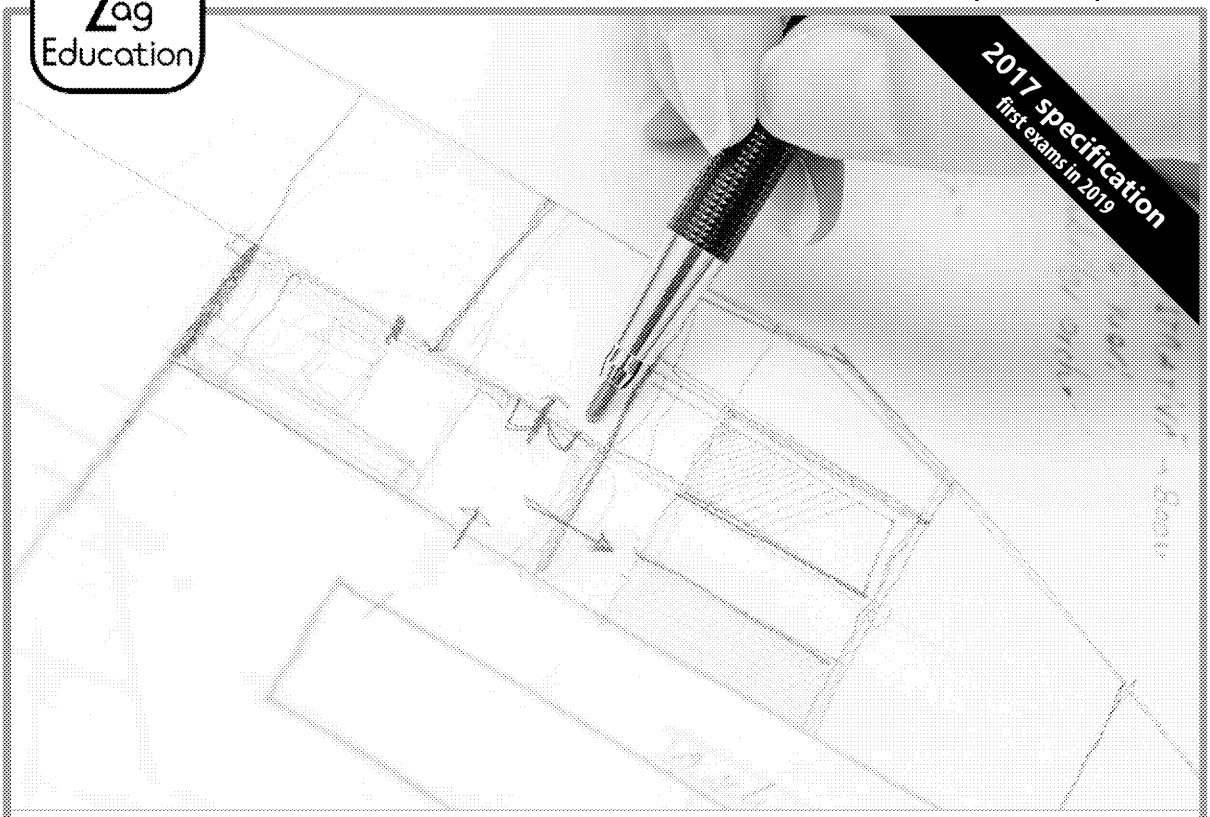
DT

GCSE (9–1) | AQA | 8552



Starters and Plenaries

for GCSE AQA DT 3.2 Polymers

zigzageducation.co.uk

POD 9379

Contents

Teacher's Introduction

Remember!
Always check the exam board website for new information, including changes to the specification and sample assessment material.

This resource contains 21 starters and plenaries which concisely cover the 2017 GCSE AQA DT (8552) specification (2017 onwards) section 3.2: **polymers**. Similar resources covering other material categories for the same specification points can be found on our website. The starters in this resource offer activities which will engage the students in the lesson following a break or provide an opportunity for students to transition from a break into a lesson by recapping on previous work. The plenaries within this resource can be used to finish a lesson and, therefore, ensure that learning occurs right up to the end of the lesson. The types of activity are varied, from written communication tasks and extracting information from text, to drawing, modelling and discussion-based activities. This is to ensure the activities appeal to students with a wide range of learning styles, keeping them interested and engaged, and enabling them to practise the wide range of skills that Design and Technology students need to demonstrate in their coursework and exams.

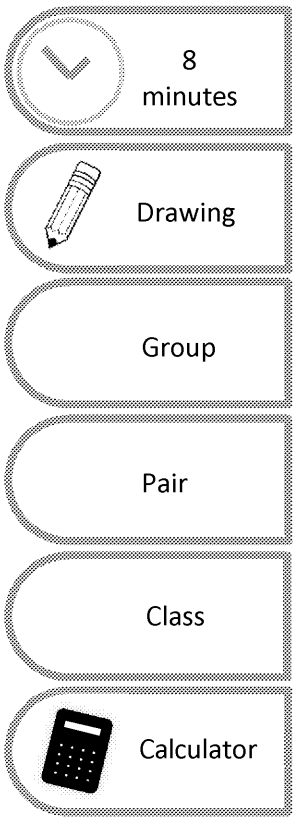
How to use this resource
A cross-reference table has been provided as a useful tool for lesson planning. It links each activity to the specification points it covers and identifies which activities are considered starters and which should be used as plenaries. The identification of each activity as a starter or plenary is only a suggestion and teachers might find that some of the activities are interchangeable.

Extra challenges
Extra challenges have been provided for some of the activities. These can be used as activity extensions to further challenge higher-ability students, as short plenary activities or even as homework tasks.

Reuse this resource
Occasionally throughout this resource you will find prompts and suggestions for different ways of using the activities and resources provided. This means that you can get more out of this pack! The suggestions can be used to create other starters and plenaries or even be incorporated into your main class activities.

Equipment
Due to the varied and creative nature of the activities in this pack, there are some activities which require equipment such as drawing materials, scissors, glue and access to the Internet. Any equipment that is needed is indicated by an 'Equipment list' in the teacher's notes. This helps keeps teachers prepared and organised.

Icons
The icons featured on each worksheet are designed to give the teacher, and the student, some key information about the activity at a glance. The icons indicate the time the students have to spend on the activity, whether it is a drawing activity and what configuration the class will be in for the activity (pair/group/class). If the activity doesn't have an icon indicating 'Pair', 'Group' or 'Class', then it is suggested that the activity be completed individually.



- **Time** – Each of the activities in this pack is designed to take 10 minutes, including time for feedback and answers. The time that students have to complete the activity is indicated by the time icon on the right-hand side of each worksheet. For instance, the time icon given on this page as an example indicates that students should spend 8 minutes on the activity. This does not include feedback time, which would be 2 minutes in this case. Recommended feedback time is indicated in the teacher's notes for each activity.
- **Drawing** – Drawing tasks have been included in order to help students develop a skill set that is relevant to Design and Technology. The drawing tasks are indicated using the drawing icon.
- **Class configuration** – A range of activities has been created for this resource which incorporates independent, paired and grouped work and which will be engaging for the students. The varied nature of the activities provides an opportunity for a range of learning styles and levels. The tasks that have been suggested for the whole class, groups or pairs are indicated using the icons to the right.
- **Calculator** – This icon indicates that the students should have access to a calculator for this activity.

Specification Cross Referenc

This table will enable you to pick and choose starters or plenaries relevant to the
teaching. While each activity has been selected as either a starter or a plenary, y
starter and plenary tasks may be interchangeable depending on how you teach t
is at the teacher's discretion when to use each task.

Specification reference	Activity
3.2.1 Selection of Materials and Components	Activity 1 – Functionality
	Activity 2 – Aesthetics
	Activity 3 – Environmental Factors
	Activity 4 – Cost
	Activity 5 – Social, Cultural and Ethical Fact
3.2.2 Forces and Stresses	Activity 6 – Forces and Stresses
	Activity 7 – Materials Can Be Enhanced
3.2.3 Ecological and Social Footprint	Activity 8 – Ecological Issues
	Activity 9 – The Six Rs
	Activity 10 – Social Issues
3.2.4 Sources and Origins	Activity 11 – Sources and Origins
3.2.5 Using and Working With Materials	Activity 12 – Working and Physical Properti
	Activity 13 – Using and Working With Mate
	Activity 14 – How To: Shape and Form
3.2.6 Stock Forms, Types and Sizes	Activity 15 – Stock Forms, Types and Sizes
3.2.7 Scales of Production	Activity 16 – Scales of Production
3.2.8 Specialist Techniques and Processes	Activity 17 – The Use of Production Aids
	Activity 18 – Tools, Equipment and Process
	Activity 19 – Tolerances and Quality Contro
	Activity 20 – Commercial Processes
3.2.9 Surface Treatments and Finishes	Activity 21 – Surface Treatments and Finish

Activity 1 – Functional

Teacher's notes and answers

Starter activity: functional	
Aim of the activity	Students to practise matching material properties to applicati
Teacher's instructions	Photocopy the activity on the next page and give one copy to e students 8 minutes to complete the activity. Spend 2 minutes a feeding back and going through student answers.
Students' task	Students should decide what each material is commonly used f appropriate column. A list of possibilities has been provided to material that doesn't have an application that it's commonly us identify it. **Extra challenge!** Could be used as a starter extension, mini plen Suggest an application for the material that has been identifie

Answers:

Thermoplastics

Name	Commo
Polyethylene terephthalate (PETE)	Water bottle
Polyvinyl chloride (PVC)	Pipes
Polypropylene (PP)	Lunchbox with living hin
Acrylic / Poly(methyl methacrylate) (PMMA)	Point-of-sale stands

Thermosetting plastics

Name	Commo
Urea-formaldehyde (UF)	(See 'Extra challenge!' a
Polyester resin	Boat hull

Extra challenge!
Plastic with missing application: urea-formaldehyde (UF)
Commonly used for: electrical fittings

Functionality

Consider the tables of plastics and their properties and the list of applications tha materials are commonly used for. Decide what each material is commonly used fo write this in the appropriate column. But wait! There is one material that doesn't application that it's commonly used for. Which material is it?

