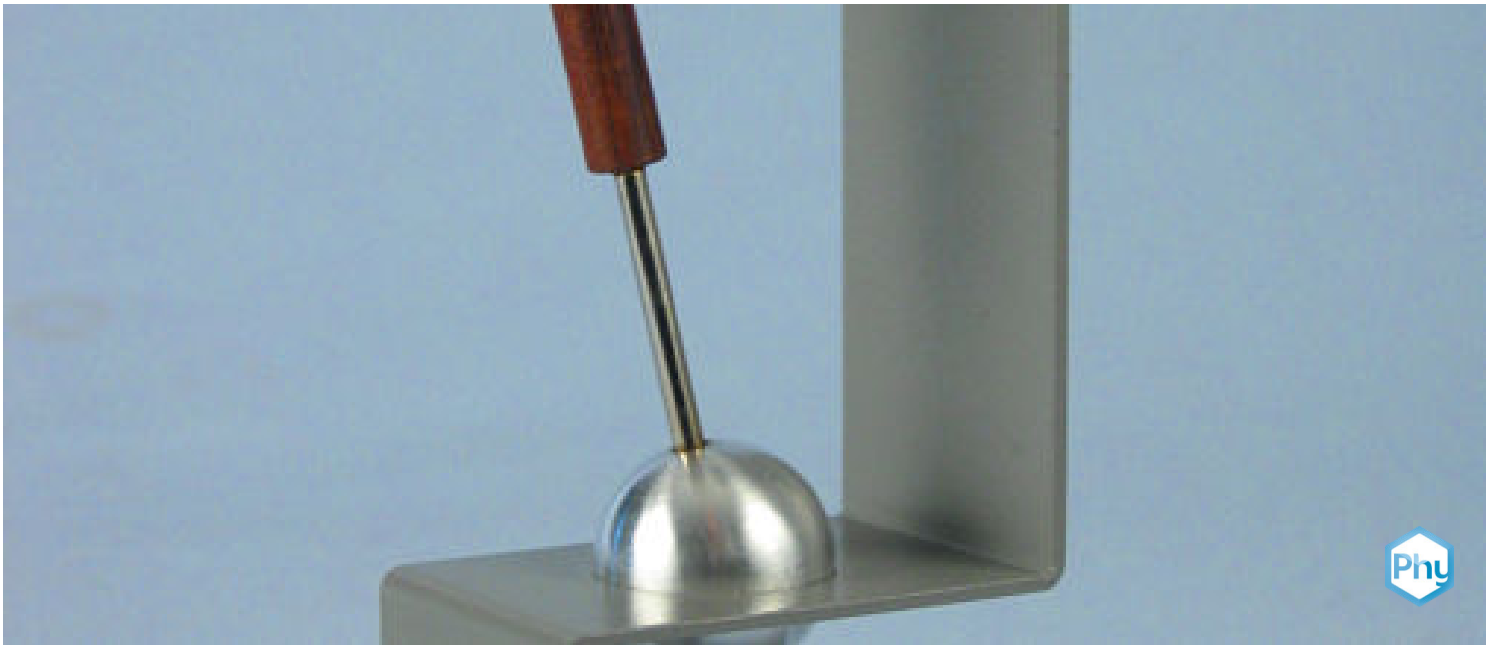
Volume expansion of solid bodies



Physics | Mechanics | Fabric & material properties

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5fd78496ce3751000353f2a6

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General information

Application

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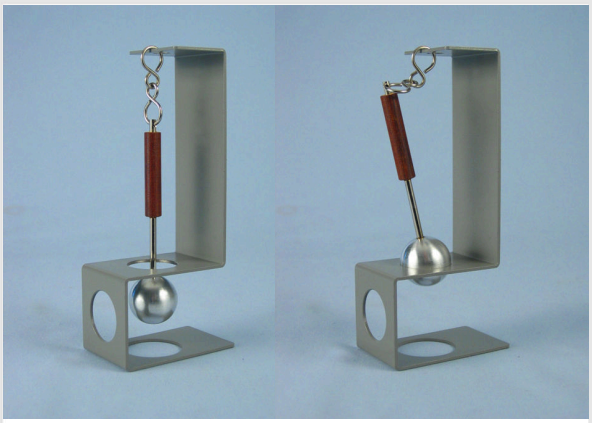

Setup

The temperature dependent behaviour of metals has many implications. For example while building constucts like bridges one has to accommodate for the possible expansion or contraction of the used metal.

