

# Keeping a house warm Radiator size



Heating engineers design, specify and install heating systems.

When it's cold outside, heat escapes from a warm house through walls, floors, ceilings, windows, doors and roofs.

The **size of the radiator** needed in a room depends on the **total heat loss** for the room.

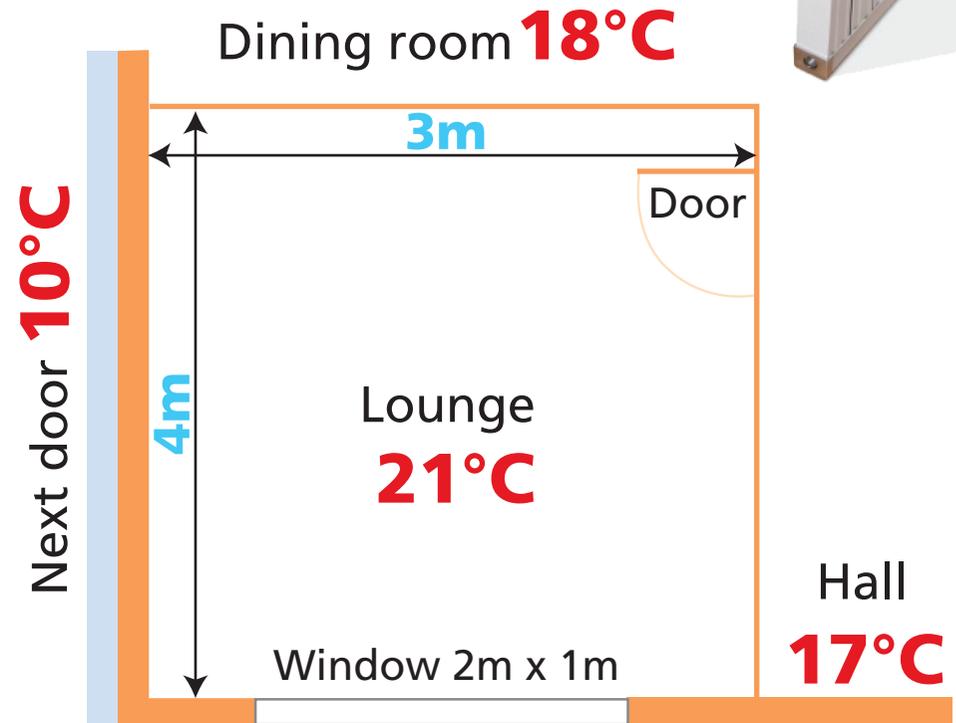
Ceiling height is **2.5 m**

Temperature of room above is **18°C**

Ground temperature is **10°C**

Use the **heat loss information sheet** to calculate the radiator size for this lounge without insulation.

**What happens if you turn the thermostat down?**



Based on an idea from Conker Statistics.



# Keeping a house warm Radiator size

...heat loss information sheet



## U values

indicate the unit heat loss rate.

Good insulators have low **U values**.

U-values for a modern house based on British Standard Guidelines.

Treat external doors the same as windows and internal doors the same as walls.

| Without insulation   | U value |
|----------------------|---------|
| Roof                 | 2.3     |
| Outside wall         | 1.6     |
| Single glazed window | 5.7     |
| Ceiling              | 1.4     |
| Floor                | 1.7     |
| Ground Floor         | 0.8     |
| Internal wall        | 1.7     |
| Party wall           | 2.1     |
| With insulation      |         |
| Roof                 | 0.4     |
| Outside wall         | 0.6     |
| Double glazed window | 2.8     |

## Air change rates

Ventilation guidelines are defined in terms of air changes per hour for room types.

| Room        | Air change rate |
|-------------|-----------------|
| Bathroom    | 2.0             |
| Bedroom     | 1.0             |
| Dining room | 1.5             |
| Hall        | 2.0             |
| Kitchen     | 2.0             |
| Landing     | 2.0             |
| Lounge      | 1.5             |
| Study       | 1.5             |

Air change rates defined for modern buildings.

Based on an idea from Conker Statistics.

Surface heat loss

$$= \text{area (m}^2\text{)} \times \text{temperature difference (}^\circ\text{C)} \times \text{U value}$$

Ventilation heat loss

$$= \text{air change rate} \times \text{room volume (m}^3\text{)} \times \text{temp difference (}^\circ\text{C)} \times 0.33$$

These equations calculate the heat loss in Watts.



