Tishk International University
Faculty of Science
Information Technology Department

Chapter Two
Newton's Laws

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GENERAL PHYSICS I (PHY1)
Week 1
Fall 2025/26
Date

Outline

- Newton’s Laws
- Law of Gravitation
- Applications of Newtons Law

Objectives

- To understand Newton’s Laws
- To understand Law of Gravitation
- To learn the application of Newton’s Laws

Newton’s Laws

- **Law I.** A particle remains at rest or continues to move with uniform velocity (in a straight line with a constant speed) if there is no unbalanced force acting on it.

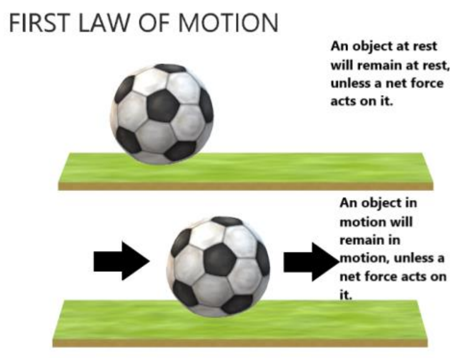
- Law II. The acceleration of a particle is proportional to the vector sum of forces acting on it and is in the direction of this vector sum.

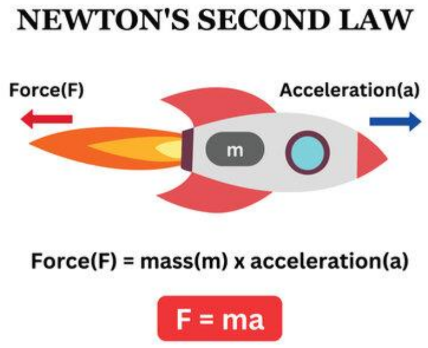
$$F = ma$$

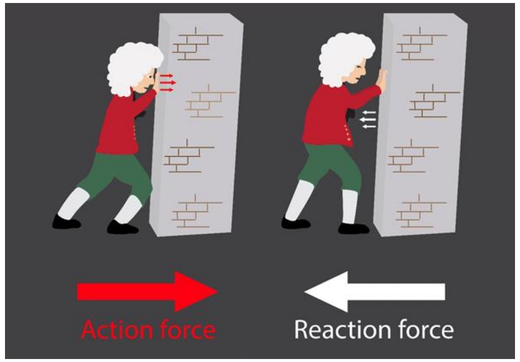
- Law III. The forces of action and reaction between interacting bodies are equal in magnitude, opposite in direction, and collinear (they lie on the same line).

Examples:

- Rocket propulsion
- Walking (your foot pushes ground → ground pushes you forward)





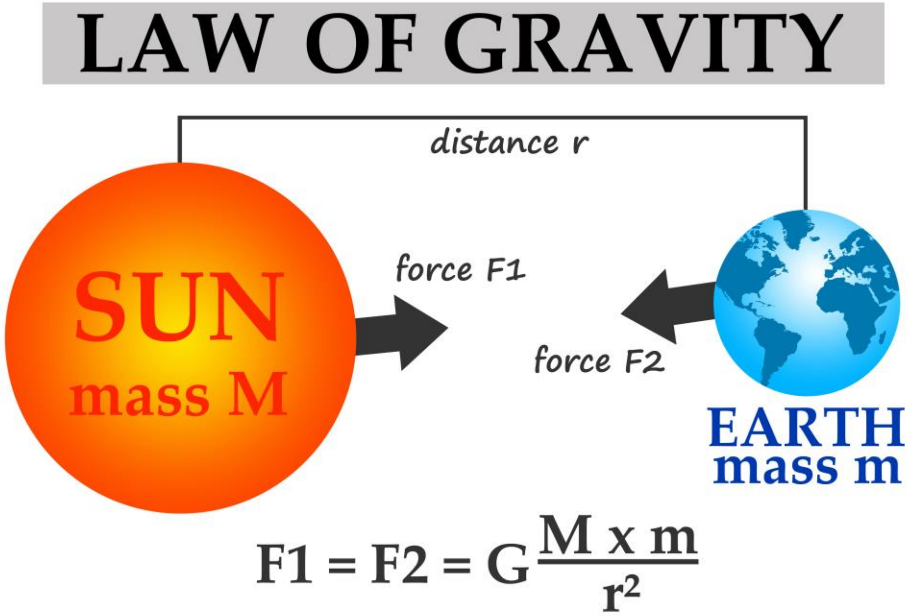


Law of Gravitation

- The gravitational force between two objects is calculating as following:

$$F = G\frac{m_1 m_2}{r^2} \qquad (1/2)$$

where F = the mutual force of attraction between two particles
G = a universal constant known as the *constant of gravitation*
m_1, m_2 = the masses of the two particles
r = the distance between the centers of the particles



Solving examples

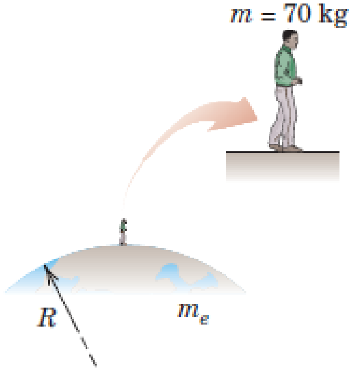
Example 1

Use Newton's law of universal gravitation to calculate the weight of a 70-kg person standing on the surface of the earth. Then repeat the calculation by using $W = mg$ and compare your two results. Use Table D/2 as needed.

