Momentum Review

Name Key

1. A ball of mass m and momentum p has kinetic energy equal to which of the following?

(A) $\frac{1}{2}\frac{p^2}{m}$

(B) $\frac{p^2}{m}$

(C) $2\frac{p^2}{m}$

(D) $\frac{1}{2}\frac{m}{p^2}$

(E) $2\frac{m}{p^2}$

$KE = \frac{1}{2}mv^2$ $\quad KE = \frac{1}{2}m\frac{p^2}{m^2}$

$p = mv$

$v = \frac{p}{m}$ $\quad KE = \frac{1}{2}\frac{p^2}{m}$

2. A force of constant magnitude F and fixed direction acts on an object of mass m that is initially at rest. If the force acts for a time interval Δt over a displacement Δx, what is the magnitude of the resultant change in the linear momentum of the object?

is impulse

(A) $F\,\Delta t$

(B) $F\,\Delta x$

(C) $F\Delta t / m$

(D) $F\Delta x / m$

(E) $mF\,\Delta t$

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3.

A railroad car of mass m is moving with speed u when it collides with and connects to a second railroad car of mass $3m$, initially at rest, as shown above. How do the speed and kinetic energy of the connected cars compare to those of the single car of mass m before the collision?

momentum is conserved so speed is less

collision is inelastic so KE is not conserved and is less

(A) **Speed Kinetic Energy**
Less Less

(B) **Speed Kinetic Energy**
Less The same

(C) **Speed Kinetic Energy**
The same Less

(D) **Speed Kinetic Energy**
The same The same

(E) **Speed Kinetic Energy**
Greater The same

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4. An empty sled of mass M moves without friction across a frozen pond at speed v_0. Two objects are dropped vertically into the sled one at a time: first an object of mass m and then an object of mass $2m$. Afterward the sled moves with speed v_f. What would be the final speed of the sled if the objects were dropped into it in reverse order?

$$Mv_0 = (M + m + 2m)v_f$$

order doesn't matter

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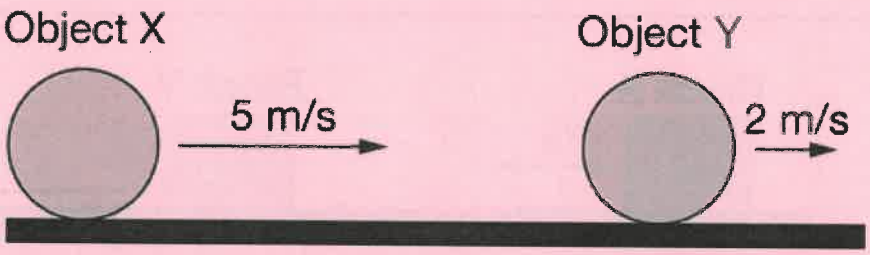
(A) $v_f / 3$

(B) $v_f / 2$

(C) v_f

(D) $2v_f$

(E) $3v_f$



Two objects of the same mass travel in the same direction along a horizontal surface. Object X has a speed of 5ms and object Y has a speed of 2ms, as shown in the figure. After a period of time, object X collides with object Y.

5. Consider the situation in which object **X** has a speed of $2\ \mathrm{m/s}$ and object **Y** has a speed of $5\ \mathrm{m/s}$ after the collision takes place. After the collision, both objects travel in the same direction. Which of the following predictions must be true about how the momentum $\vec{p}$ of the two-object system and the kinetic energy K of the two-object system change from before the collision to after the collision?

P $m(5) + m(2) = m(2) + m(5)$ momentum Conserved

$7m = 7m$

KE $\frac{1}{2}m(5)^2 + \frac{1}{2}m(2)^2 = \frac{1}{2}m(2)^2 + \frac{1}{2}m(5)^2$ KE Conserved

$\frac{1}{2}m(29) = \frac{1}{2}m(29)$

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(A)

$\vec{p}$	K
Remains constant	Remains constant

(B)

$\vec{p}$	K
Remains constant	Decreases

(C)

$\vec{p}$	K
Decreases	Remains constant

(D)

$\vec{p}$	K
Decreases	Decreases

6.

