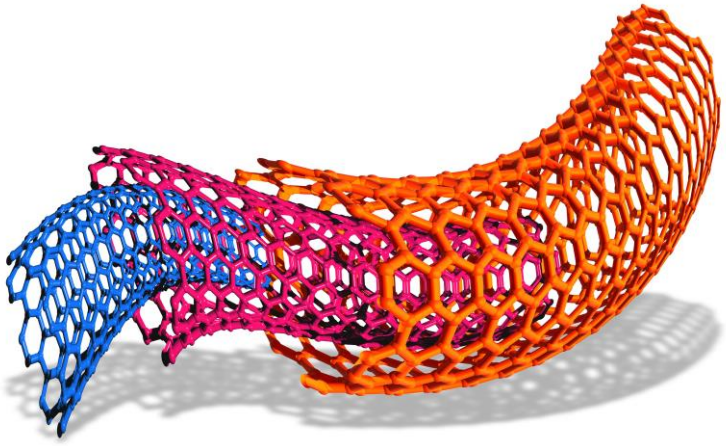
Cambridge Assessment International Education

Teaching Pack

Making nylon

Cambridge O Level

Chemistry 5070



Version 2.0

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Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note
Our *Teaching Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and/or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Teaching Packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.

↓

Lab lesson (1 hour*)	
Option 1 – run the experiment	**Option 2 – virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.

↓

Debriefing lesson (1 hour*)
This lesson consolidates and builds on the progress learners have made. In some cases this also includes the opportunity to practise extended writing skills.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this *Teaching Pack* you will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: Making nylon

This *Teaching Pack* focuses on a demonstration for making nylon using a diacyl chloride and a diamine using condensation polymerisation.

The syllabus reference for this experiment is:

- 11.5 Polymers

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations**:

- how to safely use techniques, apparatus and materials
- make and record observations.

Prior knowledge

Knowledge from the following syllabus topics is required for this experiment.

- 11.5 Polymers

Going forward

The knowledge and skills gained from this experiment will be useful for when you teach learners about natural polymers.

Briefing lesson: Risk assessments

Resources	• Worksheets A, B, C and D
Learning objectives	By the end of the lesson: • ***all*** learners should be able to identify the equipment needed for the experiment • ***most*** learners should be able to write a simple risk assessment • ***some*** learners will be able to provide feedback on a risk assessment.

Timings	Activity
5 min	**Starter/Introduction** Discuss general safety in the laboratory with learners. Hand out Worksheet A, which contains some of the most common hazard symbols. Explain to learners that these symbols appear on chemical bottles and are used in risk assessments. (**Note:** notation regarding chemical hazard symbols does not appear on any question paper materials.)
15 min	**Main lesson** Hand out Worksheet B (a basic method for making nylon with some suggestions for equipment). Get learners (working in pairs) to produce a diagram and method for making nylon (they will need to select the appropriate equipment).
10 min	Discuss with learners the risks associated with this experiment and the safety issues involved including the two chemicals that are used in the demonstration.
10 min	Ask learners, in pairs, to complete a risk assessment for this experiment using Worksheet C.
10 min	Then, get learners to peer review the risk assessment for another learner pair. Can they identify any omissions or errors? Learners should query anything that looks unclear or unsafe in the risk assessments and provide feedback as necessary.
10 min	**Plenary** Learners should now complete Worksheet D, which asks them specific questions about the hazard symbols found on the chemicals used in the demonstration.

Lab lesson: Option 1 – run the experiment

Resources	• Teacher notes • *Teacher walkthrough* video • Worksheets E, F and G • Equipment as outlined in the notes
Learning objectives	By the end of the lesson: • ***all*** learners should understand that nylon is produced from a diamine and a dicarboxylic acid • ***most*** learners should be able to draw one repeat unit of the polyamide produced • ***some*** learners will be able to apply this knowledge to understand how polyesters are made.

Timings	Activity
15 min	**Starter/Introduction** Get learners to review the equipment to be used from the briefing lesson. Explain to learners that in the demonstration a diacyl chloride is going to be used instead of a dicarboxylic acid (show the difference). Inform them that this allows for a quicker reaction. Tell learners that the outcome is the same. Ask learners to complete Worksheet E. Can they draw a diamine and a dicarboxylic acid and predict how water is formed?
20 min	**Main lesson** **Safety** This experiment should be performed as a demonstration. All learners should wear eye protection. Protective gloves should be worn to carry out the experiment and by any learners wishing to touch the finished product. Give learners Worksheet F, which they should complete during the demonstration. Demonstrate how to make nylon following the teacher method provided. Point out along the way: • why two layers form • that as the nylon is extracted more nylon forms at this interface • good lab practice. Stop the demonstration either when all the solutions are used or when enough nylon film has been generated. If the nylon thread breaks, simply start a new thread. Remember to wash the nylon thoroughly with water and/or ethanol. **Safety** Take care and only handle the nylon with gloves as chemicals may still be trapped inside the hollow thread.
15 min	After the demonstration, review with learners the process of condensation polymerisation. Introduce polyesters, which are formed between a dicarboxylic acid and a dialcohol. Again, water is removed and an ester linkage is made.
10 min	**Plenary** Give learners Worksheet G and ask them to draw the monomers required for producing (1) a polyamide and (2) a polyester and draw a repeat unit of each polymer.