Common uses include:
pipes, point-of-sale stands, lunchbox with living hinge, water bottle, boat hull

Thermoplastics

Name	Working properties	Physical properties
Polyethylene terephthalate (PETE)	• Resistant to chemical corrosion • Fully recyclable • Tough and durable • Low cost	• Lightweight • Clear (transparent) • Can be easily coloured
Polyvinyl chloride (PVC)	• Hard and tough • Resistant to chemical corrosion and weathering • Can be flexible or ridged • Low cost	• High-gloss finish • Coloured
Polypropylene (PP)	• Flexible • Tough • Resistant to heat, chemical corrosion and weathering • Fatigue resistant	• Can be translucent • Can be easily coloured • Lightweight
Acrylic / Poly(methyl methacrylate) (PMMA)	• Tough • Brittle when thin • Easily scratched	• Can be very clear (high optical qualities), translucent and opaqu • Can be easily coloured • Lightweight

Thermosetting plastics

Name	Working properties	Physical properties
Urea-formaldehyde (UF)	• Hard • Brittle • Heat resistant • Very good electrical insulator	• Limited colours availab usually white • Opaque
Polyester resin	• Brittle • Tough when added to glass fibre • Heat resistant • Good electrical insulator	• Can be easily coloured • Very clear

Extra challenge!
Suggest an application for the material you have identified as not having an appli

Activity 2 – Aesthetic

Teacher's notes and answers

Starter activity: aesthetic	
Aim of the activity	Students to practise design sketching, annotation and commu making appropriate aesthetic choices to reflect a given target
Teacher's instructions	Photocopy the activity page and give one copy to each studen profiles so you have at least one profile per student (or group paper!). Cut them out, fold them up and put them into a hat/b students (or group of students) can pick a target market witho Give the students 8 minutes to complete the activity. Allow 2 session for a few students to explain the features of their desi
Students' task	Students should pick a target market profile. Using this target redesign the handwash bottle to appeal to the target market.

Answers:

Target market	Features of product – to appeal to
Young children (3–9)	• Bright colours • Bold, simple designs • Fun fonts • Animals and characters
Pre-teen (10–12)	• Bright and neon colours • Featuring bands or relevant TV shows • Has a 'cool' factor, e.g. features pop star / firefi
Teen (13–18)	• A range of colours that go well together (could colours, but has fewer primary colours) • Designs reflect current trends • Bold designs that could be more complex
Young adult (19–24)	• Simplified colour palette, e.g. tones and shades an accent colour (e.g. yellow on an otherwise a scheme) • Use of textures and finishes to convey theme o convey strength and toughness and gloss finish • Reflects fashions and trends from social media
Adult (25+)	• Simple colour palette, more neutral • Higher quality look and finish • Less variety in textures and finishes, a simplifie
Older adult (65+)	• A soft colour palette • Shape and form reflect product

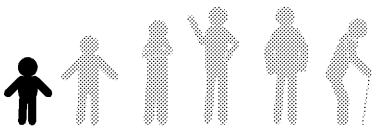
Teachers notes – target market profiles

Reuse this resource!
Use these target market profiles to inspire quick design activities. This helps students to practise their drawing skills and develop their ideation techniques!

Instructions:

- Photocopy this pag
profiles for each st
groups and give a t
- Cut out the profile
- Fold up the profile
hat/bowl/containe
- Let the students pi
- Use the target mar
to inspire quick de
design skills.

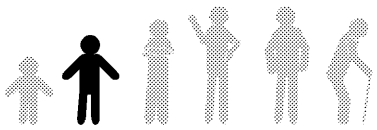
Target market: young children



Fact file:
Age: 3–9
Key information:

- Limited reading ability
- Short attention span
- Safety is important
- Might be messy
- Parents will be the person buying the products

Target market: pre-teen



Fact file:
Age: 10–12
Key information:

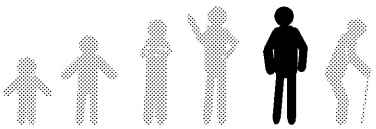
- Fashions and trends are important
- Safety is important
- Parents are likely to be the people buying the products, unless using pocket money

Target market: young adult

Fact file:
Age: 19–24
Key information:

- Fashions and trends are key
- They have some disposable income
- Experimental with styles and brands
- Interested in new and emerging technology

Target market: adult



Fact file:
Age: 25+
Key information:

- Practicality becomes more important
- Financial obligations = less disposable income (children, housing, etc.)
- May have established brand loyalty

Aesthetics

Choose a target market profile at random. Redesign the aesthetics of the liquid handwash bottle to appeal to the target market. Identify which features of your d will make it appeal to the target market. Annotate your design.

Within the redesign consider:

- Surface finish
- Texture
- Colour

Activity 3 – Environmental

Teacher's notes and answers

Starter activity: environmental	
Aim of the activity	Students to understand the possibilities of recycled and reuse
Teacher's instructions	Photocopy the activity on the next page and give one copy to e students 8 minutes to complete the activity. Spend 2 minutes a feeding back and going through student answers.
Students' task	Students should work in pairs to examine the exisitng product were in a 'past life' before they were reused or recycled.

Answers:

Picture 1: plastic bottles
Picture 2: plastic yoghurt bottle
Picture 3: car tyre

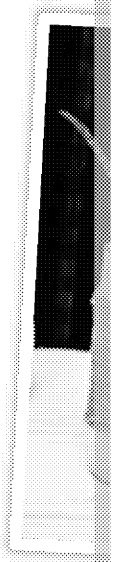
Extra challenge!
Plastic bags, woven into fabric

These stools are made by Reform Studio. The fabric on these stools is woven fr bags. The plastic bags that are used to make the fabric are recycled after being have been rejected by the manufacturers for being flawed. This is an example o materials from ethical sources.

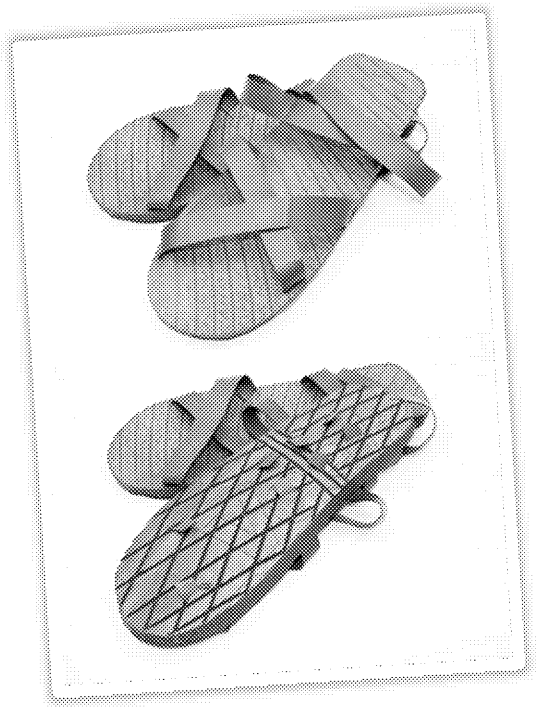
Environmental factor

Consider the products below. Can you work out what they were before they were recycled/upcycled/reused?

