### Some Uses of Symbols in Physics

<table>
<thead>
<tr>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>( f, y ) in; ( 3f = 1y )</td>
</tr>
<tr>
<td>( N, kg, m, s ) in; ( 1N = 1kg \cdot m/s )</td>
</tr>
</tbody>
</table>

Units are often left off of written expressions to make them easier on the eye. Expert problem solvers pay attention to them only when checking to make sure an expression is dimensionally correct. A final answer almost always has associated units, which should be stated explicitly.

### Constants

- \( \pi \)
- \( e \)
- \( G, R \)
- \( E_{\text{Earth}}, M_{\text{Earth}} \)
- \( \rho_{\text{water}} \)
- \( g, i, j \)

Expert problem solvers learn to recognize constants quickly and selectively ignore them as they read algebraic expressions.

### Unknowns

- \( x \) in:
  - \( 5x - 9 = 91 \)
- \( t \) in:
  - \( (3m/s) t + 2m = 8m \)

When you are able to write an equation that includes only one unknown quantity, then you can solve for the unknown. Most physics students are very adept at this.

### Parameters

- \( f(\mathbf{r}) = \frac{G M_m}{r^2} \)
- \( x(\mathbf{t}) = (3m/s) \mathbf{t} - (5m/s^2) \mathbf{t}^2 \)
- \( v(\mathbf{t}) = (3m/s) - (10m/s^2) \mathbf{t} \)

The examples show expressions with more than one unknown quantity.

One quantity is a function of the other; in physics we often say that one quantity depends on the other. \( x(\mathbf{t}) \) is a shorthand way of writing that this is an expression that describes how the variable \( x \) depends on the variable \( t \). \( x \) is called the dependent variable, and \( t \) is the independent variable because the value of \( x \) is determined through the equation by the value of \( t \).

The equation is a rule that governs how \( x \) and \( t \) are related. In physics, we describe these relationships in specific ways:

- \( x \) is proportional to \( t^2 \)
- \( v \) is proportional to \( t \)
- \( F \) is inversely proportional to \( r^2 \)

### Co-Varied Quantities

- \( x, y \) in:
  - \( y(x) = 9x - 2 \)
  - \( x(t) = (3m/s) t - (5m/s^2) t^2 \)
  - \( v(t) = (3m/s) - (10m/s^2) t \)

In physics, models are based on functional relationships between physical quantities. Expert problem solvers recognize parameters in algebraic expressions and focus on the functional relationship between \( x \) and \( t \). Once the equation is determined, the algebra can be manipulated to solve for any quantity that is desired in a particular problem (including, perhaps, one of the parameters).

### Units

- \( m, b \) in:
  - \( y(x) = mx + b \)
- \( v_0, x_0 \) and \( a \) in:
  - \( x(t) = x_0 + v_0 t + \frac{1}{2} a t^2 \)
- \( k \) in:
  - \( F(x) = -kx \)
- \( \mu, m \) in:
  - \( \Delta U(x) = \mu mg x \)

In physics, models are based on functional relationships between physical quantities. Expert problem solvers recognize parameters in algebraic expressions and focus on the functional relationship between \( x \) and \( t \). Once the equation is determined, the algebra can be manipulated to solve for any quantity that is desired in a particular problem (including, perhaps, one of the parameters).