Summary Lecture 7

Newton’s 2nd Law:
The acceleration of a body is directly proportional to the net force acting on it, and inversely proportional to its mass.

\[ \vec{F}_{\text{net}} = m\vec{a} \]

The direction of the acceleration is in the direction of the applied net force.

Force:
Force is a vector.
Forces are measured in units of Newton (N). 1 N is the force required to accelerate a mass of 1 kg with 1 m/s².

1 N = 1 kg m/s²
Inertial Reference Frames

- Newton’s 1st law holds
- moving with constant velocity
  ≠ not rotating and not accelerating

Weight

Force of gravity acting on a mass
\[ F = mg, \text{ down} \]

Newton’s Third Law of Motion:
Whenever one object exerts a force on a second object, the second exerts an equal and opposite force on the first.

Note: the action and the reaction force are exerted on different objects
Newton’s Law of Gravity

**Force of Gravity**

Directed along the line connecting the 2 masses. Always attractive.

\[ F_G = G \frac{m_1m_2}{r^2} \]

Universal Gravitational Constant
\[ G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \]

Weight, revisited:

\[ F_W = mg = G \frac{mM_E}{r_E^2} \]

\[ g = G \frac{M_E}{r_E^2} \]
RECIPE:

○ For each body in the problem

- Draw the free body diagram including all forces acting ON this body
- Define your coordinate system (positive x, positive y)
- If necessary, split up forces in horizontal and vertical components (x and y)
- Determine the net force \( \vec{F}_{net} = \sum \vec{F} \)
  separately for x and y, if necessary:

  \[
  F_{Net x} = \sum F_x \quad F_{Net y} = \sum F_y
  \]

- Apply Newton’s second law

  \( \vec{F}_{net} = m \vec{a} \)

  separately for x and y, if necessary:

  \[
  F_{Net x} = ma_x \quad F_{Net y} = ma_y
  \]

- \( m \) is the mass of this body

  \( a \) is the acceleration of this body

○ Solve equations for unknowns