

# Understanding Sustainability

## Teachers' Notes and Classroom Activities



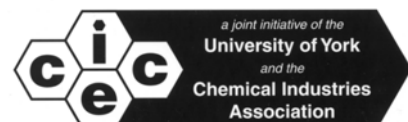
A resource for teaching Sustainable Development  
in Science, Geography and Citizenship.

For students aged 11 – 18.

[www.sustainability-ed.org](http://www.sustainability-ed.org)



The Institute of Materials, Minerals & Mining



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<b>Contents</b>	<b>Page</b>
Activities and curriculum links	1
<b>Activities</b>	
Sustainability-ed.org (DART activity)	4
Getting to school (sustainable transport)	7
Hybrid cars	11
Which is best – natural or synthetic fabrics?	13
Life cycle analysis: strawberries from plant to plate	25
Life cycle analysis: wood or PVC window frames	31
Waste disposal: should we incinerate?	37

This resource can be downloaded from the [www.sustainability-ed.org](http://www.sustainability-ed.org) web site.

With the generous support of the Institute of Materials, Metals and  
Mining, PVC division.

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## Curriculum Links

\*KS5 Citizenship / PSHE / Tutor period

Activity	Page	Summary	Science	Geography	Citizenship	D & T
Sustainability questions	4	Directed activity using <a href="http://www.sustainability-ed.org">www.sustainability-ed.org</a> to answer questions on sustainable development.	KS4	KS4		KS3 KS4
Getting to school (sustainable transport)	7	Introduces concepts of sustainable development by looking at transport used to get to school.	KS3 KS4	KS3 KS4	KS3 KS4 KS5*	KS3 KS4
Hybrid cars	11	Students research and produce a sales brochure or advert to describe how a hybrid car works.	KS3 KS4	KS3 KS4		KS3 KS4 KS5
Which is best – natural or synthetic?	13	Practical investigations to test the physical properties of cotton compared to polyester. Context is choosing fabric for outdoor coat.	KS3 KS4			KS3 KS4
	20	Life cycle analysis of information on the production and use of cotton and polyester.	KS4 KS5	KS4 KS5		KS3 KS4 KS5
Life cycle analysis: strawberries from plant to plate		Students look at strawberries from three sources: imported, UK grown and local pick your own. Decide which is the most sustainable.	25	KS3 KS4 KS5	KS3 KS4 KS5*	
Life cycle analysis: wood or PVC window frames	31	Students look at the sustainability of window frames made from wood and from PVC.				KS3 KS4 KS5
Waste disposal: should we incinerate?	37	Groups make presentations for and against the building of a waste incinerator.	KS3 KS4 KS5	KS3 KS4 KS5	KS3 KS4 KS5	

## Sustainable development in the curriculum

[www.sustainability-ed.org](http://www.sustainability-ed.org) is a web site that can contribute to the teaching of sustainable development and understanding ideas in the Science GCSE curriculum. It is also ideal for exploring issues in sustainable development in Geography GCSE.

The tables summarise current National Curriculum links with [www.sustainability-ed.org](http://www.sustainability-ed.org).

### Science

#### Key stage 3

- Sc2 5a About ways in which living things and the environment can be protected, and the importance of sustainable development
- Sc3 2i About possible effects of burning fossil fuels on the environment and how these effects can be minimised.

#### Key stage 4

- Sc1 1d To consider the power and limitations of science in addressing industrial, social and environmental questions, including the kinds of questions science can and cannot answer, uncertainties in scientific knowledge, and the ethical issues involved.
- Sc2 4b/5b How the impact of humans on the environment depends on social and economic factors, including population size, industrial processes and levels of consumption and waste.
- Sc2 4c/5c About the importance of sustainable development.

### Geography

#### Key stage 3

- 1e Appreciate how people's values and attitudes, including their own, affect contemporary social, environmental, economic and political issues, and to clarify and develop their own values and attitudes about such issues
- 3a The location of places and environments studied. Places and environments in the news and other a significant places and environments.
- 3e To explain how places are interdependent.
- 5b Explore the idea of sustainable development and recognise its implications for people, places and environments and for their own lives.
- 6f Population distribution and change.
- 6i Development.
- 6j Environmental Issues.
- 6k Resource Issues.

**Citizenship****Key stage 3**

- 1i The world as a global community, and the political, economic, environmental and social implications of this, and the role of the European Union, the Commonwealth and the United Nations.
- 3c Reflect on the process of participating.

**Key stage 4**

- 1f The opportunities for individuals and voluntary groups to bring about social change locally, in Europe and internationally.
- 1h The rights and responsibilities of consumers, employers and employees.
- 1j The wider issues and challenges of global interdependence and responsibility, including sustainable development and Local Agenda 21.
- 2c Contribute to group and exploratory class discussions, and take part in formal debates.

**Design and Technology****Key stage 3**

- 1c develop criteria for their designs to guide their thinking and to form a basis for evaluation
- 3c identify and use criteria to judge the quality of other people's products, including the extent to which they meet a clear need, their fitness for purpose, whether resources have been used appropriately, and their impact beyond the purpose for which they were designed [for example, the global, environmental impact of products and assessment for sustainability].

**Key stage 4**

- 1b consider issues that affect their planning [for example, the needs and values of a range of users; moral, economic, social, cultural and environmental considerations; product maintenance; safety; the degree of accuracy needed in production]
- 3c ensure that their products are of a suitable quality for intended users [for example, how well products meet a range of considerations such as moral, cultural and environmental] and suggest modifications that would improve their performance if necessary

## Sustainable development questions

Students use the web site [www.sustainability-ed.org](http://www.sustainability-ed.org) to answer questions relating to sustainable development (30minutes). It can be given as class work or as a homework if access to the internet is available.

Level: KS4

Questions assess students understanding of sustainable development / ability to gather information from the [www.sustainability-ed](http://www.sustainability-ed.org) web site.

**Resources** Access to [www.sustainability-ed.org](http://www.sustainability-ed.org)

Work sheet *SD questions* (attached below)

**Answers to questions** 1 - Write down a definition for sustainable development.  
There are several definitions. The web site lists:

Brundtland report (World Commission on Environment and Development)

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Forum for the Future

"Sustainable development is a dynamic process which enables all people to realise their potential and to improve their quality of life in ways which simultaneously protect and enhance the Earth's life support systems".

2a - Explain what is meant by social sustainability.

Addresses the needs (and to a lesser extent the wants) of people. Things like ensuring access to education, healthcare, housing, food, clean drinking water etc. Could also mention aspects such as convenience and affordability. E.g. if public transport is too expensive for people, then it is not socially sustainable (nor is it economically sustainable also).

2b - Explain what is meant by economic sustainability.

Looks at the generation of wealth for individuals, businesses and also nations. This wealth then allows social and economic aspects to be addressed. For example, the creation of jobs will allow people to improve their lifestyles and, in the most severe cases, release them from poverty.

2c - Explain what is meant by environmental sustainability.

Possibly the most usual sector linked with sustainable development. Environmental impacts look at the use of natural resources (many are finite) and the disposal of waste.

3a - How much carbon dioxide you are responsible for each year?

Typically somewhere between 7 – 15 tonnes per year for a resident of the UK.

3b – What effect is increased level of carbon dioxide in the atmosphere having on the environment?

Leading to increased global warming.  
Effects of global warming are climate change. May describe more extremes in weather conditions such as droughts, floods, hurricanes, prolonged summers and wetter winters in the UK.

3c - Suggest ways that you could reduce the amount of carbon dioxide you produce.

Suggestions may include using more public transport, cutting electricity consumption, reducing heating levels, fly less, use the car less etc.

3d - What is the Kyoto agreement?

Kyoto conference (1997) looked at reducing global emissions of greenhouse gases. Targets to reduce emissions to an average of 5% below 1990 levels by 2012.

Treaty also set in place 'carbon trading' concept. Countries had permitted levels of CO<sub>2</sub>. Low CO<sub>2</sub> producers can sell their allowances to high CO<sub>2</sub> producers.

4 - Briefly list some of the social and environmental issues that are facing the earth's increasing population.

Range of any sensible issues. May include providing housing for all, clean drinking water, accessibility to health care, tackling climate change, developing 'clean' energies, problems associated with increasing urbanisation of population, reducing production of wastes, using natural resources more effectively, tackling deforestation etc.

## Sustainable Development

### Your task

Visit [www.sustainability-ed.org](http://www.sustainability-ed.org) and then answer the questions.

### Questions

- 1 Write down a definition for sustainable development.
  
- 2 Sustainable development has three linked parts:
  - Social
  - Environment
  - EconomicThese are sometimes called 'People, planet and profit.'
  - a Explain what is meant by social sustainability.
  - b Explain what is meant by economic sustainability.
  - c Explain what is meant by environmental sustainability.
  
- 3 Go to the 'Are you sustainable' section of the web site. Click onto the Carbon Calculator.
  - a Use the carbon calculator.  
How much carbon dioxide you are responsible for each year?
  - b What is the effect of increased level of carbon dioxide in the atmosphere having on the environment?
  - c Suggest ways that you could reduce the amount of carbon dioxide that you produce.
  - d What is the Kyoto agreement?
  
- 4 The Earth's population is currently around 6.5 billion people.  
  
Briefly list some of the social and environmental issues that are facing the earth's increasing population.



## Sustainable transport – getting to school

The activity (30mins) introduces the idea of looking at more sustainable transport by using the journey to school as a context.

Levels: KS3, 4 or 5.

Aim is for students to be able to critically look at the different methods of getting to school. Students discuss the options and rate them, working in small groups of 3-4.

**Activity** Students use the information cards to discuss the different methods of getting to school.

Following their discussion, students rate each of the methods by looking at social, environmental and economic aspects.

Complete graphs to visualise each of the methods and give an overall 'sustainability rating.'

Plenary discussion to see what transport students feel is the most sustainable. Look for issues that will influence individual's decisions on getting to school:

- Convenience and social interaction.
- Journey time / distance from school.
- Availability of local transport.
- Effects on congestion around school.
- Safety to passengers and pedestrians.
- Effects on environment - local (air quality) and global (climate change).
- Use of natural resources
- Costs and economic impacts.

Take a class poll to see the different choices. Comment on sustainability. How could they change their method of transport to become more sustainable? Will they change?

**Resources** One copy of instructions and graphs sheet per student (*Getting to school 1*)  
One set of information cards per group (*Getting to school 2 and 3*)

1. Look at the information cards.
2. Give a score for each type of transport.  
Think of the three parts to sustainability.

