

# RADIATION

Note:

- The thermal radiation is infrared radiation and that all objects emit this radiation.
- The thermal energy transfer by thermal radiation does not require a medium.
- For an object to be at a constant temperature, it needs to transfer energy away from the object at the same rate that it receives energy

## EFFECT OF SURFACE COLOUR AND TEXTURE ON THE ABSORPTION AND REFLECTION OF INFRA-RED RADIATION:

### GOOD EMITTERS AND ABSORBERS OF INFRA-RED [ IR ] RADIATION



The above image shows the following set-up:

- Two beakers are taken with equal amount of water and at the same starting temperature.
- Each beaker is kept at the same distance from the light source.
- The beakers are exposed to the light for the same length of time

It is observed that:

- The silvered beaker with a shiny surface has less temperature rise as compared to the dark matt black coloured beaker for the same amount of time.
- When the light source is removed, it is observed that the dull black matt coloured beaker loses heat more quickly than the shiny-silvered beaker during the same length of time

**Conclusion:** Dark, matt surfaces are good absorbers and emitters of infrared radiation. Light, shiny surfaces are poor absorbers and emitters of infrared radiation.

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### **SPECIAL CASES:**

1. If the rate at which an object emits radiation is greater than the rate at which it absorbs radiation, it indicates that the object is cooling.
2. When the rate at which an object emits radiation = Rate at which it absorbs radiation, it means the object is at the same constant temperature as its surroundings.
3. When the rate of emitted radiation is less than the rate of the absorbed radiation, it means the object is heating up. The temperature of the object is increasing.

The rate of emission of radiation depends on:

- ✓ The surface temperature and
- ✓ The surface area of an object

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## THE TEMPERATURE OF THE EARTH IS AFFECTED BY THE FACTORS CONTROLLING THE BALANCE BETWEEN INCOMING AND THE RADIATION EMITTED BY THE EARTH'S SURFACE

### DAYTIME:

- ✓ A large amount of EM radiation is transferred to the Earth's surface and atmosphere during the daytime .
- ✓ During bright sunlight, the temperature of the earth's surface increases. This is because although some radiation does get absorbed by the atmosphere ,most of it passes through the atmosphere and then gets absorbed by the Earth's surface. When the earth's surface gets warmed up, the air around it also gets warmer. The overall result the rising of the Earth's temperature as more EM radiation is absorbed as compared to what is emitted.
- ✓ Also a clearer sky, results in even higher temperatures as very less amount of the Sun's energy is reflected back into space and more is rather absorbed.

### NIGHT-TIME:

- ✓ During night, more EM radiation is emitted than is absorbed. Temperature is seen to decrease due to the lack of sunlight .There is also an increase in the heat loss on the days when the sky is clear .
- ✓ The EM is also absorbed by greenhouse gases like carbon dioxide and methane, which overall adds to a reduction in the temperature of the earth's surface.
- ✓ When the night sky is clear, there occurs a great fall in the temperature This is because the emitted infrared radiation is not reflected or absorbed by clouds.
- ✓ Conversely, with cloudy nights, some of the emitted radiation from the Earth's surface is reflected back off the clouds or absorbed by them, so the night-time temperature fall is not as great.

On the whole, there exists a fairly constant temperature on the Earth and allows for the survival of different life-forms.

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### Infra-red radiation:

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### Infra-red radiation:

- It is a part of the electromagnetic spectrum.
  - Every object around us emits infra-red radiation.
  - The hotter the object is, the more infra-red radiation it emits.
  - Very hot objects emit light as well as infrared radiation.
  - Infra red radiation does not require a medium to travel.
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### Experiment for detecting infra-red radiation:

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A glass prism splits the white light into a spectrum of colours. When the thermometer is placed beyond the red part of the spectrum, the temperature of the thermometer is increased due to some invisible radiation. This invisible radiation is called as infra-red radiation as its frequency is less than the frequency of the red part of the visible spectrum.

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**Thermal radiation:** The radiation emitted by an object because of its temperature is also called as thermal radiation. Because this type of radiation may also emit light along with infra red radiation.

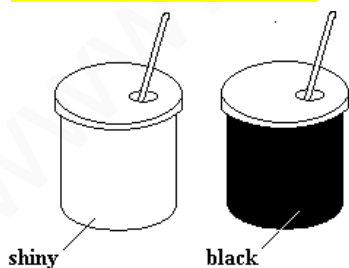
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**Effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of radiation.**

### Dark, matt surfaces:

- ✓ Emit infra-red radiations better than light, shiny surfaces.
  - ✓ Absorb infra red radiations better than light, shiny surfaces.
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**Experiment to check which surface is a good absorber and a good emitter of infra red radiation:**



