3-5 At-Home Learning Resources

(Blue Packet)

Week #4

The Richland School District cares deeply about the well-being of our students and families. We highly encourage our students and families to set a daily routine that includes the following:

For our elementary families:

- **Read daily with your child**
- **Play family games (board games, cards, puzzles, charades, pictionary, etc.)**
- **Engage in an outside activity**
- **Cook/bake with your child**
- **Maintain relationships with your child's teacher**

These supplemental activities, readings, and other resources are available to students and families to continue learning and exploring while schools are closed in response to the novel coronavirus.

Students are not required to complete and/or turn in any assignments nor will any of these materials be used to assess students academically. Please feel free to use these optional resources as needed. Additional resources are available at:
https://www.rsd.edu/programs/at-home-learning/pre-k-elementary-resources

Objective

The student will produce facts and opinions.

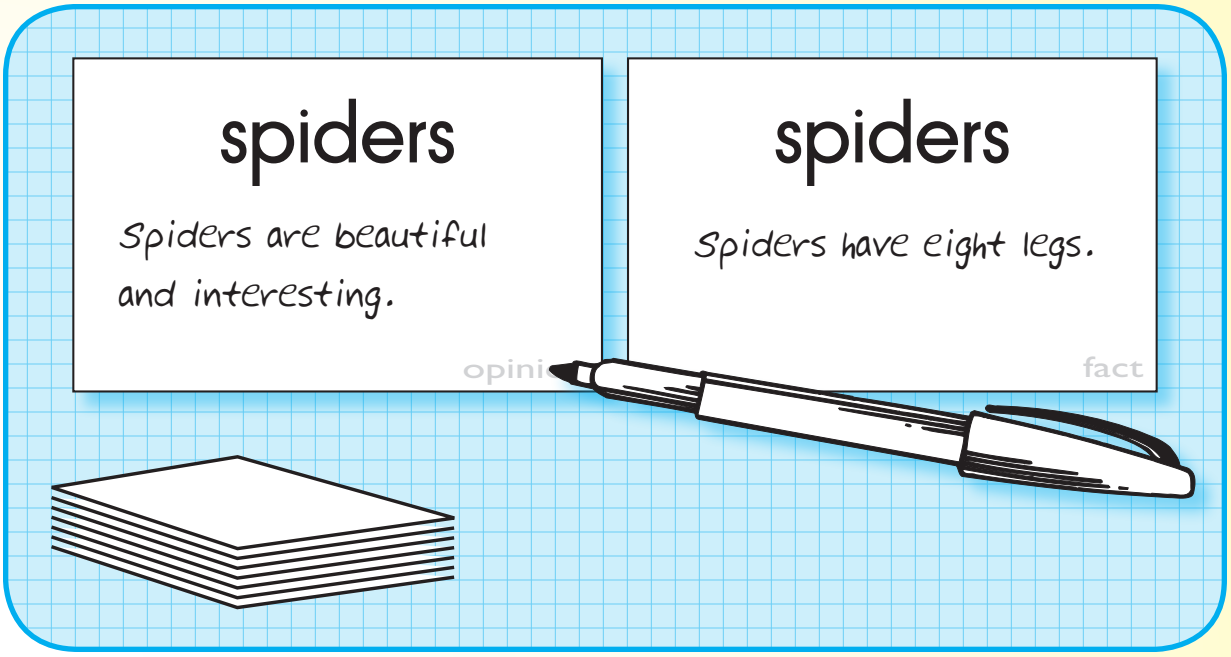
Materials

- Fact and opinion cards (Activity Master C.027.AM1a - C.027.AM1b)
  Laminate.
- Vis-à-Vis® markers

Activity

Students write facts and opinions based on a selected topic.

