PHY201: Homework 1

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7^{th} November 2019

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1 Horizontally Excited Pendulum

1.1

Under normal assumptions, we would write the position of the pendulum as:

$$\begin{pmatrix} x \\ z \end{pmatrix} = \begin{pmatrix} x_f + l\,sin\theta \\ -l\,cos\theta \end{pmatrix}$$

However for $\theta \ll 1$, we can use the Taylor series of the trigonometric functions to approximate $cos\theta \approx 1$ and $sin\theta \approx \theta$. We therefore have:

$$\begin{pmatrix} x \\ z \end{pmatrix} = \begin{pmatrix} x_f + l\theta \\ -l \end{pmatrix}$$

1.2

We now consider the forces in the direction of the bar at the point mass. We observe two forces: the constraint force in the bar, that acts parallel to the bar, and the force due to gravity, that acts straight down. By projecting the force due to gravity along the direction of the bar, we can write the equation

$$F_{bar} - mg\,cos\theta = ma$$

with a the component of the acceleration in the direction of the bar. However we know the bar to be rigid, hence $a = 0$, and as established before, over the studied range, $cos\theta = 1$. We can therefore re-write the equaiton above as

$$F_{bar} = mg$$

1.3

1.4

1.5

1.6

2 Equilibrium of Two Masses

2.1

2.2

2.3

2.4

3 Suspended Bar

3.1 One Mass Only

3.1.1

3.1.2

3.1.3

3.1.4

3.1.5

3.1.6

3.1.7

3.2 Connected Masses

3.2.1

3.2.2

3.2.3

3.2.4