

How do we describe motion?

speed the rate at which an object is moving

velocity speed in a certain direction

acceleration

a change in velocity, meaning a change in either speed or direction.

momentum mass times velocity

force can change an object's momentum, causing it to accelerate

Mass vs. Weight

How is mass different from weight?

An object's mass is the same no matter where it is located, but its weight varies with the strength of gravity or other forces acting on the object.

When is an object **weightless**?

An object is weightless when it is in **free-fall** even though the mass is *unchanged*

How did Newton change our view of the universe?

Newton showed that the same physical laws that operate on Earth also operate in the heavens, making it possible to learn about the universe by studying physical laws on Earth. This went against Aristotle.

Newton's Laws of Motion

Newton's First Law of Motion An object moves at a constant velocity if there is no net force acting upon it.

Newton's Second Law of Motion Force = mass * velocity

Newton's Third Law of Motion For any force, there is always an equal and opposite reaction force.

Why do objects move at constant velocity?

Conservation of momentum an object's momentum cannot change unless the object transfers momentum to or from other objects

When no force is present, no momentum can be transferred so an object must maintain its speed and direction.

What keeps a planet rotating and orbiting the Sun?

Conservation of angular momentum a planet's rotation and orbit cannot change unless the planet transfers angular momentum to another object

The planets in our solar system do not exchange substantial angular momentum with each other or anything else, so their orbits and rotation rates remain steady.

Basic Energy

kinetic energy energy of motion

radiative energy energy carried by light

potential energy stored energy

Energy is always conserved—it can be neither created nor destroyed. Objects receive whatever energy they now have from exchanges of energy with other objects.

What determines the strength of gravity?

Universal law of gravitation states that every object attracts every other object with a gravitational force that is proportional to the product of the objects' masses and declines with the square of the distance between their centers

Newton's and Kepler's laws

1) Newton showed that any object going around another object will obey Kepler's first two laws.

2) He showed that ellipses (or circles), which define **bound orbits**, are not the only possible orbital shape—orbits can also be **unbound** and in the form of parabolas or hyperbolas.

3) He showed that two objects actually orbit their common **center of mass**.

4) **Newton's version of Kepler's third law** allows us to calculate the masses of orbiting objects from their orbital periods and distances.

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