Project Report

Physics concept

Physics concepts which I use are as follows.

First, it is a moment concept. It is used to rotate a beam by using a value of a total of moment.

$$\boxed{\sum M = \sum Fr}$$

$\sum M = \sum Fr \sum M$ = A total of moment $[N/m^2]$

$\sum Fr$ = a total of force on a beam $[N/m^2]$ where

F = mass (in kg.) multiplies g (a constant value of gravity force) [N]

r = distance from fulcrum (in meter) [m]

<u>Description</u>

This formula is used to calculate whether how will the beam tilt to?

- *$\sum M$ = 0 it means that the beam is balanced*
- *$\sum M$ = negative value it means that the beam is tilted left*
- *$\sum M$ = positive value it means that the beam is tilted right*

Second, it is a moment of inertia. It is used to make a beam tilt realistically.

$$\boxed{I = \frac{1}{12}mr^2}$$

$$\boxed{I = \frac{1}{12}m(width^2 + length^2)}$$

I = inertia's value that is a specific value of each objects [kgm^2]

m = mass of an object that is used a base to rotate [kg]

$r = \frac{1}{12}(width^2 + length^2)$ = A specific value of a thing (I used a rectangular plate) [m]

Description:

This formula is used to make the beam more realistic in its rotation.

Third, it is a rotational motion, having angular acceleration and angular velocity in the play.

For an angular acceleration:

$$\boxed{\tau = I\alpha = \sum Fr}$$

$$\boxed{\alpha = \frac{\tau}{I}}$$

$$\boxed{\alpha = \frac{\tau}{\frac{1}{12}m(width^2 + length^2)}}$$

Note: Assume that weight of beam is light (mass = 0)

$$\boxed{\alpha = \frac{12\tau}{(width^2 + length^2)}}$$

τ (Torque) = A total of moment $[N/m^2]$

$\sum Fr$ = a total of force on a beam $[N/m^2]$ where

F = mass (in kg.) multiply g (a constant value of gravity force) [N]

r = distance from fulcrum (in meter) [m]

I = inertia's value that is a specific value of each object [kgm^2]

α = angular acceleration $[rad/s^2]$

Description:

This formula is used to make the simulation more realistic by having torque affects the angular velocity of the beam, accelerating rotation.

For angular velocity:

$$\boxed{\omega_2 = \omega_1 + \alpha t}$$

ω = an angular velocity of the beam $[rad/s]$

ω_2 = a present value of omega in that time

ω_1 = a previous value of omega in previous time

α = angular acceleration $[rad/s^2]$

t = time [s]

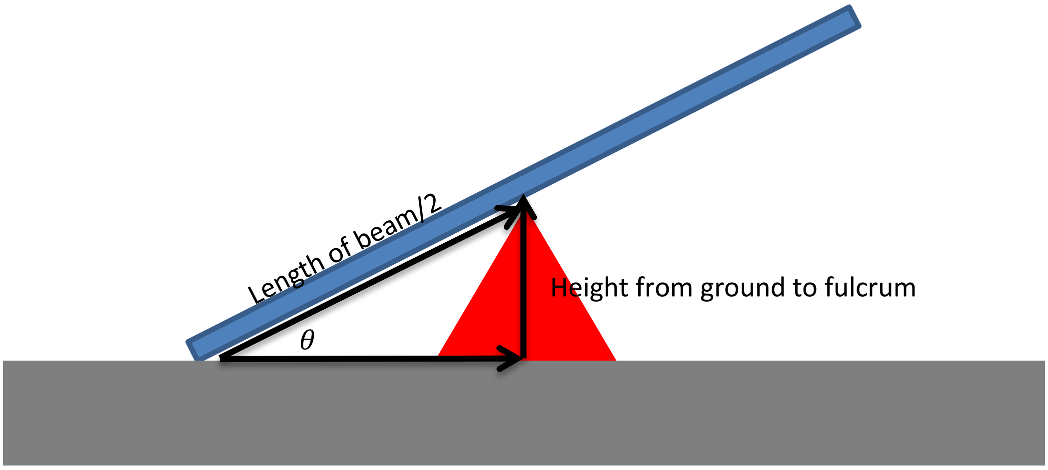
Description:

This formula is used to make the beam moves by getting a value from angular acceleration at that time add with previous the beam's velocity to be a present value of the beam's velocity.

