THE PHYSICS QUESTION BANK · AQA GCSE PHYSICS

Cut the Bills – Insulating a Home

A one-hour lesson. Learn how energy is lost from buildings, then advise a family on how to cut their energy bills on a budget.

Name: _____ Class: _____ Date: _____

How to use this worksheet: work through the steps in order and write your answers in your exercise book. Copy every blue 📝 box neatly – these are your revision notes. When you have finished a step, check your work against the **Answers** at the end and correct anything in a different colour.

📝 **COPY INTO YOUR BOOK**

By the end of this lesson I will be able to:

1. explain what affects how quickly a building loses energy

2. describe ways to reduce unwanted energy transfers

3. use payback time to choose the best-value insulation.

Step 1: Starter (5 minutes)

Picture a house on a cold winter's day with the heating on. **List every place you think heat escapes from.** Try for at least five.

📝 **COPY INTO YOUR BOOK**

Energy always moves from hot to cold. A house loses energy through the roof, walls, windows, floor and draughts.

Step 2: Read and write (8 minutes)

Copy these three questions into your book. Then read the text and answer them in full sentences.

1. What does a high thermal conductivity mean?
2. Name two ways of reducing unwanted energy transfers.
3. How does the thickness of a wall affect how quickly a house cools?

📖 **READ**

Keeping the heat in

Energy is always transferred from a hotter place to a colder one. In a home, energy that escapes outside is **wasted**, so we try to reduce these **unwanted energy transfers**.

Every material has a **thermal conductivity**. A material with a **high** thermal conductivity, such as a metal, lets energy pass through by conduction quickly. A material with a **low** thermal conductivity, such as air, wool or foam, transfers energy slowly – so it is a good insulator. The **thicker** the walls, and the lower their thermal conductivity, the **more slowly** the house cools down.

Two main ways of reducing unwanted energy transfers are **thermal insulation** (such as loft and cavity wall insulation) and **lubrication** (oiling moving parts of machines to reduce friction,

so less energy is wasted by heating).

📝 **COPY AND COMPLETE**

A material with a _____ thermal conductivity transfers energy quickly. Good insulators have a _____ thermal conductivity. Two ways to reduce unwanted energy transfers are thermal _____ and _____.

Step 3: Key facts (7 minutes)

📝 **COPY INTO YOUR BOOK**

A building loses energy faster when:

1. its walls have a HIGH thermal conductivity

2. its walls are THIN

3. there is a LARGE temperature difference between inside and outside.

Examples of insulation: loft insulation (fibre wool), cavity wall insulation (foam between the two layers of wall), double glazing (a gap between two panes of glass), draught excluders and hot water tank jackets.

📝 **COPY INTO YOUR BOOK**

Many insulators work by TRAPPING AIR. Air has a very low thermal conductivity, so energy is transferred through it slowly.

Quick check: which would lose energy faster – a thin brick wall or a thick brick wall? Why?

Step 4: Payback time (7 minutes)

📝 **COPY INTO YOUR BOOK**

payback time = cost ÷ saving per year

The SHORTER the payback time, the BETTER value it is.

Your task: copy the table and work out the payback time for each option.

Option	Cost	Saving per year	Payback time
Loft insulation	£400	£250	?
Cavity wall insulation	£800	£300	?
Double glazing	£6000	£150	?
Draught excluders	£50	£40	?
Hot water tank jacket	£20	£30	?

✅ Score out of 5. Which option is the best value? Which is the worst?

Step 5: Main task – Cut the Bills (12 minutes)

You're an energy adviser. The Patel family live in an old house with no insulation. They have **£1500** to spend and want to cut their bills as much as possible.

Your task: write them a short report with these headings: 1. What to buy (£1500 or less). 2. How much they'll save each year, and the payback time for the whole package. 3. How it works – explain one option using the words thermal conductivity and air. 4. What not to buy yet, and why.

Start with the options that have the shortest payback time.

Step 6: Exam practice (13 minutes)

Q1 (2 marks) Explain how loft insulation reduces the energy lost from a house.

Q2 (3 marks) Loft insulation costs £450 to fit and saves £180 per year. Calculate the payback time.

Q3 (4 marks) House A has thin walls with a high thermal conductivity. House B has thick walls with a low thermal conductivity. Explain which house cools down faster on a cold night.

✅ Add up your marks out of 9.

Step 7: Exit ticket (8 minutes)

Think about your own home. Which one change would save your family the most money? Then finish:

- The best insulation to buy first is… because…
- Materials that trap air are good insulators because…
- One thing I'm still not sure about is…

Answers

Only look at these once you have written your own answer!

Step 1: Starter (5 minutes)

Roof, walls, windows, floor, and gaps around doors and windows (draughts). In an uninsulated house the walls and roof lose the most.

Step 2: Read and write (8 minutes)

(1) It transfers energy by conduction quickly – a poor insulator. (2) Thermal insulation and lubrication. (3) Thicker walls cool more slowly – the rate of energy transfer is lower.

Gaps: high · low · insulation · lubrication

Step 3: Key facts (7 minutes)

The thin wall – energy is conducted through a thinner wall at a higher rate.

Step 4: Payback time (7 minutes)

Loft 1.6 years · Cavity wall 2.7 years · Double glazing 40 years · Draught excluders 1.25 years · Tank jacket 0.67 years (about 8 months).

Step 5: Main task – Cut the Bills (12 minutes)

1. Loft (£400), cavity wall (£800), draught excluders (£50), tank jacket (£20) = £1270. 2. £250 + £300 + £40 + £30 = £620 a year; payback 1270 ÷ 620 ≈ 2 years. 3. Loft insulation fibres trap air, which has a very low thermal conductivity, so energy is transferred through the roof much more slowly. 4. Not double glazing – £6000 is over budget and takes 40 years to pay back.

Step 6: Exam practice (13 minutes)

Q1: It traps air, which has a low thermal conductivity (1), so the rate of energy transfer through the roof is reduced (1).

Q2: payback = cost ÷ saving (1); 450 ÷ 180 (1); = 2.5 years (1).

Q3: House A cools faster (1); higher thermal conductivity means a higher rate of conduction (1); thinner walls also increase the rate (1); so House A loses energy more quickly and its temperature falls faster (1).