A Physics   Name_____

Enrichment – Gravitation

Instructions

Gravitation is the study of the forces, fields, energy, etc. that are related to the gravitational attraction between objects. This assignment has 2 options: a construction project and a computer program. You may choose to do one or both.

Project

One of the models we use to describe gravity is the "fabric of space-time". Construct a model that will demonstrate the following:

1. The bending/curvature of space-time around objects of varying mass
2. Circular motion of objects in orbit (you should have at least 1 object in orbit around another object).

Submit the following along with your physical model:

1. A video of objects moving on your "space-time" model. You may choose to record yourself giving the following explanations in your video rather than writing them down.
2. Explanation of gravitational potential and why it is a negative quantity. Explain how this relates to the shape of "space-time".
3. Explanation of how objects gain speed as the approach a "divot" in space-time made by a larger mass. Explain how this relates to gravitational potential.

Record the following data and make the following calculations to analyze your model Include all of the work you do in association with each calculation.

1. Measure and record the mass of two of your objects (the object being orbited and the object in orbit.
2. Make a rough measurement of the speed of an object on your model.
3. Calculate... (show all work for your calculations)
   a. The change in kinetic energy from when the object first started moving.
   b. The change in gravitational energy from when the object first started moving.
   c. The distance the object theoretically travelled.
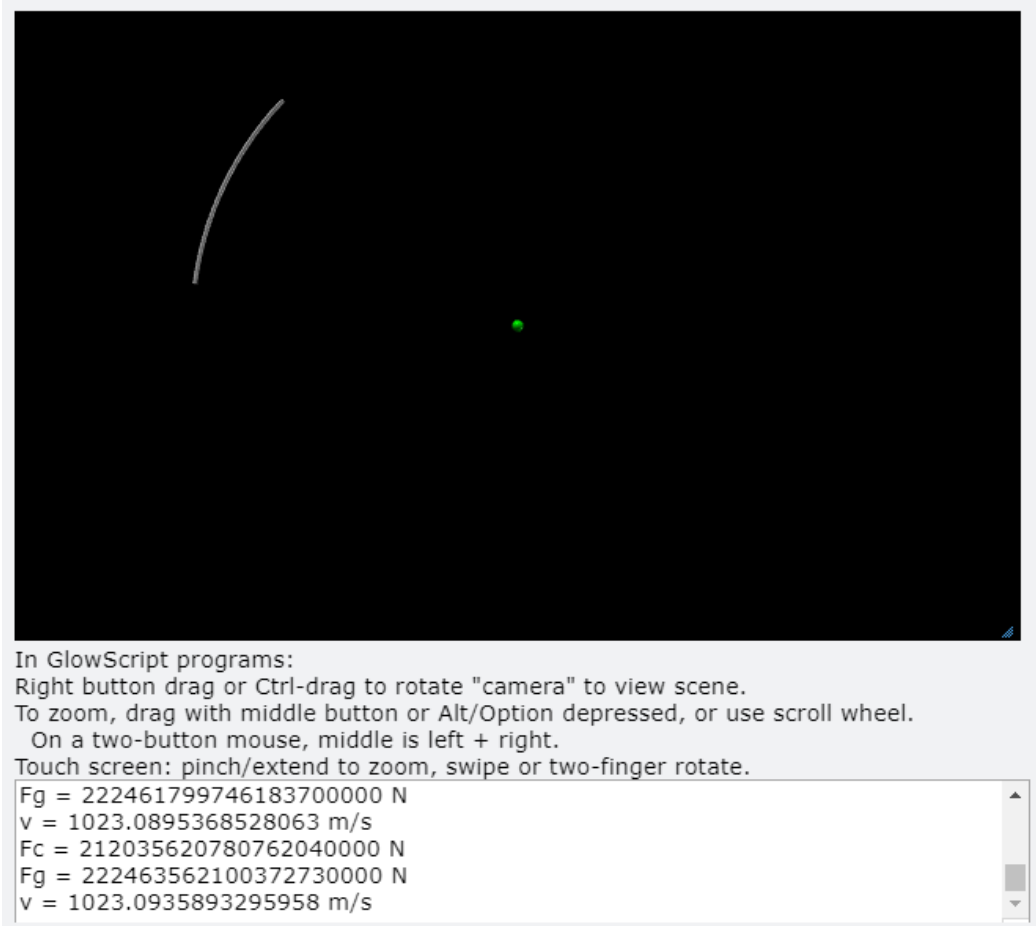   d. The centripetal force the object initially experienced.

VPython

In this activity you will use a computer program to demonstrate and analyze the motion of various scenarios. BEFORE beginning this lesson you need to complete the VPython Directions document (also posted on the weebly. I expect a high comment-to-code ratio in all code submissions.

Go to *__glowscript.org__*, and click on the ***Sign In*** link in the upper right corner.

- Go to: http://www.glowscript.org/#/user/jmckeon/folder/Public/program/GravitationExample
- Click on "Edit this program" at the top left of the screen.

Resource used to create this activity: Computer Science for Teachers conference

- This is a rough outline of a program created to show objects in orbit. Adjust the values so they are the actual values of the Earth and moon.
- Fill in the bottom of the program with two functions for calculating the force (see comments).
- Use one of the force formulas to change the orbiting object's (the Moon's) position. See example programs for ideas.
- At the very bottom of the program I have written code to print out the values for the forces and of the velocity of "thing 2". If you do all the coding correctly, you should end up with something like this:


```
In GlowScript programs:
Right button drag or Ctrl-drag to rotate "camera" to view scene.
To zoom, drag with middle button or Alt/Option depressed, or use scroll wheel.
  On a two-button mouse, middle is left + right.
Touch screen: pinch/extend to zoom, swipe or two-finger rotate.
Fg = 222461799746183700000 N
v = 1023.0895368528063 m/s
Fc = 212035620780762040000 N
Fg = 222463562100372730000 N
v = 1023.0935893295958 m/s
```

The green dot is the "Earth" and the white arc is the "Moon" with its path drawn out behind it. The numbers at the bottom
- Calculations:
  - ***To be finished late***