Picture 1:



Picture 2:



Picture 3:

Extra challenge!
This product is a little challenging. Need a hint? These products are made by Reform Studio. Check them out at **zzed.uk/9379-rstudio**

Activity 4 – Cost

Teacher's notes and answers

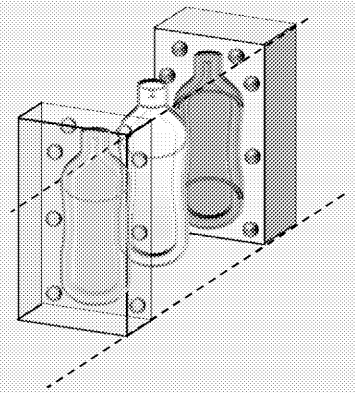
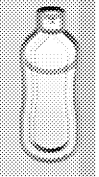
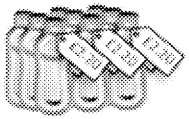
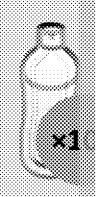
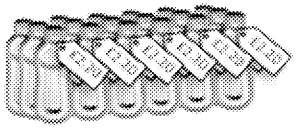
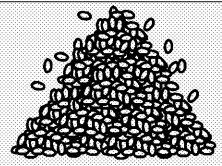
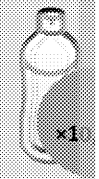
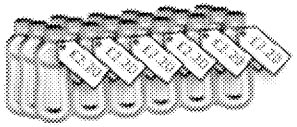
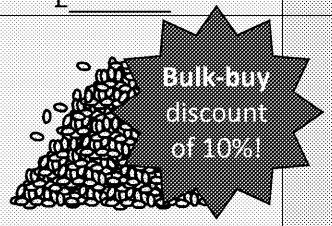
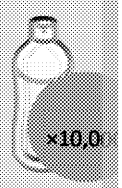
Starter activity: cost	
Aim of the activity	Students to learn how to take cost into consideration when ca idea of bulk-buy discount is introduced.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e students 8 minutes to complete the activity. Spend 2 minutes a feeding back and going through student answers. Provide calcu
Students' task	Students should work in pairs to fill in the gaps in the table be a calculator if needed.

Answers:

Product retail price	-	(Mould cost	+	Material for product	=	Produ
1 product sells for £2.20		1 mould = £10,000.00		Enough material for 1 product = £1.00		1 pro £10,(
100 products sell for £**220.00**				Enough material for 100 products = £100.00		100 pr £**10,**
10,000 products sell for £22,000.00				Enough material for 10,000 products = £**10,000.00**		10,000 = £**20,**
10,000 products sell for £22,000.00				**Bulk-buy discount of 10%!** Enough material for 10,000 products = £9,000.00		10,000 = £**19,**

Cost

Fill in the gaps in the table below. You can use a calculator if you need to!

Product retail price	Product cost (Mould cost + Material for product = Product c		
 1 product sells for £2.20	 1 mould = £10,000.00	 Enough material for 1 product = £1.00	 1 product = £1
 100 products sell for £_____		 Enough material for 100 products = £100.00	 100 products =
 10,000 products sell for £22,000.00		 Enough material for 10,000 products = £_____	 10,000 proc £_____
 10,000 products sell for £22,000.00		 Enough material for 10,000 products = £9,000.00	 10,000 proc £_____

Activity 5 – Social, cultural and e

Teacher's notes and answers

Starter activity: social, cultural and e	
Aim of the activity	Students to learn how social, cultural and ethical factors affec
Teacher's instructions	Photocopy the activity on the next page and give one copy to e minutes to complete the activity. Spend 2 minutes at the end o going through student answers.
Students' task	Students should read the mini case studies and decide whethe social responsibility, cultural influences or ethical sources.

Answers:

What factors does this product
☑ Social ☐ Cultu

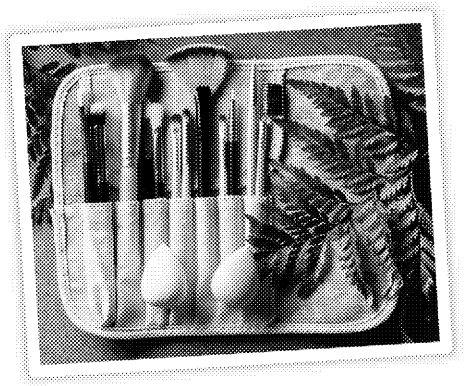
What factors does this product
☐ Social ☐ Cultu

What factors does this product
☐ Social ☑ Cultu

Social, cultural and ethical

Read the mini case studies below and decide whether they fall into the category responsibility, cultural influences or ethical sources.

Case study 1:
Azahara bought a make-up case made from fair trade materials. This meant that knew that fair wages had been paid to the farmers growing the crops used to ma fabric that the make-up case is made of.



What factors does this product
☐ Social ☐

Case study 2:
Azahara has decided to go vegan (eliminating products that are made by/of anim looking into replacing products made from leather with alternatives that are not she still wants the products to be durable and affordable. She has recently bough polyurethane instead of leather.

What factors does this product
☐ Social ☐

Case study 3:
Azahara has travelled to Japan. She was shocked at the amount of plastic packag food packaging. She found it to be quite wasteful. Hygiene and cleanliness are pa appeal to customers, Japanese companies often use individual wrappings and lo

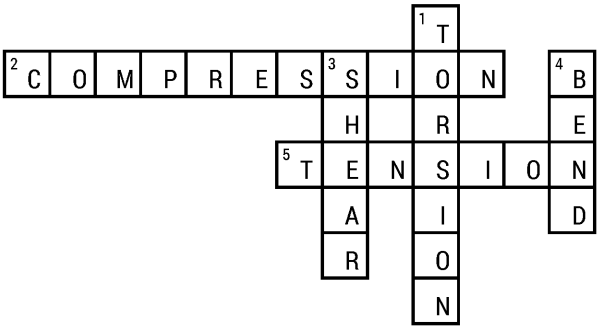
What factors does this product
☐ Social ☐

Activity 6 – Forces and st

Teacher's notes and answers

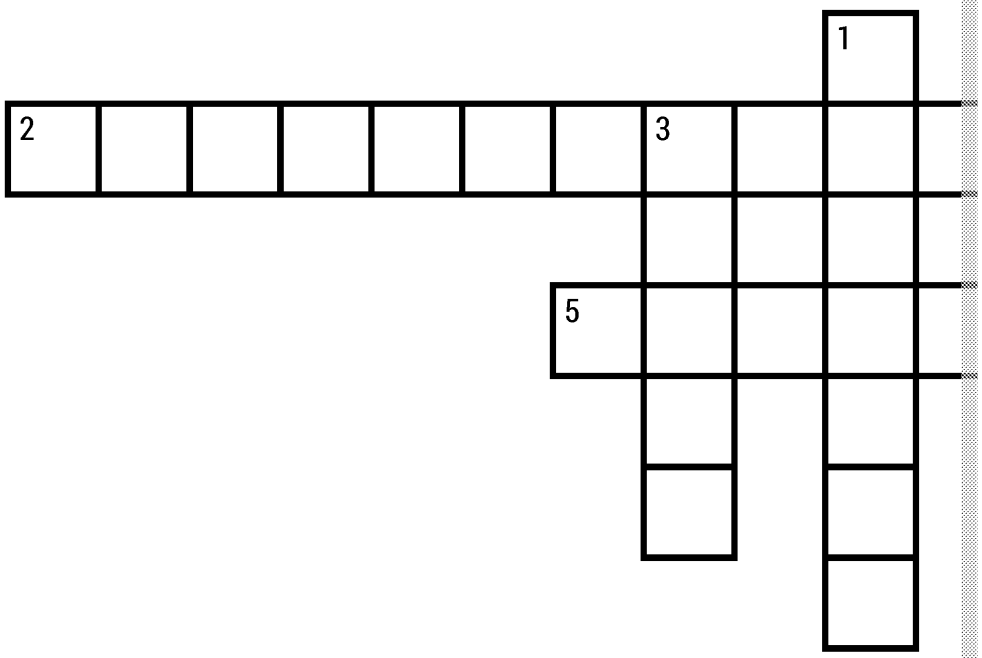
Plenary activity: forces and st	
Aim of the activity	Students to solidify knowledge of types of forces and stresses.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	Students should complete the crossword puzzle.

Answers:



Forces and stresse

Complete the crossword below. Solve the clues to identify the words and write t
the crossword.



Across

2 When force is applied in opposite directions, to opposite ends, to push either en

5 When force is applied in opposite directions to pull either end away from each ot

Down

1 When force is being applied through twisting. (7)

3 When force is being applied in opposite directions, on different planes. The obje
may eventually break. (5)

4 When force is applied and creates or increases an angle or curve. (4)

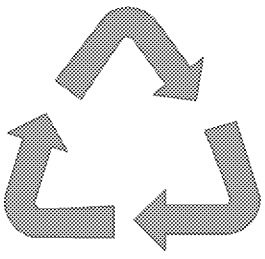
Activity 7 – Materials can be

Teacher's notes and answers

Plenary activity: materials can be	
Aim of the activity	Students to demonstrate their knowledge of how materials ca be used as a recap or to identify students' existing knowledge
Teacher's instructions	Photocopy the activity on the next page and give one copy to statements on the board. Engage the class in a discussion to id are true or false, and why students think that. If the students have an activity page each they can cut out the hold up the relevant board to display their answer. This will he individual students' answers. You can ask students with an inc their answer is right, then explain the correct answer.
Students' task	Students should discuss as a class whether the statements are to explain the reasons behind their answers.

