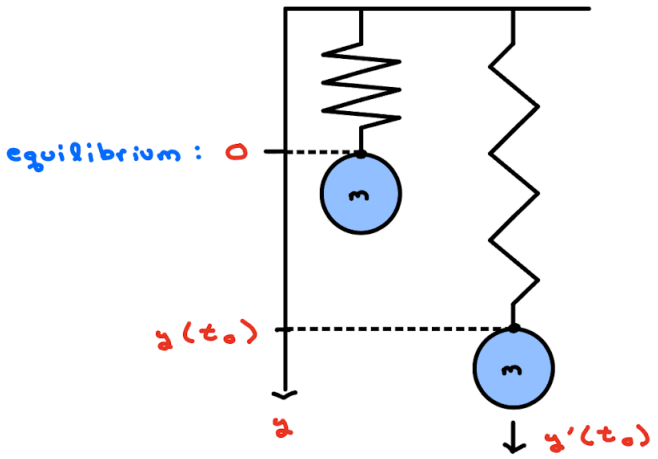
A. **Harmonic Motion.** We consider a mass $m$ hanging from a spring so that $y$ measures the displacement down from equilibrium.




We may also be provided an initial position $y(t_0)$ and an initial velocity $y'(t_0)$ as depicted.

Spring constant $k$ measures the stiffness of the spring.

By **Hooke's law** the combination of the restoring force of the spring and the force due to gravity is:

Hooke's law says that the restoring force of the spring at displacement $x$ from **weightless** equilibrium equals $kx$.

Damping constant $\mu$ measures the resistance to motion of the medium (e.g. air).

The motion–resisting force due to damping is:

Newton's second law says that the total force acting on an object equals its mass times its acceleration.

By Newton's second law:

**Harmonic Motion with No External Force.**

**Example 1.** A $10\ \mathrm{kg}$ mass is hanging from a spring with spring constant $50\ \mathrm{kg/s^2}$ and is placed in a viscous medium that provides a damping constant $20\ \mathrm{kg/s}$. The mass is held still $2\ \mathrm{m}$ down from equilibrium, and at time $t = 0$ is released. Find a formula for its displacement $y(t)$ down from equilibrium at time $t$ sec.