02 - Heat Capacity of Metals

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Goals

In this experiment, we determine the specific heat capacity of Al, Fe and brass cubes and prove the Dulong Petit Law by measuring the rate of change of temperature by heating the cubes up in a calorimeter full of hot water.

Data and Graphs

For the experiment, we simply measure the initial temperatures of the calorimeter, and add 300ml of water at 50C to find the heat capacity of the calorimeter

t_k	t_w	m_w	t_m	C_k
18	50	300	48	84
21	50	300	48	93.3
21	50	300	48	93.3

thus, the average heat capacity of the calorimeter comes out to

$$c_{kavg} = 90.2$$

knowing this, we can calculate the heat capacity of our metals with our measurements after observing the change in temperature in ten minutes.

	t_k	t_2	t_m	m_p	m_w	c	C
Brass	19	100	22	171.2	300	0.303	51.93
Al	19	100	24	179.8	300	0.494	88.8
Fe	19	100	21	180	300	0.189	34.18

Conclusion

With this experiment, using the conservation of energy, we prove the Dulong-Petit Law:

$$\delta Q = dU + pdV$$

$$C_V = \left(\frac{\partial U}{\partial T} \right)_V$$

according to Debye model, we see that

$$C_V(T) = \left(3Nk \left(\frac{T}{\theta} \right)^3 \right) 3 \int_0^{\theta/T} \frac{z^4 e^z dz}{(e^z - 1)^2} = 3NkD(T/\theta)$$

which aligns with the Dulong-Petit Law:

$$C_v = 3Nk$$