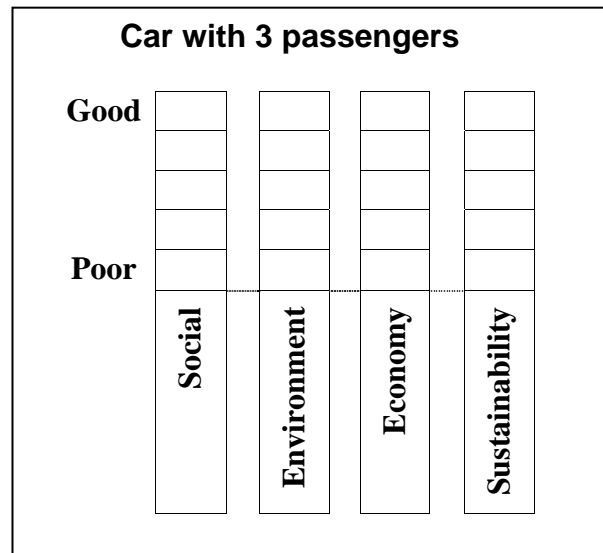
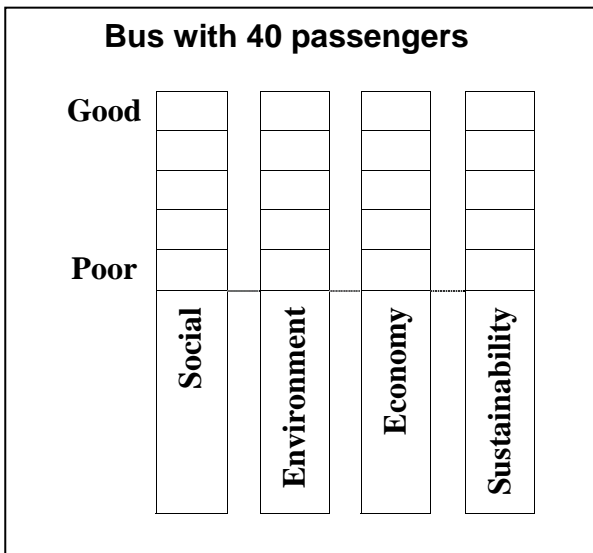
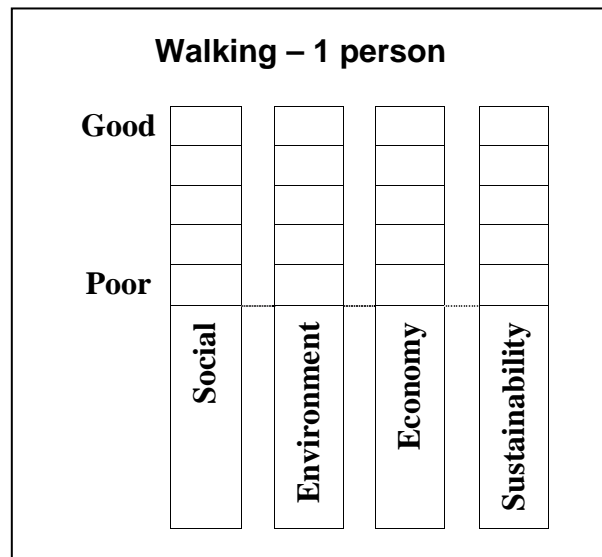
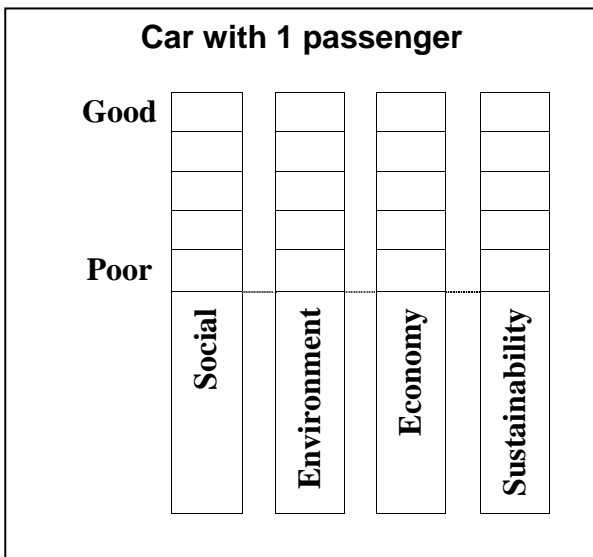
**Social** How well does the transport help people to get to school?  
What impact does the transport have on the local community?

**Environmental** What impact does the transport have on the environment?

**Economic** How expensive is the transport?  
Does the transport contribute to people's wealth.

3. Complete the bar charts to show how you score each type of transport.

Which method do you think is the most sustainable?



**Car – driver and one passenger**

<b>CO<sub>2</sub> emissions</b>	262g per passenger (1.5km total)
<b>Congestion</b>	Causes congestion
<b>Journey time</b>	6 minutes
<b>Convenience</b>	Door-to-school with little effort
<b>Cost</b>	50p per passenger plus cost of car
<b>Jobs created</b>	Employment in car production
<b>Resources used</b>	Oil (petrol). Materials for car production.
<b>People transported</b>	1

**Car – driver and three passengers  
(shared between three families)**

<b>CO<sub>2</sub> emissions</b>	115g per passenger (3km total)
<b>Congestion</b>	Causes congestion
<b>Journey time</b>	18 minutes
<b>Convenience</b>	Three houses to pick up passengers, then to school.
<b>Cost</b>	£1.00 per journey plus cost of car
<b>Jobs created</b>	Employment in car production
<b>Resources used</b>	Oil (petrol). Materials for car production.
<b>People transported</b>	3

**Walking**

<b>CO<sub>2</sub> emissions</b>	Zero
<b>Congestion</b>	Reduces congestion
<b>Journey time</b>	20 minutes
<b>Convenience</b>	Effort required to walk – helps fitness
<b>Cost</b>	Zero
<b>Jobs created</b>	Zero
<b>Resources used</b>	Zero
<b>People transported</b>	1

**Bus – driver and 40 passengers**

<b>CO<sub>2</sub> emissions</b>	75g per passenger (1.2km total)
<b>Congestion</b>	Reduces congestion but still uses road
<b>Journey time</b>	12 minutes
<b>Convenience</b>	Walk to bus stop. Bus drops off outside school.
<b>Cost</b>	65p per passenger
<b>Jobs created</b>	Bus company employs people. Also industry to make bus.
<b>Resources used</b>	Oil (petrol). Materials for bus production.
<b>People transported</b>	40

## Petrol–Electric hybrid cars

### Create an advertisement or marketing leaflet for a hybrid car (45mins)

Task is suitable for independent study or homework

Level: KS3 and 4

Students work in pairs or individually.

Students research the energy changes in an electric-petrol hybrid car and produce an explanation of the technology.

Highlight the advantages of using a electric-petrol hybrid.

Produce work in the form of an advertisement or information brochure.

**Activity** Introduce the task with a brief discussion of the energy changes in a petrol car and a petrol-electric hybrid. See points to look for below.

- Petrol car – chemical energy to movement, heat and sound.
- Lots of energy wasted.
- Hybrids harness the wasted energy to increase efficiency.

Use the worksheet to set the problem to students.

Students research the properties of electric-petrol hybrid cars from [www.sustainability-ed.org](http://www.sustainability-ed.org) (and other sources as appropriate) before producing the advertisement or information leaflet.

### Points to look for in advert / brochure

Look at the energy changes that take place in a hybrid car.

- Hybrid still uses petrol but gets greater miles per gallon of petrol and so reduces carbon dioxide emissions. Especially in urban driving.
- Petrol engine used at higher speeds (typically >25mph).
- Hybrid uses energy when slowing to charge batteries.
- Energy in batteries drive the car at slow speeds and so reduce petrol consumption.

Also the social aspects:

- Hybrids are generally more expensive than petrol equivalent. May be balanced by savings on petrol costs.
- Hybrids now have comparable performance to petrol cars. Earlier electric-only cars had poor performance.
- Technology is still relatively new. There may be comments on reliability.

**Resources** Access to the [www.sustainability-ed.org](http://www.sustainability-ed.org) web site.

Is this the car of the future?

This car does not look remarkable. But it is a new type of car.

It is an electric-petrol hybrid car.

It runs on both petrol and electricity.



### What are hybrid cars?

Visit the sustainability web site.

1. Go to **[www.sustainability-ed.org](http://www.sustainability-ed.org)**
2. Navigate to the Sustainable Development Case Studies.
3. Go the section on Electric cars.
4. Look at the information on electric-petrol hybrid cars.

### Your task

Produce a poster or brochure to advertise an electric-petrol hybrid car.

You should:

- Explain how electric-petrol hybrid cars work.
- Describe why a hybrid car gives better miles per gallon in town traffic than a normal petrol car.
- Describe the advantages to the environment of using a hybrid car.
- Persuade customers to buy an electric-petrol hybrid car.

# Is natural always better than synthetic?

## Cotton v Synthetic

These activities compare cotton fabric with a synthetic fabric. Any synthetic fabric can be used. Polyester is readily available.

There are two separate activities. These could be run in sequence or as stand-alone activities.

### Material properties (pages 13 – 19)

60 minutes in class.

Students investigate the physical properties of cotton and polyester to see which is best for use as an outdoor coat.

Practical investigations that compare durability, water-proof, weight and washability.

Key stage 3 or 4.

All abilities.

### Life cycle analysis (pages 20 – 24)

45 minutes in class or for homework.

Data analysis and interpretation using the sustainability-ed web site.

Key stage 4 (high ability) or key stage 5.

## Material properties

**Activity** Completed in one lesson (60 minutes).

Students are challenged to design experiments that compare cotton and polyester. The context is choosing a fabric that would be suitable for making an outdoor coat. Suggested tests include:

- Resistance to abrasion.
- Water-proof ability.
- Weight when dry and wet.
- Washability.

Students can also consider factors such as the cost (affordability) of the materials. The impact of the production and use of the two materials (social, economic and environmental) are examined in the life cycle analysis activity.

**Resources****Differentiation**

The worksheets have increasing levels of detail. This allows you to choose the appropriate level of information for your class.

Sheet reference	Content
<b>Student 1</b> (most able - p15)	Simply describes that the task is to test which fabric would be the best. No further guidance. Two copies are made on one page.
<b>Student 2</b> (p16)	Describes the task and suggests some of the properties that the students may want to consider in testing the fabric. Does not suggest methods for the range of tests.
<b>Student 3</b> (p17)	Gives methods for the tests. Does not give any information on presenting results.
<b>Student 4 and 5</b> (less able - p18 and p19)	Sets out tables for results .

The equipment will depend on the complexity of the tests designed by the students. A suggested set of equipment for each group would consist of:

- 4 squares of each fabric (roughly 10cm x 10cm)
- 250cm<sup>3</sup> beaker
- 25cm<sup>3</sup> measuring cylinder
- small piece of abrasive sandpaper
- stirrer (glass rod or similar)
- access to electronic balance
- access to water supply
- safety glasses as required
- stop clock

**Risk assessment**

A full risk assessment should be undertaken by the class teacher before carrying out any of the suggested activities.



Outdoor coat.

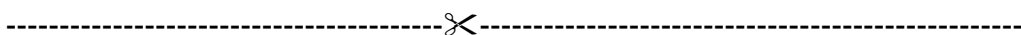
What is better? Cotton or synthetic?  
Which is more sustainable?

You need to choose a fabric that will be used to make an outdoor coat.

What properties would you want from a coat that you wear outside?

### Test the fabrics

- What scientific tests can you do to see which material is best?
- How can you make the comparisons fair and reliable?
- Go to **www.sustainability-ed.org** to compare the sustainability of cotton and polyester.  
Which is the most sustainable? Give reasons for your answer.



Outdoor coat.

What is better? Cotton or synthetic?  
Which is more sustainable?

You need to choose a fabric that will be used to make an outdoor coat.

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Which is the most sustainable? Give reasons for your answer.

Outdoor coat.

What is better?  
Cotton or synthetic?  
Which fabric is more sustainable?



You need to test two fabrics for an outdoor coat.

Think about the properties that the coat will need to have.  
What would you want from a coat that you wear outside?