Final, it is mathematics concepts which is important to make simulation be realistic

That's trigonometry. I have to find critical angle which is the limit of beam's angle that can't go beyond this by using sine's properties

$$Sin\ \theta = \frac{opposite}{hypotenus}$$

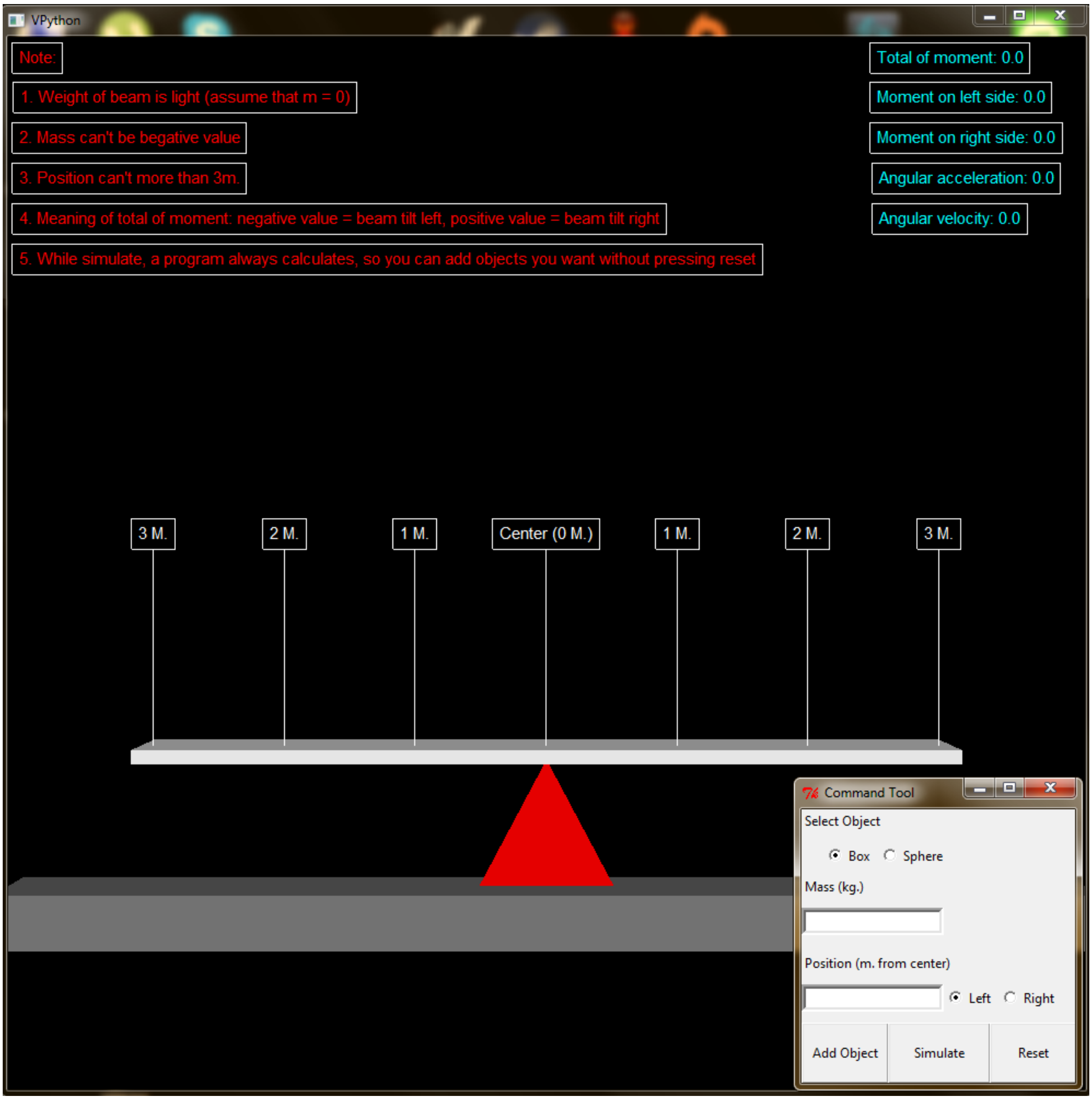


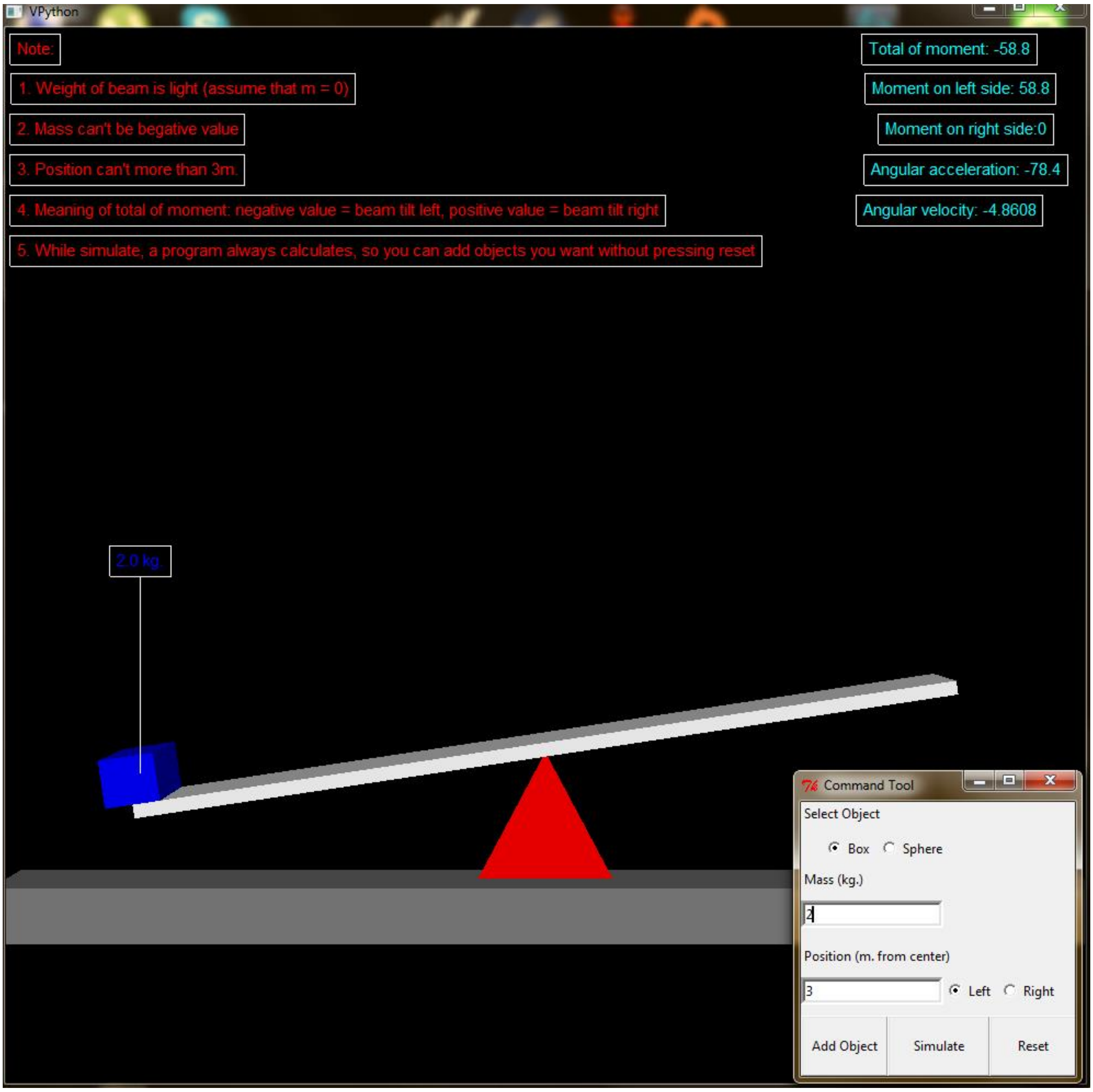
$$Sin\ \theta = \frac{Height}{Length\ /\ 2}$$

