Heat Capacity

Touch each object. What do you notice?

- **Table top** - wood

  warmer

  25°C

- **Table leg**

  colder

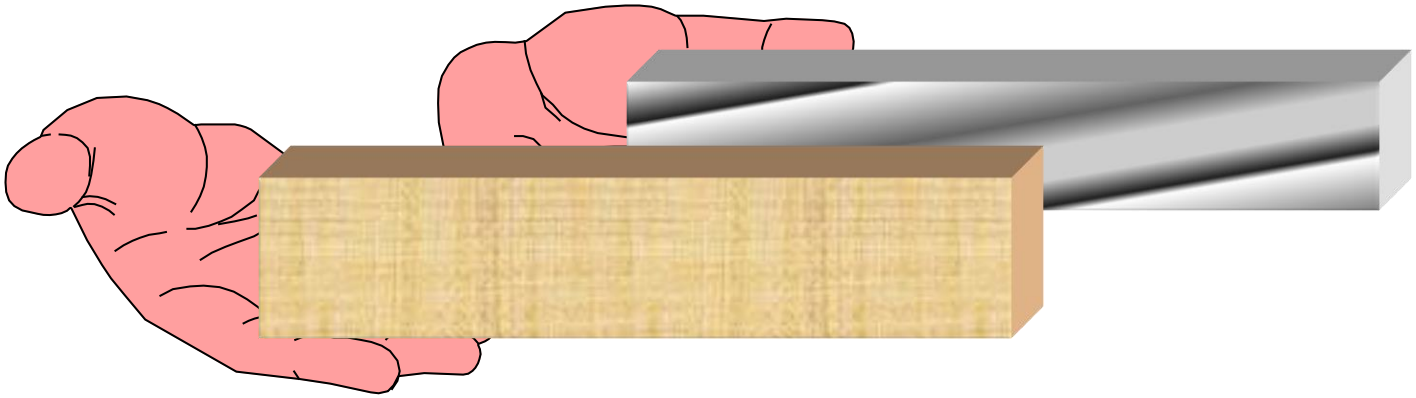
  25°C

Why does metal feel colder than wood, if they are both at the same temperature?

Metal is a good heat conductor:

1. **Easy to transfer heat to it (from fingertips)**
2. **Holds heat for a short time**

Wood is a good insulator and heat from fingertips moves slowly to the wood… so the wood feels warmer than the metal.



- **Another example: you will possibly have noticed that it is easier to warm up a saucepan full of oil than it is to warm up one full of water**

- **So what affects the amount of heat required to warm up a substance?**

Quantity of Heat

- **Amount of heat needed to change temperature of a substance depends on:**
  1. **How much temperature will change**
  2. **Quantity of substance**
  3. **Nature of substance**

Heat Capacity

- Describes how easy it is to heat up a substance, and how long it takes to cool
- Unique to each substance
- Physical property of a substance
- Think: why do Toronto and Vancouver have warmer winters than Regina?

Heat Capacity

The amount of heat (Q) transferred (-) or absorbed (+) by a substance depends on

- **Mass of substance (m)**
- **Specific heat capacity (C)**
- **Change in temperature (ΔT)**

$$Q = mC\Delta T$$

Unit of Heat: J = Joule

Specific Heat Capacity

- **Specific Heat Capacity (C) of a substance is the amount of heat required to raise the temperature of 1 g of the substance by 1^{o}C (or by 1 K).**
- **Units are J $^{o}C^{-1}$ g^{-1} or J K^{-1} g^{-1}**
- **Sometimes the mass is expressed in kg so the units could also be J $^{o}C^{-1}$ kg^{-1} or J K^{-1} kg^{-1}**

- Approximate values in **J K^{-1} kg^{-1}** of the Specific Heat Capacities of some substances are**:**

Air	**1000**	**Lead**	**125**
Aluminum	**900**	**Mercury**	**14**
Asbestos	**840**	**Nylon**	**1700**
Brass	**400**	**Paraffin**	**2100**
Brick	**750**	**Platinum**	**135**
Concrete	**3300**	**Polythene**	**2200**
Cork	**2000**	**Polystyrene**	**1300**
Glass	**600**	**Rubber**	**1600**
Gold	**130**	**Silver**	**235**
Ice	**2100**	**Steel**	**450**
Iron	**500**	**Water**	**4200**

How much energy would be needed to heat 450 g of copper metal from a temperature of 25.0°C to a temperature of 75.0°C? The specific heat of copper, C, at 25.0°C is 0.385 J g^{-1} °C)

$Q = ?$

$m = 450\ g$

$C = 0.385\ \frac{J}{g°C}$

$T_f = 75.0°C$

$T_i = 25.0°C$

$Q = mC\Delta T$

$= mC(T_f - T_i)$

$= (450\ g)\left(0.385\ \frac{J}{g°C}\right)(75.0°C - 25.0°C)$

$= 8625\ J$

$= 8.66 \times 10^3\ J$

It takes 132 J of energy to heat a sample of iron from 12.3°C to 33.9°C. What is the mass of the iron sample?

$Q = 132\ J$

$m = ?$

$C = 450\ \frac{J}{kg°C}$

$T_f = 33.9°C$

$T_i = 12.3°C$

$$\frac{Q}{C\Delta T} = \frac{(m)C\Delta T}{C\Delta T}$$

$$m = \frac{Q}{C\Delta T} = \frac{Q}{C(T_f - T_i)}$$

$$= \frac{132\ J}{450\ \frac{J}{kg°C}(33.9°C - 12.3°C)} \quad \frac{1}{\frac{1}{kg}} = kg$$

$$= 0.0136\ kg$$

$$= 1.36 \times 10^{-2}\ kg$$

A 3.50 g sample of pure gold releases 33.1 J of heat. Its initial temperature was 78.2°C. What is the final temperature of the sample?

$Q = 33.1\ J$

$m = 3.50\ g$

$C = 0.129\ \frac{J}{g\,^\circ C}$

$T_f = ?$

$T_i = 78.2\ ^\circ C$

$Q = mC(T_f - T_i)$

$\frac{Q}{mC} = T_f - T_i$

$T_i + \frac{Q}{mC} = T_f - T_i + T_i$

$T_f = \frac{Q}{mC} + T_i$

$\frac{J}{\frac{J}{g\,^\circ C}} = {}^\circ C$

$= \frac{33.1\ J}{(3.50\ g)(0.129\ \frac{J}{g\,^\circ C})} + 78.2\ ^\circ C$

$= 73.3\ ^\circ C + 78.2\ ^\circ C =$ C

152.4 mL of ethanol is cooled from 60.0^{o}C to 43.7^{o}C. The density of ethanol is 0.789 g/mL. How much energy is transferred?