Answers:

Statement
Reinforcing a material makes it weaker.
You can reinforce a material by adding layers of the same material, or another material.
Stiffening a material always makes it stronger.
Making a material more flexible can make it stronger.
You can make plastics more flexible by adding plasticisers during the production process.



Reuse this resource!
Think about laminating the 'True' and 'False' cards and reusing them for more true/false tasks.

Materials can be enhan

Are the statements below true or false? You decide! Tick to indicate whether you
the statement is true or false. Then, hold up the 'True' or 'False' card to share yo
answer with the class. Be prepared to explain the reason for your answer.

Statement	True	F
Reinforcing a material makes it weaker.		
You can reinforce a material by adding layers of the same material, or another material.		
Stiffening a material always makes it stronger.		
Making a material more flexible can make it stronger.		
You can make plastics more flexible by adding plasticisers during the production process.		

True

Fa

Activity 8 – Ecological is

Teacher's notes and answers

Plenary activity: ecological is	
Aim of the activity	Students to demonstate their knowledge of when and how ca product life cycle.
Teacher's instructions	Photocopy the activity on the next page and give one copy to students 5 minutes to complete the activity. Spend 5 minutes feeding back and going through student answers.
Students' task	Students should work in pairs to cut out the carbon footprints product life cycle to demonstrate when carbon is produced. T why they think carbon is produced, how it's produced and a w carbon could be reduced. **Extra challenge!** Discuss the effect on a product's carbon footprint when it is manufactured internationally.

Answers:

Allow any valid answers.
Example answers:

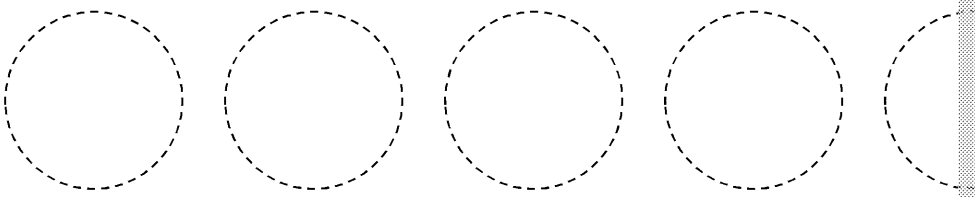
- Carbon is produced when sourcing materials because the processes used t raw materials are energy intensive and require the burning of fuel, which r atmosphere. Carbon emissions could be reduced by aiming to make the pr using less energy will cause less carbon to be produced.
- The production of plastic stock forms is energy intensive. Producing energ require the burning of fuel, which releases carbon into the atmosphere. Ca reduced by aiming to make the process as efficient as possible – using less to be produced. Reducing wastage could also help to reduce carbon emiss materials will have to be used.
- The manufacturing of plastic products is energy intensive. Producing energy to the burning of fuel, which releases carbon into the atmosphere. Making the pr wastage are valid ways of reducing carbon emissions from manufacturing. Hov designed to use the least possible amount of material; this will help to reduce t by the product (its carbon footprint).
- The nature of a plastic cup is to be disposable. It has planned obsolescence doesn't directly produce carbon, designing the product to have a longer us and prevent more products from having to be made to replace it (making carbon).
- Disposal and recycling of the product can cause carbon emissions. Firstly, t disposal or recycling will produce carbon by using fuel. Then, if the produc carbon. The process of recycling the plastic is also energy intensive and wi not as energy intensive as sourcing and producing a product from the raw

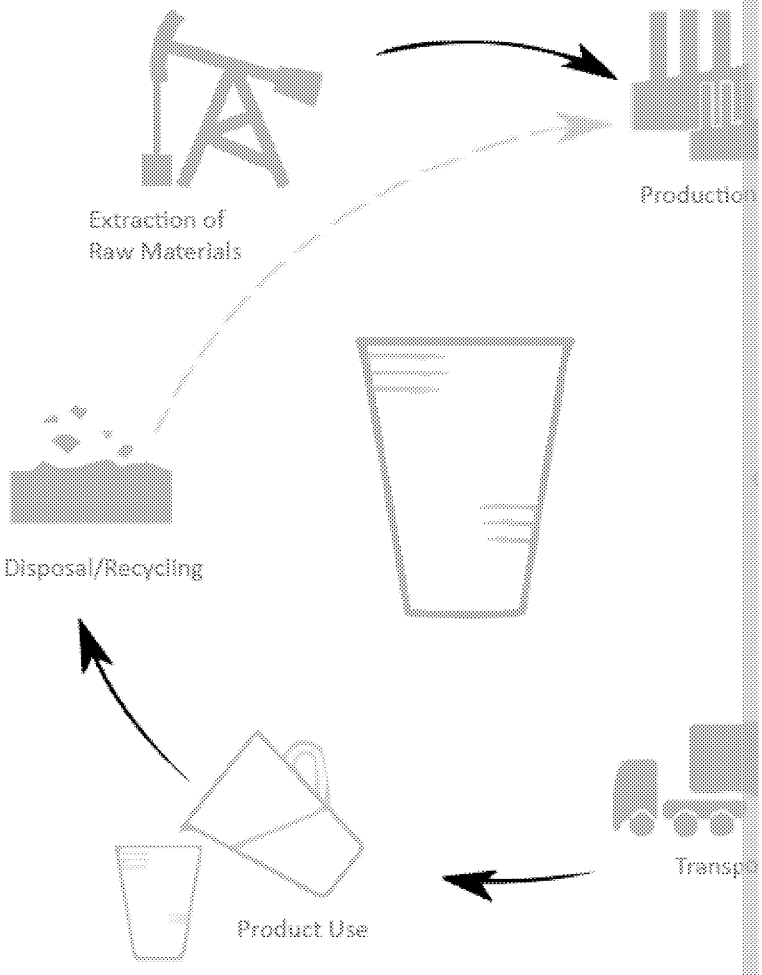
Extra challenge!
The carbon footprint is bigger because more fuel is used to transport the produ some countries that manufacture products cheaply do not have to follow the sa manufacturers in the UK, so there is less time and money spent trying to make t environmentally friendly. This can lead to larger carbon footprints.

Ecological issues

In pairs, consider the product life cycle of a plastic cup (shown below). Cut out the
footprints and place them on the life cycle at stages where you think carbon is pro

Be ready to explain why you think carbon is produced, how it's produced and a v
the production of carbon could be reduced at each stage that you have identified
example has been completed for you.





Carbon is produced
product(s) through
vehicles. It is expelle
as petrol and diesel
when extracting the
produced by transp
reducing the produc
has to travel betwe
manufacturer, reta

Extra challenge!
Discuss the following question:
How is the carbon footprint of a product affected if the product is manufactured in a country different from the location of the final consumer (e.g. made in China, used in the UK)?

Activity 9 – The Six R

Teacher's notes and answers

Starter activity: the Six R	
Aim of the activity	Students to learn the definitions of the Six Rs and be able to id
Teacher's instructions	Split the class into groups of three. Photocopy the activity she next two pages and give one activity sheet to each group of st students decide who will be the judge for their group (or nom student who will be the judge the answer page, with instructio Give the students 10 minutes to complete the activity. Exisitin or the paper counters (found on the answer page) can be cut o For weaker students, consider providing them with a list of the
Students' task	In groups of three, students should play noughts and crosses. The Six Rs is the answer to the clue / being defined to be able to place the students is a judge who will let the players know whetherthey answer. The first player to get a row of three wins.

Answers:

Repair	**Repair**	**Reuse**
Reduce	**Recycle**	**Rethink**
Refuse	**Recycle**	**Reduce**

A differe

The class could play noughts a the teacher be

This game cou Cut out the q the correspo (attach with player claims answer, thei answer, clair themselves given is inco

The Six Rs

In groups of three, play noughts and crosses! One person is 'noughts' and the oth
'crosses'; the third person is the judge. The players take turns to place the counte
the grid. The first person to get a row of three wins (remember your row can also
diagonal). But wait! There's a twist! In order to put down your nought or cross, yo
decide which of the Six Rs matches the definition or clue. If you get it right, you c
down your counter and claim the square; if you get it wrong, the other player get
claim the space. The judge will have the answers and will tell you whether you ha
correct answer!