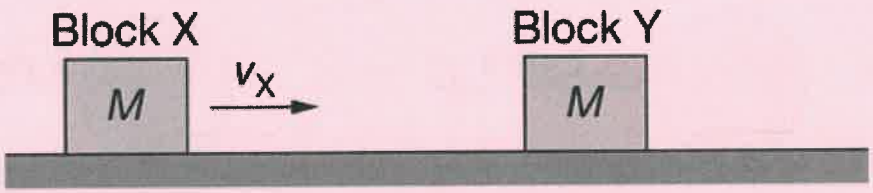

Figure 1. Before the collision

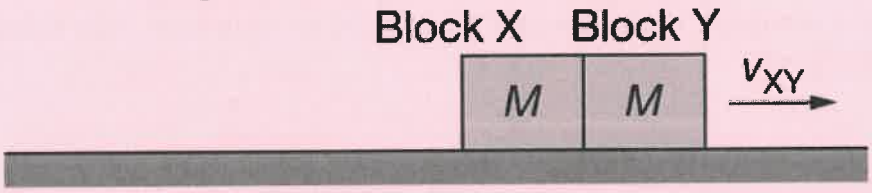

Figure 2. After the collision

Block X slides along a horizontal surface with a speed v_X toward block Y that is initially at rest, as shown in Figure 1. After block X collides with block Y, the two blocks remain stuck together and travel at a velocity of v_{XY}, as shown in Figure 2. Frictional forces are considered to be negligible. Which of the following claims is correct regarding the momentum of the system containing only block X and the system that contains block X and block Y?

Block X transfers momentum to Block Y ← External to Block X System
So Block X system is open
There are no external forces on both Block X and Y
So Block X-Y system is closed

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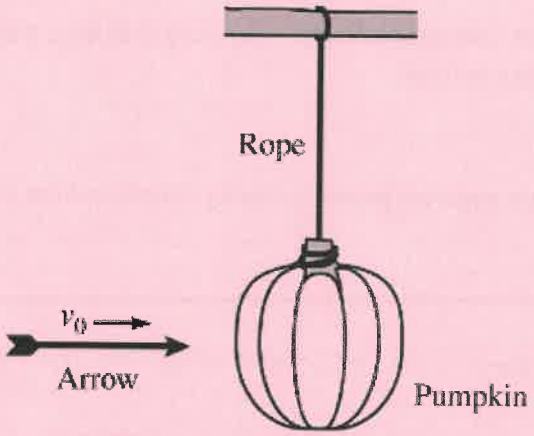
(A) The system containing block X is an open system, and the system of both blocks is an open system.

(B) The system containing block X is an open system, and the system of both blocks is a closed system.

(C) The system containing block X is a closed system, and the system of both blocks is an open system.

(D) The system containing block X is a closed system, and the system of both blocks is a closed system.

7.



An archer tests various arrowheads by shooting arrows at a pumpkin that is suspended from a tree branch by a rope, as shown to the right. When struck head-on by the arrow, the pumpkin swings upward on the rope. The maximum angle θ that the rope makes with the vertical is different for each arrowhead that the archer tests. Each arrow, including its arrowhead, has the same mass m and is shot with the same velocity v_0 toward the right.

The arrowheads are made of different materials, however, and each behaves differently when it strikes the pumpkin, as described below.

- *Embedded arrow:* Strikes the pumpkin and remains embedded, while the pumpkin swings to angle θ_{emb}.

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- *Pass arrow:* Passes all the way through the pumpkin and continues traveling away from the archer, while the pumpkin swings to angle θ_{pass}.

- Bounce arrow: Bounces off the pumpkin back toward the archer, while the pumpkin swings to angle θ_{bounce}.

a. Rank the three angles θ_{emb}, θ_{pass}, and θ_{bounce} from greatest to least in the spaces indicated below. Use "1" for the greatest angle, "2" for the next greatest, and so on. If any two or all three angles are the same, use the same number for their ranking.

2 θ_{emb} 3 θ_{pass} 1 θ_{bounce}

b. In a clear, coherent, paragraph-length response that may also contain figures and/or equations, justify your ranking.

Please respond on separate paper, following directions from your teacher.

In each collision momentum is conserved. What ever momentum is lost by arrow is gained by pumpkin. The pass threw has the least change in momentum of arrow. The embedded arrow has more change in momentum of arrow. The bounce has the most change in momentum of arrow. This can be observed by the change in the arrows velocity. Because of conservation of energy, the pumpkin with greatest velocity will convert more KE into PE and travel higher. This creates a greater θ. Because the Bounce pumpkin had greatest change in momentum, it will have greatest θ.