1-D Kinematics Labs

Three labs that have to do with motion and kinematics!
You should write the results in your *lab notebook* (the College Board is very insistent about this). There are tables etc. in this packet, but those are just guidelines. Everything should be written in your lab notebook!
You don't need to do them in order, and you probably won't because of materials.

Lab A: Calculating Acceleration Using the Balcony

1. Go to the balcony by the staircase at the end of the science hallway. Use the one that goes down to the math hall, *not* the one that goes to the cafeteria.

2. Measure the height of the balcony using a ruler. You don't need to use anything else! NO climbing up, you can do it perfectly safely and easily if you think about it. Note that you need to find the height in *meters!*

Height of balcony: [copy this into your lab notebook!]

3. The next step is to drop a tennis ball off the balcony. Somebody MUST be standing the doorway making sure that nobody comes. That is VERY VERY important.

4. Measure the time that it takes the ball to fall from the top of the balcony until it strikes the ground. You can use a stopwatch online or one you have.

Measure six times and take the average measurement for more accuracy.
If any of the times is an outlier (a measurement very different from the others), redo that measurement before taking an average.

Time 1:	Time 4:
Time 2:	Time 5:
Time 3:	Time 6:

Average Time of Drop: [copy the table above and the average time into your lab notebook!]

5. While it is falling, see if you can observe that the tennis ball is *accelerating*!

6. You ultimate goal is to find the acceleration of the tennis ball. You can do this using ht information you already have and one of the four kinematic equations:

$v_f = v_i + a \cdot \Delta t$	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$\Delta y = v_i \cdot \Delta t + \frac{1}{2}a(\Delta t)^2$	$v_f^2 = v_i^2 + 2a \cdot \Delta y$

[notice I replaced all the Xs with Ys because this is *vertical* not *horizontal* displacement]

Write your calculations in your lab notebook:

7. The acceleration of an object falling on earth (without air resistance or any forces acting on it) is known to be 9.81 m/s^2.

Calculate the percent difference between this number and the number you calculated
In this formula, the theoretical value is 9.81 m/s^2 and the observed value is what you calculated.

$$\%\text{difference} = \frac{|\text{Theoretical Value} - \text{Observed Value}|}{\text{Theoretical Value}} \times 100\%$$

If you got less than 30 % difference, you did a great job!

8. Write at least two sources of error for this lab:

9. Write 3 ways that you could improve this lab:
1. one way to improve it that you could actually do
2. one way to improve it but you can't do because it is unsafe
3. one way to improve it but is really expensive

Lab B: Two Toy Cars

Find two toy cars that move at a constant velocity. I use the *tumble buggies* for this lab. They move at a constant velocity, and also flip over!

Do something to make one of the cars slow down. Describe how you did it.

Place the cars exactly 2 meters apart, facing each other. (Mark the two start lines with tape).

If the cars start at the same time, where will they collide? Calculate any way you can and then mark that spot on the floor with a piece of tape. Describe your tests and calculations in your lab notebook. There are *many many* ways to complete this lab, some with complicated formulas, some with simple formulas, some with no formulas at all. Figure out your own way.

Lab C: Position-Time Graph from a Metronome

Get a metal track and a plastic car. Put a single textbook under the metal track to make a very slight ramp.
Run the car down the ramp, and make sure somebody catches it at the bottom. Notice it accelerates, but very slightly!

Google "Metronome", which brings up a simple electronic metronome. Set the metronome so it ticks every half a second (120 bpm).

Let the car go on a tick, and then find it *position* each tick after. Measure from the back of the car (which starts at position = 0)

Measure until the car reaches the bottom. Create a table of the results in your lab notebook.

Time	Position
0	
0.5 s (1 tick	
1.0 s (2 ticks)	
1.5 s (3 ticks)	
2.0 s (4 ticks)	
2.5 s (5 ticks)	
3.0 s (6 ticks)	
3.5 s (7 ticks)	
4.0 s (8 ticks)	

Using your table, create a graph of *position-time*.

Using the graph of position time:
a) Estimate the acceleration of the car using one of the 4 kinematic equations:

b) Using your estimate for acceleration, make a graph of velocity-time and acceleration-time for the car.