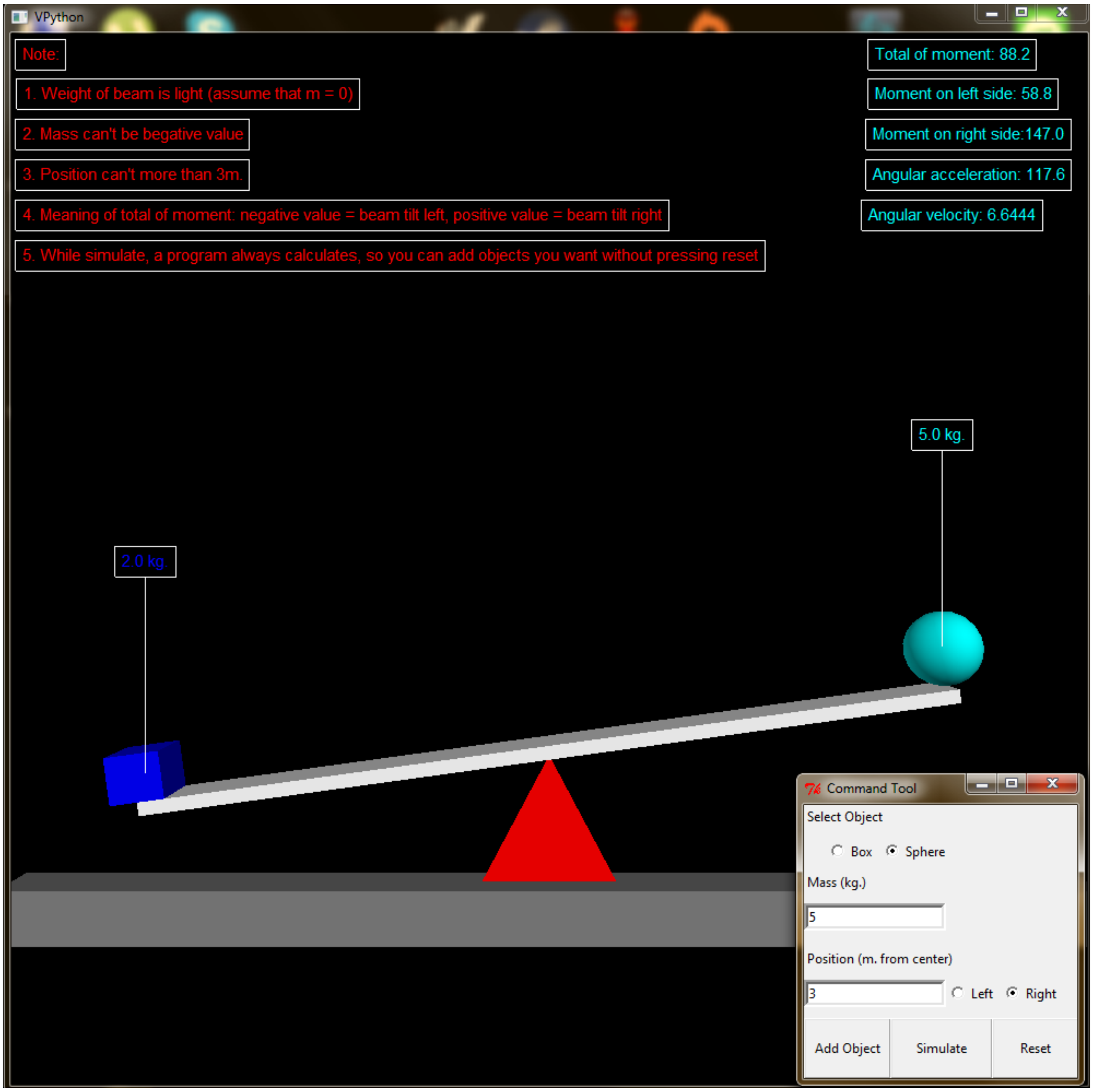
$$\theta = \sin^{-1}\frac{Height}{Length/2}$$

Therefore, critical angle is arcsin $\frac{Height}{Length/2}$

Sample screenshots of my simulation




VPython
Note:
1. Weight of beam is light (assume that m = 0)
2. Mass can't be begative value
3. Position can't more than 3m.
4. Meaning of total of moment: negative value = beam tilt left, positive value = beam tilt right
5. While simulate, a program always calculates, so you can add objects you want without pressing reset
Total of moment: -58.8
Moment on left side: 58.8
Moment on right side:0
Angular acceleration: -78.4
Angular velocity: -4.8608
2.0 kg
Command Tool
Select Object
Box
Sphere
Mass (kg.)
2
Position (m. from center)
3
Left
Right
Add Object
Simulate
Reset


VPython
Note:
1. Weight of beam is light (assume that m = 0)
2. Mass can't be begative value
3. Position can't more than 3m.
4. Meaning of total of moment: negative value = beam tilt left, positive value = beam tilt right
5. While simulate, a program always calculates, so you can add objects you want without pressing reset
Total of moment: 88.2
Moment on left side: 58.8
Moment on right side:147.0
Angular acceleration: 117.6
Angular velocity: 6.6444
2.0 kg.
5.0 kg.
Command Tool
Select Object
Box
Sphere
Mass (kg.)
5
Position (m. from center)
3
Left
Right
Add Object
Simulate
Reset

