

## The Earth's Resources Mastery Booklet

We use the Earth's natural resources to provide warmth, shelter, food and transport. If we do not alter them in any way (e.g. fruit for eating) then the resource is referred to as natural. If we have changed or made a new resource, it is referred to as "synthetic" (e.g. plastics).

All resources can be either finite (will run out) or renewable (will not run out). Crude oil can be used to manufacture fuel, but it will one day run out so is finite. We can also grow crops to turn into fuel but we can always grow more crops, so they are renewable. Most of the resources we use day-to-day are finite.

Where natural resources are running out it is down to scientists to design alternatives that are sustainable. Sustainable development is where we can meet the needs of current generations without compromising future generations.

1. How do finite and renewable resources differ?
2. Give two examples of finite resources
3. Give two examples of renewable resources
4. Car tyres are made of synthetic rubber. Suggest an advantage of using synthetic rubber instead of natural rubber
5. Suggest a disadvantage of synthetic rubber
6. Poly(ethene) is made from ethene which comes from crude oil.
  - a. What is crude oil?
  - b. What type of material is poly(ethene)
  - c. How are alkenes made from alkanes?
  - d. When ethene reacts with oxygen it produces carbon dioxide and water. Write a word equation for this reaction.
  - e. What are the potential negative consequences of releasing carbon dioxide into the atmosphere?
7. Coal is a fossil fuel that can be combusted
  - a. In a combustion reaction the temperature of the surroundings increases. What type of reaction is this?
  - b. Is coal a renewable or finite resource?
  - c. Explain your answer
  - d. The owner of a coal power plant wants to replace coal with wood chippings. Explain why such action is more sustainable than continuing to use coal.
8. Iron can be extracted from iron (III) oxide through reacting it with carbon. Carbon dioxide is a waste product.
  - a. Write a word equation for this reaction
  - b. What name is given to this type of reaction?
  - c. Why is electrolysis not necessary to extract iron?
  - d. Is iron oxide a renewable resource?

### Water safe to drink

The Earth's water originally condensed as rain as the Earth cooled. Now, it is collected in rivers, lakes, oceans and underground. This water is often not safe to drink as it can contain high levels of dissolved salts and dangerous microbes.

Water that is safe to drink is called **potable water**. This is water with safe levels of dissolved salts and no dangerous microbes. It is not **pure** because it is still a mixture of water and other substances, but the other substances are safe.

To obtain potable water we first choose an appropriate source of water, then we filter it to remove undissolved substances and then it is **sterilised**. Sterilisation is where harmful micro-organisms are killed. We use chlorine, ozone or ultraviolet light to sterilise water.

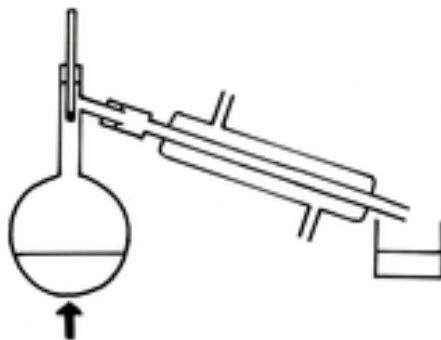
9. Why is it important to not drink from "naturally occurring" sources of water?
10. Why is it important to only drink water that has been sterilised?
11. Why is tap water not chemically pure, even though it is potable?
12. What is the difference between pure water and potable water?
13. If water is clear, looks clean and does not smell is it safe to drink?
14. Which is more pure, rainwater or river water?
15. Challenge 1: Is water a renewable or finite resource?
16. Challenge 2: anhydrous copper sulphate turns blue in the presence of water. Why can it not be used as a test for the purity of water?

## Desalination

Sea water contains high levels of sodium chloride and cannot be drunk safely. Desalination is the process of removing sodium chloride from water and can be conducted through distillation or “reverse osmosis” using membranes. These processes require a lot of energy so are typically only conducted by wealthy countries in areas where there is no other water source.

17. Desalination can be carried out through distillation. Label the diagram below with the following labels

- |                          |                           |
|--------------------------|---------------------------|
| a. Condenser             | f. Flask                  |
| b. Thermometer           | g. Distilled water        |
| c. Salty water is boiled | h. Beaker                 |
| d. 100° C                | i. Salty water            |
| e. Vapours condense      | j. Steam leaves the flask |



18. Why is desalination only carried out in wealthy countries?  
19. Why does the United Kingdom not obtain drinking water by desalination?  
20. What are the two ways of carrying out desalination?  
21. Why is sea water not potable water?  
22. Explain why bottled water sold at the canteen should not be labelled as “pure water”  
23. Water obtained through distillation does not need sterilisation  
a. What is sterilisation?  
b. Why is it normally important?  
c. In what three ways do we normally sterilise water?  
d. Why does distilled water not need to be sterilised?  
24. Challenge: Is desalination a **sustainable** process?

