HEAT AND TEMPERATURE

What is HEAT?

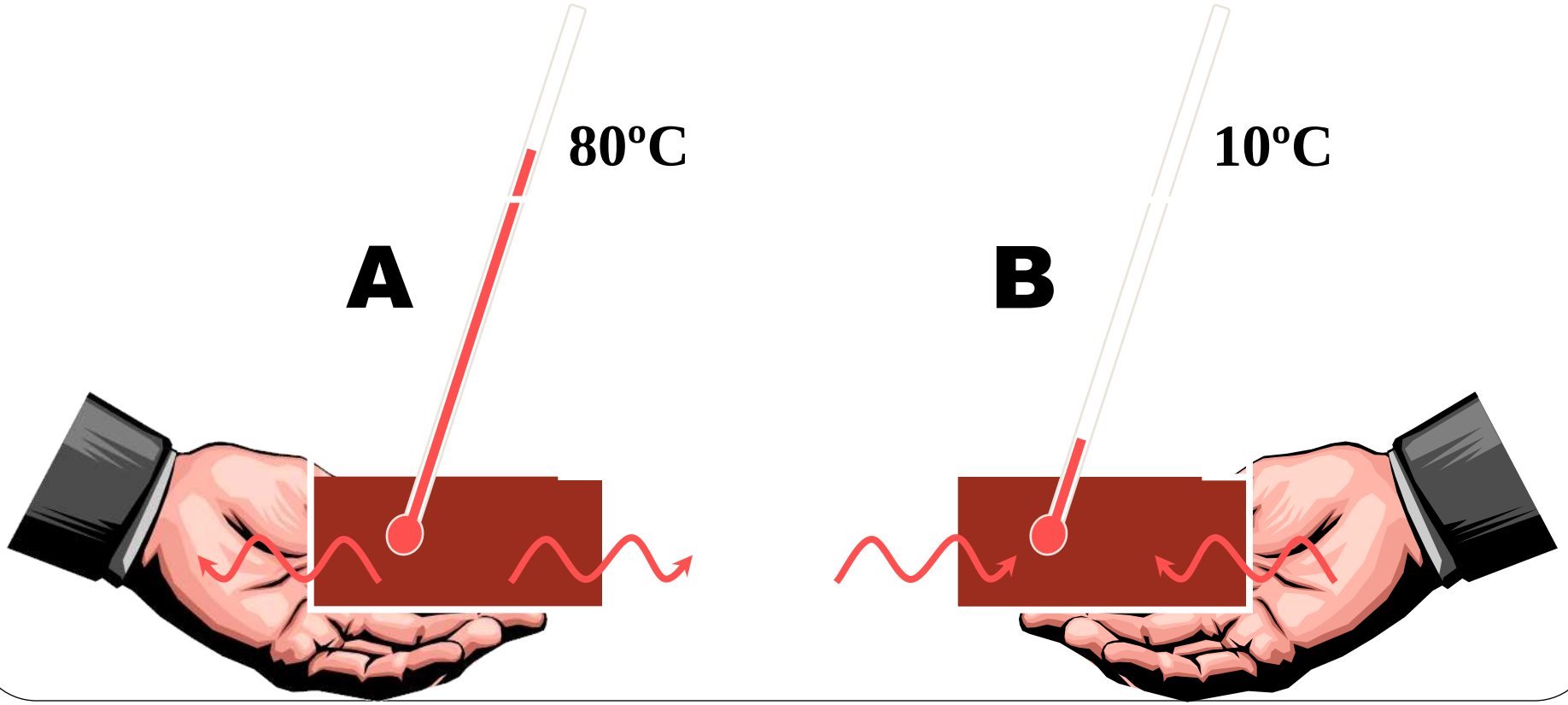
- A form of energy associated with the motion of molecules through solid and fluid

Heat Transfer

- **Heat**
  - thermal energy that flows from a warmer material to a cooler material
- Like work, heat is…
  - measured in joules (J)
  - a transfer of energy

