Required Practical Review

Physics Practical – Thermal Insulators – <u>Separate Physics Only</u>

Free science lessons: https://www.youtube.com/watch?v=lLH45loyPUA
GCSEpod: https://members.gcsepod.com/shared/podcasts/title/10976

Know it

Heat energy can move through a substance by conduction. Heat energy is conducted from the hot end of an object to the cold end. Poor conductors of heat are called insulators. All objects give out and take in **thermal radiation**, which is also called **infrared radiation**. The hotter an object is, the more infrared radiation it emits.Thermal insulators can reduce the heat transfer from a warm object. They do this by reducing conduction or radiation (depending on the material used).

There are 2 parts to the required practical.

Method (Part 1- Investigating the effectiveness of different materials as thermal insulators.):

1. Use the kettle to boil water and then put 80 ml of this hot water into a 100 ml beaker.

2. Place the small 100 ml beaker inside the large beaker.

3. Use a piece of cardboard, with a hole for the thermometer, as a lid for the large beaker.

4. Insert the thermometer through the hole in the cardboard lid so that its bulb is in the hot water.

5. Record the temperature of the water and start the stopwatch.

6. Record the temperature of the water every 5 minutes for 20 minutes.

7. Repeat steps 1 to 6, but this time fill the space between the small and the large beaker with an insulating material. Make sure that you use the same volume of water each time.

8. Draw cooling curve graphs by plotting temperature against time for each insulator.

9. From your graphs, determine which material is the best insulator.

10. Record your results in a table such as the one below. 11. Plot a cooling curve for each type of material used.

Method (Part 2 - Investigating factors that may affect the thermal insulation properties of a material):

1. Use the kettle to boil water and then put 200 ml of this hot water into a 250 ml beaker.

2. Use a piece of cardboard, with a hole for the thermometer, as a lid for the beaker.

3. Insert the thermometer through the hole in the cardboard lid so that its bulb is in the hot water.

4. Record the temperature of the water and start the stopwatch.

5. Record the temperature of the water every 5 minutes for 20 minutes.

6. Repeat steps 1 to 5, **but this time insulate the beaker by wrapping one or more layers of insulating material around the beaker**. The insulating material may be held in place by using rubber bands. Make sure that you use the same volume of water each time.

7. Draw cooling curve graphs by plotting temperature against time for each number of different layers of insulation.

8. From your graphs, write a conclusion about the effect of changing the number of layers of insulation.

9. Record your results in a table such as the one below.

10. Plot a cooling curve for each type of material used

Analysis.

Hot liquids will cool down quite quickly when left in a beaker, as heat will be lost to the surroundings. Much of this heat is conducted through the walls to the air around, and through the base into the surface on which it is resting.

By plotting a cooling curve for each experiment we can very easily compare how quickly energy is transferred from the liquid using the different insulators/different amounts of the same insulator.

The type of insulator used will affect how quickly heat is lost from the beaker of water. Using insulators that have air pockets reduces heat lost as air is great as an insulating material. There are large gaps between particles in the air, making it difficult for energy to be passed on. This reduces the amount of heat that manages to 'escape' through the paper! Adding more layers of an insulator will trap more air, again making it harder for energy to be transferred to the surroundings.

Review it:

Complete the tasks below in your book.

Up to grade 4

1. Name 2 control variables in the investigation.

2. List different methods of insulation you will find in your home.

Grade 5-7

3. A student conducted an investigation similar to method 2.

   a) Calculate the temperature change for each test.

Material	Number of layers	Water temperature at the start, in °C	Water temperature after 10 mins, in °C
A	1	82.5	66.0
B	1	83.0	71.5
A	2	81.5	72.0
B	2	75.0	67.5

   b) Which material was the better insulator? Give a reason for your answer.

3. Why would using a data logger to measure temperature be better than a regular thermometer?

Grade 7+

4. Explain why the use of cavity wall and loft insulation in a home will help to reduce the cost of electricity/gas for the homeowner.

Test It:

Q1.

Many people use a sleeping bag when they sleep in a tent. Sleeping bags, designed to keep a person warm, have a fibre filling.

