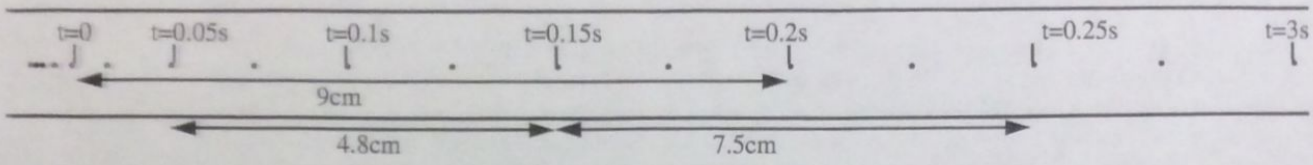
Physics Practice Problems: Kinematics

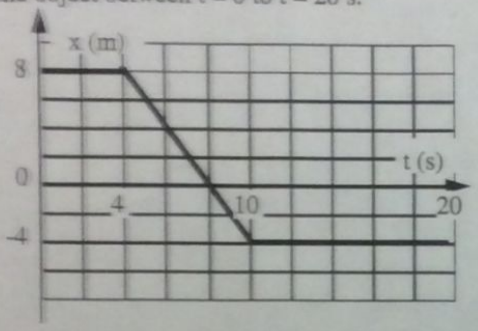
Terms, motion graphs, etc.

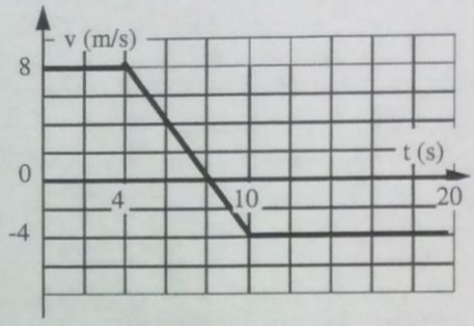
1. Convert 900 km/h to the unit of m/s.
2. The dot-timer tape below records the motion of a toy car.



a) Find the speed of the car at t = 0.2 s. Use cm for the unit of length and s for the unit of time.
b) Find the position of the car at t = 0.2s. c) Find the average velocity of the car from t = 0 to 0.2 s.

3. From the position vs. time graph on the left, find a) the instantaneous velocity of the object at t = 6s, and b) the average velocity of the object between t = 0 to t = 20 s.





4. Use the velocity vs. time graph on the right, find: a) The instantaneous velocity at t = 10 s.
b) The average acceleration from t =10 s to t = 20 s. c) The total displacement between t=0 s and t = 20 s.
d) The average velocity between t = 0 s and t = 20 s. e) The acceleration at t = 8s.
5. A person walks north for 50 m at 0.5 m/s, stand still for 60 seconds and then walks south back 50 m to the starting point at 2 m/s. Find a) the total distance traveled, b) the total displacement, c) the average speed and d) the average velocity.

Constant acceleration motion problems: (also prob. 21 on p.2)

6. A car decelerates at a rate of 2.0 m/s^2 and comes to a complete stop after traveling 25 m. What was the speed of the car right before the deceleration?
7. An airplane must reach a speed of 60 m/s for takeoff. If the plane can accelerate at a constant rate of 2 m/s^2, what minimum runway length is required for the airplane to takeoff safely?
8. A car **decelerates** from 25 m/s to 5 m/s in 20 seconds. How far does the car travel in these 20 seconds?
9. A car **decelerates** from 25 m/s to 5 m/s at 10 m/s^2. How far does the car travel during this deceleration?
10. A car traveling at 20 m/s decelerates at a constant rate to a complete stop after traveling 40 m. a) What is the average speed of the car during this process? b) How long does it take for the car to stop?
11. A car is traveling at 18 m/s when the driver sees a disabled car in the middle of the road. He takes 0.8 s to react (assume that the car travels at constant speed during this reaction time), then steps on the brakes and slows at 9.0 m/s^2. How far does the car go before it stops?

