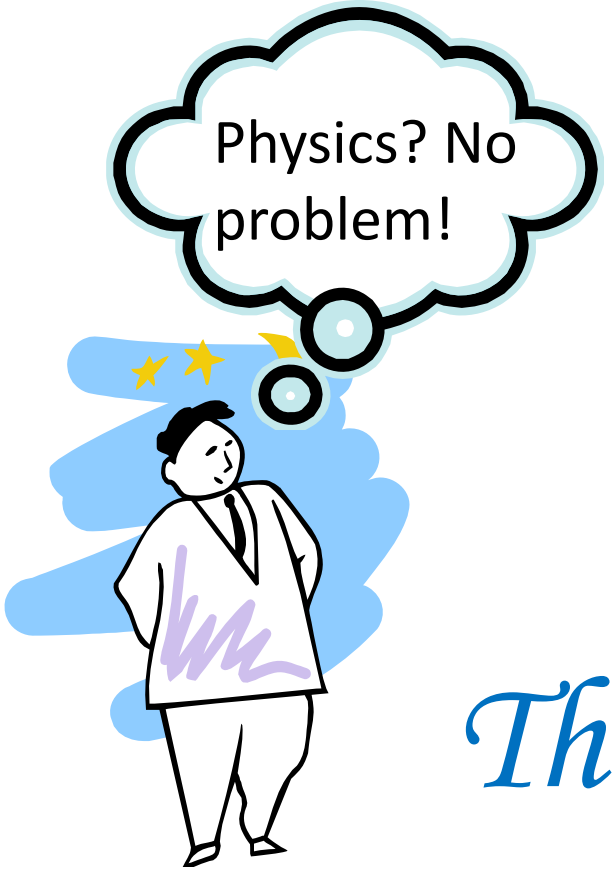
How to Solve Physics Problems

The first thing to remember is:

DON'T PANIC!



Remind yourself:
You absolutely can solve a physics problem if you try

Then do the following:

1. Plan your strategy

2. Follow your plan

3. Check your work

1. Plan your strategy

Read the entire problem carefully

Make sure you understand all the terms

Draw a big picture to

Show what's going on

Organize your thoughts

Introduce variables for physical quantities (try to use mnemonic names, e.g., v for velocity, h for height, etc.)

This picture does not have to be beautiful!

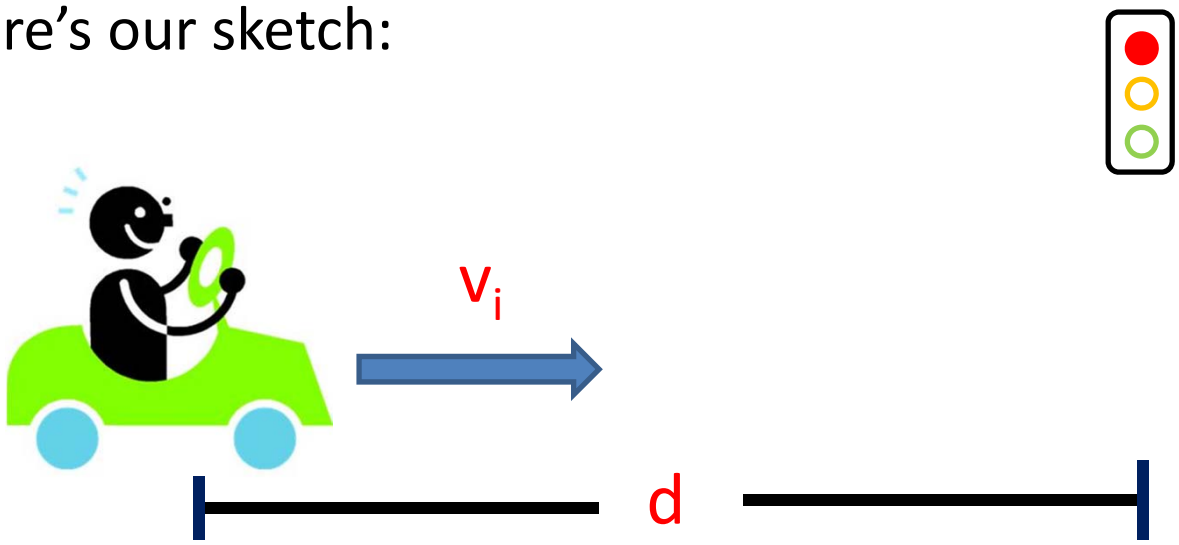
Let's look at an example:

1. A driver is traveling at a constant 20 m/s, when the traffic light at the intersection ahead turns red. The driver steps on the brakes.

