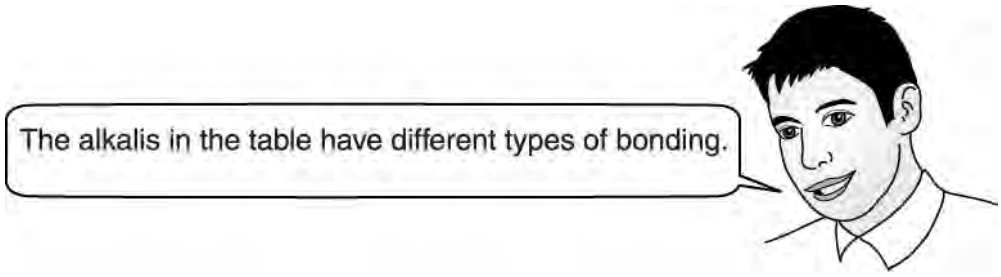
1. Matt finds out about the bonding in some compounds.

He dissolves them in water and uses a pH meter to find out if each compound is an acid or an alkali.

The table shows his results.

Compound	Bonding in compound	Acid or alkali?
sodium hydroxide	ionic	alkali
ammonia	covalent	alkali
hydrogen chloride	covalent	acid
ethanoic acid	covalent	acid
calcium hydroxide	ionic	alkali

Matt has an idea.



Do you agree with Matt's idea?

Use examples from the table to explain your reasoning.

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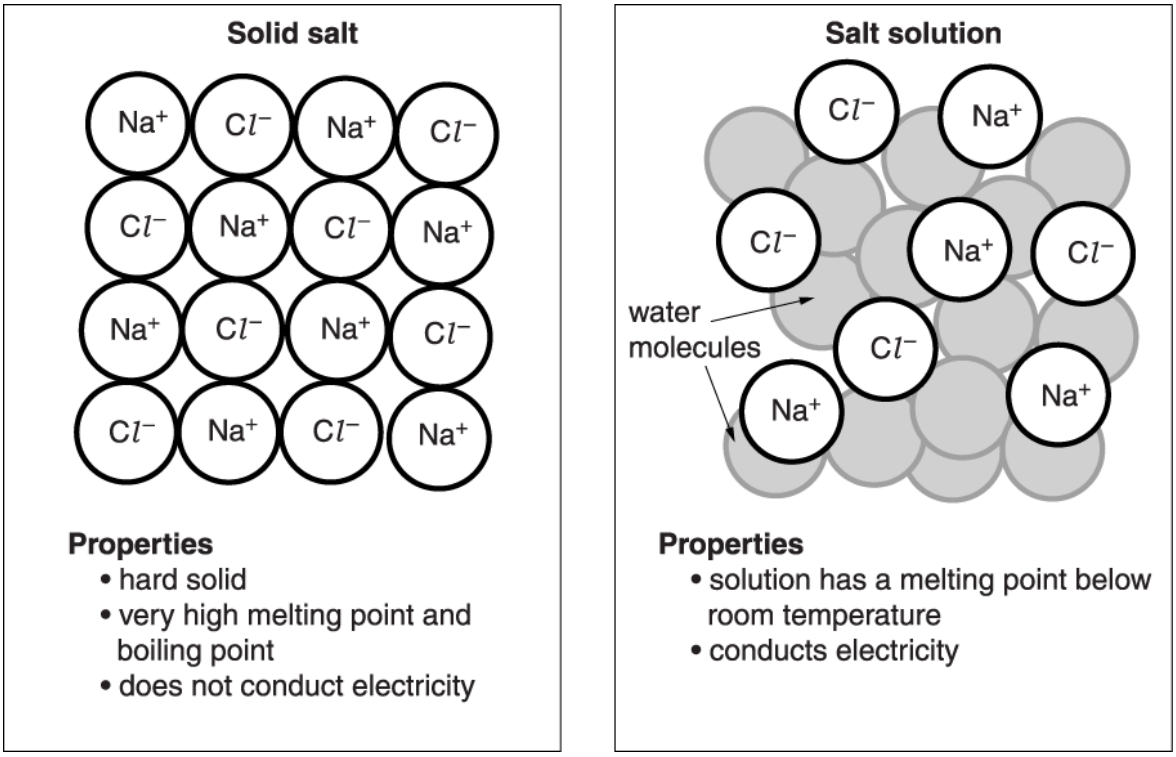
[2]

2. The chemical name for common salt is sodium chloride.

The information shows the properties and arrangement of particles in solid salt and in salt solution.

