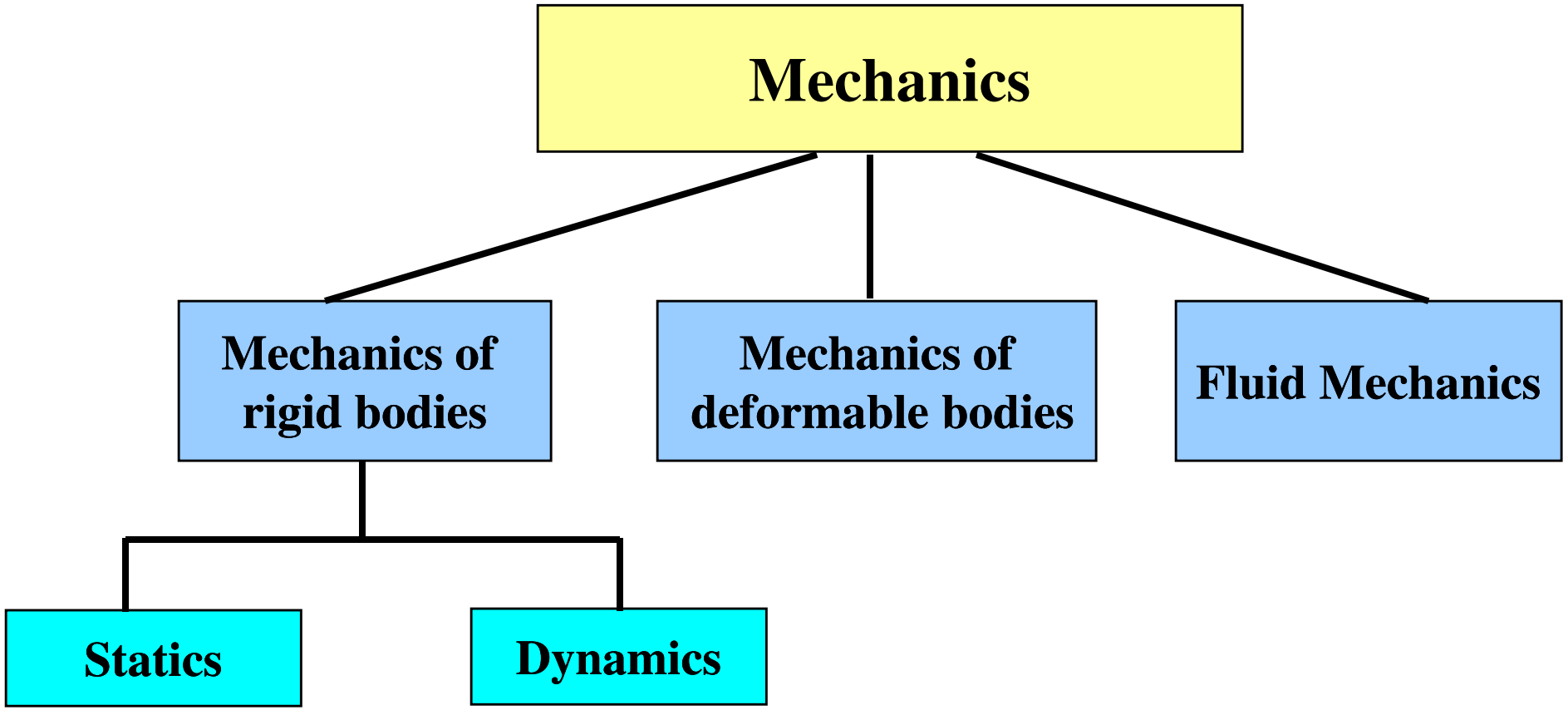
Chapter 1
General Principles

Mechanics : A branch of the physical science that is concerned with the state of rest or motion of bodies subjected to the action of forces.



- **Statics** deals with equilibrium of a body that is
  - either at *rest*
  - or moves with *constant velocity*.
- **Dynamics** deals with *accelerated motion* of a body.

❑ Fundamentals Concepts

I. Idealizations

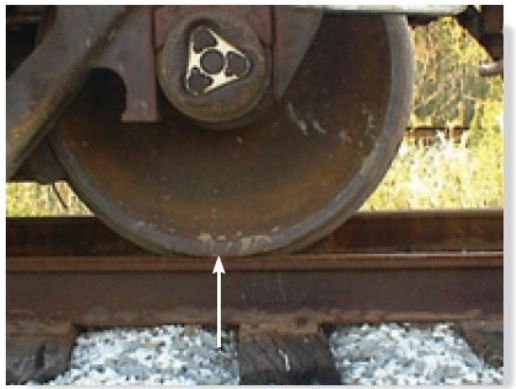
1. Particle

- has a mass
- size can be neglected

2. Rigid Body

- a combination of a large number of particles

3. Concentrated Force



- represents the effect of a loading which is assumed to act at a point on a body.