You only have a few samples of the two fabrics.  
Some tests could damage the fabric.

Think about the best order to do the tests.

You may think about testing things like:

- How tough is the fabric? What happens if it rubs against something rough?
- Is the fabric waterproof?
- How heavy is the fabric? Is it light enough to make a coat?
- What happens if the fabric gets wet? How long does it take to dry?
- What happens if the fabric gets dirty? Can it be washed easily?

### Fair test

What scientific tests can you do to see which fabric is the best?

Make sure they are controlled so that they give a fair comparison of the two materials.

Go to [www.sustainability-ed.org](http://www.sustainability-ed.org) to compare the sustainability of cotton and polyester.

Which is the more sustainable? Give reasons for your answer.

What is better?  
Cotton or synthetic?  
Which fabric is more sustainable?



### How tough is the fabric?

1. Take a square of fabric and place it on a flat surface.
  2. Rub the material with a piece of sandpaper.  
Take care with the rough sandpaper.
  3. Count how many strokes it takes before the fabric is damaged.
- How can you make sure that each fabric gets the same treatment?
  - How can you measure the amount of damage?

### How heavy is the fabric?

1. Measure the dry fabric's area.
  2. Weigh the piece of dry fabric.
  3. Calculate the fabric's weight per square centimetre.
  4. Soak the fabric in water.
  5. Weigh the wet fabric.
- How can you measure the wet cloth without damaging the electronic balance?

### Is the fabric waterproof?

1. Put 10cm<sup>3</sup> of water into a measuring cylinder.
  2. Stretch the fabric over the top of the measuring cylinder and turn it upside down over a beaker to collect the drips.
  3. Measure how much water leaks through the cloth in 1 minute.
- How can you get reliable results?

### Which fabric is easiest to get clean?

1. Rub some soil or other dirt into a small part of the fabric.
  2. Wash the fabric in a beaker of water.
  3. Look to see how well the dirt has been removed.
- How can you give both fabrics the same amount of dirt?
  - How can you wash them the same?
  - How can you judge the amount that the dirt has been removed?

### Which is the more sustainable fabric?

Go to [www.sustainability-ed.org](http://www.sustainability-ed.org)

In the case studies section, look at cotton and polyester.

Which is the most sustainable? Give reasons for your answer.

## Outdoor coat - cotton or synthetic?

## Results

## How tough is the fabric?

Type of fabric	Cotton	Synthetic
Number of strokes to cause damage		
Toughest material (✓)		

## How heavy is the fabric?

Dry fabrics	Cotton	Synthetic
Area of fabric (length x width)	cm <sup>2</sup>	cm <sup>2</sup>
Weight of fabric	g	g
Grams per square centimetre	g.cm <sup>-2</sup>	g.cm <sup>-2</sup>
Lightest fabric when dry (✓)		

Wet fabrics	Cotton	Synthetic
Area of fabric (length x width)	cm <sup>2</sup>	cm <sup>2</sup>
Weight of fabric (grams)	g	g
Grams per square centimetre	g.cm <sup>-2</sup>	g.cm <sup>-2</sup>
Lightest fabric when wet (✓)		

### Is the fabric waterproof?

Volume of water let through the fabric in 1 minute	Cotton	Synthetic
Test 1	cm <sup>3</sup>	cm <sup>3</sup>
Test 2	cm <sup>3</sup>	cm <sup>3</sup>
Test 3	cm <sup>3</sup>	cm <sup>3</sup>
Average for three tests	cm <sup>3</sup>	cm <sup>3</sup>
Most waterproof (✓)		

### Does the fabric wash easily?

Type of fabric	Cotton	Synthetic
Dirt level after washing		
Easiest to get clean (✓)		

### Conclusions

Which fabric should be used to make an outdoor coat?  
 Give reasons for your decision.  
 Think about the fabric's properties and their sustainability.

## Cotton v polyester life cycle analysis

**Activity** 45 minutes data analysis and interpretation exercise.

Suitable for more able key stage 4 students and key stage 5 students.

Students examine the information on cotton and polyester life cycles given on the [www.sustainability-ed.org](http://www.sustainability-ed.org) web site.

Produce two 'footprints' for the production and use of the fabrics.

Students decide on which they feel is the most sustainable and give reasons for their choice. This will vary according the emphasis placed on the different factors.

**Resources** Access to [www.sustainability-ed.org](http://www.sustainability-ed.org) web site.

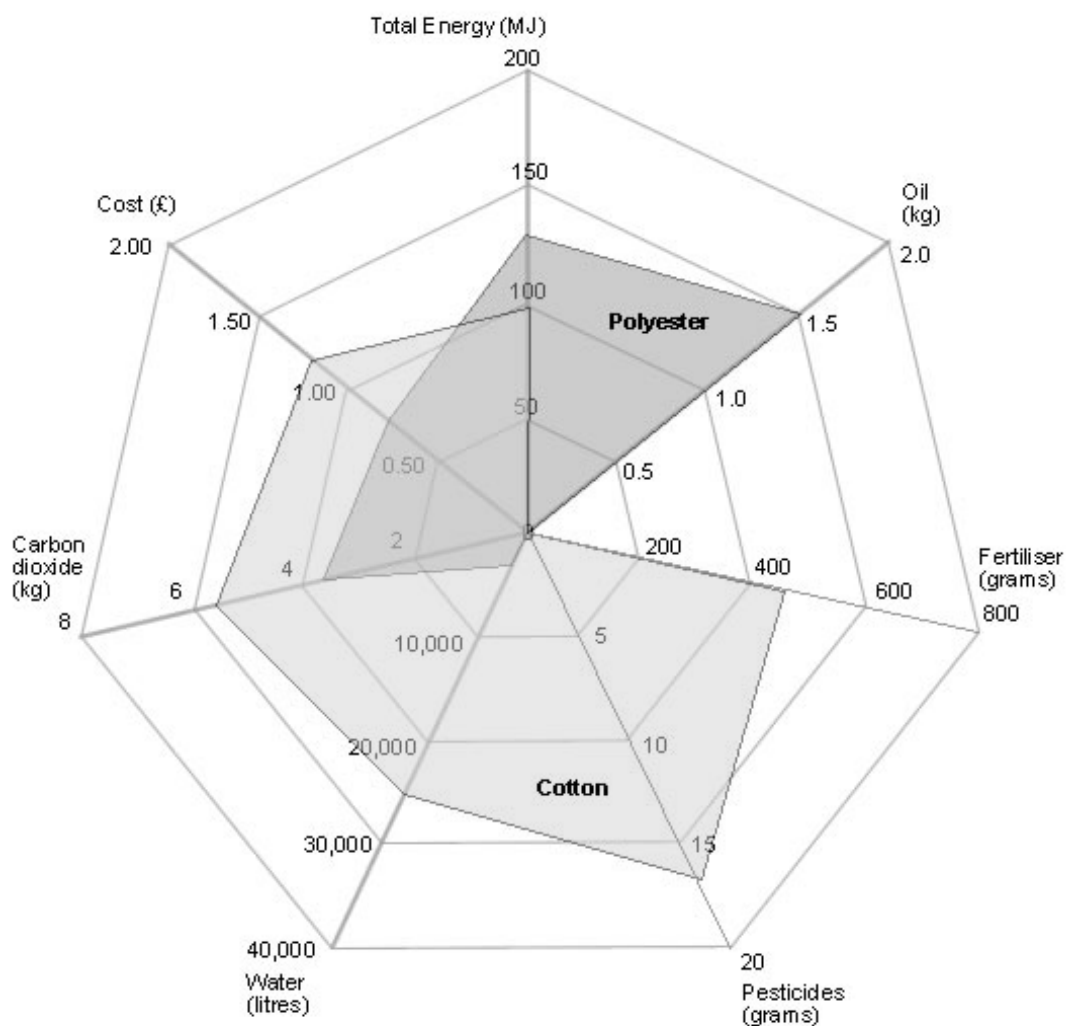
Worksheet referenced *LCA 1* sets out the question and task for the students.

Axes for the graphs are provided in sheets *LCA 2* and *LCA 3*.

**LCA data** Students should find the following data on the sustainability-ed web site for the production and weaving of 1kg of fabric.

	<b>Polyester per kg</b>	<b>Cotton per kg</b>
<b>Total energy use (MJ)</b>	130	100
<b>Oil (kg)</b>	1.5	0
<b>Fertilisers (g)</b>	0	457
<b>Pesticides (g)</b>	0	16
<b>Water (litres)</b>	1308	26100
<b>Carbon dioxide (kg)</b>	3.8	5.3
<b>Approx cost (£)</b>	0.78	1.13

Radar graph is shown overleaf.



Data for the use and disposal should include some or all of the following.

	Polyester per kg	Cotton per kg
Energy wash (MJ)	3.4	3.4
Energy tumble dry (MJ)	-	12.6
Energy recovery from incineration (MJ)	33	7
Water per wash (litres)	49	49
Shrinkage (% per 100 washes)	4	7
Loss of strength (% per 100 washes)	8	17

## Sustainability - cotton v polyester life cycle analysis

Cotton and polyester can both be made into fabrics. Cotton is a natural fibre that comes from the cotton plant. Polyester is a synthetic fibre that is made from oil or gas.

### Your task

1. Go to the sustainability-ed web site: [www.sustainability-ed.org](http://www.sustainability-ed.org)
2. Navigate to the Sustainable Development Case Studies and select the Cotton or Polyester case study.
3. Use the information in the Life Cycle Analysis section to **complete the table**.
4. Use the data in your table to draw a 'radar graph' to compare the **production** of 1kg of cotton and 1kg of polyester.
5. Compare the information for the **use and disposal** of cotton and polyester.

### Life cycle analysis

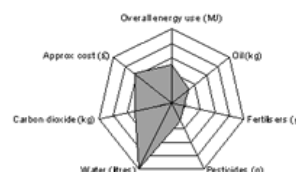
Fibre production and weaving	Polyester per kg	Cotton per kg
Overall energy use (MJ)		
Oil (kg)		
Fertilisers (g)		
Pesticides (g)		
Water (litres)		
Carbon dioxide (kg)		
Approx cost (£)		

### Question

Which do you think is the more sustainable fabric?  
Give reasons for your choice.