Teacher notes

Watch the *Teacher walkthrough* video for making nylon and read these notes.

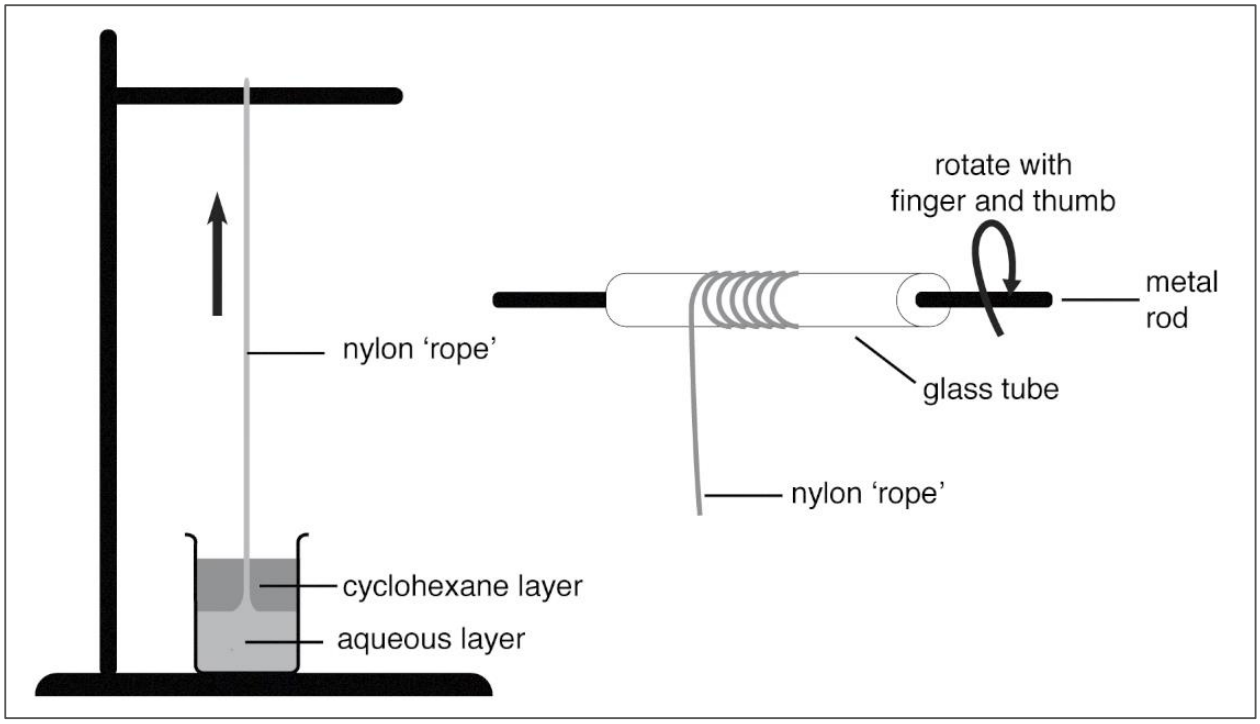
This experiment should be done as a demonstration only.

You will need:

- access to a fume cupboard
- a small beaker (either 10 cm^3 or 25 cm^3)
- a glass rod or spindle
- tweezers
- 5 cm^3 decanedioyl dichloride (3–5% solution in cyclohexane)
- 5 cm^3 1,6-diaminohexane solution (3–5% aqueous solution)

Experiment set-up

Note: this set-up diagram shows how a glass tube/rod could be used instead of a spindle or cotton reel.



Safety

The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.

It is your responsibility to carry out an appropriate risk assessment for this experiment.

Substance	Hazard	First aid
Decanedioyl chloride (solid)	 GHS05 (*corrosive* **C**)  GHS07 (*moderate hazard* **MH**)	**In the eye:** rinse the eye with gently-running tap water for 15 min. See a doctor. **Vapour breathed in:** remove to fresh air. Call a doctor if breathing becomes difficult. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing. Wash the skin with plenty of water. See a doctor if irritation or symptoms persist.
1,6-Diaminohexane (solid)	 GHS05 (*corrosive* **C**)  GHS07 (*moderate hazard* **MH**)	**In the eye:** rinse the eye with gently-running tap water for 15 min. See a doctor. **Vapour breathed in:** remove to fresh air. Call a doctor if breathing becomes difficult. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing. Wash the skin with plenty of water. See a doctor if irritation or symptoms persist.
Cyclohexane	 GHS02 (*flammable* **F**)  GHS08 (*health hazard* **HH**)  GHS07 (*moderate hazard* **MH**)  GHS09 (*hazardous to the aquatic environment* **N**)	**In the eye:** rinse the eye with gently-running tap water for 15 min. See a doctor. **Vapour breathed in:** remove to fresh air. See a doctor. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing. Wash the skin with plenty of soap and water. See a doctor if irritation or symptoms persist.

