RSC | Advancing the Chemical Sciences

Disposable cups and the environment


Disposable cups and the environment – information cards


Disposable cups and the environment – data table

Index 6.2.2
3 sheets
Index 6.2.3
4 sheets

Our society is becoming more conscious of the need to look after our environment and conserve its natural resources. We try to make choices that are 'environmentally friendly' and are sometimes prepared to pay more for products that seem to be better for the environment. One choice that could affect the environment is the choice of material to be used for making disposable cups.

In this activity, students put themselves in the role of a manager in a take-away hot drinks company. They have to choose which of two materials will be best for making the cups for their drinks – polystyrene or paper. Most students will assume at the start that paper cups would be better for the environment because paper is made of a natural, renewable material. However, on examination of the evidence this appears not to be the case.

Suggested lesson plan

Starter

You could begin this activity by displaying headlines or articles from newspapers that express concern about the use of plastics. Alternatively, you could discuss with students which material they feel is more 'environmentally friendly' – paper or polystyrene. Ask them what evidence they have to support their views. Discuss why people who are environmentally conscious might use disposable cups. Reasons could include: they are more hygienic; they are more convenient and appropriate for use in certain situations.

Main activity

Give each student a worksheet and a table to complete and each pair or group a thoroughly shuffled pack of information cards. The cards could be laminated to protect them and make them easier to reuse. Alternatively, they could be copied onto cardboard.

Students read the information on the cards and use it to complete the table. This allows them to analyse the environmental impact of each of the two options for making disposable cups. They then complete the questions on the worksheet.

Plenary

Discuss students' findings and highlight in particular those facts which surprised them. Discuss why the general perception is that paper would be the more environmentally friendly material to use. Ask students if there are any aspects of the debate about which they feel they do not have enough information to make an informed decision.

Follow up
Students make a leaflet to share their findings with the general public. This could be set for homework or done in a subsequent lesson.

Answers

1. Consumers might want a disposable cup because they do not want to stay in the shop where they have purchased their drink – they may wish to take the drink on a train or to work for instance. They may also prefer disposable cups because they perceive them to be more hygienic.
2. Students should answer based on their own views.

Item	Paper cup	Polystyrene cup
Making the cups (per cup)		
Mass of wood and bark needed (g)	33	0
Mass of petroleum needed (g)	4.1	3.2
Mass of other chemicals needed (g)	1.8	0.05
Tick the material whose manufacture uses the most		
Steam	✓ (12 times as much)	
Electricity	✓ (36 times as much)	
Cooling water	✓ (twice as much)	
Tick the material whose manufacture produces the most		
Waste water	✓ (580 times as much)	
Water pollution	✓ (10 times as much)	
Metal salts		✓
Waste gases	✓ (per cup)	
Using the cups		
Mass of 1 cup (g)	10.1	1.5
Cost of 1 cup (pence)	5	2
After use		
Can the cup be reused?	✘	✓
Can the material be recycled?	✘	✓
Can it be burnt?	✓	✓
How much energy will you get from 1 kg if you burn it?	20 MJ	40 MJ
What mass of material would go in a landfill from 1 cup?	10.1 g	1.5 g
Is it biodegradable?	✓	✘

Table 1 Data table for the cups

RSC | Advancing the Chemical Sciences

3. The paper cups will have higher transport costs as they are heavier and more petrol/diesel will therefore be needed to get them to the shops.

4. The main advantage of paper cups is that they are biodegradable.

5. The main advantages of polystyrene cups are that they use fewer raw materials and their manufacturing process consumes less energy and produces less waste than that of paper cups. Polystyrene cups are also lighter than paper ones, which leads to lower transport costs.

6.
   - Anaerobic decomposition is decomposition without using oxygen (breaking down)
   - Biodegrade – to be broken down by living organisms
   - Greenhouse gas – a gas that contributes to global warming.

7. This will depend on the answers given earlier. It is likely that the main advantage of using paper (the fact that it is biodegradable) now appears to be less of an advantage than previously thought.

8. The polystyrene cup is probably better for the environment when all the factors are taken into consideration. It is not only the disposal of the cup that needs to be considered, but the materials used to make and transport it too.

9. The answer to this is up to the student. They may choose polystyrene as it probably is more 'environmentally friendly' or paper because of the persistent belief among consumers that it is better for the environment.

You could mark the leaflet for:

- Scientific accuracy
- Persuasiveness of the arguments
- Presentation.

References and further information

M. Hocking, *Science*, 1991, **251**, 504.

J. Emsley, *New Scientist*, 1991, **1791** (19 October), 132.

Disposable cups and the environment – information cards

The main raw material needed to make a paper cup is wood, which is a renewable resource. However, collecting wood impacts on the landscape - trees have to be cut down both for use as wood and to make space for roads so that the wood can be transported.

A polystyrene cup is made from oil. Collecting and transporting oil can cause environmental damage, particularly if spills occur during drilling or transportation.

More petroleum is needed to make a paper cup than a polystyrene one. This is because the wood for the paper cups has to be transported by road or rail to the manufacturing plant. The oil or natural gas needed to make polystyrene cups is taken to the plant through a pipeline. 4.1 g petroleum is needed to make a paper cup but only 3.2 g for a polystyrene one. If the paper cup has a plastic or wax coating even more

Paper cups are made from bleached wood pulp, which is made from wood chips. Only about half the chips are turned into pulp. Bark and some wood waste are burned to supply energy for the process. In total about 33 g wood and bark is used per cup.

A paper cup weighs about 10.1 g; a polystyrene one about 1.5 g.