Fibre filling

(i)   Complete the sentence by choosing the correct words from the box.

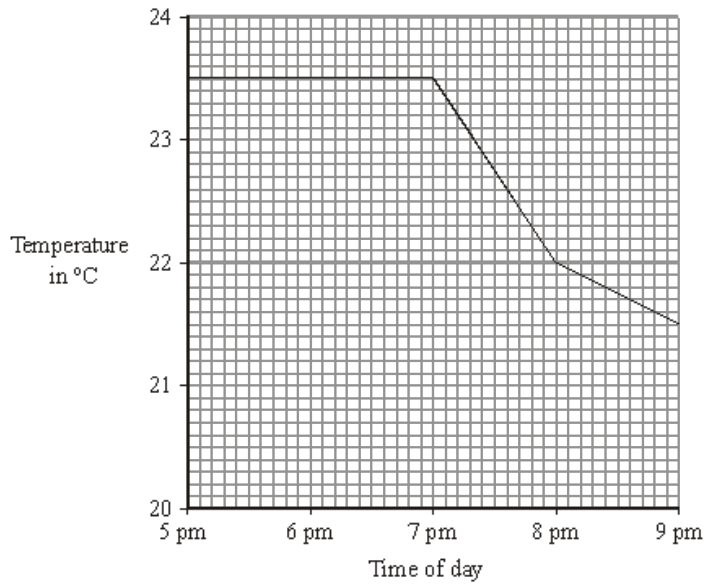| conduction   convection   radiation |
| --- |

The fibre is designed to reduce heat transfer by
_____ and

_____

(ii)   Explain why the fibre is good at reducing heat loss from a person sleeping in the bag.

_____

_____

_____

_____

(Total 3 marks)

Q2.

(a)   The graph shows the temperature inside a flat between 5 pm and 9 pm. The central heating was on at 5 pm.
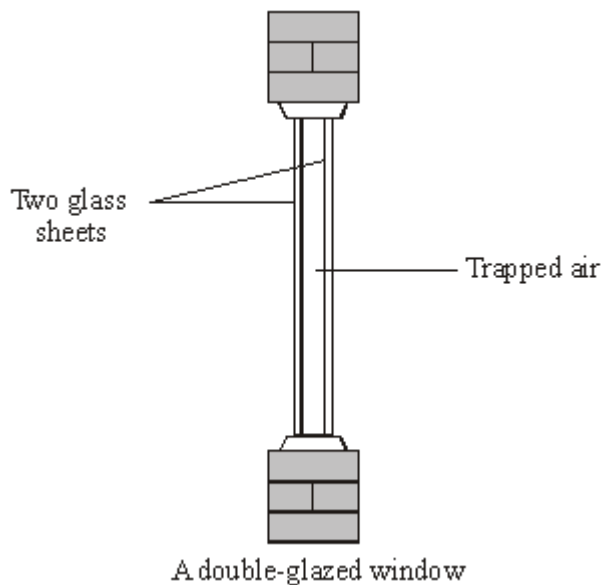

(i)   What time did the central heating switch off?

_____

(1)

(ii)   Closing the curtains reduces heat loss from the flat.

What time do you think the curtains were closed?

_____

Give a reason for your answer.

_____

(2)

(b)   Less heat is lost through double-glazed windows than through single-glazed windows.

Two glass sheets

Trapped air

A double-glazed window

Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

conduction	conductor	convection	evaporation	insulator	radiation

Air is a good _____ . When trapped between two sheets of

glass it reduces heat loss by _____ and

_____

(3)

(c)   The table gives information about three types of house insulation.

