

# POLYMERS 3

**Q1.** The table below shows the masses of some gases given off when one gram of each of the polymers, A, B, C and D, are burnt in air.

		Combustion products in mg						
	Polymer name	C <sub>2</sub> H <sub>4</sub>	CH <sub>4</sub>	CO <sub>2</sub>	CO*	NO <sub>2</sub> *	HCN*	NH <sub>3</sub> *
<b>A</b>	Kevlar	–	–	1850	50	10	14	0.5
<b>B</b>	Acrylic	5	17	1300	170	45	40	3.0
<b>C</b>	66 Nylon	50	25	1200	250	20	30	–
<b>D</b>	Polyester	6	10	1000	350	–	–	–

Toxic gases are marked with \*.

Match polymers, A, B, C and D, with the numbers 1– 4 below.

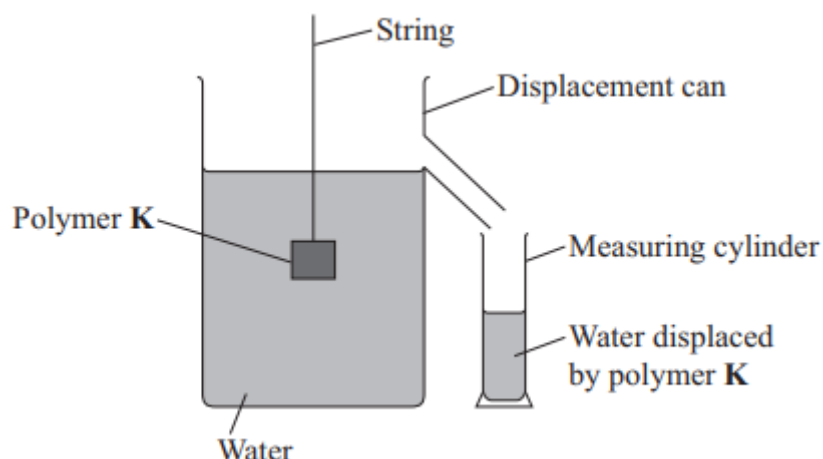
- 1 the polymer that produces the most HCN
- 2 the polymer that produces the most ethene
- 3 the polymer that produces no hydrocarbons
- 4 the polymer that produces the largest total mass of toxic gases

(4 marks)

**Q2.** Some polymers can be used for tooth fillings. A good polymer should not shrink in the tooth cavity.

A scientist tested a polymer, K, to see how much it shrinks when it sets.

- He made a sample of the polymer in a container with a volume of 10 cm<sup>3</sup> exactly.
- He allowed the polymer to set hard.
- He removed the polymer from the container and measured its volume again, using the apparatus shown.
- He repeated the test three times.



The scientist then tested three different polymers, L, M and N, in exactly the same way.

The results are shown in the table.

Polymer	Volume of water displaced in cm <sup>3</sup>			
	Test 1	Test 2	Test 3	Test 4
<b>K</b>	9.6	9.8	9.7	9.8
<b>L</b>	7.8	8.2	8.9	10.2
<b>M</b>	9.2	9.5	9.6	10.0
<b>N</b>	9.2	9.6	8.5	9.7

(a) Which statement about the results is correct?

- 1 All four polymers would be equally good as dental fillings.
- 2 Polymer K shows the most consistent results.
- 3 Polymer L is the best for dental fillings because it gives the highest values.

(1 mark)

(b) Which one of the following could be the reason for the reading of 10.2 cm<sup>3</sup> for polymer L, Test 4?

- 1 The piece of string was too long.
- 2 The polymer was dropped into the water in the displacement can.
- 3 At the start, the water was below the level of the spout.
- 4 Some water had evaporated.

(1 mark)

(c) One of the tests on polymer M gives a volume of 10.0 cm<sup>3</sup>. Does this mean it is the best polymer?

