The Cooling of Metals

Imagine you have samples of aluminum, copper, gold, and silver. Each sample is in the form of a cube—with sides 1 cm in length—and is suspended by a thread from a wooden dowel. The metals, which are suspended in air at a temperature of 25 °C, are placed in a beaker of boiling water where they remain until the water returns to a boil. All four metals are now at a temperature of 100 °C. If you remove the samples and place them on a block of ice, which metal will melt the most ice? You many assume that no heat is lost in other ways.

Although the four metals experience the same change in temperature when heated from 25°C to 100°C, they do not absorb the same amount of energy. To determine the amount of energy absorbed by each metal we use the equation

$$q = mS\Delta T$$

where q is the amount of energy absorbed in Joules, m is the metal's mass in grams, S is the metal's specific heat in J/g•°C and ΔT is the change in temperature. To find the mass for each metal we need their respective densities. The densities and specific heats for these metals, as reported at the web site *Chemicool* are shown in the following table:

metal	density (g/cm^3)	S (J/g•°C)
aluminum	2.702	0.90
copper	8.96	0.38
gold	19.32	0.128
silver	10.5	0.235

Because the cubes have a volume of 1 cm^3, each metal's density is the same as its mass. The amount of heat absorbed by each metal is

$$q_{Al} = (2.702\ \text{g}) \times (0.90\ \text{J/g•°C})(100^{\circ}\text{C} - 25^{\circ}\text{C}) = 182\ \text{J} \approx 180\ \text{J}$$

$$q_{Cu} = (8.96\ \text{g}) \times (0.38\ \text{J/g•°C})(100^{\circ}\text{C} - 25^{\circ}\text{C}) = 255\ \text{J} \approx 260\ \text{J}$$

$$q_{Au} = (19.32\ \text{g}) \times (0.128\ \text{J/g•°C})(100^{\circ}\text{C} - 25^{\circ}\text{C}) = 185\ \text{J} \approx 190\ \text{J}$$

$$q_{Ag} = (10.5\ \text{g}) \times (0.235\ \text{J/g•°C})(100^{\circ}\text{C} - 25^{\circ}\text{C}) = 185\ \text{J} \approx 190\ \text{J}$$

The cube of metal melting the most ice is copper because it absorbed the most energy and, consequently, has the most energy to dissipate.