Gravity Well

P4-1385

INSTRUCTIONAL GUIDE

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Gravity Well:

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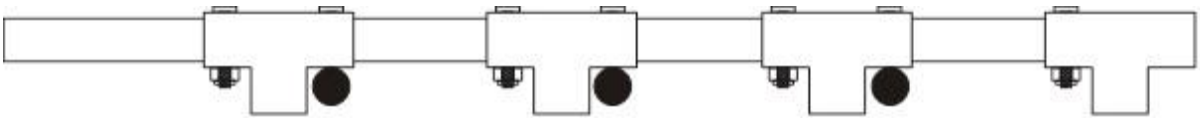
Introduction

This Apparatus provides an interactive and exciting demonstration that allows students to visualize the mechanism by which massive objects are attracted to each other.

Set-Up

1. Assemble the four long black tubes using the bolts and ball knobs provided as shown:



Ensure all bolts are secure and inspect all joints for signs of damage before continuing

2. Bend the assembly into a circle and connect one end to the other using the remaining bolt (Two people are recommended). **Under no circumstances should the frame be left bent without all bolts in place.** The lower structure requires no mechanical fastenings and relies on the friction fit of the tubes in their respective joints.
3. Assemble the 4 shorter black tubes into the 4-way junction and place the flat on the floor with the 90° elbows facing upwards.
4. Use the white tubes to connect the base to the circular frame.

Carefully inspect the joints and tubes for signs of damage before assembling the top tube. If there are any signs of damage do not use. Exercise care when assembling and disassembling the apparatus. The apparatus is intended to support a maximum of 2kg. Do not exceed this limit.

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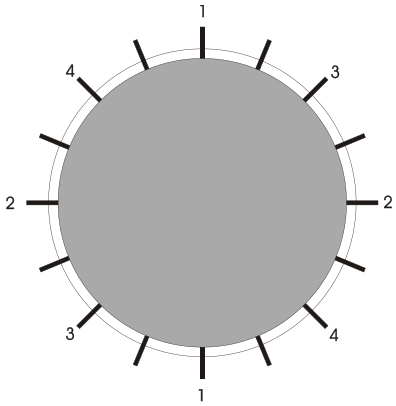
Stretching the Lycra

It is important to create an even tension across the sheet; this is best achieved by methodically working around the whole sheet attaching opposite points in pairs as per the diagram to the right.

Once the first eight clamps are in place the remaining eight should be spaced evenly between them. The sheet should then only require small adjustments to achieve a smooth even stretch across the frame.



Activities

1. Star Formation: Start by rolling two or three small marbles in random directions across the sheet. Notice that the force of attraction between them is small as the distortion that they create in the sheet is small. As more marbles are added to the sheet one or two will touch and create a larger dimple. This will continue until the dimple is large enough to create an appreciable depression and any marbles that are added to the sheet will be attracted immediately to the group.
2. Orbital period: Place the large metal ball in the center of the sheet to represent a star. Roll a marble in such a way that it 'orbits' the star. As the marble begins to get closer to the large metal ball add a second marble. The variation in orbital period with distance should be apparent. Extra marbles may be added as required.
3. Variation of force with mass: If the large metal ball is replaced with a heavier object – maximum 2kg. (Stock masses work well for this) A more massive object creates a larger dimple and therefore other masses are attracted to it with a greater force
4. Earth and moon pair: By selecting two flat masses (roughly 500g) and placing them some distance apart on the sheet. It is possible to model the 'free return' trajectory of a craft that would loop the moon and return to Earth.

Disassembly

- Remove the sheet and fold and lift off the ring to disassemble the lower structure.
- Hold the ring vertically with one side on the ground, hold firmly at a joint and remove a bolt with a ball knob. Pull the joint apart and carefully lower one end to the ground. It can be helpful to stand on the tube and 'walk' it open. **Do not allow the ring to 'spring' apart.**
- Once the tension is removed the remaining ball knobs and bolts may be removed. Leave the nylock nuts and bolts in place.

Resources

Introduction video:
https://youtu.be/mgZ84NAW0zU

Reviewing Newton's Laws Coolstuff Blog:
https://www.arborsci.com/blogs/cool/oct-newton-s-laws-revisited

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