Teacher method

This is the method for providing the demonstration for making nylon.

Do not share this method with learners.

Before you begin
Plan how you are going to carry out the demonstration.

Think about:
- the layout required so that learners can see
- the amount of equipment/chemicals required
- the waste protocol for the lab
- appropriate risk assessments and ensure they have been carried out.

Steps	Notes
1. Set-up the demonstration, ensuring that you have all the necessary equipment and reagents	
2. Add 5 cm^3 of 1,6-diaminohexane to a small beaker.	
3. Carefully pour 5 cm^3 of the decanedioyl dichloride down the side of the beaker so that this layer sits on top of the first layer.	*Do not mix the layers.*
4. Using tweezers pull out the nylon film that has formed at the interface from the centre and hook onto either a glass rod or wooden spindle.	*Now is a good time to ask learners what they observe in the beaker.*
5. Rotate the rod/spindle – more nylon should be created at the interface and allow you to collect until all the solutions have been used.	*If the film breaks, start a new thread using the tweezers.*
6. Wash the collected nylon with water and/or ethanol.	*Take care when handling the nylon – use gloves as chemicals may still be trapped inside the hollow thread. Any learners who wish to handle the thread should also be provided with gloves.*

Lab lesson: Option 2 – virtual experiment

Resources	• *Virtual experiment video* for making nylon • Worksheets E, F and G
Learning objectives	By the end of the lesson: • ***all*** learners should understand that nylon is produced from a diamine and a dicarboxylic acid • ***most*** learners should be able to draw one repeat unit of the polyamide produced • ***some*** learners will be able to apply this knowledge to understand how polyesters are made.

Timings	Activity
15 min	**Starter/Introduction** Get learners to review the equipment to be used from the last lesson. Explain to learners that in the demonstration a diacyl chloride is going to be used instead of a dicarboxylic acid (show the difference). Inform them that this allows for a quicker reaction. Tell learners that the outcome is the same. Ask learners to complete Worksheet E. Can they draw a diamine and a dicarboxylic acid and predict how water is formed?
35 min	**Main lesson** Give learners Worksheet F and show them the video for *Making nylon*. Learners need to fill in Worksheet F as the video plays. **Note:** You may need to play the video more than once so that all learners can fill in their worksheets. After playing the video, discuss with the class that nylon is one type of condensation polymer and that there are other types. Discuss with learners that polyesters are also formed by condensation polymerisation. Discuss with learners any safety issues they noticed during the video, what the risk was and how it was dealt with. You might want to discuss the use of gloves, good lab practice etc.
10 min	**Plenary** Give learners Worksheet G and ask them to draw the monomers required for producing (1) a polyamide and (2) a polyester and draw a repeat unit of each polymer.

Debriefing lesson: Reviewing risk

Resources	• Worksheets H, I and J • Safety animation
Learning objectives	By the end of the lesson: • ***all*** learners should understand that a risk assessment is an important part of safety • ***most*** learners should be able to understand the components of a risk assessment • ***some*** learners will be able to review how hazards influence the equipment list.

Timings	Activity
10 min	**Starter/Introduction** Show the learners the safety animation that can be found on the *Resource Plus* platform. Lead a class discussion around each of the points of the safety animation: risk, hazards, precautions and good practice. What have they learnt and how will they put safety concepts into practice in future?
20 min 20 min	**Main lesson** In pairs, ask learners to discuss what a good risk assessment would contain. Then, working in pairs, give learners Worksheet H. This is an example risk assessment. Using a highlighter pen they should mark-up the incorrect parts. Once the learners have found the errors in the risk assessment, ask them to correct it, providing additional support where required. Now, give learners Worksheet I. Individually, learners need to fill in the gaps using the word bank provided. Ask learners to swap their answers with another learner and mark each other's work and provide feedback where necessary.
10 min	**Plenary** Hand out Worksheet J. Working individually, learners need to match the left-hand column with the right-hand column.

Worksheets and answers

	Worksheets	Answers
For use in the *Briefing lesson:*		
A: Hazard symbols	**14**	**—**
B: Selecting equipment	**15–16**	**28**
C: Writing a risk assessment	**17**	**29**
D: Safety	**18–19**	**30–31**
For use in *Lab lesson: Option 1:*		
E: Monomers used to make nylon	**20**	**32**
F: Condensation polymerisation	**21**	**33**
G: Demonstration questions	**22–23**	**34–35**
For use in *Lab lesson: Option 2:*		
E: Monomers used to make nylon	**20**	**32**
F: Demonstration questions	**21**	**33**
G: Condensation polymerisation	**22–23**	**34–35**
For use in the *Debriefing lesson:*		
H: Example risk assessment	**24–25**	**36–37**
I: Summary	**26**	**38**
J: Matching exercise	**27**	**39**

Worksheet A: Hazard symbols

Here are some of the common hazard symbols you might find on chemical bottles.

