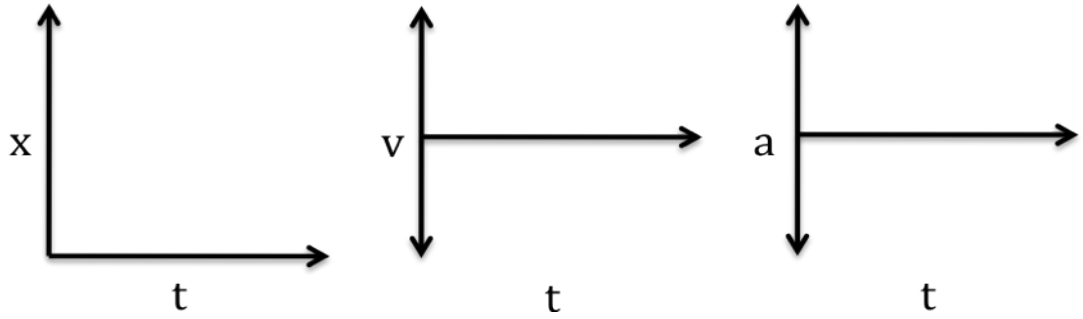
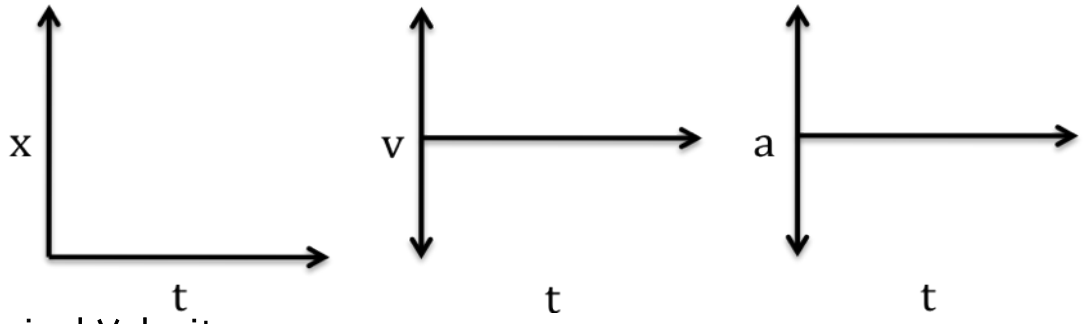
Free Fall and Terminal Velocity

Part 1: Graphing Free-fall

Using a dotted line, predict the position-time, velocity-time and acceleration-time graphs for an object that is dropped from a very tall building with negligible air resistance. Once the simulation is complete, use a solid line to draw the actual graph.



Using a dotted line, predict the position-time, velocity-time and acceleration-time graphs for an object that is thrown upward, then returns to its original position. Assume negligible air resistance. Once the simulation is complete, use a solid line to draw the actual graph.



Part II: Terminal Velocity

Terminal velocity is achieved when a dropped object no longer accelerates (velocity is constant) due to increasing air resistance. An elephant and a feather are dropped from a very tall building. The elephant has a mass of 500 kg, the feather has a mass of 0.5 kg. Although Galileo confirmed that all objects accelerate at the same rate, our own practical experiences will tell us that the elephant will hit the ground first.

1. Begin by drawing a force diagram for the elephant and the feather the instant they are dropped from the edge of the building.

2. Calculate the net force for each object.

3. Now draw a force diagram and write a sum of the forces equation for the objects once they have reached terminal velocity.

4. How much is the Force of the Air (air resistance) required for each object to attain terminal velocity? Show your work.

Falling objects initially accelerate (gain speed) because there is no force big enough to balance the downward force of Earth. Yet as an object gains speed, it encounters an increasing amount of upward air resistance force. In fact, objects will continue to accelerate (gain speed) until the air resistance force increases to a large enough value to balance the downward force of Earth. Since the elephant has more mass, it experiences a greater downward force of Earth. The elephant will have to accelerate (gain speed) for a longer period of time before there is sufficient upward air resistance to balance the large downward force of gravity. Now answer these questions about the elephant and feather falling.

TRUE or FALSE:

a. The elephant encounters a smaller force of air resistance than the feather and therefore falls faster.

b. The elephant has a greater acceleration of gravity than the feather and therefore falls faster.

c. Both elephant and feather have the same force of earth, yet the acceleration of gravity is greatest for the elephant.

d. Both elephant and feather have the same force of earth, yet the feather experiences a greater air resistance.

e. Each object experiences the same amount of air resistance, yet the elephant experiences the greatest force of earth.

f. Each object experiences the same amount of air resistance, yet the feather experiences the greatest force of earth.

g. The feather weighs more than the elephant, and therefore will not accelerate as rapidly as the elephant.

h. Both elephant and feather weigh the same amount, yet the greater mass of the feather leads to a smaller acceleration.

i. The elephant experiences less air resistance and than the feather and thus reaches a larger terminal velocity.

j. The feather experiences more air resistance than the elephant and thus reaches a smaller terminal velocity.

k. The elephant and the feather encounter the same amount of air resistance, yet the elephant has a greater terminal velocity.