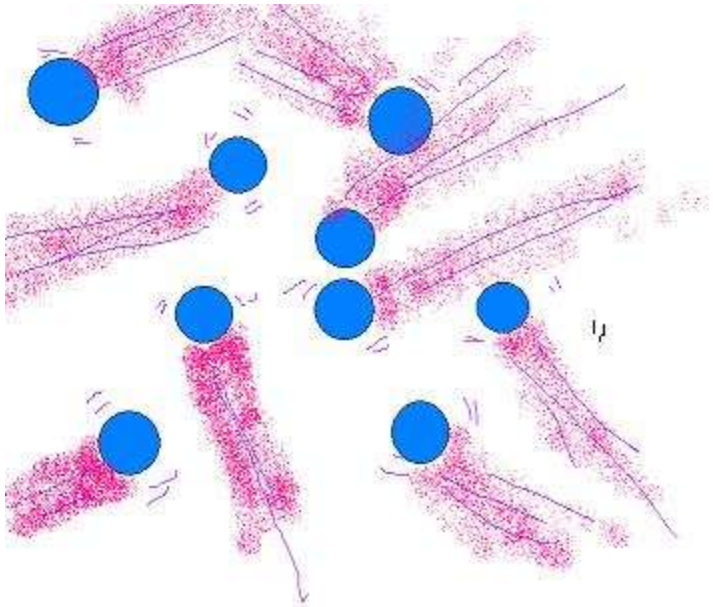
Heat Transfer

- Why does A feel hot and B feel cold?
  - Heat flows from A to your hand = hot.
  - Heat flows from your hand to B = cold.



What is HEAT?

- Particles move about more and take up more room if heated – this is why things expand if heated

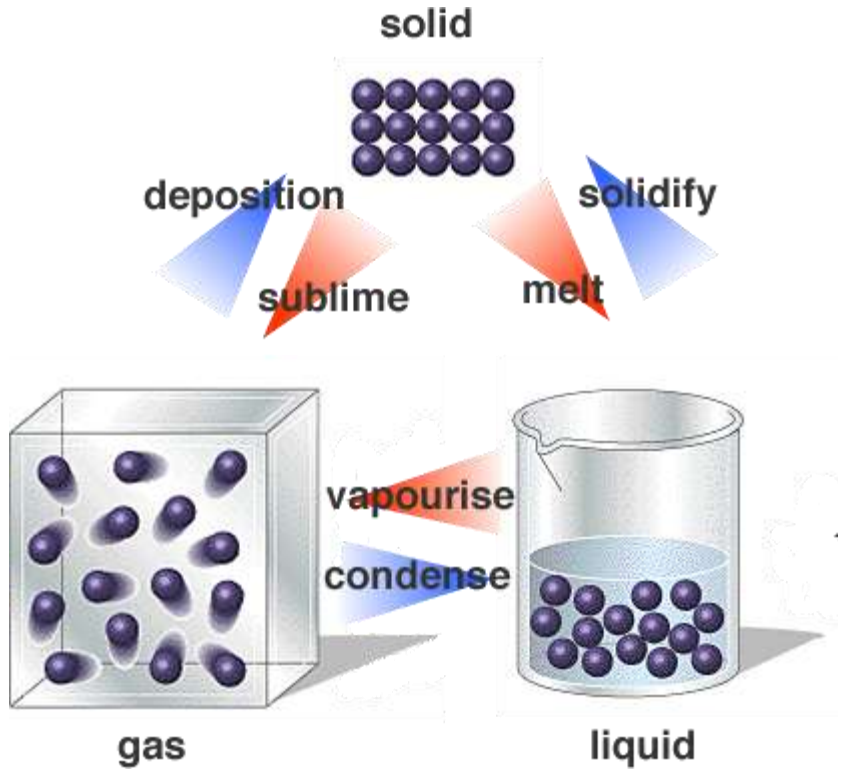


HEAT ENERGY

It is also why substances change from:

solids liquids gases

when heated



Heat and Temperature

- The temperature of an object tells us how **HOT** it is
- It is **NOT** the same as heat energy although the two quantities are related.

  e.g. a beaker of water at 60 °C is hotter than a bath of water at 40 °C **BUT** the bath contains more joules of heat energy

Heat and Temperature

- Temperature is used to measure the heat energy in degrees Celsius
- We use a thermometer to measure the energy

Heat and Temperature

- Temperature can also be measured in Fahrenheit and Kelvin

Baseline Temperatures

	Kelvin K °	Celsius C °	Fahrenheit F °
boiling water	373.15	100	212
melting ice	273.15	0	32
absolute zero	0	-273.15	-459.67

Heat and Temperature

- If an object has no energy it is at absolute zero

  -273° C

Going from Celsius to Fahrenheit

Convert 37 °C to °F.

