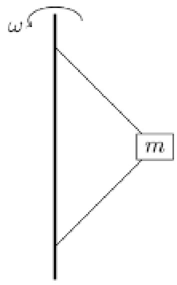
Periodic Physics Problems: II

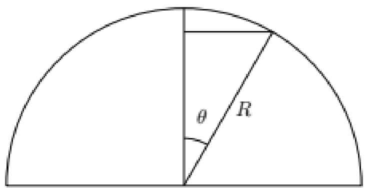
TJ Physics Team

Due: October 5th, 2018

α. A mass m is connected to a vertical revolving axle by two strings of length l, each making an angle of 45° with the axle, as shown below. Determine the tension in each string.



β. A small object is placed on top of a hemisphere of a very large mass. The object is nudged and it slides down the hemisphere. Determine at what angle the object will lose contact with the hemisphere.



γ. Given that the ***Pauli Matrices*** are defined as:

$$\sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \qquad \sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \qquad \sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}.$$

Their normalized eigenvectors are

$$|\uparrow\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \qquad |\downarrow\rangle = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

$$|\rightarrow\rangle = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ 1 \end{pmatrix} \qquad |\leftarrow\rangle = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ -1 \end{pmatrix}$$

$$|\otimes\rangle = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ i \end{pmatrix} \qquad |\odot\rangle = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ -i \end{pmatrix}.$$

Fill in the values for $\bullet$ and show that:

$$\sigma_z |\otimes\rangle = |\odot\rangle;\ \sigma_z |\odot\rangle = |\otimes\rangle;\ \sigma_y |\rightarrow\rangle = \bullet\, |\leftarrow\rangle;\ \sigma_y |\leftarrow\rangle = \bullet\, |\rightarrow\rangle;\ \sigma_x |\otimes\rangle = \bullet\, |\odot\rangle;\ \sigma_x |\odot\rangle = \bullet\, |\otimes\rangle$$