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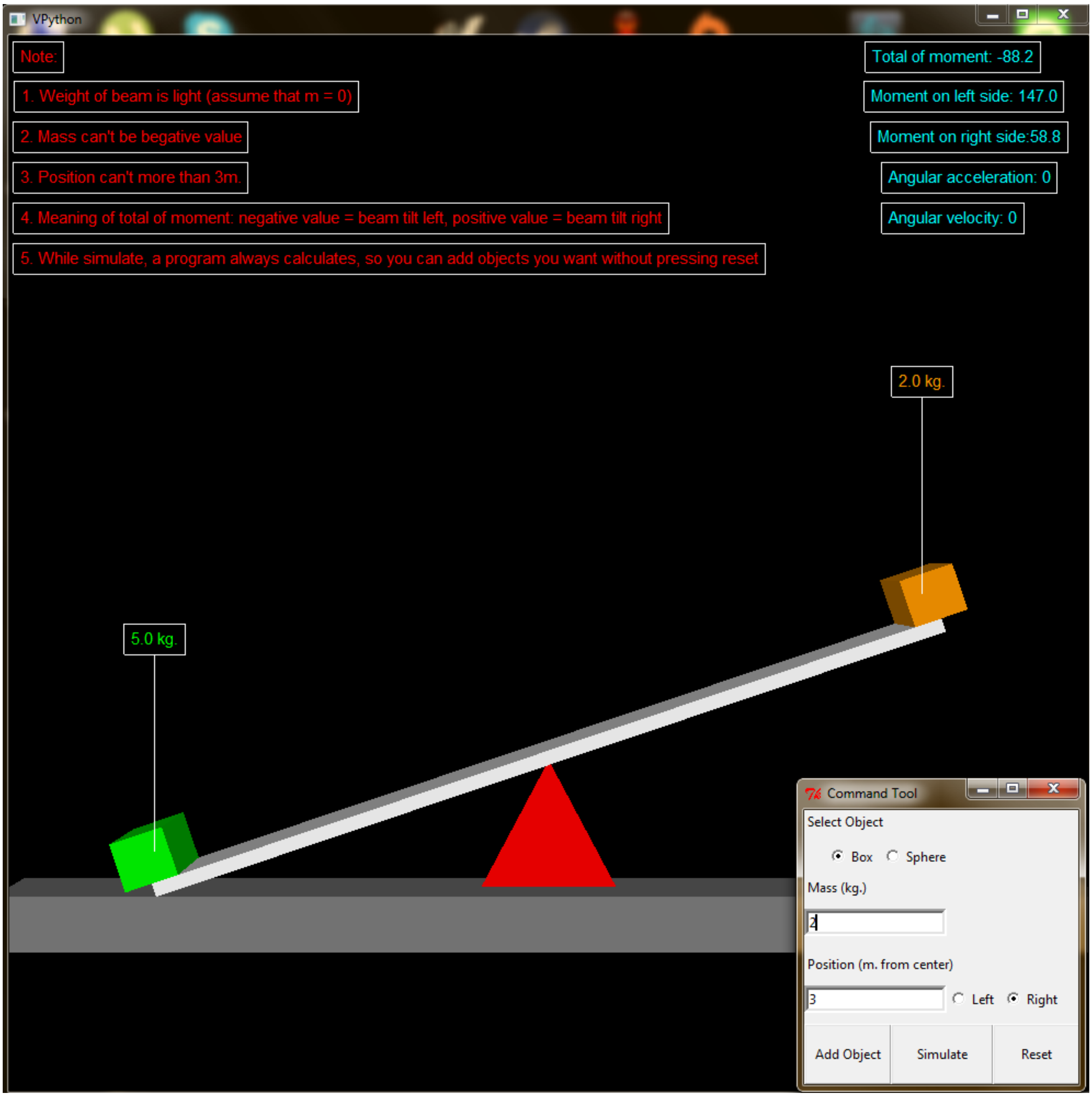
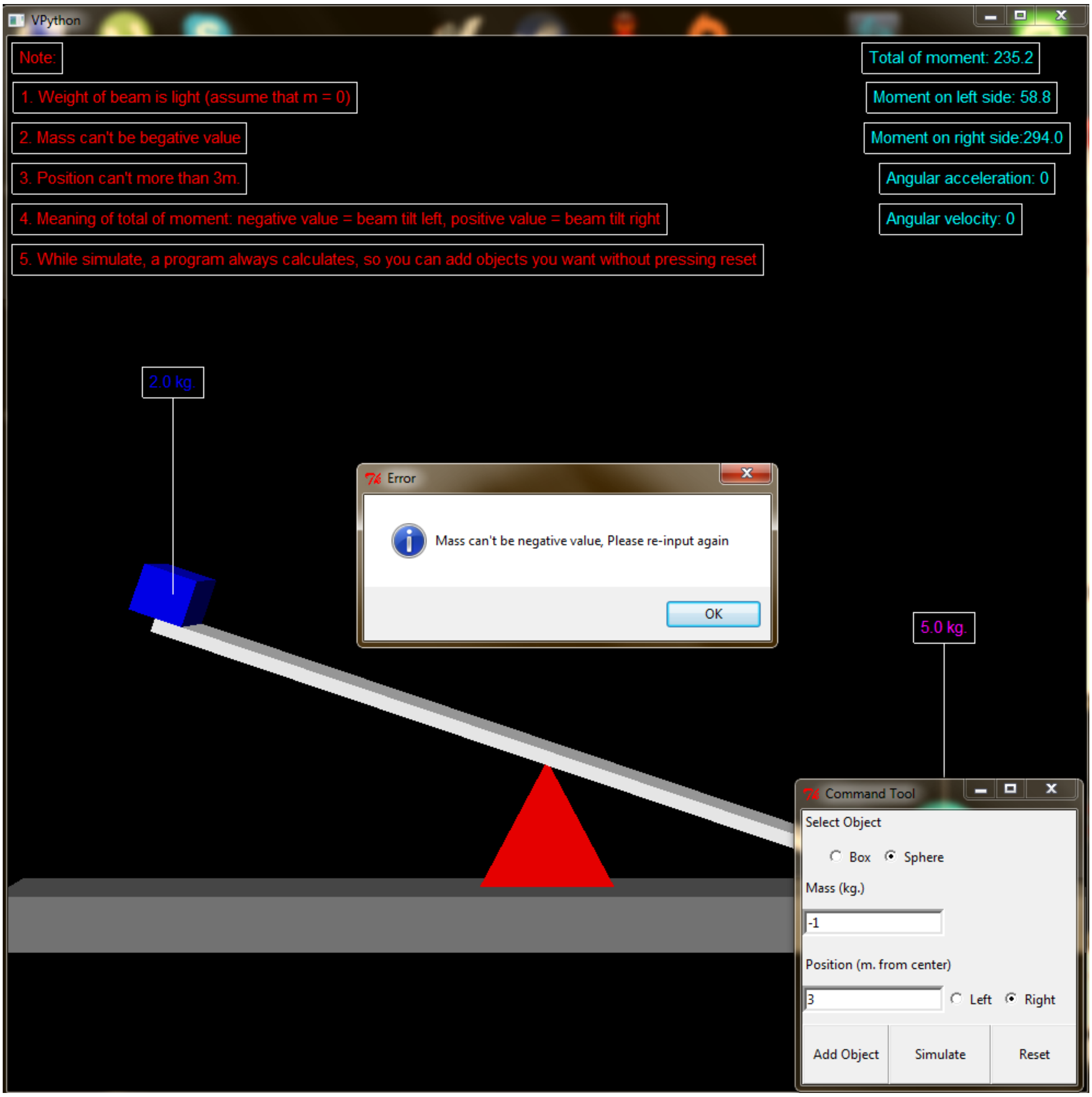
