GRACE Education Curriculum Satellites	
Teachers	Grades 6-8
Science	

Center of Mass

Background: GRACE is the name of a pair of satellites that will measure the gravity field of Earth. GRACE stands for Gravity Recovery and Climate Experiment. GRACE will help study problems in geophysics, oceanography and atmospheric science.

Finding the center of mass is important for the GRACE satellites. One of the instruments on the GRACE satellites will be an accelerometer. An accelerometer is an instrument that measures the acceleration of the satellite in order to keep the satellites in alignment with each other, so there is no atmospheric effect for drag. If the accelerometer were located elsewhere, the two satellites would not stay in their set positions. For the accelerometer to measure only the non-gravitational forces, it is important that the spacecraft center of mass be placed at the center of mass of the accelerometer.

Objectives: To determine an individual's center of mass.

Standards: Science: unifying concepts and processes; science as inquiry; science and technology

Vocabulary: Accelerometer drag center of mass inertia

Materials:

Cloth	Eraser
Chalkboard	Scissors
Pencil	Cardboard

Directions to the Teacher:

Provide information to the students about the GRACE mission. Explain that mass is the property of a body that is a measure of its inertia and that is commonly taken as a measure of the amount of material it contains and causes it to have weight in a gravitational field. Each student will find their center of mass by conducting the following experiment:

1. Stand with the left side of your body against a wall, making sure your left foot is completely against the wall. Lift your right foot. Record your observations.
2. Stand with your back against the wall, making sure your heels are also touching the wall. Drop a cloth on the floor, just in front of your toes. Pick up the cloth without bending your knees or moving your feet. Record what happens.
3. On the floor, get down on your elbows and knees. Place your elbows directly in front of your knees. At the tip of your middle fingers, place a chalkboard eraser on its edge. With your hands behind your back, lean forward and knock the block over with your nose. Record your observations.
4. Try step three again, but this time with someone holding down your ankles. Record your observations.
5. Sit with your back flat against a chair. Fold your arms in front of you. Stand up without leaning forward. Record your observations.

After the students conduct this experiment, distribute copies of the GRACE satellite scale drawing copied on cover stock paper. Have the students cut out the satellite. Using the eraser tip of a pencil, find the center of mass for the GRACE satellite.

Extensions:

- Complete the "Build it and they will come experiment at: http://www.explorescience.com/activities/Activity_page.cfm?ActivityID=33
- Using a see saw on the play ground, balance several items at different locations to find the center of mass.

References / Resources:

http://www.explorescience.com/activities/activity_list.cfm?categoryID=10
http://www.shu.ac.uk/schools/sci/sol/contents.htm
http://www.csr.utexas.edu/grace

Observations:

- Lifting Right Foot: _____
  _____
- Picking Up Cloth: _____
  _____
- Knocking Over Eraser with Nose: _____
  _____
- Holding Ankles Down: _____
  _____
- Getting Up Out of a Chair: _____
  _____

Conclusions: Answer below using *complete sentences*!

1. Where do you think your center of mass is located while you are standing? *Why?*

2. Where do you think your center of mass is while you are sitting? *Why?*

3. Why is it important for the center of mass of a car or truck to be in a proper position?

4. A scale drawing of a GRACE satellite follows. Trace the shape onto a piece of cardboard and cut it out. Find the center of mass of the model by balancing it on the eraser end of your pencil. Then, place an X on the center of mass in the drawing below.

5. How would your center of mass be affected on planets with different gravitational pulls? Example: Mars, Jupiter, etc.

GRACE Scale Drawing