- 1 Yes, because it has given the volume needed.
- 2 No, because a single result should not be relied upon.
- 3 Yes, because it would be the highest value that could be obtained.
- 4 No, because the first test is always the most accurate.

(1 mark)

(d) Any polymer used for dental fillings should not be biodegradable because it would . .

- 1 cost too much to make.
- 2 be poisonous.
- 3 shrink too much.
- 4 break down after it has been put in place.

(1 mark)

**Q3.** Some properties of two forms of poly(ethene) are shown in the table.

Polymer	Density in kg per m <sup>3</sup>	Tensile strength in MPa
Low-density poly(ethene) – LDPE	925	16
High-density poly(ethene) – HDPE	950	28

The molecules of low-density poly(ethene) and high-density poly(ethene) are represented in the diagrams.

**Low-density poly(ethene) – LDPE**



**High-density poly(ethene) – HDPE**



(a) The reason for the differences in strength and density between LDPE and HDPE is that . . .

- 1 they contain different elements in their structure.
- 2 they were made under different conditions.
- 3 they have different colours added.

4 different monomers are used to make the chains.

(1 mark)

**(b)** HDPE has a higher density than LDPE because . . .

1 it is stronger.

2 more plastic is used to make LDPE.

3 the polymer molecules pack closer together in HDPE.

4 LDPE has shorter polymer chains.

(1 mark)

**(c)** Which is the most appropriate method for disposal of a non-biodegradable polymer such as poly(ethene)?

1 freeze it so that it returns to the original monomer

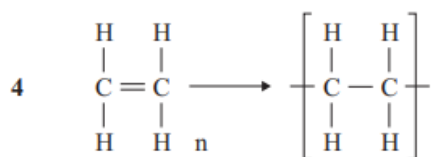
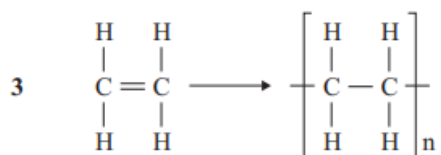
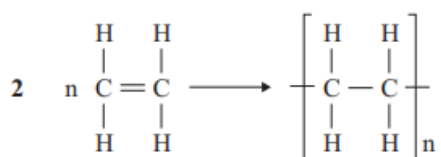
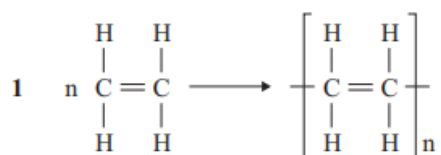
2 dispose of it at sea

3 bury it in the ground

4 break it down by adding microorganisms

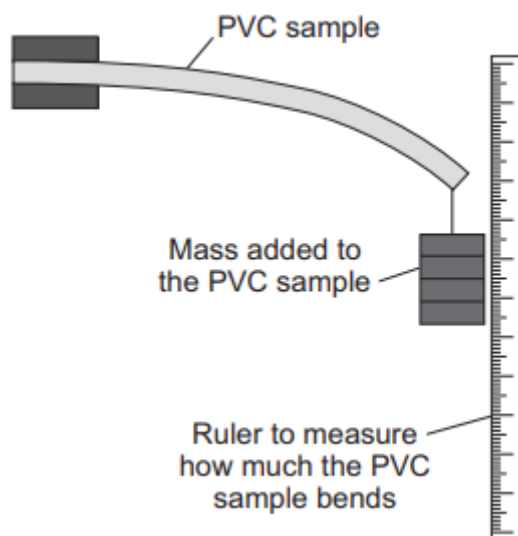
(1 mark)

**(d)** Which one of the following is the correct balanced equation for the polymerisation of ethene to form poly(ethene)?



(1 mark)

**Q4.** A scientist investigated how much the plastic polyvinyl chloride (PVC) bends when a mass is added. He used the apparatus shown in the diagram.



He measured the bending of PVC samples containing different percentages of an added chemical called a plasticiser. The PVC samples were all the same size.

The results are shown in the table.

