
Directions to Teacher:

1. Introduce the class to GRACE using posters and the GRACE web site:
<http://www.csr.utexas.edu/grace/>
2. Explain to the students that messages are often put in code for secrecy and security. To decode is to take the coded message and figure it out or decipher it.
3. Distribute the Satellite Subtraction Worksheets.
4. Each student will work independently to solve the subtraction problems.
5. Upon completion of the subtraction problems the students will fill in the blanks with the letters that match the numerical answers on the GRACE Decoded Message.
6. Solve the GRACE message.

Extensions:

Students will write a different message about the GRACE satellites.

Students will exchange their messages and have another student solve the new message.

Students will develop a Satellite multiplication table and match it with coded letters.

References / Resources:

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

<http://essp.gsfc.nasa.gov/grace/>

http://op.gfz-potsdam.de/grace/index_GRACE.html

Satellite Subtraction

Directions: Solve the math problems below. Place the correct letter that corresponds with the math answer on the correct lines of the Decoding GRACE sheet to reveal a message about the GRACE mission.

$\begin{array}{r} 18 \\ -10 \\ \hline \end{array}$	$\begin{array}{r} 25 \\ -15 \\ \hline \end{array}$	$\begin{array}{r} 16 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 63 \\ -19 \\ \hline \end{array}$	$\begin{array}{r} 27 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 59 \\ -19 \\ \hline \end{array}$
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A B C D E F

$\begin{array}{r} 51 \\ -19 \\ \hline \end{array}$	$\begin{array}{r} 31 \\ -19 \\ \hline \end{array}$	$\begin{array}{r} 41 \\ -28 \\ \hline \end{array}$	$\begin{array}{r} 21 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 36 \\ -18 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -3 \\ \hline \end{array}$
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G H I J K L

$\begin{array}{r} 20 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 33 \\ -17 \\ \hline \end{array}$	$\begin{array}{r} 68 \\ -29 \\ \hline \end{array}$	$\begin{array}{r} 77 \\ -43 \\ \hline \end{array}$	$\begin{array}{r} 83 \\ -48 \\ \hline \end{array}$	$\begin{array}{r} 91 \\ -26 \\ \hline \end{array}$
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M N O P Q R

$\begin{array}{r} 63 \\ -15 \\ \hline \end{array}$	$\begin{array}{r} 91 \\ -33 \\ \hline \end{array}$	$\begin{array}{r} 58 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 90 \\ -21 \\ \hline \end{array}$	$\begin{array}{r} 102 \\ -34 \\ \hline \end{array}$	$\begin{array}{r} 108 \\ -23 \\ \hline \end{array}$
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S T U V W X

$\begin{array}{r} 116 \\ -35 \\ \hline \end{array}$	$\begin{array}{r} 140 \\ -35 \\ \hline \end{array}$
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Y Z

Use the answers and corresponding letter to fill in the blanks on the next page.

Reveal the Hidden GRACE Message

32	65	8	9	20		13	48		58	68	39	
48	8	58	20	2	2	13	58	20	48			
2	39	9	8	58	20	44		10	81			
32	34	48		8	16	44						
9	39	11	11	49	16	13	9	8	58	13	16	32
68	13	58	12		8							
11	13	9	65	39	68	8	69	20				
65	8	16	32	13	16	32						
48	81	48	58	20	11		13	58				
68	13	2	2		11	20	8	48	49	65	20	
69	8	65	13	8	58	13	39	16	48		13	16
58	12	20		32	65	8	69	13	58	81		
40	13	20	2	44		10	81		58	12	20	
65	8	16	32	20		10	20	58	68	20	20	16
58	12	20		58	68	39						
48	8	58	20	2	2	13	58	20	48			