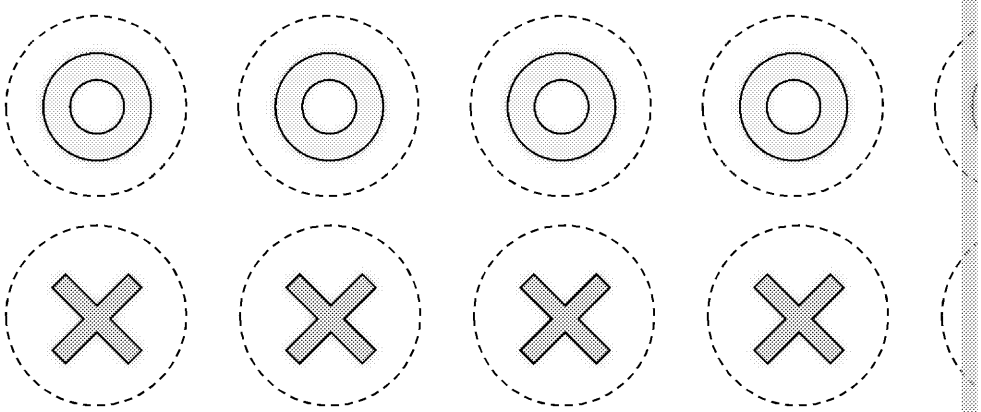
Fix something that is broken or worn.	When something breaks, you can try to _____ it instead of throwing it away and buying a new one.	To
To use less of something is to _____ your consumption.	To process the raw materials of an item and use it again in a different way.	To
Say no to excess consumption.	If a raw material comes from a finite source it is especially important to _____ it so that the materials it is made of can be used again.	

WARNING!

Answers below. For judge's eyes only!

Repair	**Repair**	
Reduce	**Recycle**	
Refuse	**Recycle**	

Counters:



Activity 10 – Social iss

Teacher's notes and answers

Plenary activity: social issu	
Aim of the activity	Students to demonstrate knowledge of social issues and pract quick sketching skills.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	Students should choose one of the social issues. Draw a storyb negative impacts of the social issue.

Answers:

Example answer for unsafe working conditions:

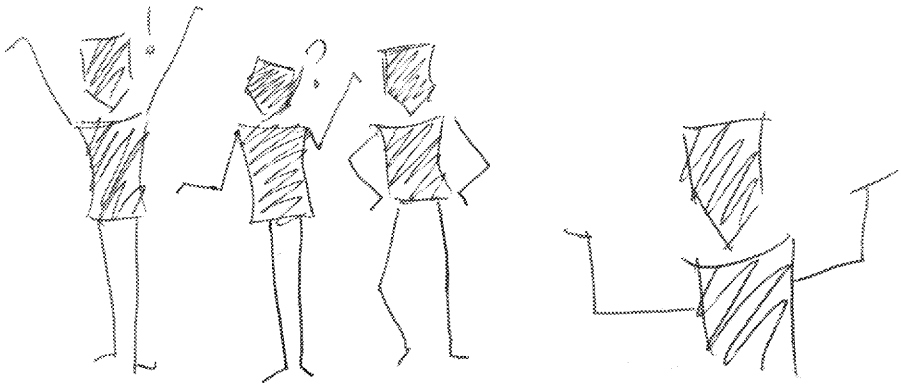
❶ Companies try to increase profits by cutting costs.	❷ Companies fail to maintain health and safety standards, or disregard them entirely.	❸ be
❹ Workers get injured, potentially in life-changing ways, or killed.	❺ Seriously injured workers can't work any more and struggle to support their families.	wo

Social issues

Choose one of the social issues listed below. Draw a storyboard demonstrating t
negative impacts of the social issue. Use the bigger boxes to draw in and the sma
boxes underneath to write short explanations about your drawings, as in a comic

Social issues:

- Unsafe working conditions
- Workers paid an unfair wage
- Ocean/marine pollution
- Atmospheric pollution

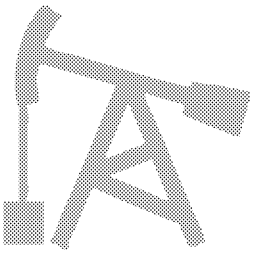


Activity 11 – Sources and

Teacher's notes and answers

Starter activity: sources and	
Aim of the activity	Students to gain an overview of the processes involved in the p source of raw material.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	Students should use the terms provided to fill in the gaps in th

Answers:

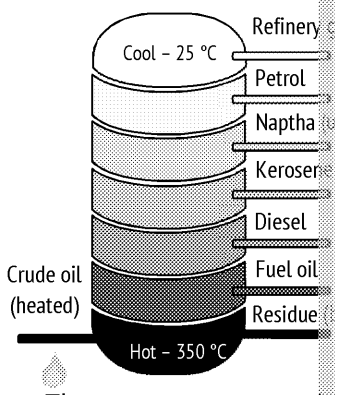


Drilling is the process used to extract crude oil from 'oil fields' which are pockets of crude oil within the earth's crust.

Crude oil is made from died millions of years a buried and formed int pressure. Crude oil is there is a limited amo

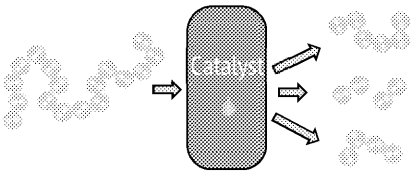
Fractional distillation change crude oil into u

To separate the produ Each product has a diff therefore, can be syph The products that have syphoned off at the bo



Cracking is the process used to make the products from the fractional distillation process.

This process **splits** the larger hydrocarbon molecules into smaller hydrocarbons using a **catalyst**. A catalyst is a substance that is used to activate or increase the rate of a chemical reaction.



The monomers created put into a polymerisati reaction occurs and the **polymers**. This process

Sources and origins

Use the terms provided to fill in the gaps in the timeline.

Terms:

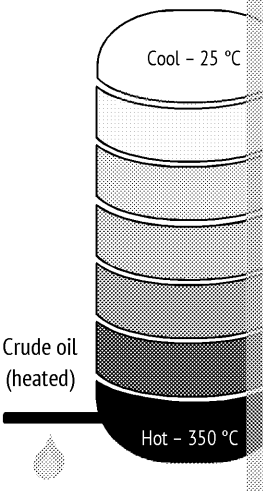
- crude oil
- drilling
- finite
- heated
- polymerisation
- splits

_____ is the process used to extract crude oil from 'oil fields' which are pockets of crude oil within the earth's crust.

_____ is m
plants that died millio
deeply buried and form
heat and pressure. Cru
which means that ther

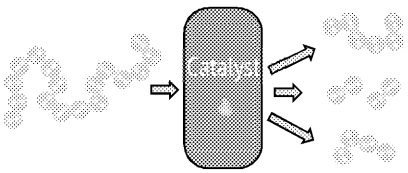
Fractional distillation is
change crude oil into us

To separate the product
_____. Each
boiling point and, there
a different level. The pr
molecules are syphoned



Cracking is the process used to make the products from the fractional distillation process.

This process _____ the larger hydrocarbon molecules into smaller hydrocarbons using a **catalyst**. A catalyst is a substance that is used to activate or increase the rate of a chemical reaction.



The monomers created
are put into a polymeris
reaction occurs and the
polymers. This process i

Activity 12 – Working and physic

Teacher's notes and answers

Plenary activity: working and physic	
Aim of the activity	Students to learn which properties are physical and which are
Teacher's instructions	Photocopy the activity on the next page and give one copy to bottom of the page, along the dotted line, to hide the definitio definitions if they need a hint. Give the students 8 minutes to minutes at the end of this session feeding back and going thro
Students' task	Students should sort the properties into either working prope should write them into the correct column.

Answers:

Physical properties	Wor
• Thermal conductivity • Electrical conductivity • Melting point • Corrosion resistance • Colour • Opacity	• Strength • Toughness • Hardness • Elasticity • Malleability • Ductility

Working and physical pro

Consider the list of material properties below. Decide whether they are physical properties or working properties. Write them into the appropriate columns.

- Colour
- Corrosion resistance
- Ductility
- Elasticity
- Electrical conductivity
- Hardness
- Malleability
- Melting point
- Opacity
- Strength
- Thermal conductivity
- Toughness

Physical properties	Wor

Need a hint?
Unfold the bottom of the page to see the definitions of physical and working pro

Physical properties: What a material is or does even when it is not in use – th

Working properties: What a material is or how it reacts while it is in use.

Activity 13 – Using and wor materials

Teacher's notes and answers

Starter activity: using and working w	
Aim of the activity	Students to develop an understanding of how the properties o improve the functionality of a commercial product.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	For the first product, students should use the terms provided description of the properties of the electrical fitting to discove improve the function of the product. For the second product t to match the needs to the properties of the materials used in **Extra challenge!** Could be used as a starter extension, mini ple The students should answer the multiple-choice question.

Answers:

1) **Electrical fitting – made from urea-formaldehyde**
This electrical fitting is made from urea-formaldehyde. It has been injectio the same unit can be produced cheaply. The surface finish is smooth and i This means that it is a neutral part of the decor within in a house. Most im urea-formaldehyde is a very good electrical insulator. This means that it do protects the user from electric shocks.

2) **Polymer seating – made from polypropylene**

Property: Strong, durable and not brittle.

Property: Can be injection moulded.

Property: Resistant to weathering and chemical corrosion.

Property: Can easily be coloured, in a wide range of colours.

Property: Lightweight.

Need: The seating ne Production sh volumes to be

Need: The customer handle, move

Need: The customer personal style they want.

