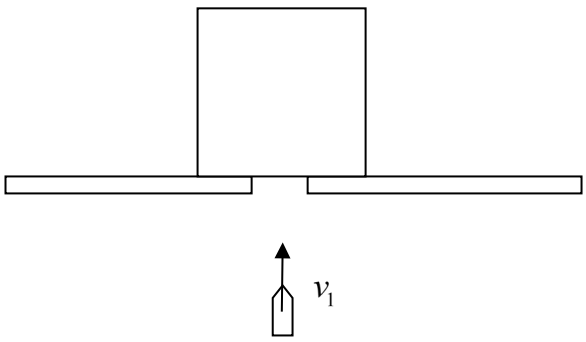
Problem 1.

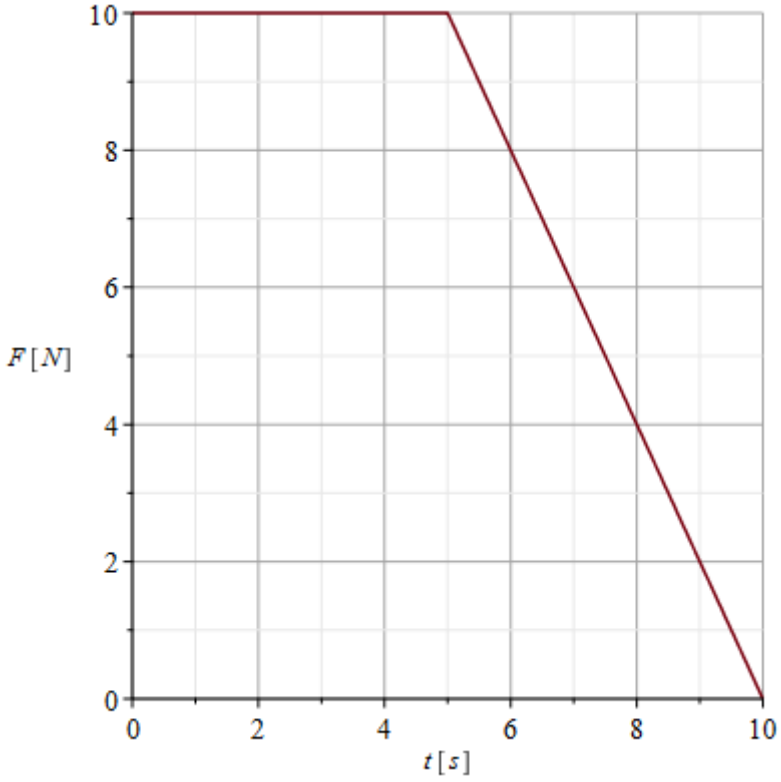
A block of mass M is on a horizontal table. There is a hole in the table, through which a bullet is shot into the block. The bullet is stopped completely and becomes embedded in the block. The bullet has mass m and speed v_1. You can assume that the penetration occurs quickly.



a) Determine the speed of the block immediately after the collision.
b) How far above the table does the block-and-bullet system travel?

Problem 2.

A particle with mass $m = 10.0$ kg has at time $t = 0$ s a velocity of $v_0 = 10.0$ m/s. The particle is affected by a time-dependent force F, shown in the figure below.



What is the particle's speed at time $t = 10$ s?

A) The speed is $v = 7.50$ m/s
B) The speed is $v = 10.0$ m/s
C) The speed is $v = 15.0$ m/s
D) The speed is $v = 17.5$ m/s
E) The speed is $v = 20.0$ m/s
F) The speed is $v = 32.0$ m/s
G) Do not know

Problem 3.

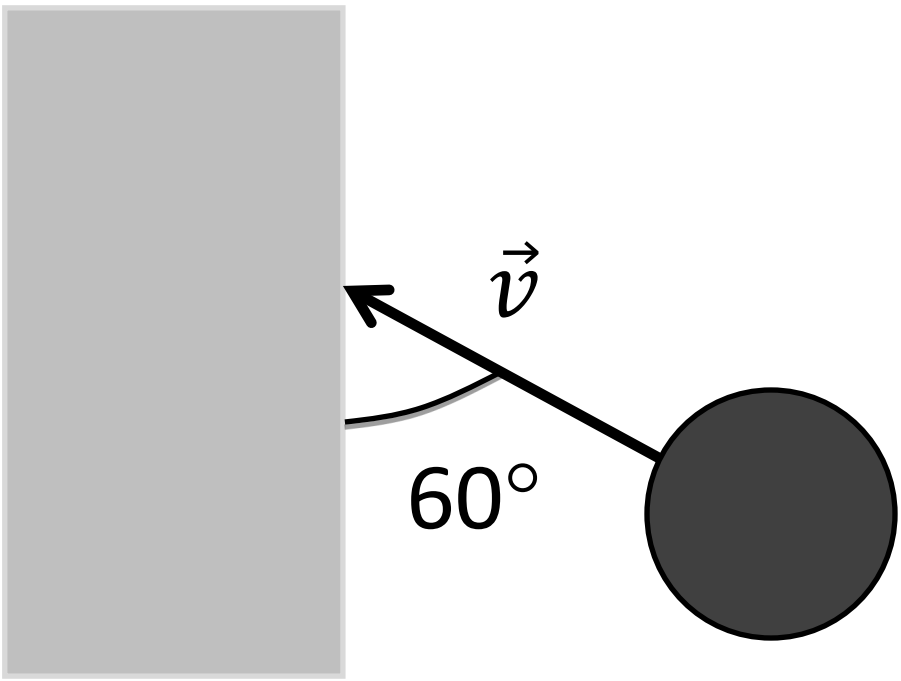
Two blocks with masses M (small block) and 2M (large block) are at rest on a smooth, horizontal table. The two blocks are connected to a compressed spring. Now, the spring expands and accelerates the two blocks.