# Keeping a house warm Reducing heat loss

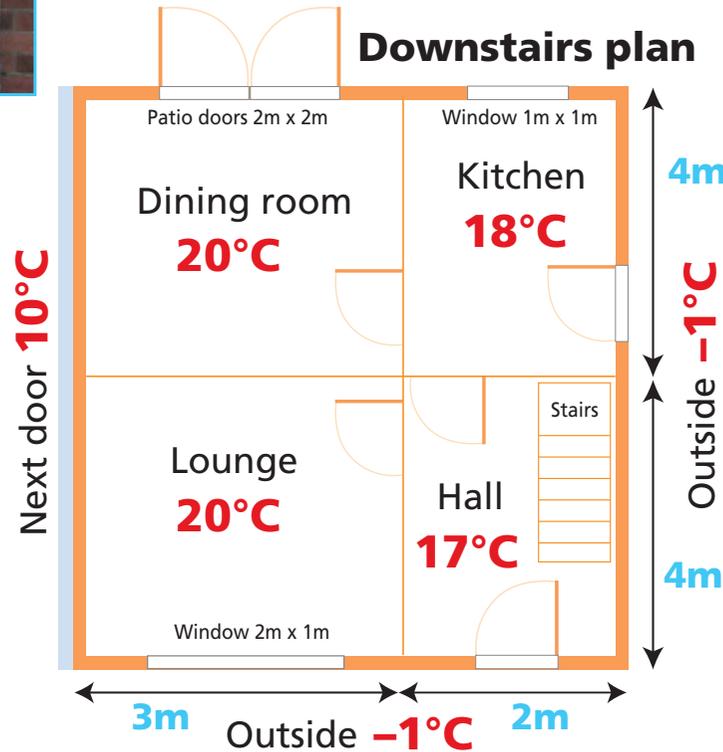


Insulation can **reduce heat loss**, help the environment and **save money**.



Ceiling height is **2.5m**.  
Ground temperature **10°C**

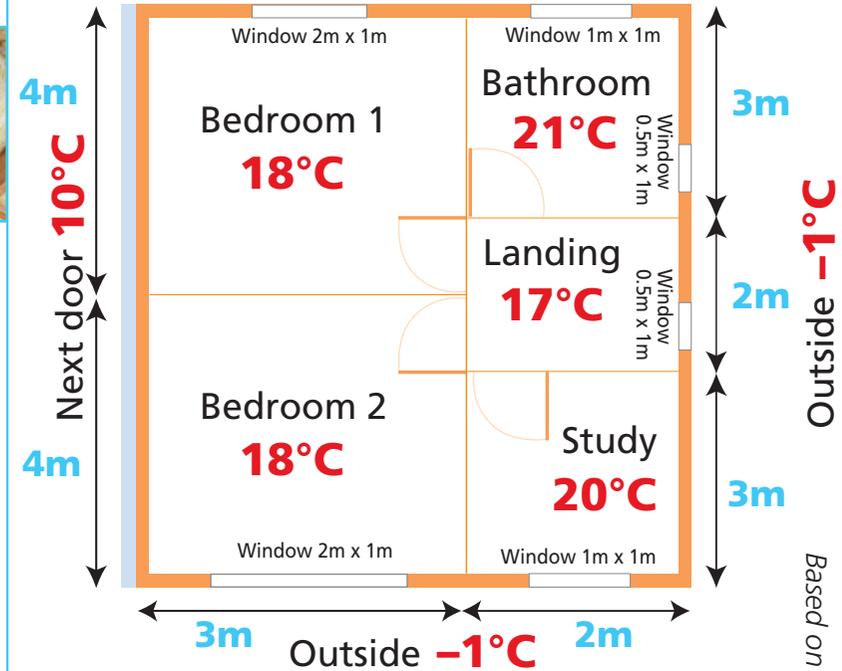
## Downstairs plan



Ceiling height is **2.5m**.

Temperature of room above (roof) **-1°C**

## Upstairs plan



What **form of insulation** has the greatest effect?

- wall insulation
- double glazing
- roof insulation

Decide how to share out the **calculations amongst the class**.



Based on an idea from Conker Statistics.



# Keeping a house warm

## Topic

Services engineers and heating engineers design, specify and install heating systems. They use heat loss calculations to decide on radiator sizes. This topic provides opportunities for pupils to work with formulas based on complex information. This will require them to choose which information to use, make assumptions and compare their results.

