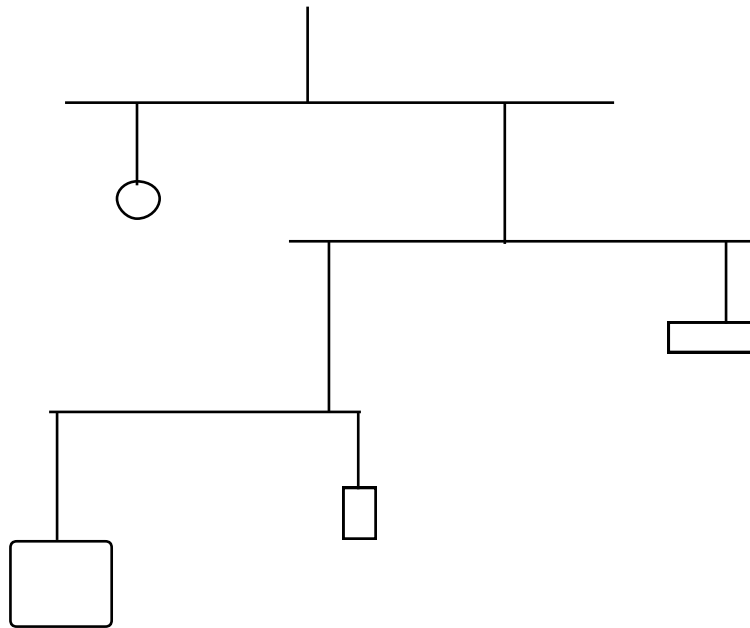Mobile

The GOAL of this project is for you to design and build a balanced hanging mobile using the physical relationships of a system in equilibrium.

You will, individually, build a mobile that will consist of at least 3 levels and at least 3 objects. Only one of the hanging objects may be symmetrical. All others must not have their center of gravity at their center of their geometry. The more interestingly they are hung the better.

Choose objects that are reflective of your humanities theme.

The mobile is due on _____.

When you bring it in, please take a digital picture of it and post it on your web page.

Also due is a paper showing calculations done to determine or to illustrate the BALANCED hanging positions. Do not forget the appropriate mass and torque of the dowels in your calculations. This also need to be posted on your web site and linked to your picture and your Humanities work.

Sample Rubric

Name

Number of levels

Theme

Write up clear in physics and theme

Torque calculations

       Includes mass of objects as weight

       Includes weights of dowels in their calculations

       Uses center of mass of dowels in calculations

       Demonstrates how mass of each section of dowel is calculated

       Includes % error for Conservation of Torque

Center of mass hanging (not all levels hung on center)

Digital picture taken and perfected

Web Presentation

Teacher Notes

Mobiles are a great authentic assessment piece for conservation of torque. Torque is a measure of the tendency of a force to rotate a body a body about some axis. It is the force for rotational motion and in a balanced system it is conserved. That is to say that the torque clockwise must be equal to the torque counterclockwise or the object will spin. In this activity, students create their mobile and calculate the torque of each half of each level and then find percent error. If the dowels mass is significant, compared to the mass of the objects the error is large, I always insist they therefore include it in the calculations. At a lower level of student I would select items much more massive then the dowels and omit this part of the calculations.

To calculate torque of individual items students mass each object. Students then change the mass of their objects to forces by converting to kilograms and multiplying by 9.8 m/s2 (the acceleration due to gravity). Students then multiply this force by the distance the object is from the pivot point.

To calculate the torque of the of the dowel students mass the entire dowel and find its length. Convert the mass in a weight (kg * 9.8 m/s2) to find Newtons per meter. They measure the length of each section of dowel, convert that to a weight and apply it to half the length of that section. It looks something like this;(((mass of dowel / 1000g/kg) * 9.8 m / s2) / total length of dowel) * length of section) you now have the weight of the dowel on a section of the mobile level. If it is on uniform shape we assume its weight to be centered at the middle of that section and therefore multiply by 1 / 2 that section's length to get the torque. There are generally two sections of dowels per level.

