NB1140: Physics 1A - Classical mechanics and Thermodynamics
Solutions to Quiz 1
Wed. 23 November 2016

Solution to Quiz 1

(a) Let $|\vec{V_{||}}| = V_{||}$ and $|\vec{V_{\perp}}| = V_{\perp}$ (the lengths of these two vectors). From the right-angled triangle in the figure on the quiz sheet, we get

$$V_{||} = Vcos(\theta) \tag{1a}$$
$$V_{\perp} = Vsin(\theta) \tag{1b}$$

(b) The bug has two velocity components, $\vec{V_{||}}$ and $\vec{V_{\perp}}$. Of these two, only the $\vec{V_{||}}$ affects the motion along the radial line that joins the lamp with the bug. $\vec{V_{\perp}}$ is perpendicular to the radial line so it cannot increase or decrease the length of this radial line. In other words, $r(t)$, which is the length of this radial line that joins the lamp with the bug at time t, cannot be decreased or increased by $\vec{V_{\perp}}$ (Remember, velocity vector tells you by how much and in which direction a position vector changes at the next moment in time). The only thing that $\vec{V_{\perp}}$ does is rotate the radial line around in a circle (look at chapter 3 in your book on non-uniform circular motion). So we can just forget about $\vec{V_{\perp}}$ and care only about $V_{||}$. At $t = 0$, we have $r(0) = R$. So we have

$$\begin{aligned} r(t) &= R - V_{||}t \\ &= R - Vtcos(\theta) \end{aligned} \tag{2a}$$

When the bug lands on the lamp, $r(t) = 0$. So at time t, when the bug lands on the lamp, we have

$$\begin{aligned} 0 &= R - Vtcos(\theta) \\ \implies t &= \frac{R}{Vcos(\theta)} \end{aligned} \tag{3a}$$