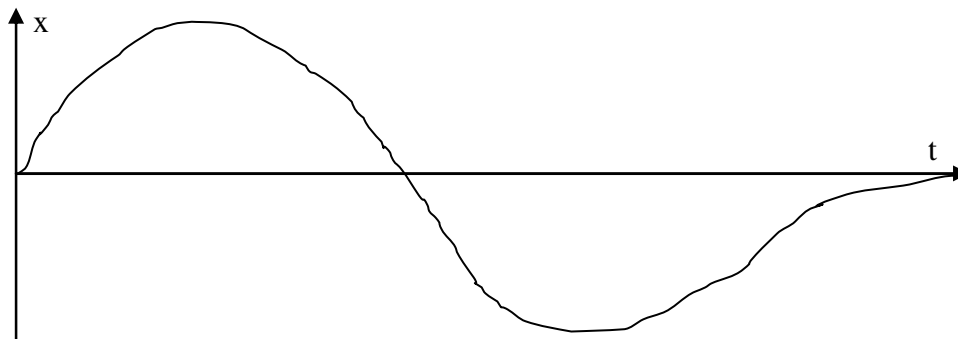


Problem Set 1: Motion in a Straight Line

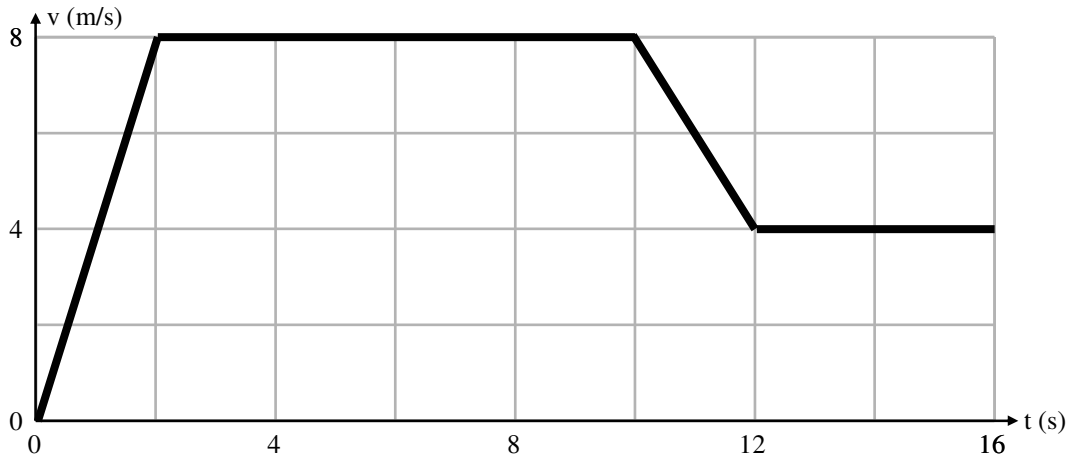
AP Physics C Supplementary Problems

1. An automobile travels on a straight road for 40 km at 30 km/h. It then continues in the same direction for another 40 km at 60 km/h. Calculate the average speed of the car during this 80 km trip.
2. The position of an object moving in a straight line is given by $x = 3.0t - 4.0t^2 + t^3$, where x is in meters and t in seconds. (a) Calculate the position of the object at $t = 1.0, 2.0, 3.0,$ and 4.0 s. (b) Calculate the object's displacement between $t = 0$ and $t = 4.0$ s. (c) Calculate the average velocity for the time interval from $t = 2.0$ to $t = 4.0$ s.
3. Two trains, each having a speed of 30 km/h, are headed toward each other on the same straight track. A bird that can fly 60 km/h flies off the front of one train when they are 60 km apart and heads directly for the other train. On reaching the other train it flies directly back to the first train, and so forth. Calculate the total distance the bird travels before the trains crash.
4. A particle had a velocity of 18 m/s and 2.4 s later its velocity was 30 m/s in the opposite direction. Calculate the average acceleration of the particle during this 2.4 s interval.
5. A particle moves along the x -axis with a x vs. t graph as shown below. Sketch roughly curves of v vs. t and a vs. t for this motion.



6. A particle moves along the x -axis according to the equation $x = 50t + 10t^2$, where x is in meters and t is in seconds. Calculate (a) the average velocity of the particle during the first 3.0 s of its motion, (b) the instantaneous velocity of the particle at $t = 3.0$ s, and (c) the instantaneous acceleration of the particle at $t = 3.0$ s.

