



GRACE Education Curriculum Intro - Bingo	
Teachers	Grades 3-8
<b>Science</b>	

## Grace Bingo

**Background Information:** Gravity! What is it? You can't see it. You can't smell it. You can't touch it! But it's there. In fact, it's everywhere. Gravity controls everything from the motion of the ocean tides to the expansion of the entire universe. To learn more about the mysteries of gravity, twin satellites named GRACE – short for Gravity Recovery and Climate Experiment – are being launched to make detailed measurements of Earth's gravity field. This experiment could lead to discoveries about gravity and Earth's natural systems, which could have far-reaching benefits to society and the world's population. More specifically, it is expected that quite a number of disciplines that study aspects of the Earth's changing climate will gain substantial benefits from data retrieved by GRACE.

- Objectives:** At the end of the lesson, students will be able to:
- Recognize key features of the GRACE satellite.
  - Understand the purpose of the GRACE mission.
  - Accurately answer questions about the Gravity Recovery and Climate Experiment.

**Standards:** Science: unifying concepts and processes; earth and space science; science and technology; physical science  
 Geography: the world in spatial terms

**Vocabulary:** gravity                                      ocean surface currents      ocean heat transport  
 sea-floor    gravity field                      solar maximum

- Materials:** Information about the Gravity Recovery and Climate Experiment: GRACE lithograph, GRACE Fact Sheet, GRACE brochure, or the official GRACE web site: <http://www.csr.utexas.edu/grace> and links.
- GRACE Bingo Cards
  - GRACE words
  - Transparency
  - Overhead Projector
  - Squares of paper cut to use as covers for Bingo
  - Bingo prizes (optional)



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### Directions to the Teacher:

Introduce the Gravity Recovery and Climate Experiment (GRACE) to the students. If available, show the video "Weighing Earth and Its Oceans". Have students conduct research about the mission to answer the questions on the attached sheet. Review the answers to the questions for accuracy and correctness. Upon completion, have students play GRACE Bingo to reinforce the answers to the questions about the mission.

1. Distribute blank GRACE Bingo cards to each individual.
2. Make the GRACE Word list into an Overhead transparency.
3. Have students select words from the GRACE word list to fill in their GRACE Bingo squares.
4. When everyone is through, you are ready to play GRACE Bingo.
5. Announce the type of Bingo game you will play – across, down, "X", or complete cover up.
6. Read a question from the GRACE question list. Ask the class to provide the correct answer. When the correct answer is given, if a student has that answer on their Bingo card, they may cover the answer.
7. Continue until someone shouts, "Bingo".
8. If you have decided to award prizes for the winner, distribute now. Remember prizes may be an edible treat or it may be: drop your lowest grade, etc. Be creative!

### References / Resources:

The following materials are available from the GRACE web site:

<http://www.csr.utexas.edu/grace>

GRACE Facts Sheet

GRACE news articles

Videos

GRACE Brochure

GRACE Lithograph

Animations



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## GRACE Questions

GRACE uses how many satellites? \_\_\_\_\_

How many years will the GRACE mission last? \_\_\_\_\_

What will GRACE provide? \_\_\_\_\_

What "connects" the satellites? \_\_\_\_\_

What does GRACE mean? \_\_\_\_\_

What is the invisible force that pulls two masses together? \_\_\_\_\_

The branch of science dealing with obtaining precise measurements of the Earth, mapping points on the surface, and studying its gravitational field, is known as: \_\_\_\_\_

The distribution of mass over the Earth is: uniform or non-uniform? \_\_\_\_\_

GRACE will make measurements so precise, it is smaller than what? \_\_\_\_\_

GRACE will launch from \_\_\_\_\_

GRACE is a joint partnership between which two space agencies? \_\_\_\_\_

The principal investigator is from where? \_\_\_\_\_

True or False - The variations in the gravity field cause the range between the GRACE satellites to vary? \_\_\_\_\_

