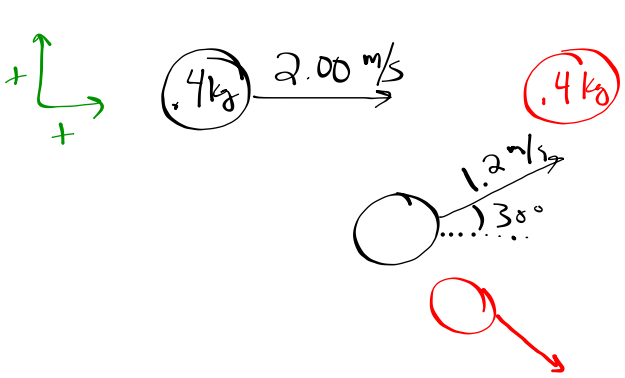
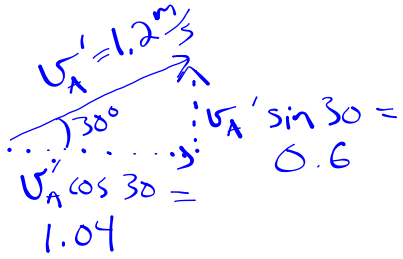
31. A billiard ball of mass m_A = 0.400 kg moving with a speed v_A = 2.00 m/s strikes a second ball, initially at rest, of mass m_B = 0.400 kg. As a result of the collision, the first ball is deflected off at an angle of 30.0° with a speed v'_A = 1.2 m/s. Taking the x-axis to be the original direction of motion of ball A, and assuming it deflects above the x-axis, find the final velocity of ball B (which will include both a magnitude as well as a direction).



$m_A = 0.4$ kg
$m_B = 0.4$ kg
$v_A = 2.00$ m/s
$v_B = 0$ m/s
$v_A' = 1.2$ m/s
$v_B' = ?$



$v_{AX} = 2.00$ m/s
$v_{AY} = 0$ m/s
$v_{AX}' = 1.04$ m/s
$v_{AY}' = 0.6$ m/s

$\Delta p = 0$

$m_A v_{AX} + m_B v_{BX} = m_A v_{AX}' + m_B v_{BX}'$

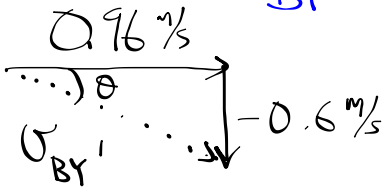
$(.4)(2) = (.4)(1.04) + (.4)(v_{BX}')$

$v_{BX}' = 0.96$ m/s

$m_A v_{AY} + m_B v_{BY} = m_A v_{AY}' + m_B v_{BY}'$

$0 = (.4)(0.6) + (.4)(v_{BY}')$

$v_{BY}' = -0.6$



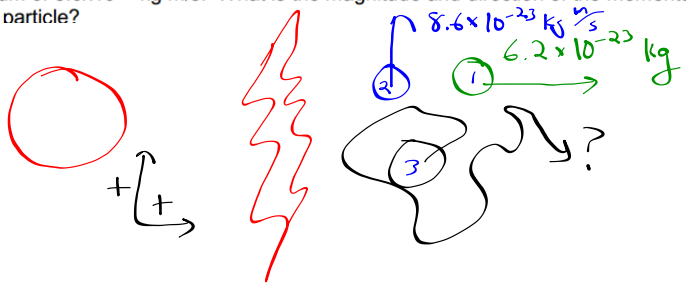
$\tan^{-1} \frac{-0.6}{0.96} = \theta$

$\theta = 32°$ Below +x axis

$0.96^2 + 0.6^2 = (v_{BY}')^2$

$v_{BY}' = 1.13$ m/s

30. A radioactive nucleus that is initially at rest suddenly decays by breaking apart into three separate particles. One particle is a neutrino (imagine it traveling along the x-axis in the positive direction). The second particle is an electron (imagine it traveling along the y-axis in the positive direction). The final particle is what remains of the nucleus (now a new nucleus). The neutrino has a momentum of 6.2×10^{-23} kg m/s and the electron has a momentum of 8.6×10^{-23} kg m/s. What is the magnitude and direction of the momentum of the recoiling nucleus, the third particle?



$p = 0 \frac{kg\ m}{s}$ $\rightarrow p_x = 0$, $p_y = 0$

$p_1' = 6.2\times10^{-23} \frac{kg\ m}{s}$ $\rightarrow p_{1x}' = 6.2\times10^{-23}$, $p_{1y}' = 0$

$p_2' = 8.6\times10^{-23} \frac{kg\ m}{s}$ $\rightarrow p_{2x}' = 0$, $p_{2y}' = 8.6\times10^{-23}$

$p_3' = ?$

$\Delta p = 0$:

$p_x = p_{1x}' + p_{2x}' + p_{3x}'$

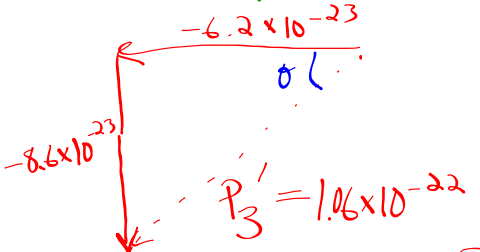
$0 = 6.2\times10^{-23} + 0 + p_{3x}'$

$p_{3x}' = -6.2\times10^{-23}$

$p_y = p_{1y}' + p_{2y}' + p_{3y}'$

$0 = 0 + 8.6\times10^{-23} + p_{3y}'$

$p_{3y}' = -8.6\times10^{-23}$



$p_3' = \sqrt{(p_{3x}')^2 + (p_{3y}')^2}$

$= 10.60\times10^{-23}$

$p_3' = 1.06\times10^{-22}$

$\tan^{-1}\frac{8.6}{6.2} = \theta$

$\theta = 54^\circ$ below $-x$ axis