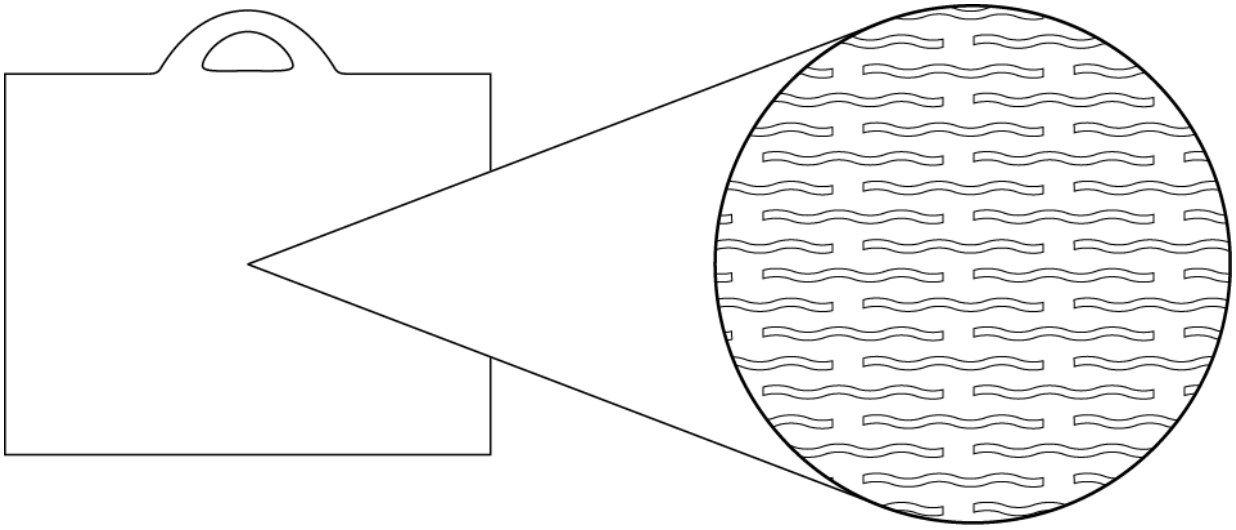


Explain how the properties of solid salt and salt solution depend on the arrangement and movement of their particles.

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

[6]

3. The diagram shows the way that the molecules are arranged in a plastic bag.



Suggest why it is easier to stretch the bag across than stretch it down.

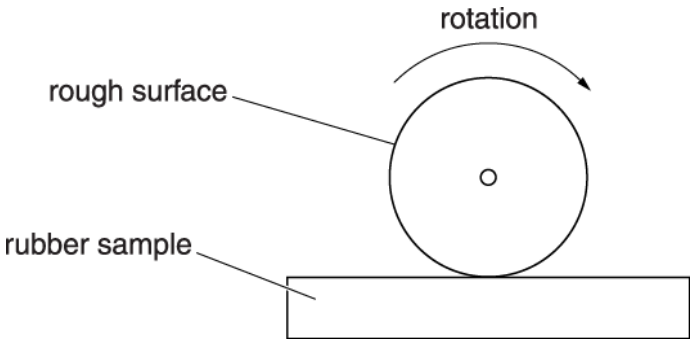
---

[2]

4. Vulcanised rubber is made by reacting natural rubber with sulfur.

Samples of vulcanised rubber and natural rubber are tested to see how hard-wearing they are.

Scientists measure the time taken to wear away 1.0 cm of the rubber.



Here are their results.

Sample number		1	2	3	4	5	6	Range	Mean
Time in mins to wear away 1.0cm rubber	natural rubber	13	15	12	13	11	14	11–15	13
	vulcanised rubber	34	33	35	37	33	32	32–37	34

(i) Why were measurements made on several samples instead of just one?

Put ticks (✓) in the boxes next to the **two** correct statements.

It allows the procedure to be practised. ☐

One sample could be faulty. ☐

The mean is closer to the true value. ☐

To make sure all samples are the same size. ☐

Vulcanised rubber has been reacted with sulfur. ☐

[2]

(ii) What do these results suggest about the effect of vulcanisation on rubber?

