PHY 305, I-Semester 2020/21, Tutorial 1

Work in the same teams as for assignments. Do "Stages" in the order below. Discuss via online (video or audio) conference on a subchannel for your group.

Stage 1 *(math review)* Review your knowledge about vectors from old course notes, books or the internet. Make sure you are comfortable with the answer to all these questions:

(i) What is a vector? How do you find the length of a vector? How do you find the angle between two vectors? When are two vectors orthogonal?

(ii) What is a vector space? How do you change basis in a vector space?

(iii) How do you add or substract vectors, multiply them with a scalar, or multiply two vectors? What is a scalar-product or a cross-product?

(iv) For two 3D vectors $\mathbf{v}_1$, $\mathbf{v}_2$ with different directions, show that $\mathbf{v}_3 = \mathbf{v}_1 \times \mathbf{v}_2$ is orthogonal to both $\mathbf{v}_1$ and $\mathbf{v}_2$. How can you use this information to mathematically define "a plane" (i.e. a straight 2D surface embedded in 3D)?

Stage 2 *(physics review)* Review your knowledge about fundamental laws of physics from old course notes, books or the internet. Make sure you are comfortable with the answer to all these questions:

(i) List three basic physical conservation laws. What are the conserved quantities? Under which conditions are they conserved?

(ii) When are these laws useful/ how can you use them?

(iii) What is the basic equation of motion of mechanics? What do you need to specify to know the motion of a particle?

(iv) A blob is sliding on the wobbly plane shown below (second page) without friction and was initially at rest and at the top as shown. Assume the wobbly plane is defined by the equation $y(x) = (H - h)\exp(-x/L) + h\cos(x/\lambda)$, find the x an y components of the velocity of the blob, once it has reached the x-coordinate x_f, assuming the only relevant force is gravity, with potential energy $V = mgy$. *(In the tutorial, it is sufficient to discuss in your team what approach to take to solve this question, if there is not enough time to do the algebra skip that).*

Stage 3 Suppose you are in a stone-throwing competition on a weird planet. The stone has a mass m and you can throw it so hard that its initial velocity is v_0. At which angle to the surface of the planet do you have to throw it, such that it reaches farthest? We assume the only two forces acting on the stone after it leaves your hand is gravity $\mathbf{F} = -mg\hat{\mathbf{z}}$ and linear drag[1] $\mathbf{F} = -\gamma\mathbf{v}$. *(In the tutorial, it is sufficient to discuss in your team what approach to take to solve this question, if there is not enough time to do the algebra skip that).*

[1] This is why the planet is weird. On earth, typically quadratic drag would dominate.

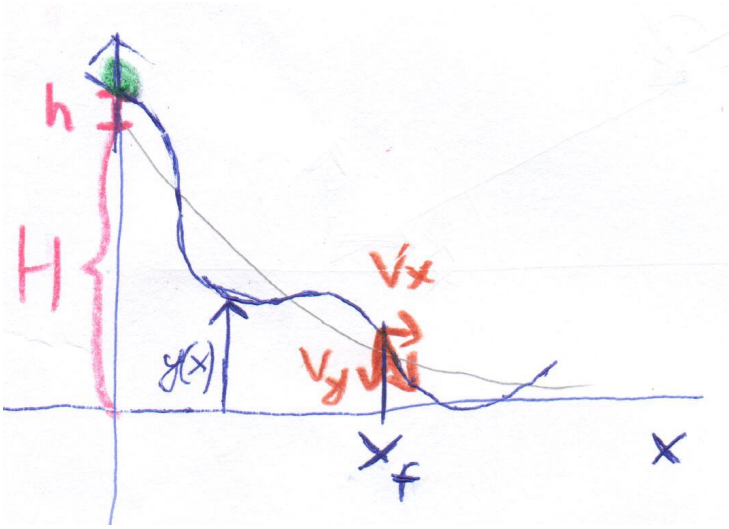

Figure 1: Sketch of wobbly plane (blue line), blob (green) and velocity (brown).