## Experiment 12: Hardness of metal

Many complex metal parts of machinery, such as cylinder heads on car engines, are made of pouring liquid metal into a mould and allowing it to set over a given period of time. Often it is found that this 'setting time' is a crucial factor in determining the physical properties of the metal, such hardness. If the setting time is very short (e.g. a few seconds) then the solid formed is often hard but usually very brittle. Long setting times (such as a few hours) can decrease the brittle

The hardness of a sample of metal can be found by dropping an indenter made of a very hard material onto the surface of the metal and measuring the diameter $d$ of the indentation surface, as shown in Fig. 3.1.

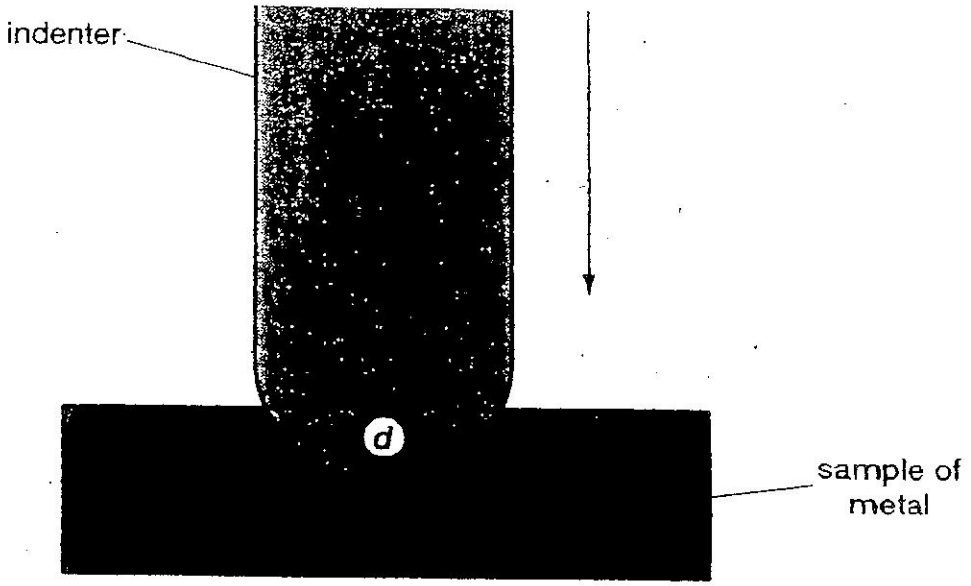


**Fig. 3.1**

Design a laboratory experiment to investigate how the hardness of lead (as measured described above) depends on the setting time of molten lead. You may assume t apparatus listed below is available, together with any other standard equipment whic found in a school or college science laboratory.

| | |
|---|---|
| Lead shot | Travelling microscope |
| Rectangular clay trough | Voltmeter |
| Bunsen burner | Thermocouple thermometer |
| Stopwatch | Low voltage power supply unit |
| Small coil of wire | Switch |
| Fume cupboard | Indenter |
| Micrometer screw gauge | Metre rule |

In your account you should pay particular attention to

**(a)** the procedure to be followed,

**(b)** the method of measuring the diameter of the indentation,

**(c)** control of variables,

**(d)** any necessary safety precautions which you would take.