Need: This seating is

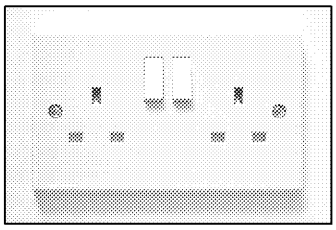
Extra challenge!
Consider the polymer seating. How could you modify the properties of the mat for its use? Choose **one** of the options below.

- ☐ Add a scent to make it smell like freshly cut grass
- ☑ Add stabilisers to help resist UV degradation
- ☐ Add plasticisers to make it really flexible
- ☐ Heat it until it turns to molten plastic

Using and working with ma

You need to develop an understanding of how the properties of a material are us
improve the functionality of a commercial product.
For the first product, use the terms provided to fill in the gaps in the description o
properties of the electrical fitting to discover how the properties affect and impro
function of the product. For the second product use arrows to match the needs to
properties of the materials used in commercial products.

1) Electrical fitting – made from urea-formaldehyde



This electrical fitting is made from urea-_____

_____, which means _____ of the same

The surface finish is smooth and it is _____ in

means that it is a neutral part of the decor within a h

urea-formaldehyde is a very good _____. This means that it _____ co

user from electric shocks.

Terms: lots formaldehyde opaque does not white

2) Polymer seating – made from polypropylene

Property: Strong, durable and not brittle.

Property: Can be injection moulded.

Property: Resistant to weathering and chemical corrosion.

Property: Can easily be coloured, in a wide range of colours.

Property: Lightweight.

Need: The seating Production high volum

Need: The custom handle, mo

Need: The custom personal st colour they

Need: This seatin

Extra challenge!
Consider the polymer seating. How could you modify the properties of the mater
its use? Choose **one** of the options below.

- ☐ Add a scent to make it smell like freshly cut grass
- ☐ Add stabilisers to help resist UV degradation
- ☐ Add plasticisers to make it really flexible
- ☐ Heat it until it turns to molten plastic

Activity 14 – How to: shape

Teacher's notes and answers

Plenary activity: how to: shape	
Aim of the activity	Students to become familiar with the process of drilling.
Teacher's instructions	Split the class into pairs. Photocopy the activity on the next pa pair of students. Give the students 8 minutes to complete the 2 minutes at the end of this session feeding back and going th
Students' task	Students should work in pairs to put the instructions for how to **Extra challenge!** Could be used as a starter extension, mini ple The students should pick pne of the processes and write a sim someone could follow.

Answers:

Order (Number 1–7)	Instruction
1	Choose the correct drill bit(s), considering size and type. You correct width of the hole, and you might need a second (sma needs to be smaller than the desired hole). If you are going t drill bit must be slightly smaller than the screw.
2	Prepare the surface of the material. Make sure the surface is out where the material will be drilled. Consider putting mask be drilled to make sure the drill doesn't slip and scratch the
3	If using a handheld drill, secure the material to a stable, flat secure the material to the bed and raise the bed to the corre
4	Insert the correct drill bit into the drill. Make sure the drill bi pillar drill, check that the safety guard is the correct height.
5	If needed, drill a pilot hole first – this will help guide a screw bigger drill bit to make sure it is lined up correctly.
6	Drill the hole, making sure the drill is at the correct angle.
7	Check the hole and remove excess dust and material.

Extra challenge! Allow valid answers.

How to: shape and fo

Put the following instructions for how to drill in the correct order by numbering th

Order (Number 1–7)	Instruction
	Check the hole and remove excess dust and material.
	Choose the correct drill bit(s), considering size and type. will need one drill bit for the correct width of the hole, a you might need a second (small) drill bit for a pilot hole needs to be smaller than the desired hole). If you are go use a screw in the hole, the drill bit must be slightly sma than the screw.
	Drill the hole, making sure the drill is at the correct angle
	If needed, drill a pilot hole first – this will help guide a sc correctly or help to guide a bigger drill bit to make sure it lined up correctly.
	If using a handheld drill, secure the material to a stable, surface. If using a pillar drill, secure the material to the b and raise the bed to the correct position.
	Insert the correct drill bit into the drill. Make sure the d is in place tightly. If using a pillar drill, check that the safe guard is the correct height.
	Prepare the surface of the material. Make sure the surfa clean and grease free. Mark out where the material will drilled. Consider putting masking tape where the mater be drilled to make sure the drill doesn't slip and scratch surface of the plastic.

Extra challenge!

Pick one of the processes below and write a simple set of instructions that some

- Cut
- Turn
- Mill
- Cast

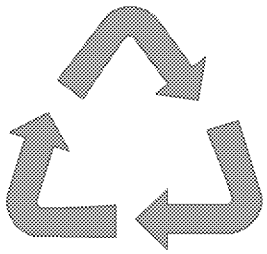
Activity 15 – Stock forms, type

Teacher's notes and answers

Starter activity: stock forms, types	
Aim of the activity	Students to test their knowledge of stock forms, types and size
Teacher's instructions	Display a question on the board or read the question out loud the four different responses (A, B, C or D). You can give studen whiteboards in order to express which choice they agree with of the room to A, B, C or D and get the students to stand in the they have chosen. Reveal the correct answer after every stude
Students' task	Students should answer the questions given by standing in the indicates the letter A, B, C or D, **or** they can use the paper lette whiteboards given to them to give their answers to the questi

Answers:

1. **C. Granules**
2. **D. Sheet**
3. **D. Sheet**
4. **A. Rod**
5. **B. Nut**



Reuse this resource!
Think about laminating these letter cards and reusing them for more multiple-choice tasks.

Stock forms, types and

The teacher will allocate a letter to each corner of the classroom, **or** you can use t
letters (A, B, C, D) given to you by your teacher to give your answers to the quest
below.

1. What stock form of plastic is used for injection moulding?

   A. Film
   B. Foam
   C. Granules
   D. Sheet

2. What stock form of plastic is used for vacuum forming?

   A. Film
   B. Foam
   C. Rod
   D. Sheet

3. What stock form is sold by length × width × thickness?

   A. Film
   B. Powder
   C. Rod
   D. Sheet

4. What stock form is sold by length × width × diameter?

   A. Rod
   B. Powder
   C. Granules
   D. Foam

5. What standard component holds a bolt in place?

   A. Screw
   B. Nut
   C. Hinge
   D. Nail

A

C

Activity 16 – Scales of pro

Teacher's notes and answers

Plenary activity: scales of prod	
Aim of the activity	Students to learn about scales of production.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e students 8 minutes to complete the activity. Spend 2 minutes a feeding back and going through student answers.
Students' task	Students should work in pairs to fill in the gaps in the table.

Answers:

Scale of production	Definition	
Prototype	**A functioning and aesthetically correct version of a design used to test and demonstrate a design.**	A b
Batch production	A specified number of products to be produced for a limited time.	**M (a**
Mass production	A large number of products produced over a long period of time.	C
Continuous production	**A production process that is constant. It operates 24/7, producing high volume for the lowest possible cost.**	S c p

Scales of production

In pairs, fill in the gaps in the table below.

Scale of production	Definition	Examples of prod
Prototype	_____ _____ _____	An example of how a product will be
Batch production	A specified number of products to be produced for a limited time.	_____ _____
_____ _____	A large number of products produced over a long period of time.	Cars and mobile phon
Continuous production	_____ _____ _____	Stock forms, standard components (e.g. cab pipes, plastic sheets)

Activity 17 – The use of produ

Teacher's notes and answers

Starter activity: the use of produ	
Aim of the activity	Students to try different methods of translating a shape, inclu and using a template.
Teacher's instructions	Split the class into groups of four. Photocopy the activity on th page, along the dotted line, to hide the shape. One of the stud see the shape until giving feedback. Give one copy of the activ students. Give the students 8 minutes to complete the activity. Spend 2 session feeding back. Guide the feedback to explore which me why. As a quick extension, the students could be asked which efficient if they were to duplicate the shape multiple times.
Students' task	Students should work together to duplicate the shape at the b three different methods given to try to achieve this aim. This a groups of four. One person from the group should not see the people in the group. Two people will use Method 1 (one of the the shape), the third person will use Method 2, and the fourth everyone has finished, or 8 minutes has passed, the students s method has generated the most accurate results.

Answers:

Method 3 is the most accurate.

This method is using a template.

The use of production c

The aim of this activity is to duplicate the shape at the bottom of this page. There three different methods given to try to achieve this aim. Get into groups of four. person from the group should not see the shape, so only reveal it to three peopl group. Two people will use Method 1 (one of these people must not have seen t shape), the third person will use Method 2, and the fourth will use Method 3. Wh everyone has finished, or 8 minutes has passed, stop and discuss which method generated the most accurate results.

Method 1 (two people):
One person describes the shape to a second person. The second person (who ha to draw the shape based on the first person's description alone.

