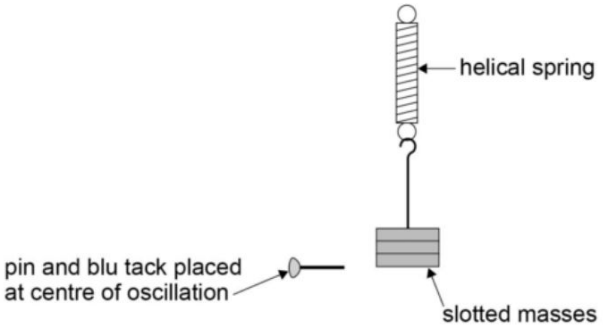
AQA Physics A-level

Required Practical 7

Investigation into simple harmonic motion using a mass-spring system and a simple pendulum

Mass-spring system

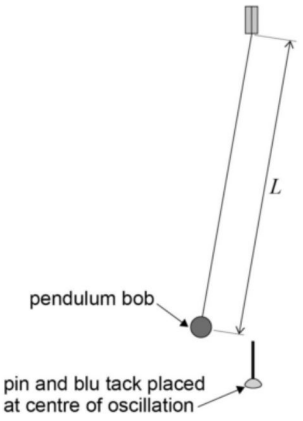
- Equipment:
  - Spring
  - 50g masses with 50g holder
  - Stand and clamp
  - Pin and blu-tack
  - Metre ruler
  - Stopwatch



- Method:
  - Set up the apparatus as shown in the diagram, with no masses slotted on the 50g holder.
  - Pull the mass hanger vertically downwards a few centimetres and release it. Start the stopwatch when it passes the fiducial marker (pin and blu-tack at the centre).
  - Stop the stopwatch after 10 complete oscillations and record this time T_{10}. Divide T_{10} by 10 to find the time period T of the mass-spring system and record this.
  - Add a 50g mass to the 50g holder and repeat this, adding 50g each time up to 500g, recording the total hanging mass m and corresponding time period T for each.
  - Repeat the experiment twice more and find and record the mean T for each m.
- Graphs and calculations:
  - Plot a graph of T^2 against m and draw a line of best fit. The gradient will be 4π^2 divided by the spring constant.
  - $T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T^2 = \frac{4\pi^2}{k}m$
- Safety:
  - Suspended masses could be dangerous if the masses fall off and injure someone. To avoid this, only pull down the spring by a few centimetres and don't attach too heavy masses to the spring.
- Improvements and notes:
  - If the spring starts to move horizontally during its oscillation, stop the oscillation and start it again making sure it is pulled vertically downwards.
  - Timing more oscillations for each mass reduces the percentage uncertainty in the time period.
  - The fiducial marker should be at the centre of the oscillation (equilibrium position) so the mass is moving past it at the fastest speed and there is the least uncertainty in starting and stopping the stopwatch.
  - A motion tracker and data logger can be used to find a more accurate value for the time period and eliminating random error in starting and stopping the stopwatch.

Simple pendulum

- Equipment:
  - Pendulum bob on 2m long string
  - Stand and clamp
  - Pin and blu-tack
  - Metre ruler
  - Stopwatch
  - Two wooden blocks



- Method:
  - Set up the apparatus as shown in the diagram.
  - Adjust the point of suspension so that the distance L from that point to the centre of mass of the pendulum bob is 1.500m.
  - Pull the pendulum to the side and release it so that it has a small amplitude and travels in a straight line. Start the stopwatch when it passes the fiducial marker (pin and blu tack at the centre).
  - Stop the stopwatch after 10 complete oscillations and record this time T_{10}. Divide T_{10} by 10 to find the time period T of the pendulum and record this.
  - Decrease the length L by 0.100m and repeat this, reducing L by 0.100m each time down to 0.500m.
  - Repeat the experiment twice more and find and record the mean T for each L.
- Graphs and calculations:
  - Plot a graph of T^2 against L and draw a line of best fit. The gradient will be 4π^2 divided by g.
  - $T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow T^2 = \frac{4\pi^2}{g}L$
- Safety:
  - No notable risks.
- Improvements and notes:
  - It is recommended to use a small pendulum bob so that it is easier to measure the length to its centre of mass. Additionally, you could measure first the length of the string and then add the radius of the bob onto this to find L.
  - The angle between the string and the downwards vertical at the maximum amplitude should be no more than about 15° for the equations to work.
  - Like the spring experiment, a motion tracker and data logger can be used.