The Law of Conservation of Momentum

when any event occurs

Total momentum NEVER changes when objects collide. No exceptions.

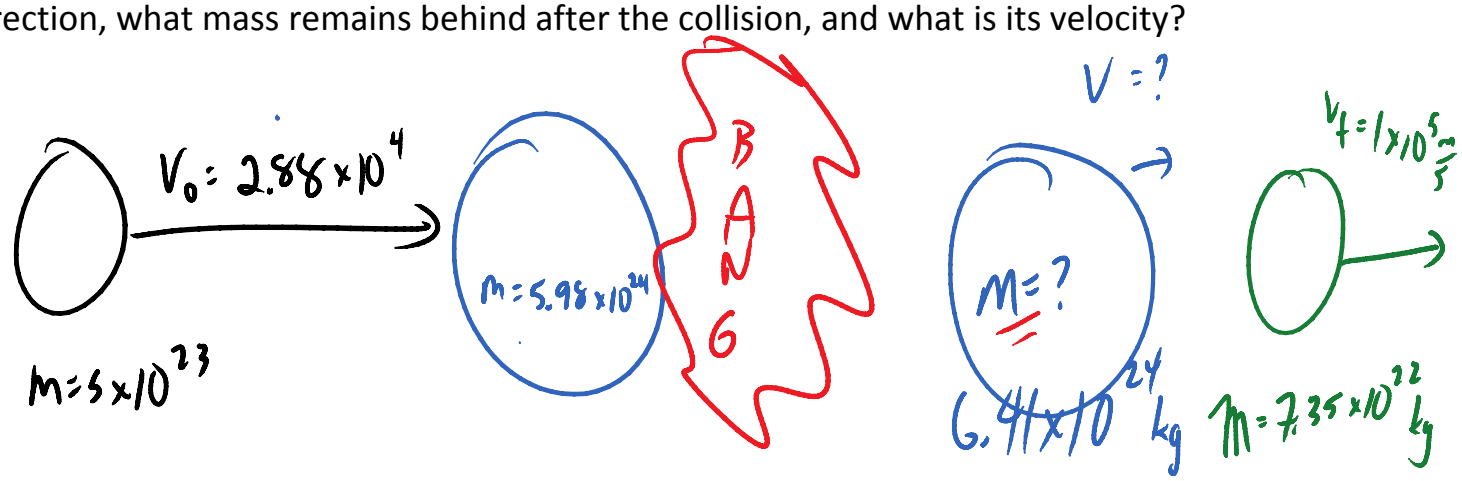
When objects collide: find the momentum of each object before they hit,
total those momentums up*
find the momentum after the event of anything moving
subtract from the total to get a missing momenta

*keep X values separate from y values

Xtotal

Ytotal

A planet of mass 5.00 x 10 ^{23} kg hurtles at 2.88 x 10 ^{4} m/s toward Earth (m_e = 5.98 x 10 ^{24} kg) at rest, the two masses collide and a piece of 7.35 x 10 ^{22} kg is ejected at 1.0 x 10 ^{5} m/s in the same direction, what mass remains behind after the collision, and what is its velocity?



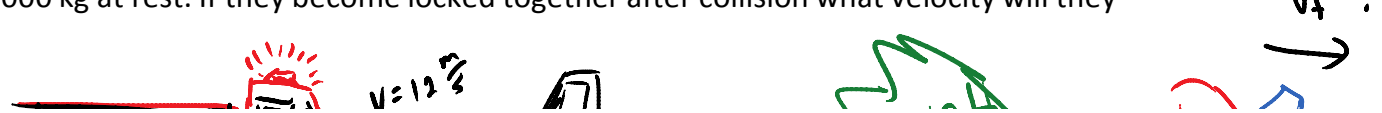
$$p_1 + p_2 = p_3 + p_4$$

$$(5 \times 10^{23})(2.88 \times 10^4) + 0 = 6.41 \times 10^{24} V + (7.35 \times 10^{22})(1 \times 10^5)$$

