

Answers

WORKSHEET

3

# ETHENE AND POLYMERS

Syllabus reference 9.2.1

- 1 Complete the following table to identify the products of reactions of ethene and the uses of these products.

REACTANTS	PRODUCTS	USES
$\text{CH}_2=\text{CH}_2$ + water + catalyst ( $\text{H}^+$ )	ethanol	antiseptic drinks
$\text{CH}_2=\text{CH}_2$ $\xrightarrow[\text{catalyst (Ag)}]{\text{strong oxidizer (O}_2)}$	ethylene oxide $\text{H}_2\text{C}-\text{CH}_2$ $\begin{matrix} \diagup \text{O} \diagdown \\ \text{O} \end{matrix}$ used as a fumigant	+ $\xrightarrow[\text{H}_2\text{O}]{\text{H}^+}$ ethylene glycol
$\text{CH}_2=\text{CH}_2$ $\xrightarrow[\text{K}_2\text{Cr}_2\text{O}_7]{\text{mild oxidizer}}$	ethylene glycol (1,2-ethanediol)	antifreeze
$\text{CH}_2=\text{CH}_2 + \text{Cl}_2$ $\xrightarrow[\text{O}_2]{\text{catalyst}}$	chloroethane or vinyl chloride	monomer for making PVC, poly(vinyl chloride)

- 2 Complete the following statements using the words from the list below.

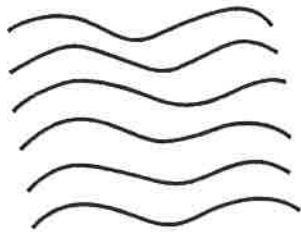
low density                      polymer                      branching                      polymerisation                      pressure  
 unbranched                      addition                      polyethylene                      thousand                      temperatures  
 monomers                      double                      catalyst

- a A chemical reaction in which many small molecules, called monomers, combine together to form one large molecule is called polymerisation. The large molecule is called a polymer.
- b An addition polymer is formed by molecules adding together without the loss of any atoms. For this type of polymer to form, the basic unit must contain a double bond.
- c When ethene polymerises it forms the polymer polyethylene which consists of a few hundred to a few thousand monomer units. Another name for this polymer is polyethene.
- d There are two processes used to form polyethylene. The older process uses high pressures, high temperatures and an initiator. The alkane chains produced in this process cannot pack

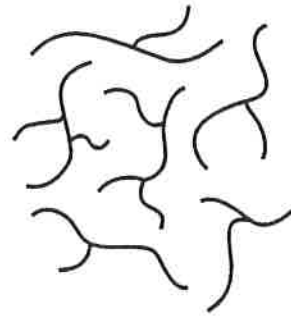
closely together in an orderly way because of the amount of chain branching. This product is called low density polyethylene.

e The newer process uses lower temperature and pressure than the older process because it relies on a catalyst to promote the reaction. This Ziegler-Natter process forms unbranched chains which are able to pack more closely together in an orderly fashion. This product is called high density polyethylene.

3 The arrangement of long chain molecules in (a) high density and (b) low density polyethylene can be represented as shown below. Low density polyethylene has many side chains which prevent the molecules packing closely together, while high density polyethylene is more rigid and does not soften at temperatures below 100°C.



(a) High density



(b) Low density

a Explain what causes the difference in density between the two types of polyethylene.

Intermolecular forces are stronger in HDPE due to the closer proximity of the chains. The branching on LDPE does not allow the chains to be as close ∴ weaker IM forces

b Which form would you expect to have the greater mechanical strength? Give your reasons.

HDPE - Stronger forces means stronger substance. However HDPE is less flexible

c Which type would be more suitable for the following applications:

i a washing up bowl

HDPE

ii a cordial bottle?

LDPE

d Explain why a shopping carrier bag made from polyethylene is a greater hazard to the environment than a paper one.

- Not made of natural materials - cannot be broken down easily by nature (i.e. are not bio-degradable)
- Can be harmful to wildlife (fish, birds, etc.)

4 Complete the following table.

POLYMER	NAME OF MONOMER	STRUCTURE OF MONOMER	COMMON USES	IMPORTANT PROPERTIES RELATED TO USE
low density polyethylene (polyethene)	ethene	$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	plastic wrap, bags, milk containers, wire insulation	Waterproof, chemical resistant, flexible, transparent (more than HDPE)
high density polyethylene (polyethene)	ethene	$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	Rubbish bins, chemical containers (e.g. petrol) buckets, toys, freezer bags	Waterproof, chemical resistant, rigid, tough (more than LDPE)
poly(vinyl chloride) PVC	Vinyl chloride	$\begin{array}{c} \text{H} & & \text{Cl} \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	Rigid water pipes, gutters, flexible garden hose, garden chairs, kitchen utensils	hard-pure form, flexible - with additives
polystyrene	Styrene	$\begin{array}{c} \text{H} & & \text{C}_6\text{H}_5 \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	Styrofoam - cups, surf boards, CD cases, drinking cups, TV cabinets, furniture	Styrofoam - light, insulating, other forms - hard, rigid

5 The following items are man-made from a polymer rather than the traditional material listed. Complete the table below giving one advantage and one disadvantage of the new material over the old.

ITEM	OLD MATERIAL	NEW MATERIAL	ADVANTAGE	DISADVANTAGE
drain pipe	ferrous material	poly(vinyl chloride)	does not corrode	not as strong or tough
carrier bag	paper	LDPE		
packaging	straw	polystyrene		
carpet	wool	polypropylene		
electrical wiring insulation	rubber	PVC		
soft drink bottles	glass	PET		