$$^{o}F = 9/5^{o}C + 32$$

$$^{o}F = 9/5(37^{o}C) + 32$$

$$= 66.6 + 32$$

$$= 98.6^{o}F$$

Going from Fahrenheit to Celsius

Convert 68°F to °C

$^{o}C = 5/9(^{o}F - 32)$

$^{o}C = 5/9(68 - 32)$

$= 5/9(36)$

$= 20\ ^{o}C$

Going from Celsius to Kelvin

Convert 100°C to K

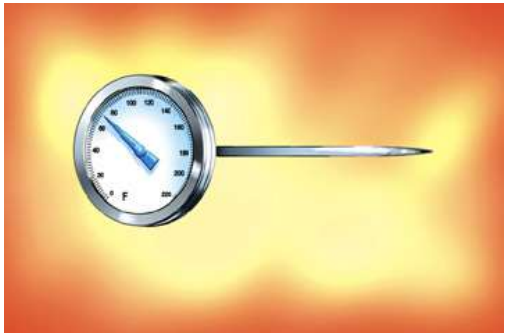
$K = {}^{o}C + 273$

$K = 100 + 273$

$= 373\ K$

Heat and Temperature

- Different types of thermometers are used for different purposes
  - Clinical
  - Cooking
  - Gas
  - Body temperature



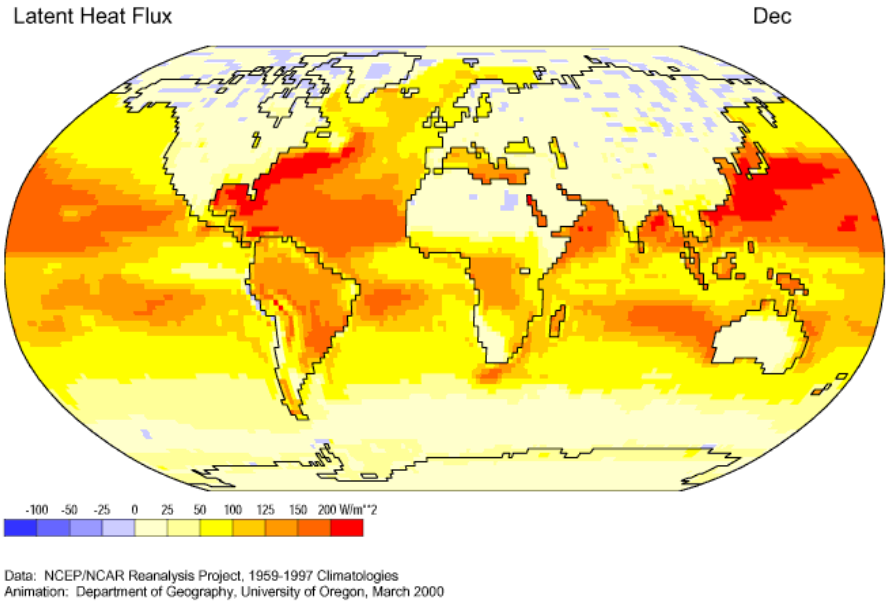
Heating and Cooling

- If an object has become hotter,
  it means that it has gained heat energy.

