OCR B Physics A-Level

PAG 2.2

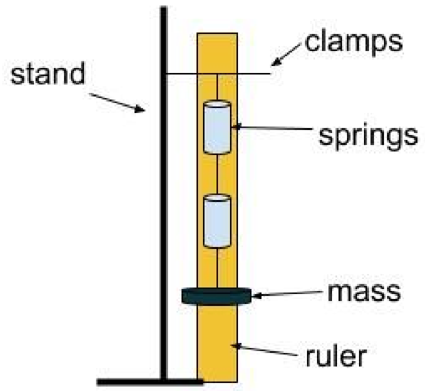
Investigating springs in series and in parallel

Equipment

- Stand and clamp
- Springs
- Metre ruler
- 50 g masses

Method

- Set up the apparatus as shown in the diagram, the arrangement of the springs is optional, here they are in series but can also be arranged in parallel and with more than two springs, the mass value is also optional but must be constant throughout the experiment.



For springs in series

1. Record the original length, L of the spring(s) and the number of springs in the series, n.
2. Attach the mass and record the new length of the springs.
3. Repeat for different values of n.

For springs in parallel

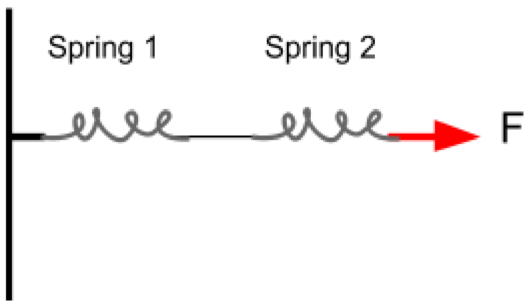
1. Record the original length of the springs in parallel.
2. Attach the mass and record the new length of the springs.
3. Repeat for different numbers of springs in parallel.

Calculations

- Work out the extension for each spring combination by finding the difference between the new length and the original length.
- For springs in series, find the spring constant of the combination, which is the force applied (mg), divided by the extension of the combination in metres.
- To check this against the theoretical spring constant for the combination, use the equation:

$$1/k_{combination} = 1/k_{spring\ 1} + 1/k_{spring\ 2} + \ldots\ 1/k_{spring\ n}$$

where k is the spring constant, the derivation of this equation can be found below:



The total extension of the combination is the sum of each spring's extension (X) and the force through each spring is the same

$X_{combined} = X_1 + X_2$ F = kX so X = F/k hence

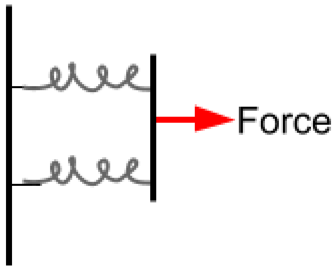
$F/k_{combined} = F/k_1 + F/k_2$ divide through by F for:

$1/k_{combination} = 1/k_{spring\ 1} + 1/k_{spring\ 2}$

- For springs in parallel, find the spring constant of the combination, which is the force applied (mg), where m is in kg, divided by the extension of the combination in metres
- To check this against the theoretical spring constant for the combination, use the equation:

$$k_{combination} = k_1 + k_2 + \ldots\ k_n$$

the derivation of this equation is found below:



The force exerted on the spring combination is equal to the sum of the forces exerted on each spring

$F_{combination} = F_1 + F_2$ as $F = kx$

$xk_{combination} = xk_1 + xk_2$

Assuming the extension of each spring is equal, and dividing through by it:

$k_{combination} = k_1 + k_2 + \dots k_n$

Safety

- Do not exert too high a force on the springs as if part of the apparatus breaks then the masses will fall and can cause injury.
- Don't let the springs recoil too quickly as they can snap on fingers and cause cuts and bruises.
- Wear eye protection.

Notes

- Using too high a force can cause the springs to become permanently extended.
- Always measure the spring's position from the same point, if it helps, mark this point with pen or tape.