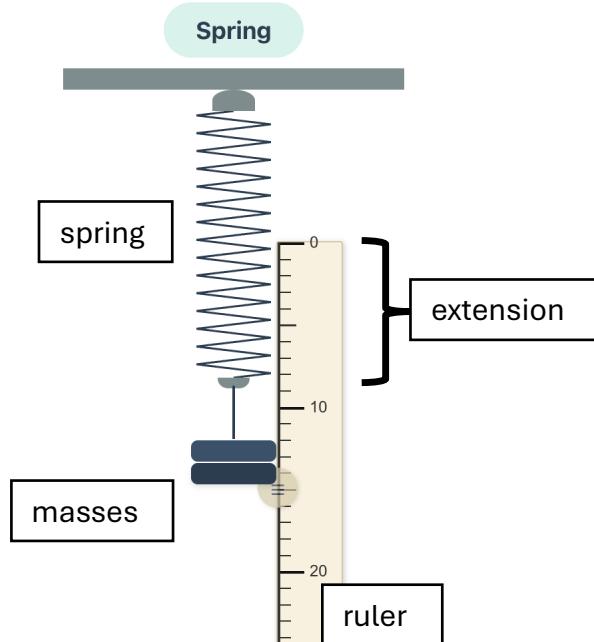


## Investigating Extension

*Aim:* The aim of this experiment is to investigate the relationship between force and extension for a spring and a rubber band



*Method:*

1. Align the ruler with the bottom of the spring.
2. Add a 100g mass to the spring
3. Record the force ( $W = m \times g$ ) and the extension
4. Repeat this process for 4 more 100g masses
5. In a real-world scenario this should be repeated 3 times and a mean taken but no randomness has been built into this simulation
6. Plot a graph of Force (N) against Extension (cm)

*Analysis of results:*

- Plot a graph of the force against extension for the spring / rubber band / metal wire
- Draw a line or curve of best fit
- If the graph has a linear region (is a straight line), then the force is proportional to the extension. You can calculate the gradient, which will be the spring constant

*Results:*

<b>Material</b>	<b>Mass (kg)</b>	<b>Force (N)</b>	<b>Extension (cm)</b>

Repeat the process using a rubber band. This time you need to record the extension while loading (adding masses) and unloading (removing masses) as rubber behaves differently in these situations

<b>Material</b>	<b>Mass (kg)</b>	<b>Force (N)</b>	<b>Loading Extension (cm)</b>	<b>Unloading Extension (cm)</b>

### **Notes on the method:**

The force,  $F$  added to the spring / rubber band / metal wire is the weight of the mass  
The weight is calculated using the equation:

$$W = m \times g$$

Where:

- $W$  = weight in newtons (N)
- $m$  = mass in kilograms (kg)
- $g$  = gravitational field strength on Earth in newtons per kg (N/kg)

Therefore, multiply each mass by gravitational field strength,  $g$ , to calculate the force,  $F$   
The force can be calculated by multiplying the mass (in kg) by 10 N/kg

NB: In some versions of this investigation you are asked to measure the full length of the spring and calculate extension from:

$$e = \text{new length} - \text{original length}$$

### **Extension**

- Repeat the experiment for different stiffnesses of spring

### **Evaluation (for exam questions about the real investigation)**

#### **Systematic errors**

- Make sure the measurements on the ruler are taken at eye level to avoid parallax error

#### **Random errors**

- The accuracy of such an experiment is improved with the use of a pointer (a fiducial marker)
- Wait a few seconds for the spring / rubber band / metal wire to fully extend when a mass is added, before taking the reading for its new length
- Make sure to check whether the spring has not gone past its limit of proportionality otherwise, it has been stretched too far

### **Safety**

Wear safety glasses in case the spring breaks

Keep feet away from below the masses in case any fall

Use a mat or soft cushion below the masses to prevent damage

Use a G clamp to fix the clamp stand to the table to prevent it from tipping over