**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. *Skip this question if you have not studied crude oil yet.*Poly(ethene) is made from ethene which comes from crude oil.
	1. What is crude oil?
	2. What is the formula for ethene?
	3. What type of material is poly(ethene)
	4. How are alkenes made from alkanes?
	5. When ethene reacts with oxygen it produces carbon dioxide and water. Write a symbol equation for this reaction.
	6. What are the potential negative consequences of releasing carbon dioxide into the atmosphere?
7. Coal is a fossil fuel that can be combusted
	1. In a combustion reaction the temperature of the surroundings increases. What type of reaction is this?
	2. Is coal a renewable or finite resource?
	3. Explain your answer
	4. 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.
	1. Write a word equation for this reaction
	2. Write a symbol equation for this reaction
	3. What name is given to this type of reaction?
	4. Why is electrolysis not necessary to extract iron?
	5. 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 let to sterilise water.

1. Why is it important to not drink from “naturally occurring” sources of water?
2. Why is it important to only drink water that has been sterilised?
3. Why is tap water not chemically pure, even though it is potable?
4. What is the difference between pure water and potable water?
5. If water is clear, looks clean and does not smell is it safe to drink?
6. Which is more pure, rainwater or river water?
7. Challenge 1: Is water a renewable or finite resource?
8. 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.

1. Desalination can be carried out through distillation. Label the diagram below with the following labels
	1. Condenser
	2. Thermometer
	3. Salty water is boiled
	4. 100°C
	5. Vapours condense
	6. Flask
	7. Distilled water
	8. Beaker
	9. Salty water
	10. Steam leaves the flask



1. Why is desalination only carried out in wealthy countries?
2. Why does the United Kingdom not obtain drinking water by desalination?
3. What are the two ways of carrying out desalination?
4. Why is sea water not potable water?
5. Explain why bottled water sold at the canteen should not be labelled as “pure water”
6. Water obtained through distillation does not need sterilisation
	1. What is sterilisation?
	2. Why is it normally important?
	3. In what three ways do we normally sterilise water?
	4. Why does distilled water not need to be sterilised?
7. 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:

1. Screening and grit removal
2. Sedimentation to produce sewage sludge and effluent
3. Anaerobic digestion of sewage sludge
	1. Biogas produced
	2. Remaining sludge can be used as fuel
4. Aerobic biological treatment of effluent
	1. Effluent can now be discharged back into rivers
5. Screening uses a large metal grate. What common items can be separated from the waste by the screen?
6. Effluent is water from the waste with no solids in it. At what stages are solids separated from the effluent?
7. Why is it important to separate solids from the effluent?
8. Why is it important to have two stages of separating solids?
9. What is anaerobic respiration?
10. What is sewage sludge?
11. What is biogas?
12. Draw a basic flowchart to illustrate how waste is treated.
13. In terms of sustainability, why is it important to treat waste water?
14. Summary water questions:
	1. 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
	2. How do they vary in terms of the ease of obtaining potable water?

**Reduce, Reuse, Recycle**

1. What steps has the British government taken to reduce the number of plastic bags used?
2. Why is it important to reduce the amount of plastic that is used?
3. From what type of chemical are plastics initially made from?
4. Different plastics have different properties. What properties would be required for:
5. Water bottles
6. Carbonated (fizzy) drink bottles
7. Underground water pipes
8. Packaging materials (like Styrofoam)
9. Chopping boards
10. Based on your answer to 15 explain why it is important to separate plastics before recycling them
11. Steel and aluminium can be separated by the use of a magnet. Explain why.
12. Give three reasons why it is important to recycle materials like steel
13. What is paper made of?
14. Why is it important to reduce the amount of new paper being made?
15. What is the largest cost in recycling?
16. 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.
17. 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
18. Used glass bottles need to be separated into different colours before they can be recycled. Explain why this is a disadvantage.
19. Glass bottles can easily be separated from plastic ones. On what property can this be carried out?
20. Glass is made of silicon dioxide. Describe the structure and bonding in silicon dioxide
21. Explain why silicon dioxide has a high melting point
22. 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** |
| **Raw materials** | 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 thisWhether 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*This is poor because it doesn’t say if it is renewable or finite. It also doesn’t* ***compare*** *the two* |
| **Manufacture and transport** | 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 energyOther metals require reduction with carbon which releases CO2Paper 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 CO2 into the atmosphere. They are also heavi**er**, 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.*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* |
| **Usage** | 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 timesSome items can be used many times, but wear and tear easier so will need to be disposed of soonerWhen 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.  |  |
| **Disposal** | 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 items is disposed of in a landfill, we need to discuss if it will decompose or remain in the landfill for a long timeSometimes 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.*Nothing here is wrong, but it is simply repeating the information in the table. You must explain* ***why*** *particular options are better or worse.* |

