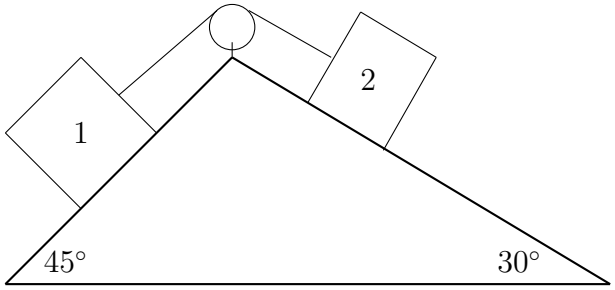
Extra Assignment 1

November 1, 2022

Q1 Two objects are connected via rope, and are rested on a wedge as shown below. The rope is supported by a pulley. Mass 1 has a mass of 2 kg, and Mass 2 has a mass of 1 kg. Mass 2 is lying on an inclination of 30°, and mass 2 is inclined at 45°

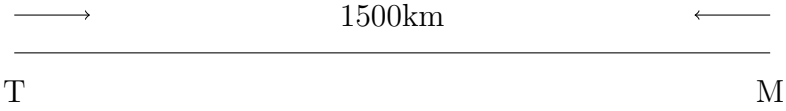


(a) To which direction will the block slide?

(b) What is the overall acceleration on both blocks?

(c) What will the tension of the spring be?

Q2 Two airplanes both weighting 1.4 tons are flying towards each other from city T and city M, which are 1500km apart.



While plane A holds at cruise at 360 km/h from the start, plane B experiences a constant thrust that has a magnitude of 12 kN for 10 min since taking off. It then transitions to cruise.

(a) When would the two planes meet each other?

(b) How far from city A will the planes meet?

Q3 Knowing that

$$W = \vec{f} \cdot \Delta d \tag{1}$$

derive the expression of gravitational potential energy $U = mgh$, where h is the elevation from the ground.

Q4 Knowing that

$$W = \vec{f} \cdot \Delta d \tag{2}$$

derive the expression of kinetic energy $T = \frac{1}{2}mv^2$, where v is the velocity. Hint: you can use one of the 5 kinematic equations, along with the definition of displacement, to derive it.

Q5 (Hard) Knowing that

$$W = \int_{\vec{r}_1}^{\vec{r}_2} \vec{f} \cdot d\vec{r} \tag{3}$$

derive the expression of kinetic energy.

Q6 The spring force defined by Hooke's law is $\vec{f_s} = -k\Delta d$,where k is the spring constant (just like the coefficient of friction, it's a number associated with the material itself).

(a) Knowing that $U = -\int \vec{f} \cdot d\vec{r}$, derive the spring potential energy.

(b) Using the equation that we learned on SPH3U1, $U = -\vec{f}\Delta d$, we can have

$$\begin{aligned} W &= -\vec{f} \cdot \Delta d \\ &= -(-kx) \cdot (x) \\ &= kx^2 \end{aligned}$$

This somehow is twice the magnitude of what the right answer is. Why is this the case? Is our math learned wrong in class? (Hint, the math we learned in is not wrong. It just had an extra condition)

Bonus A string on a violin with length l plays an A natural at 440Hz. If you want to play an E natural at 660Hz, how short do you need the string to be in order to make this sound? Google online for some hints.