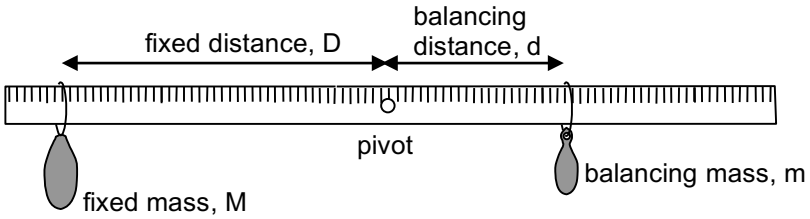
Balanced Beam Experiment

Aim

To find the mathematical relationship between the balancing mass, **m**, and the balancing distance, **d**, when a pivoted metre rule is balanced.

Equipment

Metre ruler (with a pivot hole at the centre), balancing masses, fixed mass, nail (for pivoting the ruler), retort stand, electronic balance.



Task

Set up the equipment:

- Fix the nail horizontally to the retort stand and pivot the ruler on the nail.
- Hang the fixed mass at a distance of 0.5m from the pivot (the ruler will tip over). Use electronic scales to find its precise mass.
- Hang different balancing masses **m** over the other end of the ruler to make the ruler balance (see diagram). Record the distance d from the pivot for each mass.

Carry out the experiment and write a report that includes:

Method:

- Identify the dependent and independent variables.
- Identify any variables that must be controlled.
- Identify how you maximized the accuracy of the data you gathered.
- Give all raw measurements in an appropriately headed results table, using appropriate units and significant figures. (You must make sufficient measurements to allow you to draw a graph that will help you determine the required relationship.)

Data analysis:

- Plot an appropriate graph to find the type of relationship between balancing mass, m, and balancing distance, d. Draw a curve of best fit (the raw data will not give a straight-line graph).
- Determine the type of relationship that this graph suggests.
- Process the data so that you can draw a straight-line graph. Plot and draw the straight-line graph.

Conclusion:

Using information from the straight-line graph, state the mathematical relationship between balancing mass, m, and balancing distance, d.

Discussion:

Discussion statements should attempt to **validate** your conclusion. They could include:

- How the findings of your investigation relate to stated physics theory. If an unexpected result is obtained you should suggest how it could have been caused or explain the effect it had on the Validity Of The Conclusion.
- For the variables you controlled, a description of how each was controlled and an explanation of why it needed to be controlled.

- For the accuracy improving techniques you used, a description of what you did and an
- explanation of why it needed to be done
- A description of any difficulties you encountered when making measurements and an explanation of how these difficulties were overcome.
- A reason why there was a limit to the range of values you chose for the independent variable.

Additional information

Physics theory states that when a beam is balanced $\boldsymbol{md = MD}$

m is the balancing mass
d is the distance between the pivot point and the balancing mass
M is the fixed mass
D is the distance between the pivot point and the fixed mass

This can also be rearranged to:

$$\boldsymbol{d = \frac{MD}{m}}$$

Check list:

- The aim of the investigation is clearly stated.
- A reasonable hypothesis predicting the nature of the relationship is made, and justified using physics theory.
- A range of control variables are identified, and strategies for controlling them are given.
- Units for all measurements are clearly stated.
- At least 2 techniques are used to improve accuracy (e.g. repeated measurements).
- Units for all calculated values are given.
- All graphs are correctly labelled, including titles, axis labels , and units.
- Value for the gradient determined correctly, and stated with correct rounding.
- Mathematical relationship between independent and dependant variables is stated.
- Experimental results are compared with theoretical results.
- A judgement is made as to whether experimental results agree with theory.
- An attempt is made to explain any discrepancies between experimental and theoretical results.
- Any problems encountered with the experimental procedure are discussed and possible solutions given.
- Discuss the limitations of the physics theory or you experimental procedure.