

Lecture Outline

1. Mechanics
2. Fundamental Concepts

Engineering Mechanics STATICS.

1. General Principles.

Objectives

- To provide an introduction to the basic quantities and idealizations (modeling) in mechanics.
- To give a statement of Newton's Three Laws of Motion and his law of Gravitation.
- To review the principles for applying the SI system of units.
- To examine the standard procedures for performing numerical calculations.
- To present a general guide for solving problems

Outline

1. Mechanics. Fundamental Concepts
2. Newton's Laws
3. Dimensions and Units of Measurement. The International System of Units
4. Numerical Calculations
5. Problem Solving Strategy.

1. Mechanics

- Mechanics is the oldest and the most highly developed branch of physics. It is concerned with the state of rest or motion of bodies that are subjected to the action of *forces* (Mechanical Interactions, changing shape, position, velocity or acceleration).

الميكانيك هو أقدم فروع الفيزياء. يُعنى بدراسة حالي سكون وحركة الأجسام المادية الخاضعة لتأثير القوى (أي فقط لتفاعلات ميكانيكية تغيير في شكل، موضع، سرعة أو تسارع الأجسام المتفاعلة)

- Mechanics can be divided into 3 branches:

- Rigid-body Mechanics

يقسم علم الميكانيك إلى: ميكانيك الجسم الصلب (مطلق الصلابة)،

- Deformable-body Mechanics

ميكانيك الجسم الصلب (القابل للتشوه)، ميكانيك السوائل.

- Fluid Mechanics

- Rigid-body Mechanics deals with

يقسم ميكانيك الجسم الصلب إلى: (1) الستاتيك (علم السكون)

- Statics: Equilibrium of bodies, at rest, or constant velocity

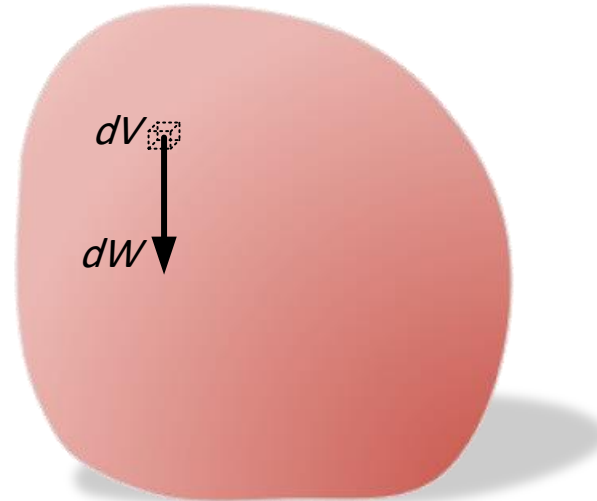
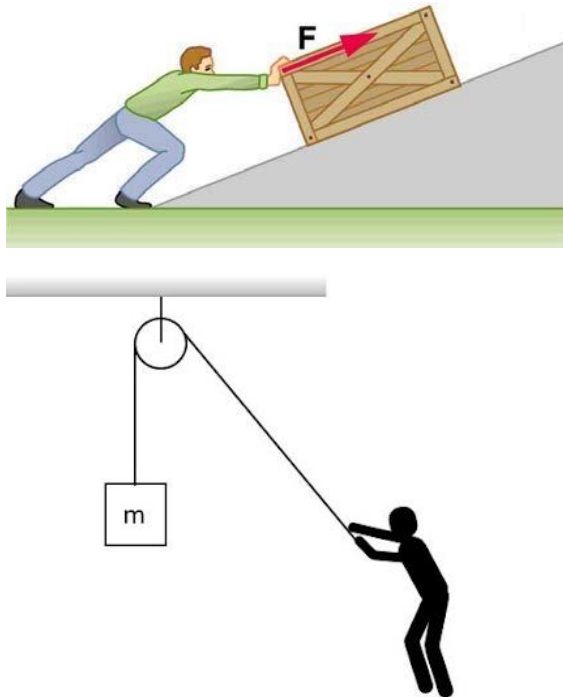
ويدرس توازن القوى المؤثرة على الأجسام الساكنة أو المتحركة

