

Objectives

- Students will discover how to encrypt and decrypt a message.
- Students will learn what a Caesar cipher is and use it to solve a riddle.
- Students will find equations of lines given two points on the line.
- Students will solve systems of linear equations to find vertices of triangles.
- Students will find equations of lines perpendicular to given lines through a given point.

Vocabulary


- Ordered pair
- Vertex of a triangle
- Equation of a line
- Perpendicular

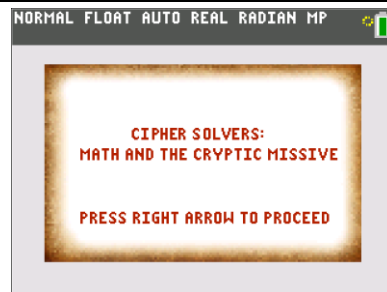
About the Lesson

- In this activity, students will be shown what a basic cipher is and how to use it to solve a riddle.
- Students need to be able to write equations of lines given two points on the line.
- Students need to be able to solve a system of two linear equations.
- Students need to know the relationship between the slope of a line and the slope of any line perpendicular to it.
- Students will be finding the equation of the perpendicular bisector of a side of a triangle, but will be given the coordinates of the midpoints, since that concept is not in an Algebra 1 curriculum.
- Students are expected to work in groups of size 3 or 4. The directions will often have students only find one equation instead of three, asking that each student in the group do a different equation.

Activity Materials

- Compatible TI Technologies:

 TI-84 Plus CE *with the latest operating system.*



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Lesson Files:

- Image0.8ca
- Image9.8ca
- Image8.8ca
- Image7.8ca
- Image6.8ca
- CipherSolver.8xp

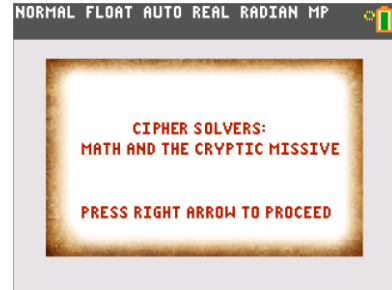
Tech Tip: Make sure when sending the program file CipherSolver.8xp to your TI-84 Plus CE calculators that the program, and image0, image9, image8, image7, and image6 are also sent.



Math and the Cryptic Missive

Integration of Algebra, Geometry and Cryptology

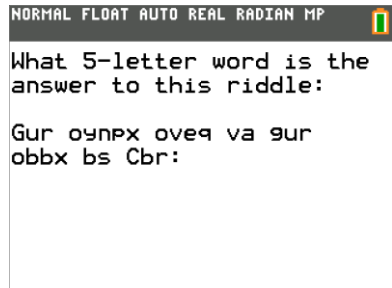
1. Run (execute) the program "CIPHER".
2. Read the opening screen. Press \blacktriangleright to proceed to the next screen.
3. In the "CipherSolvers" menu, press $\boxed{1}$ or $\boxed{\text{enter}}$ to proceed to "Day 1: Strange Message".
4. Read the next six pages, make notes as needed. Press \blacktriangleright to proceed to the next screen and press \blacktriangleleft to go back a screen.



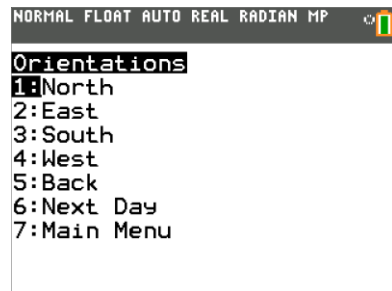
5. Use a Caesar shift of 13 letters to decrypt this message,
Gur oynpx oveq va gur obbx bs Cbr
 then type the 5-letter word that answers this riddle. Press $\boxed{\text{enter}}$.
 (Hint: Make sure your calculator is in alpha mode to type)

Answer: RAVEN

A	B	C	D	E	F	G	H	I	J	K	L	M
N	O	P	Q	R	S	T	U	V	W	X	Y	Z



6. Read the next four pages, make notes as needed.
7. At the "Orientations" menu, the options are based upon the clues that you read. Each option shows one orientation of the template and the four numbers it highlights. Choose three orientations based on the clues you read and write them below.



- a. Write the letter and the number assigned to it for the first orientation. Then press \blacktriangleright to proceed.

North

 A 4 **T** 10 **M** 2 **H** 20

- b. Write the letter and the number assigned to it for the second orientation. Then press \blacktriangleright to proceed.

East

 T 26 **M** 16 **H** 3 **A** 18

- c. Write the letter and the number assigned to it for the third orientation. Then press \blacktriangleright to proceed.

