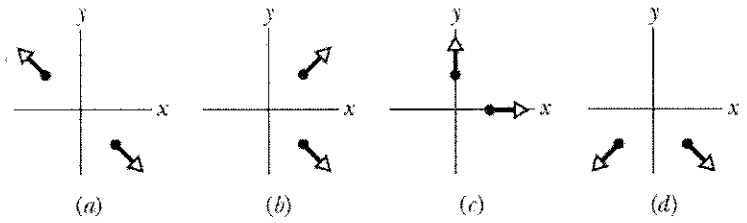
AP Physics
Instructor: Mr. Butler

2D Collisions
Momentum Conservation

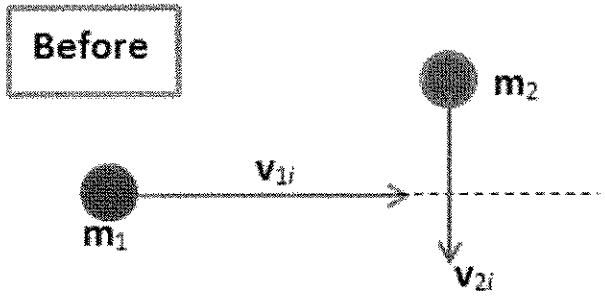
1.

In the four situations indicated in the figure below, an object explodes into two equal-mass fragments when the object is at the origin of the coordinate system. The velocity vectors of the fragments are indicated; they are directed either along an axis or at 45° to an axis.



For each situation, determine the direction of travel of the object before the explosion, or note that the object was at rest before the explosion. For each situation, state your reasoning demonstrating how you determined your answer and be certain to incorporate fundamental principles as part of your justification.

2. A two-dimensional collision takes place and the **Before** arrangement of the two colliding particles are shown below.



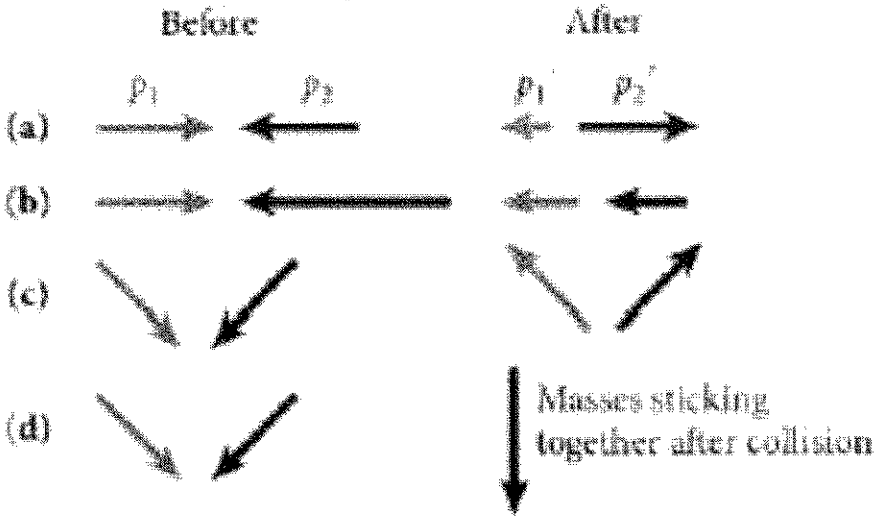
Draw the **After** arrangement of the particles if the collision if ***perfectly inelastic***.

Include the following in your diagram:

a. The velocity vector(s)
b. The expressions for each velocity vector
c. The angles that define the directional orientation of the velocity or momentum.

3.

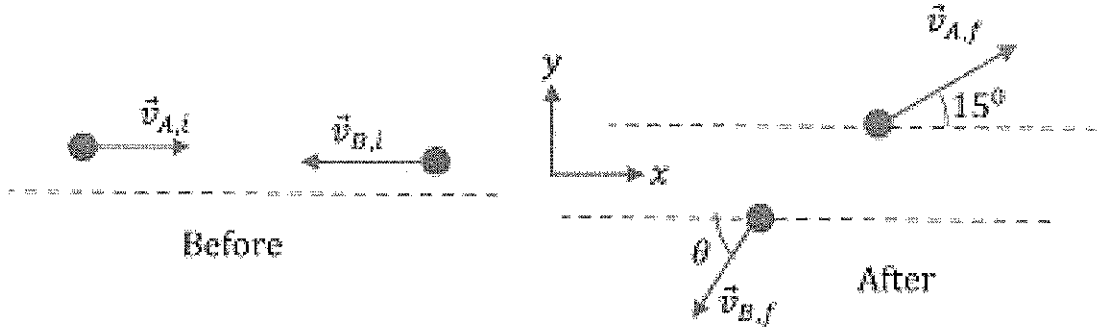
Two masses collide. Which of the following sets of **Before – After** momentum vectors violate the law of momentum conservation?



(e) None of the above situations violate the momentum conservation law.

4.

A two-dimensional collision between two identical particles takes place on a flat horizontal frictionless surface. The **Before** and **After** arrangement of the particles is shown in the diagram below.



Which of the following statements regarding the collision is(are) correct?