1. Place fact and opinion cards face down in a stack. Provide each student with a Vis-à-Vis® marker.
2. Taking turns, student one selects top card from stack and reads the topic and the fact or opinion designation (printed at the bottom of the card) to partner (e.g., spider, opinion).
3. Writes a fact or opinion sentence that corresponds to the designation. For example, Spiders are beautiful and interesting.
4. Explains why it is a fact or opinion. For example, "This is my opinion, because someone else might think that spiders are ugly and scary."
5. Reverse roles.
6. Continue until all cards are used. Pair fact and opinion sentences about the same topic together and discuss the differences between the facts and opinions.
7. Peer evaluation



Extensions and Adaptations

- Record facts and opinions on student sheet (Activity Masters C.027.SS1).
- Make more fact and opinion cards (Activity Master C.027.AM2).
- Write more facts and opinions according to new topics (Activity Master C.027.SS2).
- Write facts and opinions (Activity Master C.005.AM3) and sort (Activity Master C.027.AM3).

homework fact	homework opinion
vacations fact	vacations opinion
sports fact	sports opinion
snacks fact	snacks opinion

fact and opinion cards

computer games fact	computer games opinion
exercise fact	exercise opinion
spiders fact	spiders opinion
music fact	music opinion

fact and opinion cards

Name _____

Matter of Fact or Opinion C.027.SS1

Topic	Fact or Opinion	Fact or Opinion Statement
homework	opinion	
vacations	fact	
sports	opinion	
snacks	fact	
exercise	opinion	
computer games	fact	
spiders	opinion	
music	fact	

C.027.AM2

Matter of Fact or Opinion

fact	opinion
fact	opinion
fact	opinion
fact	opinion

blank fact and opinion cards

Name _____

Matter of Fact or Opinion C.027.SS2

Topic	Fact or Opinion	Fact or Opinion Statement
peanut butter	opinion	
books	fact	
math	opinion	
weather	fact	
snakes	opinion	
ocean	fact	
rules or laws	opinion	
cars	fact	

FACT

header

OPINION

header

header cards

Questions to Ask Before, During, and After Reading

These are questions to help engage students in discussions and conversations about reading. These questions are just suggestions and other questions can be added to this list based upon the type of reading students are involved in.

Before Reading

- What is the title of the book or text?
- What does this title make you think about?
- What do you think you are going to read about? (Make a Prediction)
- Does this remind you of anything?
- Are you wondering about the text or do you have any questions before reading?
- Skim through the article. Do any pictures, key words, and/or text features stand out to you?

During Reading

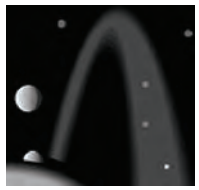
- What is happening so far?
- What does the word _____ mean on this page?
- What do you think the author is trying to communicate in this part?
- What do you think was important in this section? Why do you think it was important?
- What can you infer from this part of the text?
- Where is the story taking place?
- Who are the characters so far?
- What do you think will happen next?
- What does this part make you think about?
- What questions do you have?
- What words help you visualize what the author is saying?
- Is there a word that you struggled with? What is the word? Let's break the word into parts and look at context clues.

After Reading

- What was this text about?
- What was the main idea? What details from the text helped you determine the main idea?
- What did you learn from this text?
- How did the author communicate his/her ideas?
- What does this text remind you of?
- What was your favorite part and why?
- Did this text have a problem? If so, what was the problem and what was the solution?
- What is your opinion about this text? What are some parts that helped you make that opinion?
- What are some questions you still have about the text?
- Does this text remind you of other texts you have read? How are they alike and/or different?
- What is a cause and effect from the text you read?

Why Does the Moon Orbit Earth?

Cross-Curricular Focus: Earth Science



The **moon orbits** Earth. When it orbits, it travels in a circle around Earth. There is a force between Earth and the moon called gravity. Because of gravity, larger objects pull smaller ones toward them. Earth is larger than the moon, so Earth pulls on the moon. At the same time, Earth is being pulled by the sun. The sun is larger than Earth. The balance between those two "pulls" is what keeps the moon in orbit around Earth.

People say the moon shines. However, the moon does not actually have any light of its own. What we see as its light is really the sun's light reflecting off of the moon. As the moon orbits Earth, Earth orbits the sun. We see different amounts of light on the moon depending on its **position.** We call the changes in the moon's appearance L*unar phases.* From one new moon to the next new moon is one complete lunar cycle.

