Heating and insulating buildings

1. The following information is from a leaflet produced by a double-glazing company.

> **Change your single-glazed windows to our energy-efficient double glazed windows and save a massive £167 a year**

total cost = number of kilowatt-hours × cost per kilowatt-hour

(a) The company assumes that energy costs 11p per kWh.

How much energy does the company claim would be saved each year by fitting its double-glazing?

1 15.2 kWh

2 1 520 kWh

3 1 837 kWh

4 183 700 kWh

(b) Double glazing for a house costs £4000. A householder saves £200 in the first year after installing the double-glazing. Fuel prices rise steadily during that year.

The pay-back time is likely to be . . .

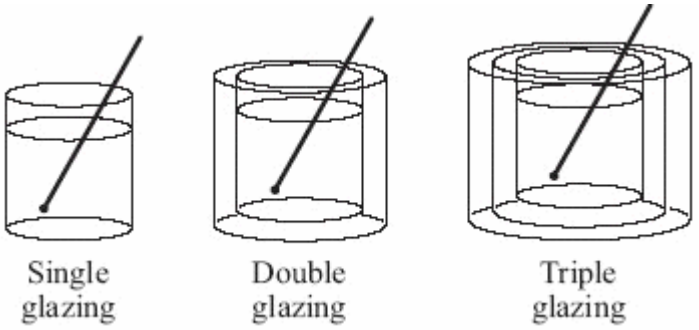
1 exactly 20 years.

2 more than 20 years if fuel prices continue to rise.

3 less than 20 years if fuel prices continue to rise.

4 less than 20 years if fuel prices fall steadily over the next few years.

(c) Some students investigated the effectiveness of double and triple glazing. They let 100 cm^3 of boiling water cool in a glass beaker for 20 minutes. They repeated the cooling with the beaker placed inside another one and then inside two beakers. The students also looked up the U-value of different types of glazing on the Internet.



The results are shown in the table.

	Single glazing	Double glazing	Triple glazing
Temperature in °C after 20 minutes	68	81	88
U-value	1.0	0.5	0.3

Which of these conclusions should the students draw from their results?

1 Double glazing is more effective than triple glazing and a greater U-value means a larger heat loss.

2 Double glazing is more effective than triple glazing and a greater U-value means a smaller heat loss.

3 Triple glazing is more effective than double glazing and a smaller U-value means a larger heat loss.

4 Triple glazing is more effective than double glazing and a smaller U-value means a smaller heat loss.

(d) One student stated that the investigation was not realistic. He said that:

- there is a difference between the area of a window and the surface area of the beakers
- the temperature difference across a window is different from the temperature difference across the beakers.

The table compares a window with the beakers in the experiment.

Which row in the table is correct?

	Surface area of window		Temperature difference across window	
	Compared with the beaker	**Effect on rate of heat transfer**	**Compared with the beaker**	**Effect on rate of heat transfer**
1	larger	slower	larger	slower
2	smaller	slower	larger	faster
3	larger	faster	smaller	slower
4	smaller	faster	smaller	faster

2. A double-glazed window is made up of two sheets of glass with a gap between them.

This gap may be filled with air or a gas such as argon.

The table gives some information from a double-glazing manufacturer.

Better insulators have lower U-values.

Type of double glazing	U-value for different gap widths				
	6 mm	8 mm	10 mm	12 mm	14 mm
Reflective glass, argon filled	2.0	2.1	1.5	1.3	1.2
Reflective glass, air filled	2.5	2.1	1.8	1.6	1.5
Plain glass, argon filled	3.1	2.9	2.8	2.7	2.6
Plain glass, air filled	3.3	3.1	3.0	2.9	2.8

(a) What is the general effect of increasing the gap width?

1 The bigger the gap, the better the window is at insulating.

2 The bigger the gap, the worse the window is at insulating.

3 There is no change in the window's ability to insulate.

4 Some types of window become better at insulating and others become worse.

(b) One of the four types of double-glazing contains a result that does not fit the general pattern.

Which type of double-glazing is this?

1 reflective glass, argon filled

2 reflective glass, air filled

3 plain glass, argon filled

4 plain glass, air filled

(c) Which one of these statements is true for the data for the 6 mm gap width?

1 The type of glass is more important for insulation than the type of filling.

2 The type of filling is more important for insulation than the type of glass.

3 The type of filling and the type of glass are equally important for insulation.

4 It is impossible to tell from the data whether the type of filling or the type of glass is more important for insulation.

(d) What can you conclude about argon from the data in the table?

