

State Any Assumptions You Need To Make -- Show All Work -- Circle Any Final Answers
Use Your Time Wisely - Work on What You Can - Be Sure to Write Down Equations
Feel Free to Ask Any Questions

“No, officer, I really don’t have any idea how fast I was going.” (50,000 points)

1.) If highways were marked with signs in the S.I. metric system, instead of m.p.h. or k.p.h, we might see something that looks like the sign at the right. (a) Normally we don’t ask you to do conversions between *standard* and *metric*, but this is a practice exam – so what is 30.0 m/s in miles per hour? ... kilometers per hour?



(b) How long (time) would it take to travel a distance of 50.0 kilometers (50,000 meters) at the posted speed limit of 30.0 m/s?

Suppose on a trip of some 50.0 kilometers, you travel the first half of the distance at a speed of 25.0 m/s.

(c) How far (distance) will you have traveled? (d) How long (time) will it have taken?

(e) How fast would you have to travel in the second half of the distance in order for your trip to take the same time as in part (b)? Would you have been speeding – or not?

The Following Problem is Brought to You by Coca-Cola™, Our Proud Sponsor (50,000 points)

2.) Michael Johnson ran the 200. m at the Atlanta Olympics in something like 19.32 seconds. (a) What is his average speed?

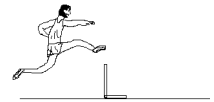


(b) Carl Lewis has run the 100. m in 9.90 seconds. If Mr. Lewis ran like that in the first 100. m of Mr. Johnson’s 200. m race, what would Carl’s average speed have to be in the second 100. m to tie the race? *Hint: How much time is there left?*

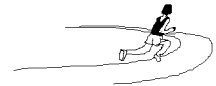


(c) Suppose Ben Johnson of Canada came along and also ran the 200. m in 19.32 seconds, but did so as constant acceleration the whole trip, starting from rest. Find his acceleration, *a*.

(d) Edwin Moses, running horizontally at 10.0 m/s, jumps over a hurdle with an initial vertical speed, v_{0y} , of 1.00 m/s. How long (time) is Edwin in the air?



(e)¹ Carl Lewis is running on an indoor track, moving at 10.0 m/s through a curve of radius 20.0 m. What is his centripetal acceleration, a_c ?



“Come Josephine In My Fly-ing Machine...!” (50,000 points)

3.) An airplane flies east for 15.0 miles at 90.0 miles/hour, then heads north for 15.0 minutes at 120. miles/hour. Find (a) the time spent flying east and (b) the distance traveled north.

Find (c) the total distance and the total time that the airplane flew.

(d) What is the average speed of the airplane based on the path that it took?

Find the “straight-line distance that the airplane flies”. Use this distance and the time answer to (c) to find (e) the average speed of the airplane based on the beginning and end points. *Which should be larger, (d) or (e)? Why?*

¹ Centripetal Acceleration might not be on Exam 1. The equation is: $a_c = v^2/r$, where *r* is the radius of the circle.

"Next Stop, High Street – Kensington," GREEN LINE – LONDON UNDERGROUND (50,000 points)

4.) In the movie *Sliding Doors*, Gwyneth Paltrow's character is split along two time paths – one where she misses the subway, and one where she makes it. We've all been there, it's just a matter of seconds difference between the close of the sliding doors in your face, or slipping between them at the last moment. Suppose you hear the train arrive in the station as you are coming down the stairs. The train will be in the station exactly one minute. You are 112 meters from the doors of the train. (a) What is the *minimum* speed that will allow you to make the train?

(b) Alice happens to look on Joe's PHYS-113 exam and sees that for part (a) he has put down 17.1 m/s as the answer. (ALICE – WHY ARE YOU LOOKING ON JOE'S PAPER? – DR. PHIL) Why does Alice know immediately that Joe's answer is WRONG? *You need to give a good Physics answer – but be brief.*

(c) The subway train travels the next station one mile away (1609 meters) in $1\frac{1}{2}$ minutes (90.0 seconds). What is the average speed of the train?

The subway train accelerates from rest to its cruising speed of 23.0 m/s in 20.0 seconds. Find its (d) acceleration and (e) how far it traveled in that time.

History in the Making... (50,000 points) NOTE: this was written in Fall 1998

5.) Mark McGwire's 65th home run this weekend and Sammy Sosa's 63rd home run last week, are quite the achievement. Yet both men miss the ball more than 2/3 of the time they go to the plate. Hitting a major league fast ball has been described as one of the hardest tasks in all of sport – it is about 18.45 meters from the pitcher to home plate (60 ft. 6 inches), and a fast ball travels at about 43.8 m/s (98 m.p.h.). (a) How long does it take for the ball to travel this distance?

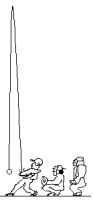
(b) The ball makes contact with the bat somewhere in 0.500 m of space on its trip to the catcher. How long is the ball in this space?



(c) Instead of hitting a home run, the batter hits the ball straight up at 45.5 m/s. How high will the ball go? *Assume that $y = 0$ is where the ball is hit. As usual, we are ignoring things like air resistance and we assume that the ball is going straight up and straight down.*

(d) How long (time) will it take for the ball to get there?

(e) How fast will the ball be going when it gets back down?

**Cheetah Hunters of the Serengeti (50,000 points)**

6.) A cheetah, initially at rest, is passed by a gazelle, who is running at 35 m.p.h. (15.6 m/s). The cheetah will start running after the gazelle with a constant acceleration of 10.0 m/s^2 . (a) If the final speed of the cheetah is 70 m.p.h. (31.2 m/s), then use the *equation without time* to find out how far the cheetah travels.



(b) How much time does it take for the cheetah to go from zero to 70 m.p.h. (31.2 m/s)?

(c) How far does the gazelle travel in this same time, running at 35 m.p.h. (15.6 m/s)?

(d) What is the average speed of the gazelle?

(e) What is the average speed of the cheetah? Does this make sense?

Steven Seagull – Action Heroes Are For The Birds (50,000 points)

7.) Seagulls like to eat nearly everything, including McDonald's french fries and clams. However, a seagull beak is not strong enough to crack open a clam shell. Imagine a gliding seagull, carrying a clam, suddenly swooping straight up, starting at 10.0 m above the beach (y_0) and an initial speed of $+22.2 \text{ m/s}$ (v_{0y}). At this point, assume the bird glides straight up, unpowered and with no air resistance. (a) How high does the seagull go?

(b) How much time does it take for the seagull to come to rest at that height?

(c) At the top of its flight, the bird lets the clam go from rest. How fast will the clam be going when it reaches the beach? *Be sure to indicate the direction, too.*

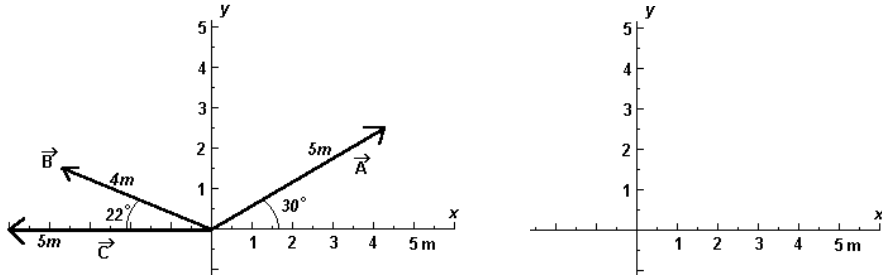
(d) The seagull has dropped the clam onto a rock, and the clam goes from the speed in (c) to rest in a distance of half a centimeter (0.500 cm). What is the acceleration of the clam? *Give answer in m/s^2 .*

(e) How many gee's is this? *Hint: what is "g" equal to? That would be 1.00 gee's.*

Vectors Pointing The Way (20,000 points) The following questions are from Spring 1995.

8. (a) Given the three vectors shown on the diagram below (\vec{A} , \vec{B} and \vec{C}), describe each of these three vectors in standard form.

(b) On the coordinate axis given, sketch out what $\vec{A} + \vec{B} + \vec{C}$ should look like. You don't need to be ruler and protractor accurate; just be able to give an idea of what length, direction, quadrant the resultant vector looks like.



(c) Find the x - and y -components of each of the three vectors.

(d) Now comes the real work: find $\vec{A} + \vec{B} + \vec{C}$ in terms of magnitude and standard angle using the analytical method.

(d) Find $\vec{A} + \vec{B} - \vec{C}$ in terms of magnitude and standard angle using the analytical method.

“Bad Boys, Bad Boys, Whatcha Gonna Do? Whatcha Gonna Do When They Come For You?” (20,000 points)

9.) Andy is late getting back to campus after a long weekend, so drives along I-94 at 80 mph. The speed limit is 65 mph, so he knows that he is gaining every mile that he drives. (a) How many seconds will it take to drive one mile at 65 mph and 80 mph?

(b) How much time will Andy save on his 145 mile trip?

(c) Unfortunately for Andy, as he comes over a hill, he and his car are noticed by Trooper Joyce of the Michigan State Police, who is parked on the side of the road. Her radar gun displays his speed: 80 mph (37.8 m/s). At the exact moment he passes her, she steps on the gas and starts accelerating at 3.00 m/s^2 . Andy has Def Leppard's Greatest Hits blaring on the stereo so loud, he never hears the siren and doesn't notice the flashing lights coming up behind him. Write down the kinematic equations for x , v and a for both Andy and Trooper Joyce.

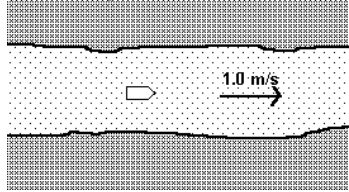
(d) Andy doesn't notice the state police car until Trooper Joyce is right next to him. At what time, t , and what distance, x , since the pursuit started, does this happen?

(e) If both Andy and Trooper Joyce start braking at -5.00 m/s^2 at the moment he sees her, will they come to a stop in the same place? Why or why not?

Bill and Ted's Excellent Adventures (20,000 points)

10.) Bill and Ted are sitting in a small boat anchored in the middle of a small river. The river water is flowing at 1.0 m/s. Bill and Ted are excellent swimmers and can swim at a constant speed of 2.0 m/s. They decide to have a race: Bill will swim off downstream 50.0 m and then back upstream to the boat. Ted will swim 50.0 m off to the side and return to the boat, but on a course perpendicular to Bill.

(a) How long will it take Bill to swim and return?



(b) How long will it take Ted to swim and return?

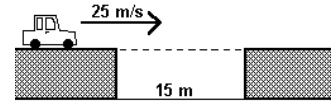
(c) Who wins the race? Does it make sense? Explain.

(d) The shore is 100 m away. Bill can row the boat at a maximum speed of 0.50 m/s. At what angle to the current should the boat travel to get to the shore the fastest? And how far downstream will the boat have travel by the time it reaches the shore?

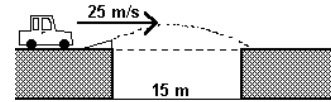
(e) If Ted joins Bill in rowing the boat, they can get the boat up twice the speed of Bill rowing alone. At what angle to the current should the boat travel in order to reach the shore without traveling downstream at all?

Making Movies... (20,000 points)

11.) This summer there will undoubtedly be plenty of movies, like last year's *Speed*, where cars (or busses) will have to jump gaps in the road. If a car traveling at 25.0 m/s (about 55 mph) came across a missing bridge, (a) how long will it take for the car to jump the gap and (b) far will the car fall as it travels across the 15.0 m gap?



(c) In the movies, cars that have to cross a horizontal gap are given a vertical component to their velocity by hitting a ramp or using explosives. Consider $v_{0x} = 25.0$ m/s. Find v_{0y} such that the car lands safely on the other side.



(d) Find the angle θ and initial velocity v_0 needed for the car to safely jump the gap.

(e) If a ramp was used to make this angle θ and the ramp was 2.00 m long, how tall would the ramp have to be?