covalent bonds are strong(er) = 2 Giant covalent structures = 2 Examiner's Comments Mostly candidates scored 1 mark for the idea of strong bonds, although this often not expressed clearly. Few identified covalent bonds. Many candidates mentioned intermolecular forces which invalidated any otherwise correct answers.
	b	i	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 4.9 award 2 marks** 7.9÷1.6 ✓ = 4.9 ✓	2 (AO2 × 2.2)	**ALLOW** 5 / 4.94 /4.938 / 4.9375 Check for incorrect rounding e.g. 4.93 would not score 2 marks Examiner's Comments Many candidates were able to calculate this correctly. Some did not show their working so when they made an error, typically in rounding, they did not gain any credit. The most common error was to subtract the densities to give 6.3. A few candidates used the melting point data by mistake.

Question			Answer/Indicative content	Marks	Guidance
		ii	**Any one from:** Atoms are packed clos**er together (in metals) / ORA** ✓ Carbon nanotubes have hollow spaces / holes **ORA** ✓ RAM of iron much bigger than RAM of C ✓	1 (AO2.1)	Assume 'it' refers to iron unless qualified. Beware of repeats of stem – 'iron is more dense than carbon' **ALLOW** (iron) layers are clos**er** together <u>Examiner's Comments</u> Some candidates could explain about the iron atoms being tightly packed. However, they often did not give comparative answers so gained no credit e.g. iron atoms are close together. Some candidates said 'they' are hollow but did not make it clear that they meant carbon nanotubes. Some just stated that iron was heavier or had more mass but few mentioned relative atomic mass. A variety of irrelevant answers were given including relating density to melting point and conductivity.
		iii	(Covalent) **bonds are stronger (than metallic bonds) / more energy needed to break (covalent) bonds / ORA** ✓	1 (AO3.2a)	**DO NOT ALLOW** Intermolecular forces references Assume 'they' relates to carbon <u>Examiner's Comments</u> Many candidates knew that carbon nanotubes had strong bonds but did not always make their answer comparative so did not score the mark. Many incorrect answers linked high melting point to high density, or just to the nanotubes being stronger.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
21			Weak intermolecular forces / weak forces **between** molecules ✓ Idea that only need a small amount of energy to break these forces ✓	2 (AO 2 ×2.1)	**DO NOT ALLOW** reference to covalent bonds in incorrect context or references to ions <u>Examiner's Comments</u> Candidates who struggled to discuss the correct type of bonding in question (a) also tended to struggle with this question for the opposite reason. They talked about covalent bonds as this is what they were shown in the displayed formula in the stem of the question. Only higher ability candidates could clearly state weak intermolecular forces between the molecules were responsible for the low boiling point. Many incorrect responses discussed 'weak covalent bonds' or 'forces between the atoms' and so were unable to have marks credited. **Exemplar 7** It has a low boiling point because little energy is required to break the single bonds inbetween each atom This response describes the breaking of the covalent bond between the atom rather than the low boiling point being related to the weak intermolecular forces between the molecules. Unfortunately this was a common misconception.
			Total	**2**	