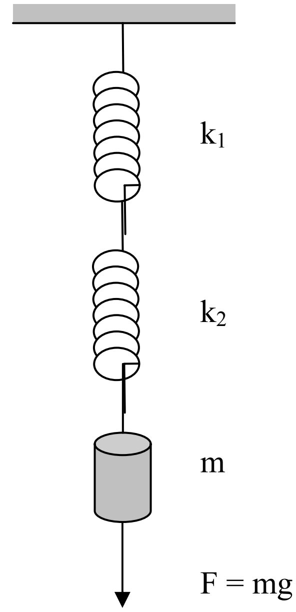
Combinations of Springs

Springs in Series

- *Consider two springs with force constants k_1 and k_2 connected in series supporting a load F = mg.*
- *Let the force constant of the combination be represented by k*
- *For the combination, supporting the load F=mg:*

$F = kx$ *(where x = the total stretch)*

and $x = \frac{F}{k}$



- *For each spring*

  - the bottom supports mg=F and stretches by x_1

  $F = k_1 x_1$ *or* $x_1 = \frac{F}{k_1}$

  - the top spring support mg plus the weight of the bottom spring (which is negligible - Thus F is the stretching force for both springs)

  $F = k_2 x_2$ *or* $x_2 = \frac{F}{k_2}$

- *The total stretch*

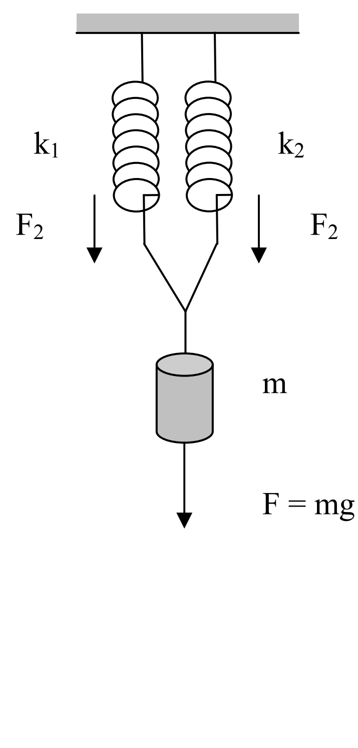
$x = x_1 + x_2$ *or* $\frac{F}{k} = \frac{F}{k_1} + \frac{F}{k_2}$

and $\boxed{\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}}$

Springs in Parallel

- *Consider two springs with force constants k_1 and k_2 connected in parallel supporting a load F = mg.*
- *Let the force constant of the combination be represented by k*
- *For the combination supporting the load F=mg:*

$F = kx$ *(where x = the total stretch)*



- *The two individual springs both stretch by x but share the load ($F = F_1+F_2$) and*

$F_1 = k_1 x$ *while* $F_2 = k_2 x$

- *Thus the total force is*

$F = F_1 + F_2$ *or* $kx = k_1 x + k_2 x$

and $\boxed{k = k_1 + k_2}$