2. If the car slows at a constant 4 m/s^2 , how long does it take for the car to come to a stop?

3. How far does the car travel while stopping?

Here's our sketch:



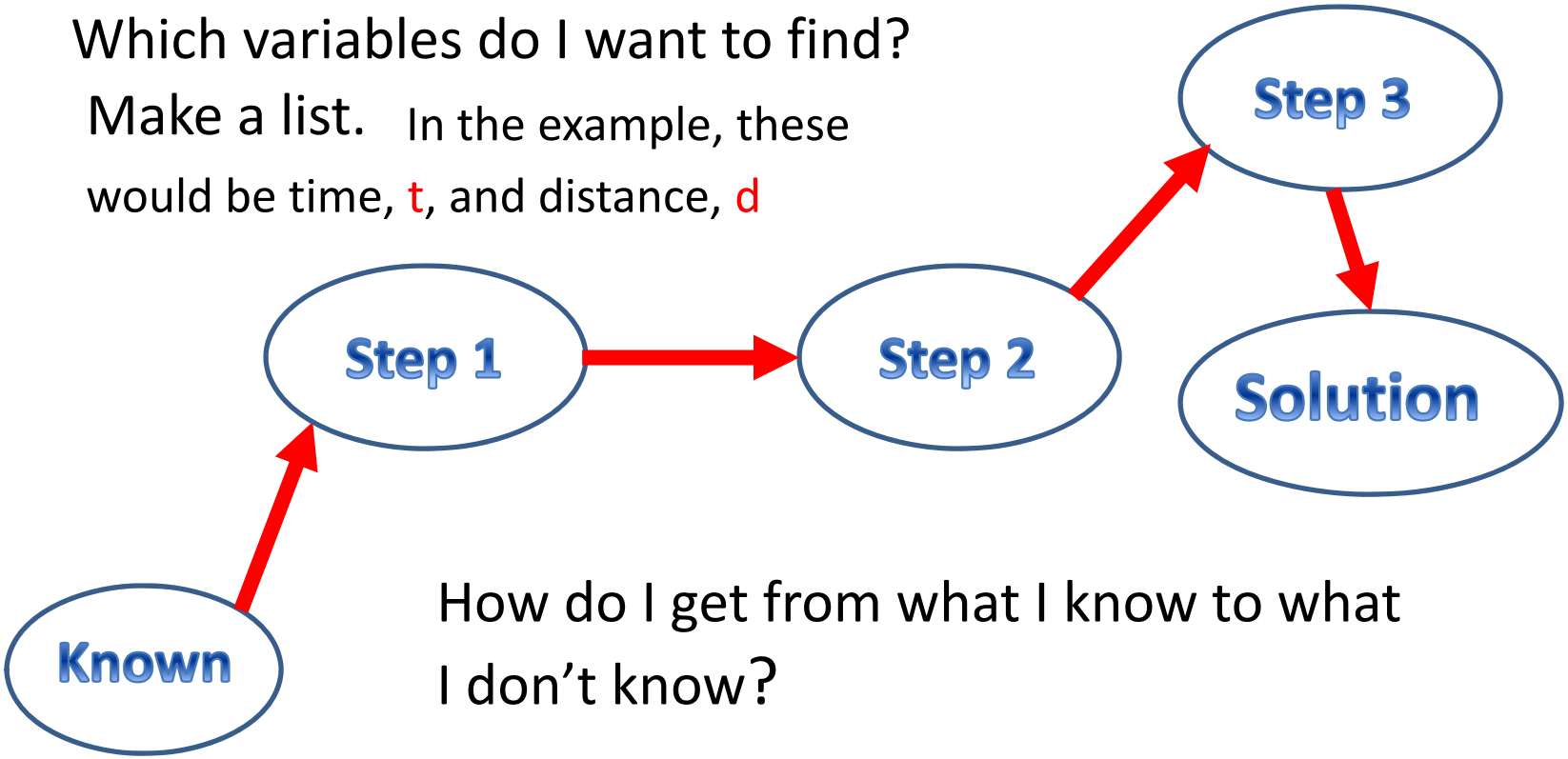
When you have your sketch, ask yourself:

Which variables do I know? Write these values down.

In the example, these would be initial and final velocities, v_i and v_f, and acceleration, a

Which variables do I want to find?