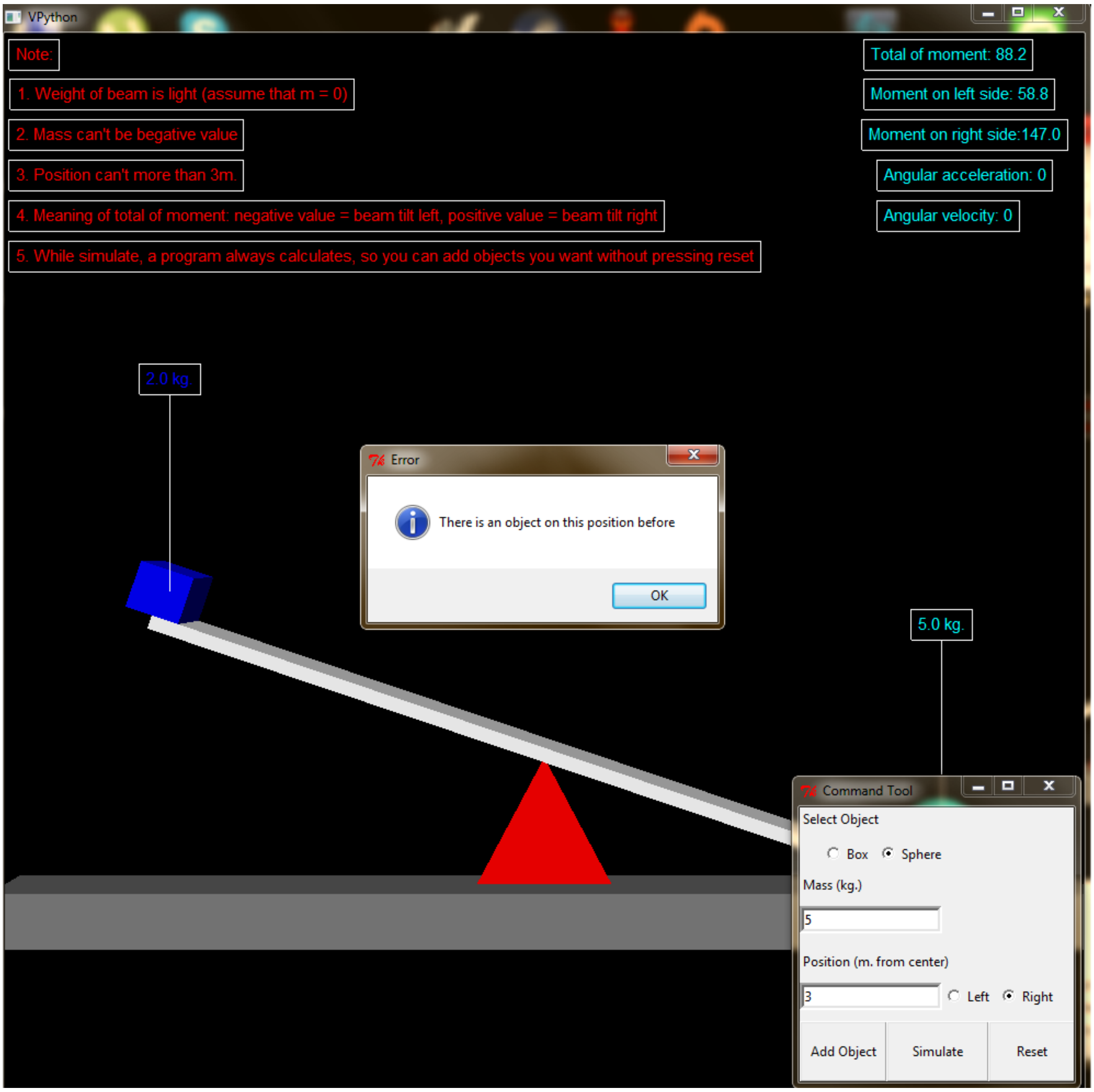
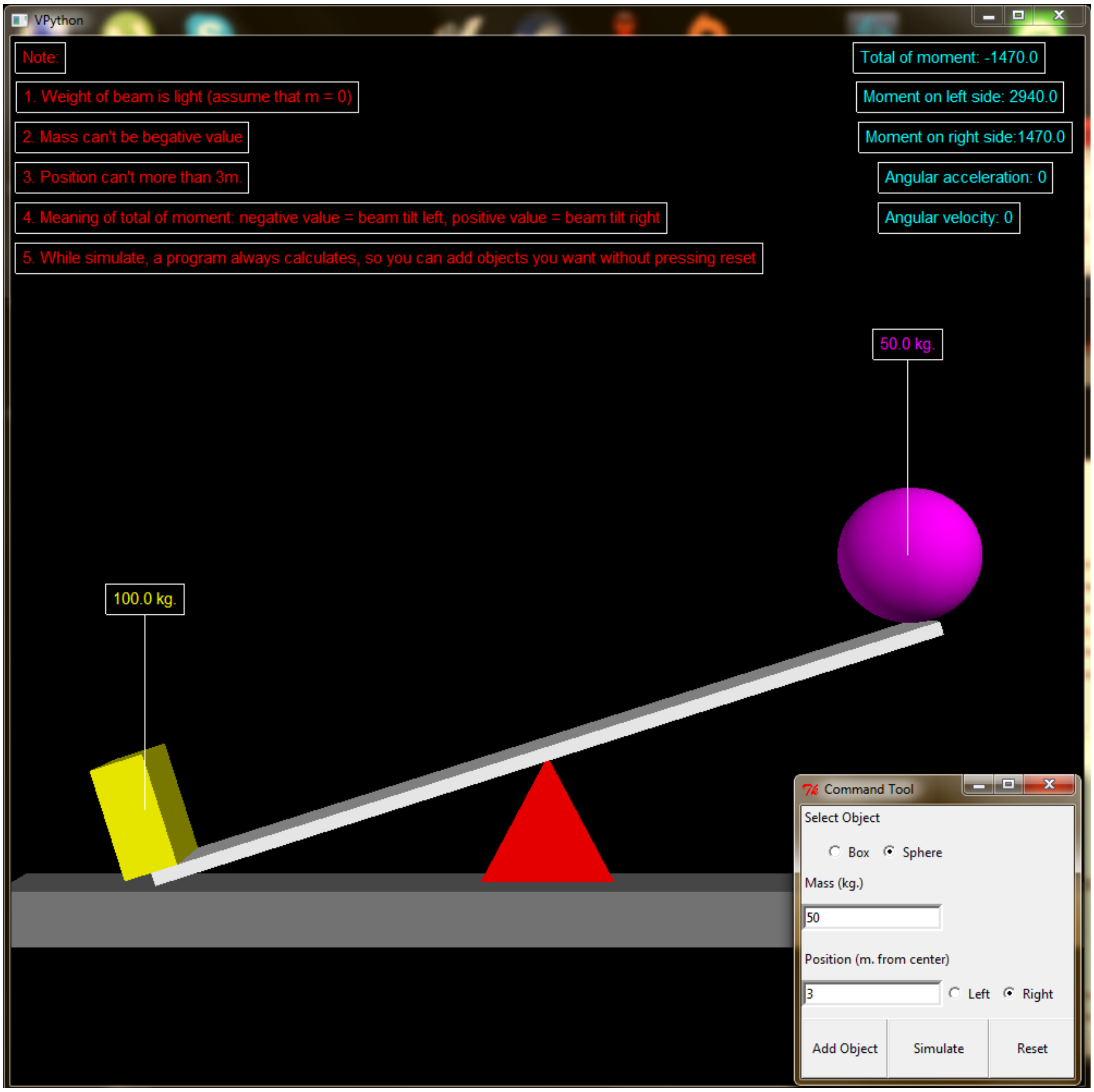