 *corrosive*	 *moderate hazard*	 *health hazard*
 *acutely toxic*	 *flammable*	 *oxidising*
 *hazardous to the aquatic environment*		

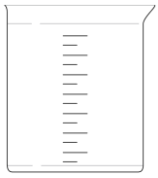
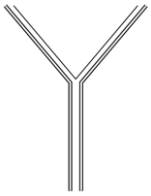
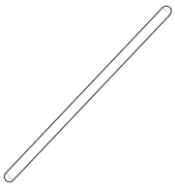
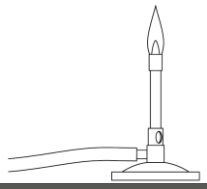
Worksheet B: Selecting equipment

Nylon is made by mixing two solutions, a diamine (dissolved in water) and a dicarboxylic acid (dissolved in cyclohexane). **Note:** a dicarboxylic acid derivative can also be used.

The two liquids are immiscible and sit on top of each other in layers. Cyclohexane has a lower density than water.

Nylon forms at the interface. The nylon will form as a hollow thread.

Draw a diagram and write a method of how you could show nylon being made. (Select from the equipment below. You can choose one, more or none of each piece of equipment.)

		
25 cm^3 beaker	**filter funnel**	**measuring cylinder**
		
tweezers	**thermometer**	**glass rod**
		
Bunsen burner	**evaporating dish**	**test-tube**

Worksheet B: Selecting equipment

Method

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Worksheet C: Writing a risk assessment

A risk assessment should be written for all experiments where there is a hazard.

The hazard could be the equipment or the chemicals being used.

Complete the table for the nylon experiment. One has been done for you.

You may need to check the hazards for the chemicals and solvents being used.

	Risk	How to reduce risk?	What to do if risk occurs?	How likely is this to happen?
Using glass	Breaking glass may cut hands.	Ensure all glass is handled carefully.	Clean up glass, wash any cuts thoroughly, clean and dress.	Unlikely

Worksheet D: Safety

The production of nylon uses 1,6-diaminohexane and decanedioyl chloride solutions. On the bottles you find the following symbols.

1. What does each of the safety symbols mean? Write your answer in the space provided.

These two symbols are found on both 1,6-diaminohexane and decanedioyl chloride bottles.	**(a)** 	…… …… ……
	(b) 	…… …… ……
This symbol is also found on the 1,6-diaminohexane bottle.	**(c)** 	…… …… ……
This symbol is also found on the decanedioyl chloride bottle.	**(d)** 	…… …… ……

Worksheet D: Safety

2. What safety advice would you give to someone using these two solutions?

1,6-Diaminohexane	…… …… …… ……
Decanedioyl chloride	…… …… …… ……

Worksheet E: Monomers used to make nylon

Here are images of a diamine and a dicarboxylic acid

1. Show how an amide link is formed.

2. Draw **two** repeating units.

Worksheet F: Demonstration questions

Answer these questions whilst watching the teacher demonstration.

1. When was nylon first produced?

……..

2. What are the two monomer units for producing nylon?

……..

3. Condensation polymerisation involves the removal of which molecule?

……..

4. Why is the second solution poured slowly down the side of the beaker?

……..

……..

……..

5. What safety precautions need to be taken with a highly flammable chemical?

……..

……..

6. Write down your observations of the beaker with the two layers.

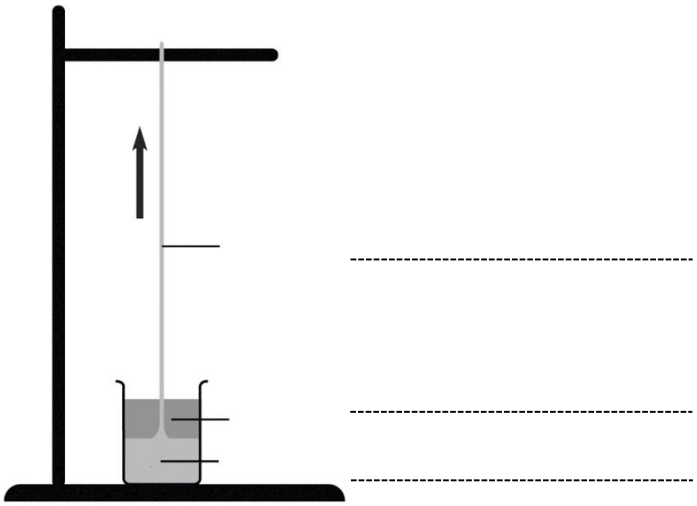
……..

……..

……..

Worksheet F: Demonstration questions

7. Label the three parts of the diagram below.



8. Why is the nylon thread washed with ethanol?

……

……

9. Name **three** uses for nylon.

……

……

……

10. How would you test the strength of the nylon thread produced?

……

……

……

Worksheet G: Condensation polymerisation

Nylon (a polyamide) is formed when a dicarboxylic acid reacts with a diamine.

