Newton's 1st & 2nd Laws of Motion

Applications, including equilibrium

Newton's First Law of Motion

- **Inertia**: A property of matter that describes an object's tendency to resist a change in its current state of motion
  - Related directly to mass—the more massive an object is, the more inertia
  - The more massive an object is, the more difficult it becomes to change its motion—start it moving, stopping it, or changing its direction

Newton's First Law of Motion

- **States:** A body at rest will remain in a state of rest (not moving); a body in motion will stay in its straight-line motion (at a constant velocity) until some outside net force acts upon the body.
  - **Means:** In order to change an object's velocity, a net force must be applied from outside the system.
  - Heavy trains are hard to stop, and you'd rather be behind a Mini Cooper than a semi when the light turns green.

Newton's second law of motion

- Most commonly known in equation form:

$$F_{net} = m \cdot a$$

- **Means:** When there is a net force acting on an object, the acceleration experienced by the object is inversely proportional to its mass
- Doubling the mass will result in half the acceleration when the same net force is applied.

Equilibrium

- An object is in a state of equilibrium when the net force acting on it is zero
- The forces acting on the object are said to be **Balanced Forces**
- The object is either stationary or is not accelerating—its state of motion remains constant

Equilibrium States

- **Static Equilibrium:**
  - The net force on an object is zero, and it is stationary.
- **Dynamic Equilibrium:**
  - The net force on an object is zero, and it is moving at a constant velocity

Weight

- The weight of an object is a measure of the force of gravity acting on that object
- The weight of an object is dependent on its mass:

$$F_g = m \cdot g$$

Example problem

- A chandelier is hanging from the ceiling from a single cable. What is the tension in the cable if the mass of the chandelier is 94.1 kg?

$$F_{net} = 0 = F_T + (-F_g)$$

$$F_g = F_T$$

$$m \cdot g = F_T$$

$$(94.1kg) \cdot (9.81m \cdot s^{-2}) = F_T$$

$$F_T = 923N$$