Percentage (%) of plasticiser added to PVC	Bending of PVC sample in mm				
	Test 1	Test 2	Test 3	Test 4	Mean
0	17	18	16	8	17
5	23	22	24	23	23
10	29	27	29	27	28

**(a)** As the plasticiser percentage increases, the bending of the PVC samples . . .

- 1 remains the same.
- 2 increases.
- 3 decreases.
- 4 increases and then decreases.

(1 mark)

- (b)** The scientist did the test four times for each percentage of plasticiser added, . . .
- 1 to control all of the variables.
  - 2 to decrease the time needed.
  - 3 to improve reliability.
  - 4 to increase the precision.

(1 mark)

- (c)** The mean bending value for 0 % plasticiser is shown in the table as 17 mm.  
The reason is that . . .

- 1 17 mm was the first reading taken.
- 2 17 mm was the most common reading.
- 3 when all values are added together and divided by 4, 17 mm is obtained.
- 4 the reading for Test 4 is an anomalous value and is ignored.

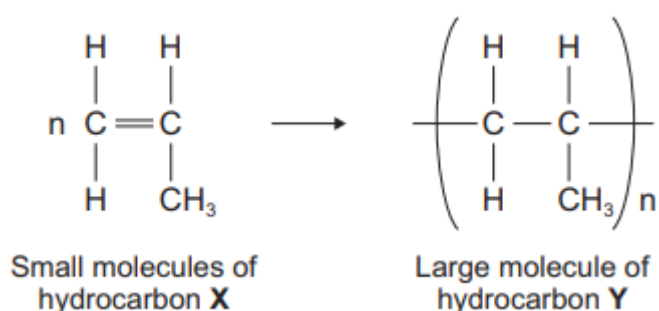
(1 mark)

- (d)** Plasticiser is not added to the PVC used to make doors because . . .

- 1 too much would be needed.
- 2 it would be too toxic.
- 3 the doors would be biodegradable.
- 4 the doors need to be rigid.

(1 mark)

- Q5.** The equation shows a chemical reaction.



- (a)** Hydrocarbon X is . . .

- 1 an alkane.
- 2 a polymer.
- 3 an alkene.

4 a catalyst.

(1 mark)

**(b)** Hydrocarbon Y is . . .

1 an unsaturated compound.

2 a polymer.

3 an alkene.

4 a monomer.

(1 mark)

**(c)** Poly(propene) is a thermosoftening polymer so it cannot be used to make . . .

1 buckets.

2 food containers.

3 non-stick coating for frying pans.

4 washing-up bowls.

(1 mark)

**(d)** Putting poly(propene) and other polymer waste into landfill creates a problem because this type of waste . . .

1 is very lightweight and blows about.

2 is not biodegradable.

3 does not dissolve in water.

4 is very dense and sinks deep underground.

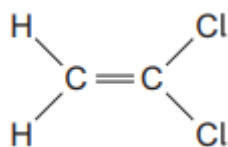
(1 mark)

**Q6.** Worldwide, about 20 billion wine bottle stoppers are produced each year. In recent years, the traditional cork stoppers have been gradually replaced by screw-top stoppers.

Cork is the bark from the cork-oak tree, which is cut off about every ten years. Tens of thousands of people in rural Portugal depend on cork for their livelihoods. Used cork can be recycled.

A screw-top stopper can be made of aluminium, inside which is a polymer sealant. The sealant is usually made of poly(ethene) or poly(vinylidene chloride). Extraction of aluminium from its ores is expensive and a lot of energy is required. It is difficult to separate the polymer from the aluminium cap to allow aluminium to be recycled.

