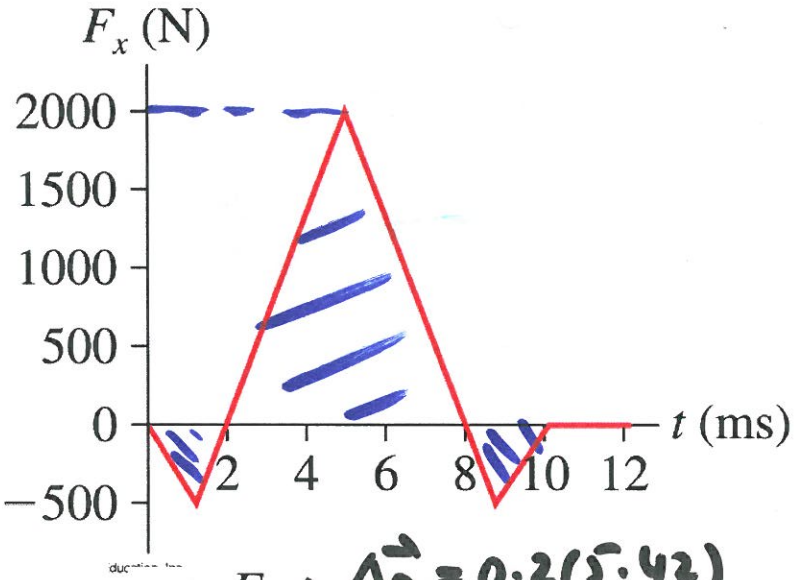
Whiteboard Problems 9-1 and 9-2 (Problems # 9-4 and 28)

4. ‖ What is the impulse on a 3.0 kg particle that experiences the force shown in FIGURE EX9.4?



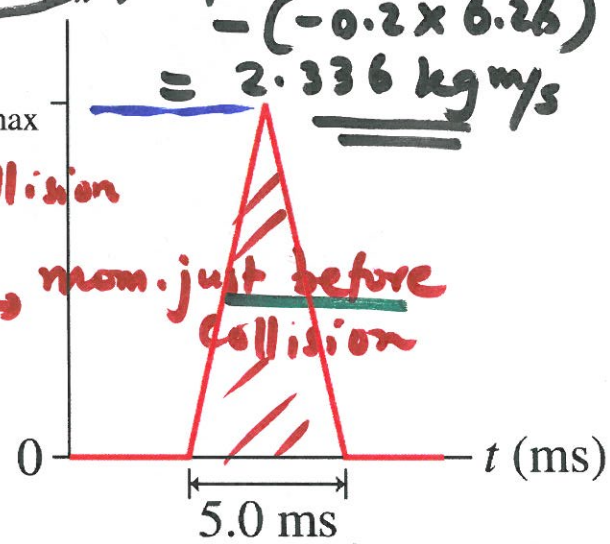
Impulse = area under the F-t curve

$= \frac{1}{2}(8-2)10^{-3} \times 2000 + \left[\frac{1}{2}(2\times10^{-3})\times(-500)\right]\times 2$

$= 6 - 1 = 5\ \text{kg m/s}\ (= \text{N.s})$

28. ||| A 200 g ball is dropped from a height of 2.0 m, bounces on a hard floor, and rebounds to a height of 1.5 m. FIGURE P9.28 shows the impulse received from the floor. What maximum force does the floor exert on the ball?

Hint: Remember! Impulse = change in momentum!



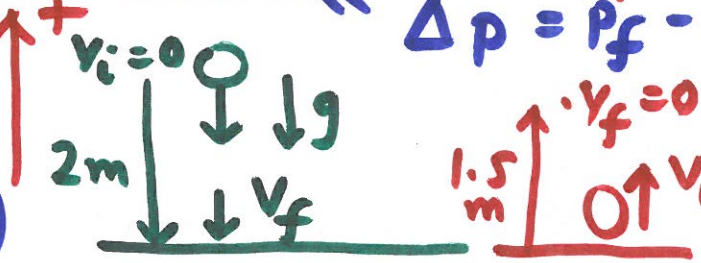
$\vec{\Delta p} = 0.2(5.42) - (-0.2 \times 6.26) = 2.336\ \text{kg m/s}$

