Question 15509

Let φ_0 denote an angle at which the ball is thrown, and v_0 denote the initial velocity, φ denote the angle between the horizontal line and velocity vector.

a) The general equation for velocity of an object, moving with constant acceleration is $\vec{v}=\vec{v}_0+\vec{a}t$. Lets write it in a vector form: $\begin{pmatrix} v_x \\ v_y \end{pmatrix}=\begin{pmatrix} v_{0x} \\ v_{0y} \end{pmatrix}+\begin{pmatrix} 0 \\ -g \end{pmatrix}t=\begin{pmatrix} v_0\cos\varphi \\ v_0\sin\varphi \end{pmatrix}+\begin{pmatrix} 0 \\ -g \end{pmatrix}t$, where $g=9.81\,m/s^2$. From here, for $t=1$, $v_x\approx 9.83\,m/s, v_y\approx -2.91\,m/s$.

b) The angle might be found from angle between v_x and v_y : $\tan\varphi=\frac{v_y(t)}{v_x(t)}=\frac{v_0\sin\varphi_0-gt}{v_0\cos\varphi_0}$, which gives $t_1=\frac{v_0}{g}(\sin\varphi_0-\cos\varphi_0\tan\varphi)\approx 0.34\,s$.

c) Below the horizontal means formal substitution $\varphi\rightarrow-\varphi$, which gives $t_2=\frac{v_0}{g}(\sin\varphi_0+\cos\varphi_0\tan\varphi)\approx 1.07\,s$.