Terylene (a polyester) is formed when a dicarboxylic acid reacts with a dialcohol.

Complete the following table.

Monomer 1	Monomer 2	Link formed	One repeat unit
$H_2N(CH_2)_2NH_2$	$HOOC(CH_2)_2COOH$	……	
$H_2N(CH_2)_6NH_2$	$HOOC(CH_2)_8COOH$	……	
$HO(CH_2)_2OH$	$HOOC(CH_2)_2COOH$	……	
$HO(CH_2)_6OH$	$HOOC(CH_2)_8COOH$	……	
$H_2N(CH_2)_6NH_2$	$ClOC(CH_2)_8COCl$	……	

Worksheet H: Example risk assessment

Here is an example risk assessment for the nylon experiment which contains errors.

Identify the errors using a highlighter pen and then suggest a correction.

The first one has been done for you.

Chemical, microorganism, procedure or equipment	Nature of hazard(s)	Control measures to reduce risk	Emergency procedure
Decanedioyl dichloride in cyclohexane	Low hazard ***Correction:*** *Highly flammable and is an irritant to the skin, lungs and eyes.*	Use the highest concentrations and volumes possible. Do inhale the fumes. Wear eye protection and avoid skin contact – use your hands when handling nylon.	If swallowed, do no more than wash out the mouth with water. Do induce vomiting. See a doctor. If it enters the eye, flood the eye with gently-running tap water for an hour. If spilt on clothing, remove contaminated material and wash skin with plenty of water.
1,6-diaminoheaxane solution	Health hazard	Use the smallest volumes possible. Do not inhale any fumes. Wear eye protection and avoid skin contact – use tweezers to handle the nylon and wear gloves.	If swallowed, do no more than wash out the mouth with water. Do **not** induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. If it enters the eye, see a doctor. If spilt on clothing, keep clothes on but wash skin with plenty of water.
Ethanol	Low hazard	Use the smallest volume possible and make sure the room is not ventilated.	If swallowed, do no more than wash out the mouth with water. Do **not** induce vomiting. See a doctor. If it enters the eye, flood the eye with gently-running tap water for 10 min. See a doctor. Allow fires in sinks, etc. to burn out. Fires at the top of test-tubes, beakers, etc. should be smothered with a damp cloth or heat-proof mat.

Worksheet H: Example risk assessment

Chemical, microorganism, procedure or equipment	Nature of hazard(s)	Control measures to reduce risk	Emergency procedure
Glassware	No hazard due to breaking glass	Check equipment is set-up securely and that there are trip hazards. Use appropriate handling techniques and equipment, e.g. test-tube holders. If glass is broken, dispose of in general waste bin. First aid kit should be used for major injuries.	**Minor cuts:** Rinse the wound with water. Get the casualty to apply a small, sterile dressing. **Severe cuts:** Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Send for a first aider.

Worksheet I: Summary

Fill in the gaps using these words. (**Note:** not all words will be used.)

diamine	interface	less	dicarboxylic acid
water	dialcohol	1,6-diaminohexane	hollow
on top	more	glass rod	tweezers

Nylon is made in the lab using a …….. (or a derivative) and a

……..

First, 5 cm^3 of …….. is added to a small beaker.

Then 5 cm^3 of decanedioyl dichloride is added slowly down the side of the beaker.

This layer sits ……. of the first layer as it is ……..

The nylon film is pulled from the centre of the …… using

…….

The nylon thread is then attached to a …… and wound around it until enough nylon has been collected.

The nylon that has been collected is washed with …….. and ethanol as chemicals

can be still be trapped in the ……. thread.

Worksheet J: Matching exercise

Match the left-hand column with the right-hand column. One has been done for you.

Nylon is a ……..	polyesters
Decanedioyl dichloride in cyclohexane is …….	interface
……. should be worn at all times.	monomer
The 1,6-diaminohexane layer sits …….. the decanedioyl layer.	condensation polymer
Polymers consist of …….. units.	chemicals
Nylon forms at the …… of the two layers.	Protective gloves
Dicarboxylic acids react with dialcohols to form ……	flammable
Nylon is made up of …….. links.	below
Hazards could be from the equipment and/or …… used.	ethanol
Nylon is washed thoroughly with water and ……	amide

Worksheet B: Answers

Learners should select the following equipment:

- 1 × beaker
- 2 × measuring cylinders (one for each chemical)
- tweezers to pull up the thread produced
- a stirring rod or test-tube – to wind the thread around.

The learners' method should include:

- Measuring out each chemical using a measuring cylinder (equal amounts)
- Placing the water soluble (diamine) into the beaker first, as it has a higher density.
- Carefully pouring the cyclohexane solution (dicarboxylic acid) into the beaker second. It should settle above the first solution as it has a lower density.
- The film formed is pulled at the interface using a pair of tweezers. This should make a thread. The thread is wrapped around the stirring rod/spindle which is turned. More thread should form at the interface.

