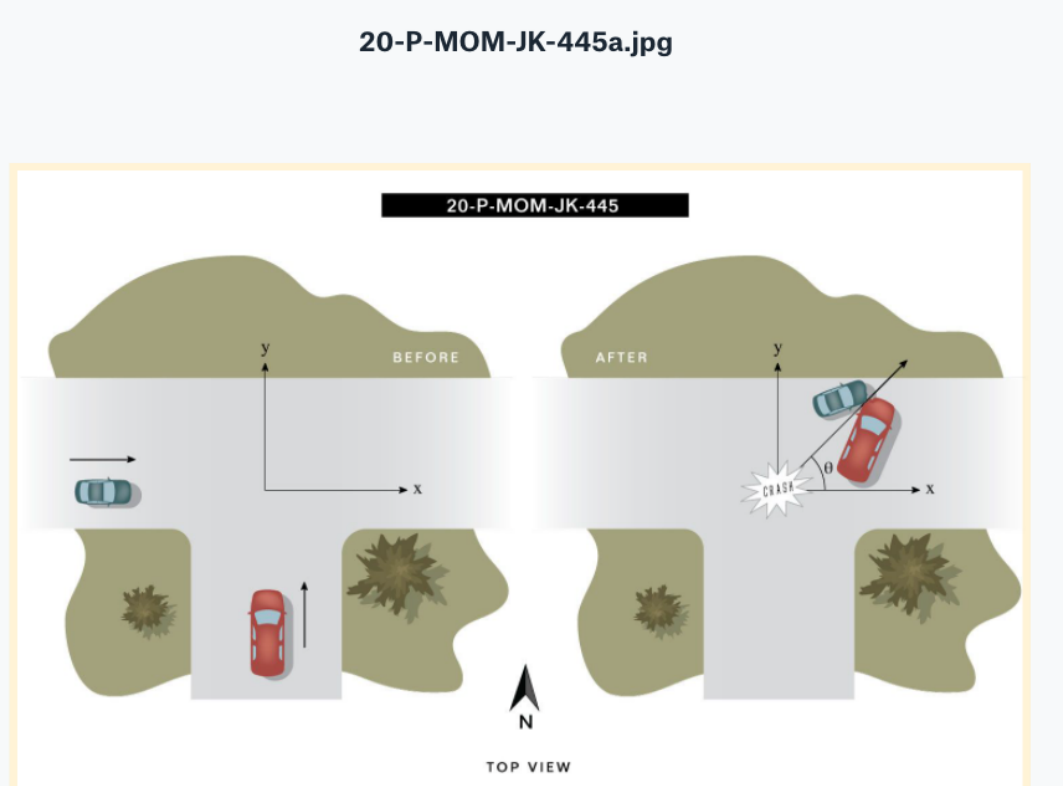
20-P-MOM-JK-445a
Collisions in two dimensions



Question: The car and the van collided in the middle of the intersection as shown. They stuck together after the collision. What was the final velocity of the car and van in metres per second immediately after the collision? Magnitude and direction.

For direction, give me the angle θ above the x-axis or North of East as shown.

The car has a mass of 999 [kg] and the van has a mass of 2345 [kg].

Before the collision, the car had been traveling at 21.2 m/s in the positive x direction (as shown) before the collision and the van had been travelling at 13.4 m/s in the positive y direction.

Assume that linear momentum was conserved.

a) What was the initial momentum of the system?

b) What was the final momentum of the system?

c) What was the final velocity of the system?

Note: on your test I will ask ONLY for the final velocity of the system. a) and b) are a hint to you.

Answers: 1a) 37900 kg m/s $\theta = 56.0°$

1b) same 379 00 kg m/s $\theta = 56.0°$

1c) 11.3 m/s at same angle , $\theta = 56.0°$

m car ranges from 1000 kg to 2000 kg
m van ranges from 2500 kg to 4000 kg

https://media.chevrolet.com/media/us/en/chevrolet/vehicles/express_cargo_van/2016.tab1.html

v car ranges from 15.1 to 19.9 m/s
v van ranges from 10.1 to 13.9 m/s

momentum before in the x direction = (m car) (v car)
momentum before in the y direction = (m van) (v van)

total momentum before, as it is a vector is
$|\overrightarrow{momentum}| = \sqrt{(m_{car}v_{car})^2 + (m_{van}v_{van})^2}$
magnitude of momentum = SQRT ((m car v car) ^{2} + (m van v van) ^{2})

Tangent of the angle theta = (m van v van) / (m car v car)
Angle = INV TAN ((m van v van) / (m car v car))

Final velocity, after the collision
Angle of momentum before the collision = angle of the velocity after the collision as momentum is conserved

The car and van stick together so the
velocity of the cars after the collision = total momentum before / total mass

$$speed\ after\ = \frac{\sqrt{(m_{car}v_{car})^2 + (m_{van}v_{van})^2}}{m_{car} + m_{van}}$$

Speed after the collision = (SQRT ((m car v car) ^{2} + (m van v van) ^{2}))

(m car + m van)

If m car = 999 kg
m van = 2345 kg
v car before = 21.2 m/s in the positive x direction (as shown)
v van before = 13. 4 m/s in the positive y direction.
Momentum before = 37900 kg m/s θ = 56.0°
Momentum after = same 379 00 kg m/s θ = 56.0°
Velocity after = 11.3 m/s at same angle , θ = 56.0°