1 It has a higher density than air.

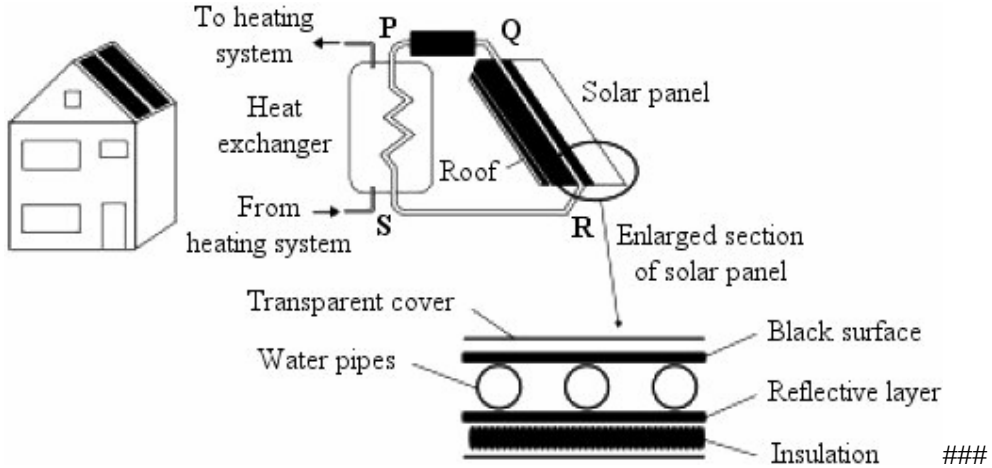
2 It has a higher U-value than air.

3 It has a lower freezing point than air.

4 It is a worse conductor than air.

3. In each part choose only **one** answer.

Solar panels transfer solar energy to heat water. This water then moves through a heat exchanger.



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A The different layers of the solar panel make the panel transfer solar energy in the most effective way. Which row of the table shows how each layer helps this?

	Black top surface covering water pipes	Insulation
1	absorbs radiant energy	stops heat conduction to roof
2	absorbs radiant energy	protects water pipes from frost
3	emits radiant energy	conducts heat to the water pipes
4	reflects radiant energy	conducts heat to roof space

B When the system is operating . . .

1 the water in tube **PS** becomes colder and moves from **S** towards **P**.

2 the water in tube **PS** becomes warmer and moves from **S** towards **P**.

3 the water in tube **QR** becomes less dense and moves from **R** towards **Q**.

4 the water in tube **QR** becomes more dense and moves from **Q** towards **R**.

C The water pipes are made of long, narrow, copper tubing laid on the underside of the black top surface.

This arrangement ensures that heat energy is . . .

1 conducted quickly to the water in the narrow tubing.

2 distributed evenly between the top surface and the tubing.

3 reflected from the top surface.

4 transferred by convection.

D Which design feature is most important for capturing maximum energy from the Sun's radiation?

1 large surface area for the panel

2 short distance between the copper tubing loops

3 well insulated copper tubing

4 wide diameter for the copper tubing

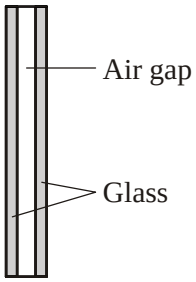
4. In each part choose only **one** answer.

Save energy with double glazing

The diagram shows a cross-section through a double-glazed window.

There is an air gap between the two sheets of glass.

The table shows the U-values for some double-glazed windows. The U-value relates to the rate at which thermal energy passes through the window. The lower the U-value, the better the insulation.



Type of glass	Gap width			
	12mm	**16mm**	**20mm**	**24mm**
Plain	2.9	2.7	2.8	3.0
Reflective	1.9	1.7	1.8	2.0

A How does thermal energy pass through a sheet of glass?

1 By conduction

2 By convection

3 By evaporation

4 By reflection

B For the best insulation, the glass should be designed to reduce the transmission of . . .

1 infra red radiation.

2 microwaves.

3 ultraviolet radiation.

4 visible light.

C Which combination of glass and gap width gives the best insulation?

1 plain glass, 12 mm gap

2 reflective glass, 16 mm gap

3 reflective glass, 20 mm gap

4 plain glass, 24 mm gap

D Which one of these conclusions is correct, according to the data in the table?

1 Plain glass is always better at reducing heat transfer than reflective glass.

2 The wider the gap, the less heat is transferred.

3 The narrower the gap, the less heat is transferred.

4 The type of glass has more effect on heat transfer than the width of the gap.