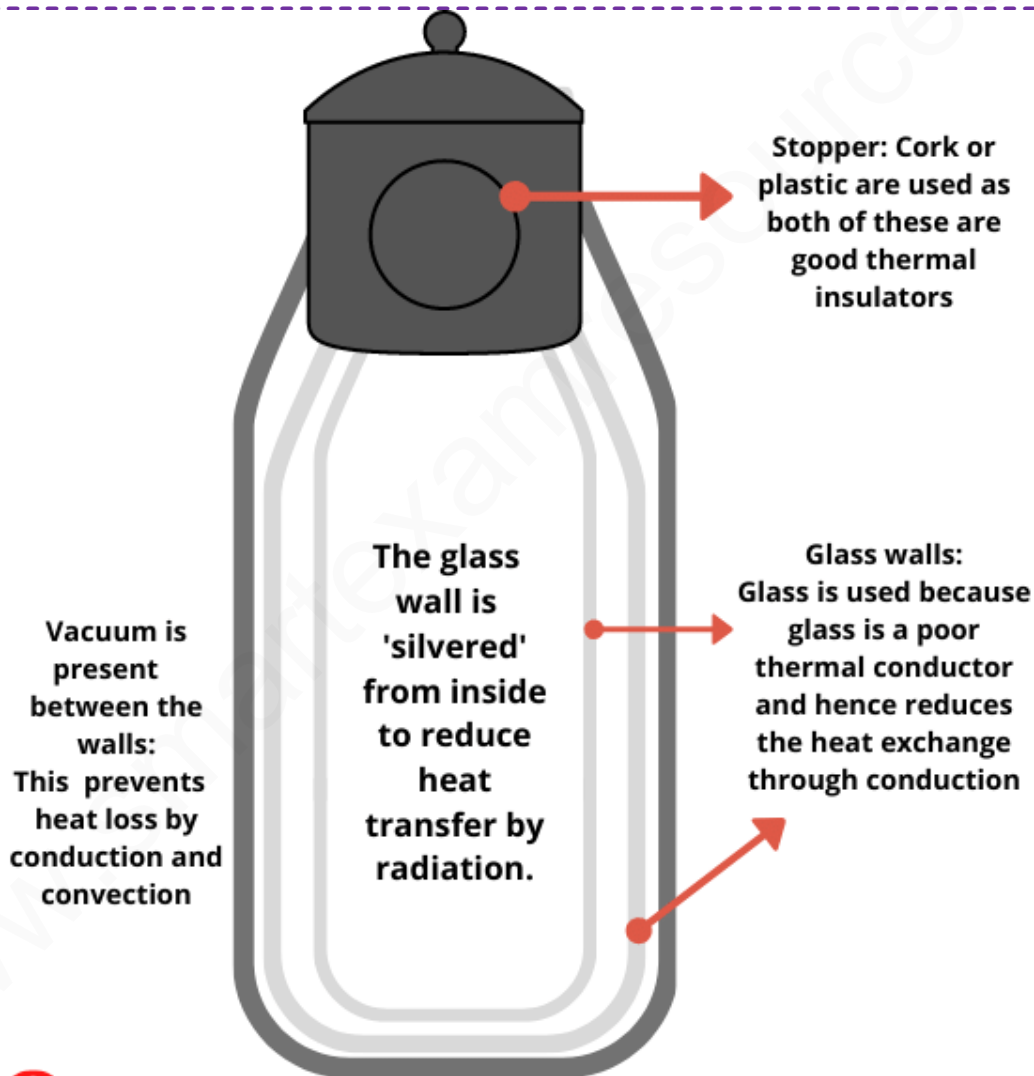
Paint one beaker white and shiny and silvery. Paint the other beaker dark matt. Fill equal volume of hot water at the same temperature. After the same time observe the change in temperature. You will find that the black matt painted beaker cools down faster.

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### Controlling the amount of radiations getting absorbed:

- In hot countries, houses are painted white so that the rays are reflected back into space and the amount of heat absorbed will be less.
- White coloured blinds or window shutters also reduce the amount on radiations absorbed by the house.
- Thick walls are constructed so that less heat is transferred due to conduction.

### Controlling the heat losses through a thermos flask:



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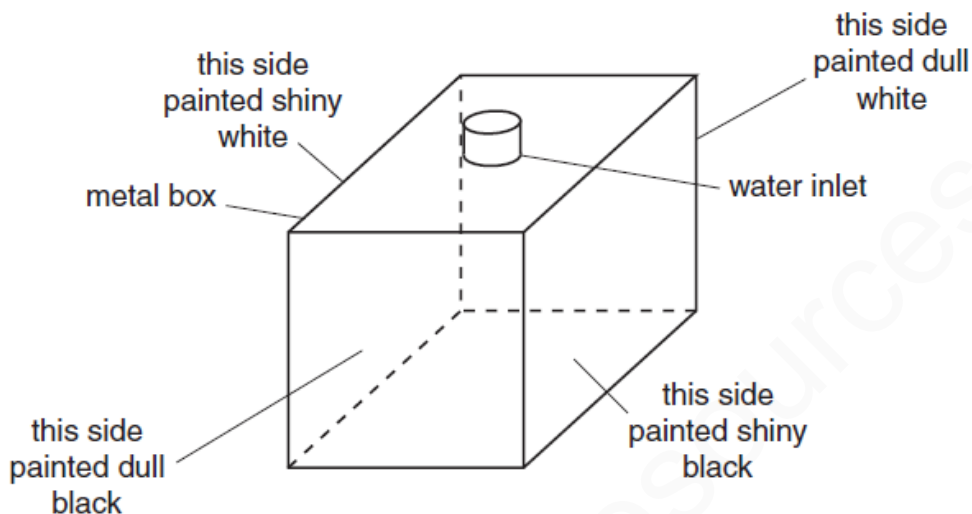
**Note:** The amount of heat emitted depends upon the surface temperature and surface area of the body

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## CONDUCTION CONVECTION RADIATION-MIXED BAG

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To use the following apparatus to check the emission of infra red radiations from different surfaces.



- Near the center of each side place an identical infra-red detector.
  - Note the temperature of each thermometer.
  - Then pour hot water in the box above.
  - Note the temperature of each thermometer after some time again for all the thermometers .
  - Note the rise in temperature of each thermometer.
  - You will find that dull black is the best emitter.
  - And the painted shiny white is the worst emitter.
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