Method 2:
The person using this method can look at the shape and use a ruler to measure a

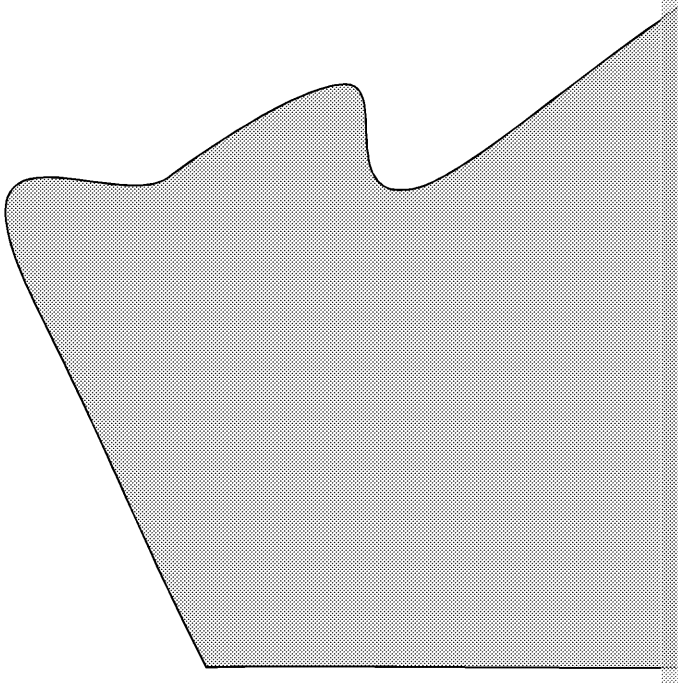
Method 3:
The person using this method can cut out the shape and draw round it, or trace i

Which of these methods is the most accurate?

Method …… **is the most accurate.**

Unfold the bottom of the page to reveal the shape for this task. Make sure that o Method 1 doesn't see the shape!

Shape:



Activity 18 – Tools, equipment a

Teacher's notes and answers

Plenary activity: tools, equipment ar	
Aim of the activity	Students to learn which manufacturing and modelling method deforming and reforming methods.
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	Students should sort the processes into three different catego deforming and reforming.

Answers:

Wastage:
- Die cutting
- Turning
- Sawing
- Drilling
- Cutting and shearing

Addition:
- 3D printing
- Bonding

Deforming and reforming:
- Vacuum forming
- Blow moulding
- Casting
- Injection moulding
- Extrusion

Tools, equipment and pro

Sort the processes into three different categories:

- Wastage – a process or technique that involves taking material away to achi desired shape
- Addition – a process or technique that involves adding material to achieve a shape
- Deforming and reforming

Category (wastage / addition / deforming and reforming)	Tools, equipment and proce
	3D printing Layers built up by a machine to produce a 3D object
	Blow moulding A manufacturing method that uses air to force a heated
	Bonding Sticking together with adhesive
	Casting A manufacturing method that involves pouring liquid pl it to set
	Cutting and shearing A way of separating and dividing materials. Can be don
	Die cutting Punching out a shape with a blade by lowering it onto th pressure
	Drilling A way of making holes in hard materials, typically using
	Extrusion Molten plastic is pushed through a die of a cross-sectio cut to length
	Injection moulding Granules of plastic are pushed through a heating chamb plastic is then pushed into a mould by a hydraulic ram.
	Sawing A way of cutting material, specifically using a tool with t
	Turning Using a lathe to shape material
	Vacuum forming A manufacturing method that involves heating plastic sh suction to tightly mould the plastic sheet to a form

Activity 19 – Tolerances and qu

Teacher's notes and answers

Starter activity: tolerances and qu	
Aim of the activity	Students to learn to identify measurements that are / are not w
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	Students should measure the length of the pieces to see whet tolerances. The measurement should be 5 cm with tolerances

Answers:

1	**Did it meet the tolerances?** ☑ Yes ☐ No
2	**Did it meet the tolerances?** ☐ Yes ☑ No
3	**Did it meet the tolerances?** ☑ Yes ☐ No
4	**Did it meet the tolerances?** ☐ Yes ☑ No
5	**Did it meet the tolerances?** ☑ Yes ☐ No
6	**Did it meet the tolerances?** ☑ Yes ☐ No
7	**Did it meet the tolerances?** ☐ Yes ☑ No

Extra challenge!

How would you make sure you get the highest quality finish when using a laser c
Choose **one** of the options below.

- ☐ Make sure the laser settings are correct for the material being used.
- ☐ Keep the machine clean and in working order.
- ☐ Make sure that an allowance is made for kerf (a small amount of material th laser cutting).
- ☑ All of the above.

Tolerances and quality c

Tolerances are the minimum and maximum meaurements that a product or part
to be in order to be usable.

Below are seven rectangles which represent seven pieces of sheet plastic that ha
cut out to form the side of a box. Measure the length of each piece to see wheth
tolerances.

The measurement should be 5 cm with tolerances of +/– 2 mm.

1. 

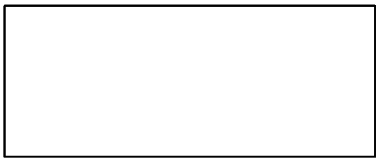
Did it meet the toler

☐ Yes ☐

2. 

Did it meet the toler

☐ Yes ☐

3. 

Did it meet the toler

☐ Yes ☐

4. 

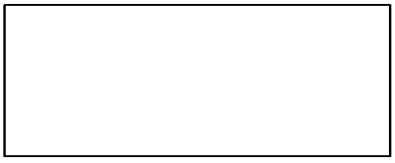
Did it meet the tolera

☐ Yes ☐

5. 

Did it meet the tolera

☐ Yes ☐

6. 

Did it meet the tolera

☐ Yes ☐

7. 

Did it meet the tolera

☐ Yes ☐

Extra challenge!

How would you make sure you get the highest quality finish when using a laser c
Choose **one** of the options below.

- ☐ Make sure the laser settings are correct for the material being used.
- ☐ Keep the machine clean and in working order.
- ☐ Make sure that an allowance is made for kerf (a small amount of material th
  laser cutting).
- ☐ All of the above.

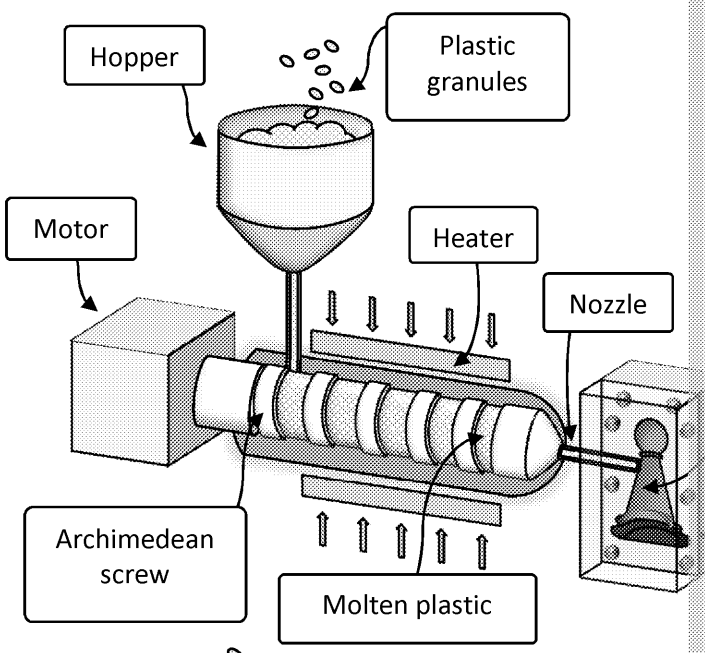
Activity 20 – Commercial pr

Teacher's notes and answers

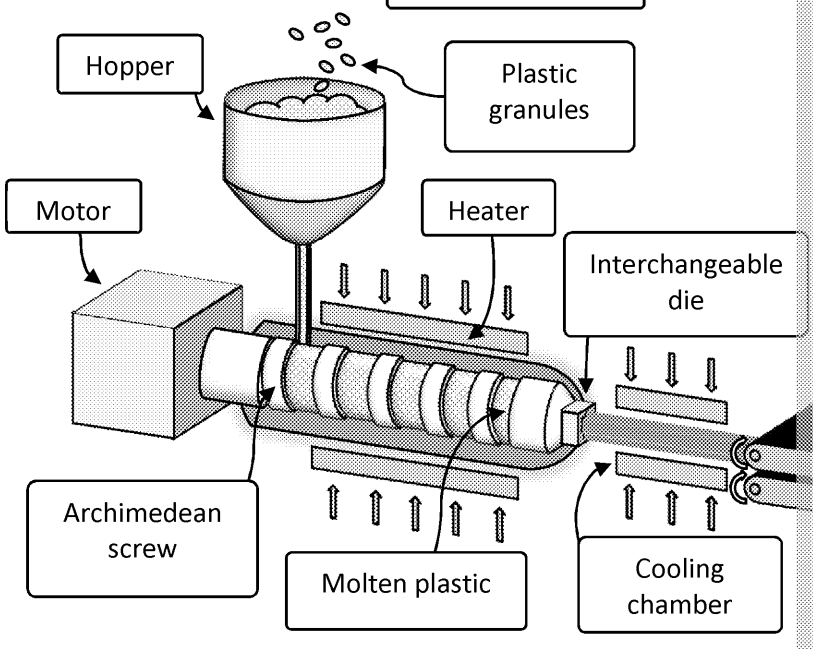
Plenary activity: commercial pro	
Aim of the activity	Students to practise knowledge of commercial processes.
Teacher's instructions	Split the class into pairs. Photocopy the activity on the next pa pair of students. Give the students 8 minutes to complete the 2 minutes at the end of this session feeding back and going th
Students' task	Students should choose from the labels given to label the diag processes.