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Other information (1/2)

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Prior knowledge

No prior knowlege is required.

Main principle

The expansion in volume of solid substances can be clearly demonstrated with the aid of a metal ball that just fits through a metal ring at room temperature. It remains stuck in the ring once it has been heated with a burner.

Other information (2/2)

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Learning objective

The goal of this experiment is to investigate the temperature dependent behaviour of metal.

Tasks

1. Investigate the influence of changing temperature on the volume of solid objects.

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Equipment

Position	Material	Item No.	Quantity
1	Ball and ring	04212-01	1
2	Beaker, Borosilicate, low form, 250 ml	46054-00	1
3	Butane burner, Labogaz 206 type	32178-00	1
4	Butane cartridge C206, without valve, 190 g	47535-01	1

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Setup and Procedure

Setup and Procedure (1/2)

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- Demonstrate that the ball fits through the circular opening in the appliance (the “ring”) at room temperature (figure 1).
- Hold the ball stem on the handle and heat up the ball for approx. 1 minute in the burner’s flame (figure 2).
- Place the ball on the opening (figure 3) and inspect the shape of the ball.
- Inspect the ball as it cools down.

Fig. 1

Fig. 2

Fig. 3

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Setup and Procedure (2/2)

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The test can be repeated once the ball has cooled down to such an extent that it is once again suspended below the opening. But prior to this the ball must have cooled down to such an extent that it is possible to hold the handle again.

- Place the glass beaker with approx. 200 ml of water next to the appliance.
- Hold the ball stem on the handle (if necessary with a cloth) and slowly immerse the ball into the water.
- Allow the ball to cool down for a few minutes.
- Repeat the experiment, this time heat up the ball for 2 minutes for instance.

Careful!
All the metal parts stay hot for a very long time! The handle will also be hot after a while.
You must therefore continue to inspect the appliance after the test or the ball must be cooled down.

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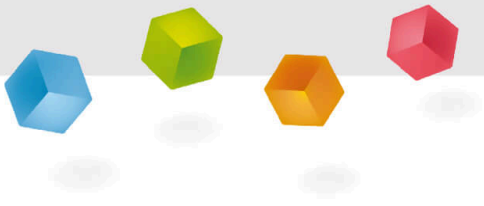

Evaluation

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Results

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At the start of the experiment the ball just fits through the opening and is suspended below the ring.
If it is heated for about 1 minute it remains stuck in the opening to begin with and suddenly falls through it after approx. 2 minutes.

If the ball is heated for about 2 minutes it can take more than 5 minutes before the ball falls through the opening. The ball shape has not changed while it was heated. You can hear a hissing noise as the ball is cooled in water, small bubbles emerge on the ball.

Evaluation

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Solid substances increase in volume as they are heated up and shrink again as they cool down. The ball shape is retained. The diameter is compared in qualitative terms with the diameter of the opening with the appliance. When cooling the ball in cold water the noise and the bubbles demonstrate that the water is boiling on the surface of the ball. Therefore the temperature of the ball is still above 100°C if it fits through the opening.

Remarks:

1. The ball must be heated for at least 0.5 minutes as it will otherwise not yet be hot enough and fall through the opening.

2. The metal ring naturally also heats up a bit as the hot ball is placed on top of it and the opening will increase slightly in size. As a result the ball does not have to cool down to quite the same extent to fit through the opening. However, this effect can be ignored in this case.

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