Symbol Conventions in Physics

In your group activities today you'll be creating symbols and equations to describe relationships in the physical world. Before you practice, you should be aware of some useful symbol tips that are used by many physicists (and in the textbooks they write). Once you're used to them, these tips can help you unpack the meaning of the symbols other people use. They can also help you remember what the symbols you've made up represent.

1) The main symbol letter usually tells you what kind of quantity it represents. This is often the first letter of the quantity-type name. For example, times usually have a letter t, distances d (or often x or y), and velocities are often represented with a letter v.

2) One situation might have several velocities, times, etc. To keep track of which one a particular symbol represents, we use extra labels as *subscripts* to make the symbols more specific. For instance, v_{Bob} could be the velocity of Bob while v_{Cat} could refer to the velocity of his cat.

Sometimes we also represent quantities *now* (initially) compared to quantities *at the end* (finally) of some motion. For instance, the initial distance between a runner and his home could be $x_{initial}$ (or x_i for short), while her final distance from home could be x_{final} (or x_f for short).

3) If you need more than one extra label to describe a quantity with a symbol, we separate the labels with commas:

$v_{Bob,i}$ = Bob's initial velocity
$t_{Ball,launch}$ = the time at which a ball is launched into the air
$t_{Ball,land}$ = the time at which a ball lands on the ground

1) Below are several statements that express relationships in the physical world using words. As a group, choose some symbols and express the same relationships as symbolic equations.

a) The total number of furniture items in this room is the number of tables plus the number of chairs.

Symbols	Description
N_{tables} N_{chairs} N_{furn}	# of tables in the room # of chairs in the room Total # of furniture items in the room

$N_{furn} = N_{tables} + N_{chairs}$

b) There are six times as many students as there are professors.

Symbols	Description
$N_{students}$ $N_{professors}$	Number of students Number of professors

$N_{students} = 6\ N_{professors}$

c) Anna and Bob walked the same distance.

Symbols	Description
d_A d_B	Distance Anna walked Distance Bob walked

$d_A = d_B$

d) Jose walked twice as far as Celeste did.

Symbols	Description
d_{Jose} $d_{Celeste}$	Distance Jose walked Distance Celeste walked

$d_{Jose} = 2\ d_{Celeste}$

e) This circle has twice the area of that square.

Symbols	Description
A_{circle} A_{square}	Circle's area Square's area

$A_{circle} = 2\ A_{square}$

2) This next set of statements start with a physical relationship between two things and ask you to derive a second, related relationship. Again as a group, choose symbols to use and come up with the requested symbolic relationship.

a) This circle has twice the area of that square. What is the relationship between the circle's radius and the square's side length?

r = circle radius
s = side length of the square

$A_{circle} = 2\ A_{square}$
$\pi r^2 = 2\ s^2$
$r = (2/\pi)^{1/2}\ s$

The radius of the circle is $\sqrt{2/\pi}$ times the square's side length.

b) Tal and Kailyn are sharing an apple. Tal's a nice guy, so he gives Kailyn twice as much of the apple as he gets. What fraction of the apple does Tal get to eat?

V_T = volume of apple Tal gets
V_K = volume of apple Kailyn gets
V_{tot} = total volume of the apple

$V_K = 2\ V_T$
$V_K + V_T = V_{tot}$ => $(2\ V_T) + V_T = V_{tot}$
$3\ V_T = V_{tot}$
$V_T/V_{tot} = 1/3$

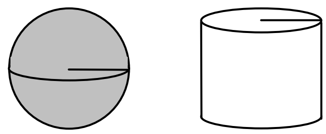
Tal will get one third of the apple.

c) Tal and Kailyn split another apple, but this time Tal gives Kailyn *N* times as much of the apple as he gets. What fraction of the apple (in terms of *N*) does Tal get to eat now?

$V_K = N\ V_T$
$V_K + V_T = V_{tot}$ => $(N\ V_T) + V_T = V_{tot}$
$(N + 1)\ V_T = V_{tot}$
$V_T/V_{tot} = 1/(N + 1)$

Tal will get 1/(N+1) th of the apple.

d) Two fuel tanks are placed side by side. One is spherical and full, the other is cylindrical and empty. Both tanks have the same diameter and height. If you poured the sphere's contents into the cylindrical tank, what would the cylinder's fuel gauge read? (i.e. what fraction of its volume would be full?)



V_{sphere} = sphere volume
$V_{cylinder}$ = cylinder's volume
R_{sphere} = sphere radius
$R_{cylinder}$ = cylinder radius
$H_{cylinder}$ = cylinder height

f = fraction of cylinder volume that's full

$R_{sphere} = R_{cylinder}$ (same diameter)
R = radius of sphere/cylinder (since they're the same value, use same symbol)
$H_{cylinder} = 2\ R_{sphere}$ (same height)

$V_{fuel} = V_{sphere} = 4/3\ \pi\ R_{sphere}^3 = 4/3\ \pi\ R^3$
$V_{cylinder} = p\ R_{cylinder}^2\ H_{cylinder} = p\ R_{cylinder}^2\ (2\ R_{sphere}) = 2\ \pi\ R^3$

$f = V_{fuel}/V_{cylinder} = (4/3\ p\ R^3)\ /\ (2\ \pi\ R^3) = 2/3$

The cylindrical tank will read 2/3 full (67.7%)

3) Now let's do a problem that looks a little more like introductory physics. A truck leaves Champaign at 1 pm heading north at 55 miles per hour. A car leaves Champaign at 2 pm heading north at 65 miles per hour. At what time will the car catch the truck?

a) Write an equation relating the truck's distance from Champaign (x_T) to the time since the truck left (t).

x_T = (55 miles/hr) t

(Check: If the truck has been driving for one hour, what distance does your equation predict for the truck? Does this agree with what we know about the truck's speed?)

x_T = (55 miles/hr) (1 hour) = 55 miles ✓

b) Write an equation relating the car's distance from Champaign (x_c) to the time since the ***truck*** left (t). (Hint: If the truck has been driving for 2 hours, how long has the car been driving?)

x_c = (65 miles/hr) (t – 1 hour)

(Check: If the ***truck*** has been driving for 2 hours, what distance does your equation predict for the car? Is this one hour's worth of distance for the car?)

(65 miles/hr)(2 hours – 1 hour) = (65 miles/hr) (1 hour) = 65 miles

c) When the car and truck meet, how do their distances from Champaign compare? Use this fact with your equations from parts a) and b) to find the time elapsed after the truck has left.

$$x_c = x_T$$

(65 miles/hr) (t – 1 hour) = (55 miles/hour) t

(65 miles/hr – 55 miles/hr) t = 65 miles

(10 miles/hr) t = 65 miles

t = 65 miles / (10 miles/hr)

= 6.5 hours

d) Convert your time since the truck left into a time on the clock.

1:00 pm + 6.5 hours = 7:30 pm