Make a list. In the example, these would be time, t, and distance, d



How do I get from what I know to what I don't know?

Take a broad, over-all view of the problem

Don’t focus on specific details at this stage

Think: What concepts or formulas can you use to solve the problem?

Hint: Often these are related to something you are learning (or have just learned)

Find the right formulas:

Look for formulas that connect the quantities that you know to the quantities that you don't know

Try to find formulas with the fewest unknowns

You will need one formula for each unknown

Going back to the example:

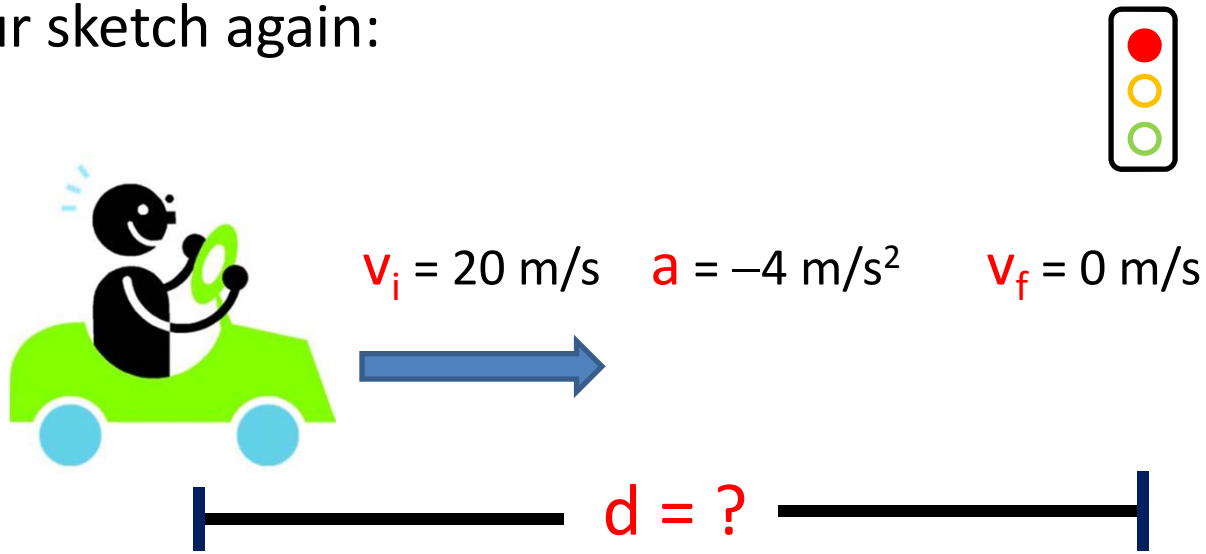
Initial and final velocities v_i and v_f , and acceleration a are known.

$v_i = 20$ m/s $\quad a = -4$ m/s^2 $\quad v_f = 0$ m/s

We want to find the stopping time t and the distance traveled d

To find these, we need to know how distance, velocity, acceleration, time and distance are related (for constant acceleration).

Our sketch again:



How are these quantities related?

Given initial velocity v_i and acceleration a, the final velocity v_f at time t is given by

$$1.\ v_f = v_i + at$$

The distance d traveled during time t is given by

$$2.\ d = v_i t + \tfrac{1}{2} at^2$$

The plan:

Use the first relationship to find the stopping time t

Use the value for t and the second relationship to find the distance traveled while stopping, d

OK! Once you have

A sketch

Variables assigned to each quantity

Lists of the known and unknown values

The formulas and ideas that you are going to use

A plan for how to use them

IT'S TIME TO...

2. Follow your plan

The exact steps will depend on:

1. The problem

2. Your strategy

To make your life easier:

- Briefly explain <u>in words</u> what you are doing in each step – write it down!
- Work with symbols as long as you can
- Write neatly and clearly – distinguish
  $+$ from t, 1 from ℓ and 7, 2 from z
- Check units and convert if necessary
- Draw x– and y– directions when using vector components
- When plugging in values, include the units

To see how this works, let's look at the example again:

We'll use 1. $v_f = v_i + at$ to find t and

2. $d = v_i t + \frac{1}{2} at^2$ to find d

Plugging in values: $v_f = 0 = 20 \text{ m/s} + (-4 \text{ m/s}^2)\ t$

$+ (4 \text{ m/s}^2)\ t \qquad + (\ 4 \text{ m/s}^2\ )\ t$

$(4 \text{ m/s}^2)\ t = 20 \text{ m/s}$

$t = 5 \text{ sec}$

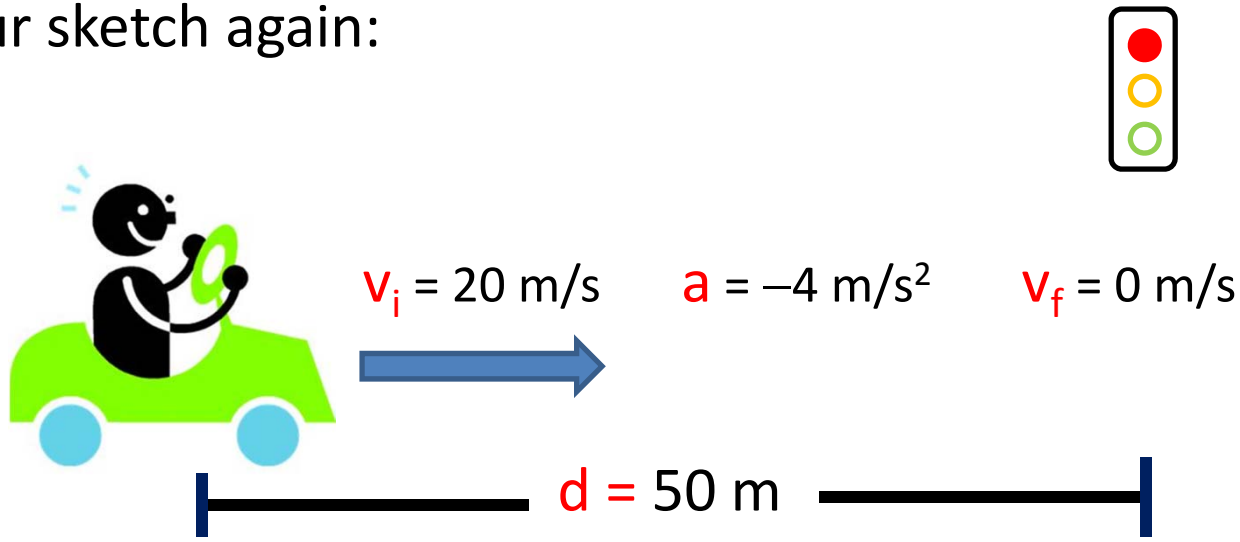
It takes 5 seconds for the car to stop

Solving for d: $d = (20\ m/s)(5\ s) + \frac{1}{2}(-4\ m/s^2)(5\ s)^2$

$d = 100\ m - 50\ m = 50\ m$

During that time, the car travels 50 meters

Our sketch again:



Remember:

To make your life easier:

If you find you are working way too hard, go back and try a new strategy.

Work step by step until you reach the solution.

When you do:

YOU'LL NEED TO...

3. Check your work

Ask yourself:

Are the units correct?

Did you have to
- divide by zero?
- take the square root of a negative number?

Is the answer possible? i.e., mass should not be negative

Is the answer reasonable?

For example, nothing can travel faster than the speed of light.

So if you are solving for the speed of a skater, and you get an answer that is greater than the speed of light:

$$V_{final} = 900{,}000{,}000{,}000 \text{ mph???}$$

then this is <u>not</u> a reasonable answer.

Once again, our example:

$v_i = 20$ m/s $a = -4$ m/s^2 $v_f = 0$ m/s

$d = 50$ m

in $t = 5$ s

Are these answers reasonable? Converting v_i from m/s to mph:

Since 1 m/s $\cong$ 2.24 mph

(20 m/s) x (2.24 mph)/(1 m/s) $\cong$ 45 mph

Highway traffic & safety engineers estimate[1] :

Ideal conditions

Average driver

Safe braking is < 15 fps (4.7 m/s^2)

Car traveling 45 mph brakes to stop in ~ 4.5 seconds

Braking deceleration distance ~ 97 feet (30 m)

So: 50 m and 5 seconds are entirely reasonable

(and the units are correct)

1. http://www.csgnetwork.com/stopdistinfo.html

Since our solution passes the checks:

WE'RE DONE!

A Final Word:

Don’t expect to be a “whiz” at this overnight

Just as in sports

and music

It takes practice to learn to solve physics problems.

So practice!

practice!

practice!

and then practice some more.

The more problems you do,
the easier it will be.

The End