1. The first 10 meters of a 100-meter dash are covered in 2 seconds by a sprinter who starts from rest and accelerates with a constant acceleration. The remaining 90 meters are run with the same velocity the sprinter had after 2 seconds.
a. Determine the sprinter's constant acceleration during the first 2 seconds.
b. Determine the sprinters velocity after 2 seconds have elapsed.
c. Determine the total time needed to run the full 100 meters.
d. On Cartesian axes, draw the displacement vs time curve for the sprinter.

2. The figure below shows nine frames from the motion diagram of two cars. Both cars begin to accelerate, with constant acceleration, in frame 3.

a. Which car has the larger initial velocity?
b. Which car has the larger final velocity?
c. Draw position, velocity, and acceleration graphs, showing the motion of both cars on each graph. Label them A and B. This is a total of three graphs with two curves on each.
d. Do the cars ever have the same position at one instant in time? If so, in which frame?
e. Do the cars ever have the same velocity at one instant in time? If so, identify the two frames between which this velocity occurs. Identify this instant on your graphs by drawing a vertical line through the graphs.

3. A world-class runner can complete a 100 m dash in about 10s. Past studies have shown that runners in such a race accelerate uniformly for a time *t* and then run at constant speed for the remainder of the race. You are to develop a procedure that will allow you to determine the uniform acceleration *a* and an approximate value of *t* for such a runner in a 100m dash. By necessity your experiment will be done on a straight track and include your whole class of eleven students.

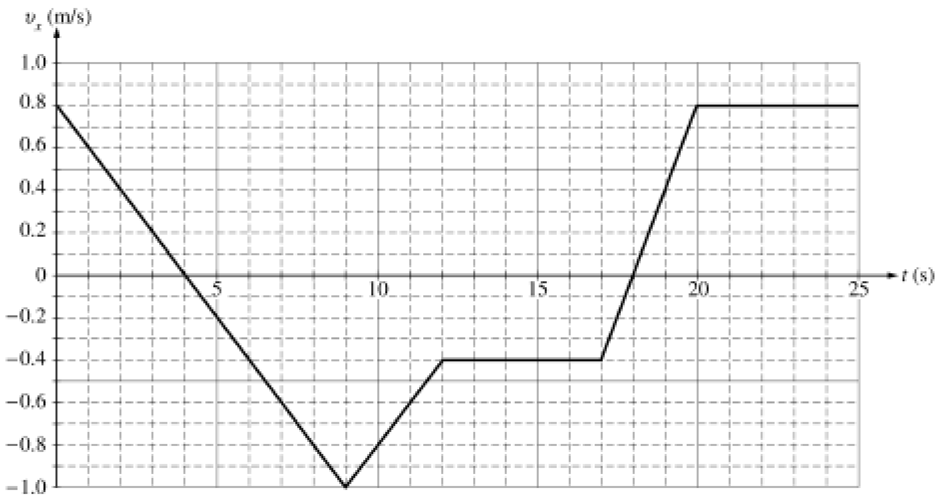
(a) By circling each appropriate item in the list below, select the equipment, other than the runner and the track, that your class will need to do the experiment.
- stopwatches
- Tape measures
- Rulers
- Masking Tape
- Metersticks
- Starters Pistol
- String
- Chalk

(b) Outline the procedure that you would use to determine *a* and *t*, including a labeled diagram of the experimental setup. Use symbols to identify carefully what measurements you would make and include in your procedure how you would use each piece of the equipment you checked in part (a).

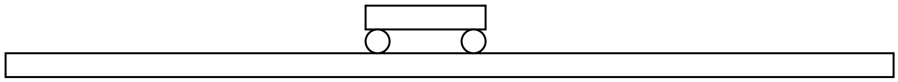
(c) Outline the process of data analysis, including how you will identify the portion of the race that has uniform acceleration, and how you would calculate the uniform acceleration.

4. A 0.50kg cart moves on a straight horizontal track. The graph of v_x versus time for the cart is given below.

(a) Indicate every time *t* for which the car is at rest.
(b) Indicate every timer interval for which the speed (magnitude of velocity) is increasing.
(c) Determine the horizontal position *x* of the cart at t = 9.0s if the cart is located at x = 2.0, at t=0s.



(d) Sketch an acceleration versus time graph for the motion of the cart from t=0s to t=25s.
(e) Explain what is wrong with the statement, “In the graph above, whenever the slope is positive, the cart is speeding-up and whenever the slope is negative, the cart is slowing down.”