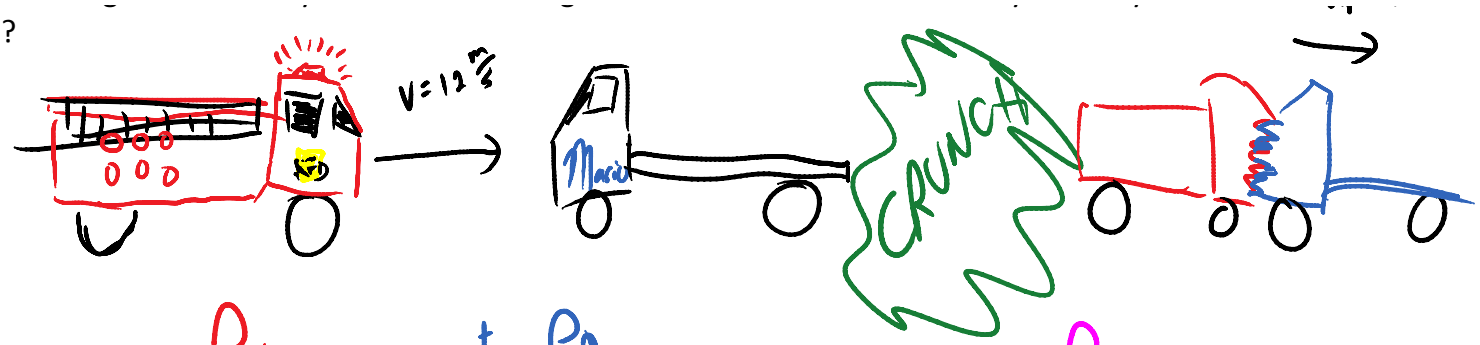
$$1.44 \times 10^{28} - 7.35 \times 10^{27} = 6.41 \times 10^{24} V$$

$$V_f = 1.09 \times 10^3 \frac{m}{s}$$

A firetruck of mass 5000 kg travels at 12 m/s down the street toward a tow truck of Mass 3000 kg at rest. If they become locked together after collision what velocity will they have?



have?

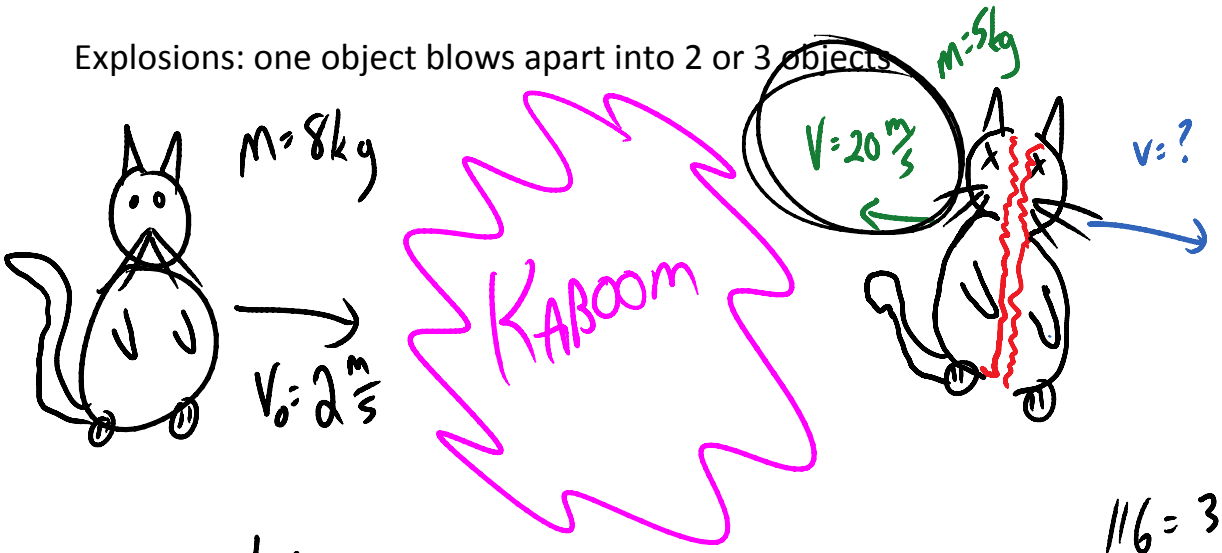


$p_1 + p_2 = p_3$

$5000(12) + = 8000V$

$60000 = 8000V$ $V = 7.5\ m/s$

Explosions: one object blows apart into 2 or 3 objects



$16 = -100 + 3V$

$116 = 3V$

$V_f = 39\ m/s$

A kid of mass 60 kg runs at 5.0 m/s toward a bobcat of mass 20 kg at rest. After collision the bobcat is moving at 20 m/s in the original direction, what is the velocity of the kid?