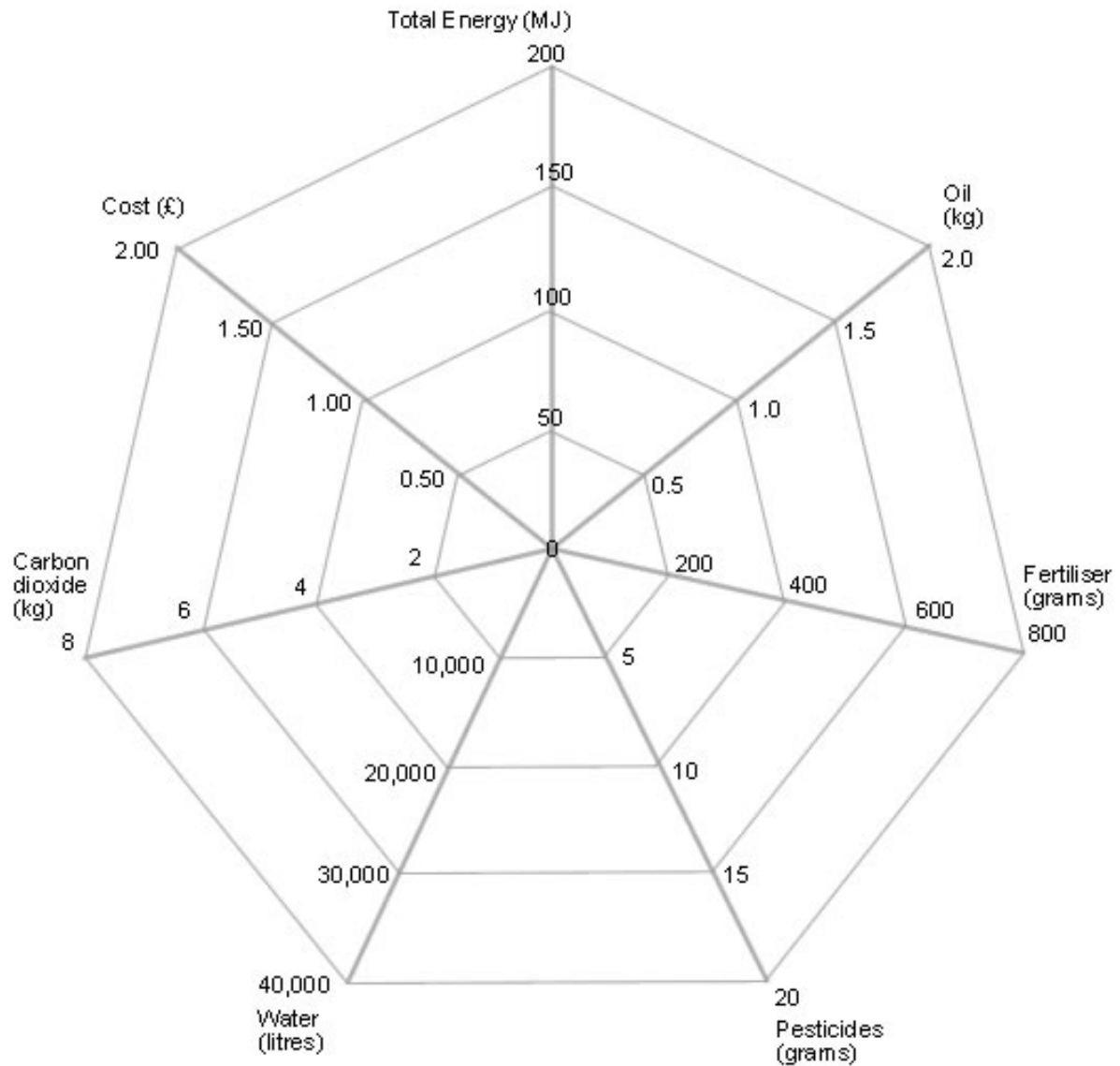
A radar graph allows you to see the 'footprint' of a product.

The scales can be different to take into account the amounts of each factor included.

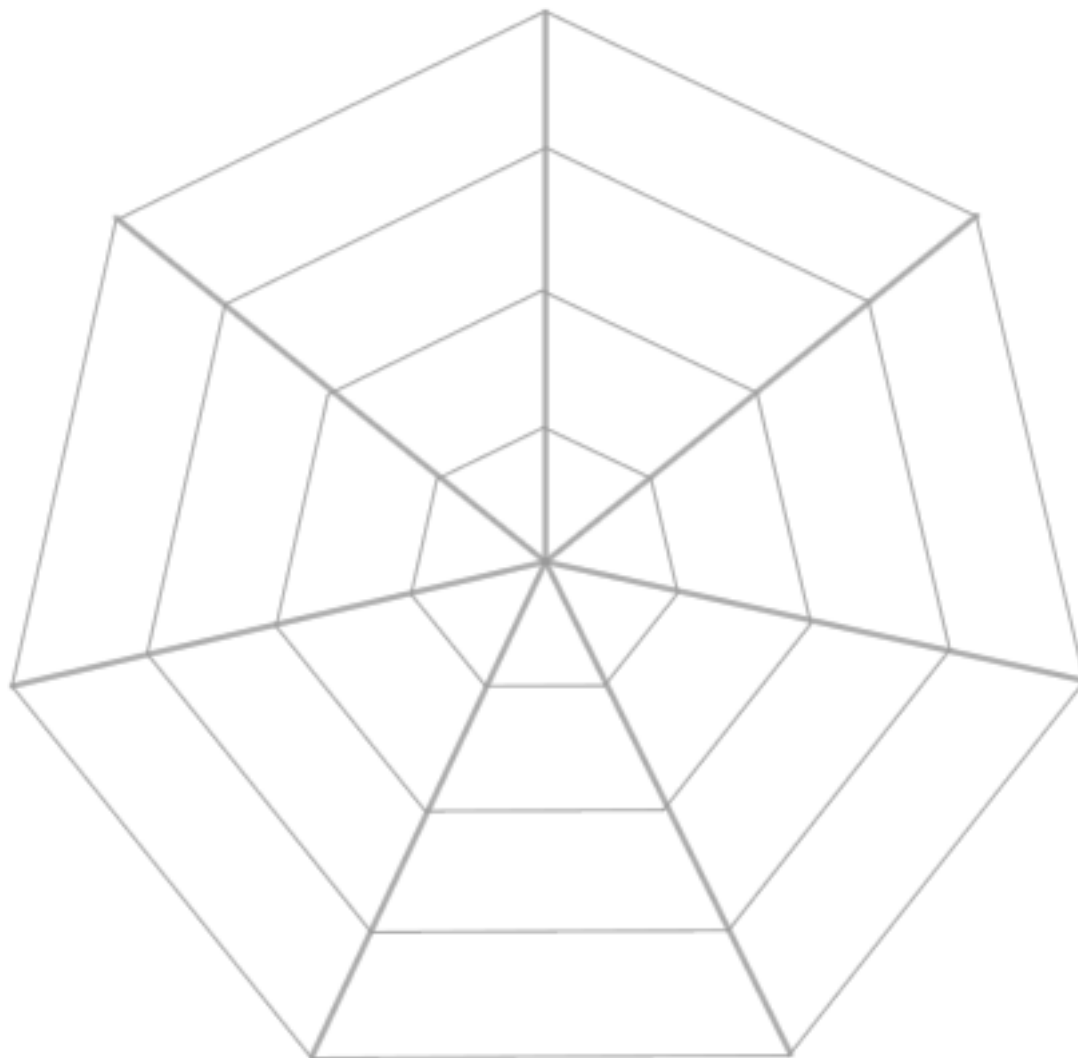




Production and weaving of 1kg of cotton compared with 1kg of polyester



## Use and disposal of 1kg of cotton compared with 1kg of polyester



## Life cycle analysis - sustainable strawberries

### Strawberries from plant to plate

Activity looks at strawberries from three different sources to see which is the most sustainable. The activity also illustrates the complexity of a product's life cycle.

Students work in groups of 3-4 (30mins)

**Resources** Photocopies of sheets and scissors to cut out cards.  
2 copies per group of work sheets *Sustainable strawberries 2* and *3*.  
1 copy of sheet *Sustainable strawberries 4*.

**Activity** Have students use the cards (next pages) to produce three 'flow diagrams' to show the production and sale of strawberries from different sources:-

- Supermarket strawberries grown in polytunnels in southern Spain.
- Strawberries grown under heated greenhouses or polytunnels in the UK.
- Strawberries from a local pick-your-own farm.

Prompt students with an initial discussion of the process:

- Growth.
- Processing (cleaning, grading etc).
- Packaging.
- Transport.
- Retail shops.
- Disposal of any wastes.
- Areas where energy is used.

Also highlight the social aspects:

- Employment and wealth creation.
- Availability of strawberries (nearly all-year round from Spain, summer only from UK growers, pick your own for only a few weeks).

On completion of the life cycles, students discuss the three sources of strawberries using these questions as a guide.

1. Which strawberries are the most environmentally-friendly?
2. Which strawberries are the best for creating jobs for people?
3. Which strawberries are the most convenient?
4. Should we only allow UK strawberries? Should we ban imports of strawberries when they are not in season in the UK?
5. How easy is it to think about a life cycle? Where should the 'boundary' be drawn to stop it spreading out further and further?

Some points to look for in a discussion include:

- Lots of things can be brought into a life cycle. For example, the energy needed to make the car that you drive to the supermarket. Stress that there must be a decision made at some point to limit its scope.
- Growing strawberries uses up land resources. Polytunnels in southern Spain are having a large environmental impact (land and water use). However, they do not require heating. Greenhouses in England may require heating during early spring.
- Farming, harvesting and processing employ people.
- Strawberries are also used in the production of other foods – jams, cakes etc. If strawberries were only available during the UK summer, what impact would that have on the producers of these foods?
- Energy is required to harvest and process the strawberries.
- Packaging helps to protect the strawberries. It can contain information such as sell-by dates and nutritional details but excessive packaging causes unnecessary waste.
- Energy is used in transport. E.g. aeroplane or overland lorry from Spain, lorries from English growers, cars to pick your own farms and cars to supermarkets.
- Waste (from the empty packaging) has to be collected from our homes for disposal.
- A wider analysis may also consider manufacture of other items used in the life cycle. Students should consider where the boundary of a life cycle analysis should be drawn.

## Sustainable strawberries: from plant to plate

Strawberries can be eaten on their own or go into jams, cakes and ice cream.

Strawberries sold in the UK could come from these three sources.

### Imported strawberries

Strawberries are imported from places such as Holland, Spain and even from the USA. This gives an all-year-round supply.

Producing and selling strawberries for sale during winter can be very profitable. The prices in the shops are higher than strawberries in the summer season and this also helps growers' profits.

### English strawberries

Strawberries are grown in greenhouses or polytunnels. Sometimes the greenhouses need heating which uses energy.

Using polytunnels mean a longer growing season for English strawberries. They may be available through the spring and summer.

### Pick your own strawberries

Some local farms have 'pick your own' schemes. Strawberries are grown in open fields. People go to the field and pick the strawberries that they want to eat.

These strawberries are usually only available for a few weeks each summer.