---

[1]

(iii) How sure can you be that your answer to **(ii)** is correct?

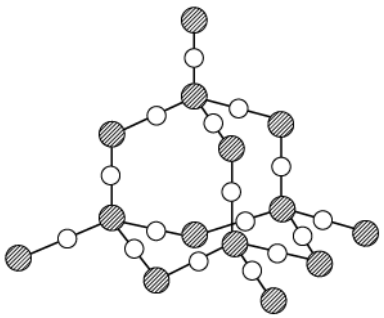
Complete the sentences by putting a ring around the correct word in each box.

I am [**sure** / **not sure**] that my answer is correct.

This is because the [**range** / **mean**] of each set of results is [**small** / **large**] compared with the difference between the two sets of results.

[2]

5. Carbon dioxide and silicon dioxide are compounds that occur naturally.
The table shows some information about the two compounds.

	carbon dioxide	**silicon dioxide**
formula	CO_2	SiO_2
structure		
melting point in °C	–78	1710
boiling point in °C	–57	2230
electrical conductivity	does not conduct	does not conduct

Which of the statements are **only true for carbon dioxide, only true for silicon dioxide** or **true for both**?
Put one tick (✓) in each row.

	Only true for carbon dioxide (✓)	Only true for silicon dioxide (✓)	True for both (✓)
contains small molecules with a few atoms in each			
has a giant structure			
contains covalent bonds			
is a gas at room temperature			

[3]

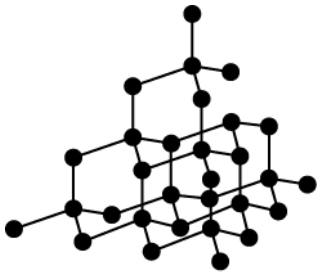
6. Sam does some research about the properties of diamond and graphite.

The table shows what he finds out.

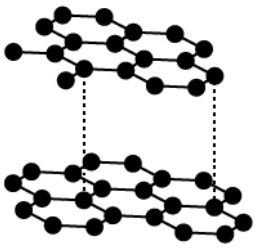
	Diamond	Graphite
Melting point in °C	3560	3650
Boiling point in °C	4830	4830
Solubility in water	insoluble	insoluble
Electrical conductivity	does not conduct	good conductor
Hardness	very hard	soft, flakes easily

Sam notices that some of the properties are similar and some are different.

He finds diagrams that show the structures of diamond and graphite.



diamond



graphite

The table shows some similarities and differences in the **properties** of diamond and graphite.

Use ideas about their **structures** to explain these similarities and differences.

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

[6]

7. A company decides to make fence posts from a plastic.

The polymer used to make the posts has a wide range of flexibility.

Which statements give an explanation for this?

Put ticks (✓) in the boxes next to the **two** best statements.

The polymer does not have any cross-linking. ☐

Plasticizer has mixed unevenly in the polymer. ☐

Only one type of monomer has been used to make the polymer. ☐

Too much plasticizer has been added to the polymer. ☐

Different batches of the polymer have different chain lengths. ☐

All of the polymer molecules are very long. ☐

[2]

8. Modern synthetic materials have replaced some materials that were used in the past.

Give one example of an object that is now made from a better synthetic material.

object _____

old material _____

new material _____

[2]

9(a). **Table 1.1** shows some information about diamond, graphite and carbon dioxide.

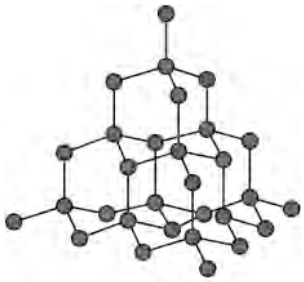
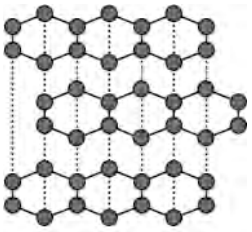
	Diamond	Graphite	Carbon dioxide
Diagram of structure			
Formula	C(s)	C(s)	$CO_2(g)$
Element or compound?	element	element	compound
State at room temperature and pressure	solid		
Structure and bonding	giant covalent	giant covalent	simple covalent

Table 1.1

Explain why diamond and graphite are elements, but carbon dioxide is a compound.

