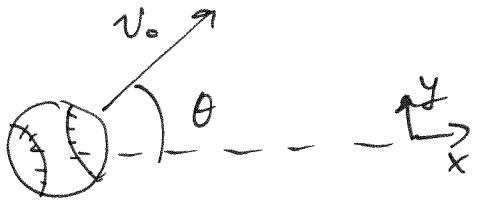
Chapter 9 Problem 34

$\theta = 30°$

$\vec{v}_0 = 25\ m/s$

$m = 250\ g = 0.25\ kg$



what is the momentum after 0.20s?

The initial momentum magnitude is

$$p = mv = (0.25\ kg)(25\ m/s) = 6.25\ kg\,m/s$$

In unit ~~vector~~ vector notation

$$\vec{v}_0 = 25\cos 30°\,\hat{i} + 25\sin 30°\,\hat{j}$$

$$= (21.7\,\hat{i} + 12.5\,\hat{j})\ m/s$$

and initial momentum vector is

$$\vec{p}_0 = (0.25\ kg)(21.7\hat{i} + 12.5\hat{j}) = (5.43\,\hat{i} + 3.13\,\hat{j})\ kg\,m/s$$

In the horizontal direction the momentum & velocity is unchanged, In the vertical direction gravity is accelerating the ball downward. After $\Delta t = 0.20s$, the new vertical velocity is

y-direction $\rightarrow v = v_0 + at = 12.5 - (9.8)(0.20) = 10.5\ m/s$

The new velocity is

$$\vec{v} = (21.7\,\hat{i} + 10.5\,\hat{j})\ m/s$$

The new momentum is

$$\vec{p} = (0.25\ kg)(21.7\hat{i} + 10.5\hat{j})\ m/s = (5.43\,\hat{i} + 2.63\,\hat{j})\ kg\,m/s$$

The new magnitude of the momentum is

$$p = \sqrt{(5.43)^2 + (2.63)^2} = 6.03\ kg\,m/s$$

The angle of travel of the ball is

$$\theta = \tan^{-1}\left(\frac{2.63}{5.43}\right) = 25.8°$$