7. The v vs. t graph shown below applies to a runner. Calculate how far the runner travels in 16 s.



8. The position of a particle moving along the x -axis depends on clock reading according to the equation

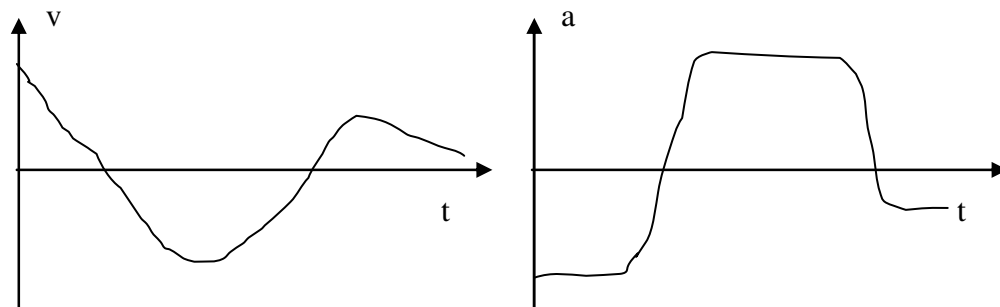
$$x = at^2 - bt^3,$$

- where x is in feet and t in seconds. (a) What dimensions and units must a and b have? For the following, let their numerical values be 3.0 and 1.0, respectively. (b) Calculate the clock reading when the particle reaches its maximum positive x position. (c) Calculate the total length of path the particle covers in the first 4.0 s. (d) Calculate the displacement of the particle during the first 4.0 s. (e) Calculate the particle's speed at the end of each of the first 4 s. (f) Calculate the particle's acceleration at the end of each of the first 4 s.
9. A rocketship in free space moves with constant acceleration equal to 9.8 m/s^2 . (a) If it starts from rest, how long will it take to acquire a speed one-tenth that of light? (b) How far will it travel in so doing? (The speed of light is $3.0 \times 10^8 \text{ m/s}$.)
10. An object has a constant acceleration of 3.2 m/s^2 . At a certain clock reading its velocity is $+9.6 \text{ m/s}$. Determine its velocity (a) 2.5 s earlier and (b) 2.5 s later.
11. On a dry road a car with good tires may be able to brake with an acceleration of 4.92 m/s^2 . (a) How long does such a car, initially traveling at 24.6 m/s , take to come to rest? (b) How far does it travel in this time interval?
12. A car moving with constant acceleration covers the distance between two points 60 m apart in 6.0 s. Its speed as it passes the second point is 15 m/s . (a) Calculate the speed at the first point. (b) Calculate the acceleration. (c) At what prior distance from the first point was the car at rest?

13. The Zero Gravity Research Facility at the NASA Lewis Research Center includes a 145 m drop tower. This is an evacuated vertical tower through which, among other possibilities, a 1 m diameter sphere containing an experimental package can be dropped. (a) For how long is the experimental package in free fall? (b) Calculate its speed at the bottom of the tower. (c) At the bottom of the tower, the sphere experiences an average acceleration of 25 g as its speed is reduced to zero. Through what distance does it travel in coming to rest?
14. A rocket is fired vertically and ascends with a constant vertical acceleration of 20 m/s^2 for 1 min. Its fuel is then all used and it continues as a free fall particle. (a) Calculate the maximum altitude reached. (b) Calculate the total time elapsed from takeoff until the rocket strikes the earth.
15. An object falls from a bridge that is 45 m above the water. It falls directly into a small boat moving with constant velocity that was 12 m from the point of impact when the object was released. Calculate the speed of the boat.
16. A stone is dropped into the water from a bridge 144 ft. above the water. Another stone is thrown vertically down 1.0 s after the first is dropped. Both stones strike the water at the same time. Calculate the initial speed of the second stone. ($g = 32 \text{ ft/s}^2$).
17. A balloon is ascending at the rate of 12 m/s at a height of 80 m above the ground when a package is dropped. (a) How long does it take the package to reach the ground? (b) With what speed does it hit the ground?

Answers:

1. 40 km/h
2. a) 1.0 s: 0 m 2.0 s: -2 m 3.0 s: 0m 4.0 s: 12 m
 b) 12 m
 c) 7 m/s
3. 60 km
4. -20 m/s^2
- 5.



6. a) 80 m/s b) 110 m/s c) 20 m/s^2
7. 100 m

8. a) ft/s^2 and ft/s^3 b) 2 s c) 24 ft
d) -16 ft
e) 1 s: 3 ft/s 2 s: 0 ft/s 3 s: -9 ft/s 4 s: -24 ft/s
f) 1 s: 0 ft/s^2 2 s: -6 ft/s^2 3 s: -12 ft/s^2 4 s: -18 ft/s^2
9. a) 3.04×10^6 s b) 4.5×10^{13} m
10. a) 1.6 m/s b) 17.6 m/s
11. a) 5 s b) 61.5 m
12. a) 5 m/s b) 1.7 m/s^2 c) 7.4 m
13. a) 5.4 s b) -53.3 m/s c) 5.8 m
14. a) 109 km b) 332 s
15. 4 m/s
16. 40 ft/s
17. a) 5.4 s b) 41 m/s