Falling objects: (also prob. 21 on p.2)

12. A ball is dropped from a window 10 m above the sidewalk. Determine the time it takes for the ball to fall to the sidewalk.
13. A camera is accidentally dropped from the edge of a cliff and 6.0 s later hits the bottom.
a) How fast was it going just before it hit? b) How high is the cliff?
14. A tennis ball is thrown straight up with an initial speed of 22.5 m/s. It is caught at the same distance above ground.
a) How high does the ball rise? b) How long does it take the ball to reach its highest point?
c) How long does the ball remain in the air? d) How fast was it going just before it is caught?
e) What is the velocity and acceleration of the ball at the highest point?
15. A rock is thrown vertically upward with a velocity of 20 m/s from the edge of a bridge 42 m above a river. a) What is the rock's speed just before it falls into the river? b) How much time does it take from the time the rock is launched to the time when the rock strikes the river water?

Projectile motion:

16. A stone is thrown horizontally at 18 m/s from the top of a cliff. The cliff is 45 m above a flat horizontal beach.
a) How long after being released does the stone strike the beach below the cliff?
b) How far from the base of the cliff does the stone land?
c) What are the vertical and horizontal components of the stone's velocity the moment before it hits the ground?
d) Another stone is thrown horizontally from the same cliff. It hits the ground 42 m away from the base of the cliff. What is the stone's initial speed?

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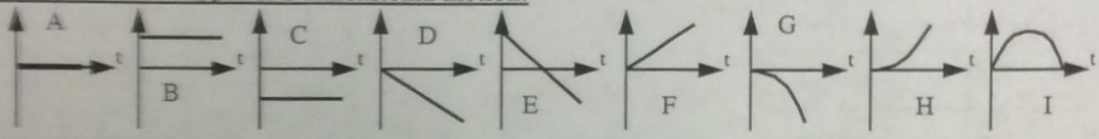
Projectile motion continued:

17. The fastest recorded pitch in major-league baseball, thrown by Nolan Ryan in 1974, was clocked at 45 m/s. If a pitch were thrown horizontally with this velocity, how far would the ball fall vertically the time it reached home plate, 60 feet (18.3 m) away?
18. A cannon ball is shot on a flat, level plane with an initial velocity of 50 m/s, 30° above the horizontal.
    a) What is the maximum height reached by the cannon ball?
    b) How long does the cannon ball stay in the air before it strikes the ground?
    c) What is the cannon ball's acceleration and velocity at the highest point of its trajectory?
    d) What is the cannon ball's acceleration and velocity the moment before it strikes the ground?
19. A long jumper leaves the ground at an angle of 20° to the horizontal and at a speed of 11 m/s.
    a) How far does he jump? b) What is the maximum height reached?
20. A projectile is shot from the edge of a cliff 42 m above ground level with an initial speed of (100/3) m/s. at an angle of 37° with the horizontal. a) Determine the time taken by the projectile to hit point P at ground level.
    b) Determine the range X of the projectile as measured from the of the cliff.
    At the instant the projectile hits point P, find
    c) the horizontal and the vertical components of its velocity, and d) the speed of the projectile.

Graph problem for different types of 1-dimensional motion:

21.



Find the accel. vs. time, velocity vs. t, and displacement vs. t graphs for each of the following cases:
a) An object moves at a constant negative velocity. b) An object moves at a constant positive velocity.
c) An object at rest begins to accelerate at a constant positive acceleration.
d) An object dropped from a certain height. e) An object tossed upward.

Vector problems:

22. A robot is commanded to walk 20 m west from its recharging unit and then walk 50 m south. Find the distance the robot is from its recharging unit at the end.
23. (optional) A child controls his remote-controlled car so that it moves in a direction 37° south of east for 6 seconds and then due east for another 4 seconds. If this toy car travels at a constant speed of 1.5 m/s, what is the magnitude of its resultant displacement in the 10 seconds?
24. (optional) **A**= (1, 2, -3), **B**= (-2, 4, -1) a) Determine a third vector, **C**, such that **C = A + B**.
    b) Determine a third vector, **C**, such that **C = A - B**.

Relative motion: Crossing river problems:

25. A boat can travel 4 m/s in still water. a) If the boat points its prow directly across a river whose current is 1 m/s, what is the speed of the boat relative to the shore? b) If the river is 150-m wide, how long will it take the boat to reach the other side? c) How far down river (from a point opposite its starting point) will the boat be when it reaches the other side?
26. A boat can travel 4 m/s in still water. If it must aim upstream at an angle of 37° (with respect to a line perpendicular to the shore) in order to travel directly across the river, a) what is the speed of the current? b) what is the resultant speed of the boat relative to the shore? c) If the river is 150-m wide, how long will it take the boat to reach the other side?