PhyzExamples: Newton's Laws

Physical Quantities • Symbols • Units • Brief Definitions

Acceleration • *a* • m/s2 • The rate at which a body's velocity changes. A body undergoes acceleration if its speed and/or direction of travel changes. Values of acceleration must sometimes be found using equations of motion. Sometimes expressed as a vector **a**.

Gravitational Acceleration • *g* • m/s2 • The vertical acceleration undergone by an object in free fall. On Earth, that acceleration is 9.8 m/s2; on the moon, it's 1.6 m/s2.

Mass • *m* • kg • The quantity of matter in a body; the measure of a body's resistance to acceleration. Quantity of inertia. NOT the same thing as *weight* (which is *gravitational force*).

Force • *F* • N or kg·m/s2 • A measure of the push or pull involved when two bodies interact. Sometimes expressed as a vector **F**.

Weight • *W* • N or kg·m/s2 • The **gravitational force** between two bodies, typically an object on or near the surface of a planet and the planet itself. Most often, that planet is Earth. NOT equivalent to mass (which is a body's quantity of matter or inertia). Weight *is* gravitational force.

Equations

$F = ma$ • Newton's Second Law ($\mathbf{F} = m\mathbf{a}$ in vector form)

$W = mg$ • "The Weight Equation" • Notice that it's just Newton's Second Law written with gravitational force and gravitational acceleration.

Smooth Operations Examples

1. Given m = 5 kg and a = 7 m/s^2. Find F.

1. m = 5 kg   a = 7 m/s^2 F = ?
F = ma
F = 5 kg · 7 m/s^2 a = F/m
<u>F = 35 N</u>

3. A bullet undergoes a 1000-m/s^2 acceleration when acted on by a 20-N force. What is the mass of the bullet?

3. a = 1000 m/s^2 F = 20 N   m = ?
F = ma
m = F/a
m = 20 N / 1000 m/s^2
<u>m = 0.02 kg = 20 g</u>

5. Given W = 152 N and g = 3.8m/s^2. Find m.

5. W = 152 N   g = 3.8 m/s^2 m=?
W = mg
m = W/g
m = 152 N / 3.8 m/s^2
<u>m = 40 kg</u>

2. Given m = 12 kg and F = 3 N. Find a.

2. m = 12 kg   F = 3 N   a = ?
F = ma
a = 3 N / 12 kg
<u>a = 0.25 m/s^2</u>

4. Given m = 75 kg and g = 9.8 m/s^2. Find W.

4. m = 75 kg   g = 9.8 m/s^2 W=?
W = mg
W = 75 kg · 9.8 m/s^2
<u>W = 735 N</u>

6. What is the weight of a 6-kg medicine ball?

6. m = 6 kg   g = 9.8 m/s^2 W = ?
(assume you're on Earth unless given reason to think otherwise.)
W = mg
W = 6 kg · 9.8 m/s^2
<u>W = 59 N</u>

7. What is the mass of a 143-N object?

7. W = 143 N   g = 9.8 m/s^2 m=?
W = mg
m = W/g
m = 143 N / 9.8 m/s^2
<u>m = 14.6 kg</u>