## Your task

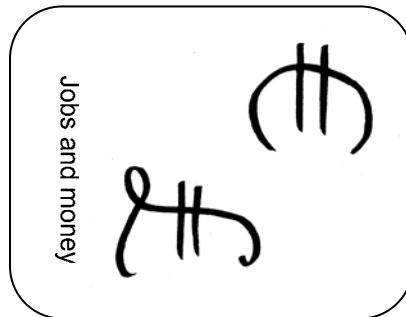
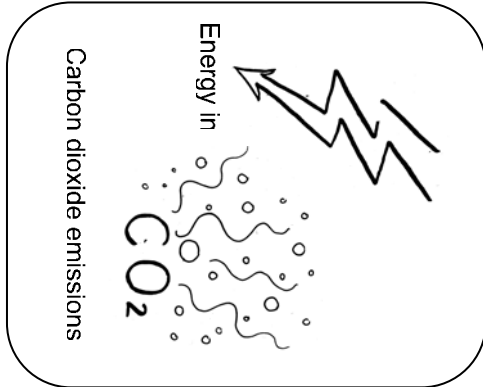
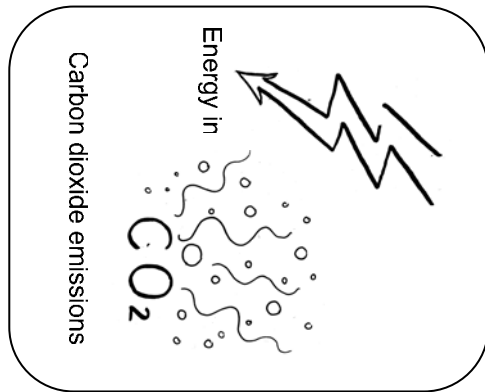
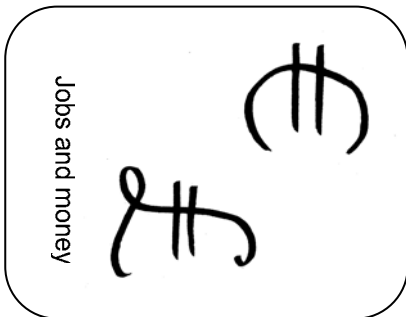
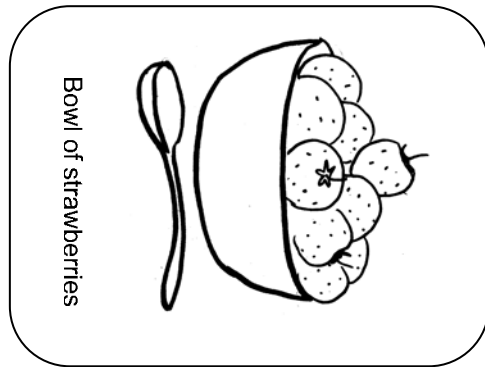
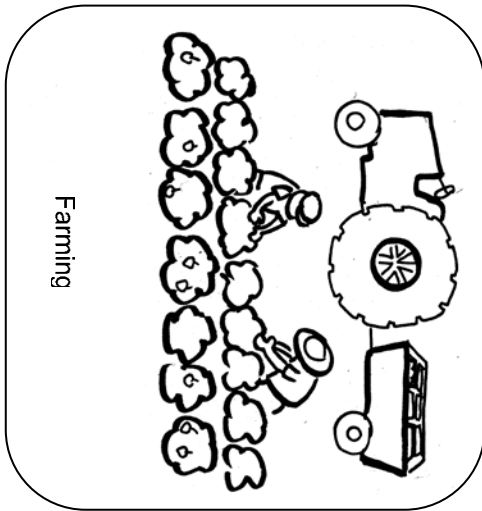
Arrange the cards to produce **three** flow diagrams to show how different strawberries get from the farm to your fruit bowl. Show this for:

- imported strawberries;
- English strawberries;
- pick your own strawberries.

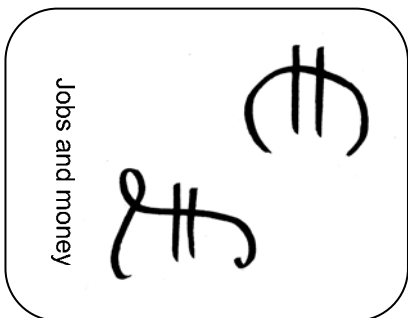
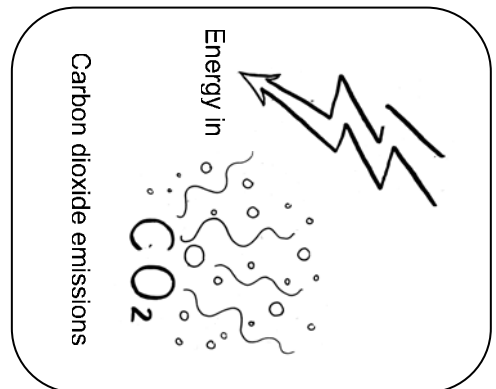
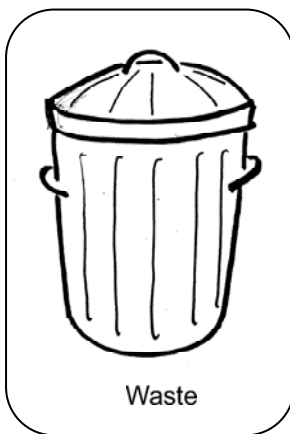
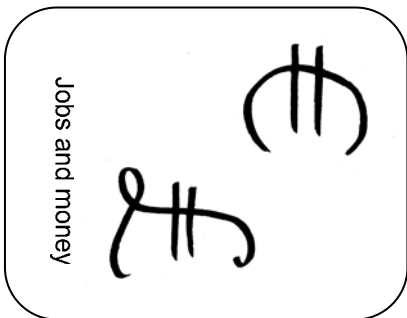
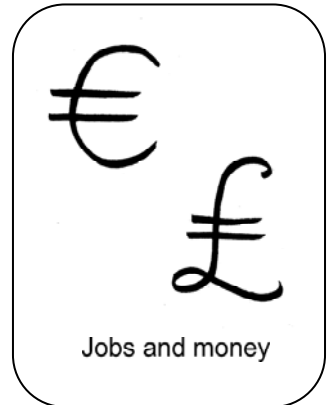
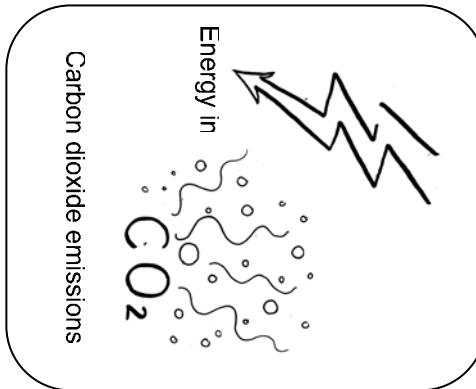
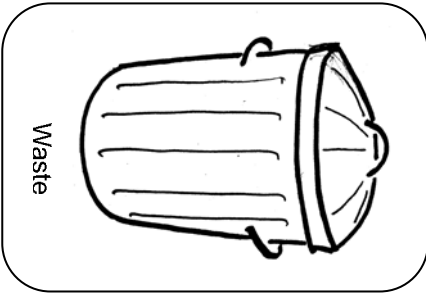
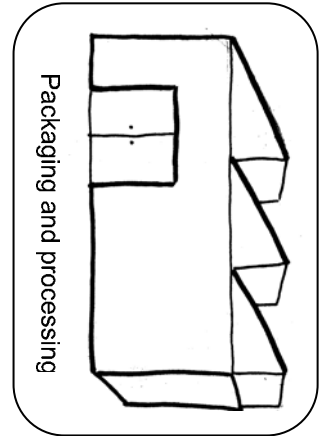
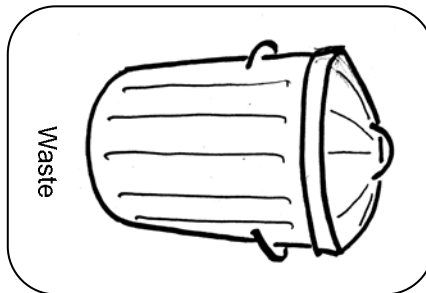
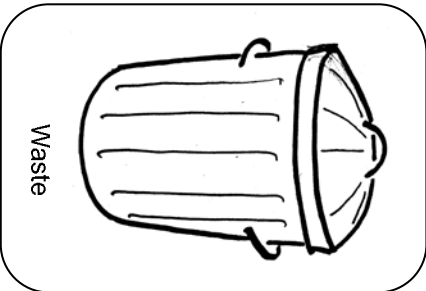
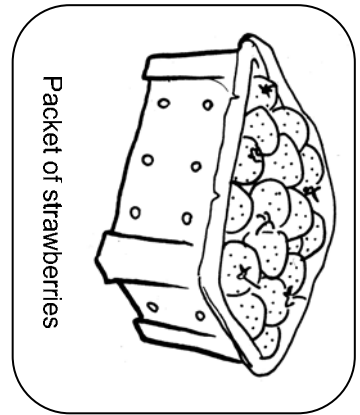
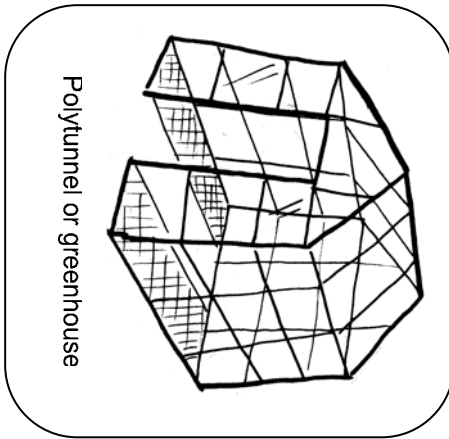
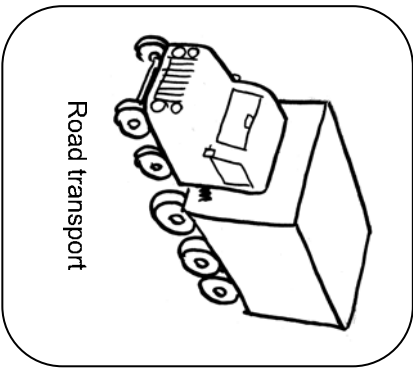
## Questions

Look at the three flow diagrams you have constructed.

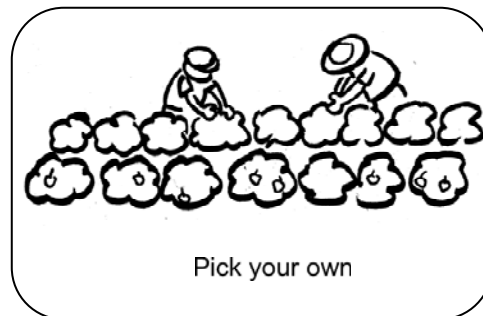
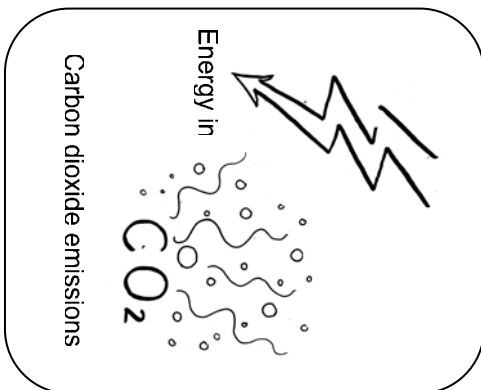
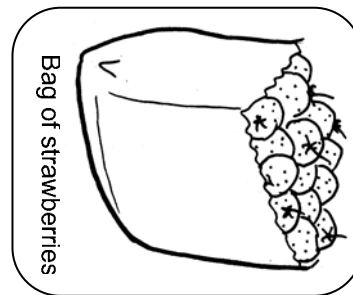
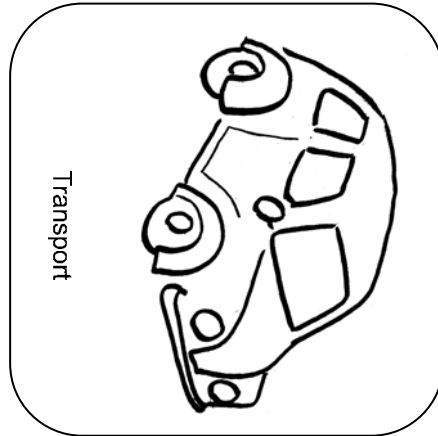
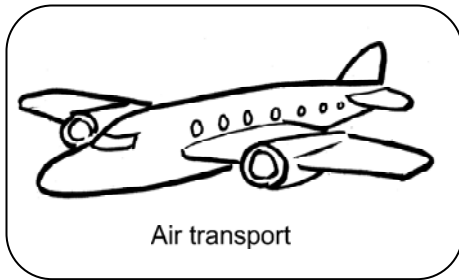
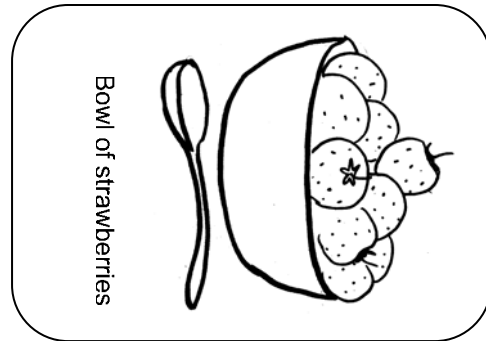
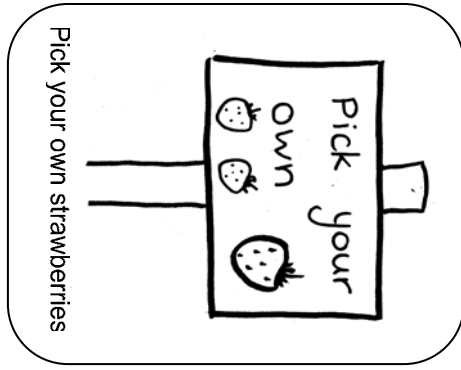
1. Which strawberries are the most environmentally-friendly?
2. Which strawberries are the best for creating jobs for people?
3. Which strawberries are the most convenient?
4. Should we only allow local strawberries? Should we ban imports of strawberries when they are not in season in the UK?
5. What extra things could you link in to the strawberry life cycle?  
Where should the 'boundary' be drawn to stop it spreading out too much?