Type of insulation	Cost to install	Money save each year on heating bills	Payback time
Double glazing	£4000	£200	20 years
Loft insulation	£300	£100	3 years
Cavity wall insulation	£600	£150	

(i)   Use the information in the table to calculate the payback time for cavity wall insulation.
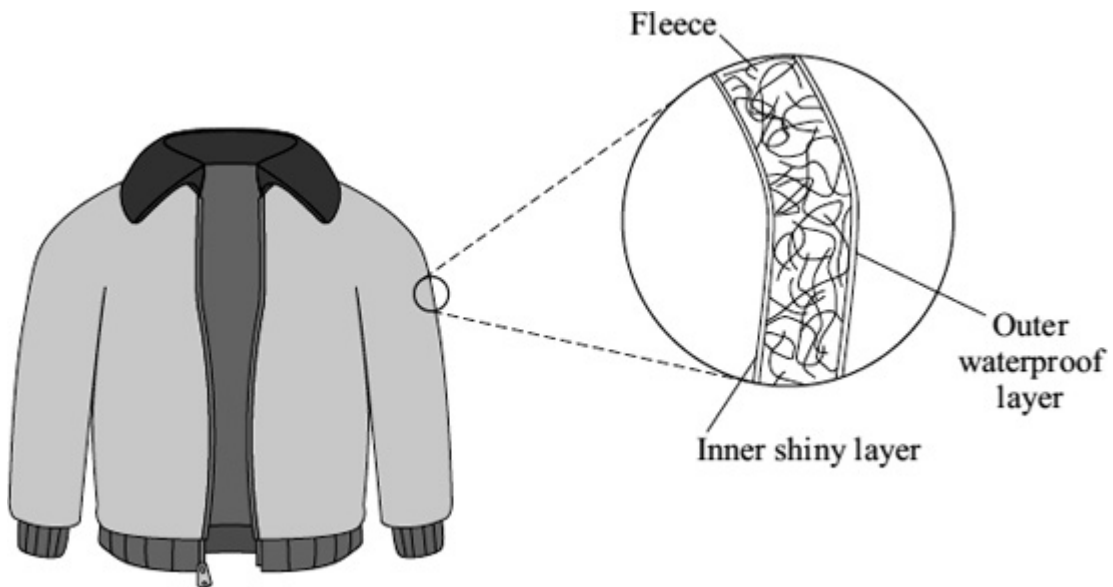
_____

(1)

(ii)   Explain why people often install loft insulation before installing double glazing or cavity wall insulation.

_____

_____

_____

_____**(2)**

(Total 9 marks)

Q3.
   (a) The diagram shows a ski jacket that has been designed to keep a skier warm.
   The jacket is made from layers of different materials.

Fleece

Outer waterproof layer

Inner shiny layer

(i)   The inner layer is shiny to reduce heat transfer.

Which process of heat transfer will it reduce?
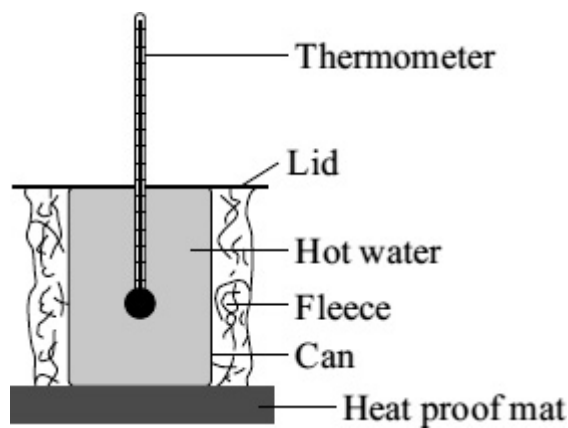
_____

(1)

