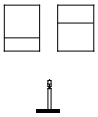
Energy and Heat

What are the factors that control heat?
How are these factors related?
DCI 3.1

Two containers of water are at 20ºC. One contains 50mL and the other 100mL. They are heated with the same source of heat for the same amount of time. If the final temperature of the 50mL sample is 50ºC what would be the final temperature of the 100mL sample?

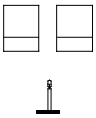


Amount and Temperature

- The amount in mass is indirectly related to the change in temperature:

$$m \propto 1/\Delta t$$

Two containers each have 50mL of water at 20ºC. Both are heated with the same source. One is heated for ten minutes and the other for five minutes. If the container that was heated for five minutes has a final temperature of 30ºC what would be the final temperature of the other sample?

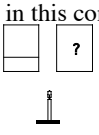


Heat and Temperature

- The change in temperature is directly related to the amount of heat applied:

$\Delta t \propto Q$

Two containers of water are at 20ºC. One contains 50g of water and is heated by a source for a specified time to a final temperature of 30ºC. The second container has an unknown amount of water and is heated with the same source to 30ºC. However, it takes twice as long to get to this final temperature. How much water is in this container?



Heat and Amount

- The amount of heat is directly related to the amount in mass:

$$Q \propto m$$

- To summarize:

$$Q \propto m\,\Delta t$$

50mL of water at 80ºC is added to 50mL of water at 20ºC. What would be the final temperature?

$Q_{lost}=Q_{gained}$

- Q lost by the hot water is gained by the cold water:

$$\therefore Q \text{ lost} = Q \text{ gained}$$

or

$$\therefore (-m\Delta t) = (m\Delta t) \text{ where } \Delta t = t_f - t_i$$

$$\therefore -(50g)(x-80ºC)=50g(x-20ºC)$$

$$\therefore (50g)(80ºC -x)=50g(x-20ºC)$$

$$\therefore 100 = 2x,\ x = 50ºC$$

50mL of water at 80ºC is added to 100mL of water at 20ºC. What would be the final temperature?

50g of water at 80ºC is added to 50g of ethyl alcohol at 20ºC. What would be the approximate final temperature?

A. 60ºC
B. 40ºC
C. 30ºC
D. 20ºC
E. 50ºC

Proportionality Constant

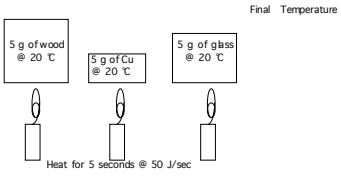
- $Q \propto m \Delta t$
- Therefore $Q = k\, m\, \Delta t$
- What is k?

- Depends on the nature of the substance.

- Ethyl Alcohol absorbs heat at about half the level of water. Therefore, it's temperature will rise more with the same amount of heat.

Heat

- A form of energy.
- The amount of heat contained by an object is related to:
- Temperature of the object
- Amount of the object
- Capacity of the object to contain energy



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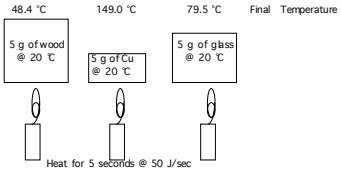

Heat Capacity

- This is the ability of a material to absorb heat.
- C = heat absorbed / Δt
- Specific Heat Capacity; C_s = heat absorbed / m•Δt
- From previous example:
- Heat 5 g of wood for 5 sec @ 50 J/sec:
- temperature changed from 20 °C to 48.4 °C.
- C_s (wood) = 1.76 J/g•°C
- C_s (Cu) = 0.385 J/g•°C
- C_s (glass) = 0.84 J/g•°C
- C_s (water) = 4.184 J/g•°C

Which metal will undergo the greatest temperature change if an equal amount of heat is added to each?

1. Fe, C_s = 0.45 J/g K
2. Al, C_s = 0.90 J/g K
3. Cu, C_s = 0.38 J/g K
4. Pb, C_s = 0.13 J/g K
5. Sn, C_s = 0.22 J/g K