DEVICE Ball and Ring Apparatus

TOPIC Thermodynamics

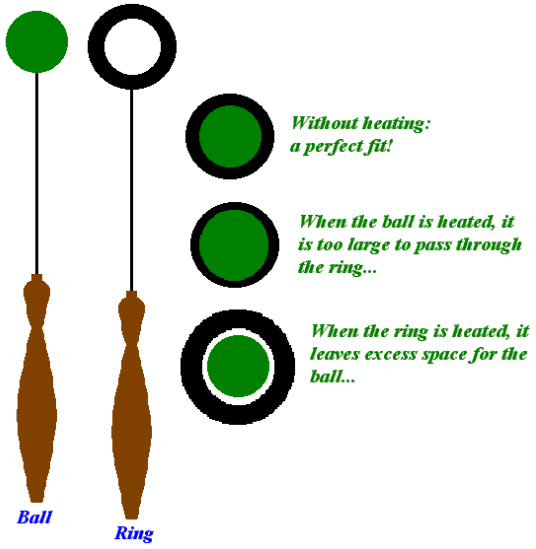
THEORETICAL BACKGROUND Thermal expansion of an object results from the change in the average separation between its constituent atoms or molecules. These atoms or molecules of the object begin to vibrate with larger amplitudes and the average separation between them increases as the temperature of the object increases. Consider that if the expansion of the object is significantly small compare with its initial dimensions, then the change in any one dimension, either length, width, or depth, is a linear function of the temperature. The general equation for the expansion of a solid object is,

$$\Delta L = L_0 \alpha \Delta T$$

where L_0 is the initial length of the object, ΔL is the change in length of the object, ΔT is the temperature change, and α is a constant known as the coefficient of linear expansion. Though the coefficient of linear expansion varies somewhat depending on the ambient temperature, it is often considered to be a constant depending on the material of the object. The ball and ring both constitute properties of brass which has a coefficient of liner expansion value of 19×10^{-6}/C°. Interestingly enough if all dimensions of the object expand with temperature, the volume of the object must also expand. Therefore if the temperature of the object with initial volume V increases by an amount ΔT then the increase in volume is

$$\Delta V = V \beta \Delta T$$

where $\beta = 3\alpha$. This is true for a solid in which the coefficient of linear expansion is the same in all directions, otherwise know as an isotropic solid.



DESCRIPTION The demo consist of the items in the diagram above; a solid brass ball and a brass ring each mounted onto wooden handles. The demo is best performed by holding either the ring or ball over an open flame from a Bunsen burner.

PROCEDURE

1. At room temperature pass the brass ball through the brass ring.
2. Using a Bunsen burner, increase the temperature of the ball and proceed to pass it through the ring. Students will be surprised by your attempts.

SUGGESTIONS