(ii)   Why is the layer of fleece good at reducing the transfer of heat from a skier's body?
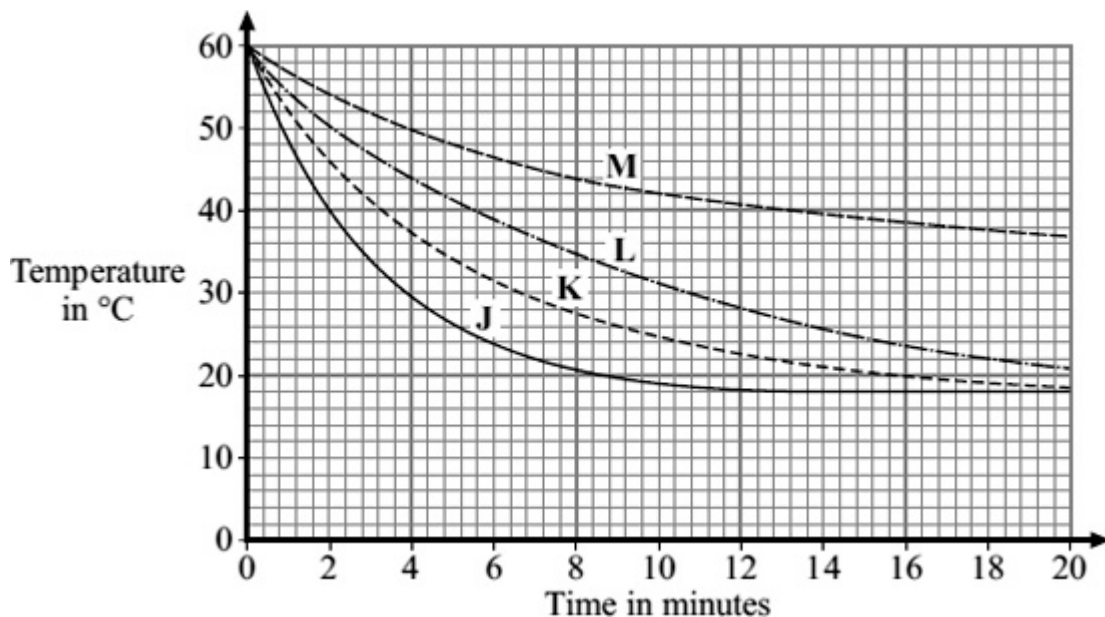
_____

_____**(1)**

(b)   A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water.
The temperature of the water was taken every two minutes for 20 minutes.

The graph shows the student's results.

(i)   In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

_____

_____

(1)

(ii)   To be able to compare the results, it was important to use the same volume of water in each test.

Give **one** other quantity that was the same in each test.

_____

_____

(1)

(iii)   Look at the graph line for fleece **K**.

Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

_____

(1)

(iv)   Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the ski jacket?

_____

Give a reason for your answer.

_____

_____

(2)
(Total 7 marks)

Mark it

Q1.

    (i)   conduction, convection

              answer can be in either order

              1

    (ii)   traps (lots of) air

              *do **not** accept heat is trapped in the fibre*

              1

        air is a (good) insulator **or** poor conductor

              1

              [3]

Q2.

    (a)   (i)   7pm

              accept 19.00 / 1900

              1

        (ii)   8pm

              accept 20.00 / 2000

              1

        temperature drops more slowly

              accept heat for temperature accept line is less steep

              1

    (b)   insulator

              1

        conduction *

              1

        convection *

              * answers can be either way around

              1

    (c)   (i)   4 (years)

              1

        (ii)   it is the cheapest / cheaper / cheap

              *do **not** accept answers in terms of heat rising or DIY*

              1

        has the shortest / shorter payback time

              *do **not** accept short payback time*

              1

              [9]

Q3.

(a)　(i)　radiation

1

　　(ii)　traps (small pockets of) air
　　　　　*do **not** accept it's an insulator*
　　　　　*do **not** accept reduces conduction and / or convection*
　　　　　*do **not** allow it doesn't allow heat to escape*

1

(b)　(i)　bigger temperature difference (between the water and surroundings) at the start (than at the end)
　　　　　*do **not** accept water is hotter*

1

　　(ii)　starting temperature (of the water)
　　　　　accept thickness of fleece
　　　　　*do **not** accept same amount of fleece*
　　　　　*do **not** accept thermometer / can*
　　　　　*do **not** accept time is the same*

1

　　(iii)　18 (°C)
　　　　　correct answer only

1

　　(iv)　**M**

1

　　　　　smallest temperature drop (after 20 mins)
　　　　　*cannot score if **M** is not chosen*
　　　　　accept it's the best insulator
　　　　　accept smallest loss in heat
　　　　　accept keeps heat / warmth in for longer

1

[7]