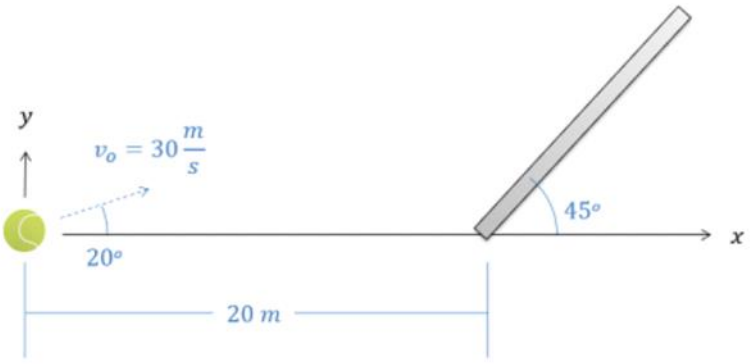
Question 3

A tennis ball is launched at an angled surface as shown below such that it will bounce up after impact. The tennis ball has an initial velocity of 30 m/s at a 20-degree angle and is launched 20 meters from the base of the surface, which itself is angled at 45 degrees. Determine the coordinates where the tennis ball is expected to impact the surface.



Projectile path

$\ddot{x}(t) = 0$

$\dot{x}(t) = 30\cos(20)$

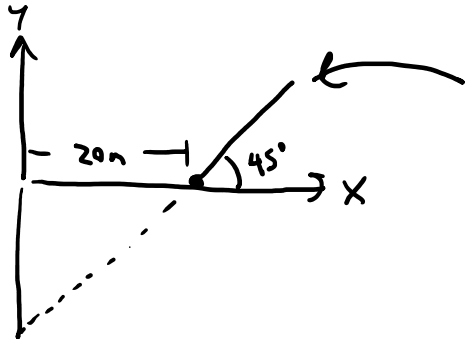
$x(t) = 30\cos(20)t$

$\ddot{y}(t) = -9.81$

$\dot{y}(t) = -9.81t + 30\sin(20)$

$y(t) = -\frac{9.81}{2}t^2 + 30\sin(20)t$

find the equation for the surface



$y = x - 20$

find t when projectile path intersects surface

$$y = x - 20$$

$$\left(-\frac{9.81}{2}t^2 + 30\sin(20)t\right) = \left(30\cos(20)t\right) - 20$$

$$-\frac{9.81}{2}t^2 + \left(30\sin(20) - 30\cos(20)\right)t + 20 = 0$$

$$t = .8959\,s \leftarrow \text{time to impact surface}$$

$$x(.8959) = 30\cos(20)(.8959) = 25.26\,m$$

$$y(.8959) = -\frac{9.81}{2}(.8959)^2 + 30\sin(20)(.8959) = 5.26\,m$$

location of impact

$$\boxed{x = 25.26\,m \quad y = 5.26\,m}$$