---

[2]

(b). Diamond and graphite have giant covalent structures.
Carbon dioxide has a simple covalent structure.

Explain how the diagrams of their structures show that these statements are true.

---

[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			sodium hydroxide and/or calcium hydroxide have ionic bonding; ammonia has covalent bonding;	2	If neither mark awarded: **allow** 1 mark for idea of both ionic and covalently bonded alkalis Examiner's Comments?? More candidates were able to use the information in the table to explain that alkalis can be covalent or ionic although some did not use examples from the table as requested.
			Total	2	
2			[Level 3] Links a property for both solid **and** solution to arrangement and/or movement of particles. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Links a property of solid **OR** solution to ideas about arrangement and/or movement of particles. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Makes a correct statement about arrangement and/or movement of particles for solid **OR** solution. 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 may include: Properties and explanation (points relevant to) solid • Hard/solid because of strong forces/attraction/ bonds • high MP/BP due to strong forces/attraction/bonds • does not conduct electricity because ions/particles cannot move (points relevant to) solution • liquid because particles can move/flow • liquid/low melting point because ions spread out (in the water) / weak forces / have less attraction /weak bonds/ water gets between ions/particles • conduct electricity because ions/charged particles can move Arrangement and movement of Ions/particles in solid • arranged in regular rows / 3D / lattice • cannot move/vibrate in place • strong forces/attraction/ bonds Ions/particles in solution • can move • random arrangement • spread out/separate

Question			Answer/Indicative content	Marks	Guidance
					• mixed with water molecules • weak forces / attraction / bonds **Do NOT allow** electron movement to explain conductivity **Incorrect word** e.g. molecule or atom limits QWC at L2 and L3. **If no reference to particles of any sort then L1 only** **Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.** **Examiner's Comments** Candidates struggled to relate their knowledge of the particles in solid and aqueous sodium chloride to the information given in the diagrams. There were some good descriptions of the arrangements but links of these to relevant properties were less common so limiting the level possible. There were frequent references to atoms or molecules in spite of ions being clearly shown in the diagrams and some did not refer to particles at all.
			Total	6	
3			**any 2 from:** molecules are aligned across the bag ; molecules slide over each other for stretching across the bag ; molecules have to be pulled away from each other / forces between molecules have to be broken to stretch down the bag	2	**Examiner's Comments** Many candidates could recognise that the molecules were aligned across the bag but few recognised the link to the ease of the ability of the molecules to slide over each other rather than separate up and down. The vast majority of candidates thought that stretching was due to the elongation of the molecule rather than the molecules sliding past each other.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
4		i	tick in box 2 (1) tick in box 3 (1)	2	**Examiner's Comments** This question was very well answered with almost all candidates scoring at least one of the two marks available.
		ii	it makes rubber more durable / more hard wearing / longer lasting / harder / stronger	1	owtte **Examiner's Comments** This question was very well answered with almost all candidates recognising that vulcanisation makes the rubber more hard wearing or durable and hence scoring the mark available.
		iii	sure range small	2	all three correct = 2 marks two correct = 1 mark **Examiner's Comments** Very few candidates scored both marks available here. Two correct responses were needed to score one mark and all three were correctly needed for both marks. The box that gave the biggest problem for candidates was the decision between range and mean.
			Total	5	
5			<table><tr><th>only</th><th>true for carbon dioxide (✓)</th><th>only true for silicon dioxide (✓)</th><th>true for both (✓)</th></tr><tr><td>contains ... in each</td><td>✓</td><td></td><td></td></tr><tr><td>... giant structure</td><td></td><td>✓</td><td></td></tr><tr><td>.. covalent bonds</td><td></td><td></td><td>✓</td></tr><tr><td>.. gas ...</td><td>✓</td><td></td><td></td></tr></table>	3	all correct = 3 3 correct = 2 2 correct = 1 1 correct = 0 **Examiner's Comments** A minority of candidates scored full marks on this question, but most scored at least one mark. The most common incorrect response selected was about the covalent bonds.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
6			**Level 3 (5–6 marks)** Links a similar and a different property to both structures. Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** Links a property to the structure for diamond or graphite. Quality of written communication partially impedes communication of the science at this level. **Level 1 (1–2 marks)** Compares **properties** and/or makes points about **structures**. Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted at grades up to C** **Relevant points include:** **Properties** (look for comparison) • both have high / similar melting points • both have high / similar boiling points • both are insoluble in water • graphite conducts but diamond does not • diamond is harder (than graphite) (needs comparison) • Graphite flakes / marks paper' and diamond does not (needs comparison) • Appearance of diamond and graphite is different **Structures** • Both have strong bonds • Both have covalent bonds • Both have giant structure / lattice structure / lots of bonds / macromolecule • Both contain carbon atoms • graphite has layers • diamond has four bonds / tetrahedral • graphite has three bonds • graphite has delocalised electrons (**accept** 'free' electrons) • graphite has weak bonds / intermolecular forces between layers • graphite has rings / hexagonal structure **Similar properties linked to structure** • (both) high melting / boiling point because strong bonds / giant structure • (both) insoluble because covalently bonded **Different properties linked to structure** • (diamond) hard because strong bonds / each atom bonded to 4 others and (graphite) Soft / flakes because of layers / weak bonds between layers

