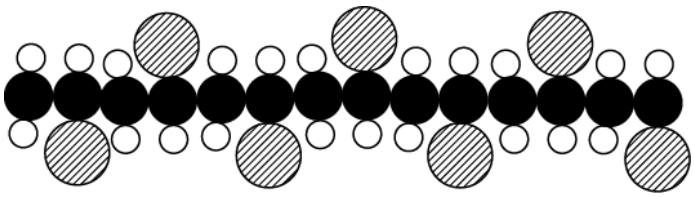
1(a). The diagram shows part of a molecule of PVC.



PVC contains carbon, hydrogen and one other element.

What is that other element?

Put a (ring) around the correct answer.

chlorine **nitrogen** **oxygen** **sulfur**

[1]

(b). **Seven** monomers have been joined together to make the polymer in the diagram above.

Which diagram shows a monomer of PVC?

Put a (ring) around the correct answer.

[1]

(c). Plasticizers are small molecules. They are added to PVC to make it more flexible.

(i) Explain how adding plasticizers makes PVC more flexible.

Put ticks (?) in the boxes to complete these sentences.

Plasticizers

move the PVC chains further apart.	
link the PVC chains.	
tangle the PVC chains together.	

This means the forces between the molecules are

stronger.	
the same.	
weaker.	

So the molecules

are held together and cannot move.	
can slide over each other.	
move out of their solid structure and become a liquid.	

[3]

(ii) PVC, which contains plasticizers, can be used for wrapping food. Plasticizers may leach out of the PVC.

Suggest why this could be harmful.

---

[2]

2. 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]

3. This is a question about poly vinyl chloride (PVC).

PVC contains carbon, hydrogen and one other type of atom.

What is the other type of atom?

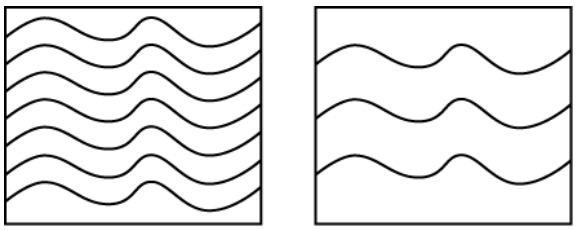
Put a ring around the correct answer.

chlorine nitrogen sodium sulfur

[1]

4. Carrier bags are made of polythene.

The diagrams show how the molecules are arranged in two types of polythene.



polythene **A** polythene **B**

(i) Put a tick (?) in the box next to the correct words to complete the sentence.

The density of polythene **A** is

higher than	
lower than	
the same as	

the density of polythene **B**.

[1]

(ii) Molecules that are **closer** together have **bigger** forces between them.

Put a tick(?) in the box next to the correct words to complete the sentence.

The breaking strength of polythene **A** is

higher than	
lower than	
the same as	

the breaking strength of polythene **B**.

[1]

5(a). Tennis balls are made from rubber.

Many small molecules react together to make long-chain molecules of rubber.

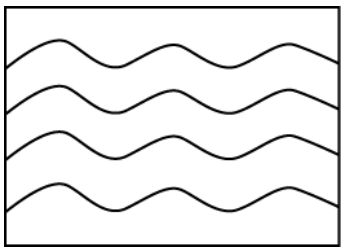
What is the name for this type of reaction?

Put a (ring) around the correct answer.

oxidation **polymerisation** **reduction** **refining**

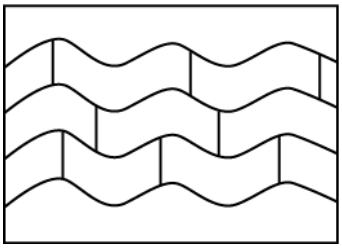
[1]

(b). This diagram shows molecules of rubber.

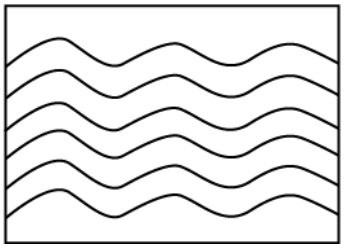


(i) Which of the diagrams **A**, **B**, or **C** shows rubber that has been **cross-linked**?

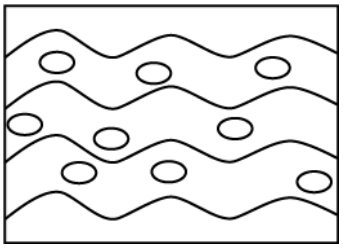
A



B



C



_____ **[1]**

(ii) The properties of rubber are changed by cross-linking or by adding plasticiser.

Complete these sentences by putting a tick (✓) in the correct box.

Cross-linking makes the rubber

harder.	☐
softer.	☐
weaker.	☐

	have a higher melting point.	☐
Adding a plasticiser makes the rubber	more flexible.	☐
	much stronger.	☐

[2]

[Total: 9]

6. **Table 9.1** shows the properties of three polymers.

Polymer	Relative breaking strength	Flexibility	Temperature at which it softens (°C)	Cost
A	very high	fairly flexible	250	very high
B	low	very flexible	70	low
C	fairly low	stiff	150	low

Table 9.1

Which of polymers, **A, B** and **C**, has the **weakest** intermolecular forces?

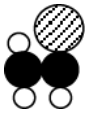
Give a reason for your answer.

Polymer ----------

Reason ----------

---------- **[2]**

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a		chlorine	1	**Examiner's Comments** Few candidates recognised 'chlorine' as the element present in PVC. Nitrogen was a popular incorrect response here.
	b		ring around 	1	**Examiner's Comments** Most candidates struggled to identify the correct repeat unit. The most frequently chosen incorrect response was that depicting two and a half repeat units.
	c	i	moves the PVC chains further apart;(1) weaker;(1) can slide over each other;(1)	3	**Examiner's Comments** A range of responses here with no real pattern of incorrect choices.
		ii	plasticizer may get into food /risk from eating the food; (1) (food) may be toxic/poisonous to humans / can't be easily broken down in the body (1)	2	**Examiner's Comments** Candidates could explain the 'leaching' of the plasticiser from the wrapping into the food and then explain the idea of these plasticisers getting into the body through the consumption of this food.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
2			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	
3			chlorine	1	**Examiner's Comments** The majority of candidates couldn't identify chlorine as the correct response.
			Total	1	
4		i	higher than	1	**Examiner's Comments** Both were well answered.
		ii	higher than	1	**Examiner's Comments** Both were well answered.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
5	a		polymerisation	1	**Examiner's Comments** A significant number of candidates scored this mark. Misconceptions were centred around the distractor of 'refining' as this was the most common incorrect response given.
	b	i	A	1	**Examiner's Comments** Again a significant number of candidates scored this mark and correctly identified that diagram A represented the cross linking.
		ii	harder; (1) more flexible; (1)	2	**Examiner's Comments** The majority of candidates scored at least one mark in this question. Usually 'harder' was the easier word to select to complete the first of the sentences describing cross linking. The plasticiser sentence appeared more challenging with a number of candidates choosing 'much stronger' where they selected an incorrect response.
			Total	**4**	
6			**B** ✓ if correct, look for 2nd mark (Lowest) softening temperature ✓	**2 (AO 3.2a × 2)**	Only allow the 2nd mark if 'B' is given. **ALLOW** breaking strength **IGNORE** flexibility **CON** cost **Examiner's Comments** The consequences of weak intermolecular forces were well understood.
			Total	**2**	