Two copies of this page per group.



Two copies of this page per group.



One copy of this page per group.



## Life cycle analysis – wood and PVC window frames

### Wood and PVC window frames?

Students work in groups of 3-4 (30mins). Using the sustainability-ed web site, students critically look at the complexity of a product's life cycle and compare the sustainability of wood and PVC window frames.

Level: key stage 4 or 5 students.

**Resources** Photocopies of sheets and scissors to cut out cards.  
2 copies of sheet *PVC or wood window frames 2*.  
1 copy of sheet *PVC or wood window frames 3*.

**Activity** Have students use the prompt cards to produce two flow diagrams for the life cycles of PVC and wooden window frames.

Prompt students with an initial discussion of the processes:

- Materials – wood (natural) and PVC (synthetic from oil).
- Obtaining wood – forests, felling, cutting and treatment for preservation.
- PVC production – oil, salt, chemical change.
- Transport.
- Production and fitting of window frames.
- Maintenance in use and life-span.
- Disposal of any wastes.
- What happens at the end of the frame's useful life? Are the materials that can be recycled actually recycled?

Also highlight the social aspects:

- Employment and wealth creation.
- Convenience for consumer.
- Consumer preferences (aesthetic issues).

On completion of the life cycles, students discuss the use of the materials for window frames.

Extension activity requires students to draw a radar graph comparing the two materials (more able students). For extra information, see the Ecodesign web in the 'tools' section at: <http://ecodesign.lboro.ac.uk/>

**Plenary discussion**

Questions to pose during plenary:

1. How does each material affect the environment?
2. How do the different materials create employment and generate wealth?
3. How does each material rate in terms of the convenience to the consumer (householder)?
4. How easy is it to think about a life cycle? Where should the 'boundary' be drawn to stop it spreading out further and further?

Some points to look for in a discussion include:

- Lots of things can be brought into a life cycle. For example, the energy needed to make the machinery that cuts down the trees. Stress that there must be a decision made at some point to limit its scope.
- Both materials use natural resources. PVC from non-renewable resource of oil or gas. Trees use up land. Sustainable forestry is increasing but also hardwoods are often obtained by clearing rainforests. See Forestry Stewardship Council at [www.fsc.org](http://www.fsc.org)
- The use of both materials create jobs and generate economic wealth.
- Energy is required to cut and process raw materials.
- Wood is usually treated with chemical preservatives to increase its life span. It should also be regularly painted during its life time. PVC does not require painting.
- Energy is used in transport.
- Waste PVC can be recycled.
- PVC window frames can be recycled to make new frames. How can this recycling be increased?
- Wood is biodegradable. Good for waste disposal but also means it needs protecting with paints / treatments to prevent rot during use.

## Sustainable window frames: wood or PVC window frames?

We all have windows. Should the window frames be made from wood or the plastic PVC? Look at the life cycle to see what you think is the more sustainable.

### Your task

1. Go to **www.sustainability-ed.org**
2. Navigate to the Sustainable Development Case Studies and select the Water Pipes and Window Frames section.
3. Look at the Window frames case study.
4. Use the picture cards to produce **two** flow diagrams. One showing the life cycle of a PVC window frame and the other the life cycle of a window frame made from wood.

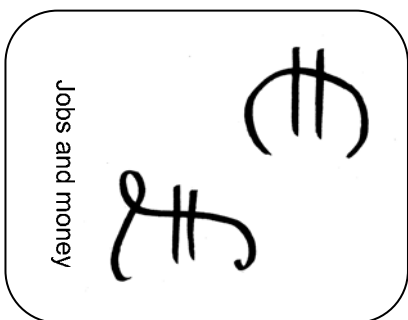
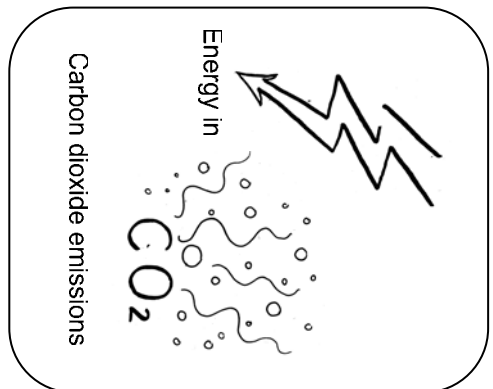
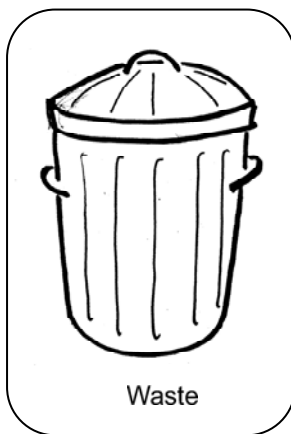
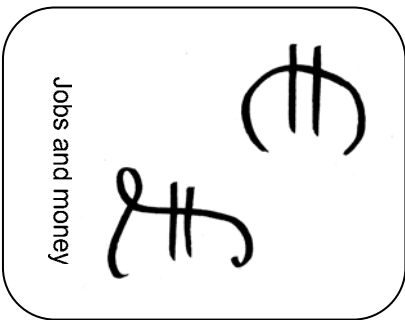
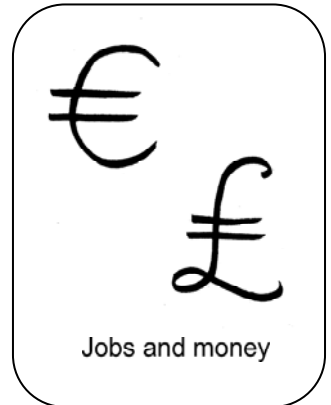
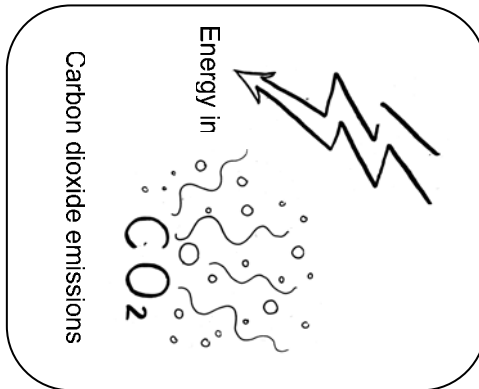
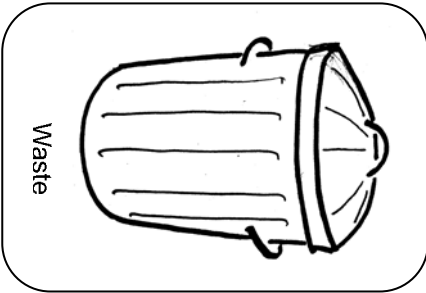
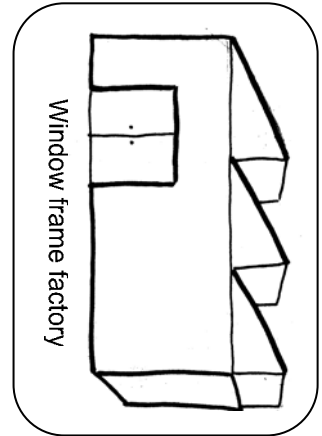
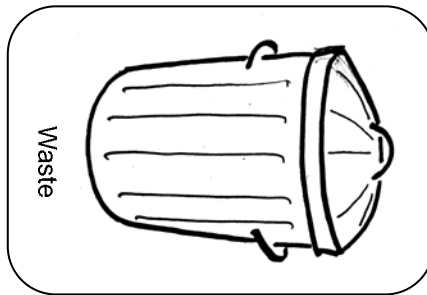
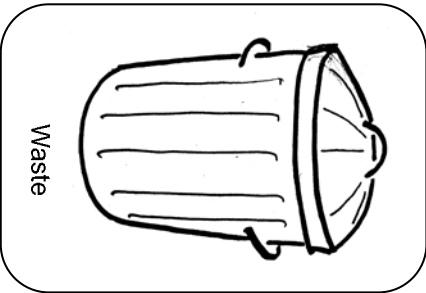
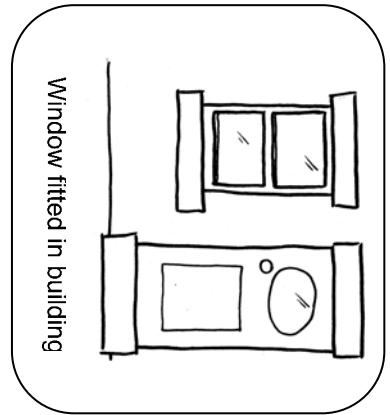
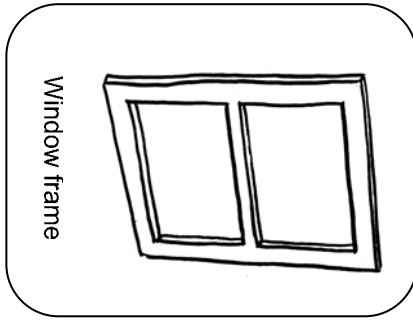
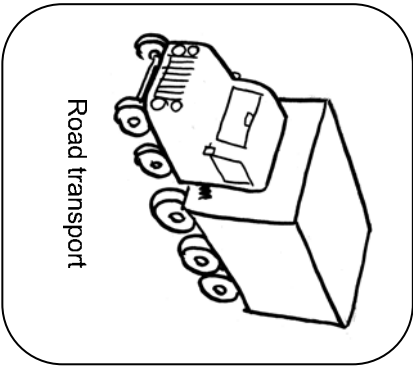
### Life cycle

Start with the raw materials and end with the frames after they are removed from the building. Some things to think about are below.

