Radiation

Objective

To find out how the darkness of a surface affects its absorption and emission of radiation.

Background information

1 Heat can be transferred by a process called radiation which does not require any medium.

2 All objects absorb and emit radiation. Objects which absorb radiation efficiently are known as good absorbers of radiation. Objects which emit radiation efficiently are known as good radiators of radiation.

Apparatus

- 1 radiator
- 2 pieces of aluminium foil
- wax
- boiling water
- 2 thermometers fitted in two stoppers
- 2 conical flasks (one painted silvery and one painted dull black)

Procedure

A Absorption of radiation by different surfaces

1 Cover the shiny side (front side) of both pieces of aluminium foil by a layer of wax of about the same size, shape and thickness. Paint the other side (back side) of one of the pieces of foil dull black.

2 Place the two pieces of foil at the same distance from a radiator with the back sides facing the radiator (Fig 4c-1 on p.5). Switch on the radiator and observe what happens to the wax.
B Emission of radiation from different surfaces

3 Fill a silvery flask and a dull black flask with the same amount of boiling water.

4 Plug the flasks using the stoppers fitted with thermometers (Fig 4c-2).

5 Record the initial temperatures of water in the two flasks.

6 Record the final temperatures of water in the two flasks after 10 minutes.

Results and analysis

A Absorption of radiation by different surfaces

1 (a) On which piece of aluminium foil does the wax melt first?

   The dull black one

   (b) Which aluminium foil is a better absorber of radiation?

   The dull black one

B Emission of radiation from different surfaces

2 Tabulate the results.

<table>
<thead>
<tr>
<th></th>
<th>Silvery flask</th>
<th>Dull black flask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial temperature of water / °C</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>Final temperature of water / °C</td>
<td>77</td>
<td>79</td>
</tr>
</tbody>
</table>

*Table 4c-1*
3. (a) In which flask is the water cooler after 10 minutes?

The dull black one

(b) Which flask is a better radiator of radiation?

The dull black one

Discussion

About the results

1. What can you conclude from the experimental results?

Dull black surfaces are better absorbers and radiators of radiation than silvery surfaces.

Further thinking

2. A student fills two identical dull black flasks with the same amount of water of different temperatures. She finds that the hotter the water, the faster it cools. Suggest two reasons for the findings by considering different transfer processes of heat.

The hotter flask has a higher rate of emission of radiation.

The hotter flask loses energy at a higher rate to the surroundings through conduction of heat.

Conclusion

Dull black surfaces are ______ good _______ (good/poor) absorbers and ________ good _______ (good/poor) radiators of radiation. Shiny or silvery surfaces are ________ poor _______ (good/poor) absorbers and ________ poor _______ (good/poor) radiators of radiation.