West

 A 6 **H** 9 **M** 10 **T** 1



8. Once you have done three different directions, select “6: Next Day”. Read the next four pages and make notes as needed.
- What word can be formed using the letters **A T M H** ?
Answer: MATH
 - In the correct order, the letters of the word correspond to $x_1, y_1, x_2,$ and $y_2,$ respectively. Using the answers found in part 7a, write the two ordered pairs below:
Answer: (2, 4); (10, 20)
 - Using the answers found in part 7b, write the two ordered pairs below:
Answer: (16, 18); (26, 3)
 - Using the answers found in part 7c, write the two ordered pairs below:
Answer: (10, 6); (1, 9)
 - Plot the three pairs of points on the CipherSolver_Graph_Paper supplied by your teacher.
Answer: See graph key at the end of the document.

9. Determine the equation of the line for each set of points.
(Note: Each person in your group should work on one equation, but a different equation, using the ordered pairs listed in 8b, 8c, or 8d.) Show your work below.

Answer: Student solutions will be for one of each of the three pairs. An example is shown below.

(2, 4); (10, 20)

$$m = \frac{20 - 4}{10 - 2} \qquad y = mx + b$$

$$m = \frac{16}{8} \qquad 20 = 2(10) + b$$

$$m = 2 \qquad 0 = b \qquad y = 2x$$



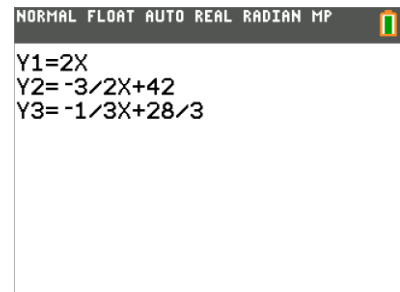
10. Write the three equations found by the members of your group below. You will be prompted to enter these into the calculator.

Answer:

$$Y1 = 2x ; Y2 = -\frac{3}{2}x + 42 ; Y3 = -\frac{1}{3}x + \frac{28}{3}$$

Graph each of the three lines on the graph paper. Do they contain the three pairs of points?

Answer: See graph key at the end of the document. Yes the lines contain the graphs.



11. What do these three lines form?

Answer: A triangle

Press to proceed.

12. Determine the vertices of the triangle created by these lines.

(Note: Each person in the group will determine the ordered pair for just one vertex, but a different vertex.) Show your work below.

Student answers will vary depending which vertex they determine. An example is shown below.

$$\begin{aligned} \text{Answer: } Y1 \text{ and } Y2 \quad 2x &= -\frac{3}{2}x + 42 \\ 4x &= -3x + 84 \\ 7x &= 84 \\ x &= 12 \quad y = 24 \end{aligned}$$

13. Write the ordered pairs for the three vertices found by the members of your group below.

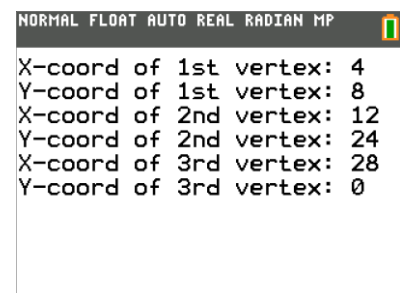
_____ (12, 24) _____ (4, 8) _____ (28, 0) _____

Check these ordered pairs on your graph paper.

Answer: The ordered pairs match the intersections on the graph.

14. For the “Day 2b: Triangle?” menu, select “1: Input vertices”. Then type in the coordinates as asked using your answers from 13.

The vertices are then shown on the graph. Press to proceed.





15. Read the five pages, make notes as needed. The last page asks you to do the following:

Determine the equations of the lines perpendicular to each of the three sides of the triangle that pass through these midpoints of the sides. (Each person in the group does a different one of these).

Show your work below.

a. (20, 12)

Answer:

$$y - 12 = \frac{2}{3}(x - 20)$$

$$y - \frac{36}{3} = \frac{2}{3}x - \frac{40}{3}$$

$$y = \frac{2}{3}x - \frac{4}{3}$$

b. (8, 16)

Answer:

$$y - 16 = -\frac{1}{2}(x - 8)$$

$$y - 16 = -\frac{1}{2}x + 4$$

$$y = -\frac{1}{2}x + 20$$

c. (16, 4)

Answer:

$$y - 4 = 3(x - 16)$$

$$y - 4 = 3x - 48$$

$$y = 3x - 44$$

d. Write the three equations found by the members of your group below.

Answer:


$$Y4 = \frac{2}{3}x - \frac{4}{3}$$

$$Y5 = -\frac{1}{2}x + 20$$

$$Y6 = 3x - 44$$

e. Graph these three equations on your graph paper.