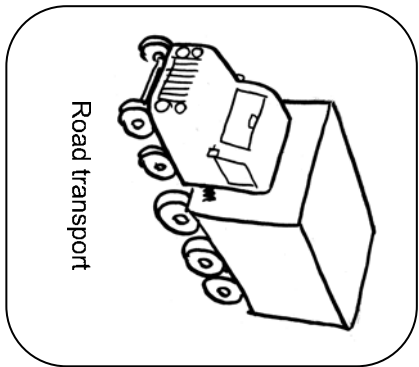
Wooden window frames	<p>Soft-wood can be from sustainable forests. Hardwoods often from cutting down rainforests. This can cause problems although some rainforests are managed in a more sustainable manner.</p> <p>The wood is often chemically treated to help preserve it.</p> <p>Wooden window frames need to be painted to prevent rotting.</p> <p>At the end of its life, a wooden frame is biodegradable.</p>
PVC window frames	<p>PVC is a synthetic plastic made from oil or gas.</p> <p>PVC window frames do not need painting during their lifetime.</p> <p>The PVC can be recycled when the frame needs replacing.</p>

Look at the two life cycles that you have constructed and answer these questions. Give reasons for your answers.

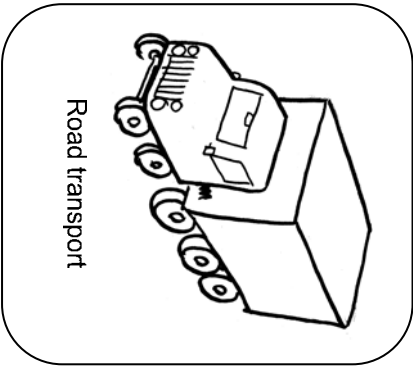
1. How does each type of window frame affect the environment?
2. How do the different materials create employment and generate wealth?
3. How does each material rate in terms of the convenience and appearance to the consumer (householder)?
4. How easy is it to think about a life cycle? Where should the 'boundary' be drawn to stop it spreading out too much?



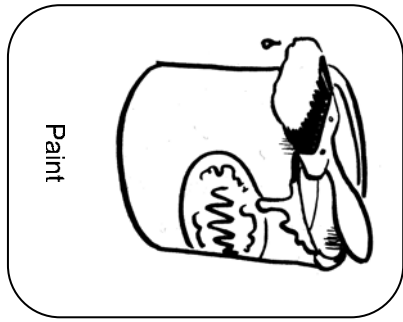
Two copies of this page per group.



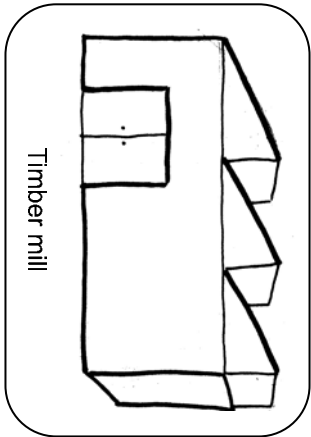
Road transport



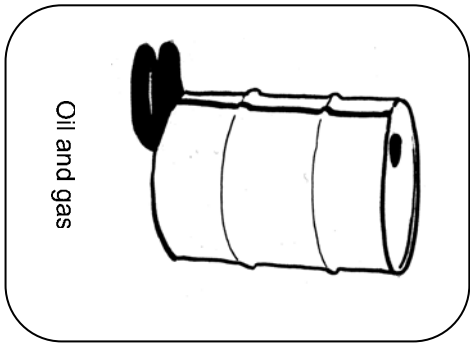
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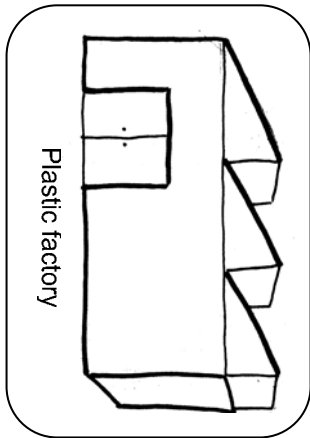
Paint



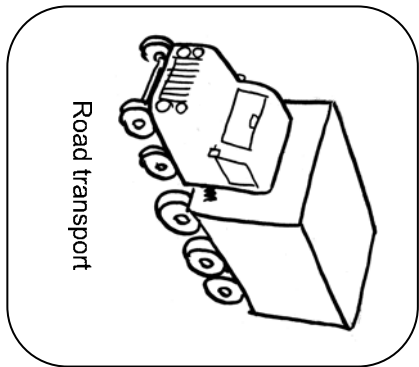
Timber mill



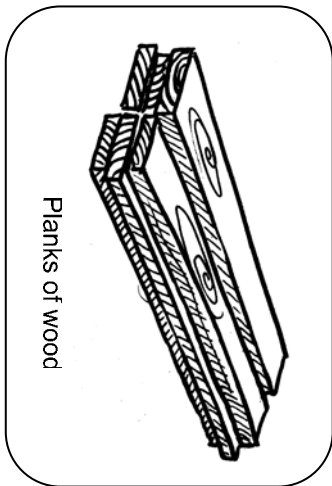
Oil and gas



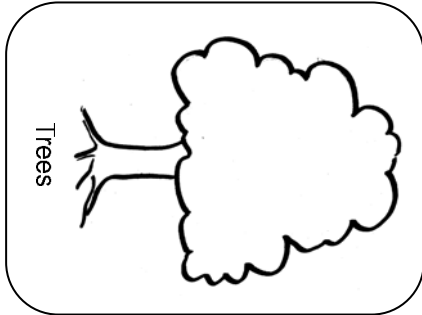
Plastic factory



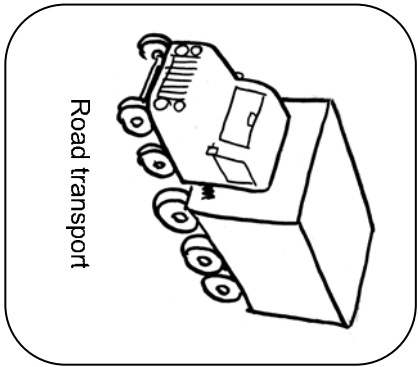
Road transport



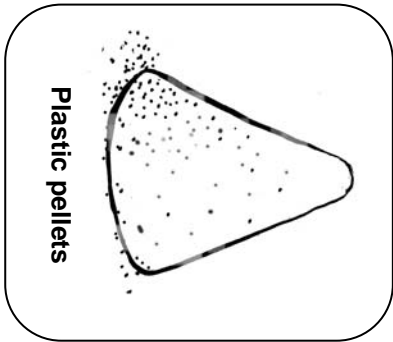
Planks of wood



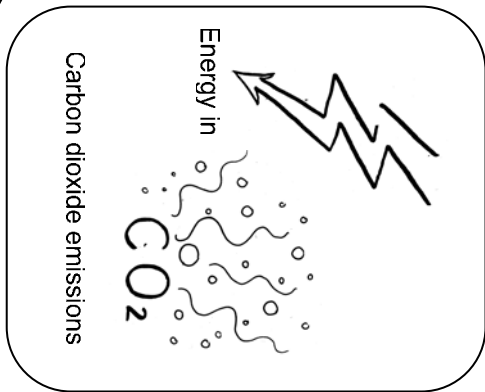
Trees



Road transport



Plastic pellets



Carbon dioxide emissions

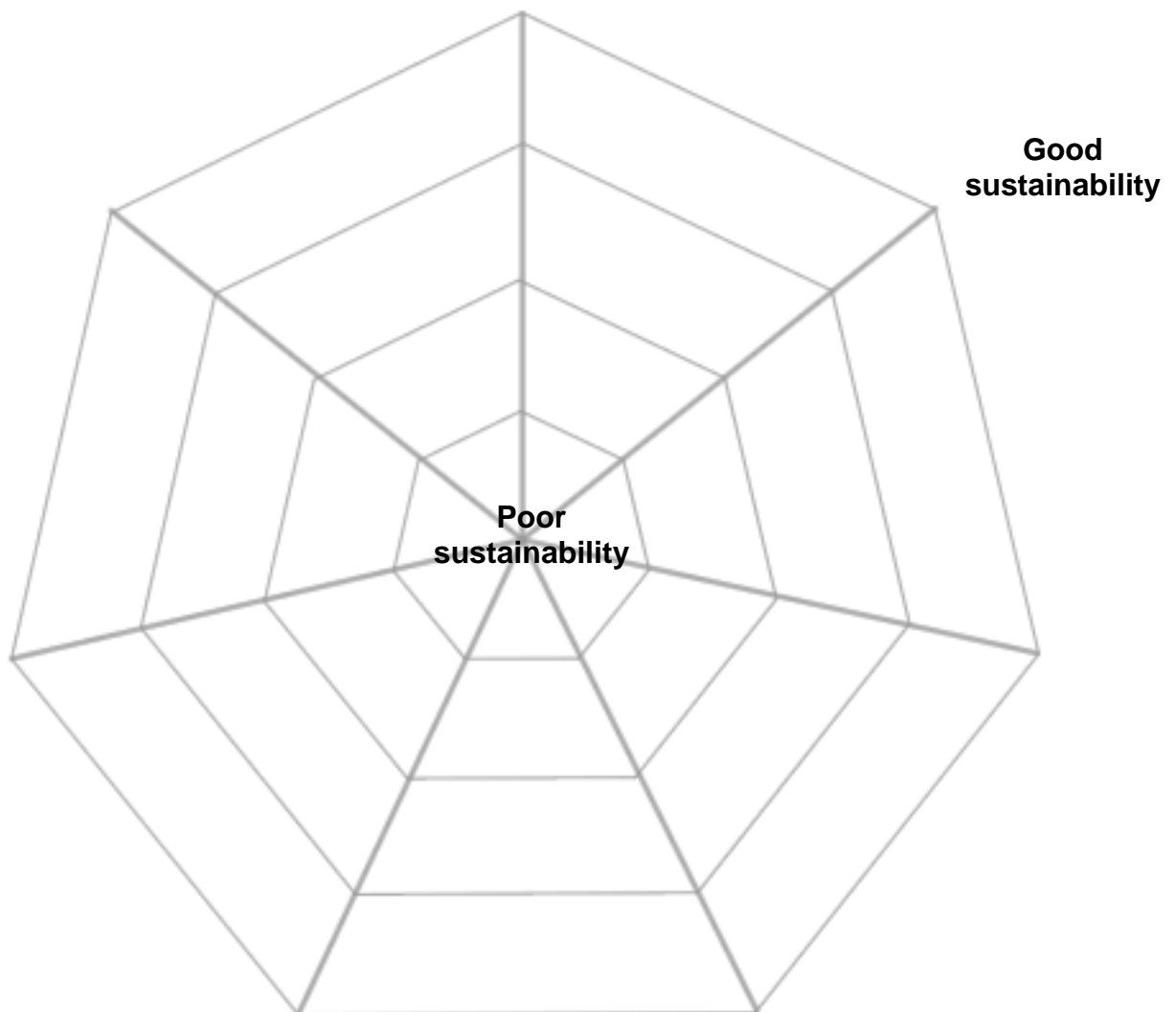
One copy of this page per group.

## Sustainable window frames: wood or PVC window frames?

1. Go to [www.sustainability-ed.org](http://www.sustainability-ed.org).
2. Look at the information on the life cycle analysis of wood and PVC window frames.
3. Choose appropriate features to compare. Think about things like getting the materials to make the frames, how the frames are made and used and then how they are disposed of when they reach the end of their useful life.

