

## Temperature as Function of Time in Bending Iron

### Equipment:

iron rod (e.g. 2 x 10 x 350 mm) with a thermocouple attached at the bending point by means of adhesive tape  
chart recorder  
two cables  
F-clamp or better bench vise

### Procedure:

Preparation: Before use, the iron rod has to be bent straight and the end which should be bent has to be soft annealed. The end clamped between the clamp or vise jaws has to be slightly wrapped with tape in order to reduce the thermal contact to the clamping device.

Procedure: The iron rod is clamped on the demonstration table by means of a F-clamp (or better clamped between the jaws of a bench vise). The thermocouple is connected with the chart recorder by means of the cables. Subsequently, the zero position of the chart recorder is adjusted to the center of the paper (50 %) and the iron rod is bent forwards and backwards. The measure range has to be chosen according to the thermocouple used, the paper advance should be approximately 250 mm/min.

### Observation:

The iron rod becomes warm when it is bent. If it is bent back to its original position the temperature rises further. Therefore, the plot of  $T$  against  $t$  resembles a stair step curve.

### Explanation:

Bending an iron rod back to its original state (after previous bending) costs again energy. This bending process is irreversible. Although the iron rod returns to its original position, it is now warmer. In this case, entropy is obviously being generated by permanent disturbance of the atomic structure of the metal and the energy involved is used up. It is not retrievable.