- Dynamics: Accelerated motion of bodies

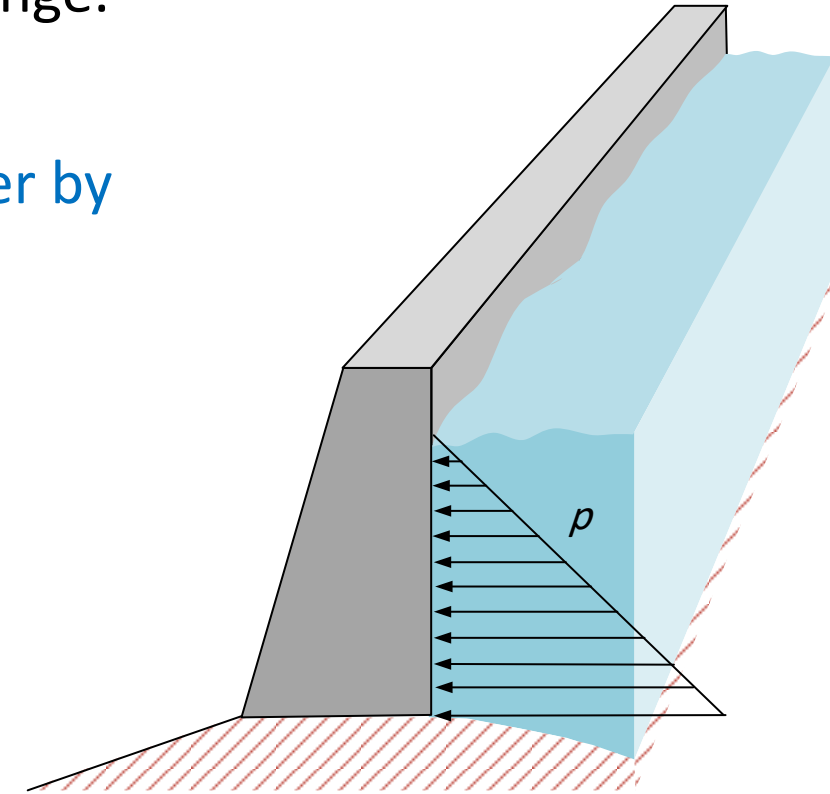
بسرعة ثابتة. (2) الديناميك ويدرس الأجسام المتسارعة.

1. Mechanics.....Fundamentals Concepts.....Basic Quantities

1. Length: used to locate positions and measure sizes
2. Mass :quantity of matter and resistance to velocity change.
2. Time: succession of events
4. Force: A “push” / “pull” exerted by one body on another by direct contact or at distance



Volume force [F/L³]
Gravity force acting at distance

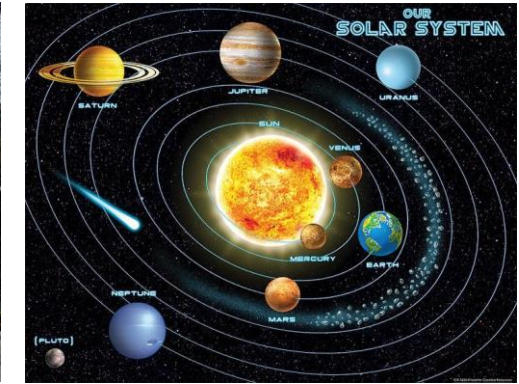


Area forces [F/L²]
Water pressure acting as contact force

1. Mechanics.....Fundamentals Concepts.....Idealization

1. Particles

- has a mass but its size can be neglected



2. Rigid Body

- a combination of a large number of particles fixed relative to each other.

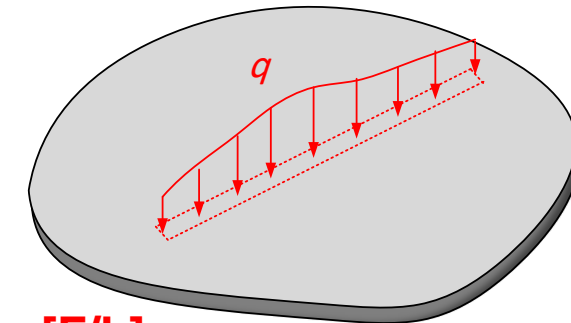
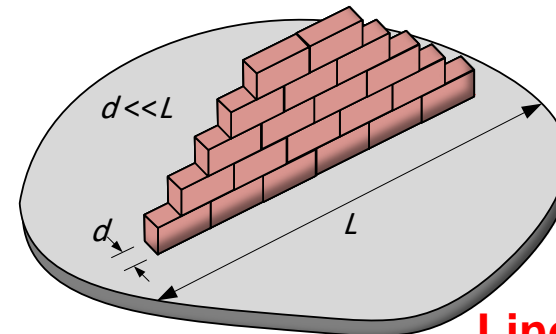


3. Concentrated Force

- the effect of a loading on a small area

4. Line force [F/L]

- Ex. Wall weight acting as contact force



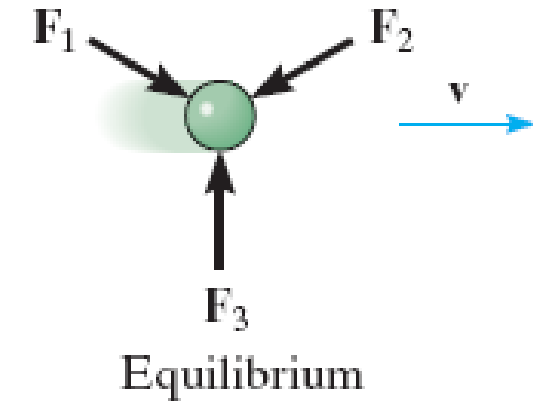
Line force [F/L]

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"