- If an object cools down, it means it has
  lost energy

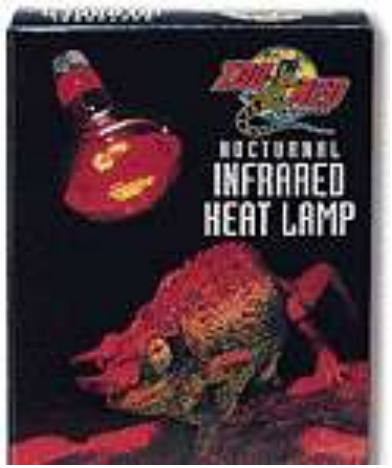
Getting Warm

- The majority of our heat comes from the sun



Other Sources of Heat Energy

- Electricity
- Combustion
- Infra-red
- Microwave
- Hot water

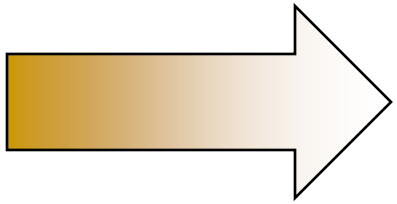


HEAT ENERGY

- **Energy transfer**
  - **Conduction**
  - **Convection**
  - **Radiation**

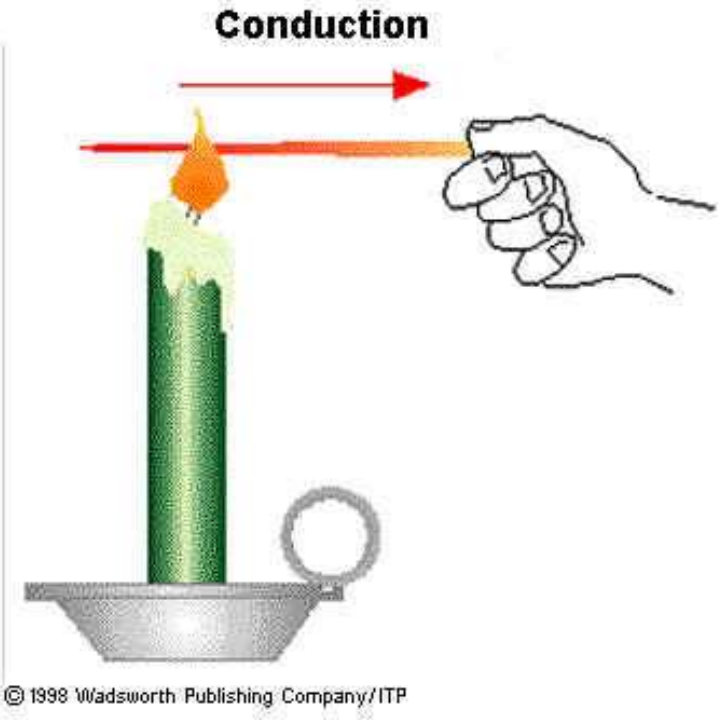
Conduction

- Heat is transferred through a material by being passed from one particle to the next
- Particles at the warm end move faster and this then causes the next particles to move faster
-

the HOT end  the cold end

Conduction cont…

- Occurs by the particles hitting each other and so energy is transferred.
- Happens **best in solids**-particles very close together



Conductors

- Materials that conduct heat quickly are called conductors
- All metals are good conductors of heat

Insulators/poor conductors

- Materials that conduct heat slowly or poorly are called insulators
- Glass, wood, plastic and rubber are poor conductors (good insulators)

Insulators/poor conductors

- Nearly all liquids including water are poor conductors (good insulators)
- Gases, including air are poor conductors

Insulators

A material which does not allow heat to pass through it easily.

Some animals have good insulation to survive severe winters.

Figure 11
The tiny pockets of air in fleece make it a good insulator. They help prevent the jogger's body heat from escaping.

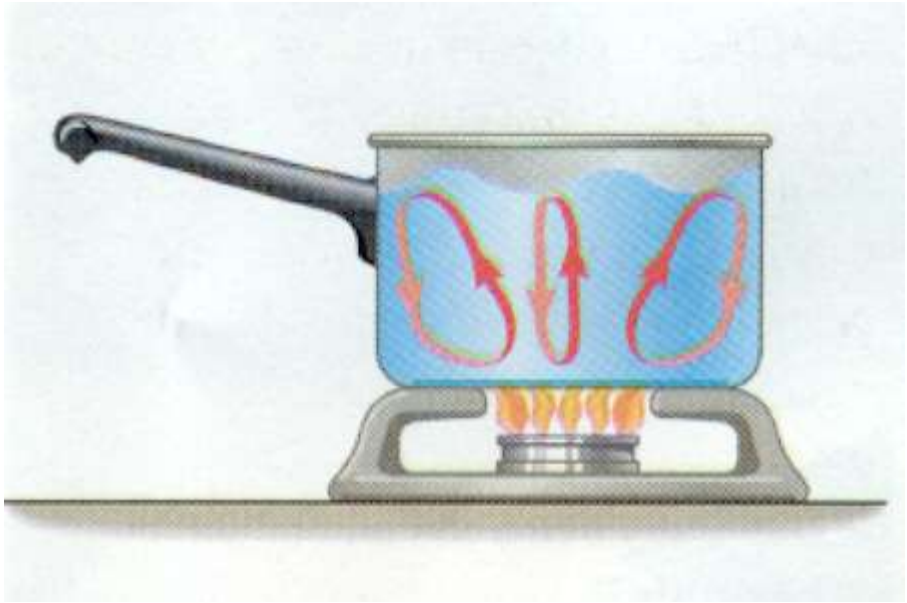
Buildings and houses are insulated so that heat does not pass out of (winter time) and into (summer time).

What are some other uses of insulation?

Figure 12
The vacuum layer of th
bottle is a very poor co
of heat.