Answer: See graph key at the end of the document.

16. Press  to proceed to the "Day 3: Let's Dig!" menu.

Select "1: Input Equations". You will be prompted to enter the equations listed in 15d above.



17. Determine the coordinates where each pair of lines intersects. Use algebra to do so and show your work below. Each person in the group will find the intersection point of two different lines.

Student work will vary depending which equations they use. An example is shown below.

$$\frac{2}{3}x - \frac{4}{3} = -\frac{1}{2}x + 20$$

$$4x - 8 = -3x + 120$$

$$7x = 128$$

$$x = \frac{128}{7} \doteq 18.286$$

$$y = -\frac{1}{2}\left(\frac{128}{7}\right) + 20$$

$$y = -\frac{64}{7} + \frac{140}{7}$$

$$y = \frac{76}{7} \doteq 10.857$$



18. Write the coordinates of the points of intersection found by the members of your group below. Express them in two ways: as an exact fraction and rounded to the nearest thousandth:

Answer:

$$Y4 \cap Y5 \quad \left(\frac{128}{7}, \frac{76}{7} \right) \quad (18.286, 10.857)$$

$$Y5 \cap Y6 \quad \left(\frac{128}{7}, \frac{76}{7} \right) \quad (18.286, 10.857)$$

$$Y4 \cap Y6 \quad \left(\frac{128}{7}, \frac{76}{7} \right) \quad (18.286, 10.857)$$

Look at these ordered pairs on your graph paper. Do they seem correct?

Answer: Yes, the ordered pairs match with the intersection found graphically.

19. Press to proceed to the “Final Step” menu.

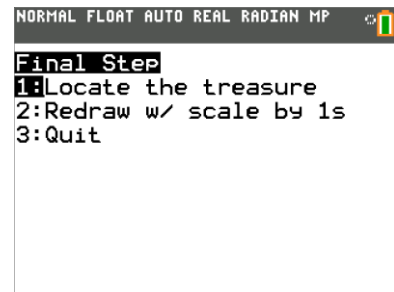
Select “1: Locate the treasure”. The three equations are displayed. Press to proceed.

Each person in the group will choose a different number: 1, 2, or 3. The point of intersection of the two lines chosen will be displayed as a decimal. Compare the calculator answer to your answer in 18 above. Press to proceed.

What did you discover?

Answer:

A solid gold key



20. Press to proceed to the “CipherSolvers” menu. Select “5: Day 4: Encryption Demo and read the page. Press to proceed to the “Day 4” Encryption Demo” menu.

a. Select “1: Encrypt”. Type an encryption key: any 4- to 12-digit number and press . Write it below.

Answer: Student responses will vary. An example is carried out below. Key:1234

b. Type your message.

Note: you may want to use A-lock (alpha lock) by pressing then . To obtain a space, it is the alpha symbol above the zero key. When finished typing your message, press .

Write it below.

Answer: Student responses will vary. Message: CIPHER SOLVER

c. After a few seconds, your encrypted message will be displayed. Write it below (Note: it may contain numbers, spaces, or other characters, not just letters).

Answer: Student responses will vary. Have students pay attention to spaces, those are important. The example is based on the above message and key.