m=10 kg m= M= 10-4.5 =5.5kg -4.5kg 20 m/s m/s

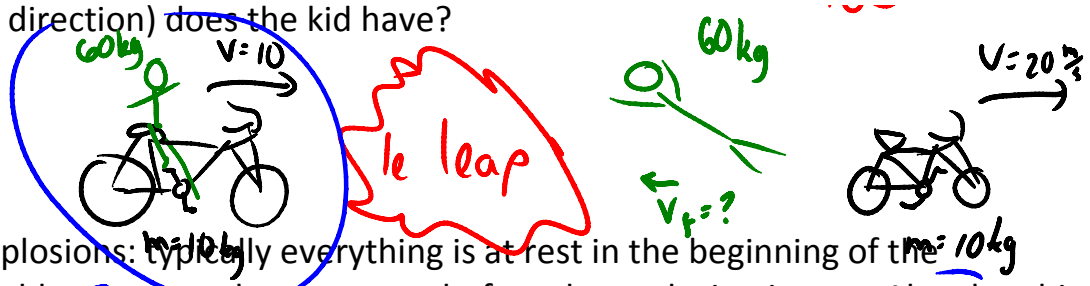
$p_1 = p_{1f} + p_{2f}$

$0 + 0 = 5.5V_f + 450$ m=60 $-\frac{450}{5.5} = \frac{5.5V_f}{5.5}$

$5(\ ) + 20(0) = p_f + V_f p_f$ V=? $-81.8\ m/s$

A 60 kg kid riding a 10 kg bike east at 10 m/s jumps backward off the bike. If the bike continues forward at 20 m/s what velocity (magnitude and direction) does the kid have?

direction) does the kid have?



Explosions: typically everything is at rest in the beginning of the problems so total momentum before the explosion is zero. Also the object That explodes splits into simple masses, no mass is lost.

70kg · 10 →

$700 \frac{kg\,m}{s} = 60 v_f + 200$

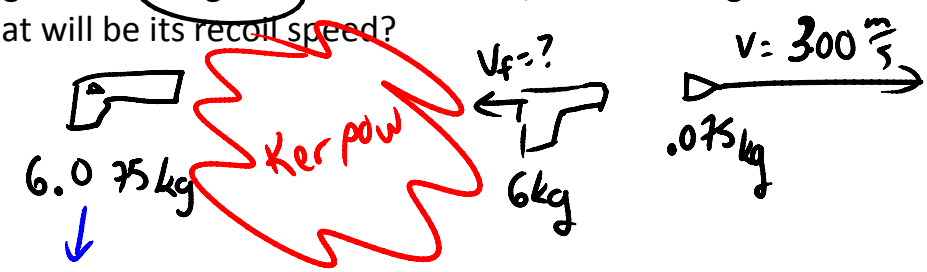
$500 = 60 v_f$

$\frac{500}{60} = 8.33 \frac{m}{s}$ same direction

Example a 10kg cat at rest explodes a 4.5 kg piece travels east at 100 m/s how fast is the other piece moving. Draw a picture!

finish 3 questions at bottom

A desert eagle fires a 75 gram bullet at 300 m/s. If the d'eagle has mass 6.00 kg what will be its recoil speed?

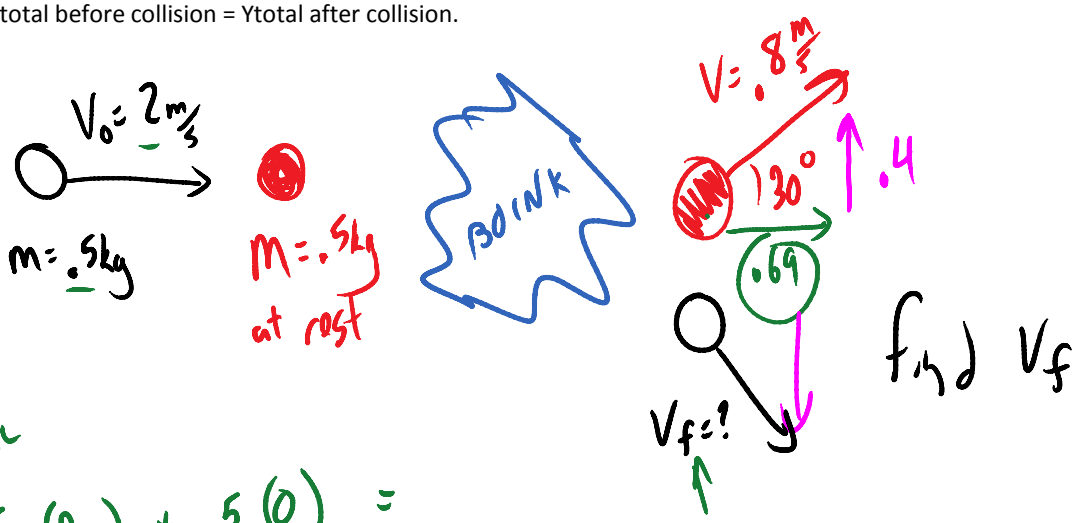


$0 = 6 v_f + 22.5$

$-\frac{22.5}{6} = v_f$

$-3.75 \frac{m}{s} = v_f$

In two dimensions the law still holds. Xtotal before collision = Xtotal after collision AND Ytotal before collision = Ytotal after collision.