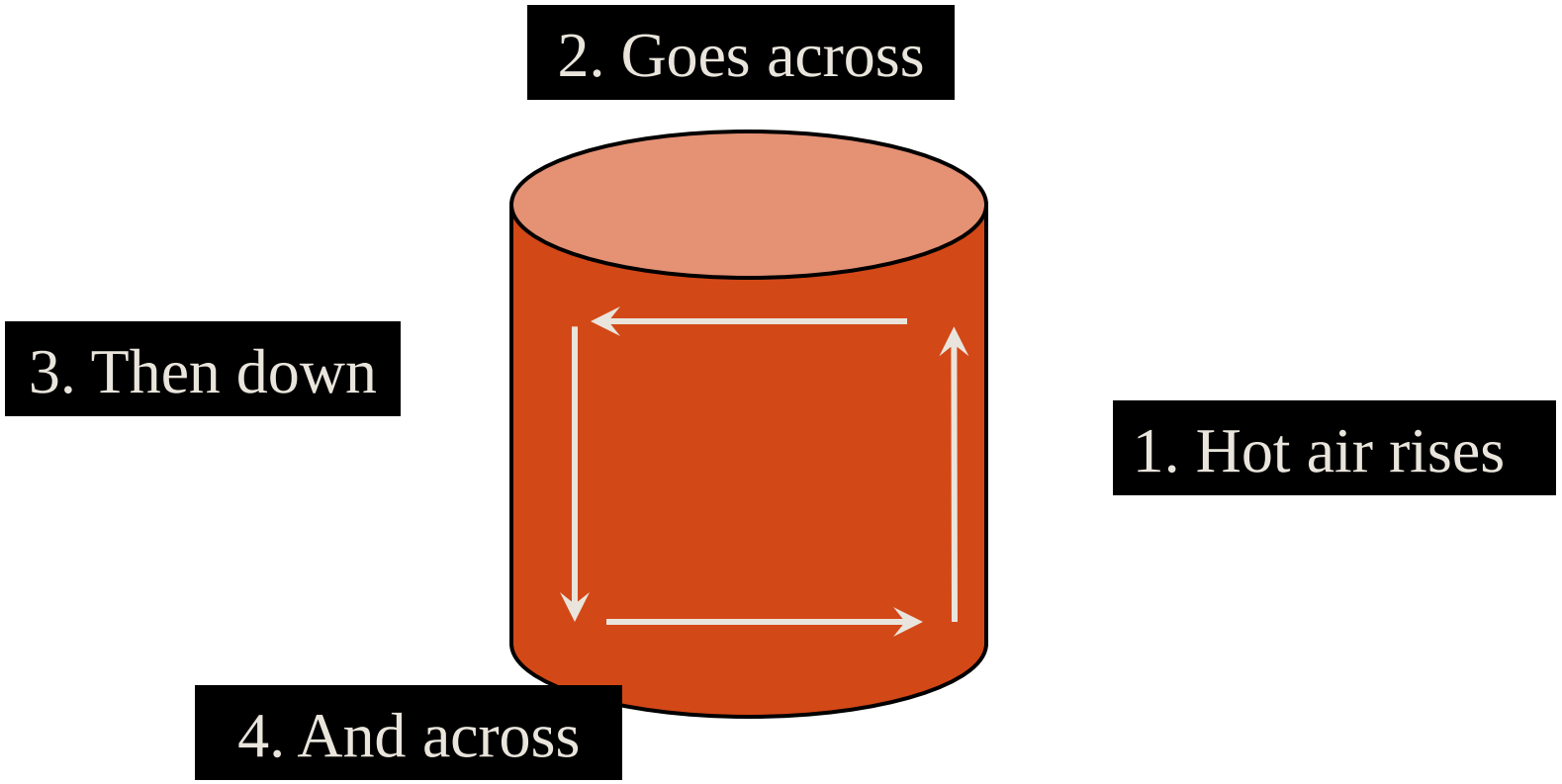
Convection

- Takes place in material where particles can move around inside the material, i.e. liquid or gas
- The heat is carried by the particles themselves moving