Worksheet C: Answers

	Risk	How to reduce risk?	What to do if risk occurs?	How likely is this to happen?
Using glass	Breaking glass may cut hands.	Ensure all glass is handled carefully.	Clean up glass, wash any cuts thoroughly, clean and dress.	Unlikely
Decanedioyl dichloride, 3–5% solution in cyclohexane (5 cm^3)	Highly flammable and harmful.	No naked flames. Wear gloves and safety glasses.	Use fire blanket to put out fire.	Very unlikely
1,6-Diaminohexane solution	No hazards identified.			
Nylon	May still contain hazardous chemicals.	Handle with gloves.	Wash infected area thoroughly.	Very unlikely

Worksheet D: Answers

1. What does each of the safety symbols mean? Write your answer in the space provided.

These two symbols are found on both 1,6-diaminohexane and decanedioyl chloride bottles.	**(a)** 	*Corrosive*
	(b) 	*Moderate hazard*
This symbol is also found on the 1,6-diaminohexane bottle.	**(c)** 	*Health hazard*
This symbol is also found on the decanedioyl chloride bottle.	**(d)** 	*Flammable*

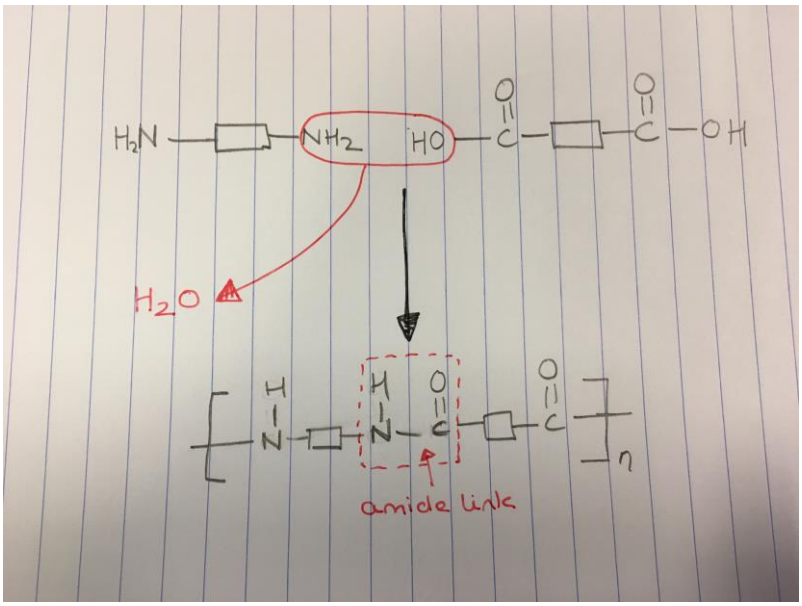
Worksheet D: Answers

2. What safety advice would you give to someone using these two solutions?

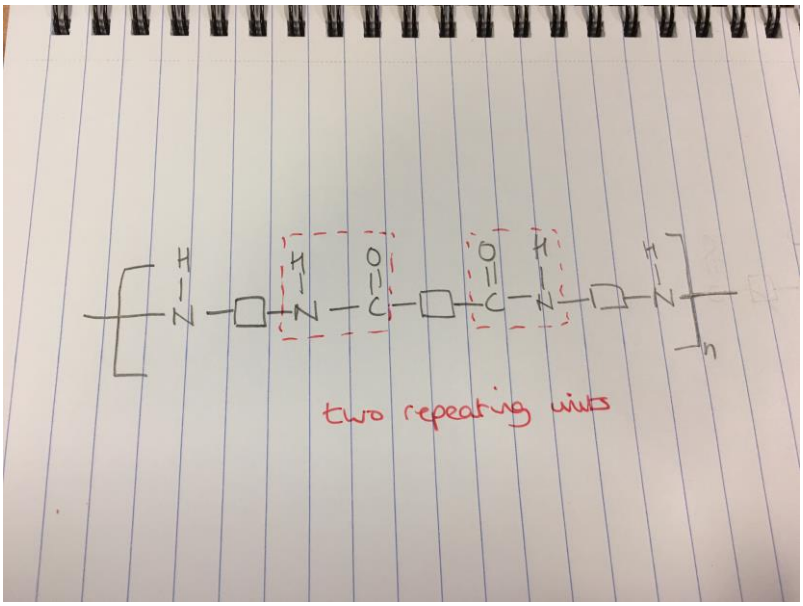
1,6-Diaminohexane	They should be wearing safety goggles and a lab coat. They should also be wearing protective gloves.
Decanedioyl chloride	They should be wearing safety goggles and a lab coat. They should also be wearing protective gloves. The solution will be flammable so there should be no naked flames nearby.

Worksheet E: Answers

1.



2.



Worksheet F: Answers

1. When was nylon first produced?

1935

2. What are the two monomer units for producing nylon?

A dicarboxylic acid and a diamine.

3. Condensation polymerisation involves the removal of which molecule?

water/H_2O

4. Why is the second solution poured slowly down the side of the beaker?

It is poured down the side of the beaker so that it will sit on top of the first layer and prevent mixing of the layers.