For extra information, see the Ecodesign web in the 'tools' section at: <http://ecodesign.lboro.ac.uk/>

4. Use the axes below to draw a radar graph comparing wood and PVC window frames.



## Sustainable waste disposal case study

Students prepare and deliver a short presentation which examines the case for and against waste incineration.

Activity supports key stages 4 or 5 depending on the level of detail included into the presentation.

Curriculum areas:

- understanding sustainable development;
- developing research skills;
- ideas in science;
- environment, earth and universe.

**Resources** Group briefing sheets are supplied. Each consists of two sheets. The first outlines the issues and the group's task. The second gives suggestions for what to include in the presentation. The second sheet can be held back to stretch more able students.

Access to **[www.sustainability-ed.org](http://www.sustainability-ed.org)**.

Waste information sheets for each group (Waste Info 1 and 2).

**Activity** The scenario is a meeting to discuss the proposed building of a new waste incinerator in a local town.

Five groups are represented and each make a short (5 minute) presentation, followed by questions. The groups represent:

- Local television – make the first report which outlines the issues.
- Local Council
- Local residents
- Environmental group
- Incinerator operators

Following the presentations, the waste disposal options can be discussed. A vote is taken on whether the incinerator is a viable option for sustainable waste disposal.

**Suggested  
lesson  
timing**

- Lesson 1      Introduce sustainable development (social, economic and environmental).  
Set scene for incinerator case study.  
Divide into groups and start preparing presentations.
- Homework      Continue work on presentations.
- Lesson 2      Complete and deliver presentations.  
Plenary discussion and vote on the incinerator option.
- Homework      Research how waste is disposed of by local council in school's area.



## Oldchester Waste Management System

Oldchester is a town that currently produces about 180-200,000 tonnes of solid municipal waste per year. Approximately 120,000 tonnes is waste from households. The rest is from business and industry.

### Landfill

Nearly 94% of municipal waste is dumped into landfill. This costs £30 per tonne.

### Recycling

6% of waste is currently recycled. This is collected from recycling centres or is collected by voluntary organisations.

Material recycled	Cost to recycle 1 tonne
Paper & board	£15
Glass	£3
Plastic	£50
Cans (Al & Fe)	£9 profit from sales
Waste motor oil	Negligible

### Compost

Oldchester council is encouraging people to make compost out of their kitchen waste.

Householders can buy compost bins at a reduced price of £6 per bin. They normally cost £20-30.

A trial composting scheme collects kitchen and garden waste. The compost that is produced is used on parks in the town. The scheme is expensive and costs £38 per tonne of waste.

## Proposed New Waste Disposal Strategy

### New incinerator

The council has suggested that an incinerator is built to burn some of the waste.

Paper and plastics in the waste will be processed into small fuel pellets that can be burned in the incinerator. This energy will produce electricity and provide heating for 1,700 local homes.

The incinerator would handle about 40% of the town's waste.

Waste gases will be treated to minimise the release of sulfur dioxide, nitrogen oxides and dioxins. Burning 'recycles' the energy in the waste but it does still produce carbon dioxide.

Some coal and shredded rubber from tyres will also be burned.

Emissions from the incinerator are shown below:

	Substance	Total released per year
<b>Into the Air</b>	Particulates	5.55 tonnes
	Carbon monoxide	27.75 tonnes
	Sulfur dioxide	55.5 tonnes
	Nitrogen oxides	167 tonnes
	Lead	47.25 kg
	Dioxins	0.111 g
<b>To Landfill</b>	Ash	12,262 tonnes
	Dust & spent lime	1,872 tonnes

## Local environmental group

### What a Load of Rubbish!

Oldchester town council has a massive waste problem. It needs to collect and get rid of around 200,000 tonnes of waste each year.

What is the best way to handle this waste?

The council wants to build a waste incinerator to burn some of the town's rubbish. This would also provide electricity and heat to local houses.

An inquiry has been set up to see if this is a good option.

### Your task

You are representatives of a local environmental group. The incinerator will be close to a local park. You are against the incinerator but understand that landfill is not a good option either.

Your task is to make a short presentation to argue against the building of the new incinerator and suggest some more environmentally-friendly options.

### Putting together your presentation

Visit the waste disposal case study on the sustainability-ed web site

1. Go to the web site at: **[www.sustainability-ed.org](http://www.sustainability-ed.org)**
2. Click onto the Sustainable Development case studies section. Choose the Load of rubbish case study.
3. Look at the Waste hierarchy options for waste disposal.
4. Look at the recycling targets for the future.

Use the information sheet to see how Oldchester disposes of its waste.

What will your presentation focus on? Gather information that will support your case.

Prepare your presentation.

- What you will say.
- What is your main message?
- What materials do you need to prepare (slides, posters etc.)

## Presentation tips

Your teacher will tell you the maximum time allowed for your presentation.

Stay in role throughout. Are you trying to appeal to people's emotions or use scientific facts to convince them?

Concentrate on the message you are trying to get across. Make sure it is clear.

Speak clearly, face the audience not the board. Keep arguments simple and any visual aids clear.

Be aware of your audience as they are in role – who are your friends and who are your enemies?

Practice using the overhead projector or computer if you are using them.

Be prepared to answer questions.

You may want to think of these issues:

- The effects of burning the waste on climate change.
- The problems caused by toxic emissions from the incinerator.
- The options shown in the 'Waste hierarchy' (see sustainability-ed web site).
- The need to encourage people to reduce the amount of waste that they make.
- The need to encourage people to recycle more.
- The incinerator will need a constant supply of waste. This may mean that people are less likely to be encouraged to produce less waste.

## Town Council representatives

### What a Load of Rubbish!

Oldchester town council has a massive waste problem. It needs to collect and get rid of around 200,000 tonnes of waste each year.

What is the best way to handle this waste?

The council wants to build a waste incinerator to burn some of the town's rubbish. This would also provide electricity and heat to local houses.

An inquiry has been set up to see if this is a good option.

### Your task

You are representatives from the Oldchester town council.

You must dispose of the local municipal waste in a responsible way but you must also think of the cost involved.

Your task is to argue for the new incinerator.

### Putting together your presentation

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Be prepared to answer questions.

You may want to think of these issues:

- The cost of waste disposal. Incineration is a relatively inexpensive option. It may help to keep down local taxes.
- The incinerator can supply heat and power to local houses.
- Building and running the incinerator will bring jobs to the area.
- Objectors are just worried about what happens where they live. In your opinion, the incinerator will be the best option for the whole of Oldchester.

## Waste incinerator operating company

### What a Load of Rubbish!

Oldchester town council has a massive waste problem. It needs to collect and get rid of around 200,000 tonnes of waste each year.

What is the best way to handle this waste?

The council wants to build a waste incinerator to burn some of the town's rubbish. This would also provide electricity and heat to local houses.

An inquiry has been set up to see if this is a good option.

### Your task

Your company has been given the contract to build and run the new waste incinerator.

You believe that the new incinerator will benefit Oldchester, its inhabitants, the local economy and of course your company.

### Putting together your presentation

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- What is your main message?
- What materials do you need to prepare (slides, posters etc.)

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Speak clearly, face the audience not the board. Keep arguments simple and any visual aids clear.

Be aware of your audience as they are in role – who are your friends and who are your enemies?

Practice using the overhead projector or computer if you are using them.

Be prepared to answer questions.

You may want to think of these issues:

- You believe that burning the rubbish is a cost-effective way of getting rid of it.
- The incinerator will also supply heat and electricity for local houses.
- Your company will provide jobs for local people.
- The emissions from the incinerator are below current Government limits on pollution.
- If the incinerator works well, you may want to expand in the future to take waste from other areas. This would bring more money and prosperity into Oldchester.
- Carbon dioxide emissions will come from the incinerator. However, it will also make electricity and local heating. The emissions from the incinerator need to be compared to the emissions from power stations that would typically burn coal, oil or gas to make the electricity.



## Local residents' group

### What a Load of Rubbish!

Oldchester town council has a massive waste problem. It needs to collect and get rid of around 200,000 tonnes of waste each year.

What is the best way to handle this waste?

The council wants to build a waste incinerator to burn some of the town's rubbish. This would also provide electricity and heat to local houses.

An inquiry has been set up to see if this is a good option.

### Your task

As local residents, you do not want the new incinerator to be built in your neighbourhood.

You believe the incinerator will cause pollution and smells from the lorries carrying the rubbish to be made into fuel pellets.

Your task is to present your arguments against the building of the new incinerator.

### Putting together your presentation

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Use the information sheet to see how Oldchester disposes of its waste.

What will your presentation focus on? Gather information that will support your case.

Prepare your presentation.

- What you will say.
- What is your main message?
- What materials do you need to prepare (slides, posters etc.)

## Presentation tips

Your teacher will tell you the maximum time allowed for your presentation.

Stay in role throughout. Are you trying to appeal to people's emotions or use scientific facts to convince them?

Concentrate on the message you are trying to get across. Make sure it is clear.

Speak clearly, face the audience not the board. Keep arguments simple and any visual aids clear.

Be aware of your audience as they are in role – who are your friends and who are your enemies?

Practice using the overhead projector or computer if you are using them.

Be prepared to answer questions.

You may want to think of these issues:

- You believe that burning the rubbish will release toxic chemicals into the atmosphere.
- The lorries that bring rubbish to be made into fuel pellets will be smelly.
- Piles of rubbish could attract rats and other pests.
- You do not believe that the heat and electricity from the incinerator will be any cheaper than your current energy supplies.
- The company will still need to dispose of the ash that remains after the rubbish has been burned. This ash contains toxic materials.

## Local television

### What a Load of Rubbish!

Oldchester town council has a massive waste problem. It needs to collect and get rid of around 200,000 tonnes of waste each year.

What is the best way to handle this waste?

The council wants to build a waste incinerator to burn some of the town's rubbish. This would also provide electricity and heat to local houses.

An inquiry has been set up to see if this is a good option.

### Your task

You are researchers for the local television station. Your task is to interview representatives from each of the other groups and produce a short news report.

You do not need to go into great detail about the issues. This is the job of the other groups. Your news report should inform the audience of the different groups and briefly mention their points of view.

Your report should be balanced and not show a preference for any of the groups.

### Putting together your presentation

Visit the waste disposal case study on the sustainability-ed web site

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3. Look at the Waste hierarchy options for waste disposal.
4. Look at the recycling targets for the future.

Use the information sheet to see how Oldchester disposes of its waste.

What will your presentation focus on? Gather information that will support your case.

Prepare your presentation.

- What you will say.
- What are the main arguments for and against the incinerator?
- What materials do you need to prepare (slides, posters etc.)

## Presentation tips

Your teacher will tell you the maximum time allowed for your presentation.

Stay in role throughout. Remember that people respond to emotional appeals as well as scientific facts.

Concentrate on the message you are trying to get across. Make sure it is clear.

Speak clearly, face the audience not the board. Keep arguments simple and any visual aids clear.

Practice using the overhead projector or computer if you are using them.

Be prepared to answer questions.

You may want to think of these issues:

- Tell people about how waste in Oldchester is currently being got rid of.
- What are the current problems with the waste disposal? Can the situation carry on as it is?
- Tell the audience what groups will be at the meeting.
- Outline each of the groups main concerns. Do not go into too much detail. The groups should argue their own case.
- Give a balanced view of all the groups.