VPython
Note:
1. Weight of beam is light (assume that m = 0)
2. Mass can't be begative value
3. Position can't more than 3m.
4. Meaning of total of moment: negative value = beam tilt left, positive value = beam tilt right
5. While simulate, a program always calculates, so you can add objects you want without pressing reset
Total of moment: 235.2
Moment on left side: 58.8
Moment on right side:294.0
Angular acceleration: 0
Angular velocity: 0
2.0 kg.
5.0 kg.
Error
Mass can't be negative value, Please re-input again
OK
Command Tool
Select Object
Box
Sphere
Mass (kg.)
-1
Position (m. from center)
3
Left
Right
Add Object
Simulate
Reset


VPython
Note:
1. Weight of beam is light (assume that m = 0)
2. Mass can't be begative value
3. Position can't more than 3m.
4. Meaning of total of moment: negative value = beam tilt left, positive value = beam tilt right
5. While simulate, a program always calculates, so you can add objects you want without pressing reset
Total of moment: 88.2
Moment on left side: 58.8
Moment on right side:147.0
Angular acceleration: 0
Angular velocity: 0
2.0 kg.
Error
There is an object on this position before
OK
5.0 kg.
Command Tool
Select Object
Box
Sphere
Mass (kg.)
5
Position (m. from center)
3
Left
Right
Add Object
Simulate
Reset


VPython
Note:
1. Weight of beam is light (assume that m = 0)
2. Mass can't be begative value
3. Position can't more than 3m.
4. Meaning of total of moment: negative value = beam tilt left, positive value = beam tilt right
5. While simulate, a program always calculates, so you can add objects you want without pressing reset
Total of moment: -1470.0
Moment on left side: 2940.0
Moment on right side:1470.0
Angular acceleration: 0
Angular velocity: 0
50.0 kg.
100.0 kg.
Command Tool
Select Object
Box
Sphere
Mass (kg.)
50
Position (m. from center)
3
Left
Right
Add Object
Simulate
Reset

Self- reflection

What did I learn from this project?

There are many things which I got when I do this project. First, moments and torque, it is a concept that can determine whether a beam will tilt on to left or right side, and this can be applied to things which can rotate by having fulcrum. Second, angular motion, angular acceleration and angular velocity, it is a concept that's used to know how things move in rotation. And the last one is some mathematics concept, trigonometry, I apply this concept to restrict how the beam can rotate with no more than some angle which is critical angle.

What did i accomplish? Success/ failure?

The real beam simulation that always calculates inputs which are received user's input which are objects on the beam. There are success and failure in my work.

For success

- My simulation can perform based on physics theories
- My outcome is liked what I thought
- My GUI is good-looking, and I feel pleased on it

For failure

- When users add object which are closed to other, the objects will overlap to each other

What are the challenges and how have you overcome it?

The challenges are to think logics that how the beam can rotate. However, the hardest thing is to make simulation is as real as a simulation can. The way to accomplish it is to find information as much as I can such as in-depth research, ask Physics instructors, and ask friends, and consider the best information of this simulation.

Thoughts, comments, feeling, or anything else i'd like to share

I think it isn't bad for this project, but I don't like that when student send a concept note. They can't change their topics and have to do that. What will happen if they do can't do that? Anyway, I feel pleased ☺

References

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http://formulas.tutorvista.com/physics/moment-formula.html

-For moment of inertia concept

http://america.pink/list-moments-inertia_2694389.html

-For Torque and angular acceleration concept

https://en.wikipedia.org/wiki/Angular_acceleration

-For angular velocity concept

http://www.sparknotes.com/testprep/books/sat2/physics/chapter10section3.rhtml

-For trigonometry concept

http://www.math.com/tables/trig/identities.htm