

Engineering Mechanics: Statics in SI Units, 12e

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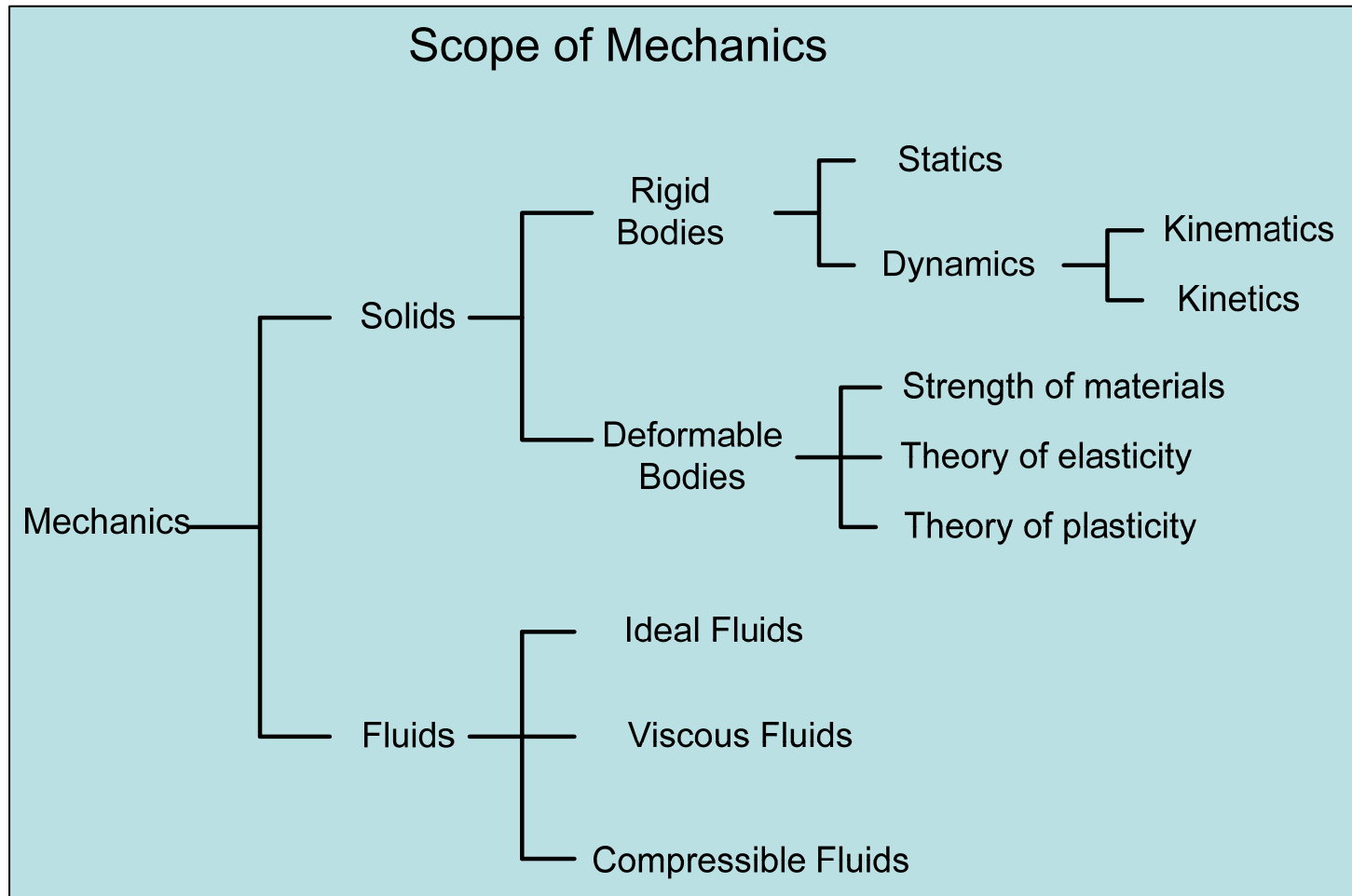
General Principles



1.1 Mechanics

- 力學：描述及預測物體在受力時靜止或運動狀態的科學

力學的範疇



1.2 Fundamentals Concepts

Basic Quantities

- Length
 - locate the position of a point in space
- Mass
 - measure of a quantity of matter
- Time
 - succession of events
- Force
 - a “push” or “pull” exerted by one body on another

1.2 Fundamentals Concepts

Idealizations

- Particles
 - has a mass and size can be neglected
- Rigid Body
 - a combination of a large number of particles
- Concentrated Force
 - the effect of a loading