## Treating Waste Water

Waste water is either sewage from human or animal excrement, agricultural waste or industrial waste.

Sewage and agricultural waste water can have : Organic matter, Harmful microbes

Industrial waste can have: Organic matter Harmful chemicals

In order to treat waste water a number of steps are followed:

- i. Screening and grit removal
- ii. Sedimentation to produce sewage sludge and effluent
- iii. Anaerobic digestion of sewage sludge
  - a. Biogas produced
  - b. Remaining sludge can be used as fuel
- iv. Aerobic biological treatment of effluent
  - a. Effluent can now be discharged back into rivers

Questions:

25. Screening uses a large metal grate. What common items can be separated from the waste by the screen?

26. Effluent is water from the waste with no solids in it. At what stages are solids separated from the effluent?
27. Why is it important to separate solids from the effluent?
28. Why is it important to have two stages of separating solids?
29. What is anaerobic respiration?
30. What is sewage sludge?
31. What is biogas?
32. Draw a basic flowchart to illustrate how waste is treated.
33. In terms of sustainability, why is it important to treat waste water?
34. Summary water questions:
  - a. There are three sources for obtaining potable water: waste water, ground water (underground, rivers and lakes) and salt water. For each of the three briefly describe how potable water is obtained
  - b. How do they vary in terms of the ease of obtaining potable water?

### Reduce, Reuse, Recycle

35. What steps has the British government taken to reduce the number of plastic bags used?
36. Why is it important to reduce the amount of plastic that is used?
37. From what type of chemical are plastics initially made from?
38. Different plastics have different properties. What properties would be required for:
  - a. Water bottles
  - b. Carbonated (fizzy) drink bottles
  - a. Underground water pipes
  - b. Packaging materials (like Styrofoam)
  - c. Chopping boards
39. Based on your answer to 15 explain why it is important to separate plastics before recycling them
40. Steel and aluminium can be separated by the use of a magnet. Explain why.
41. Give three reasons why it is important to recycle materials like steel
42. What is paper made of?
43. Why is it important to reduce the amount of new paper being made?
44. What is the largest cost in recycling?
45. Glass can either be made from sand or recycled from used glass. Both materials need to be melted before they can be turned into new glass.
  - a. Used glass has a lower melting point than sand. Explain why it is an advantage to recycle used glass rather than sand to make glass
  - b. Used glass bottles need to be separated into different colours before they can be recycled. Explain why this is a disadvantage.
  - c. Glass bottles can easily be separated from plastic ones. On what property can this be carried out?
  - d. Glass is made of silicon dioxide. Describe the structure and bonding in silicon dioxide
  - e. Explain why silicon dioxide has a high melting point
  - f. Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers. The Government states that this is because plastic bags use up resources that are not renewable and that the manufacture of plastic bags produces carbon dioxide. Most of these plastic bags are made from poly(ethene). The table shows methods to deal with large numbers of used plastic bags.

Method	Description of what happens to the plastic bag
Reused	used again by the customer
Recycled	collected, transported, washed and melted to make new plastic items
Burned	collected, transported and burnt to release heat energy
Dumped	mixed with other household waste, collected, transported and disposed of at a landfill site

Use the information and your knowledge and understanding to briefly give one advantage and one disadvantage for each of these methods. (4)

### Life Cycle Assessment (LCA)

An LCA is a process of looking at the entire life cycle of a product looking at cost and sustainability. The main stages of assessment are:

- Extracting and processing raw materials
- Manufacturing and packaging
- Use and operation during its lifetime
- Disposal at the end of lifetime (including transport and distribution)

To answer questions about LCA, you will normally be provided with information and be asked to interpret it, often as a piece of extended writing for 4-6 marks. The example below is modelled for you to show you how to do it yourself.

**EXAMPLE QUESTION:** Disposable cups are made from coated paper or poly(styrene). The table below shows information on the life cycle assessments (LCAs) of disposable cups.