Answers:

1. **Injection moulding**



2. **Extrusion**

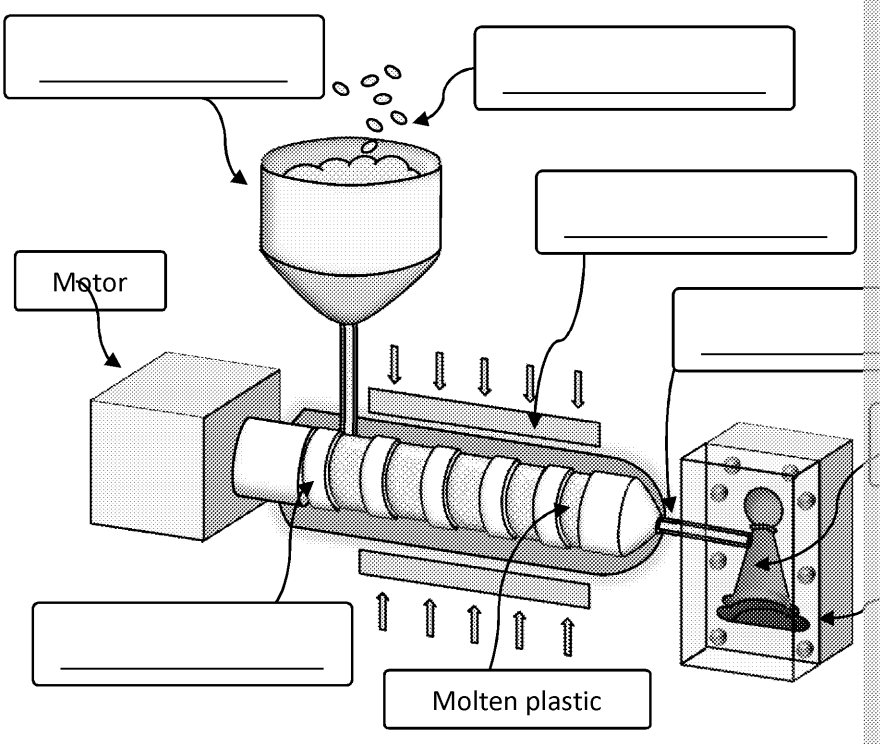


Commercial processe

The diagrams below illustrate the processes of injection moulding and extrusion. the diagrams using the words provided.

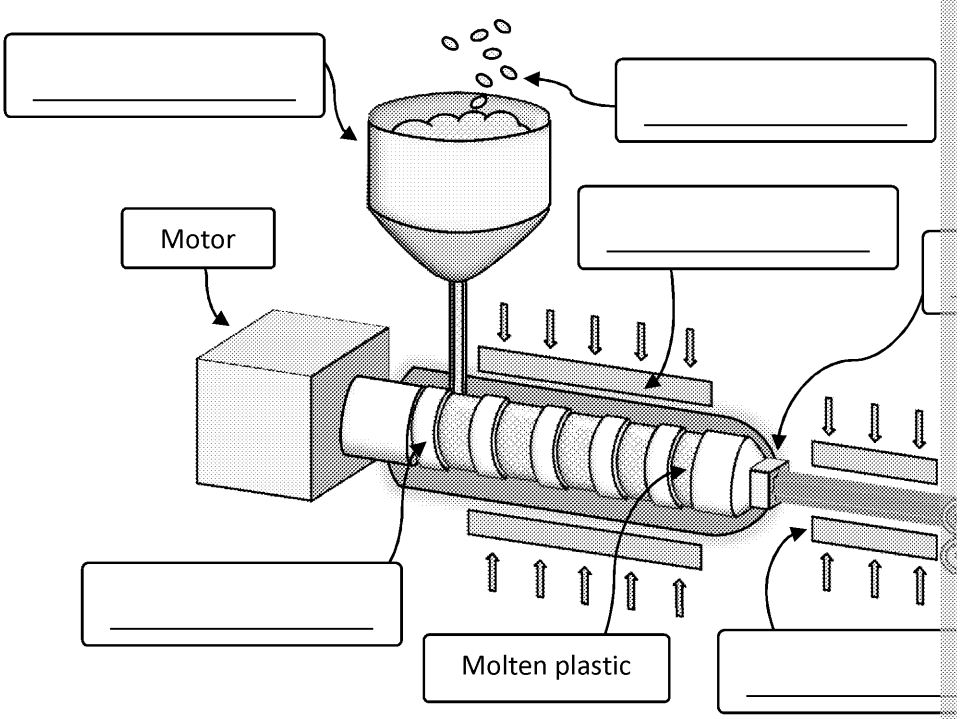
1. **Injection moulding** – choose from the labels below:

   Archimedean screw, heater, hopper, mould, mould cavity, nozzle, plastic granules



2. **Extrusion** – choose from the labels below:

   Archimedean screw, heater, cooling chamber, hopper, extruded plastic, in mould cavity, plastic granules



Activity 21 – Surface treatments

Teacher's notes and answers

Plenary activity: surface treatments	
Aim of the activity	Students to practise their knowledge of surface treatments an
Teacher's instructions	Photocopy the activity on the next page and give one copy to e 8 minutes to complete the activity. Spend 2 minutes at the en and going through student answers.
Students' task	Students should number the instructions in the correct order. finishes include olishing, printing and vinyl decals.

Answers:

Polishing

Polishing is used to produce a high-shine finish and a high-quality appearance.

Number of instruction	Instruction
1	Clean and degrease the surface of the material.
2	Sand the surface with a series of sandpaper grit levels – from harsh t smooth the surface.
3	Buff the surface using a cotton wheel and cutting compound to crea

Printing

Heat transfer printing / sublimation printing and hydrographic printing are both techni

Heat transfer printing

Number of instruction	Instruction
1	Print your design onto special paper.
2	Clean and degrease the surface of the material.
3	Place the image face down onto the surface.
4	Apply heat to the reverse – this transfers it to the surface of the plas
5	Remove the backing paper.

Hydrographic printing

Hydrographic printing allows a graphic design to be applied to a three-dimensional surf

Number of instruction	Instruction
1	Print your design onto water-soluble film.
2	Float the film onto a water bath.
3	When an activator solution is added, the film dissolves and leaves the
4	Clean and degrease the surface of the material.
5	Dip the product into the water – as it enters the bath, the image is w

Vinyl decals

Vinyl decals are shapes and designs that are cut out of a film made of vinyl.

Number of instruction	Instruction
1	Prepare your design and cut it out of the vinyl film and backing. (You cutter or CNC cutter.)
2	Clean and degrease the surface of the material.
3	Peel the backing off the vinyl film and apply the design onto the surf surface.
4	Smooth down the vinyl decal and carefully push out any air bubbles

Surface treatments and fi

Consider the instructions for surface treatments and finishes. The order of the instructions has been mixed up! Number the instructions in the correct order.

Polishing

Polishing is used to produce a high-shine finish and a high-quality appearance.

Number of instruction	Instruction
	Buff the surface using a cotton wheel and cutting compound to c
	Clean and degrease the surface of the material.
	Sand the surface with a series of sandpaper grit levels – from har smooth the surface.

Printing

Heat transfer printing / sublimation printing and hydrographic printing are both te plastics.

Heat transfer printing

Number of instruction	Instruction
	Apply heat to the reverse – this transfers it to the surface of the p
	Clean and degrease the surface of the material.
	Place the image face down onto the surface.
	Print your design onto special paper.
	Remove the backing paper.

Hydrographic printing

Hydrographic printing allows a graphic design to be applied to a three-dimensior

Number of instruction	Instruction
	Clean and degrease the surface of the material.
	Dip the product into the water – as it enters the bath, the image is
	Float the film onto a water bath.
	Print your design onto water-soluble film.
	When an activator solution is added, the film dissolves and leave the bath.

Vinyl decals

Vinyl decals are shapes and designs that are cut out of a film made of vinyl.

Number of instruction	Instruction
	Clean and degrease the surface of the material.
	Peel the backing off the vinyl film and apply the design onto the s surface.
	Prepare your design and cut it out of the vinyl film and backing. (use a die cutter or CNC cutter.)
	Smooth down the vinyl decal and carefully push out any air bubb