find V_f

X_{TOTAL}

$.5(2) + .5(0) =$

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$= (.5)(.69) + m V_{fx}$

$1 = .355 + .5 V_{fx}$

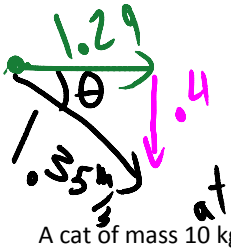
$\frac{.645}{.5} = \cancel{.5} V_{fx} = 1.29 \frac{m}{s}$

y

$(.5)(0) + .5(0) = 0 = .5(.4) + .5 V_{fy}$

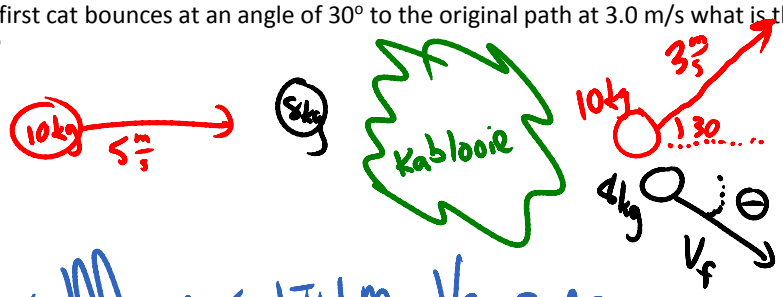
$0 = .2 + .5 V_{fy}$

$\frac{-.2}{.5} = -.4 = V_{fy}$



at 17° S from E

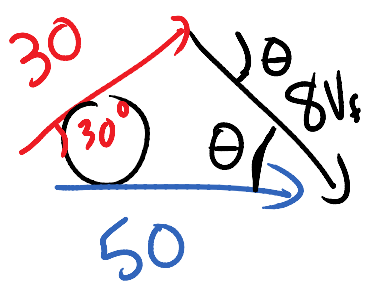
A cat of mass 10 kg slides at 5.0 m/s on a frictionless surface toward an 8.0 kg cat at rest. They collide, if the first cat bounces at an angle of 30° to the original path at 3.0 m/s what is the velocity of the second cat?



① Draw Momentum Vectors

② Move P_{finals} into tip to tail fashion

③ Initial P is resultant



$c^2 = a^2 + b^2 - 2ab\cos\theta$

$= 30^2 + 50^2 - 2(30)(50)\cos 30$

$c^2 = 802$

$c = 28.3 \frac{kg\,m}{s}$

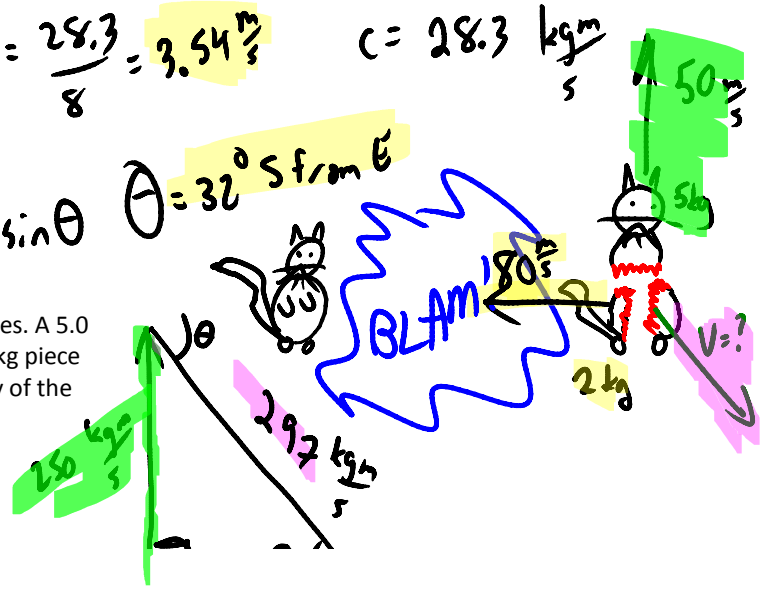
$V = \frac{28.3}{8} = 3.54 \frac{m}{s}$

$\frac{\sin\theta}{30} = \frac{\sin 30}{28.3}$

$\frac{30 \sin 30}{28.3} = \sin\theta$

$\theta = 32°$ S from E

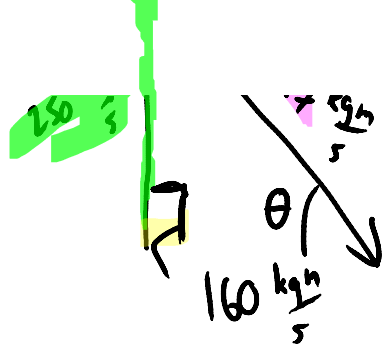
A 10 kg cat at rest explodes into 3 pieces. A 5.0 kg mass travels north at 50 m/s, a 2.0 kg piece travels west at 80 m/s find the velocity of the third piece.



$\sin\theta \quad \sin 90$

$$\frac{\sin\theta}{250} = \frac{\sin 90}{297}$$

$$\sin\theta = \frac{250 \sin 90}{297}$$



$\theta = 57^\circ$ S from E