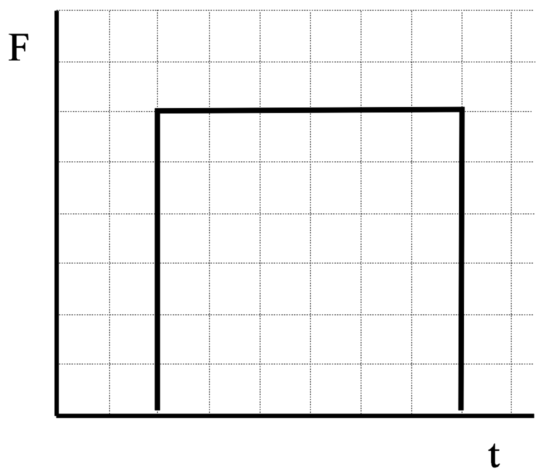
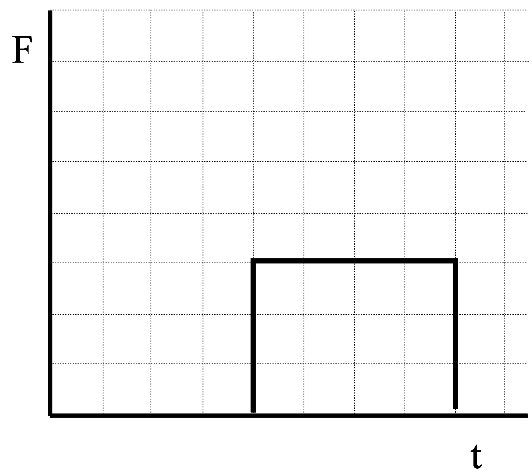
First Name:____________________ Last Name:________________________________

1. You have two 2 kg objects. Each has a velocity $\vec{v} = -5\hat{x}$ m/s. One of those objects is subjected to the force shown in the graph on the left. A positive force implies a force in the $+\hat{x}$ direction. The time over which the force was non-zero is 12 s. As a result of that force, the object ends up with a velocity $\vec{v} = 25\hat{x}$ m/s.

   A) Use the concepts of impulse and momentum to calculate the force applied.

   B) If the second object were subjected to the force shown in the graph on the right (the force and time axis scales are the same), what would its final velocity be? Explain your reasoning.





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2. You have 2 blocks A and B with masses M_A and M_B. You know what M_A is, but not what M_B is. Both blocks slide along a **frictionless** table. You launch block A with speed v_0 towards block B, which is stationary. After the collision, the velocity of block A has reversed direction, and is now half as large in magnitude. Sketch the collision, clearly showing the "before the collision" state, and the "after the collision" sate.

3. Compare the blocks before and after the collision. Circle one.

   A) Does the momentum of block A change during the collision? Yes / No

   B) Does the momentum of block B change during the collision? Yes / No

   C) Does the momentum of the system change during the collision? Yes / No

4. Let v_B be the velocity of block B after the collision. Find v_B in terms of the other variables in the problem.

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5. Does the final velocity of block B increase or decrease with increasing mass M_B? Argue whether your answer makes sense using Newton's laws. **Use English sentences, not a bunch of equations.**

6. Compute the total mechanical energy (potential + kinetic) of the system (blocks A and B together) before and after the collision. Are they *necessarily* equal? Justify your answer. If you believe the initial and final energies don't need to be equal to each other, do we know whether one must be bigger than the other? If yes, say which one is bigger and how you know. If no, explain why we can't tell.

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7. Circle one: The total mechanical (potential+kinetic) energy of a system is always conserved during a collision.

   True / False

8. During the collision of blocks A and B, which force was stronger, the force of block A on block B, or the force of block B on block A. Justify your answer.

9. A friend of yours has a block C of unknown mass. He slides his block towards your block A with an initial speed v_0 at the same time as you slide the block A towards block C with that same initial speed v_0. v_0 is also the same initial speed as for questions 2 and 3. You are not allowed to see the collision, or measure the final velocity of block C, but you do know that after the collision, block A is at rest.

   A. In which direction is block C moving after the collision. Justify your answer. If you think it is not possible to tell which direction block C is moving, or if you think block C is at rest after the collision, explain why.

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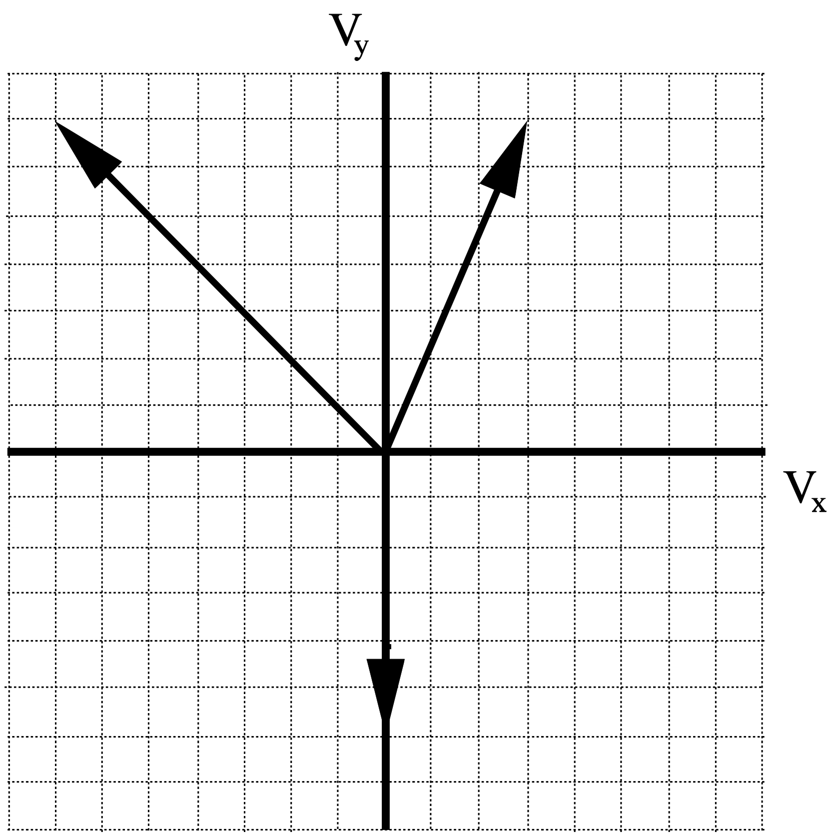
B. Is block C more or less massive than block A? Explain how you know. If you think it is not possible to tell if C is more massive than A, explain why.

C. After the collisions, is the speed of block C larger or smaller than v_0? Explain how you know. If you think it is not possible to tell if the final speed of C is larger than v_0, explain why.

Contact: (Drew) milsom@email.arizona.edu

10. A mass $5M$ which is initially at rest breaks into four pieces; three have mass M and one has mass $2M$. The figure shows the *velocity* vectors for the three mass M pieces. Accurately draw in the velocity vector for the mass $2M$ piece. Show your reasoning and/or calculations.



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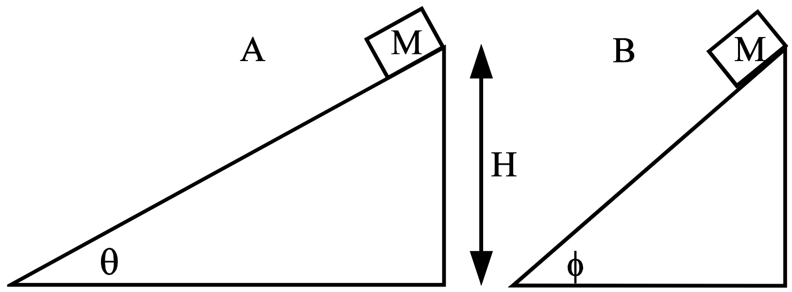
Identical blocks slide down two different inclines as shown. The inclines have the same height but are at different angles. Each incline is **frictionless** and each block is released from rest.



11. In which case is the speed of the block larger when it gets to the bottom of the incline or are they the same size? Explain your reasoning.

12. Is the linear momentum of each block at the bottom of the incline the same? Explain why or why not. (If you think it matters, you may assume that each block is at the very bottom of the incline and has not yet reached the horizontal surface.) **Hint:** Remember momentum is a vector.

13. In which case is the magnitude of the linear momentum at the bottom of the incline larger or are they the same size? Explain your reasoning.

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14. In which case is the magnitude of the impulse given to the block during this process larger or are they the same size? Explain your reasoning.

15. In which case is the net force acting on the block during this process larger or are they the same? Explain your reasoning.

16. In which case is the time it takes to reach the bottom longer or are they the same? Explain your reasoning.

17. Are your answers to Questions #15-16 consistent with your answer to Question #14? Explain why or why not.

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