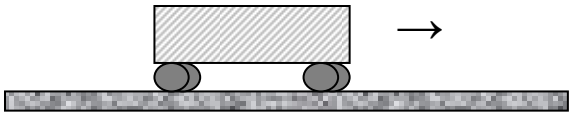
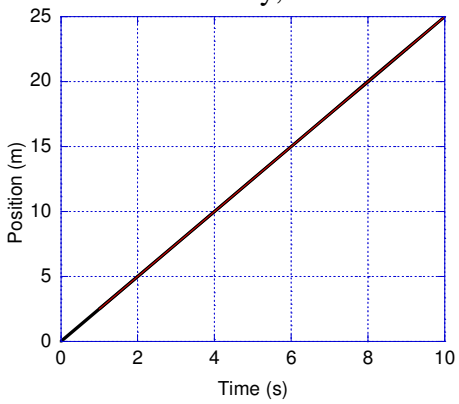
Module 3 Forces

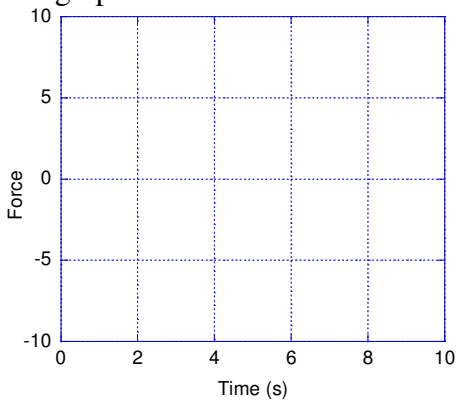
I. Forces: Newton's Laws



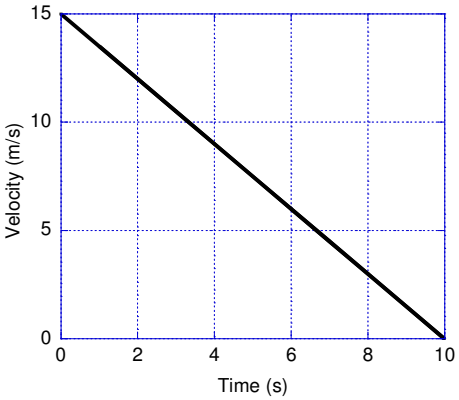
A 2.0 kg cart slides on a track as shown. Answer the questions that follow, assuming that the friction between the cart and the track is so small that the force of friction can be neglected, unless told otherwise.

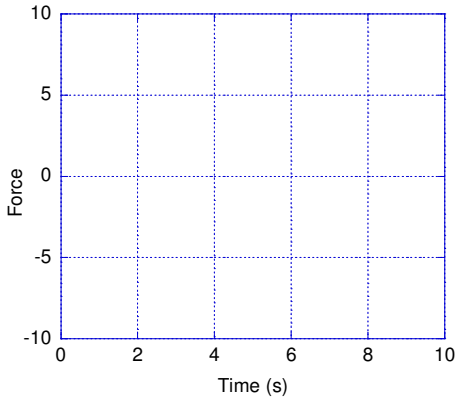
a. The cart moves to the right and its displacement is described by the graph below. Describe the force if any, in words and draw a graph of its behavior with time.



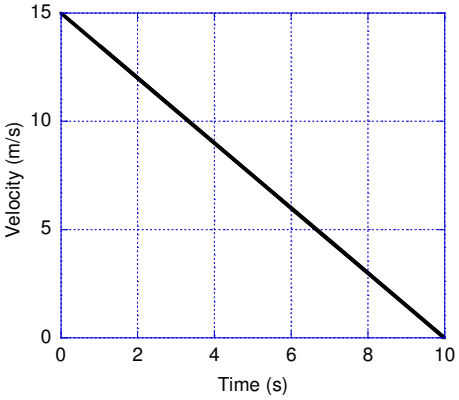


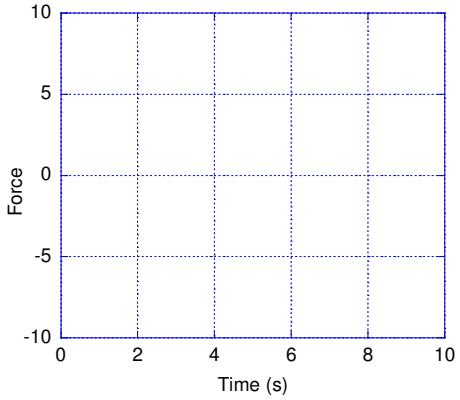
b. Brakes are applied and the cart slows down as described by the velocity graph below. Draw a graph to show the force acting on the cart.





