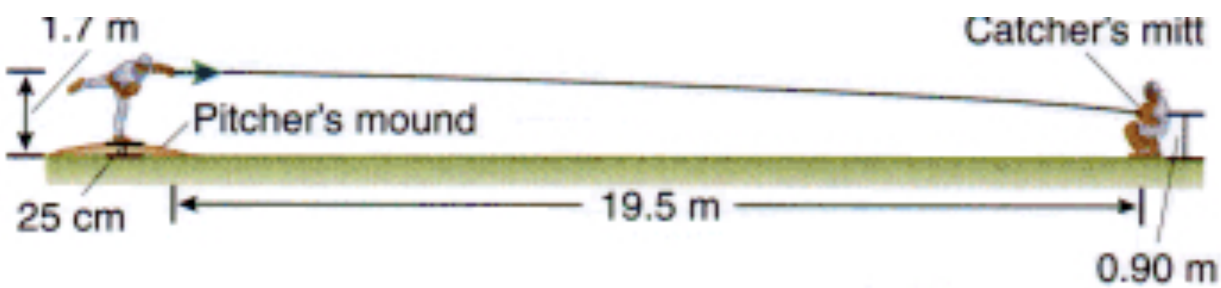
1. **While standing in an elevator you see a screw fall from the ceiling as it moves upward at a constant speed of 2.2 m/s. The elevator ceiling is 3 m above the floor. How long is the screw in the air? Is there more than one way to solve it? What if a_E=2.2m/s^2 (up) & v_E=2.2m/s when screw falls?**

2. **An object travels at a constant rate of 3.0 m/s from t=0.0 s to t=3.0 s. It then accelerates at 1.0 m/s^2 over the next 2.0 s. Then it accelerates at -2.0 m/s^2 over the next 2.0 s. For the last 3.0 s, its position remains the same. Sketch v vs. t, a vs. t, and s vs. t over the 10.0 s interval.**

3. **An inquisitive physics student and mountain climber climbs a 51.0 m cliff that overhangs a calm pool of water. He throws two stones vertically downward, 1.00 s apart, and observes that they cause a single splash. The first stone has an initial speed of 2.00. m/s downward.**
   a. **How long after release of the first stone do the two stones hit the water?**
   b. **What initial velocity must the second stone have if they are to hit simultaneously?**
   c. **What is the speed of each stone at the instant the two hit the water?**

1. **A jet airliner moving initially at 330 mph due east enters a region where the wind is blowing at 80 mph in a direction 30.0° north of east. Determine the new speed and direction of the aircraft relative to the ground.**

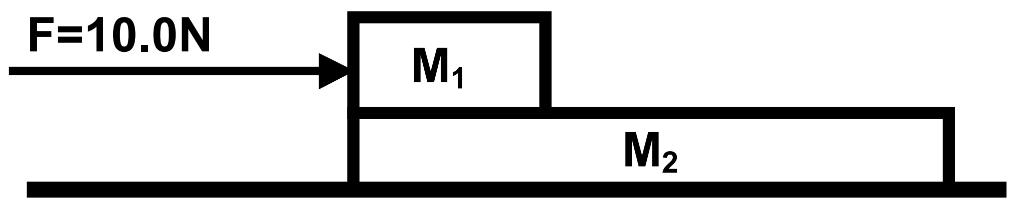
2. **A pitcher throws a fastball. The ball is released horizontally from the pitcher's mound when the hand of the pitcher is at an elevation of 1.7 m above the level field. The catcher catches the ball 19.5 m away at an elevation of 0.90 m above the ground. Calculate the initial speed of the ball as it left the pitcher's hand.**



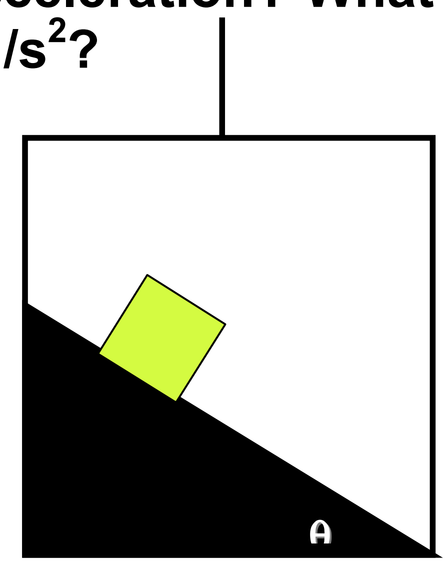
3. **A ball is tossed from an upper-story window of a building. The ball is given an initial velocity of 8.20 m/s at an angle of 15.0° below the horizontal. It strikes the ground 3.00 s later.**
   a. **How far horizontally from the base of the building does the ball strike the ground?**
   b. **Find the height from which the ball was thrown.**

1. **What are the forces acting on a person in an elevator accelerating upward? What are the forces acting on the elevator? What are the forces acting on the system defined by the person and elevator?**

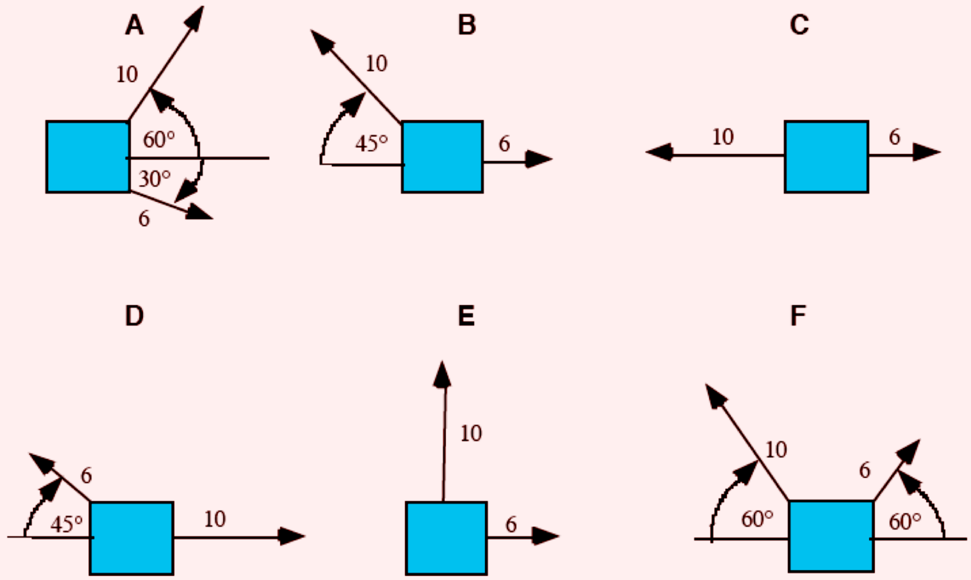
2. **Consider the system below. The 10.0N force only acts on the top object only. There is a frictional force between M_1 and M_2 and between M_2 and the table supporting M_2. Draw a separate free-body diagram for each object. <u>You must indicate all forces acting on the objects using words only (no labels)</u>.**



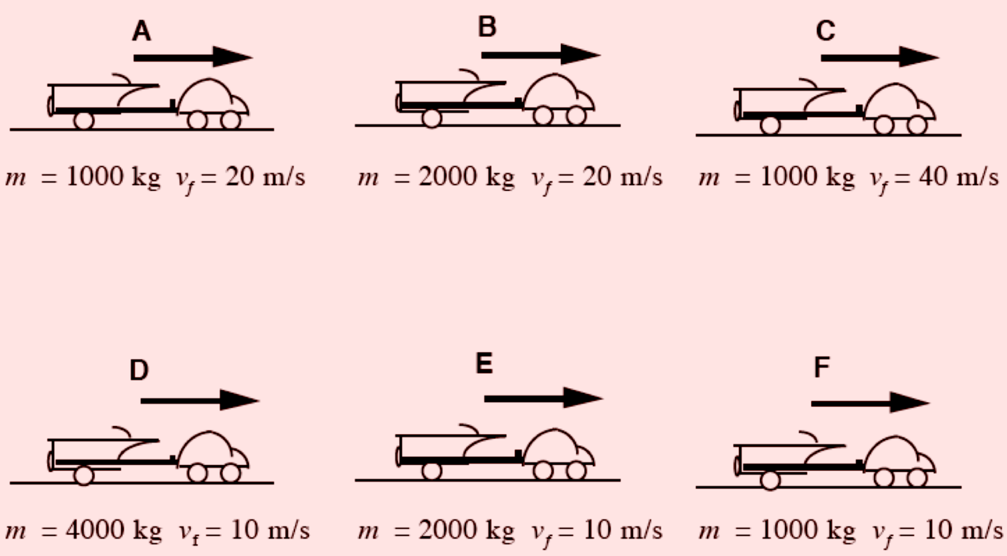
3. **A block and incline plane are placed in an elevator that is moving upward at a constant speed v=2m/s. What is its acceleration? What if it is accelerating upward at $2m/s^2$?**



The six figures below show treasure chests with two forces acting upon them. The lengths of the force vectors represent the magnitudes of the forces. Rank these situations from greatest to least with regard to the final speed of the treasure chest after 2 seconds. All chests start at rest. If you believe that two of the situations have the same final speed, place both of their letters at the same rank.

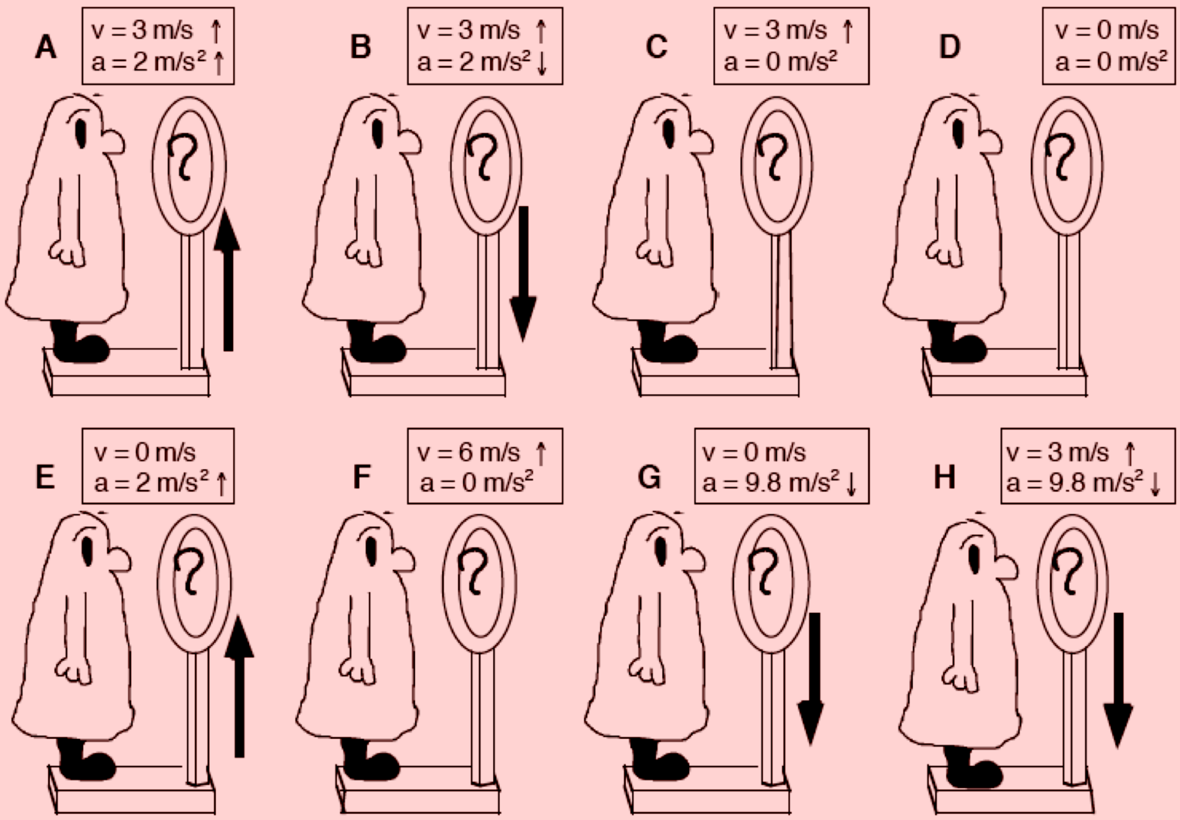


Rank, from greatest to least, on the basis of the difference between the strength (magnitude) of the force the car exerts on the boat trailer, and the strength of the force the boat trailer exerts on the car. All the boat trailers and cars are identical, but the boat trailers have different loads, so the boat trailers masses vary.

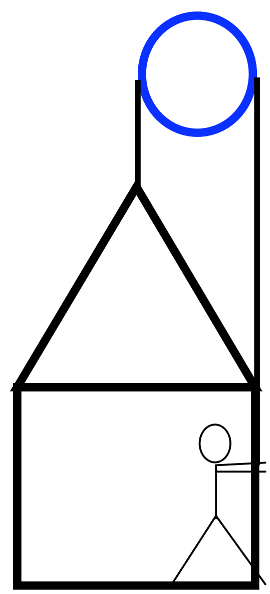


The figures below depict situations where a person is standing on a scale in eight identical elevators. Each person weighs 600 N when the elevators are stationary. Each elevator now moves (accelerates) according to the specified arrow that is drawn next to it. In all cases where the elevator is moving, it is moving upward.

Rank the figures, from greatest to least, on the basis of the *scale weight* of each person as registered on each scale. (Use $g = 9.8\ \text{m/s}^2$.)



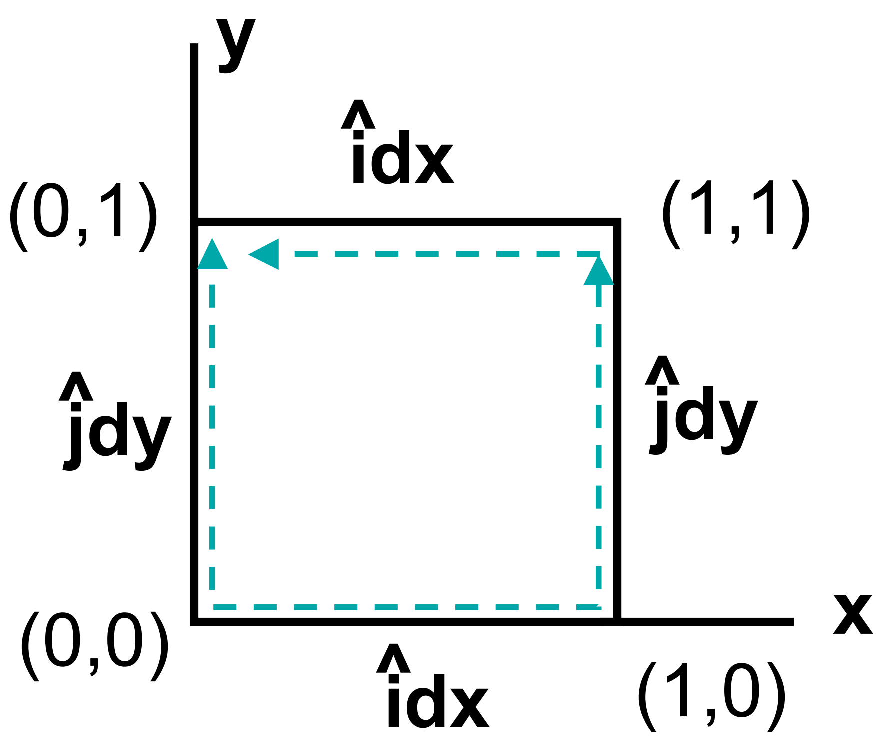
4. A painter weighing 128 lb stands on a 32lb bosun's chair to paint a house. To get started she accelerates herself and the chair at a rate of $2 ft/s^2$. With what force must she pull on the rope? What is the force on the pulley? After 1 s she pulls so that she and the chair go up at a constant speed of 2ft/s. With what force must she pull on the rope (refer to problem 5-51)?



5. A coin placed 31.0 cm from the center of a rotating, horizontal turntable slips when its speed is 50.9 cm/s. What is the coefficient of static friction?

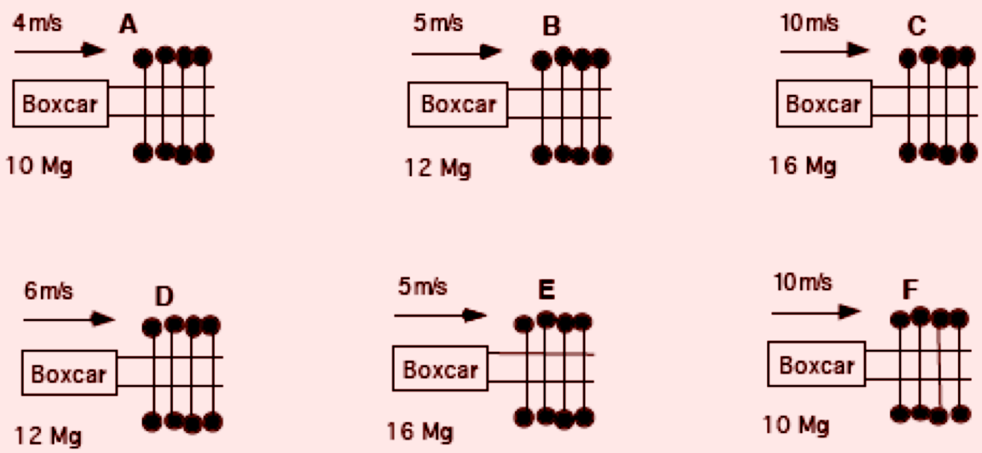
6. **Jill pushes an 8.0kg box is through a distance of 8.0m up a 20° frictionless incline. The applied force is parallel to the incline.**
   a. **What is the work done by the normal force and gravity?**
   b. **If the box is pushed at a constant speed of 2.0m/s, what is the force applied by Jill?**
   c. **Suppose that she decides to double the applied force over the next 4.0m. How fast will the box be moving after applying the larger force?**

7. **Consider the motion of an object from (0,0) to (0,1) over the two paths shown. If the applied F=3xyi+3y^{2}j, calculate the work done by the force on the object over the three paths.**

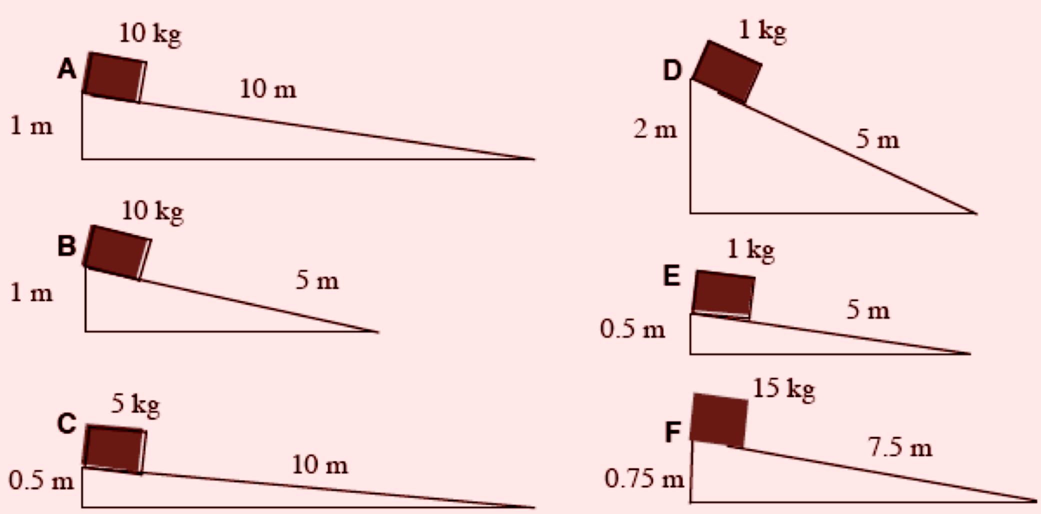


In a western movie, a confederate raiding party stopped a runaway boxcar carrying gold by using many ropes tied to trees. Given below are six boxcars that are moving along horizontal railroads at specified speeds. Also given are the masses of the boxcars. All of the boxcars are the same size and shape, but they are carrying loads with different masses. All of these boxcars are going to be stopped by plowing through a large number of these secured ropes. All of the boxcars need to be stopped in the same distance.

Rank these situations from greatest to least on the basis of the strength of the forces that will be needed to stop the boxcars in the same distance. That is, put first the boxcar on which the strongest force will have to be applied to stop it in *x* meters, and put last the boxcar on which the weakest force will be applied to stop the boxcar in the same distance.

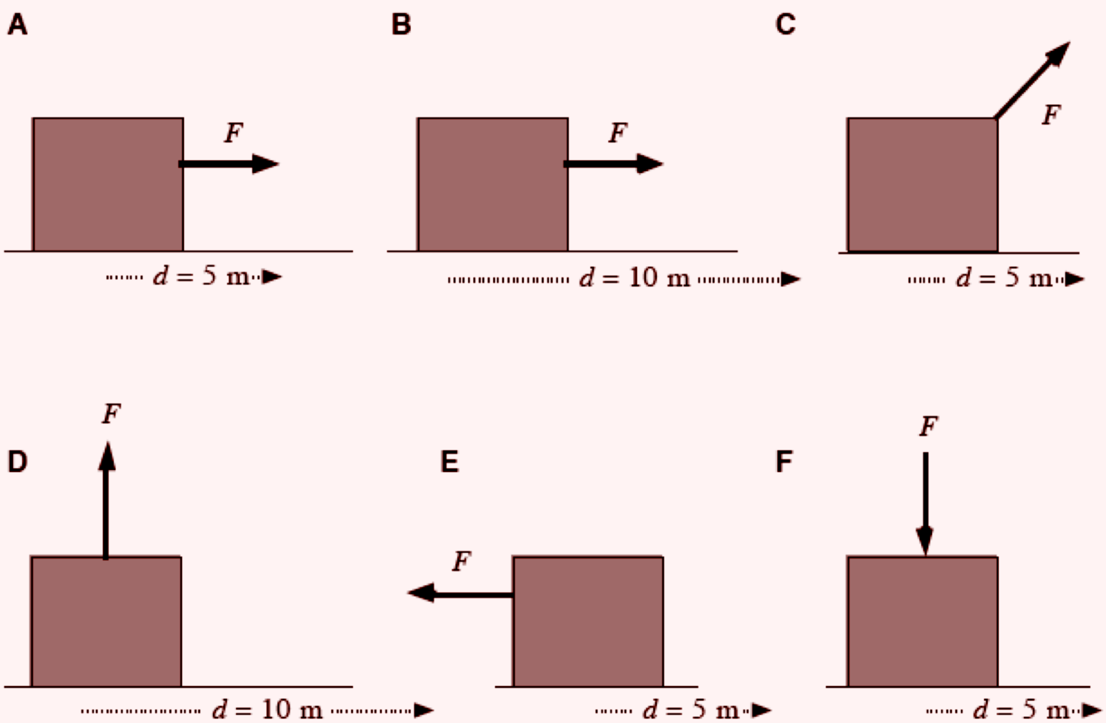


Rank, in order from greatest to least, the final kinetic energies of the sliding masses the instant before they reach the bottom of the incline. All surfaces are frictionless. All masses start from rest.



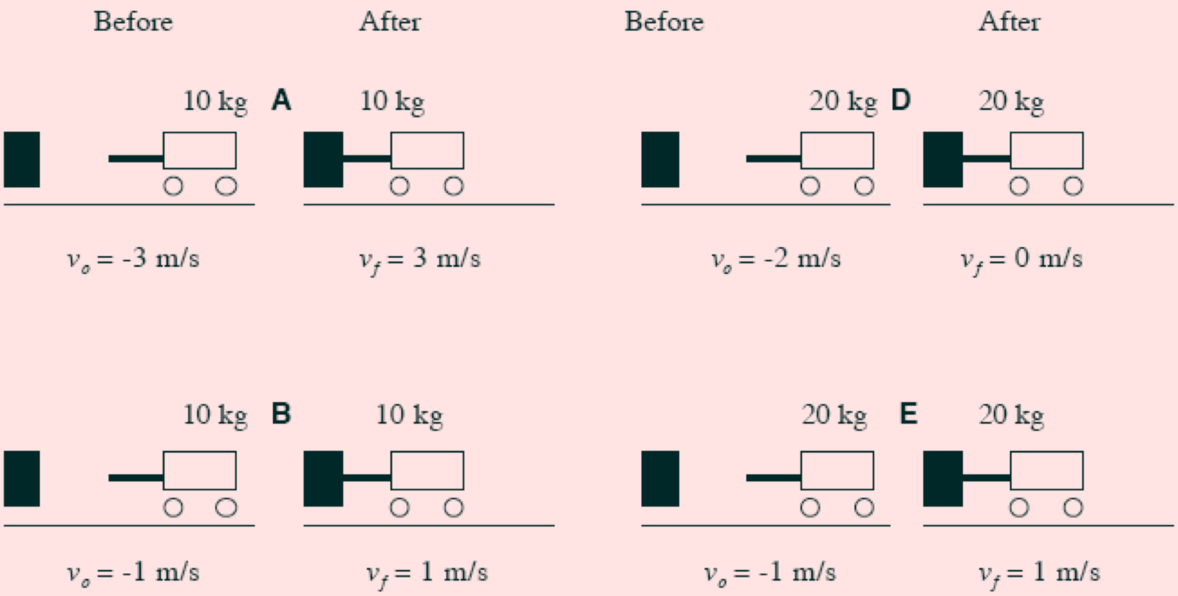
In the figures below, identical boxes of mass 10 kg are moving at the same initial velocity to the right on a flat surface. The same magnitude force, F, is applied to each box for the distance, d, indicated in the figures.

Rank these situations in order of the work done on the box by F while the box moves the indicated distance to the right.



A cart with a spring plunger runs into a fixed barrier. The mass of the cart, its velocity just before impact with the barrier, and its velocity right after collision are given in each figure.

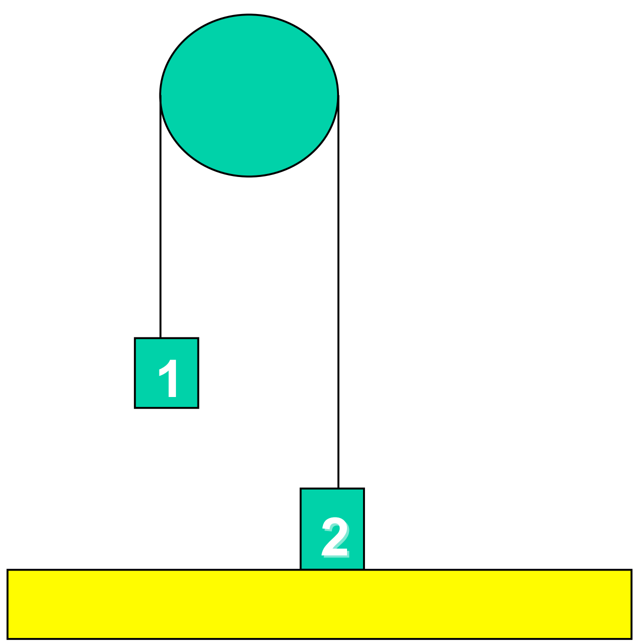
Rank the change in momentum for each cart from the greatest change in momentum to the least change in momentum (+ direction is to the right and - to the left with –4 < -2).



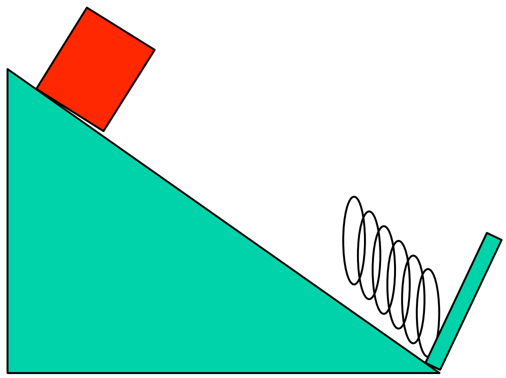
8. A 10.0 kg watermelon is launched off a 30.0m tower. Its initial velocity is 20.0m/s at 30 degrees above the horizontal. Find its speed when it hits the ground. Does the launch angle matter?

9. A light, rigid rod is 77.8 cm long. Its top end is pivoted on a low-friction horizontal axle. The rod hangs straight down at rest with a small massive ball attached to its bottom end. You strike the ball, suddenly giving it a horizontal velocity so that it swings around in a full circle. What minimum speed at the bottom is required to make the ball go over the top of the circle?

10. The Atwood machine shown has two masses, m_1 = 4.0 kg and m_2 = 2.0 kg. The initial height above the ground of m_1 is 2 m. What is the speed of m_1 just before impact with the ground?

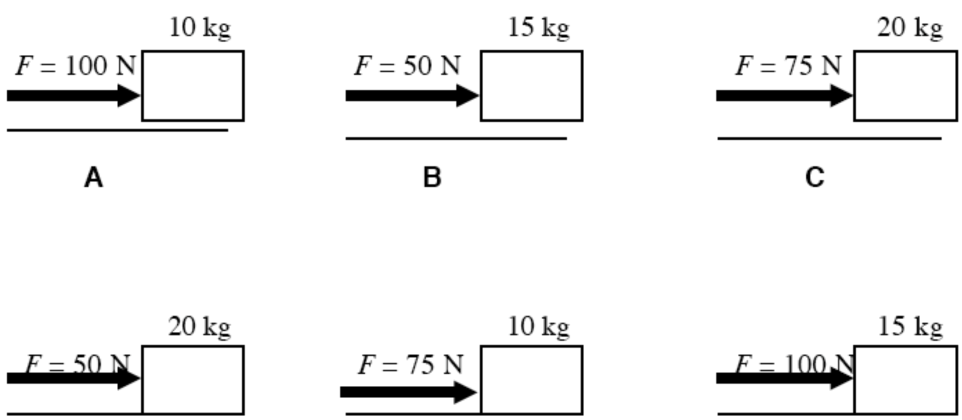


11. A 1.0 kg block slides down an incline (30°) a distance of 1 m where it slams into a spring (k = 100 N/m). If μ_k = 0.2, what is the speed of the mass after the spring is compressed by 0.1 m?

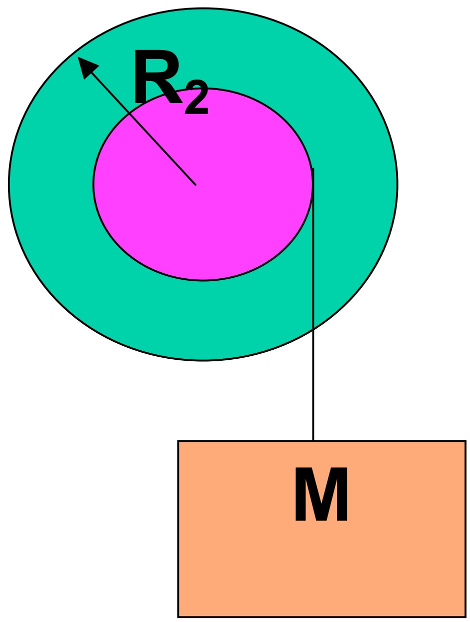


Various similar boxes are being pushed for 10 m across a floor by a *net* horizontal force as shown below. The mass of the boxes and the net horizontal force for each case are given in the indicated figures.

Rank the change in kinetic energy for each box from the greatest change in kinetic energy to the least change in kinetic energy. All boxes have an initial velocity of +10 m/s (+ direction is to the right and - to the left with –4 < -2).



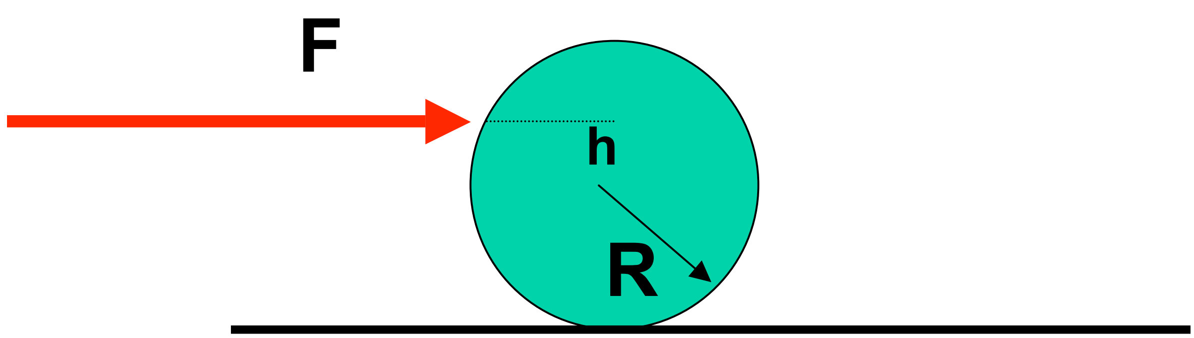
12. **A mass M is hung from a two-step pulley as shown below. The pulley is composed of two disks of radius R_1 and R_2 and rotational inertia I_1 and I_2, respectively. The string is wound around the pulley and the mass is released. Calculate the acceleration of the falling mass M.**



13. **A disk rolls down an incline plane of angle α. Calculate its acceleration. Solve it in more than one way.**

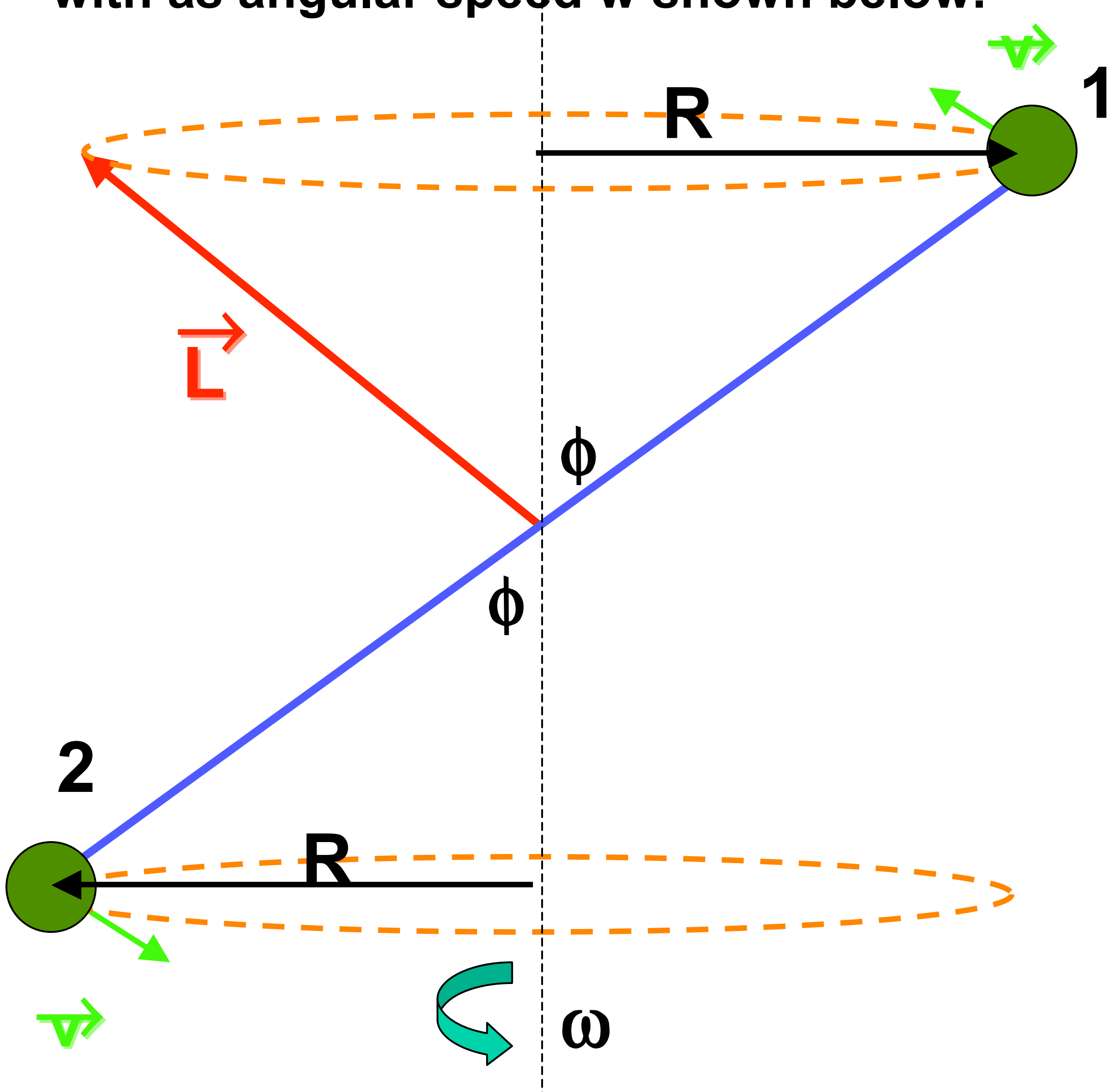
14. A 1 kg ball traveling at 1 m/s perpendicular to a 1 kg thin rod 2 m in length that is at rest, undergoes an elastic collision with the end of the rod. What are the linear velocities of the ball and the rod and the angular speed of the rod after the collision? (Hint: the ball's path is unchanged after the collision.)

15. A solid ball (pool cue) is struck by a stick as shown below. Its velocity is v_o just after the interaction. Because of its "forward english" the velocity of its center of mass is 9/7 v_o when it rolls without slipping. Find h the point where it was is struck (with respect to its center)?



16. Consider an Atwood's machine with masses M_1>M_2 tied to strings. The pulley has mass M_P and radius R. Calculate the acceleration of the masses. Solve it in more than one way.

17. Consider two masses connected by a light rod of length d and rotating about a vertical axis with as angular speed w shown below.



18. **Assume a person bends forward to lift a load "with his back" as shown in the figure below. The person's spine pivots mainly at the fifth lumbar vertebra, with the principal supporting force provided by the erector spinalis muscle in the back. To estimate the magnitude of the forces involved, consider the model shown in the figure for a person bending forward to lift a 200-N object. The person's spine and upper body are represented as a uniform horizontal rod of weight 350 N, pivoted at the base of the spine. The erector spinals muscle, attached at a point two thirds of the way up the spine, maintains the position of the back. The angle between the spine and this muscle is 12.0°. Find the tension in the back muscle and the compression force in the spine (2710N 2650N). Is it wise to lift with your back?**