5. A cart on a long horizontal track can move with negligible friction to the left or to the right. During the time intervals when the cart is accelerating, the acceleration is constant. The acceleration during other time intervals is also constant, but may have a different value. Data is taken on the motion of the cart, and recorded in the table below.

Displacement x(m)	Velocity v(m/s)	time t(s)
2	- 4	0
	- 2	1
	- 2	2
	- 2	3
	1	6
	1	7
	0	9
	0	10

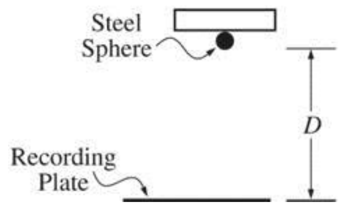
(a) Plot these data points on a v vs t graph and draw straight lines between each data point connecting each data point to the one before it.

(b) List all of the times between t = 0 and t = 10 s at which the cart is at rest.

(c) During which time interval is the magnitude of the acceleration the greatest and what is this maximum value?

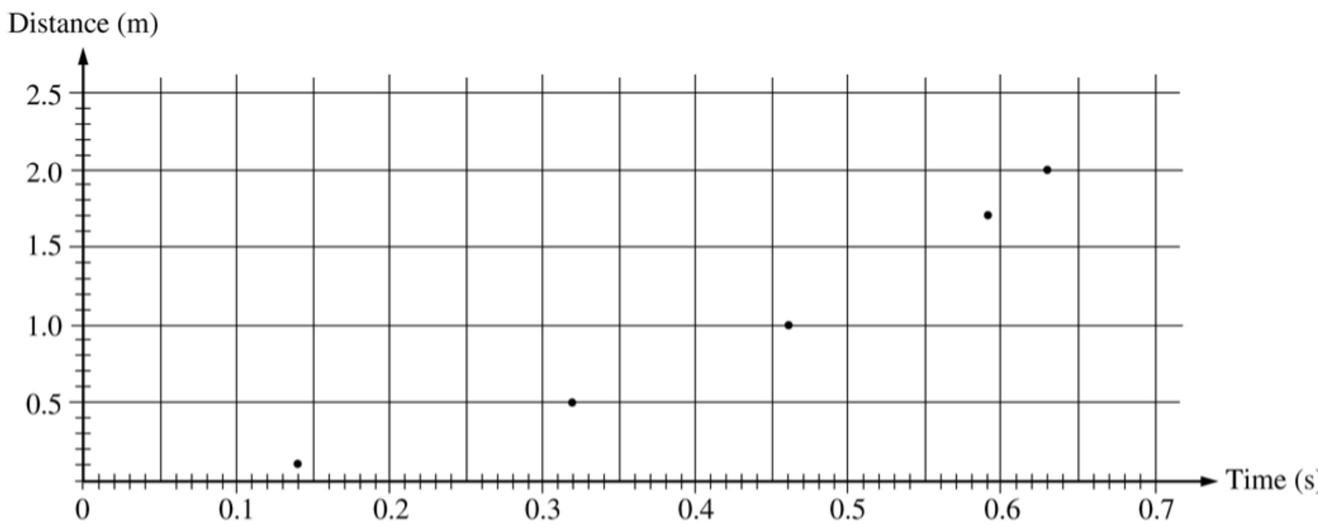
(d) Find the displacement of the cart from x = 0 at a time of 10s.

(e) Sketch the *acceleration* vs. *time* graph for the motion of this cart from t = 0 to t = 10 s.



6. A student wishing to determine experimentally the acceleration *g* due to gravity has an apparatus that holds a small steel sphere above a recording plate, as shown above. When the sphere is released, a timer automatically begins recording the time of fall. The timer automatically stops when the sphere strikes the recording plate.
   The student measures the time of fall for different values of the distance *D* shown above and records the data in the table below. These data points are also plotted on the graph.

Distance of Fall (m)	0.10	0.50	1.00	1.70	2.00
Time of Fall (s)	0.14	0.32	0.46	0.59	0.63



(a) On the grid above, sketch the smooth curve that best represents the student's data

The student can use these data for distance D and time t to produce a second graph from which the acceleration g due to gravity can be determined.

(b) If only the variables D and t are used, what quantities should the student graph in order to produce a linear relationship between the two quantities?
(c) Plot the data points for the quantities you have identified in part (b), and sketch the best straight-line fit to the points. Label your axes and show the scale that you have chosen for the graph.
(d) Using the slope of your graph in part (c), calculate the acceleration g due to gravity in this experiment.
(e) State one way in which the student could improve the accuracy of the results if the experiment were to be performed again. Explain why this would improve the accuracy.