A paper cup costs about 5p; a polystyrene one about 2p.

To make paper, chemicals such as chlorine, sodium hydroxide, bleach, sulfuric acid, sulfur and limestone are needed. These chemicals are not recycled. In total about 1.8 g of these chemicals are needed per cup.

Efficient catalysts are used to make polystyrene so most of the chemicals involved can be recycled. About 0.05 g chemical waste is produced per cup.

So much wood pulp is used to make a paper cup that the whole process requires about 12 times as much steam, 36 times as much electricity and twice as much cooling water as the process used to make a polystyrene cup.

About 580 times as much waste water is produced during the manufacture of a paper cup as when a polystyrene one is made. The waste chemicals are mainly removed from the water but there is still at least 10 times more chemical waste than for polystyrene.

Making polystyrene produces about 20 kg waste metal salts per tonne. Making paper produces 1– 20 kg, depending on which paper plant it is.

More waste gas is produced for polystyrene than for paper per tonne of material made. However, paper cups are heavier than polystyrene ones so less waste gas is produced per polystyrene cup.

Polystyrene cups can be reused because they do not soak up water. Paper cups can be reused but washing can destroy them.

Polystyrene cups can be recycled. The recycled material cannot be used for food or drink but it can be made into packing materials, insulation, patio furniture, tiles and other products. However, at present only a small proportion of polystyrene waste is recycled.

Paper cups cannot be recycled. The glue that holds the parts of the cup together cannot be removed in the recycling process. If the paper is coated with plastic it is even harder to find a way to recycle it.

Both paper and polystyrene can be burnt in an incinerator so that the energy produced can be used. Paper provides 20 MJ per kg and polystyrene gives 40 MJ per kg.

Disposable cups and the environment

Our society is becoming more conscious of the need to look after our environment and conserve its natural resources. We try to make choices that are 'environmentally friendly' and are sometimes prepared to pay more for products that seem to be better for the environment. One choice that could affect the environment is the choice of material to be used for making disposable cups.

You are a manager in a company with shops selling take-away hot drinks. You have to decide whether you should sell your drinks in paper or polystyrene cups. You have done some research and it shows that your customers are concerned about the environment and will buy their drinks from the company they think takes most care of it. They do not mind that it might make the drinks cost a little more.

1. Why do consumers who are concerned about the environment want to have disposable drink cups? What makes them particularly useful?

.....

.....

.....

2. Which cups do you think you should use for your hot drinks? Explain your answer.

.....

.....

.....

.....

When deciding which of two materials will have less impact on the environment you need to consider all aspects of the product. You should include the effects of making it, transporting it, using it and disposing of it (what happens when it is thrown away) in your assessment.

Collect a data table and a set of information cards. Each of the cards shows an important piece of information about one of the two types of cup. Use the information to help you complete the table and then answer the questions.

3. Which type of cup will have higher transport costs and will require more petrol to be used to get the cups to the shops? (Hint: look at the masses of the cups.)

.....

.....

4. What are the main advantage(s) of paper cups?

.....

.....

5. What are the main advantage(s) of polystyrene cups?

.....

.....

Most waste in Britain ends up in a landfill site.

Bulldozer at work on a landfill site
(Photograph courtesy of Biffa)

Waste in landfill sites

In a landfill site, the rubbish is put into a large hole in the ground. Other waste is piled on top of it. This means that very little oxygen can get to the rubbish, so when it biodegrades it does so anaerobically. The same number of cups will produce six tonnes of waste if the cups are made of paper or one tonne of waste if they are made of polystyrene.

When six tonnes of paper cups biodegrade anaerobically they produce 2370 kg methane and 3260 kg carbon dioxide. Methane, like carbon dioxide, is a 'greenhouse gas' – it is believed to contribute to global warming. One molecule of methane is thought to cause about 10 times more warming than one molecule of carbon dioxide. During anaerobic decomposition, methane and carbon dioxide are produced in the ratio 2:1. This is worse for global warming than burning the cups: the waste gas produced by burning is nearly all carbon dioxide.

Recent research has provided evidence that paper put into a landfill site does not always degrade or biodecompose, especially in dry regions. 50 year old newspapers that are still complete and readable have been dug up from landfill sites.

6. What do the following terms mean?

a Anaerobic decomposition

.....

.....

b Biodegrade

.....

.....

c Greenhouse gas.

.....

.....

7. Does the information above affect your answers to questions 4 and 5? If so, how?

.....

.....

8. From the evidence you have here, which of the cup materials appears to be better for the environment? Explain your answer. Does this surprise you?

.....

.....

9. As a drinks company manager, which cups would you choose for your stores? Explain your answer.

.....

.....

.....

Design a leaflet to be handed out in your shops to explain to customers your choice of material for making the cups. You should include at least some positive and some negative points for each of the possibile materials, as well as the reasons for your final choice.

Disposable cups and the environment – data table

Item	Paper cup	Polystyrene cup
Making the cups (per cup) Mass of wood and bark needed (g)		
Mass of petroleum needed (g)		
Mass of other chemicals needed (g)		
Tick the material whose manufacture uses the most Steam		
Electricity		
Cooling water		
Tick the material whose manufacture produces the most Waste water		
Water pollution		
Metal salts		
Waste gases		
Using the cups Mass of 1 cup (g)		
Cost of 1 cup (pence)		
After use Can the cup be reused?		
Can the material be recycled?		
Can it be burnt?		
How much energy will you get from 1 kg if you burn it?		
What mass of material would go in a landfill from 1 cup?		
Is it biodegradable?		

Other relevant information: