

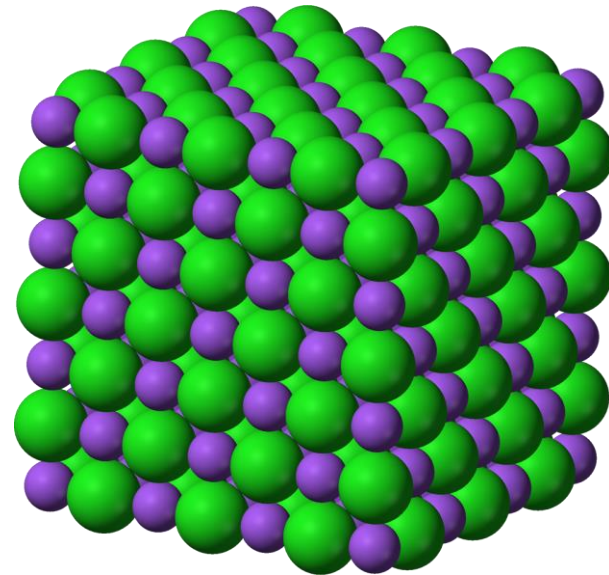
Convection, Conduction, Radiation

States of Matter

- Solid
- Liquid
- Gas

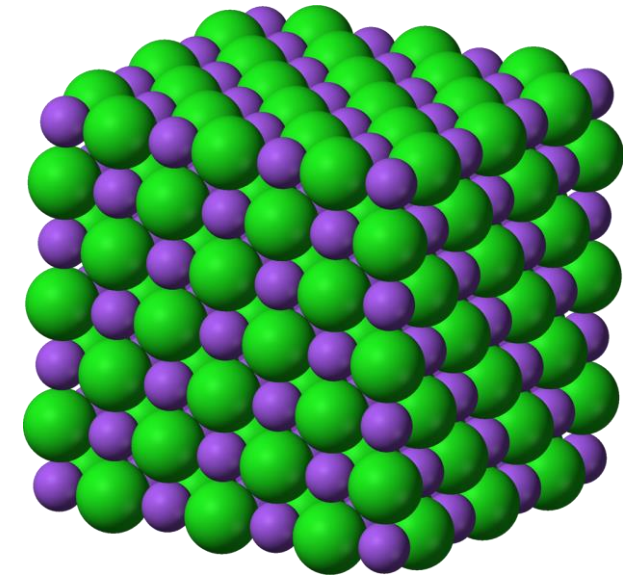
Solids

- How is a solid structured?
- What are the kinetic energies of the particles in a solid compared to those in a liquid or gas? Higher? Lower? The same?
- What does it mean for a solid to have a high temperature? What happens at the microscopic level?



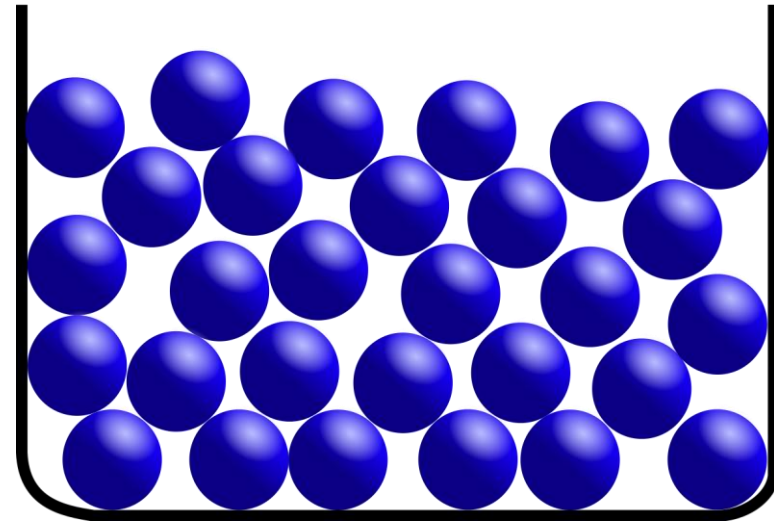
Solids

- How is a solid structured? **Fixed volume and shape**
- What are the kinetic energies of the particles in a solid compared to those in a liquid or gas? **Lower than liquid and gas**
- What does it mean for a solid to have a high temperature? What happens at the microscopic level?
 - **More energy -> More vibrations between the atoms**



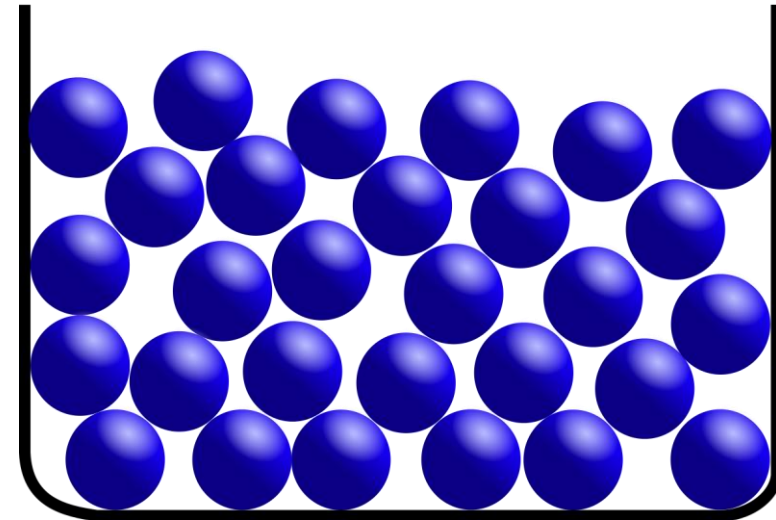
Liquids

- How is a liquid structured?
- What are the kinetic energies of the particles in a liquid compared to those in a solid or gas? Higher? Lower? The same?
- What does it mean for a liquid to have a high temperature? What happens at the microscopic level?



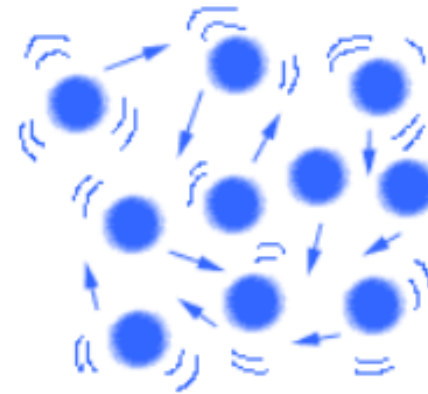
Liquids

- How is a liquid structured? **Fixed volume, takes shape of container**
- What are the kinetic energies of the particles in a liquid compared to those in a solid or gas? **Higher than solid, lower than gas**
- What does it mean for a liquid to have a high temperature? What happens at the microscopic level?
 - **More energetic particles -> Atoms that make up the liquid move around more**



Gases

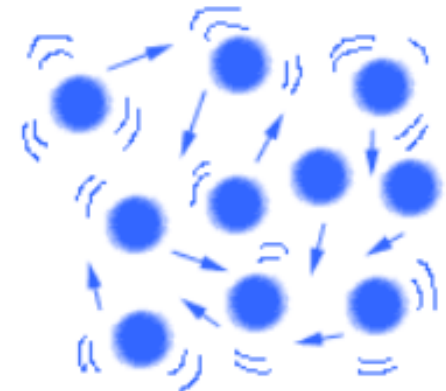
- How is a gas structured?
- What are the kinetic energies of the particles in a gas compared to those in a solid or liquid? Higher? Lower? The same?
- What does it mean for a gas to have a high temperature? What happens at the microscopic level?



Intermolecular structure of gas

Gases

- How is a gas structured? **Expands to take shape and fill volume of container**
- What are the kinetic energies of the particles in a gas compared to those in a solid or liquid? **Higher than liquids and solids**
- What does it mean for a gas to have a high temperature? What happens at the microscopic level?
 - **More energetic particles -> Gas particles are moving around a lot more quickly.**



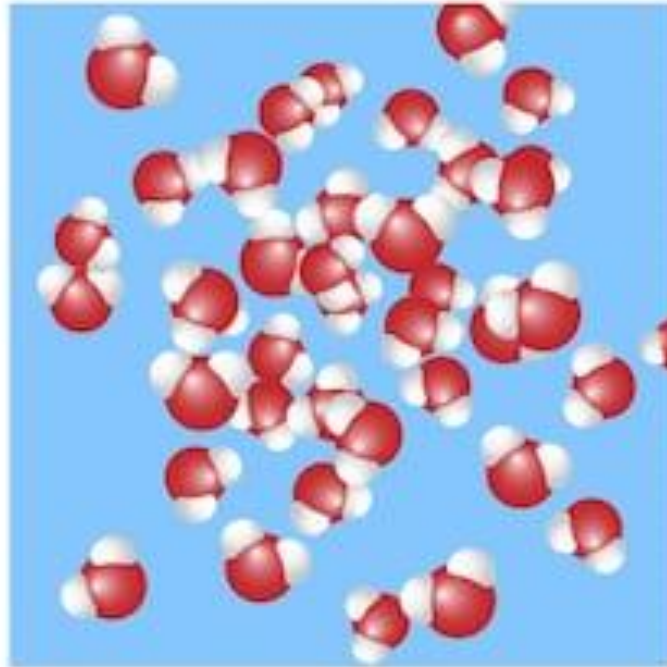
Intermolecular structure of gas

Ice



Solid

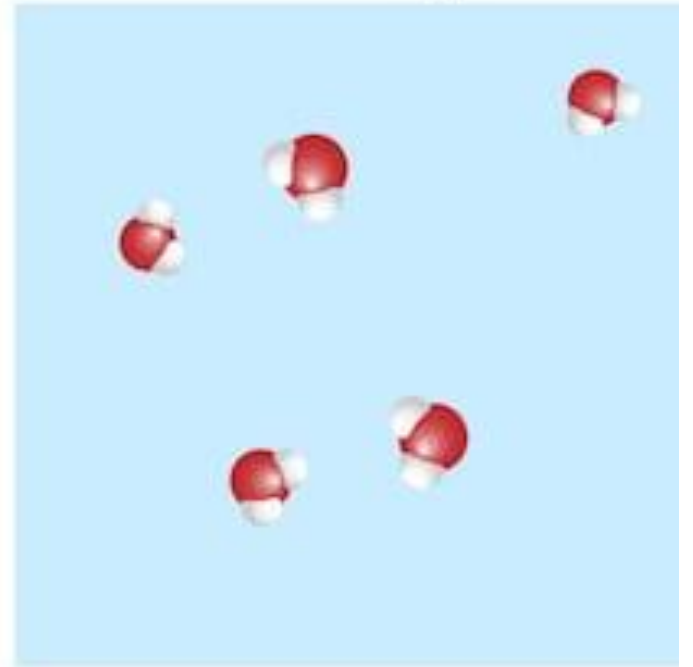
Water



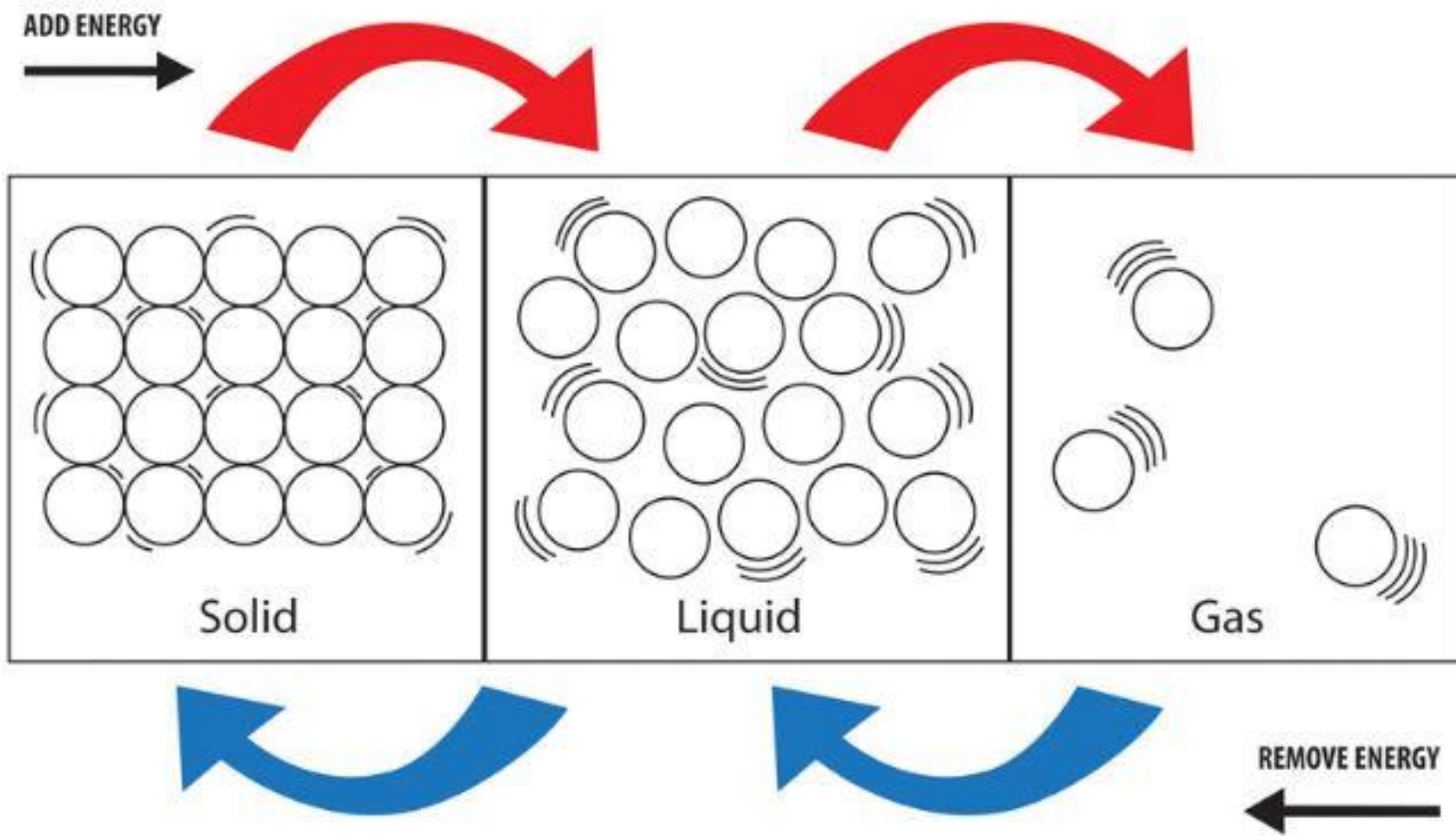
Liquid

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Water Vapor



Gas



Energy & Heat

- What is energy?
- What is heat?
- What are their units? ALWAYS think about the units in physics!
- What is the difference between energy and heat?

Energy & Heat

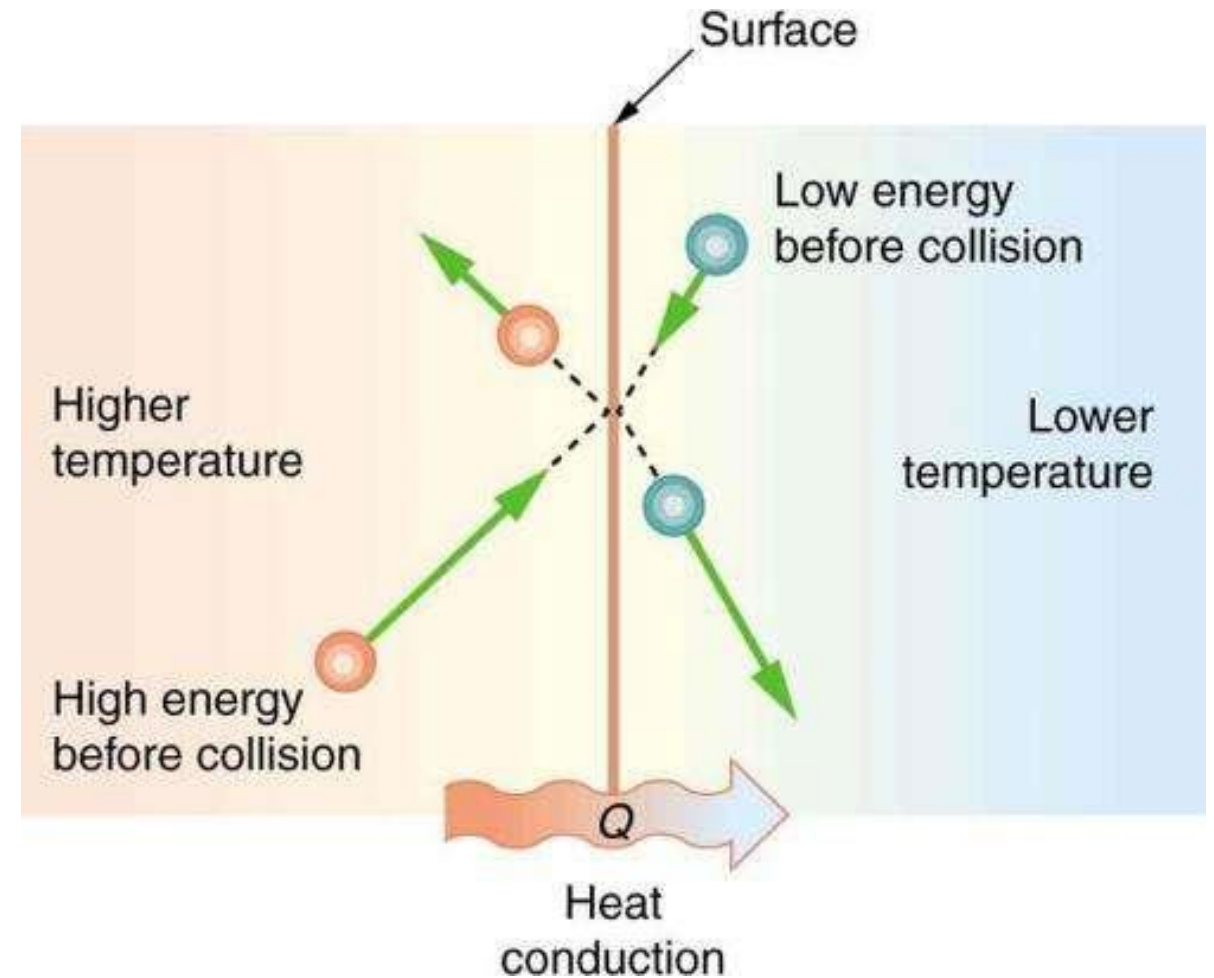
- What is energy? ← Refers to TOTAL energy inside an object
- What is heat? ← Refers only to the energy that can be TRANSFERRED to another object. The THERMAL ENERGY.
- What are their units? ALWAYS think about the units in physics!
 - Their units are both in JOULES – the unit for energy
- What is the difference between energy and heat?
 - See above!

How is energy transferred between objects?

- Conduction
- Convection
- Radiation

Conduction

- Two thermal bodies IN CONTACT.
- Microscopic collisions between particles cause heat transfer.
- Heat *spontaneously* flows from a hotter object to a colder object.



Conductors and Insulators of Heat

- Thermal Conductors – Materials that allow heat to be transferred more easily
 - Example: Metals!
- Thermal Insulators – Materials that don't allow heat to be transferred easily.
 - Example: The plastic handle on your frying pan!

Examples of conduction

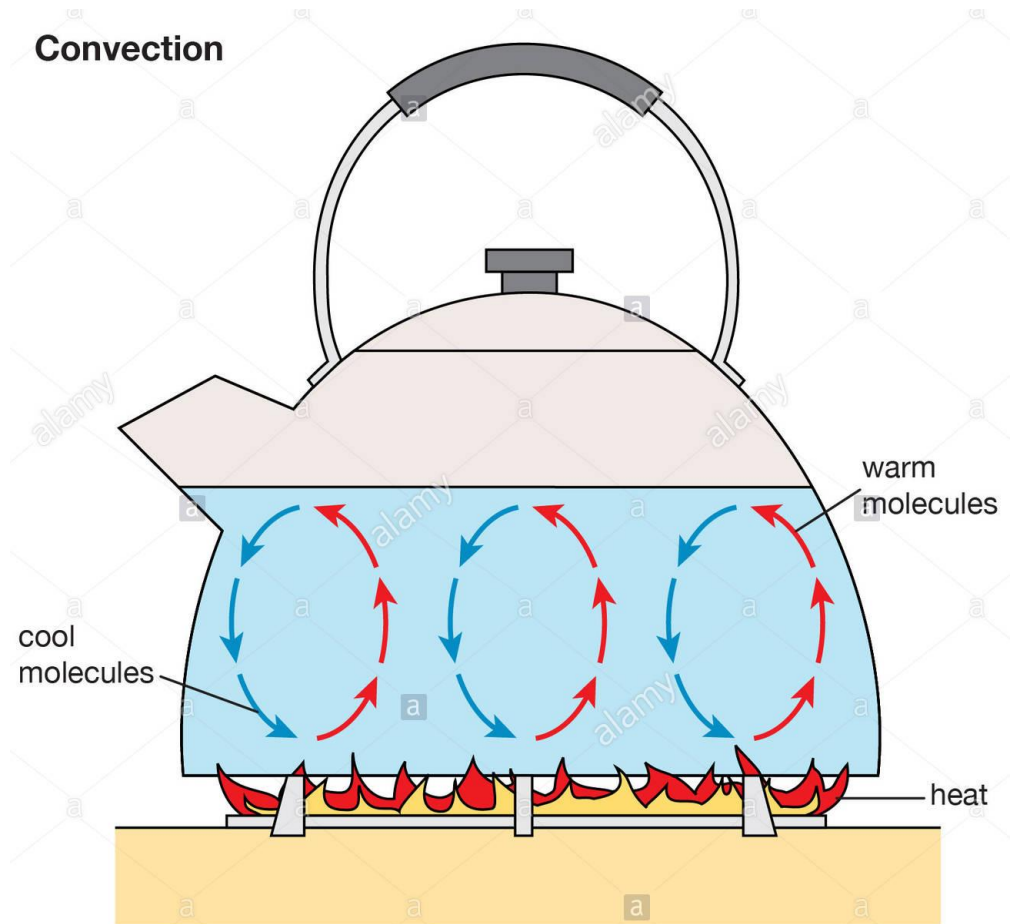
- What are some examples of conduction in everyday life?

Examples of conduction

- What are some examples of conduction in everyday life?
 - A stove element heating a pot
 - Chocolate melting in your hand
 - Touching a metal object on a very cold day
 - Putting on warmed-up clothes and feeling their heat

Convection

- Heat transfer due to BULK movement of particles in a liquid or gas
- “Hot air rises”
- Also: “cold air falls”!



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Examples of Convection

What are some examples of convection in everyday life?

Examples of Convection

- Holding your hand above candles on a birthday cake
- Hot air balloon
- Lava Lamp
- Fan in your computer
- Atmospheric convection
- Oceanic circulation
- Stars (the sun!)
- Ovens
- Radiator

Lava Lamp



Thermal Radiation

- Any object with a temperature greater than absolute zero or 0K (around -273°C) emits thermal radiation
 - Thermal radiation = light generated by heat
- What is the most important example of thermal radiation (infrared waves) in our daily lives?

Thermal Radiation

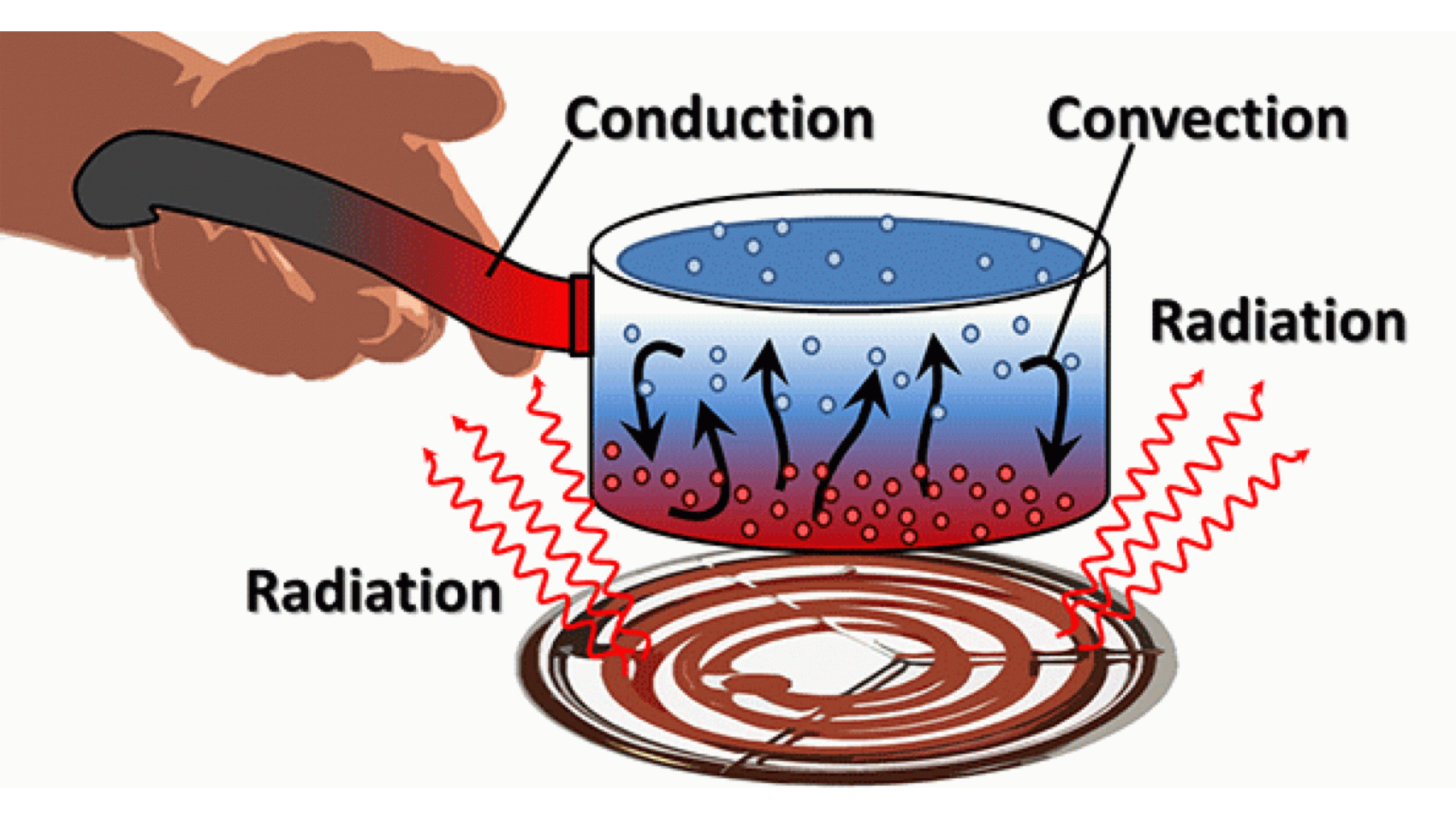
- Any object with a temperature greater than absolute zero or 0K (around -273°C) emits thermal radiation
 - Thermal radiation = light generated by heat
- What is the most important example of thermal radiation (infrared waves) in our daily lives?
 - The sun!

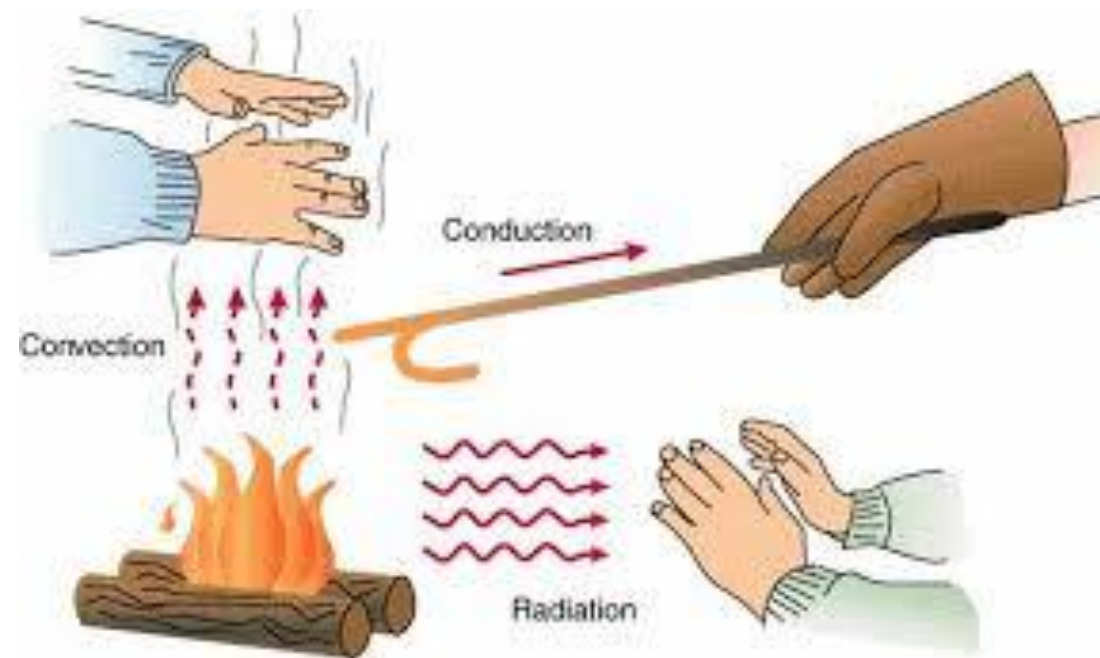
Reflection and Absorption of Thermal Radiation (Infrared Waves)

- What colours are good absorbers of infrared waves?
- What colours are good reflectors of infrared waves?
 - Have you seen the metallic blankets given to people with hypothermia?

Reflection and Absorption of Thermal Radiation (Infrared Waves)

- What colours are good absorbers of infrared waves?
 - Dark colours and black!
- What colours are good reflectors of infrared waves?
 - Bright colours and/or shiny materials!
 - Have you seen the metallic blankets given to people with hypothermia?





Quiz!

<https://jeopardylabs.com/play/conduction-convection-or-radiation-49>