Ages 11–14

Circular Designers

Think like an engineer: design waste out before it happens.

FOR THE ADULT

Students move from sorting waste to designing it out. They redesign real packaging, rank everyday items on the waste hierarchy, record a repair or reuse story, run a short quiz that includes landfill gas, and carry out a data investigation of their school's waste.

Time: Five lessons of 50–60 minutes, or a two-day project

YOU WILL NEED

- Clean, empty packaging from home (adult-checked)
- Printed worksheets
- Rulers, pencils, scrap card for prototypes
- A kitchen or parcel scale
- Disposable gloves and a clear bag for the waste investigation (handled by the supervising adult)
- Spreadsheet software or squared paper for charts

LEARNING GOALS

- Explain the waste hierarchy and apply it to real decisions
- Evaluate packaging design for material use, reuse and ease of recycling
- Explain why biodegradable waste in landfill produces methane and how modern sites manage it
- Plan, collect and analyse data, and present conclusions with limitations

SAFETY FIRST

- Only clean, dry, adult-checked items are used — no glass, sharp metal, batteries, aerosols, chemicals or food-soiled waste
- In the school waste investigation, only the supervising adult handles the bag, wearing gloves; students record and weigh pre-sorted clean dry items
- No burning, heating or gas-producing experiments
- Tools for prototypes are used under supervision

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Redesign the package

Your brief: Pick a product your family buys often. Redesign its packaging so that it uses less material, can be reused, or is easy to separate for recycling — while still protecting the product.

STEPS

1. Describe the current package: what materials, how many parts, what it protects against.
2. List what the package must do (protect, keep fresh, show information, be safe to carry).
3. Sketch two different redesign ideas and label the materials.
4. Choose one idea and build a quick card prototype.
5. Compare old and new: count parts, materials and estimate weight.
6. Identify one trade-off your design creates (cost, shelf life, convenience).

SUCCESS LOOKS LIKE

- My design still does everything the original package had to do
- It reduces material, enables reuse, or separates easily into single materials
- I have explained at least one trade-off honestly

Sketch, photo or notes

REFLECT

Who would need to change their behaviour for your design to work — the shop, the customer, the collector?

Would your design still work in a hot climate?

Which level of the waste hierarchy does your design target?

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Rank it: the waste hierarchy

- The hierarchy, best first: Reduce → Repair → Reuse → Repurpose → Recycle → Recover (energy) → Dispose.
- For each item, choose the highest level that is realistic and safe.
- Give a reason — and say what would have to be true for a higher option to work.

Item	Best realistic option	Why?	What would make a higher option possible?
Broken school chair	*Repair*	*Only one leg is loose — a new bolt fixes it*	—

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Rank it: the waste hierarchy — think about it

Which items could not go higher than 'Recycle'? What stops them?

Why is recycling not at the top of the hierarchy?

Find one item where the 'best' choice depends on local facilities.

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Repair and reuse story

Your brief: Find one everyday item at home or school that was repaired, passed on or given a second job instead of being thrown away. Tell its story.

STEPS

1. Photograph or sketch the item before and after.
2. Explain what went wrong, or why it was no longer wanted.
3. Describe the repair or new use and who did it.
4. Estimate what was saved: money, materials, a trip to the shop.
5. Check: is the new use safe and clean?

SUCCESS LOOKS LIKE

- The story has a clear before, what changed, and after
- I explain the benefit in at least two ways
- I have thought about safety

Sketch, photo or notes

REFLECT

What skills or tools made the repair possible?

Why do some products get thrown away instead of repaired?

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Circular thinking quiz

- Choose one answer for each question.
- Use the key to check, then discuss the explanations.

1. Which comes highest in the waste hierarchy?

A. Recycling | B. Energy recovery | C. Prevention / reduction | D. Landfill

2. Food and paper break down in a landfill without much oxygen. Which gas is produced?

A. Oxygen | B. Methane | C. Helium | D. Nitrogen only

3. Why does methane from landfill matter?

A. It smells nice | B. It is a powerful greenhouse gas and can be flammable | C. It makes plants grow | D. It is harmless

4. What do well-run modern landfills do with landfill gas?

A. Nothing | B. Collect it through pipes and burn it in a flare or use it to make electricity | C. Store it in balloons | D. Let pupils experiment with it

5. What does 'contamination' mean in recycling?

A. Recycling that is too clean | B. Wrong or dirty items mixed in, which can spoil a load | C. A type of plastic | D. A recycling truck

6. Which design is usually easiest to recycle?

A. Plastic with a foil layer glued on | B. A single material with no labels glued on | C. Paper coated in plastic | D. Mixed fabrics stitched together

7. A 'circular economy' aims to…

A. Make products round | B. Keep products and materials in use for as long as possible | C. Burn waste for energy | D. Send waste abroad

8. Why might repairing a phone be better than recycling it?

A. Recycling can't recover anything | B. Repair keeps all the energy and materials used to make it in use | C. Phones can't be recycled | D. Repair is always free

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Investigate your school's waste

- Plan: what question are you answering? (For example: what share of our classroom waste is paper?)
- Agree your categories before you start.
- The supervising adult empties one day's classroom waste into a clear bag and sorts out only CLEAN, DRY items onto a tray. Anything wet, sharp or unknown stays in the bag.
- Weigh each category of clean items in a container (subtract the container's weight).
- Calculate each category as a percentage of the total you weighed.

Category	Weight (g)	% of total	Could it be avoided, reused or recycled?	Notes
Paper and card	*420*	*35%*	*Mostly recyclable; some single-sided sheets could be reused*	*Lots of drafts*

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Investigate your school's waste — think about it

Present your results as a pie chart or bar chart.

What are the limitations of your data? (one day, one class, clean items only…)

Write one recommendation for your school with the evidence that supports it.

How would you check whether your recommendation worked?

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Notes for teachers and parents

- Science: decomposition, anaerobic processes and greenhouse gases; properties and separation of materials.
- Maths: percentages, data handling and choosing appropriate charts; discuss sample size and bias.
- Design & technology: the redesign challenge follows a full design–make–evaluate cycle.
- Geography: link to resources, climate and how cities manage waste.
- Moral / citizenship education: responsibility, stewardship of shared resources and evidence-based persuasion.
- Landfill gas is taught by diagram and discussion only. Never attempt to produce or collect gas in class.

TAKE IT FURTHER

- Present the waste investigation to school leadership with a costed recommendation.
- Run a repair café or swap event with adult volunteers.
- Research how a modern engineered landfill is lined, monitored and capped — and why.

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Answer key

CIRCULAR THINKING QUIZ

#	Answer	Why
1	C. Prevention / reduction	Preventing waste avoids every downstream impact, so it comes first.
2	B. Methane	Without oxygen, microbes produce landfill gas, which is mostly methane and carbon dioxide.
3	B. It is a powerful greenhouse gas and can be flammable	Methane traps much more heat than carbon dioxide over the short term and can be explosive in confined spaces.
4	B. Collect it through pipes and burn it in a flare or use it to make electricity	Gas is drawn out through wells and pipes, then flared or used as fuel — never something to experiment with.
5	B. Wrong or dirty items mixed in, which can spoil a load	Food, liquids or the wrong materials can lower the quality of a whole load.
6	B. A single material with no labels glued on	Single-material designs are easier to sort and reprocess.
7	B. Keep products and materials in use for as long as possible	Circular means designing out waste and keeping materials circulating at their highest value.
8	B. Repair keeps all the energy and materials used to make it in use	Recycling recovers some materials, but repair keeps the whole working product — and everything invested in it — in use.

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