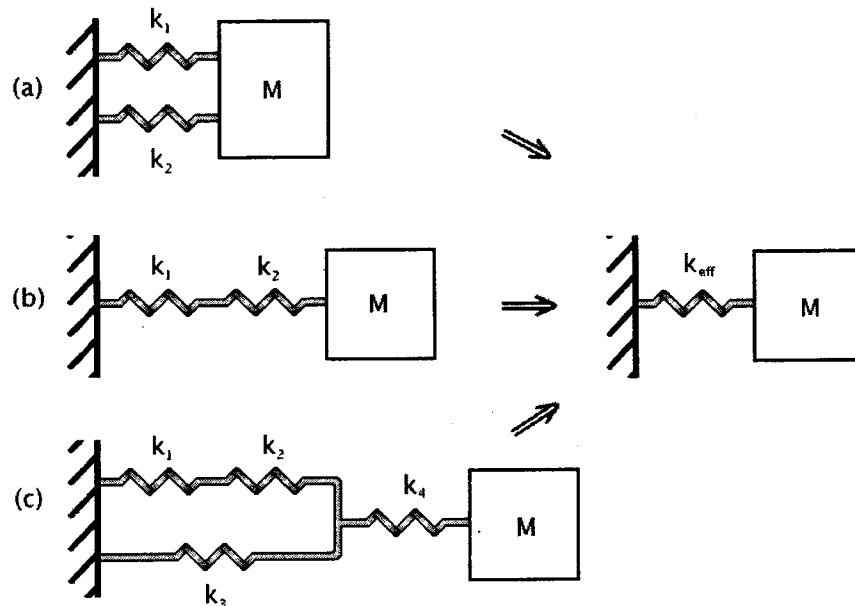


QP49

System of Springs



The restoring force on a spring is governed by Hooke's Law, $F = -kx$. Springs are linear devices, so any combination of springs can be modelled as a single spring with an effective spring constant $F = -k_{\text{eff}}x$. Refer to the diagram for parts (a), (b), and (c). Your final answers will not depend on M .

- (a) (2 points) Derive the relation between k_1 , k_2 , and k_{eff} for springs attached in parallel. You should find:

$$k_{\text{eff}} = k_1 + k_2 \quad (1)$$

- (b) (3 points) Derive the relation between k_1 , k_2 , and k_{eff} for springs attached in series. You should find:

$$\frac{1}{k_{\text{eff}}} = \frac{1}{k_1} + \frac{1}{k_2} \quad (2)$$

Hint: Consider the balance of forces at the junction of the two springs.

- (c) (2 points) Find k_{eff} for the illustrated system. The springs are attached by rigid rods and do not bend.
- (d) (3 points) Suppose you use your Caltech degree to get a job at a spring factory. The factory can produce springs of any length; springs of length l have spring constant k . A client orders a spring with constant $k/3$. What must be the length of this spring? If you cut a spring of length l in half, what will the spring constant be?