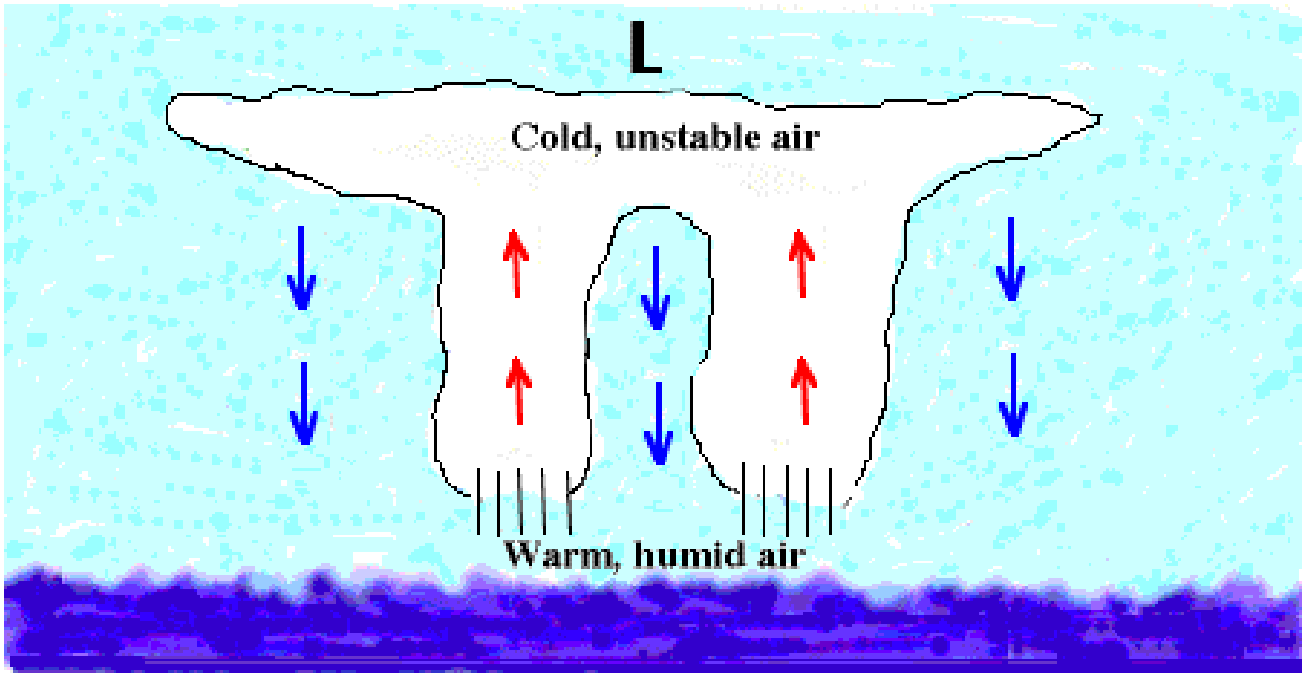
Convection Currents

- Hot liquids and gases expand and rise while the cooler liquid or gas falls



Convection cont…

- The sun can cause large convection currents - WINDS
- During daytime the land warms up more than the sea. The warm air rises over the land and cool air falls over the sea. So we feel a sea breeze.
- How can convective currents be used?



