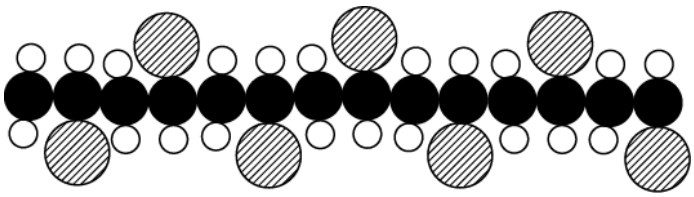
1(a). The diagram shows part of a molecule of PVC.



(i) Name the missing element.

● is a carbon atom

○ is a hydrogen atom

◍ is a ..... atom.

[1]

(ii) **Seven** monomer molecules have been joined together in this diagram.

Draw a diagram to show one monomer of PVC.

[1]

(b).

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

Explain how adding plasticizers makes PVC more flexible.

---[3]

(ii) In some parts of the world there is a ban on the use of plasticized PVC to wrap food.

Explain why some scientists think that plasticized PVC is not safe when it is in contact with food.

---[2]

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2. Carrier bags are made of polyethene.

There are two types of polyethene.

High density polyethene (HDPE) is stronger than low density polyethene (LDPE).

HDPE is more crystalline than LDPE.

How do the **arrangements of molecules** in HDPE and LDPE differ?

Suggest a reason why this makes HDPE stronger.

You may use diagrams to help you answer.

---

[2]

3.

The table shows the properties of three polymers.

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

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

Give a reason for your answer.

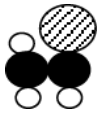
Polymer ----------

Reason ----------

---

[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a	i	chlorine	1	
		ii		1	**Allow** any clearly recognisable representation of the monomer. Accept chemical symbols as the diagram. **Examiner's Comments** A large percentage did not name the atom correctly in part (i). All sorts of answers were given ranging from chloride to atoms such as helium, silicon or argon. More were able to draw the monomer of PVC having been shown part of the molecule in part (ii). Correct diagrams here were generally drawn well.
	b	i	Plasticizer moves molecules / chains apart; (1) this weakens / breaks the intermolecular forces;(1) allows the molecules / chains to slide over each other; (1)	3	Must be idea of increased separation **Allow**: bonds between molecules
		ii	Plasticizers can get into food / Plasticizers leach out ;(1) (plasticizer) could have harmful effect when eaten with the food;(1)	2	**Examiner's Comments** In part (i) few could explain logically why adding plasticizers makes PVC more flexible. Only half the candidates scored any marks, with very few gaining the full three. There were many mixed up ideas about polymer modifications. Some confused adding plasticizers with breaking crosslinks and others suggested adding plasticizers affected the crystallinity of the PVC. The main problem with answers to part (ii), was that candidates thought PVC was harmful and did not realise it was the plasticizers that leached into food which may cause harm when eaten.
			Total	7	

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Question			Answer/Indicative content	Marks	Guidance
2			Any two from: Polymer chains are closer together in HDPE / more regular / aligned; LDPE is branched and HDPE is not; so there are more / stronger forces between chains; Therefore need more energy / harder to pull the chains apart so HDPE is stronger;	2	'it' is HDPE **ignore** any other structure eg plasticizers, cross links **allow** other words for chains eg molecules, polymers **ignore** 'stronger bonds' but **accept** 'stronger bonds between chains' **Examiner's Comments** There were some good descriptions of crystallinity in HDPE and its effect on intermolecular forces and the strength of the polymer. Some candidates are still unclear about the difference between inter-molecular forces and covalent bonds whilst others incorrectly answered this question in terms of cross linking and plasticizers.
			Total	2	
3			B✓ Lowest softening temperature ✓	2 (AO 2 × 3.2a)	**IGNORE** references to flexibility/strength
			Total	2	