Which of the following statements are correct?

A) The two blocks receive the same amount of momentum from the spring
B) The large block receives a larger amount of momentum from the spring than the small block.
C) The small block receives a larger amount of momentum from the spring than the large block.
D) The two blocks receive the same kinetic energy from the spring.
E) The small block receives more kinetic energy from the spring than the large block.
F) The large block receives more kinetic energy from the spring than the small block.
G) Do not know

Problem 4.

A ball collides with a stationary wall as shown in the figure. The ball's mass is 0.1 kg, and it arrives with a speed of $v = 10$ m/s. The collision is elastic, and there is no force of friction between the ball and the wall. A high-speed-camera measures the contact between the ball and the wall to last $\Delta t = 1.0 \cdot 10^{-3}$ s.



What is the magnitude of the *average* force, F_{av} on the ball from the wall in this time-frame?

A) $F_{av} \cong 5.0 \cdot 10^2$ N
B) $F_{av} \cong 8.7 \cdot 10^3$ N
C) $F_{av} \cong 1.0 \cdot 10^3$ N
D) $F_{av} \cong 1.7 \cdot 10^3$ N
E) $F_{av} \cong 2.0 \cdot 10^3$ N
F) Do not know

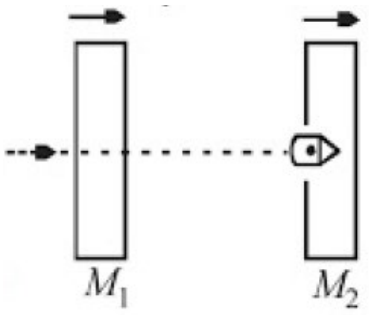
Problem 5.

Two blocks A and B move towards each other in a straight line on a smooth table. The blocks have the same speed *u.* Block A has mass *m* and moves to the right (positive direction), while block B has mass 4*m* and moves to the left. There is Velcro at the front of each block, ensuring that the blocks undergo a completely inelastic collision.

a) Determine the speed of the blocks after the collision.
b) The total kinetic energy of the blocks after the collision is the following fraction of the total kinetic energy of the blocks before the collision:

A) 0
B) $\frac{9}{25}$
C) 1
D) $\frac{1}{4}$
E) $\frac{9}{10}$
F) Do not know

Problem 6.



Two blocks with masses M_1 and M_2 lie on a horizontal, smooth table. A bullet with speed v and mass m passes completely through block M_1. Immediately after, the bullet impacts block M_2 and thereafter travels with M_2. After perforating M_1, the bullet has a speed of v_1. After the collisions, M_1 and the body consisting of M_2 and m both have a speed of v_2.

a) Find an expression for v_1 and v_2.

Problem 7.

Two cars crash into each other on a road. After the collision, they stick together and move as a single body. The first car has mass 1500 kg and drives to the east with speed 25.0 m/s before the collision. The second car has mass 2500 kg and drives northwards with speed 20.0 m/s before the collision.

a) Determine the magnitude and direction of the velocity of the cars after the collision.

Problem 8.

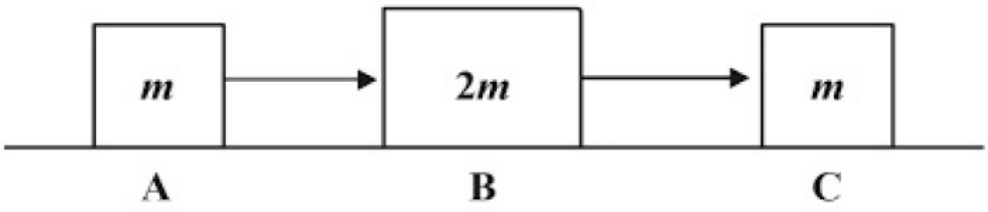
Two blocks A and B move towards each other in a straight line on a smooth table. The blocks have the same speed *u.* Block A has mass *m* and moves to the right (positive direction), while block B has mass 4*m* and moves to the left. On the front of each block is a spring, which ensures that the blocks undergo an elastic collision.

The velocities of the blocks v_A and v_B after the collision are

A) $v_A = -\frac{11}{5}u$ and $v_B = -\frac{1}{5}u$
B) $v_A = 0$ and $v_B = 0$
C) $v_A = -\frac{23}{17}u$ and $v_A = -\frac{7}{17}u$
D) $v_A = -u$ and $v_B = u$
E) Do not know

Problem 9.

Three blocks, A, B and C can slide along a horizontal, smooth surface. The blocks have mass *m,* 2*m,* and *m,* respectively. Block A moves towards block B with a speed of 9.0 m/s and undergoes a central, elastic collision with B. Afterwards, B undergoes a central, completely inelastic collision with C.



What is the final speed of block C?

A) 1.0 m/s
B) 2.0 m/s
C) 3.0 m/s
D) 4.0 m/s
E) 5.0 m/s
F) 6.0 m/s
G) 7.0 m/s
H) 8.0 m/s
I) Do not know