Encrypted message: 2J7O V3V23LV1

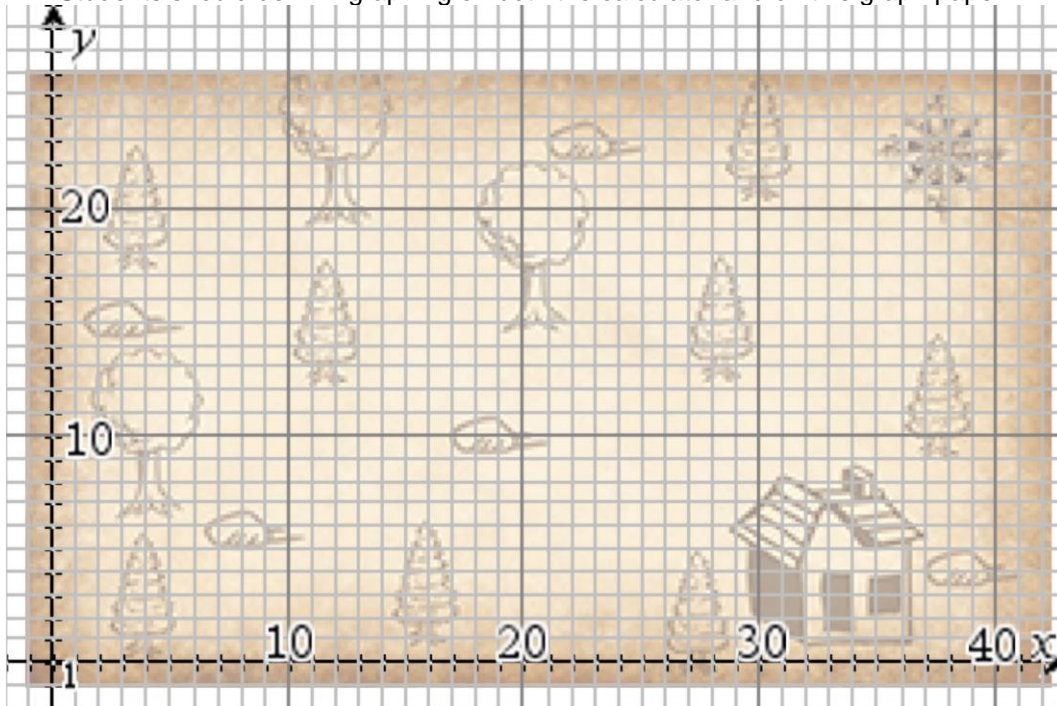


21. Press to proceed to the “Day 4: Encryption Demo” menu. Select “2: Decrypt”.
- Type the exact encrypted message from 20c. Press .
 - Answer: Student responses will vary. The example is based on the encryption from 20.**
Encrypted message: 2J7O V3V23LV1
 - Type the encryption key from 20a. Press .
 - Answer: Student responses will vary. The example is based on the encryption from 20.**
Key: 1234
 - After a few seconds, the decrypted (original) message will be displayed, but only for 5 seconds! So watch closely.
Decrypted message: CIPHER SOLVER
 - Do another encrypted message, if you like.
- e. When finished, at the “Day 4: Encryption Demo” menu, select “4: Quit” This will remove all images, clear the ‘y =’ menu, and place your calculator back to its default settings.



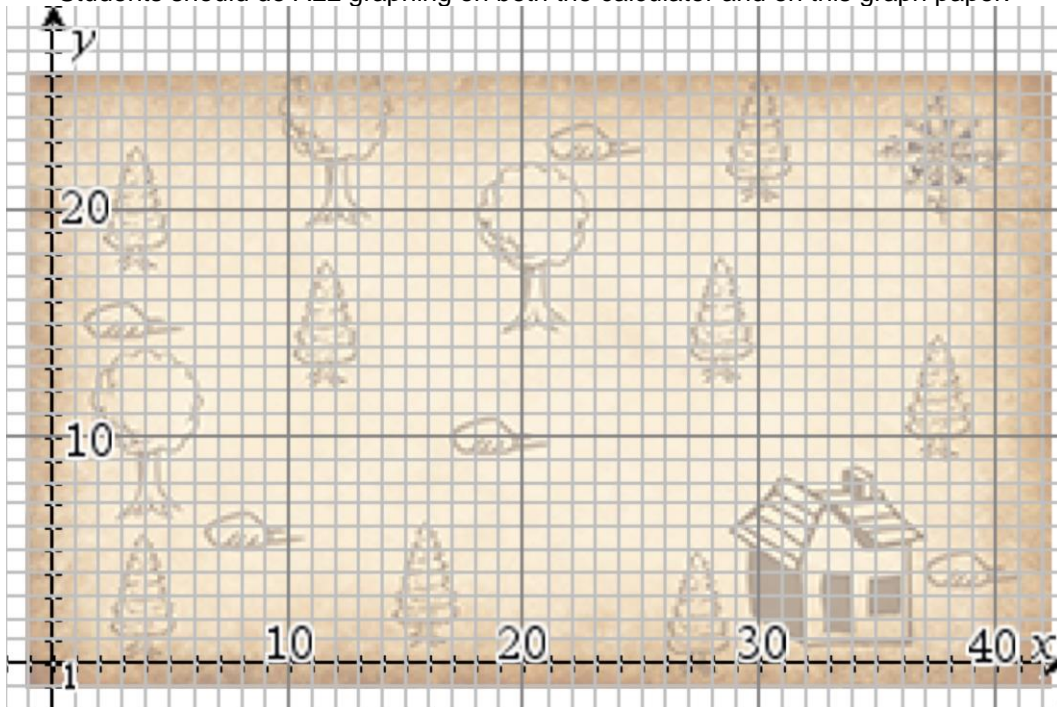
Cipher Solver Graph Paper

Students should do ALL graphing on both the calculator and on this graph paper.



Cipher Solver Graph Paper

Students should do ALL graphing on both the calculator and on this graph paper.





Graph paper key:

