Force

NEWTON'S LAWS OF MOTION

First Law (Law of Inertia)

Every body continues in its state of rest or of uniform velocity in a straight line unless it is compelled to change that state by the application of some resultant external force.

In other words, there can be no acceleration (speed up, slow down, change directions) without a force.

Second Law

The acceleration of a body is directly proportional to the resultant force acting upon it and is inversely proportional to the mass of the body.

In other words, force equals mass times acceleration.

Third Law

Whenever one body exerts a force upon a second body, the second body exerts an equal and opposite force upon the first.

In other words, there is no action without reaction.

NEWTON'S LAW OF UNIVERSAL GRAVITATION

Between every two particles in the universe there is a force of gravitational attraction (F_G) which is proportional to the product of the masses of the two particles (m_1 and m_2, respectively) and inversely proportional to the square of the distance (r) between them.

In equation form:

$F_G = \frac{Gm_1m_2}{r^2}$, where G = the universal gravitational constant, $6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2$

FORMULAS

$F = ma$ $\qquad F_g = mg$, where $g = 10\ m/s^2$ $(9.81\ m/s^2)$ $\qquad F = \frac{F_g a}{g}$

where "F" is force, "F_g" is force due to gravity (also known as weight), "m" is mass, "a" is acceleration, and "g" is acceleration due to gravity at the earth's surface. Note: "F" may also be referred to as the **net force**, the **unbalanced force** or the **resultant force**.

EXERCISES

A. A playing card is placed over the mouth of a glass of water. A coin is then placed on top of the card. With a quick flick of a finger, the card is knocked away so that the coin drops into the glass. Which of Newton's Laws of Motion best explains the action of the coin?

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