

## Recycling plastics – is it worth it?

This resource accompanies the article **The science behind sustainable home insulation** in *Education in Chemistry* which looks into the advantages and disadvantages of using plastics in our homes and can be viewed at: [rsc.li/40LEaUk](https://rsc.li/40LEaUk)

### Learning objectives

- 1 Reinforce your knowledge and understanding of recycling plastics and life cycle assessments.
- 2 Practise your evaluation and extended writing skills.
- 3 Practise your maths skills in the context of scientific problems.

The questions at the end of the resource require written answers that give learners, and yourself, the opportunity to assess progress with the above learning objectives.

### Introduction

Learners can find open-ended questions that require evaluation particularly challenging. This activity allows learners to practise this skill in the context of life cycle assessments for different ways of disposing of plastics. The activity also gives learners more experience of writing extended-response answers and solving context-based mathematical questions.

### How to use this resource

This activity would ideally be part of or follow your teaching of polymer disposal and life cycle assessment. The background information sheet and data sheet provide all the essential information for the activity.

Consider the skill level and support needs of your class before deciding how to present the activity. It is divided into two parts, each containing an evaluation question. Do not ask learners to move on to part 2 until they have had some kind of feedback on their attempt at part 1. You can live mark an answer using a visualiser or learners can peer assess using examples of level 1, 2 and 3 responses. Learners who are ready for a greater challenge can attempt the whole activity independently in a less structured way.

Learners who need more support with maths skills can complete the calculations for incineration in question 1 as a worked example before they try the calculations for recycling. Similarly, you can model an approach to the evaluation in question 2 before learners try question 4.

Question 5 asks learners to reflect on their own attitude to recycling and whether their evaluation affected it. Ask learners about their behaviours at the start of the lesson so they can compare.

## Answers

1. (a) **Disposal by incineration:**  $6500 + 1500 - 400 = 7600 \text{ kJ}$   
**Disposal by recycling:**  $4300 + 1500 + 200 = 6000 \text{ kJ}$   
 You can also discuss with learners why the additional 200 kJ is needed for recycling (transport and running the plant that sorts, shreds and melts the PET).

(2 marks)

- (b) **Disposal by incineration:** Energy saved =  $8010 - 7600 = 410 \text{ kJ}$   
 Percentage of landfill energy =  $100 \times \frac{410}{8010} = 5.1\%$   
**Disposal by recycling:** Energy saved =  $8010 - 6000 = 2010 \text{ kJ}$   
 Percentage of landfill energy =  $100 \times \frac{2010}{8010} = 25.1\%$

(2 marks)

2. Exam specifications typically have their own style of mark scheme for evaluation questions based on the level of response, such as that shown below.

|                                                                                                                          |                  |
|--------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>Level 3:</b> a judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given. | <b>5–6 marks</b> |
| <b>Level 2:</b> some logically linked reasons are given. There may also be a simple judgement.                           | <b>3–4 marks</b> |
| <b>Level 1:</b> relevant points are made. They are not logically linked.                                                 | <b>1–2 marks</b> |
| No relevant content.                                                                                                     | <b>0 marks</b>   |

Use the scheme for the particular exam specification you are working with, along with the indicative content suggested below. This list is not exhaustive, so give credit for any good points.

- Recycling uses less (non-renewable) fossil fuels ...
- ... which helps to conserve the remaining reserves.
- Incineration saves a little energy, while recycling saves more (or some kind of mathematical comparison, eg, recycling saves five times the amount of energy that incineration saves).
- (However) incineration and recycling both still require quite a lot of energy.
- Using more energy may be less of a problem if a good supply of renewable energy is available (eg, hydroelectric).
- Incineration turns the carbon in the PET into greenhouse gases, so contributes more to global warming compared to landfill and recycling.
- Recycling produces less greenhouse gases overall as less new PET is needed to manufacture the bottles.

[Judgement] All three factors suggest recycling is the best method of disposal.

3. (a) **Renewable:** can be replaced at the same rate as it is used up (or words to that effect).
- (b) **Biodegradable:** can be broken down naturally in the environment by biological activity/microorganisms such as bacteria or fungi.
- (c) **Carbon capture:** removal (for storage or use) of carbon dioxide from the emissions of a process (or words to that effect).

(3 marks)

4. Use the scheme for the exam specification you are working with as in question 2, drawing on the indicative content given below. This list is not exhaustive, so give credit for any good points in the response.
- Biodegradable plastics would not remain in the ground so could help with lack of landfill space ...
  - ... but may take a long time to break down ...
  - ... or might not be suitable for holding fizzy drinks.
  - Toxic gases from incinerators are a big concern for the public living nearby.
  - Carbon capture would prevent the high amounts of greenhouse gases produced from incineration.
  - Recycling needs to be relatively easy to do (available bins etc), otherwise a lot of people will not bother.
  - If all the recycled PET went into making other products (eg, fibres and sheets) that can use 100% recycled PET, energy use and greenhouse gas emissions would be significantly less.

[Judgment] Some kind of overall conclusion which justifies which method of disposal is best, considering the points highlighted. For the highest level, look for a weighing up of the evidence in order to reach a decision.

(6 marks)

Although not directly related to the disposal method, some learners might also point out here or in question 2 that most of the energy use and greenhouse gas production results from the use of non-renewable fossil fuels. Therefore, both can be lowered significantly by manufacturing the PET from renewable resources.

5. This question is not part of the assessment of evaluation skills but asks learners to reflect on the relevance of the content to their own behaviour. If appropriate, you can do this as an anonymous class survey.

(1 mark – just for the motivation to do it and make the total add up to 20)

