Storyline: answers to assignments

1 **a** **i** Nylon-6,8 **ii** nylon-9,9 **iii** nylon-4,4

b **i** $-CO-(CH_2)_5-NH-$, nylon-6

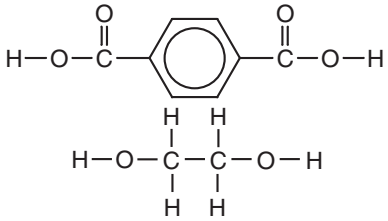
ii $-NH-(CH_2)_5-NH-CO-(CH_2)_5-CO-$, nylon-5,7

c **i** $H_2N(CH_2)_5NH_2$ and $ClCO(CH_2)_8COCl$

ii HCl

iii $-NH-(CH_2)_5-NH-CO-(CH_2)_8-CO-$

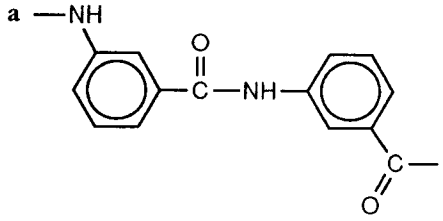
2 **a**



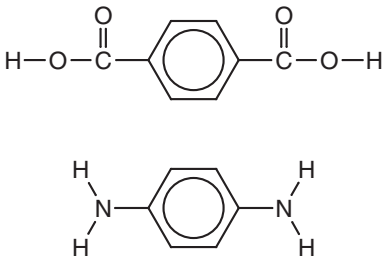
b Permanent dipole–permanent dipole and instantaneous dipole–induced dipole.

3 Poly(ethenol) dissolves in aqueous solutions; polyester made from lactic acid hydrolyses. A more precise rate of polymer dissolution can be obtained from the latter. Further, the product of hydrolysis occurs naturally in the body.

4 **a**



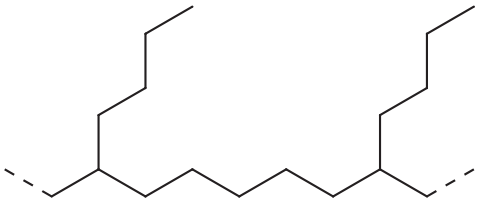
b



c The –NH groups in Kevlar become protonated and the interchain hydrogen bonding is disrupted.

d Protons are transferred from the polymer to the water. The hydrogen bonding in Kevlar is re-established.

5 **a**



b **i** The polymer chains in lldpe do not pack together as regularly as in hdpe.

ii The polymer chains in lldpe pack together more regularly then in ldpe and the intermolecular forces are consequently stronger.

6 **a** Students should be able to come up with some interesting ideas, eg protective films around young plants.

b There are many, eg drainpipes and plastic fasciae on buildings.

c Nothing happens to it.

Activities: notes and answers to questions

DP2.1 Making nylon

Safety note Information about hazardous chemicals is given on the activity sheet. Decanedioyl dichloride is corrosive and toxic and is a powerful irritant to the eyes. It should be handled in a fume cupboard.

Some students will have already done this activity in earlier studies. It is not intended that they should repeat the experiment.

a $nH_2N(CH_2)_6NH_2 + nClOC(CH_2)_8COCl \rightarrow -(-HN(CH_2)_6-NH-CO-(CH_2)_8CO-)_n + 2nHCl$

b Nylon-6,10

DP2.2 Taking nylon apart

Safety note Information about hazardous chemicals is given on the activity sheet. The liquid throughout this experiment contains 30% sulphuric acid. This is very concentrated (5–6 mol dm^{-3}).

Students should take care when handling it, particularly when performing the vacuum filtration and adding the solution to sodium hydrogencarbonate.

Many teachers have preferred to perform Part 1 of this activity as a demonstration, and to use double quantities and a 250 cm^3 flask. Students can then take samples of impure crystals and work with them from Part 2 onwards.

The nylon-6,6 granules should have disappeared after about 1 hour, but the mixture should be refluxed for at least $2\frac{1}{2}$ – 3 hours for hydrolysis to be completed.

If you do not have an electric or gas-heated melting point apparatus, the set-up in Figure 2 in the activity offers a low cost alternative. A suitable liquid to use would be dibutylphthalate or a high-boiling silicone oil. The melting point of pure hexanedioic acid is 153–154 °C.

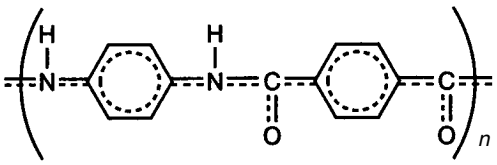
a It is more soluble in hot water than in cold.

b The presence of impurities lowers the melting point. The substance no longer melts sharply, but over a range.

c $-HN(CH_2)_6-NH-CO-(CH_2)_4CO- + H_2O \rightarrow H_2N(CH_2)_6NH_2 + HOOC(CH_2)_4COOH$

DP4 Comparing models of nylon-6,6 and Kevlar

In Kevlar, electrons are delocalised over the whole molecule – not just over the benzene rings:



The result is to strengthen the bonds and to stiffen the molecule making it rod-like. The delocalised structure prevents rotations about bonds in the chain.

a and **b** There is flexibility in the carbon chain in nylon, but not in the benzene ring in Kevlar. The model of nylon can be stretched more easily without breaking bonds; it will therefore be more elastic.

c **ii** The **C–C** bonds and **N–C** bonds associated with the delocalised structure in Kevlar are shorter; the stronger bonding in Kevlar confers greater stability to heat.

DP5 Bubble gum – or bubble glass?

a The warm gum is elastic.

b If it is pulled too hard it deforms permanently.

c The cold gum snaps when it is bent because it is below its T_g.