GRACE will launch into what type of orbit? \_\_\_\_\_

The GRACE satellites will launch on what vehicle? \_\_\_\_\_

To get the satellites into the same nominal orbit, a re-ignitable third stage was added to the rocket. What is it called? \_\_\_\_\_

The GRACE satellites will travel approximately how far apart? \_\_\_\_\_

The GRACE satellites launched on what date? \_\_\_\_\_

GRACE will help to unravel global climatic issues by enabling a better understanding of ocean \_\_\_\_\_ & \_\_\_\_\_

GRACE is expected to track the movement and changes in ice sheets and changes in what? \_\_\_\_\_

Can GRACE study deep ocean currents? \_\_\_\_\_

GRACE will track changes in the structure of the solid \_\_\_\_\_

The GRACE satellites were built in \_\_\_\_\_

The GRACE satellites will travel how high above the earth? \_\_\_\_\_

What two instruments allow GRACE to map the Earth's gravity field by taking accurate measurements between the two satellites? \_\_\_\_\_ & \_\_\_\_\_

Another name for the Earth's gravity field is \_\_\_\_\_

GRACE is the inaugural flight of NASA's \_\_\_\_\_

The GRACE project is divided into \_\_\_\_\_ systems.



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## GRACE Answers

2

5

new map of Earth's gravity field

K-band microwave link

Gravity Recovery and Climate Experiment

Gravity

Geodesy

Non-uniform

Width of a human hair

Plesetsk, Russia

German Space Agency, DLR and U.S. Space Agency, NASA

The University of Texas CSR

True

Polar

Rocket

Breeze

170 - 270 km apart

March 16, 2002

surface currents and heat transport

global sea level rise

yes - GRACE can study ocean currents near the surface and far beneath the waves

Earth

Germany

300 to 500 km

GPS and Microwave Ranging System

Geoid

Earth System Science Pathfinder Program (ESSP)

Five - Satellite, Science Instrument, Launch Vehicle, Mission Operations, Science Data.



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## GRACE Questions/Answers

GRACE uses how many satellites? 2

How many years will the GRACE mission last? 5

What will GRACE provide? new map of Earth's gravity field

What "connects" the satellites? K-band microwave link

What does GRACE mean? Gravity Recovery and Climate Experiment

What is the invisible force that pulls two masses together? gravity

The branch of science dealing with obtaining precise measurements of the Earth, mapping points on the surface, and studying its gravitational field, is known as: geodesy

The distribution of mass over the Earth is: uniform or non-uniform? non-uniform

GRACE will make measurements so precise, it is smaller than what? human hair width

GRACE will launch from Plesetsk, Russia

GRACE is a joint partnership between which two space agencies? U.S. and Germany

The principal investigator is from where? University of Texas CSR

True or False - The variations in the gravity field cause the range between the GRACE satellites to vary? True

GRACE will launch into what type of orbit? Polar

The GRACE satellites will launch on what vehicle? Rocket

To get the satellites into the same nominal orbit, a re-ignitable third stage was added to the rocket. What is it called? Breeze

The GRACE satellites will travel approximately how far apart? 170 - 270 km apart

The GRACE satellites launched on what date? March 16, 2002

GRACE will help to unravel global climatic issues by enabling a better understanding of ocean surface currents and heat transport

GRACE is expected to track the movement and changes in ice sheets and changes in what? global sea level rise

Can GRACE study deep ocean currents? Yes

GRACE will track changes in the structure of the solid Earth

The GRACE satellites were built in Germany

The GRACE satellites will travel how high above the earth? 300 to 500 km

What two instruments allow GRACE to map the Earth's gravity field by taking accurate measurements between the two satellites? GPS and Microwave Ranging System

Another name for the Earth's gravity field is geoid

GRACE is the inaugural flight of NASA's Earth System Science Pathfinder Program

The GRACE project is divided into five systems.



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