Now all the students need to do is find the total torque of each section per level. Generally we start from the bottom up. Conservation states clockwise torque of objects + torque of dowel = counterclockwise torque of objects + torque of dowel.

Sample Diagram
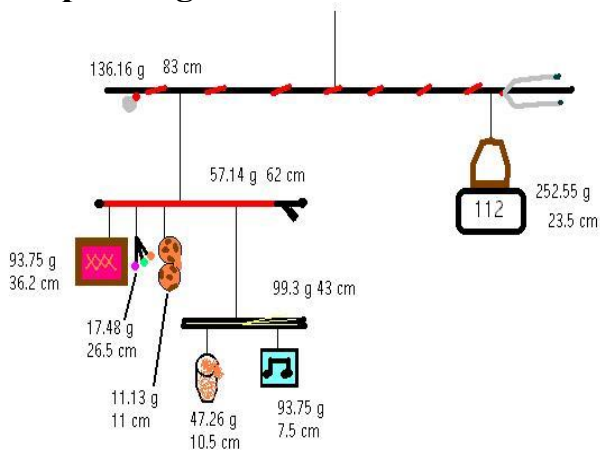
Level One Bottom
Mass of dowel = _____ grams
Length of dowel = _____centimeters
Density of Dowel Grams / Cm of dowel (*9.8N/Kg *1Kg/1000Grams * 1 Meter/ 100Cm)) =
_____N/m
Mass of object 1 = _____grams
Weight of Object 1 (Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg) _____Newtons
Distance of Object 1 in meters _____ meters
Torque of Object 1((Weight of Object * distance) +((Length of arm * Density of dowel)*1/2 length))
_____N*m
Mass of object 2 = _____grams
Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg _____Newtons
Weight of Object 2 (Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg) _____Newtons
Distance of Object 2 in meters _____ meters
Torque of Object 2((Weight of Object * distance) +((Length of arm * Density of dowel)*1/2 length))
_____N*m

Level 2

Density of Dowel Grams / Cm of dowel (*9.8N/Kg *1Kg/1000Grams * 1 Meter/ 100Cm)) =
_____N/m
Mass of object 3 = _____grams
Weight of Object 3 (Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg) _____Newtons
Distance of Object 3 in meters _____ meters
Torque of Object 3((Weight of Object * distance) +((Length of arm * Density of dowel)*1/2 length))
_____N*m
Mass of object 4 = _____grams
Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg _____Newtons
Weight of Object 4 (Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg) _____Newtons
Distance of Object 4 in meters _____ meters
Torque of Object 4 ((Weight of Object * distance) +((Length of arm * Density of dowel)*1/2 length))
_____N*m

Level 3 TOP

Density of Dowel Grams / Cm of dowel (*9.8N/Kg *1Kg/1000Grams * 1 Meter/ 100Cm)) =
_____N/m
Mass of object 5 = _____grams
Weight of Object 5 (Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg) _____Newtons
Distance of Object 5 in meters _____ meters
Torque of Object 5((Weight of Object * distance) +((Length of arm * Density of dowel)*1/2 length))
_____N*m
Mass of object 6 = _____grams
Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg _____Newtons
Weight of Object 6 (Mass of object * 1 Kg / 1000 grams * 9.8 N/Kg) _____Newtons
Distance of Object 6 in meters _____ meters
Torque of Object 6((Weight of Object * distance) +((Length of arm * Density of dowel)*1/2 length))
_____N*m

Sample Data Chart

	Weight (N)	Distance (M)	Torque (N*M)	Total	% error
Object 1					
Dowel 1				cw	
Object 2					
Dowel 2				ccw	
Object 3					
Dowel 3				cw	
Object 4					
Dowel 4				ccw	
Object 5					
Dowel 5				cw	
Object 6					
Dowel 6				ccw	