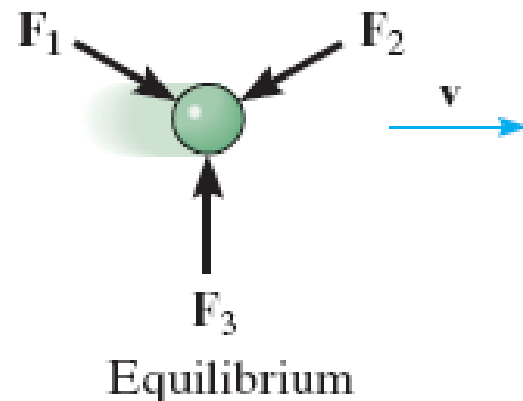


1.2 Fundamentals Concepts

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"



1.2 Fundamentals Concepts

Newton's Three Laws of Motion

- **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"

$$F = ma$$



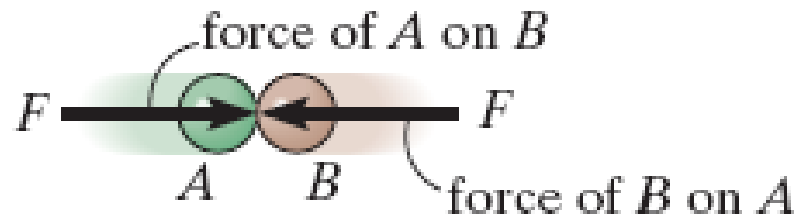
Accelerated motion

1.2 Fundamentals Concepts

Newton's Three Laws of Motion

- **Third Law**

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



Action – reaction

1.2 Fundamentals Concepts

Newton's Law of Gravitational Attraction

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

F = force of gravitation between two particles

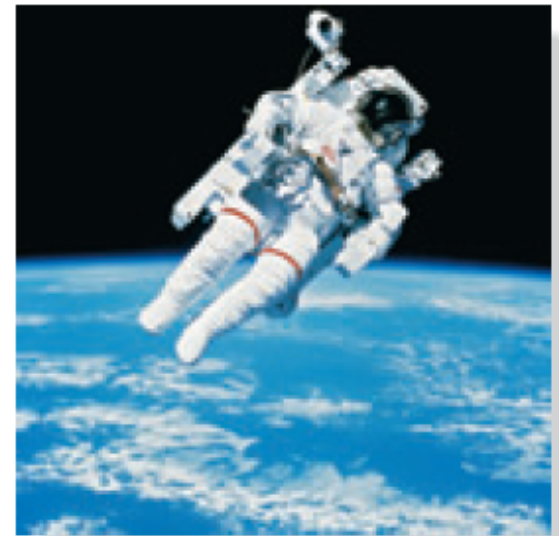
G = universal constant of gravitation

m_1, m_2 = mass of each of the two particles

r = distance between the two particles

$$\text{Weight: } W = G \frac{mM_e}{r^2}$$

Letting $g = GM_e / r^2$ yields $W = mg$



1.3 Units of Measurement

SI Units

- Stands for *Système International d'Unités*
- SI system specifies length in meters (m), time in seconds (s) and mass in kilograms (kg)
- Force unit, Newton (N), is derived from $F = ma$

1.3 Units of Measurement

TABLE 1-1 Systems of Units

Name	Length	Time	Mass	Force
International System of Units	meter	second	kilogram	newton*
SI	m	s	kg	$\frac{\text{N}}{\left(\frac{\text{kg} \cdot \text{m}}{\text{s}^2}\right)}$

1.4 The International System of Units

TABLE 1-2 Prefixes

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

Prefix

Item	Power of 10
a(tto)	-18
f(empto)	-15
p(ico)	-12
n(ano)	-9
μ (micro)	-6
m(ili)	-3
k(ilo)	3
M(ega)	6
G(iga)	9
T(era)	12
P(eta)	15
E(xa)	18

RULES FOR USING SI SYMBOLS (Section 1.4)

- No Plurals (e.g., $m = 5 \text{ kg}$ not kgs)
- Separate Units with a \cdot (e.g., meter-second = $m \cdot s$)
- Most symbols are in lowercase (some exception are **N**, **Pa**, **M** and **G**)
- Exponential powers apply to units , e.g., $\text{cm}^2 = \text{cm} \cdot \text{cm}$

NUMERICAL CALCULATIONS (Section 1.5)

- Must have dimensional “homogeneity.” Dimensions have to be the same on both sides of the equal sign, (e.g. distance = speed \times time.)

$$L = L/T \times T$$

- Use an appropriate number of significant figures (3, 4 for answer, at least 4 for intermediate calculations).

Why?

END OF LECTURE