# Forces during the expansion of solid bodies

Physics > Mechanics > Fabric & material properties

Physics > Mechanics > Forces, work, power & energy

| 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/5fd78b74ce3751000353f2d4

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# General information

## Application

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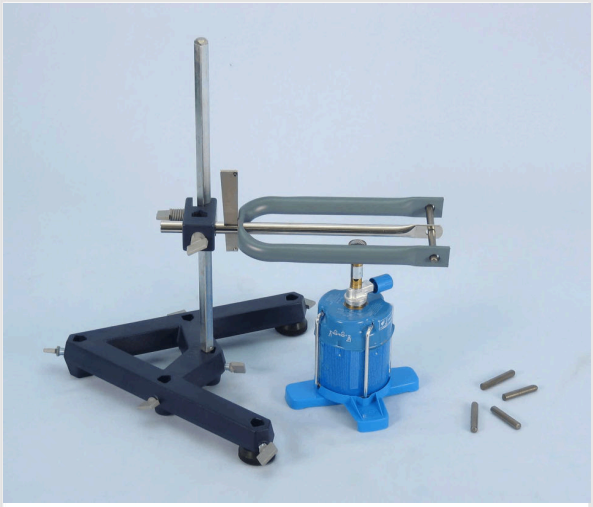

Setup

The temperature dependent behaviour of solids has many implications. For example while building constucts like bridges one has to accommodate for the possible expansion or contraction of the used metal. As such the understanding of the behaviour of such solids is very important for their use in construction.



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## Other information (1/2)

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**Prior knowledge**

No prior knowlege is required.

**Main principle**

The length of metal tubes or rods alters when heating them up or cooling them down. If a hot tube is firmly fixed in place then great forces will act upon its holders when cooling down. In this experiment one side of the holder consists of a rigid pin made of cast iron which is destroyed by this force when cooling down the tube.

## Other information (2/2)

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**Learning objective**

The goal of this experiment is to learn about the strong forces involved in the temperature dependent behaviour of solids.

**Tasks**

1. Use the Tyndall's bar breaker to demonstrate the forces involved with the temperature dependent behaviour of solids.



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## Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Support base DEMO | 02007-55 | 1 |
| 2 | Support rod, stainless steel, 500 mm | 02032-00 | 1 |
| 3 | Right angle clamp expert | 02054-00 | 1 |
| 4 | Pin shearing apparatus | 04220-00 | 1 |
| 5 | Crucible tongs, 200 mm, stainless steel | 33600-00 | 1 |
| 6 | Butane burner, Labogaz 206 type | 32178-00 | 1 |
| 7 | Butane cartridge C206, without valve, 190 g | 47535-01 | 1 |



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# Setup and Procedure

## Setup

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- Setup is performed according to Fig 1, insert the brass tube into the right-angle clamp in such a way that the narrower end of the tensioning wedge points downwards.
- Pull up the tensioning wedge, insert the cast iron pins in the pin shearing apparatus and clamp it firmly in place by pressing the tensioning wedge down. (If the clamping wedge juts out more than a third of the way out below a spacer ring should be placed between the clamping wedge and the ushaped support. The screw on the clamping wedge must be detached to do this.)
- The distance between the burner and the brass tube should be about 2 cm.

Fig. 1



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## Procedure

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- Heat up the brass tube, then occasionally lightly tap the clamping wedge with a second pin or with the crucible tongs so the brass tube with the cast iron pin are always securely fixed in place. (Otherwise the u-shaped holder can turn and the pin can slip.)
- Heat up the whole length of the brass tube until the clamping wedge reached the stop.
- Remove the burners.
- Observe the cast iron pins.

**Careful!** The brass tube and the cast iron pin will get very hot! Only touch the broken pin fragments with the crucible tongs.

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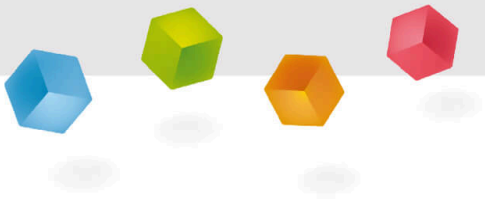

# Evaluation



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## Results

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When heating the brass tube its color changes and becomes red-hot at the point of the flame after a heating time of approx. 5 minutes. The wedge can easily be knocked into the slot by lightly tapping it. When cooling down the tube the cast iron pin will suddenly break after about 4 to 5 minutes. The sides of the pin fly off to the side some 1 to 2 meters.

## Evaluation

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The brass tube expands when heated. As a result the slot in the tube is displaced more in the direction of the clamping wedge and this can slip further down or be knocked slightly downwards. When it cools down the contraction of the tube is then prevented by the fact that it is clamped firmly in place. The forces that arise in the tube (Fig. 2) are so high that the cast iron pin that is not very elastic is destroyed.

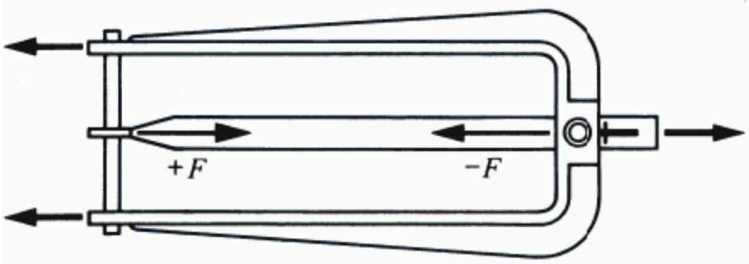


Fig. 2



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