	Coated paper cups	Poly(styrene) cups
Raw materials	Wood	Crude oil
Mass of 1 cup in g	8.3	1.9
Energy to produce 1 cup in kJ	550	200
Energy released when 1 cup is burned in kJ	166	76
Biodegradable	Yes	No
Recyclable	No	Yes

Evaluate the use of coated paper compared with poly(styrene) to make disposable cups. Use the table above and your knowledge and understanding of LCAs. (6)

For an LCA question we want to look at four things: *raw materials, manufacture and transport, usage, disposal*. They are elaborated on in the table:

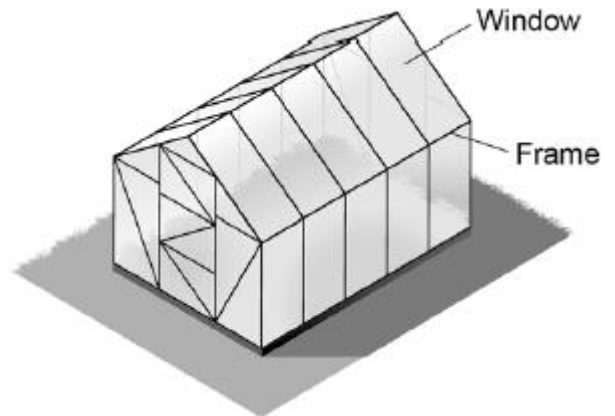
Stage of LCA	What it means	Things to consider	Example of a good statement	Example of a poor statement
<b>Raw materials</b>	What are the different items made of?	Whether the raw materials are renewable or non-renewable How much land is used to make them and if there is habitat loss because of this Whether there has to be deforestation in production	Coated paper cups rely on wood for their production, which is a renewable resource, but polystyrene cups require crude oil which is a finite resource.	There's lots of wood for paper cups but not a lot of oil for polystyrene cups  <i>This is poor because it doesn't say if it is renewable or finite. It also doesn't compare the two</i>
<b>Manufacture and transport</b>	How are the different items made? How are the materials for them transported? How are they transported once made?	How much energy is needed for each (as this may come from non-renewable sources and release carbon dioxide) How much energy is required for transport (depends on distance, type of transport and mass of items) You need to be adding your own knowledge here e.g.: Some metals require electrolysis which requires a lot of energy Other metals require reduction with carbon which releases CO <sub>2</sub> Paper requires a lot of water	Paper cups require a lot more energy to manufacture than polystyrene ones. This could need more finite resources and release CO <sub>2</sub> into the atmosphere. They are also heavier, which means they need more energy to transport.	Coated paper cups need 550kJ of energy and polystyrene ones 200. Coated paper cups are also heavy.  <i>This is poor because it does not compare the two, it just says what each one is. It also does not explain why there would be a problem with more energy or weight</i>
<b>Usage</b>	How long can each item be used for? How energy efficient is it whilst in usage?	Some items can only be used once, but others can be used many times Some items can be used many times, but wear and tear easier so will need to be disposed of sooner When discussing items that use energy (like cars), their efficiency is important: how much energy is required to move a car a certain distance?	Both paper cups and polystyrene cups are only used once, so there is no difference in their usage.	
<b>Disposal</b>	How do we dispose of the item when we are finished with it?	Some items can be reused or recycled. When discussing recycling, you need to talk about the energy cost of separating materials and of actually carrying out the recycling. It is also a good idea to say that recycling is important as it conserves resources. If an item is disposed of in a landfill, we need to discuss if it will decompose or remain in the landfill for a long time Sometimes items are incinerated. Some items like paper or wood will release energy when incinerated which we can use for other processes. Other items might release toxic fumes when incinerated (like most plastics)	Paper cups cannot be recycled, but polystyrene ones can. This would conserve finite resources. If the cups are going to a landfill, paper ones will biodegrade, but polystyrene ones will not, causing more landfill space to be required.	You can recycle polystyrene cups, but not paper ones. Polystyrene ones are not biodegradable, but paper ones are.  <i>Nothing here is wrong, but it is simply repeating the information in the table. You must explain why particular options are better or worse.</i>

You will want to finish with a conclusion.

46. Now do it yourself: Use the information above to answer the question *Evaluate the use of coated paper compared with poly(styrene) to make disposable cups. Use the table above and your knowledge and understanding of LCAs.*

47. The diagram shows a greenhouse.

A greenhouse frame can be made from wood or aluminium. The table gives some information about wood and aluminium.