Vinylidene chloride has the structure:

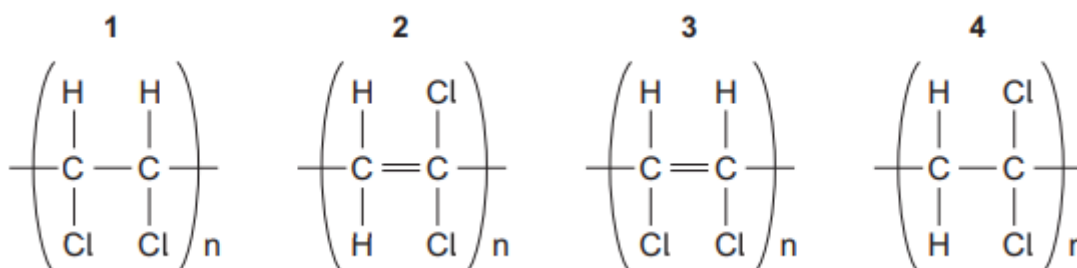


(a) One difference between ethene and vinylidene chloride is that . . .

- 1 only ethene is an unsaturated compound.
- 2 only vinylidene chloride will react with iodine.
- 3 only vinylidene chloride is obtained from crude oil.
- 4 only ethene is a hydrocarbon.

(1 mark)

(b) The formula for poly(vinylidene chloride) is . . .



(1 mark)

(c) There are two likely consequences of wine companies using metal screw-top stoppers with polymer sealants instead of cork.

Which row in the table correctly shows the two likely consequences?

<b>1</b>	increased use of crude oil	loss of employment in rural Portugal
<b>2</b>	reduction in carbon dioxide emissions	loss of employment in rural Portugal
<b>3</b>	reduction in carbon dioxide emissions	loss of important forest habitat
<b>4</b>	increased use of crude oil	reduced amount of material to landfill

(1 mark)



- (d) Scientists are researching the consequences of using screw-top stoppers with polymer sealants instead of cork.

Which row in the table below gives the correct description of an issue and its impact?

	Issue	Impact
1	ethical	effect on the price of wine
2	social	effect on the rural communities
3	environmental	effect on the quality of wine
4	economic	effect on cork forest habitat

(1 mark)

- Q7. The table shows the properties of four polymers, A, B, C and D.

	Properties
A	is not damaged at high temperatures and has a non-stick surface
B	is strong, does not rot and can be pulled into fibres
C	makes a very light, solid foam that is a good heat insulator
D	is transparent, waterproof and stays flexible over a wide range of temperatures

Match polymers, A, B, C and D, with the numbers 1– 4 in the table below.

	How the polymer could be used
1	to make disposable cups for hot drinks
2	to make string and rope
3	to make the coating on frying pans
4	to make bags used to store frozen foods

(4 marks)

**Q8.** Different polymers have different properties.

Match properties, A, B, C and D, with the uses 1– 4 in the table.

- A can withstand high temperatures and is non-stick
- B can be stretched into fibres
- C makes a very light, solid foam which is a good heat insulator
- D strong, rigid and a good electrical insulator

Uses	
1	to make disposable cups for hot drinks
2	to make the coating on frying pans
3	to make shirts and trousers
4	to make the handles of tools

(4 marks)

**Q9.** Scientists working for a plastics company tested three different types of poly(ethene) to see how much they would stretch before tearing.

**(a)** The scientists used identical apparatus, equal-sized pieces of poly(ethene), and carried out all the tests at the same temperature. They did this so that . . .

- 1 all the variables were kept the same.
- 2 it was easier and cheaper to carry out the tests.
- 3 all the measurements would be accurate.
- 4 only the independent variable would affect the results.

(1 mark)

- (b)** Cling film, a very thin sheet of poly(ethene), is used to wrap sandwiches. Which row in the table shows two properties of poly(ethene) that make it suitable for use as cling film?

	Property 1	Property 2
1	tears when stretched	is easily coloured and printed
2	is easily coloured and printed	is transparent
3	is transparent	is airtight
4	is airtight	easily melts when heated

(1 mark)

- (c)** Sandwiches could be wrapped in paper and packed in paper bags. Paper is made from wood. When a tree is cut down, another tree can be planted to replace it. An advantage of using paper instead of cling film is that . . .