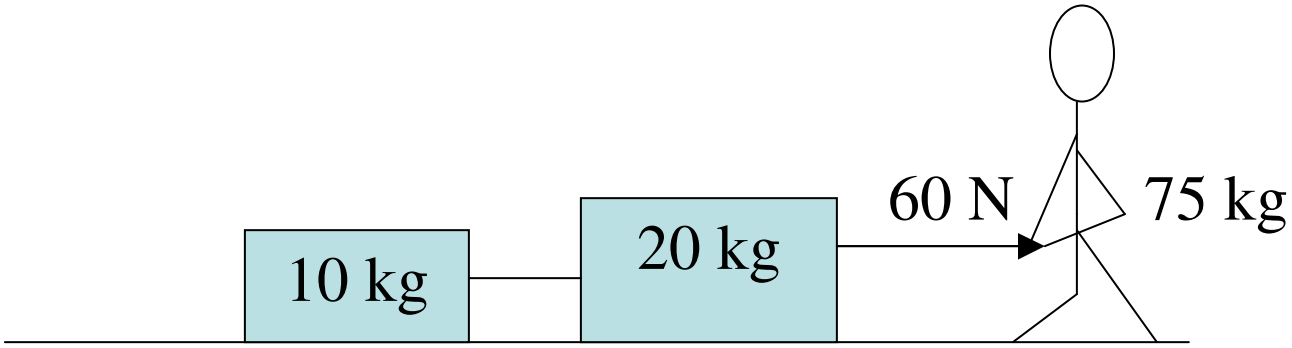
c. Show quantitatively on the graph how the force in (b) would change if the mass of the cart were doubled to 4.0 kg.





II. Applications of Newton's II Law

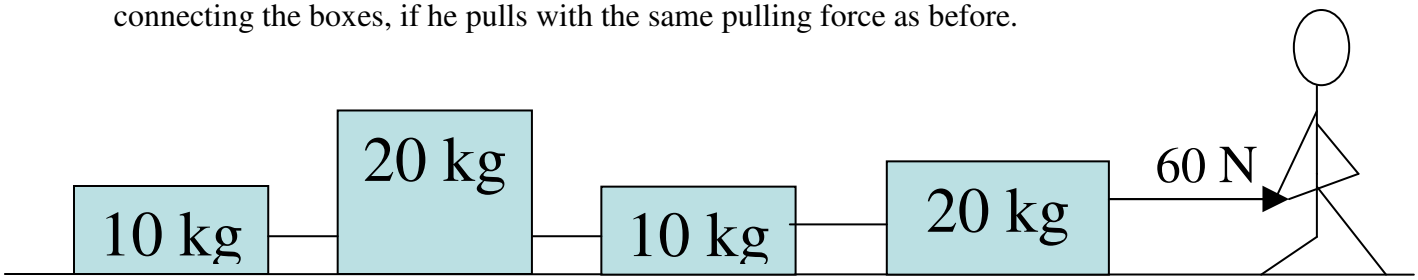
(a) A 75 kg maintenance worker is pulling wheeled crates of mass 20 kg and 10 kg each on a smooth floor with a force of 60 N as shown. Draw all the forces present. (Assume that the friction between the crates and the floor is negligible)



(b) What is the direction of tension in the rope connecting the two crates?

(c) What is the magnitude of this tension in (b)?

(d) The worker now stops and picks up two more crates – of mass 10 kg and 20 kg each – so that he is now pulling 4 crates. Find the magnitudes of the tension in each of the ropes connecting the boxes, if he pulls with the same pulling force as before.



(e) The worker drops off the two 2 crates he picked up and heads with the original two to a rough stretch of flooring where the coefficient of kinetic friction between the individual crates and the floor is 0.25. Find the tension in the rope connecting the boxes if the pulling force applied is now 120 N.

III. The Center for Student Engagement in Science is getting a supercomputer cluster for a computer room on the second floor of the science building. A group of Physics I students (of whom you happen to be one) volunteer to pull the rack up the ramp of the science building. The computers and the wheeled rack they are housed in have a combined mass of 500 kg. Assume that the coefficient of kinetic friction between the wheels of the rack and the flooring of the ramp is 0.2 and that the incline of the ramp in the science building is about15 degrees.

(a) Draw all the forces that act on the rack as your group pushes the rack up the ramp.

(b) What is the minimum force you would have to apply to move the rack up the ramp at a constant velocity of 1.0 m/s.

(c) How would the force you apply change if you needed to get the computers up the ramp at constant velocity of 2 m/s?