## Mathematical activities

Radiator size

Reducing heat loss

## Planning for teaching – some suggestions

**Radiator size** focuses on finding the radiator size for one room, the lounge, in an older house which is not insulated or double glazed. Before beginning the activity engage your pupils in a discussion about heat loss to establish that heat escapes from a warm house through walls, floors, ceilings, windows, doors and roofs. Introduce the idea that radiator size required depends on this heat loss and on the heat loss caused by ventilation and that heating engineers use two formulas to work out these heat losses. The surface area heat loss formula uses U values – good insulators have low U values. The ventilation heat loss formula includes a multiplier of 0.33; this is the ventilation factor which is the specific heat of air at 20°C. The recommended radiator size should be bigger than the total of the two heat losses.

You might choose to work through the use of these formulas for one of the room surfaces in order to help your pupils organise their calculations and resolve any problems in using the **Radiator size: heat loss information sheet**.

### Lounge with no insulation 21°C

| Surface         | Area (m <sup>2</sup> )   | Temp diff (°C) | U value      | Surface heat loss (Watts)     |
|-----------------|--------------------------|----------------|--------------|-------------------------------|
| Ceiling         | 12                       | 3              | 1.4          | 50.4                          |
| Floor           | 12                       | 11             | 1.7          | 224.4                         |
| Window          | 2                        | 22             | 5.7          | 250.8                         |
| Window wall     | 5.5                      | 22             | 1.6          | 193.6                         |
| Party wall      | 10                       | 11             | 2.1          | 231                           |
| Dining wall     | 7.5                      | 3              | 1.7          | 38.25                         |
| Hall wall       | 7.5                      | 4              | 1.7          | 51                            |
|                 |                          |                | Sub-total    | 1039.45                       |
| Air change rate | Volume (m <sup>3</sup> ) | Temp diff (°C) | 0.33         | Ventilation heat loss (Watts) |
| 1.5             | 30                       | 4              | 0.33         | 59.4                          |
|                 |                          |                | <b>Total</b> | <b>1098.85</b>                |

The required radiator size for this lounge is therefore greater than 1100 Watts. Turning down the thermostat by 1°C reduces this by about 10%.

These calculations prepare the way for the more challenging second activity **Reducing heat loss** where pupils are invited to investigate which type of insulation has the greatest effect. (Double glazing has a significant effect but roof insulation is more important for the upstairs rooms.) Structuring and organising the way they work and their results is an important part of the mathematics the pupils undertake in this activity. Plans for the upstairs and downstairs of a house are provided. There are three possible options for the downstairs rooms – no insulation, wall insulation and double glazing. The upstairs rooms introduce a fourth option – roof insulation. This means that there are 32 sets of calculations to share amongst the class. Ask your pupils to work in groups ensuring that more than one member of the group work on the same set of calculations so that they can discuss any assumptions they need to make and check that they are using the right information and that their calculations are correct. Encourage the groups to compare their work within the group and to discuss their results before facilitating a whole class discussion to share their conclusions.

## Careers link-up

Services engineering may be a hidden career to many – but they are in demand and play a significant part in building design and energy reduction. Designing heating installations and controlling energy consumption are just a small part of what Building Services Engineers do. The careers materials links include information about routes into the sector (from apprentice to graduate), case studies of people working in the sector at all levels and information on different roles and specialisms (including design, installation, maintenance, heating, lighting, air conditioning, ventilation, lifts, acoustics, fire detection, energy conservation and more).

**Careers factsheets** can be found at <http://www.cibse.org/index.cfm?go=page.view&item=688>

On the Good Day careers site (Summit Skills) <http://www.goodday.org.uk/Careers/7> look at case studies of Ivan, Kieran and Mary-Ann.

## Want to know more?

Contact STEM Subject Choice and Careers  
info@careersinstem.co.uk

The Centre for Science Education  
Sheffield Hallam University  
City Campus, Howard Street  
Sheffield S1 1WB

**Tel:** 0114 225 4870

or for more information on careers go to Maths careers at [www.mathscareers.org.uk/](http://www.mathscareers.org.uk/)  
or Future Morph at [www.futuremorph.org/](http://www.futuremorph.org/)

A Department for Education initiative to promote subject choice and careers in Science, Technology, Engineering and Maths (STEM) delivered by the Centre for Science Education at Sheffield Hallam University and Babcock.

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