5. What safety precautions need to be taken with a highly flammable chemical?

No naked flames

Good ventilation

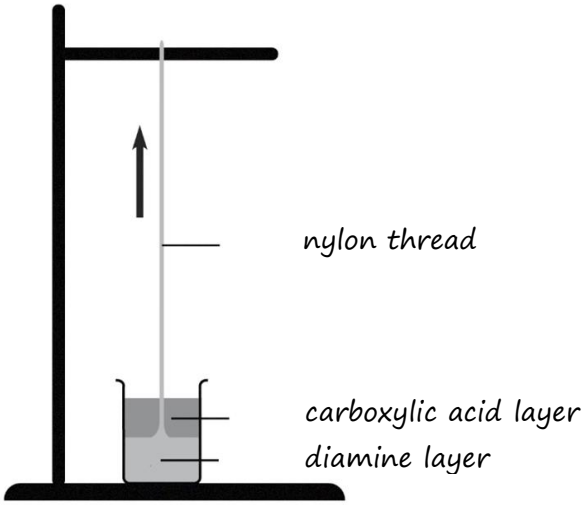
Always replace the cap on the bottle

6. Write down your observations of the beaker with the two layers.

Both layers are colourless. Top layer is less dense than the bottom. A grey film can be observed at the interface of the layers.

Worksheet F: Answers

7. Label the three parts of the diagram below.



8. Why is the nylon thread washed with ethanol?

Because chemicals may still be present inside the hollow nylon thread.

9. Name **three** uses for nylon.

ropes

seat belts

dental floss

*(**OR** any other suitable answers)*

10. How could you test the strength of the nylon thread produced?

Attach weights to one end of the nylon thread. Keep adding additional weight to the thread until it breaks.

Worksheet G: Answers

Monomer 1	Monomer 2	Link formed	One repeating unit
$H_2N(CH_2)_2NH_2$	$HOOC(CH_2)_2COOH$	amide	$(–NH(CH_2)_2NHCO(CH_2)_2CO–)$
$H_2N(CH_2)_6NH_2$	$HOOC(CH_2)_8COOH$	amide	$(–NH(CH_2)_6NHCO(CH_2)_8CO–)$
$HO(CH_2)_2OH$	$HOOC(CH_2)_2COOH$	ester	$(–O(CH_2)_2OCO(CH_2)_2CO–)$
$HO(CH_2)_6OH$	$HOOC(CH_2)_8COOH$	ester	$(–O(CH_2)_6OCO(CH_2)_8CO–)$
$H_2N(CH_2)_6NH_2$	$ClOC(CH_2)_8COCl$	amide	$(–NH(CH_2)_6NHCO(CH_2)_8CO–)$

Worksheet H: Answers

Chemical, microorganism, procedure or equipment	Nature of hazard(s)	Control measures to reduce risk	Emergency procedure
Decanedioyl dichloride in cyclohexane	Low hazard ***Correction:*** *Highly flammable and is an irritant to the skin, lungs and eyes.*	Use the highest concentrations and volumes possible. ***Correction:*** *lowest* Do inhale the fumes. ***Correction:*** *Do not inhale* Wear eye protection and avoid skin contact – use your hands when handling nylon. ***Correction:*** *use tweezers and wear gloves when handling nylon.*	If swallowed, do no more than wash out the mouth with water. Do induce vomiting. See a doctor. ***Correction:*** *Do not induce vomiting.* If it enters the eye, flood the eye with gently-running tap water for an hour. ***Correction:*** *15–20 min.* If spilt on clothing, remove contaminated material and wash skin with plenty of water.
1,6-diaminoheaxane solution ***Correction:*** *solution in water*	Health hazard ***Correction:*** *Corrosive and a health hazard*	Use the smallest volumes possible. Do not inhale any fumes. Wear eye protection and avoid skin contact – use tweezers to handle the nylon and wear gloves.	If swallowed, do no more than wash out the mouth with water. Do **not** induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. If it enters the eye, see a doctor. ***Correction:*** *flood the eye with running water for 15–20 min.* If spilt on clothing, keep clothes on but wash skin with plenty of water. ***Correction:*** *remove contaminated clothes*

Worksheet H: Answers

Chemical, microorganism, procedure or equipment	Nature of hazard(s)	Control measures to reduce risk	Emergency procedure
Ethanol	Low hazard ***Correction:*** *Highly flammable*	Use the smallest volume possible and make sure the room is not ventilated. ***Correction:*** *room is well ventilated.*	If swallowed, do no more than wash out the mouth with water. Do **not** induce vomiting. See a doctor. If it enters the eye, flood the eye with gently-running tap water for 10 min. See a doctor. Allow fires in sinks, etc. to burn out. Fires at the top of test-tubes, beakers, etc. should be smothered with a damp cloth or heat-proof mat.
Glassware	No hazard due to breaking glass ***Correction:*** *Low hazard*	Check equipment is set-up securely and that there are trip hazards. ***Correction:*** *are no trip hazards.* Use appropriate handling techniques and equipment, e.g. test-tube holders. If glass is broken, dispose of in general waste bin. ***Correction:*** *sharps bin.* First aid kit should be used for major injuries. ***Correction:*** *minor injuries.*	Minor cuts: Rinse the wound with water. Get the casualty to apply a small, sterile dressing. Severe cuts: Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Send for a first aider.