- 1 the use of paper bags is sustainable.
- 2 paper is non-biodegradable.
- 3 paper has been used for hundreds of years.
- 4 paper does not blow about in the wind like plastic

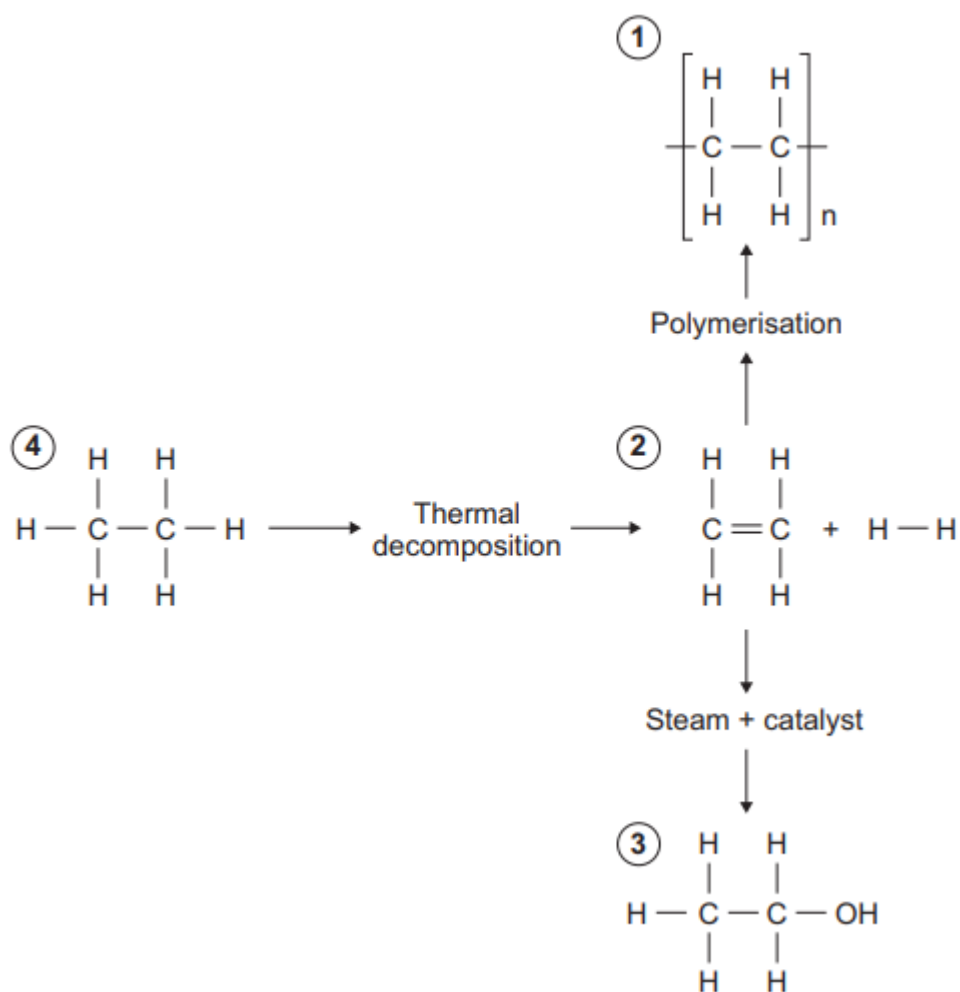
(1 mark)

- (d)** Poly(ethene) can be recycled. A problem that has to be overcome at the recycling centre is that poly(ethene) . . .

- 1 is mixed with other polymers.
- 2 is difficult to melt down.
- 3 is a poor conductor of electricity.
- 4 is not biodegradable.

(1 mark)

**Q10.** The flow chart shows a series of chemical reactions.



Match substances, A, B, C and D, with the numbers 1– 4 in the flow chart.

- A Ethane
- B Ethanol
- C Ethene
- D Poly(ethene)

(4 marks)

Total marks (40)