Radiation

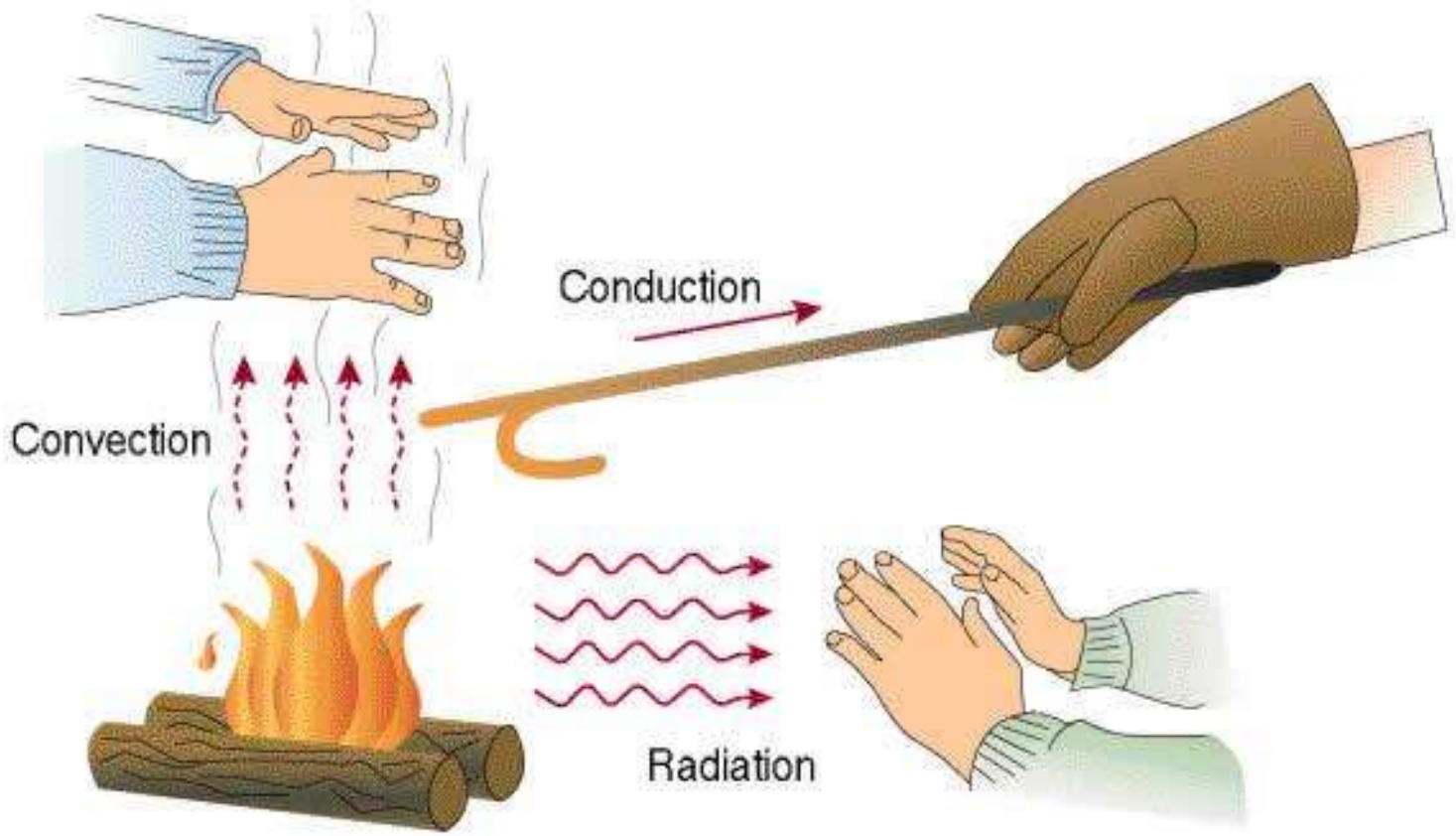
- Transfer of heat directly form the source to the object by a wave, travelling as rays.

Radiation

- Heat radiation is also known as

INFRA-RED RADIATION

- All objects that are hotter than their surroundings give out heat as infra-red radiation


Conduction
Convection
Radiation

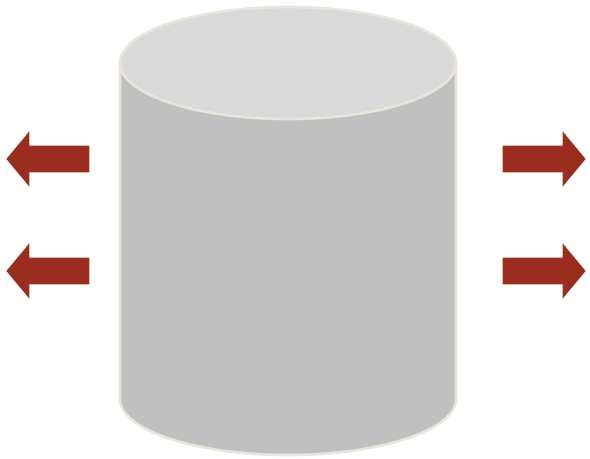
Emitters

- Hotter objects emit (give out) heat
- Different surfaces emit heat at different speeds
- A **dull black** surfaces **loses** energy more quickly – it is a **good radiator**

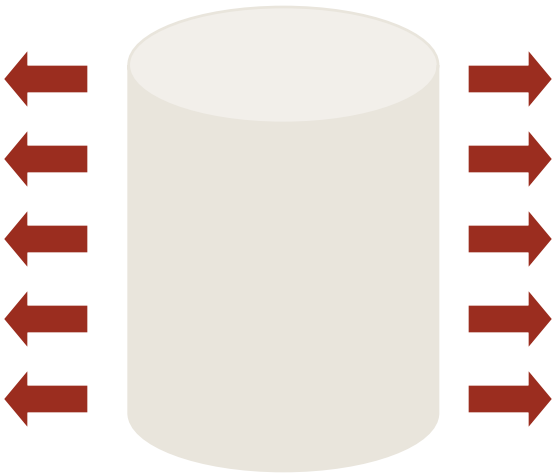
Emitters

- A **bright shiny** or **white** surface is a **poor radiator**
- Marathon runners need to keep warm at the end of races, covering in shiny blankets reduces radiation and therefore heat loss.

