Introduction to Planning Question

Name: Suggested solutions ( )

Class: ..... **Date:** .....

Exercise 1 (N99/4/3)

Many complex metal parts of machinery, such as cylinder heads on car engines, are made by 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 as hardness. If the setting time is very short (e.g. a few seconds) then the solid formed is often very hard but usually very brittle. Long setting times (such as a few hours) can decrease the brittleness.

The hardness of a sample 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 at the surface, as shown in Fig. 1.1.

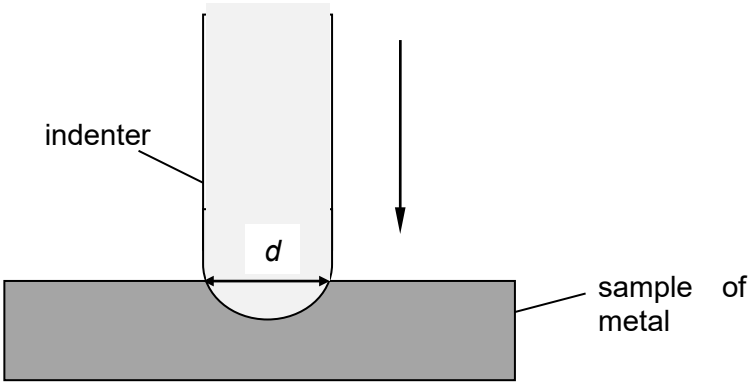


Fig. 1.1

A laboratory experiment is to be conducted to investigate how the hardness of lead (as measured by the test above) depends on the setting time of molten lead.

Identify the following:

(i) independent variable: setting time *t*

(ii) dependent variable: diameter *d* of the indentation

(iii) control variables (there may be more than one): height from which indenter is released, mass, shape and orientation of indenter

Exercise 2 (N97/4/3)

An air rifle can be used to fire small metal pellets which have a speed of about 150 m s^{-1} on leaving the rifle. When an absorbent material is placed some distance from the rifle, the pellets are observed to penetrate the material to a depth of three or four centimetres.

An experiment is to be designed to investigate how the depth of penetration varies with the speed of the pellet when they are fired from a mounted air rifle into sheets of absorbent material such as cork.

(a) Identify the following:

(i) independent variable: speed v of pellet

(ii) dependent variable: depth x of penetration

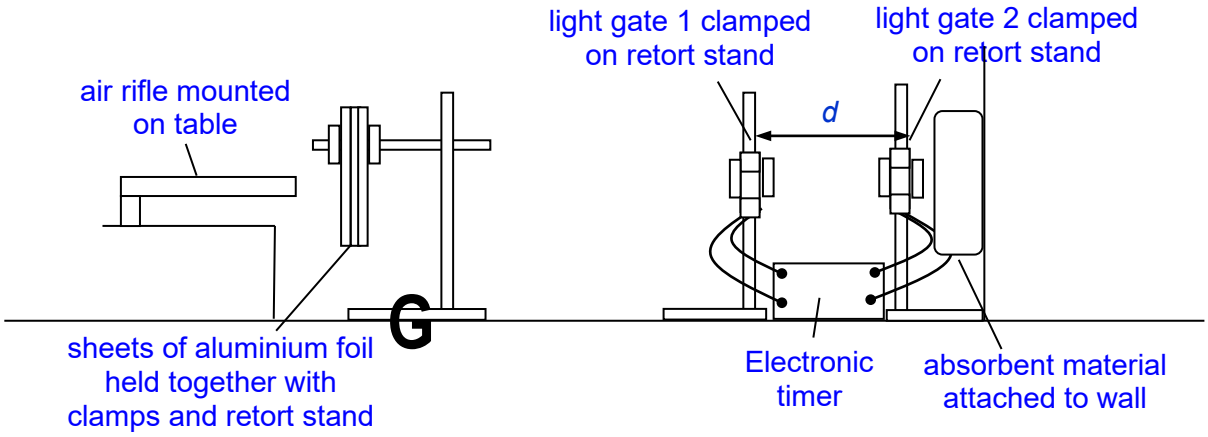
(iii) control variables (there may be more than one): type of pellets used, i.e., same mass and shape
type of absorbent material used
orientation of rifle relative to absorbent material

Suppose the following equipment is available, together with any other standard laboratory apparatus that would be found in a school or college science laboratory.

Mounted air rifle (assume that the pellets leave this rifle with a fixed speed)
Connecting wires
Light gates
Electronic timer
Rule
Sheets of absorbent material
Thin aluminium foil

Design an experiment to carry out this investigation.

(b) Draw a diagram of your set-up:



(c) Describe briefly how you would

(i) measure the independent variable.

1. Upon firing the pellet, measure the time taken t for the pellet to move from one light gate to the other.
2. Adjust the distance d to be sufficiently large such that the electronic timer is able to register the time of travel of the pellet.
3. Measure d of light gates using a metre rule.
4. Determine v using $v = d/t$.

(ii) measure the dependent variable.

Use the tail of a vernier callipers to measure x after removing the pellet with a tweezer.

(iii) vary the independent variable.

Vary v by varying the number of sheets of aluminium foil placed in front of the air rifle.

Note: Power of air guns is adjustable. If power is adjusted instead of using aluminium foils to reduce the speed of pellet,

(i) independent variable: speed v of pellet when fired from rifle

(iii) control variables: distance of rifle from absorbent material