Reveal the Hidden GRACE Message

Answer Sheet

<u>G</u>	<u>R</u>	<u>A</u>	<u>C</u>	<u>E</u>		<u>I</u>	<u>S</u>		<u>T</u>	<u>W</u>	<u>O</u>	
32	65	8	9	20		13	48		58	68	39	
<u>S</u>	<u>A</u>	<u>T</u>	<u>E</u>	<u>L</u>	<u>L</u>	<u>I</u>	<u>T</u>	<u>E</u>	<u>S</u>			
48	8	58	20	2	2	13	58	20	48			
<u>L</u>	<u>O</u>	<u>C</u>	<u>A</u>	<u>T</u>	<u>E</u>	<u>D</u>		<u>B</u>	<u>Y</u>			
2	39	9	8	58	20	44		10	81			
<u>G</u>	<u>P</u>	<u>S</u>		<u>A</u>	<u>N</u>	<u>D</u>						
32	34	48		8	16	44						
<u>C</u>	<u>O</u>	<u>M</u>	<u>M</u>	<u>U</u>	<u>N</u>	<u>I</u>	<u>C</u>	<u>A</u>	<u>T</u>	<u>I</u>	<u>N</u>	<u>G</u>
9	39	11	11	49	16	13	9	8	58	13	16	32
<u>W</u>	<u>I</u>	<u>T</u>	<u>H</u>		<u>A</u>							
68	13	58	12		8							
<u>M</u>	<u>I</u>	<u>C</u>	<u>R</u>	<u>O</u>	<u>W</u>	<u>A</u>	<u>V</u>	<u>E</u>				
11	13	9	65	39	68	8	69	20				
<u>R</u>	<u>A</u>	<u>N</u>	<u>G</u>	<u>I</u>	<u>N</u>	<u>G</u>						
65	8	16	32	13	16	32						
<u>S</u>	<u>Y</u>	<u>S</u>	<u>T</u>	<u>E</u>	<u>M</u>		<u>I</u>	<u>T</u>				
48	81	48	58	20	11		13	58				
<u>W</u>	<u>I</u>	<u>L</u>	<u>L</u>		<u>M</u>	<u>E</u>	<u>A</u>	<u>S</u>	<u>U</u>	<u>R</u>	<u>E</u>	
68	13	2	2		11	20	8	48	49	65	20	
<u>V</u>	<u>A</u>	<u>R</u>	<u>I</u>	<u>A</u>	<u>T</u>	<u>I</u>	<u>O</u>	<u>N</u>	<u>S</u>		<u>I</u>	<u>N</u>
69	8	65	13	8	58	13	39	16	48		13	16
<u>T</u>	<u>H</u>	<u>E</u>		<u>G</u>	<u>R</u>	<u>A</u>	<u>V</u>	<u>I</u>	<u>T</u>	<u>Y</u>		
58	12	20		32	65	8	69	13	58	81		
<u>F</u>	<u>I</u>	<u>E</u>	<u>L</u>	<u>D</u>		<u>B</u>	<u>Y</u>		<u>T</u>	<u>H</u>	<u>E</u>	
40	13	20	2	44		10	81		58	12	20	
<u>R</u>	<u>A</u>	<u>N</u>	<u>G</u>	<u>E</u>		<u>B</u>	<u>E</u>	<u>T</u>	<u>W</u>	<u>E</u>	<u>E</u>	<u>N</u>
65	8	16	32	20		10	20	58	68	20	20	16
<u>T</u>	<u>H</u>	<u>E</u>		<u>T</u>	<u>W</u>	<u>O</u>						
58	12	20		58	68	39						
<u>S</u>	<u>A</u>	<u>T</u>	<u>E</u>	<u>L</u>	<u>L</u>	<u>I</u>	<u>T</u>	<u>E</u>	<u>S</u>			
48	8	58	20	2	2	13	58	20	48			

Satellite Subtraction

Answer Sheet

Directions: Solve the math problems below. Place the correct letter that corresponds with the math answer on the correct lines of the Decoding GRACE sheet to reveal a message about the GRACE mission.

$\begin{array}{r} 18 \\ -10 \\ \hline 8 \end{array}$	$\begin{array}{r} 25 \\ -15 \\ \hline 10 \end{array}$	$\begin{array}{r} 16 \\ -7 \\ \hline 9 \end{array}$	$\begin{array}{r} 63 \\ -19 \\ \hline 44 \end{array}$	$\begin{array}{r} 27 \\ -7 \\ \hline 20 \end{array}$	$\begin{array}{r} 59 \\ -19 \\ \hline 40 \end{array}$
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A B C D E F

$\begin{array}{r} 51 \\ -19 \\ \hline 32 \end{array}$	$\begin{array}{r} 31 \\ -19 \\ \hline 12 \end{array}$	$\begin{array}{r} 41 \\ -28 \\ \hline 13 \end{array}$	$\begin{array}{r} 21 \\ -6 \\ \hline 15 \end{array}$	$\begin{array}{r} 36 \\ -18 \\ \hline 18 \end{array}$	$\begin{array}{r} 5 \\ -3 \\ \hline 2 \end{array}$
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G H I J K L

$\begin{array}{r} 20 \\ -9 \\ \hline 11 \end{array}$	$\begin{array}{r} 33 \\ -17 \\ \hline 16 \end{array}$	$\begin{array}{r} 68 \\ -29 \\ \hline 39 \end{array}$	$\begin{array}{r} 77 \\ -43 \\ \hline 34 \end{array}$	$\begin{array}{r} 83 \\ -48 \\ \hline 35 \end{array}$	$\begin{array}{r} 91 \\ -26 \\ \hline 65 \end{array}$
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M N O P Q R

$\begin{array}{r} 63 \\ -15 \\ \hline 48 \end{array}$	$\begin{array}{r} 91 \\ -33 \\ \hline 58 \end{array}$	$\begin{array}{r} 58 \\ -9 \\ \hline 49 \end{array}$	$\begin{array}{r} 90 \\ -21 \\ \hline 69 \end{array}$	$\begin{array}{r} 102 \\ -34 \\ \hline 68 \end{array}$	$\begin{array}{r} 108 \\ -23 \\ \hline 85 \end{array}$
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S T U V W X

$\begin{array}{r} 116 \\ -35 \\ \hline 81 \end{array}$	$\begin{array}{r} 140 \\ -35 \\ \hline 105 \end{array}$
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Y Z

Use the answers and corresponding letter to fill in the blanks on the next page.
