Phyz Examples: Newton’s Laws

Physical Quantities • Symbols • Units • Brief Definitions

Acceleration • $a$ • m/s$^2$ • 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/s$^2$ • The vertical acceleration undergone by an object in free fall. On Earth, that acceleration is 9.8 m/s$^2$; on the moon, it’s 1.6 m/s$^2$.

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/s$^2$ • A measure of the push or pull involved when two bodies interact. Sometimes expressed as a vector $F$.

Weight • $W$ • N or kg·m/s$^2$ • 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 ($F = ma$ 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$^2$ $a = F/m$
   
   $F = 35$ N

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
   
   $a = 0.25$ m/s$^2$

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$^2$
   
   $m = 0.02$ kg = 20 g

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$^2$
   
   $W = 735$ N

5. Given $W = 152$ N and $g = 3.8$m/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$^2$
   
   $m = 40$ kg

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$^2$
   
   $W = 59$ N

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$^2$
   
   $m = 14.6$ kg