	Wood	Aluminium
Raw material	Renewable	Non-renewable
Mass of greenhouse frame in kg	80	20
Useful lifetime in years	20	50
End of useful life	Can be chopped up and used as fuel	Can be recycled into new aluminium products

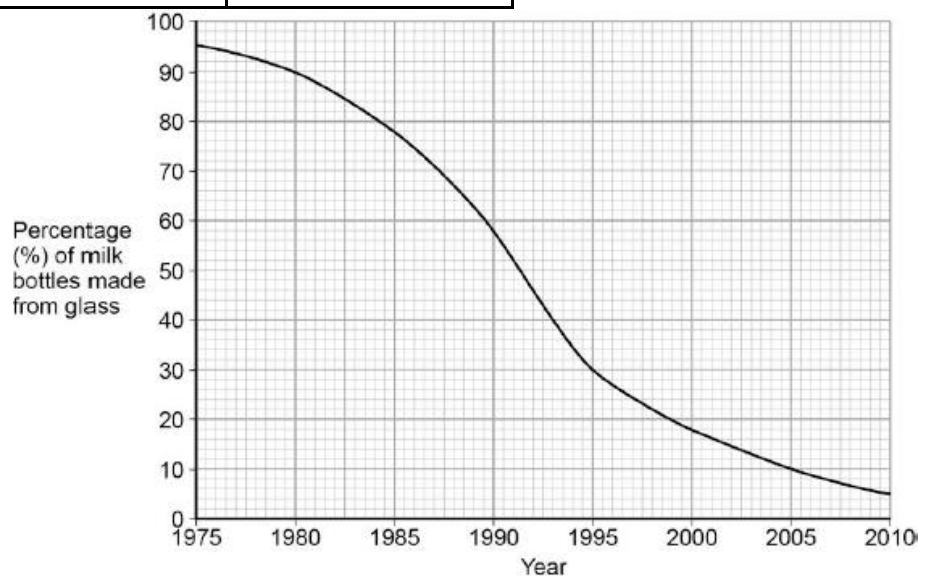
Evaluate the use of each material for making greenhouse frames. (remember to structure your answer under the headings: raw materials, manufacture and transport, usage, disposal) (4)

48. Greenhouse frames are transported by lorry. The lorry used can carry a maximum load of 12 tonnes. Calculate the largest number of wooden greenhouse frames which could be transported by the lorry. (1 tonne = 1000kg)
49. It is more sustainable to make greenhouse frames from recycled aluminium than from aluminium from aluminium ore. Give two reasons why. (2)
50. Greenhouse windows can be made from glass or from polymers. The table gives information about glass and a polymer

	Glass	Polymer
Density in g / cm <sup>3</sup>	2.8	1.2
Cost in £ per m <sup>2</sup>	20	28
Effect of sunlight	No effect	Discolours over time

Evaluate the use of each material for making greenhouse windows (4).

51. Plastic and glass can be used to make milk bottles. The figure below shows the percentage of milk bottles made from glass between 1975 and 2010. Plot the points and draw a line on the figure above to show the percentage of milk bottles made from materials other than glass between 1975 and 2010.
52. The table below gives information about milk bottles.



	Glass milk bottle	Plastic milk bottle
Raw materials	Sand, limestone, salt	Crude oil
Bottle material	Soda-lime glass	HD poly(ethene)
Initial stage in production of bottle material	Limestone and salt used to produce sodium carbonate.	Production of naphtha fraction.
Maximum temperature in production process	1600 °C	850 °C
Number of times bottle can be used for milk	25	1
Size(s) of bottle	0.5 dm <sup>3</sup>	0.5 dm <sup>3</sup> , 1 dm <sup>3</sup> , 2 dm <sup>3</sup> , 3 dm <sup>3</sup>

Percentage (%) of recycled material used in new bottles	50 %	10 %
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Evaluate the production and use of bottles made from soda-lime glass and those made from HD poly(ethene). Use the information given and your knowledge and understanding to justify your choice of material for milk bottles. (6)

### Summary problem

A student wishes to investigate the reaction between various metals and water.

53. Does the water for this investigation need to be potable? Explain your answer.
54. The student adds potassium to the water. What will they observe?
55. Give a word equation for the reaction of potassium with water.
56. The student decides to use pure water for this investigation. What is pure water?
57. What is the pH of the water at the start? Explain your answer.
58. Will the pure water conduct electricity? Explain your answer.
59. The student adds 30g of potassium to the water. What mass of potassium hydroxide will be produced?
60. How can potassium be extracted from solid potassium hydroxide.
61. The student repeats the experiment, but warms up the water first. How will this affect the rate of reaction? Explain your answer.
62. During the reaction, a thermometer in the water shows a small increase. Is this reaction exothermic or endothermic?
63. Draw an energy level diagram for this reaction.
64. The student then adds lithium to fresh water. Lithium is less reactive than potassium. Explain why.
65. How could the student use the equipment already mentioned throughout this question to put a number of metals in order of their reactivity? Include a discussion of which variables would need to be controlled.
66. The student decides to use four different metals including copper. Explain why copper is malleable.
67. Explain why copper can conduct thermal energy.
68. What property of copper makes it useful as a resource?
69. Why is copper considered a finite resource?