GRACE Education Curriculum Satellites	
Teachers	Grades 6-8
Math	

GRACE by the Numbers

Background Information: The Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system between two spacecraft to measure the Earth's gravity field and its time variability over five years. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to earth's poles. GRACE will provide a framework for studying the gravitational signatures of gigantic continent-sized underground water reservoirs, or aquifers. It also will provide a never-before-available perspective on global ocean circulation and the time variability of Earth's overall external shape, or geoid. This fundamental dataset could enable great improvements in existing ocean radar altimetry datasets, and retrospective improvements of seasonal to inter-annual climate change estimates.

Objectives: At the end of the lesson, the students will be able to:

- Increase their knowledge about the GRACE satellite.
- Improve number and operation skills.
- Enhance ability to work individually or cooperatively to complete the number puzzle using the given clues.

Standards: Math: numbers and operations; algebra; connections
Science: physical science

Vocabulary: geoid dataset microwave tracking system

Materials: Number puzzle Clues

Directions to the Teachers:

After providing background information about the GRACE mission to the students, copy and distribute the handout "GRACE by the Numbers". Either have the students work individually or in cooperative groups. Using their mathematical abilities, students will complete the number problems relating to the GRACE satellite. Place the answers in their correct location on the number grid.

Extensions:

Develop a new puzzle. One copy should be blank and one copy should have the answers included. After review, the teacher will distribute puzzles for student completion in class. An example of a web site to use as a resource is: http://www.puzzlemaker.com/

Complete the mathematics crossword at: http://www.surfnetkids.com/games/math-cw.htm

References / Resources:

To learn more about the mission, visit: http://www.csr.utexas.edu/grace

http://www1.tpgi.com.au/users/puzzles/page2.html

http://www.rhlschool.com/math5n32.htm

http://www.mathgoodies.com/puzzles/

GRACE by the Numbers Puzzle

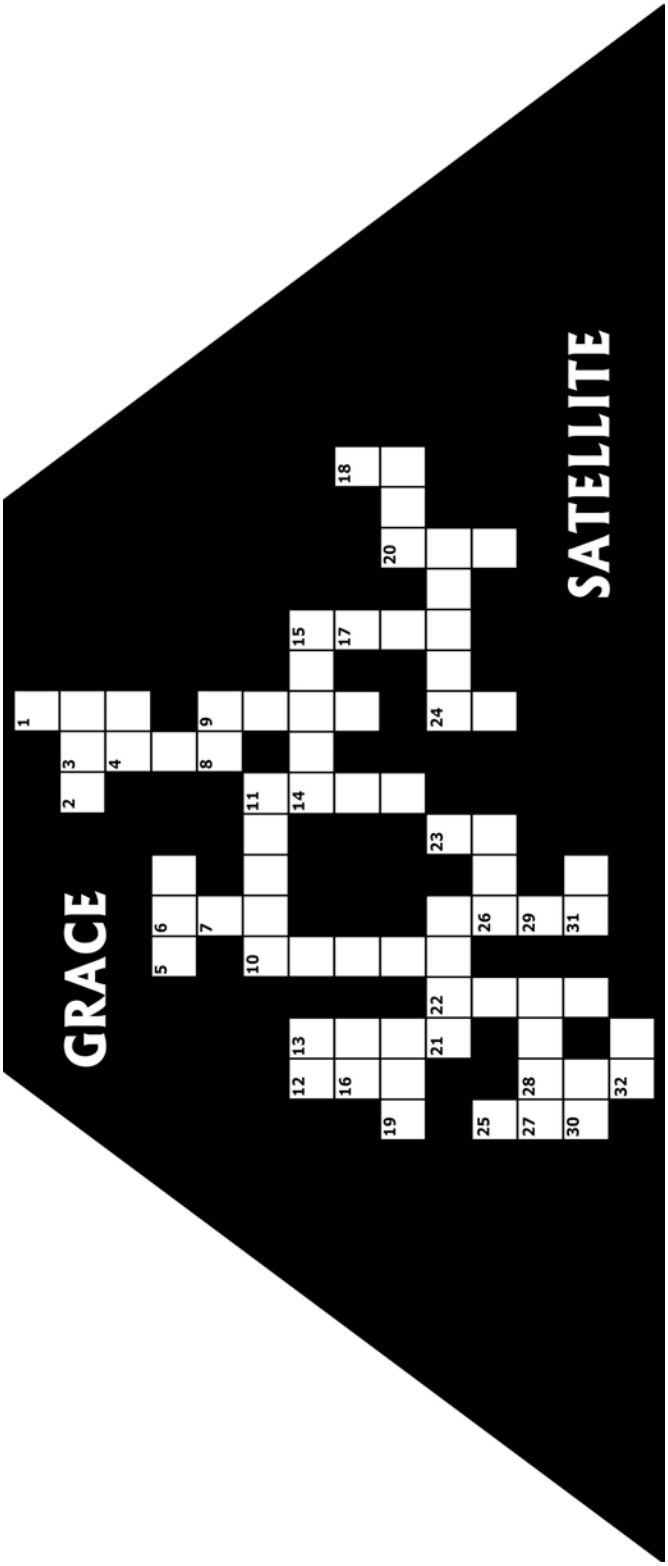
Down:

1	When you find this number, you have the width in millimeters between GRACE's umbilical connections. Evaluate $2^3*3*5*7$.
3	Subtract four and one tenth from one thousand and you'll discover the width (in millimeters) of a large solar panel on GRACE.
6	This simplified ratio for 2 in 250 is the failure rate for the booster rocket GRACE will fly on. So it's 1 to what?
9	In millimeters, find the length distance between GRACE's launchers. The prime factorization of the number is: 2^4*5*23.
10	GRACE makes this many observations every day. Use scientific notation to find it: 3×10^4
11	From this fuel tank's center point to center point, this measure in mm is: 1140.4 rounded to the nearest 10°.
12	Solve for x: 5x=750. Then multiply x by 1/100 That is the number of hours for GRACE to orbit the earth to the nearest hundredth.
13	Launch year is ___?___. In mathematical terms, that's $(2x10^3) + (0x10^2) + (0x10^1) + 1x10^0$).
15	The height of the trapezoidal shape of GRACE is seven hundred seventy-five and six tenths millimeters. Write this number in standard form.
18	Write 0.15 as a percent. That's the degrees per hour GRACE shifts its orbit.
20	See 26 across (free answer).
22	If you add 113 yards and 17 inches, you have _____ inches. But wait! Change the label. That's GRACE's insertion into orbit in seconds.
23	1-1/2 hours written in minutes is an equivalent number to 4 across.
24	What's the number that tells how many days GRACE will take to "map" Earth's gravity without starting over? This is also the number of days in June.
25	Subtract 240 from 1,000. This number (in mm) is the width distance between launchers.
28	_____ + 12.7°F is normal body temperature. The GRACE mission costs this in millions. Do you need another hint? Launch year minus 1915.1.

Across:

1	Three times two hundred plus one hundred minus six. This is the length (in meters) of one base of the trapezoid of the GRACE satellite.
3	This number is an equivalent decimal for 9. It's how many minutes it takes GRACE to download data.
4	If you find the width of GRACE's battery case, it's found by calculating the days in two non-leap years minus the days in two weeks minus one day, all less than one hundred.
7	15 x □ = 30. This number represents the number of GRACE Satellites.
8	From the center of the GRACE satellite, the outside thruster is angled this many degrees. What is one tenth more than 4 across?
10	Round 359.5096 to the nearest hundredth. This is the distance in millimeters from the USO component to the satellite.
12	Information is downloaded every XII hours from GRACE to the ground.
14	If you multiply, 19, 437 x 1/10, you discover the second base length in mm of GRACE's trapezoid shape.
16	This many megabytes of information is downloaded from GRACE each day. Find 50% of 100.
17	How many kilometers per second does GRACE travel? Find the fourth prime number.
18	If you find $3{,}457{,}285^0$, you have how many degrees GRACE is from the poles.
19	GRACE weighs this number of kilograms: 20^2.
20	If you find 15 ∗ 1 1/2, you'll know how many degrees each orbit of GRACE differs.
21	Evaluate $10^2(7 + 7)$. It's this many seconds for an air jet's burn.
24	End to end, GRACE measures .00031647 x 10^7 millimeters.
26	This is the maximum distance in km the GRACE satellites are apart. Find $2*3^3*5$.
27	The next even number after six thousand eight hundred seventy-six gives you the radius from GRACE to the center of the Earth.
28	GRACE has large solar panels. Figure out $1^{100} + 1^3 + 1^0$. That's how many.
29	The square root of 25 will tell you the life expectancy of GRACE. (Hint: its palindrome is 50.)
30	The accuracy of GRACE's measurement is this _____in micrometers. What counting number is neither prime nor composite? Follow this pattern: _____, 02, 03.
31	This constant is the acceleration of gravity in meters per second squared.. Multiply 1/10 by 98 to find the number.

GRACE BY THE NUMBERS
GRACE SATELLITE NUMBER PUZZLE



GRACE BY THE NUMBERS
ANSWER KEY