Physics 206a

Homework Assignment IV
due February 5, 2007

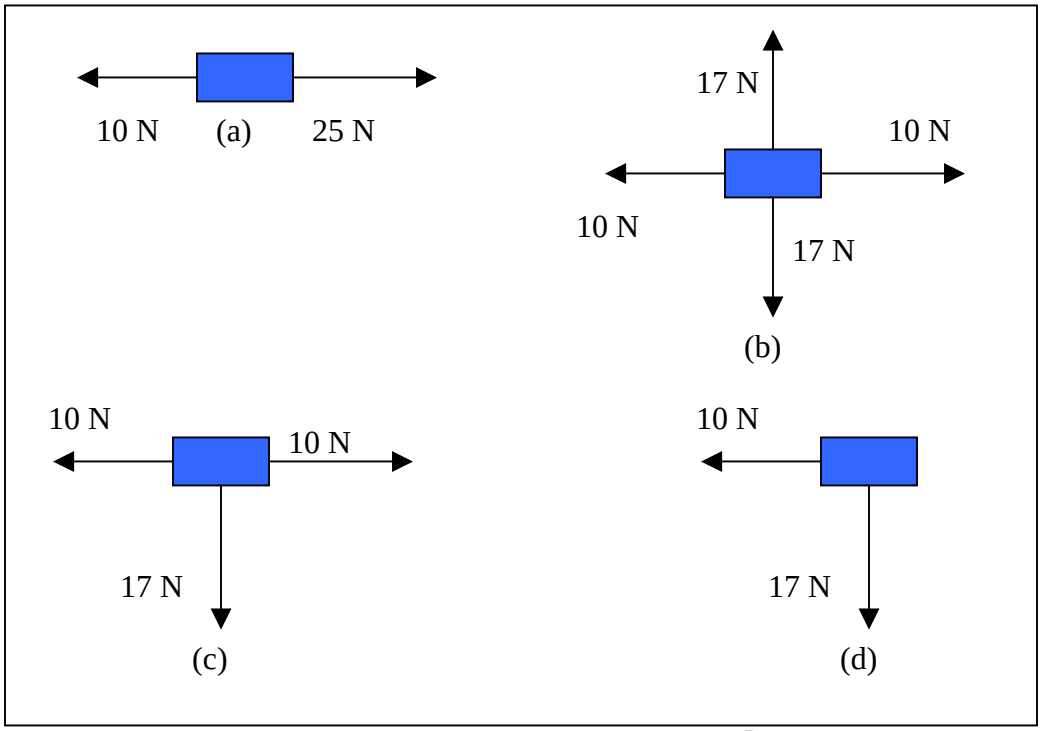
Note that this is due on Monday. You have an exam scheduled for Friday, February 2, so the due date on this has been shifted to allow you some breathing room to study for the exam. Nevertheless, the next assignment will be due on Friday, February 9.

1. Starting with Newton's second law, determine the unit of force in the SI system. Express this in terms of the fundamental units of that system. This unit is called the "Newton" and is abbreviated by the letter "N".

2. 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 the same speed. If another car departs from the same point as the first one at the same time as the first one and travels directly east, how fast does it have to travel if the two cars are to collide?

3. What is the net force acting on a hockey puck sliding on the ice at a constant velocity of $10\,\frac{m}{s}$ in the $\hat{x}$ direction? Explain your answer in terms of Newton's laws.

4. Find the magnitude and direction of the net force on the object in each of the free-body diagrams in the figure below.



5. Refer again to the figure in problem #4. If the objects all have a mass of 1.7 kg, what is the acceleration experienced by them in each case?

6. Yet again, refer to the objects shown in problem #4. After 13 seconds, what is the velocity of each object? At that same time, what is the displacement vector (assuming the objects all begin at the origin) for each object?

7. In your lab exercise (#3, on Jan. 29-30), you place a mass on an inclined airtrack. In class, I will derive the acceleration of the mass using a coordinate system with one axis parallel to the track. Derive an expression for the acceleration of the mass (the cart) as a function of the angle of the incline using the "usual" coordinate system, i.e., one in which the *y* axis is in the direction of gravity. Draw a free-body diagram of the cart and determine the forces (both size and direction) in this coordinate system. You may consider the mass of the cart to be simply "*m*".

8. An airplane is flying at a height of 50,000 meters at a constant velocity of $260\,\frac{\text{meters}}{\text{second}}$ in the $\hat{x}$ direction. A bomb is dropped out of it. The bombardier wishes to strike a target which is at $x = 100{,}000\,\text{meters}$. At what x coordinate should the airplane be for the bomb to hit this target? Assume no air-resistance for the bomb. Explain your answer.
9. What is the velocity with which the bomb in problem #8 will strike the target?
10. A baseball is thrown with an initial velocity of $40\,\frac{\text{meters}}{\text{second}}$ at an angle of 53° relative to horizontal. (It is safe to assume that the thrower is at the same height as the ground—this is an approximation, but it is sufficient for this problem.)
    a. How long after it is thrown will it reach a height of 10 meters while traveling upward?
    b. How long after it is thrown will it reach its maximum height?
    c. What is its maximum height?
    d. How long after it is thrown will it reach a height of 10 meters while traveling downward?
    e. How long after it is thrown will it hit the ground?
    f. How far away from the thrower will it be when it hits the ground?
    g. What will its velocity be when it hits the ground?