Self-directed learning: The 5 Kinematics Equations

*Use a **pencil** and follow the instructions provided below. You may work alone or with a partner. There are checkpoints throughout the process so the teacher can monitor your progress.*

Part 1
Sketch a **velocity**-time graph with a diagonal line (not through the origin)
Label 2 points on your line (t_1, v_1) and (t_2, v_2). [not (0, 0)]
What does v_1 and v_2 mean?

☐ **Check with the teacher before moving on**

Part 2
What does the slope of your graph represent?
Use your graph and generate a general equation for the slope of your line. *Use* Δt *for* $t_2 - t_1$, but keep $v_2 - v_1$.

☐ **Check with the teacher, then enter this equation 1 into box 1 on page 2 of this handout**

Part 3
What does the area under your graph represent?
Use your graph and generate a general equation for the area under your line between $t_1 + t_2$.

☐ **Check with the teacher, then enter this equation 2 into box 2 on page 2 of this handout**

Part 4
Use the equation 1 and isolate it for v_2.
Substitute v_2 into equation 2
Expand & simplify

☐ **Check with the teacher, then enter your final equation 3 into box 3 on page 2**

Part 5
Use the **Equation 1** and isolate it for v_1.
Substitute v_1 into equation 2.
Expand & simplify

☐ **Check with the teacher, then enter your final equation 4 into box 4 below**

Part 6
Use the equation 1 and isolate it for Δt.
Substitute Δt into equation 2
Expand & simplify
Isolate for v_2^2

☐ **Check with the teacher, then enter your final equation 5 into box 5 below**

List the 5 quantities of kinematics: _____

Box 1	Equation 1		
Box 2	Equation 2		
Box 3	Equation 3		
Box 4	Equation 4		
Box 5	Equation 5		

What is the significance of the last column on the right?

Here are some sample situations that we will use the BIG five to help describe.

Problem 1

A traffic light turns green and an anxious student floors the gas pedal, causing the car to acceleration at 3.4 m/s^2 for a total of 10.0 seconds. We wonder: How far did the car travel in that time?

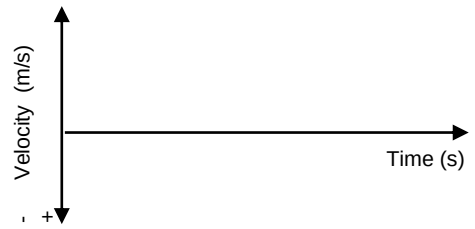
Draw a motion diagram of the situation and attach the given information. What is the question asking for? Which equation is best?	Sketch a velocity-time graph for the problem 

1. Sometimes students get stuck and say, “I am given only two numbers, the acceleration and time. I need three to solve the problem. I’m stuck!” Explain how to help the student.

Complete the remaining GRASP steps and solve this problem.

Problem 2

An automobile safety laboratory performs crash tests of vehicles to ensure their safety in high-speed collisions. The engineers set up a head-on crash test for a Smart Car which collides with a solid barrier. The engineers know the car initially travels at 100 km/h and the car crumples 0.78 m during the collision. The engineers have a couple of questions: How much time does the collision take? What was the car's acceleration during the collision?

Draw a diagram of the situation, label the two events involved and attach the given information. Event ①: Event ②:	Sketch a velocity-time graph for the problem 

Complete the remaining GRASP steps and solve this problem.

Problem 3

Speed Trap The brakes on your car are capable of slowing down your car at a rate of 5.2 m/s^2. You are travelling at 137 km/h when you see a cop with a radar gun pointing right at you! What is the minimum time in which you can get your car under the 100 km/h speed limit?

GRASP solution (always include a diagram!)