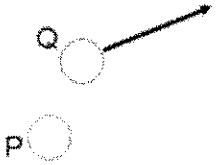
a. The total negative momentum of Particle *B* before the collision must be equal to the total negative momentum of Particle *B* after the collision because momentum must be conserved.
b. Particle *A*'s momentum after the collision must be equal to Particle *B*'s momentum before the collision since during a collision momentum is transferred.
c. According to the momentum conservation law, the sum of *x*-momenta of Particle *A* and Particle *B* after the collision must be zero since the sum of their *x* momenta before the collision was zero.
d. According to momentum conservation, angle θ must be equal to 15^0 since Particle *A* and Particle *B* have identical masses.
e. The sum of velocities of the particles before the collision must be equal to the sum of velocities of the particles after the collision.

5.

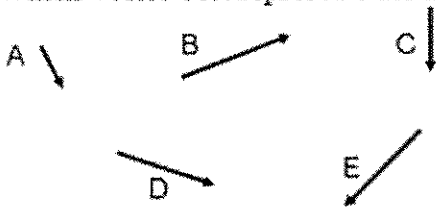
Two objects strike a glancing blow. The diagram below shows the momenta of some of the objects are shown before and after the collision.

Before the collision

After the collision

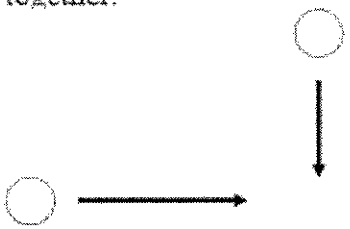


Which vector best represents the momentum of object P after the collision?

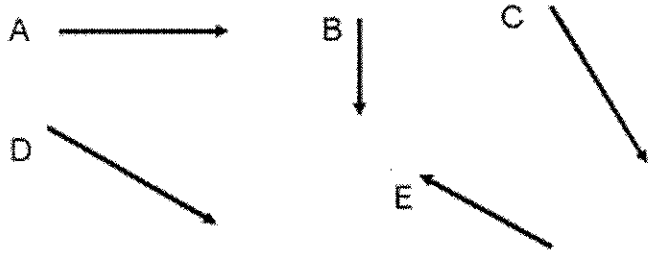


6.

Two objects of equal mass with the speeds indicated by the vectors below, collide and stick together.

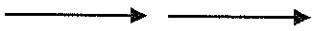


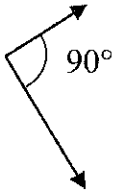
Which vector below best represents the velocity of the combined objects after the collision?

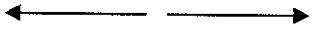


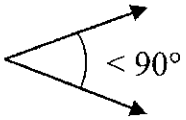
7.

A billiard ball moving with an initial velocity v elastically collides with another billiard ball of equal mass that was at rest. Which of the following sets of vectors could represent the final velocity vectors of the two balls after the collision?

a. 

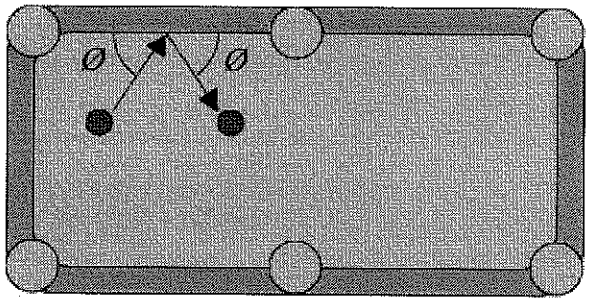
b. 

c. 

d. 

e. 

8.



View looking down on pool table

A billiard ball hits the side of a pool table at an angle Ø as shown in the top view above, and bounces away at the same angle, and with the same speed. Which vector indicates the direction of the net change in momentum of the billiard ball?

a. 

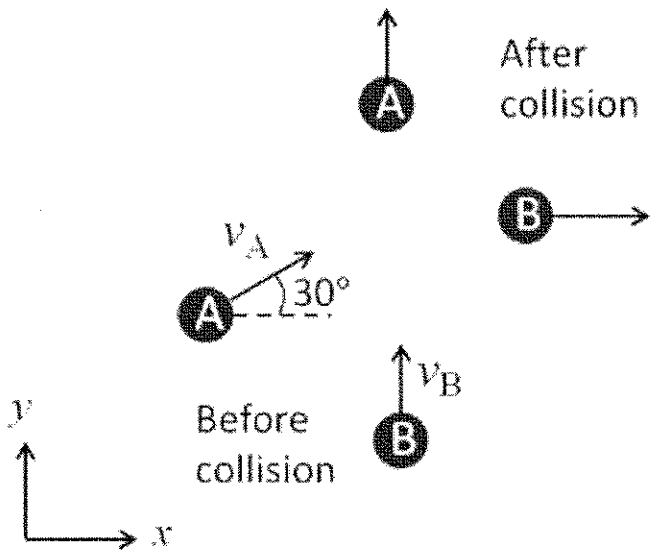
b.

c. 

d. 

e. 

Challenge Problem



Two billiard balls, A and B, are moving on a frictionless table as shown above. Their masses are $m_A = 0.8\ kg$ and $m_B = 0.5\ kg$. Before collision, ball A is moving in the direction 30° off the x-axis with speed $v_A = 6\ m/s$, while ball B is moving along the +y-axis with speed $v_B = 2\ m/s$. After collision, ball A moves along the +y-axis, while ball B moves along the +x-axis. Ignore air resistance.

What is P_{after}, the magnitude of the total momentum after collision?

a. $P_{after} = 4.16\ kg \cdot m/s$
b. $P_{after} = 5.37\ kg \cdot m/s$
c. $P_{after} = 2.75\ kg \cdot m/s$
d. $P_{after} = 3.4\ kg \cdot m/s$
e. $P_{after} = 7.56\ kg \cdot m/s$