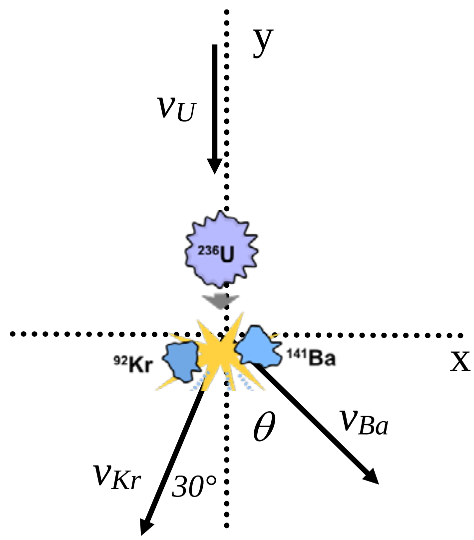
General Physics I - Quiz #4 Name ______________________________



The diagram to the right represents the fission of Uranium – 236. The fission products are Krypton – 92, Barium – 141 and three neutrons. For this problem, let's just focus on the fission of U – 236 to Kr – 92 and Ba – 141. (Neglect the neutrons since they have relatively small masses.)

Before fission, the uranium with a mass of 236 is traveling downward at a speed of 2.0×10^6 m/s. After fission, the krypton atom (mass of 92) is traveling at 2.5×10^6 m/s with an angle of 30° to the left of the downward direction. What is the resulting velocity of the barium atom (mass of 141)? *Give your answer in the form of magnitude and direction.*

From the diagram the initial velocity of the uranium is

$$\vec{v}_U = -2.0 \times 10^6\, \hat{\jmath}\; m/s$$

and the final velocity of krypton is

$$\vec{v}_{Kr} = 2.5 \times 10^6 \frac{m}{s}(-\sin(30)\,\hat{\imath} - \cos(30)\hat{\jmath}) = \{-1.25 \times 10^6\,\hat{\imath} - 2.17 \times 10^6\,\hat{\jmath}\}\; m/s$$

Begin with conservation of momentum

$$\vec{P}_0 = \vec{P}_f$$

$$m_U \vec{v}_U = m_{Kr}\vec{v}_{Kr} + m_{Ba}\vec{v}_{Ba}$$

Solve for the final velocity of Barium.

$$\vec{v}_{Ba} = \frac{m_U \vec{v}_U - m_{Kr}\vec{v}_{Kr}}{m_{Ba}}$$

$$\vec{v}_{Ba} = \frac{236\,(-2.0 \times 10^6\,\hat{\jmath}) - 92(-1.25 \times 10^6\,\hat{\imath} - 2.17 \times 10^6\,\hat{\jmath})}{141}$$

$$\vec{v}_{Ba} = \frac{1.15 \times 10^8\,\hat{\imath} - 2.72 \times 10^8\,\hat{\jmath}}{141} = \{8.16 \times 10^5\,\hat{\imath} - 19.3 \times 10^5\,\hat{\jmath}\}\; m/s$$

The magnitude of the velocity is

$$v_{Ba} = \sqrt{(8.16 \times 10^5)^2 + (-19.3 \times 10^5)^2} = 2.10 \times 10^6\; m/s$$

The angle, θ, can be calculated with the formula

$$\tan\theta = \frac{opp}{adv} = \frac{v_x}{v_y}$$

$$\theta = tan^{-1}\left(\frac{v_x}{v_y}\right) = tan^{-1}\left(\frac{8.16 \times 10^5}{19.3 \times 10^5}\right) = 22.9^o$$

Notice I left the negative sign off the y-component of velocity. Since I am using the diagram to determine the value of θ, I only needed to know how big the side is, not in what direction the vector was pointing. From the diagram the angle is to the right of the downward direction.