You will want to finish with a conclusion.

1. 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.*
2. 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)

1. 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)
2. It is more sustainable to make greenhouse frames from recycled aluminium than from aluminium from aluminium ore. Give two reasons why. (2)
3. 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 3 | 2.8 | 1.2 |
| Cost in £ per m 2 | 20 | 28 |
| Effect of sunlight | No effect | Discolours over time |

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

1. 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.
2. 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 inproduction of bottlematerial | Limestone and salt used to produce sodium carbonate. | Production of naphtha fraction. |
| Maximum temperaturein production process | 1600 °C | 850 °C |
| Number of times bottle can be used for milk | 25 | 1 |
| Size(s) of bottle | 0.5 dm3 | 0.5 dm3, 1 dm3, 2 dm3, 3 dm3 |
| Percentage (%) of recycled material used in new bottles | 50 % | 10 % |

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)

**Metal extraction**

1. What method of extraction is used for metals
	1. Less reactive than carbon
	2. More reactive than carbon
2. Define ore
3. Why is gold found naturally in the Earth’s crust?
4. Why is it important to find alternative methods to extract metals?
5. State the main steps involved in phytomining
6. Phytomining is often said to be a “carbon neutral” process. Explain why.
7. Purification of copper after phytomining often involves electrolysis. Explain why this means the process is not carbon neutral.
8. State the main steps involved in bioleaching

**Summary problem**

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

1. Does the water for this investigation need to be potable? Explain your answer.
2. The student adds potassium to the water. What will they observe?
3. Give a word and symbol equation for the reaction of potassium with water.
4. *Challenge: Construct an ionic equation for potassium in this reaction.*
5. *Challenge: Construct a half equation for potassium in this reaction.*
6. The student decides to use pure water for this investigation. What is pure water?
7. What is the pH of the water at the start? Explain your answer.
8. Will the pure water conduct electricity? Explain your answer.
9. The student adds 30g of potassium to the water. What mass of potassium hydroxide will be produced?
10. If the volume of water at the start was 5930cm3, what is the concentration of the potassium hydroxide produced? (Triple only: give your answer in mol/dm3)
11. The student added 30g of potassium to 5930g of water. Explain why the mass of the solution at the end is not 5960g.
12. *Challenge: predict the actual mass of solution at the end*
13. The student conducts electrolysis on the resulting solution. Predict the substances that will be produced at each electrode.
14. Explain why potassium is not produced.
15. How can potassium be extracted from solid potassium hydroxide.
16. The student repeats the experiment, but warms up the water first. How will this affect the rate of reaction? Explain your answer.
17. During the reaction, a thermometer in the water shows a small increase. Is this reaction exothermic or endothermic?
18. Draw an energy level diagram for this reaction.
19. The student then adds lithium to fresh water. Lithium is less reactive than potassium. Explain why.
20. 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.
21. The student decides to use four different metals including copper. Explain why copper is malleable.
22. Explain why copper can conduct thermal energy.
23. What property of copper makes it useful as a resource?
24. Why is copper considered a finite report?
25. Give three different methods for extracting copper from its ores.