II. Basic Quantities

1. **Length**
   - locate the position of a point in space

2. **Mass**
   - measure of a quantity of matter

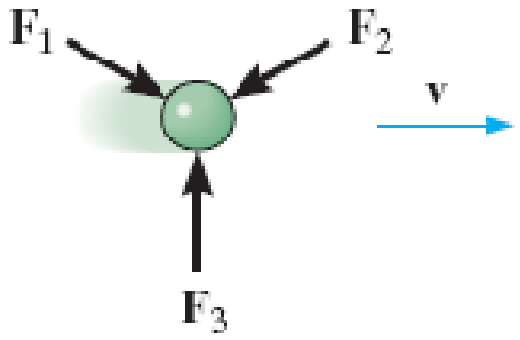
3. **Time**
   - succession of events

4. **Force**
   - a “push” or “pull” exerted by one body on another
   - characterized by its magnitude, direction & point of application.

III. Newton's Three Laws of Motion

- **First Law**

  "A particle originally at rest, or moving in a straight line with constant velocity, will remain in this state provided that the particle is not subjected to an unbalanced force"



Equilibrium

Second Law

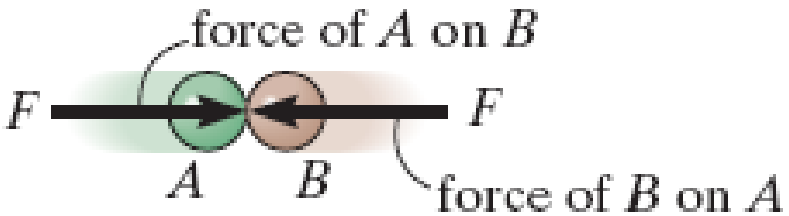
"A particle acted upon by an *unbalanced force* **F** experiences an acceleration **a** that has the same direction as the force and a magnitude that is directly proportional to the force"

$$\mathbf{F} = m\,\mathbf{a}$$

Accelerated motion

Third Law

"The mutual forces of action and reaction between two particles are equal and, opposite and collinear"



Action – reaction

IV. Newton's Law of Gravitational Attraction

$$F = G\frac{m_1 m_2}{r^2}$$

where

F = force of gravitation between two particles

G = universal constant of gravitation

m_1, m_2 = mass of each of the two particles

r = distance between the two particles

V. Weight

Let $m_1 = M_e =$ mass of the earth

$m_2 = m =$ mass of a particle on the earth's surface

$r = R =$ distance between the earth's center and the particle

Then the gravitational force between the earth and the particle, is termed the weight (W) of the particle

$$W = G\frac{M_e m}{R^2}$$

or

$$\boxed{W = mg}$$

where

$$g = GM_e / R^2$$

Units of Measurement

- SI system specifies length in meters (m), time in seconds (s) and mass in kilograms (kg)

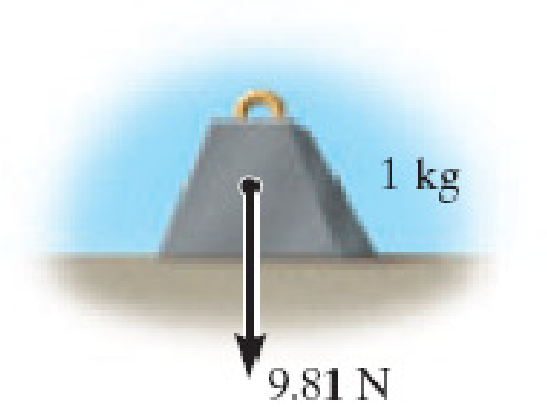
- The unit of force, called a newton (N), is derived from $\mathbf{F} = m\mathbf{a}$

Name	Length	Time	Mass	Force
International Systems of Units (SI)	Meter (m)	Second (s)	Kilogram (kg)	Newton (N) $\left(\frac{kg.m}{s^2}\right)$

Note:

- At the standard location,

  $g = 9.806\ 65\ m/s^2$



- For calculations, we use

  $g = 9.81\ m/s^2$

- Thus, from $W = mg$, a body of mass 1 kg has a weight of

  $$W = (1)\ (9.81) = 9.81\ N$$

Prefixes

TABLE 1–2 Prefixes

	Exponential Form	Prefix	SI Symbol
Multiple			
1 000 000 000	10^9	giga	G
1 000 000	10^6	mega	M
1 000	10^3	kilo	k
Submultiple			
0.001	10^{-3}	milli	m
0.000 001	10^{-6}	micro	μ
0.000 000 001	10^{-9}	nano	n