

Chapter 4

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. Newton's first law
2. Newton's second law
3. Newton's third law
4. inertial mass (also called *mass* for short)
5. weight
6. inertia
7. force (i.e. *external* force to be exact)
8. interaction
9. translational equilibrium
10. net force (or *total* force)
11. contact force
12. action-at-a-distance force

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- Total (or *net*) force:

$$\Sigma \vec{F}_{on\ A} = \vec{F}_{on\ A\ by\ 1} + \vec{F}_{on\ A\ by\ 2} + \vec{F}_{on\ A\ by\ 3} + \vec{F}_{on\ A\ by\ 4} + \dots \quad (1)$$

- Newton's second law for an object labeled A:

$$\vec{a}_A = \frac{\Sigma \vec{F}_{on\ A}}{m_A} \quad (2)$$

or

$$\Sigma \vec{F}_{on\ A} = m_A \vec{a}_A \quad (3)$$

- Newton's third law (for an interaction of two objects):

$$\vec{F}_{on\ 2\ (by\ 1)} = -\vec{F}_{on\ 1\ (by\ 2)} \quad (4)$$

Skills

1. Identify an interaction (action-reaction) pair by following this procedure:
 - (a) Identify the type of interaction (contact or action at a distance).
 - (b) Identify the two "sides" of the interaction by (a) describing one of the two forces by a statement like "force on A (by B)" and (b) describing the other force interchanging the A and B like "force on B (by A)."
 - (c) Because the two forces are vectors, give their directions, making sure that they are opposite.
2. Identify all forces on an object (by defining all interactions with that object).
3. Calculate the ratio of the masses of two objects that collide.
4. Calculate the net force on an object by adding all forces being exerted on the object. (You must be able to add force vectors algebraically and pictorially.)

Lab Skills

1. Use force sensors and carts of various masses to verify Newton's third law.
2. Use force sensors and accelerometers on colliding carts to verify Newton's second law.