Solution. The two results are

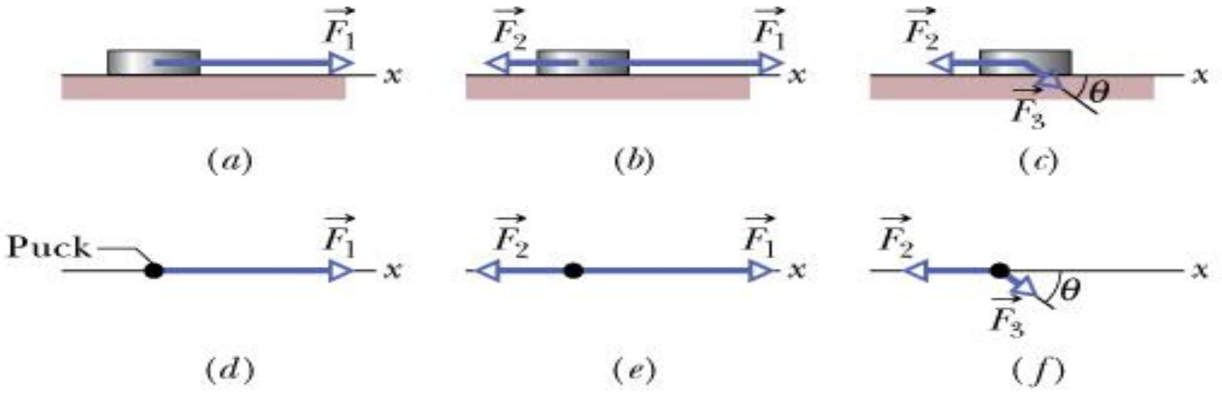
$$W = \frac{Gm_e m}{R^2} = \frac{(6.673\cdot 10^{-11})(5.976\cdot 10^{24})(70)}{[6371\cdot 10^3]^2} = 688\text{ N} \qquad \textit{Ans.}$$

$$W = mg = 70(9.81) = 687\text{ N} \qquad \textit{Ans.}$$



Example 2

- One or two forces act on a puck that moves over frictionless ice along an x axis, in one-dimensional motion. The puck's mass is m = 0.20 kg. Forces $\mathbf{F_1}$ and $\mathbf{F_2}$ and are directed along the x axis and have magnitudes $F_1 = 4.0$ N and $F_2 = 2.0$ N. Force $\mathbf{F_3}$ is directed at angle $\theta = 30°$ and has magnitude $F_3 = 1.0$ N. In each situation, what is the acceleration of the puck?



$$F_{net,x} = ma_x$$

$$a)F_1 = ma_x$$

$$a_x = \frac{F_1}{m} = \frac{4.0\,\text{N}}{0.2\,\text{kg}} = 20\,\text{m/s}^2$$

$$b)F_1 - F_2 = ma_x$$

$$a_x = \frac{F_1 - F_2}{m} = \frac{4.0\,\text{N} - 2.0\,\text{N}}{0.2\,\text{kg}} = 10\,\text{m/s}^2$$

$$c)F_{3,x} - F_2 = ma_x \qquad F_{3,x} = F_3\cos\theta$$

$$a_x = \frac{F_3\cos\theta - F_2}{m} = \frac{1.0\,\text{N}\cos 30^\circ - 2.0\,\text{N}}{0.2\,\text{kg}} = -5.7\,\text{m/s}^2$$

Example 3

A 2.49×10^4 N Rolls-Royce Phantom traveling in the $+x$-direction makes an emergency stop; the x-component of the net force acting on it is -1.83×10^4 N. What is its acceleration?

SOLUTION

2.49×10^4 N is the car's *weight*,

ITE: The mass of the car is

$$m = \frac{w}{g} = \frac{2.49 \times 10^4\ \text{N}}{9.80\ \text{m/s}^2} = \frac{2.49 \times 10^4\ \text{kg} \cdot \text{m/s}^2}{9.80\ \text{m/s}^2}$$

$$= 2540\ \text{kg}$$

Rolls-Royce Phantom

Then $\sum F_x = m a_x$ gives

$$a_x = \frac{\sum F_x}{m} = \frac{-1.83 \times 10^4\ \text{N}}{2540\ \text{kg}} = \frac{-1.83 \times 10^4\ \text{kg} \cdot \text{m/s}^2}{2540\ \text{kg}}$$

$$= -7.20\ \text{m/s}^2$$

References (in APA style)

- ✓ Young, H. D., Freedman, R. A., & Ford, A. L. (2014). University physics with modern physics (p. 822). New York: Pearson.
- ✓ Sommerfeld, A. (2016). *Mechanics: Lectures on theoretical physics, Vol. 1* (Vol. 1). Elsevier.