Physics 206a

Homework Assignment III

due January 26, 2007

Reminder: The first exam will be held on February 2 (Friday). It will include material through that covered on assignment #4, although the emphasis will be on material through assignment #3.

1. Two runners, **A** and **B** depart from the same starting point. Runner **A** goes directly North with a speed, relative to the ground, of $5\frac{meters}{second}$ while runner **B** goes directly west with a speed, also relative to the ground, of $7\frac{meters}{second}$.
    a. What is the speed of runner **A** as seen by runner **B**?
    b. What is the velocity of runner **A** as seen by runner **B**?
    c. What is the velocity of runner **B** as seen by runner **A**?
2. A vector has a length of 7.2 and is oriented 51° relative to the x axis of a Cartesian coordinate system. (Positive angles correspond to counterclockwise rotation.) Express this vector in terms of the unit vectors parallel to the x and y axes.
3. Three vectors are added together. The first has a length of 2.9 and is oriented at 22°. The second vector has a length of 5.1 and is oriented at –37°. The third vector has a length of 3.5 and is oriented at 113°. Find the resultant **algebraically** (i.e., using unit vectors). *After* finding the resultant algebraically, express it in terms of a size and direction. Note: All angles are relative to the x axis.

4. An airplane is traveling at a constant velocity of $203\frac{\text{meters}}{\text{second}}$ relative to the ground, oriented 17 degrees north of east. A skydiver jumps out of the airplane and (after opening his parachute) falls at a constant velocity of $3.7\frac{\text{meters}}{\text{second}}$ straight down. What is the velocity of the airplane as seen by the skydiver? (You can treat "north" as being the $\hat{y}$ direction and "east" as being the $\hat{x}$ direction in both this and the next question, if you'd like. This would make the up/down direction $\pm\hat{z}$.)

5. A car travels at $26\frac{\text{meters}}{\text{second}}$ oriented 30 degrees north of east. It travels for 3 kilometers. It then turns so that it is oriented to the south. It travels at $30\frac{\text{meters}}{\text{second}}$ for 27 minutes. What is its velocity at the end of that time (assuming it keeps on going)?

6. Two cars are traveling in the $\hat{y}$ direction. At some instant in time (let's call it t=0), one is 123 meters behind the other. The one in front is traveling at $23\frac{\text{meters}}{\text{second}}$ while the one in the rear is traveling at $26\frac{\text{meters}}{\text{second}}$. At what time (relative to t=0) will the one in the rear catch the one that was initially in front?

7. Two men are playing catch in a train (hey, they're bored). They throw a ball back and forth with a speed of $5\frac{\text{meters}}{\text{second}}$ along the length of the train. From the perspective of an observer watching from the side of the tracks, the train has a velocity of $18\frac{\text{meters}}{\text{second}}\hat{x}+18\frac{\text{meters}}{\text{second}}\hat{y}$. From the perspective of the observer outside of the train, what is the velocity of the ball when it is going toward the front of the train? What is the velocity of the ball when it is going toward the back of the train? What is the speed of the ball?

8. An object is traveling $5\frac{\text{meters}}{\text{second}}\hat{x}$. It undergoes an acceleration of $-1.2\frac{\text{meters}}{\text{second}^2}\hat{x}$. What is its velocity after 3 seconds? What is its velocity after 5 seconds?

9. An airplane lands with a speed of $53\frac{\text{meters}}{\text{second}}$. It accelerates to a stop at a constant rate. (Remember: We don't use the word "decelerate" in this class.) If its acceleration is $-1.2\frac{\text{meters}}{\text{second}^2}$, how far does it travel before coming to a stop? (Note that this is a one-dimensional problem, so we don't need to specify a direction + or – suffices. You are welcome to specify a direction if you like, however—it's not wrong, just not strictly necessary.)

10. An oil tanker is traveling at $11\frac{\text{meters}}{\text{second}}$ when it notices an iceberg 2.8 kilometers in front of it. Its maximum acceleration is $0.02\frac{\text{meters}}{\text{second}^2}$ (whether forward or backward). Will it strike the iceberg? If so, how fast will it be going when it strikes? If not, how far from the 'berg will it be when it stops?

11. A police car passes a car traveling in the exact opposite direction. The police car is traveling at $32\frac{\text{meters}}{\text{second}}$ and the officer notices that the oncoming car is traveling at $35\frac{\text{meters}}{\text{second}}$. The police car begins braking at the exact instant the two cars pass each other. The police car accelerates to a stop at a rate of $4\frac{\text{meters}}{\text{second}^2}$ and then accelerates at the same rate until the police car catches the speeder. (All speeds and accelerations in this problem were given relative to the ground.)

    a. How long after the two cars initially pass each other will it be before the police car catches the speeder?

    b. When the police car catches the speeder, what will its speed be, relative to the ground?

c. When the police car catches the speeder, what will its speed be relative to the speeder?

d. Is the acceleration stated in this problem for the braking portion of the motion a realistic value?

e. Is the acceleration stated in this problem for the “pursuit” portion of the motion a realistic value?