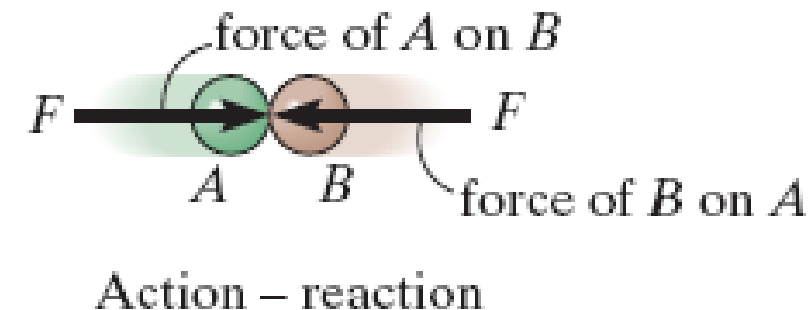
Second Law

"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"



Third Law

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



Newton's Law of Gravitational Attraction

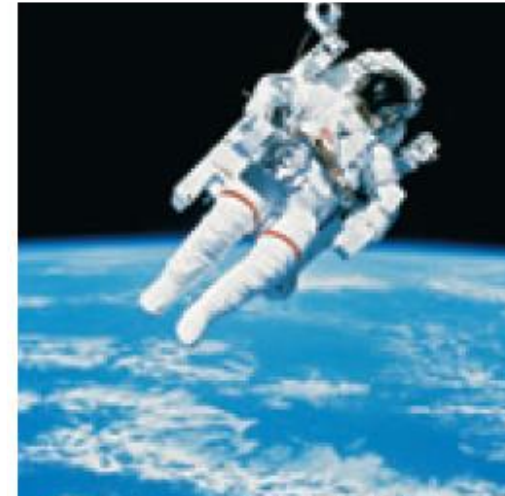
$$F = G \frac{m_1 m_2}{r^2}$$

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

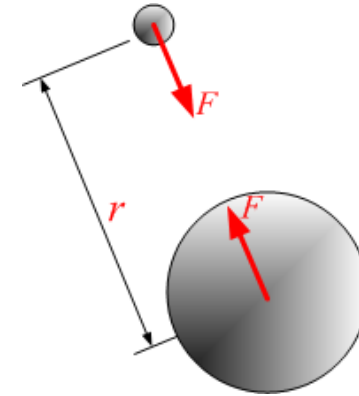


Weight: $W = G \frac{mM_e}{r^2}$

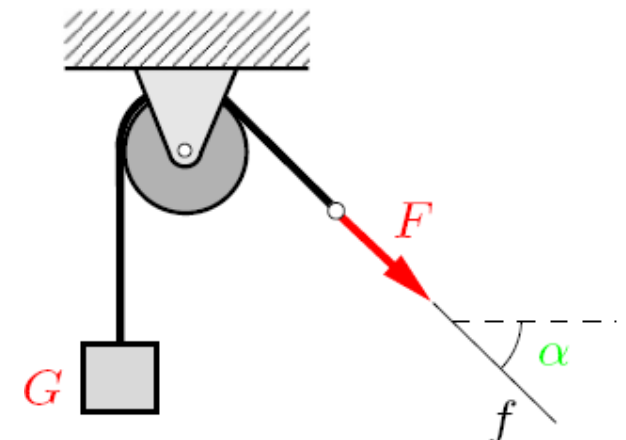
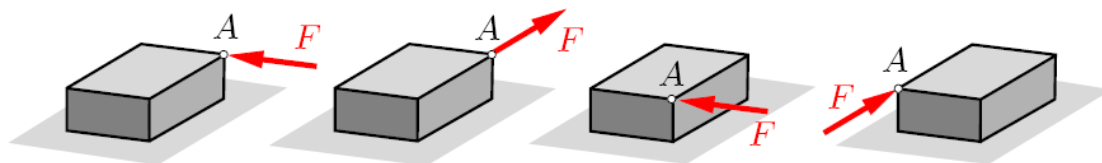
Letting $g = GM_e / r^2$ yields $W = mg$

1. Mechanics....Fundamentals Concepts The Forces

- Forces cannot be seen or directly observed. They are measured by their effects on bodies, rest (balance), deformation, motion.
- Assuming that gravity and its effects are known from experience, a force is characterized as a quantity that is comparable to gravity.
- A concentrated force is **a bound vector** characterized by three properties: magnitude, direction, & point of application.



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



QUIZ

1. The subject of mechanics deals with what happens to a body when _____ is / are applied to it.
(A) magnetic field (B) heat (C) forces (D) neutrons (E) lasers
2. _____ Mechanics still remains the basis of most of today's engineering sciences.
(A) Newtonian (B) Relativistic (C) Greek (D) Euclidean
3. For a statics problem your calculations show the final answer as 12345.6 N. What will you write as your final answer?
(A) 12345.6 N (B) 12.3456 kN (C) 12 kN (D) 12.3 kN (E) 123 kN