Worksheet I: Answers

Nylon is made in the lab using a *dicarboxylic acid* (or a derivative) and a *diamine*.

First, 5 cm^3 of *1,6-diaminohexane* is added to a small beaker.

Then, 5 cm^3 of decanedioyl dichloride is added slowly down the side of the beaker.

This layer sits *on top* of the first layer as it is *less dense*.

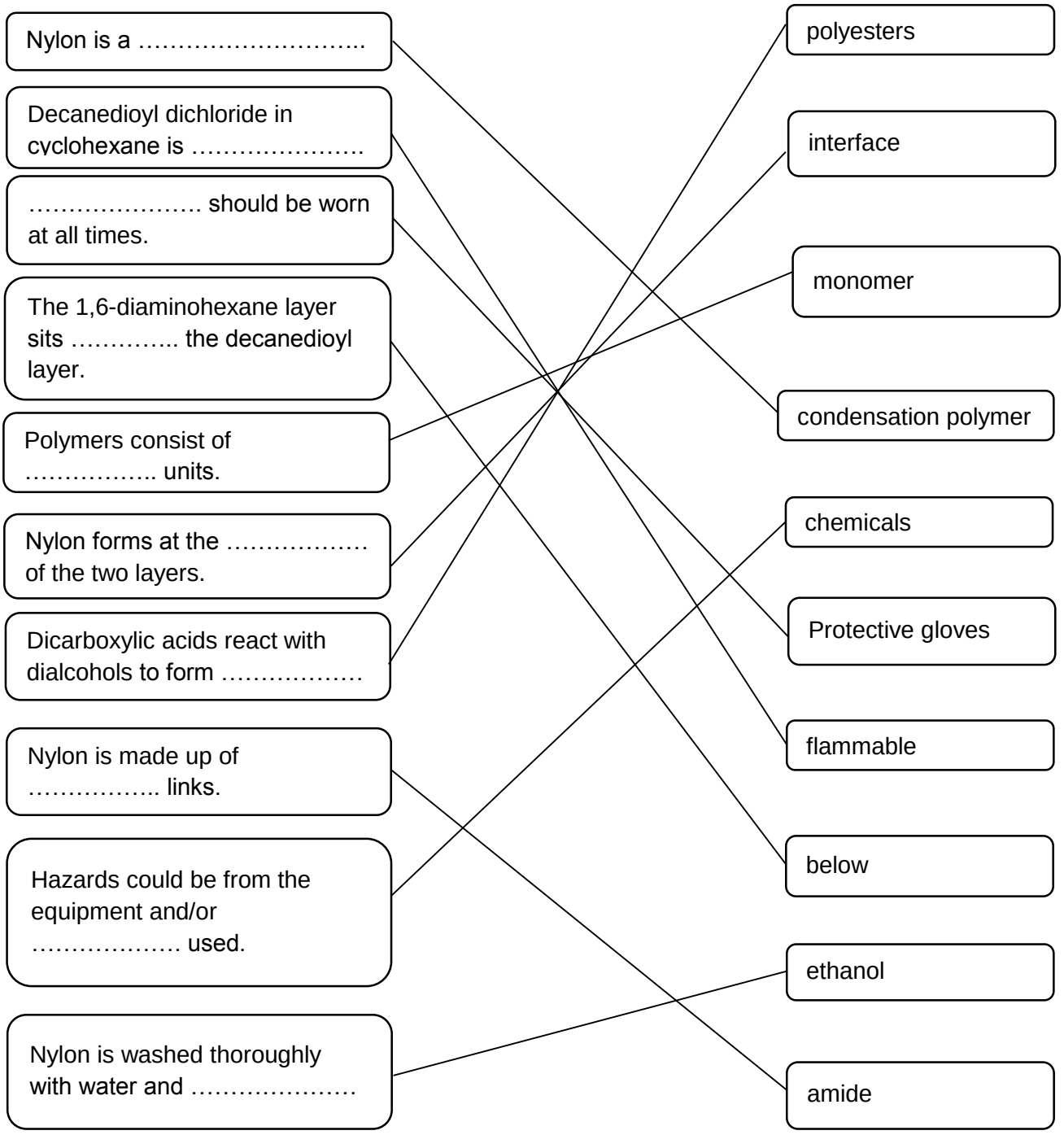
The nylon film is pulled from the centre of the *interface* using *tweezers*.

The nylon thread is then attached to a *glass rod* and wound around it until enough nylon has been collected.

The nylon that has been collected is washed with *water* and ethanol as chemicals can be still be trapped in the *hollow* thread.

Worksheet J: Answers

Match the left-hand column with the right-hand column. One has been done for you.



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