mom. just after collision

$\Delta p = p_f - p_i$ → mom. just before collision

Area under F-t curve $= \frac{1}{2}(5\times10^{-3})(F_{max}) = 2.336$

$\Rightarrow \boxed{F_{max} = 935\ \text{N}}$



$v_f^2 = v_i^2 + 2a\Delta y \rightarrow 0 = v_i^2 + 2(-9.8)(1.5)$

$v_f^2 = 0 + 2(-9.8)(-2)$

$v_i = 5.42\ \text{m/s}$

$v_f = -6.26\ \text{m/s} \downarrow$

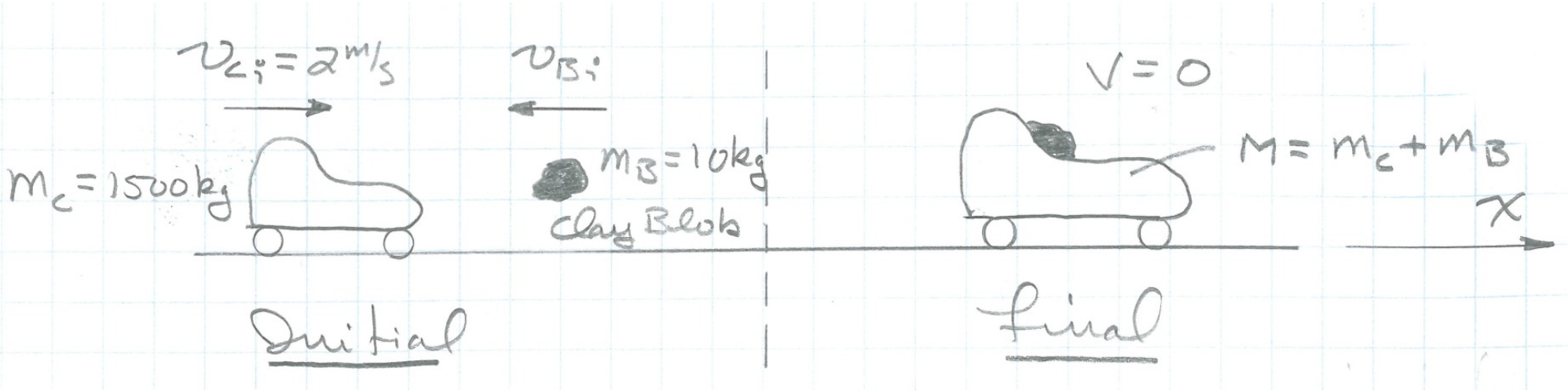
$\therefore \vec{p}_f$ = mom. just AFTER collision $= 0.2(5.42)\uparrow$

$\therefore \vec{p}_i$ = mom. just before collision $= 0.2(-6.26) \downarrow$

Whiteboard Problem 9-3: Problem # 9-19

19. | A 1500 kg car is rolling at 2.0 m/s. You would like to stop the car by firing a 10 kg blob of sticky clay at it. How fast should you fire the clay? What a ridiculous way to stop a car, but it would work – might break the windshield!

Your sketch should look like this (what is the system?):



