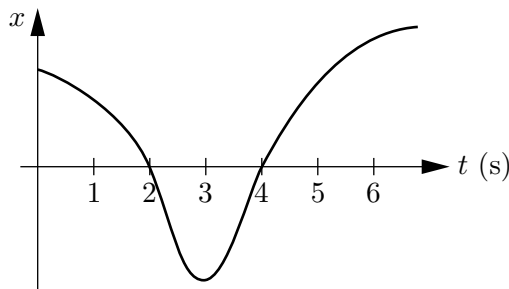


Problem Set 1

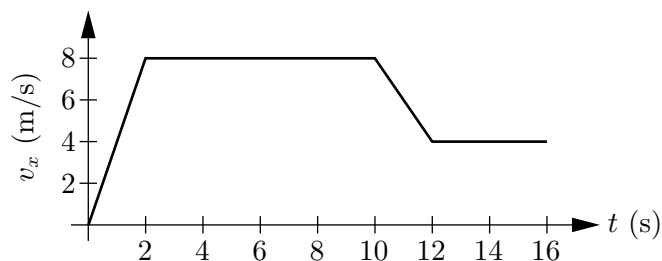
(due Friday, Jan. 7)

1. A room is 20 ft, 2 in long and 12 ft, 5 in wide. What is the floor area in (a) square feet and (b) square meters? If the ceiling is 12 ft, 2.5 in above the floor, what is the volume of the room in (c) cubic feet and (d) cubic meters?
2. Later this semester we'll encounter the formula $T = 2\pi\sqrt{\ell/g}$ for the time T that it takes a pendulum to swing back and forth. Here ℓ is the length of the pendulum and g is a constant with units of m/s^2 . Check that this equation is dimensionally correct, that is, check that the formula on the right-hand side indeed has units of time (seconds).
3. In physics we usually measure speed in meters per second. Suppose an object is moving at a speed of one meter per second. What is this in miles per hour?
4. Carry out the following arithmetic operations, paying proper attention to significant figures: (a) the sum of the numbers 756, 37.2, 0.83, and 2.5; (b) the product 3.2×3.563 ; (c) the product $5.6 \times \pi$; (d) the difference $425,991 - 425,987$.
5. An automobile travels on a straight road for 40 km at 30 km/hr. It then continues in the same direction for another 40 km at 60 km/hr. (a) What is the average velocity of the car during this 80 km trip? (Take the direction of travel to be the x direction.) (b) What is its average speed? (c) Sketch a graph of x vs. t , and indicate how the average velocity is found on the graph. (d) Sketch a graph of v_x vs. t .
6. The graph below pertains to an armadillo that scampers left and right along the x axis. (We'll refer to the $+x$ direction as right and the $-x$ direction as left.) (a) When, if ever, is the animal to the left of the origin on the axis? When, if ever, is its velocity (b) negative, (c) positive, and (d) zero?



7. (a) Can an object have zero velocity and still be accelerating? (b) Can an object have constant velocity and still have a varying speed? (c) Can the velocity of an object reverse direction when the object's acceleration is constant? (d) Can an object be increasing in speed as its acceleration decreases?
8. An automobile increases its speed uniformly from 25 km/hr to 55 km/hr in 0.50 minutes. A bicycle rider uniformly speeds up to 30 km/hr from rest in the same amount of time. Calculate their accelerations.

9. The illustration below shows the velocity of a runner as a function of time. Carefully trace this graph onto a piece of graph paper, leaving room above and below it. Then, using the same horizontal scale, carefully draw graphs of position vs. time (above) and acceleration vs. time (below) for the same motion. Finally, describe the motion of the runner in words.



10. A train is initially at rest at $x = 0$. It then starts moving in the $+x$ direction, gradually speeding up until it reaches its “cruising speed”. After it has been at cruising speed for a while, someone hits the emergency brake, rapidly bringing the train to a stop. Sketch qualitatively accurate graphs of position, velocity, and acceleration vs. time for the motion of the train. Place your graphs vertically one above the other, so that corresponding times match up on the three graphs.
11. A jumbo jet must reach a speed of 360 km/hr (225 mph) on the runway for takeoff. The length of the runway is 1.8 km. What is the minimum (constant) acceleration needed? (Hint: Use the Constant Acceleration Problem Worksheet.)
12. Raindrops fall to earth from a cloud 1700 m above earth’s surface. If they were not slowed by air resistance, how fast would the drops be moving when they struck the ground? Would it be safe to walk outside during a rainstorm? (Hint: Use the worksheet.)

Study Guide

You should understand the basic definitions of velocity and acceleration in one dimension:

$$v_x = \frac{\Delta x}{\Delta t}, \quad a_x = \frac{\Delta v_x}{\Delta t}.$$

You should be able to draw and interpret graphs of x , v_x , and a_x for any type of one-dimensional motion.

If the acceleration of an object is constant, then you can use the following equations to describe and predict the motion for all time:

$$v_x(t) = v_x(0) + a_x \cdot t,$$
$$x(t) = x(0) + v_x(0) \cdot t + \frac{1}{2} a_x t^2.$$

Be sure not to use these equations unless the acceleration is (at least approximately) constant!

The acceleration of a freely falling object near earth's surface, neglecting air resistance, is straight down and has magnitude

$$g = 9.8 \text{ m/s}^2.$$

You should memorize this number.