C-Team Practice Problems: Kinematics

1. A runner runs 2.9 km, in a straight line, in 9.0 min and then takes 30 min to walk back to the starting point. (The running and walking is in a straight line.)
(a) What is the runner's average velocity for the first 9 min?

(b) What is the average velocity for the time spent walking?

(c) What is the average velocity for the whole trip?

(d) What is the average speed for the whole trip?

2. Cosmonaut Andrei, your co-worker at the International Space Station, tosses a banana at you at a speed of 18 m/s. At exactly the same instant, you fling a scoop of ice cream at Andrei along exactly the same path. The collision between banana and ice cream produces a banana split 8.4 m from your location 1.4 s after the banana and ice cream were launched. HINT: The effects of gravity can be neglected since we are orbiting the Earth!

(a) How fast did you toss the ice cream?

(b) How far were you from Andrei when you tossed the ice cream?

3. At $t = 0$, a stone is dropped from a cliff above a lake; 1.8 seconds later another stone is thrown downward from the same point with an initial speed of 47 m/s. Both stones hit the water at the same instant. Find the height of the cliff.

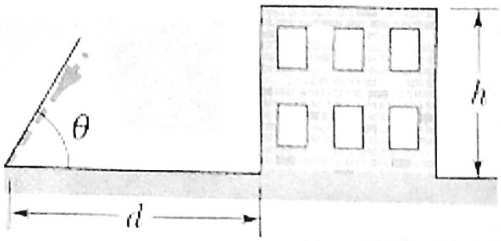
4. You are a student in a science class that is using the following apparatus to determine the value of g. Two photogates are used. (Note: You may be familiar with photogates in everyday living. You see them in the doorways of some stores. They are designed to ring a bell when someone interrupts the beam while walking through the door.) One photogate is located at the edge of a 1.00-m-high table and the second photogate is located on the floor directly below the first photogate. You are told to drop a marble through these gates, releasing it from rest at the same height as the table. The upper gate starts a timer as the ball passes through it. The second photogate stops the timer when the ball passes through its beam.
(a) Prove that the experimental magnitude of free-fall acceleration is given by $g_{exp} = (2\Delta y)/(\Delta t)^2$, where Δy is the vertical distance between the photogates and Δt is the fall time. (Do this on paper. Your instructor may ask you to turn in this work.)

(b) For your setup, what value of Δt would you expect to measure, assuming g_{exp} is the standard value (9.81 m/s^2)?

(c) During the experiment, a slight error is made. Instead of locating the first photogate even with the top of the table, your not-so-careful lab partner locates it 0.50 cm lower than the top of the table. However, she does manage to properly locate the second photogate on the floor directly below the first. What value of g_{exp} will you and your partner determine? What percentage difference does this represent from the standard value of g?

5. A projectile is launched with speed v_0 at an angle of θ_0 above the horizontal. Find an expression for the maximum height it reaches above its starting point in terms of v_0, θ_0, and g. (Ignore any effects due to air resistance.)

6. In the figure, a ball is thrown leftward from the left edge of the roof, at height h above the ground. The ball hits the ground 1.61 s. later, at distance d = 25 m from the building and at angle $\theta = 51°$ with the horizontal.



(a) Find h.

(b) What is the magnitude and angle of the velocity at which the ball is thrown?

(c) Is that angle above or below the horizontal?

7. A flowerpot falls from the ledge of an apartment building. A person in an apartment below, coincidentally in possession of a high-speed, high-precision timing system, notices that it takes 0.25 s to fall past his 3.5 m tall window. How far above the top of the window is the ledge from which the pot fell?

All of these problems are from Webassign.