$p_i = p_f$

$1500(2) - 10v_B = 1510(0)$

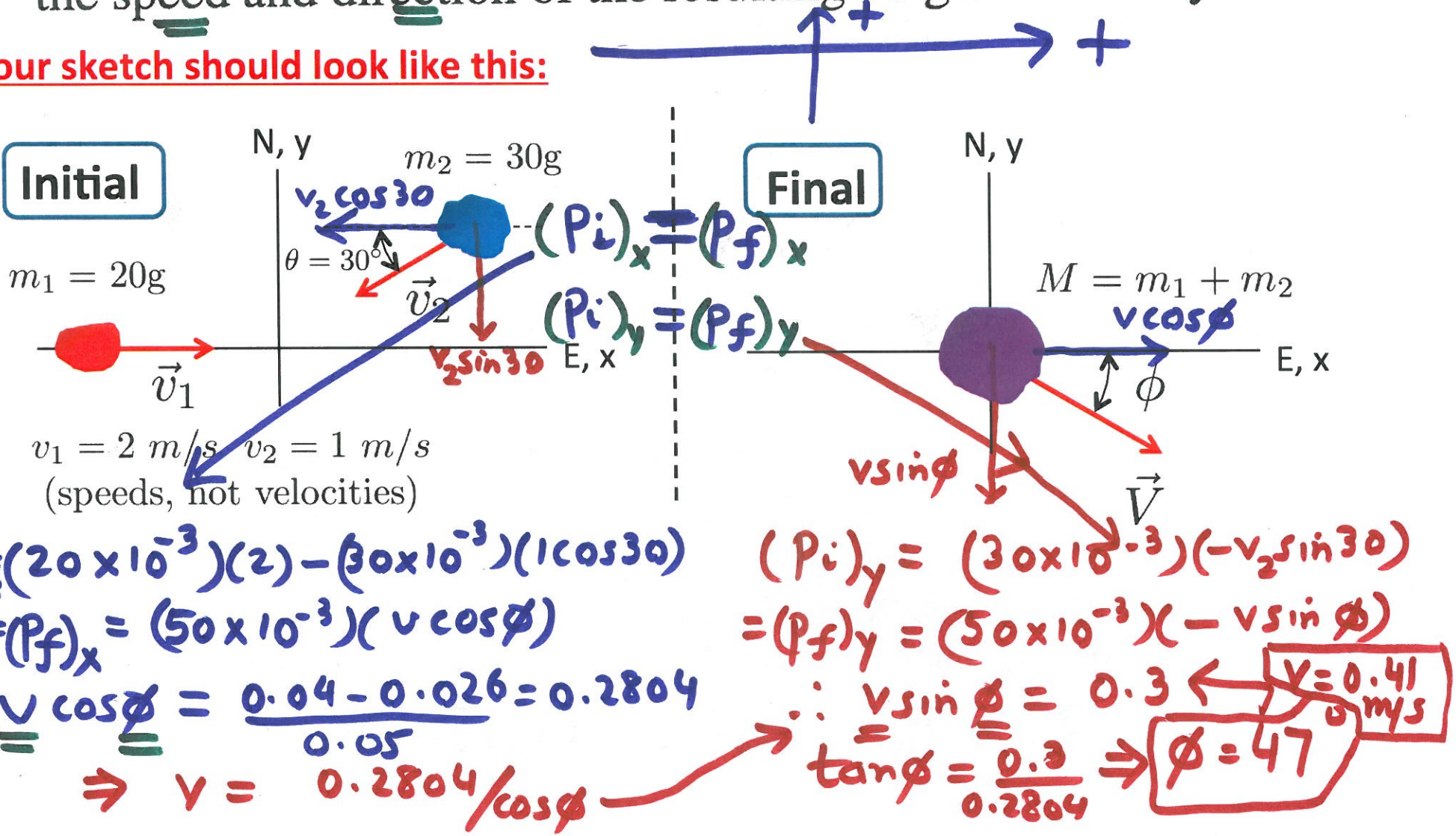
Therefore, $v_B = 3000/10 = 300$ m/s

Whiteboard Problem 9-4: Problem # 9-62

(Another perfectly inelastic collision, but this time in 2D...so conserve p_x and p_y!)

62. || A 20 g ball of clay traveling east at 2.0 m/s collides with a 30 g ball of clay traveling 30° south of west at 1.0 m/s. What are the speed and direction of the resulting 50 g blob of clay?

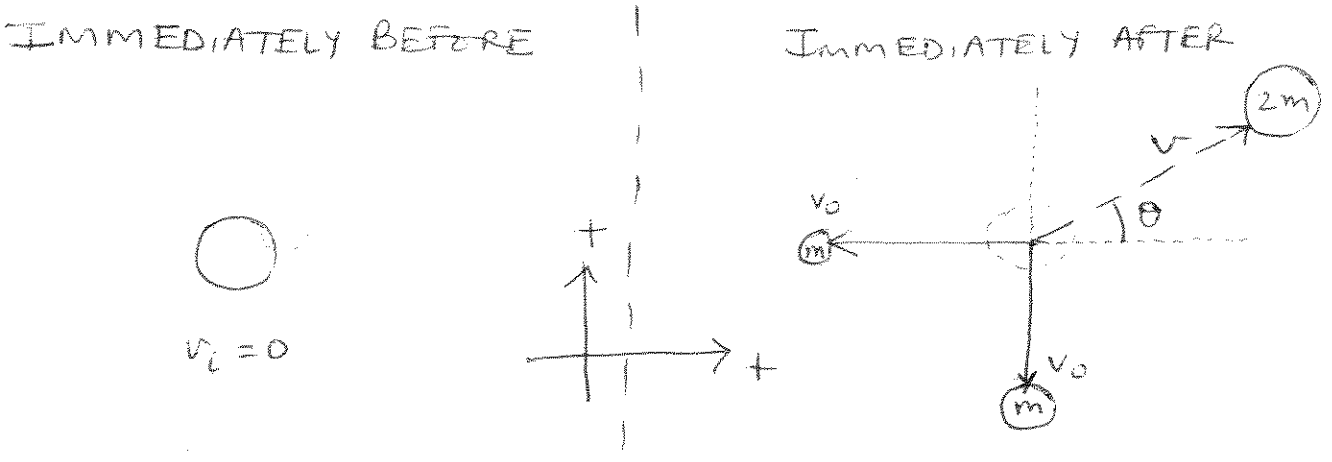
Your sketch should look like this:



Whiteboard Problem 9-4: Problem # 9-41

A firecracker in a coconut blows the coconut into three pieces. Two pieces of equal mass fly off south and west, perpendicular to each other, at speed v_0. The third piece has twice the mass as the other two. What are the speed and direction of the third piece? Give the direction as an angle east of north.

Draw a sketch of "immediately before" and "immediately after" the collision!



$P_i = P_f$

x: $0 = 2mv\cos\theta - mv_0 \Rightarrow v\cos\theta = \frac{v_0}{2}$ —(i)

y: $0 = 2mv\sin\theta - mv_0 \Rightarrow v\sin\theta = \frac{v_0}{2}$ —(ii)

From (i) & (ii), $\sin\theta = \cos\theta$ when $\boxed{\theta = 45^\circ}$

& therefore $v = \frac{v_0}{2 \cdot \frac{1}{\sqrt{2}}} = \boxed{\frac{v_0}{\sqrt{2}}}$ is the speed

Whiteboard Problem 9-5: Problem # 9-43

A bullet of mass m is fired at speed v into a block of wood of mass M that is at rest. The block, with the bullet embedded, slides a distance d across a horizontal surface. The coefficient of kinetic friction between the block and the surface is μ_k. Find an expression for the bullet's initial speed v.
(The expression should be in terms of m, M, μ_k, d, and, of course, g)