

MOTION AND FORCES

Newton's laws predict the motion of most objects.

STANDARDS¹

- Students know* how to solve problems that involve constant speed and average speed.
- Students know* that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest Newton's first law .
- Students know* how to apply the law $F = ma$ to solve one dimensional motion problems that involve constant forces Newton's second law .
- Students know* that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction Newton's third law .
- Students know* the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.
- Students know* applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed .
- Students know* circular motion requires the application of a constant force directed toward the center of the circle.

FRAMEWORK EQUATIONS²

- $\Delta x = v\Delta t$
- $a = \Delta v/\Delta t$
- $F = ma$
 $v = v_0 + at$
 $x = x_0 + v_0t + 1/2 at^2$
- $\mathbf{F}_{12} = -\mathbf{F}_{21}$
- $W = mg \quad g \approx 9.8 \text{ m/s}^2$
- $F = mv^2/r$

x	position
v	speed
t	time
a	acceleration
F	force
m	mass
W	weight
g	gravitational acceleration
r	radius

1. *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve*. This sheet does not include starred, "opportunities to learn" standards.

2. *California Science Framework for K 12 Public Schools*. Some equations were modified for this sheet to better align with conventional notation.

This sheet was prepared by Dean Baird www.phyz.org and is not a publication of the California Department of Education.