Emitters of heat



Bright shiny can
Poor radiator



Dull black can
Good Radiator

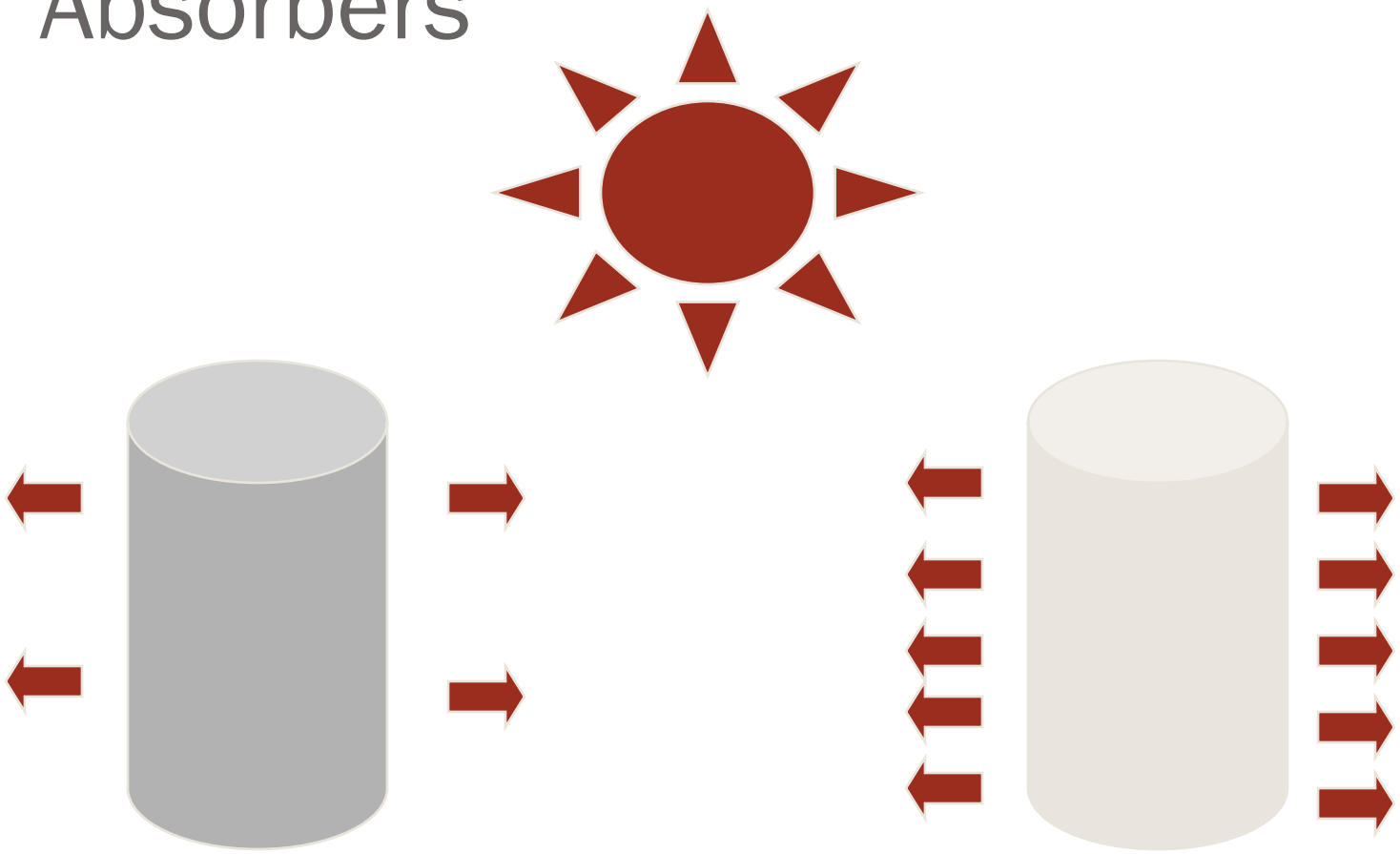
Absorbers

- Cooler objects absorb (take in) heat
- Substances absorb heat at different speeds
- Dull, black surfaces absorb heat quickly
- Bright, shiny surfaces absorb heat slowly

Absorbers

- In hot countries, people wear bright white clothes and paint their houses white to reduce absorption of energy from the sun.
- Petrol storage tanks sprayed silver to reflect sun’s rays

Absorbers



Shiny, bright can
Poor absorber

Dull black can
Good absorber