Question			Answer/Indicative content	Marks	Guidance
					• (diamond) does not conduct because electrons cannot move and (graphite) conducts because electrons move / are 'free' / delocalised **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** **Examiner's Comments** There were very few answers reaching Level 3; usually because candidates could not describe structure using the correct terminology and this meant they could not describe both a similarity and difference based on structure. Many achieved 2 marks for correctly identifying properties. At Level 1 there were a lot of good answers but candidates never got past comparing properties and / or structures. Some effort had clearly been made but there were very vague descriptions of tightly or loosely packed "molecules" or "gaps allowing electricity to get through". Often candidates were aware that it was 'things' moving which were responsible for graphite's conductivity, but they often chose the wrong 'thing' eg ions/atoms/layers. Level 2 responses were usually awarded for graphite being 'soft due to the layers'.
			Total	6	
7			Plasticizer has mixed unevenly in the polymer. ☐ Plasticizer has mixed unevenly in the polymer. ✓ Plasticizer has mixed unevenly in the polymer. ☐ Different batches of the polymer have different chain lengths. ☐ Different batches of the polymer have different chain lengths. ✓ Different batches of the polymer have different chain lengths. ☐	2	**Examiner's Comments** This question was poorly answered. Candidates appeared to choose statements based on the keywords rather than the 'best' statements to actually answer the question.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
8			named sensible article eg tennis racquet (no mark) old material consistent with article eg wood (1) new material consistent with article eg carbon fibre (1)	2	**allow** 'plastic' for new material **Examiner's Comments** The best answers here were where simple objects were chosen eg 'window frames', the old material identified as 'wood' and the new material of 'PVC'. Other correct responses included bag, paper and plastic or tennis racket, wood and carbon fibre. Some students did not name an article at all, while others picked the most obscure objects. Many candidates used silk and cotton as their old material for items of clothing and nylon for the new material. A common error was mixing up the old and new materials. Eg where the object was given as 'shoes', the old material 'polymer/plastic' and the new material 'leather' Some candidates missed the point and named a material rather than an object eg 'silk' rather than 'scarf'. This then gave the candidates problems in naming the old material, for example, the old material used to make silk.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
9	a		diamond and graphite contain only carbon (atoms)✓ carbon dioxide contains carbon and oxygen (atoms) / also contains oxygen (atoms)✓	2 (AO 2× 1.1)	ALLOW only one <u>type</u> of atom / all same atom ALLOW two <u>types</u> of atom / different IGNORE mixtures / elements <u>Examiner's Comments</u> Candidates should be aware that an element contains only one type of atom and a compound has more than one type of atom joined together in a fixed ratio. In this case it was sufficient to identify that the elements contained <u>only</u> carbon atoms but that carbon dioxide had carbon and oxygen.
	b		diamond and graphite contain many atoms (bonded together) / many bonds / lattice ✓ carbon dioxide is a small molecule / contains only a few / 3 atoms (bonded together) / few / 2 bonds ✓	2 (AO 2× 1.1)	IGNORE because they are very big ALLOW 'they are very big molecules'. <u>Examiner's Comments</u> Both structures have covalent bonding, so a good answer is focused on the scale of the structure, with many atoms or bonds in a giant structure and very few in a simple structure.
			Total	4	