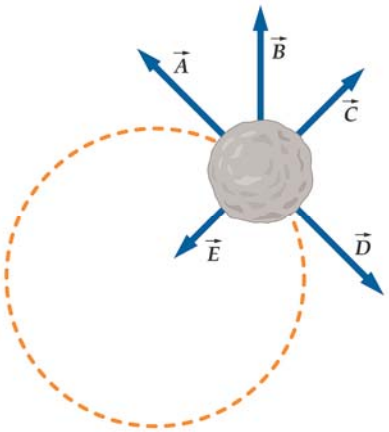
INSTRUCTIONS: Write your NAME and LECTURE SECTION (I: Ruchti, II: Hildreth) on the front of the blue exam booklet. The exam is closed book, and you may have only pens/pencils and a calculator (no stored equations or programs and no graphing). Show all of your work in the blue book. For problems II-V, an answer alone is worth very little credit, even if it is correct – so show how you get it.

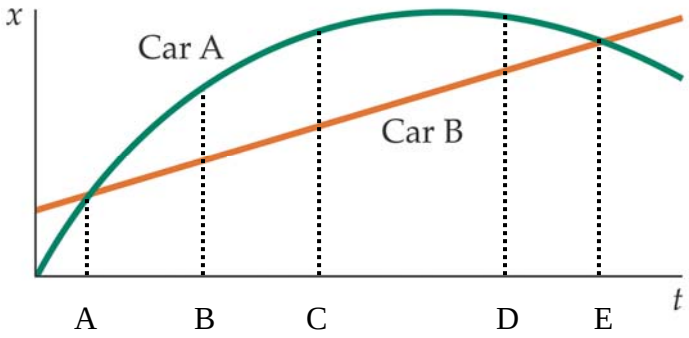
Suggestions: Draw a diagram when possible, circle or box your final answers, and cross out parts which you do not want us to consider.

I. Multiple Choice Questions (4 points each) Please write the letter corresponding to your answer for each question in the grid stamped on the first *inside* page of your blue book. No partial credit is given for these questions.

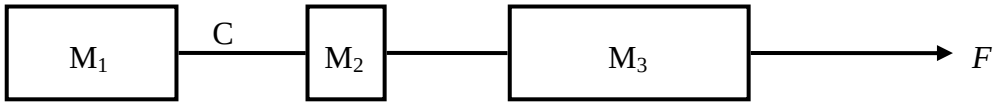
1. A man in an Olympic hammer throw event swings a stone attached to a tether in a horizontal circle at constant speed, as shown in the figure. Which of the vectors could represent the velocity of the stone?
(a) A or B, (b) C or E (c) A or D (d) A (e) E



2. The positions of two cars in parallel lanes on a straight stretch of highway are plotted as functions of time in the figure. At which times are the cars traveling in opposite directions?
(a) A (b) A or B (c) C (d) D (e) D or E

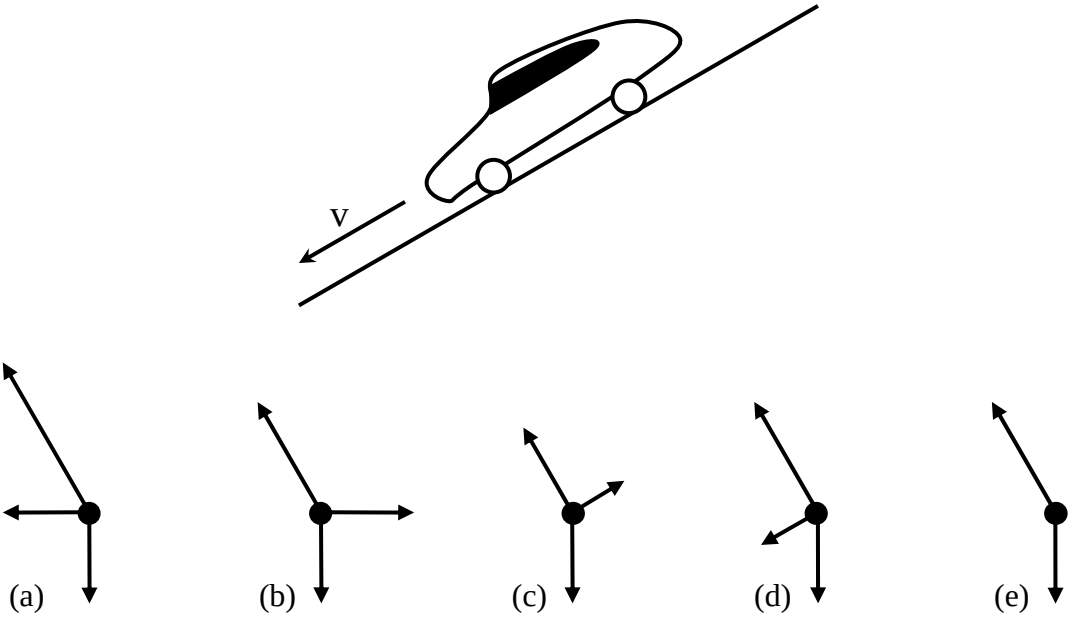


3. Three boxes are connected by strings as shown in the figure and are pulled to the right with a force F=12N, sliding along a frictionless horizontal plane. The masses are M_1 = 4kg, M_2= 2kg, and M_3 = 6kg. What is the tension in the string C?

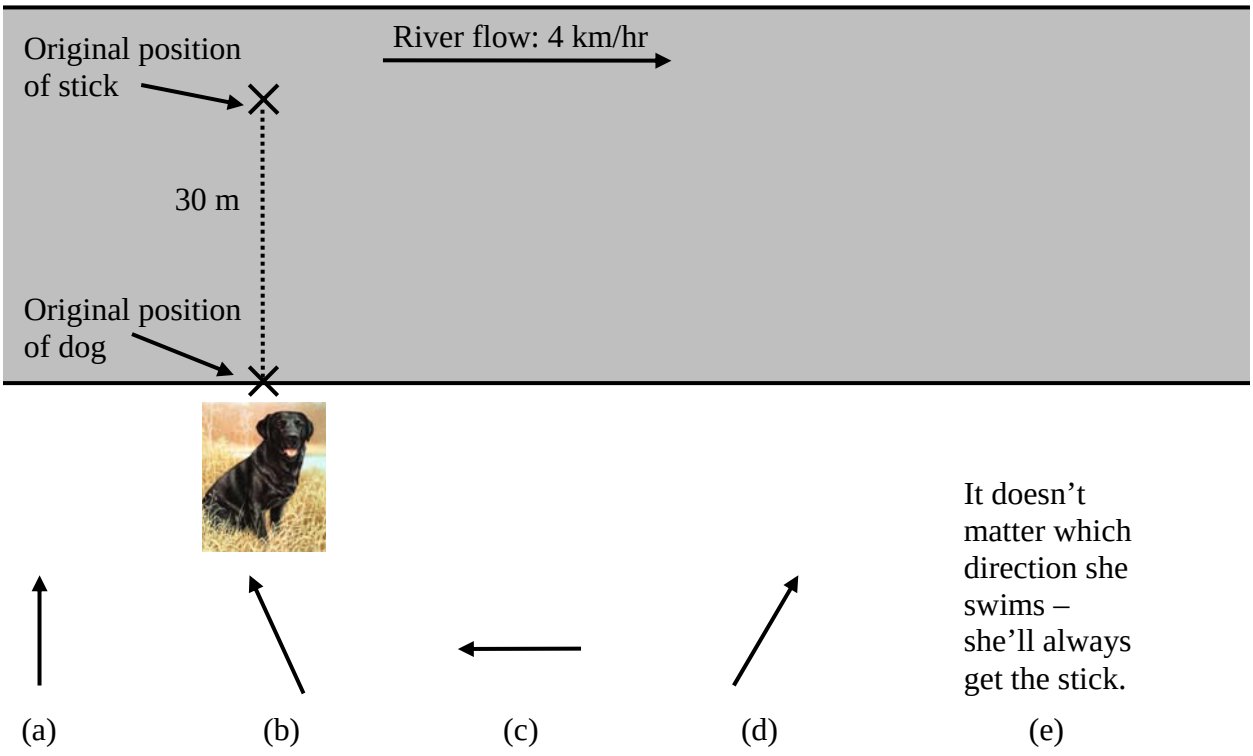


(a) 12 N (b) 8 N (c) 4 N (d) 6 N (e) 2 N

4. A car moves downhill at constant velocity. Which of the following free-body diagrams could represent all of the forces acting on the car?



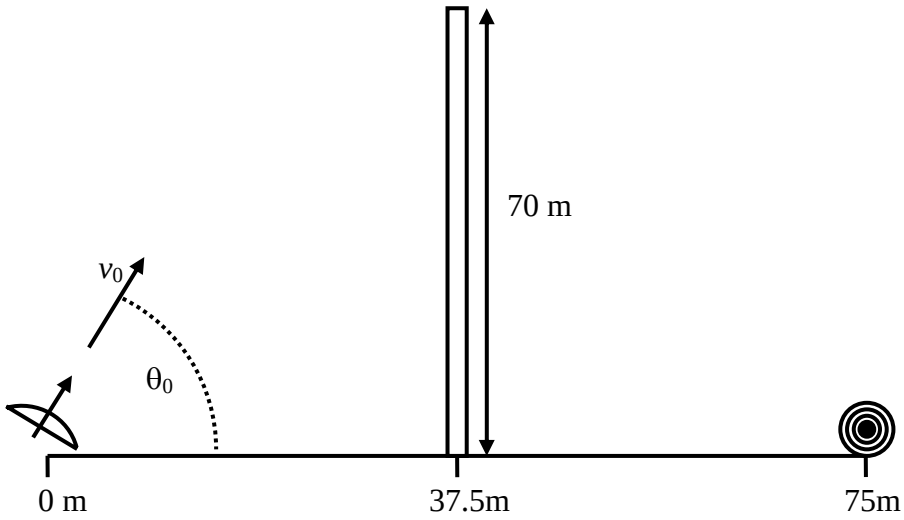
5. An intrepid retriever is fetching sticks thrown out into a river. The river flows from left to right at 4 km/hr. The dog can swim at 6 km/hr in still water. A stick is thrown 30 m from the bank directly out into the river and begins to float downstream. The dog begins to swim at the instant the stick hits the water. What direction should the dog's velocity *with respect to the river* be so that she will reach the stick? (Hint: what is the stick's velocity with respect to the river?)



Problems (20 points each)

II. A scale is placed on the floor of an elevator. A mass M = 10 kg is placed on the scale.

(a) Draw a free-body diagram for the mass M.
(b) Initially the elevator is at rest, $v = 0$ *m/s*. What does the scale read for the weight of the mass?
(c) The elevator now begins to accelerate upwards with an acceleration $a = 2$ *m/s*^{2}. In this situation, what is the apparent weight (the scale reading) of the mass?
(d) Later on, the acceleration ceases and the elevator continues to move upward with constant velocity, $v = 5$ *m/s*. What is the apparent weight of the mass for this situation?
(e) Finally, the elevator now slows with a net acceleration of $a = -3$ *m/s*^{2}. What is the apparent weight of the mass in this case?

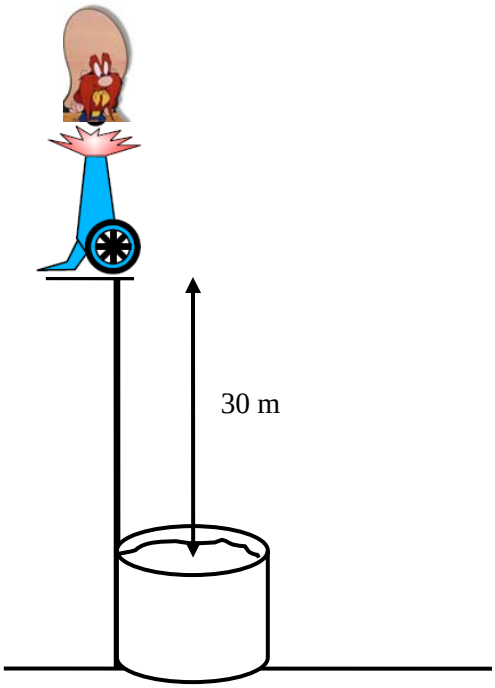


III. A crossbow archer is practicing for the medieval X-games. His goal is to hit a target 75m away, but to do so he must shoot over a wall 70m high that is located half the distance to the target as shown in the figure above, right. The crossbow fires a dart at a fixed speed of $v_o = 38.4$ *m/sec*.

(a) Find the angle θ_o with which he must shoot the dart to just clear the top of the wall and strike the target. [For the purposes of this problem you may assume that the target and the dart's launch point are at the same elevation; you may ignore air resistance.]
(b) Find the time it takes for the dart to reach the target.
(c) At what angle does the dart strike the target? Draw a diagram so that we understand how your angle is measured.

IV. In a variant of Warner Brothers cartoon "Fearless Freep", Yosemite Sam is located on a platform high above a stage. He is fired from a cannon vertically upward with a velocity v_{oy} = 6 m/s and ends up landing in a barrel of water on the stage below. Assume the platform is at an elevation of 30 m above the water surface and that the motion is in the vertical dimension only.

(a) How long is he in the air before hitting the water?
(b) Find the velocity with which he strikes the surface of the water.
(c) Assuming his net *deceleration* (including gravity) is a constant 30 m/s^2 once he is in the water, how far below the surface of the water does he go before he stops moving downward?



V. Two blocks are in contact on a frictionless inclined plane with angle of inclination θ. A force F pushes on the left block, causing both blocks to accelerate.

(a) Draw a free body diagram for each of the blocks, clearly showing all of the forces that act on each of them and your chosen coordinate system.
(b) Write down Newton's 2nd Law (sum of forces) for each block.
(c) Find the acceleration of the system along the ramp and the force of contact between the two blocks in terms of the constants given.
(d) If F=30N, m_1 = 4kg, and m_2=6kg, what is the net acceleration?