It takes the moon between 27 and 28 days to complete an orbit around Earth. The moon's orbit is measured from one new moon to the next new moon. It starts in the west and moves toward the east. To complete one full orbit, the moon travels about 1,423,000 miles.The moon travels very fast. It moves at 2,288 miles per hour.

Name: _____

Answer the following questions based on the reading passage. Don't forget to go back to the passage whenever necessary to find or confirm your answers.

1) What two **spheres** are being pulled by the force of gravity?

_____

2) Why does Earth pull on the moon instead of the other way around?

_____

3) What's really happening when the moon is said to shine?

_____

4) Which moves faster, your family car or the moon?

_____

5) Name one new thing that you learned about the moon or its orbit. _____

_____

_____

_____

Import/Export

Cross-Curricular Focus: History/Social Sciences

When the colonists first arrived in America, there were no stores to go and buy things that they needed or wanted. The people often did not have the supplies to be self-sufficient. They had to rely on products shipped to them from other countries, mainly England. When you bring products in from another country, you **import** them into your own country.

Goods were imported by ship to major colonies with a port on a bay. The port had to be a safe place for large ships to dock. People who wanted the products traveled to the port. People could not buy too much, though. They had to **transport** whatever they bought to their homes in wagons or on horseback.

The colonies became more self-sufficient over time. Crops like tobacco and rice proved to be very successful in the South. The soil there was especially rich in nutrients. Large plantations used the labor of many indentured servants and slaves. It was hard work to bring in the plentiful harvests. Soon, goods began to flow in the other direction. The colonies started to **export** goods back to England and other countries to sell.

As rumblings of independence started, colonists were relying less and less on goods they had to import. Local merchants continued to sell items from other countries. However, the prices kept increasing as the English government added taxes to the goods. Merchants began to carry more locally produced goods.

The U.S. became independent. It grew and expanded westward. This created a unique opportunity for entrepreneurs to start businesses. They purchased extra supplies and took them to the frontier for people to buy. They could only carry a small amount of extra supplies over the long distance. These goods were hard to find on the frontier and very desirable. The entrepreneurs could charge high prices because so many people wanted to buy the rare items. This economic principle is called the law of supply and demand.

Name: _____

Answer the following questions based on the reading passage. Don't forget to go back to the passage whenever necessary to find or confirm your answers.

1) Why was it necessary for the early colonists to rely on imported goods?

_____

_____

2) What does import mean?

_____

_____

3) What were the crops in the South that were successful?

_____

_____

4) Can you think of any goods than are imported into the U.S. today? Name one.

_____

_____

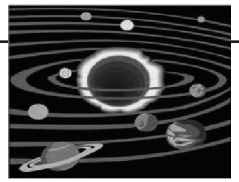
5) Is "supply and demand" economics fair? Explain. _____

_____

_____

The Inner Planets

Cross-Curricular Focus: Earth Science



Name: _____

Answer the following questions based on the reading passage. Don't forget to go back to the passage whenever necessary to find or confirm your answers.

Earth is just one of the planets in our solar system. Planets are large bodies that rotate around the sun. They reflect its light and warmth. The planets that are located closest to the sun are made out of rocky material. They are relatively small and heavy. In contrast, the planets that are farther away from the sun are much larger. They are formed of light gases. All planets follow a certain path around the sun. They are held a specific distance from the sun by the sun's strong gravitational force.

The inner planets, or those closest to the sun, are Mercury, Venus, Earth and Mars. Even though these planets are all small and rocky, they have more differences than they have things in common.

Because Mercury is the closest to the sun, the side that faces the sun gets as hot as 427^{O} Celsius. At the same time, the side that faces away from the sun is a freezing -173^{O} Celsius. Mercury also has a slower rate of rotation than Earth. Days and nights on Mercury are much longer than ours. The extreme temperatures alone make it a very unlikely place for life. With an atmosphere too thin for human breathing, it's obvious that people won't be living on Mercury any time soon.

The next planet from the sun is Venus. Below clouds of sulfuric gas lies its 96% carbon dioxide atmosphere. That might be nice for a plant, since a plant "breathes" carbon dioxide, but not for a person. If you managed to survive the atmosphere, the surface of the planet is hot enough to melt solid metal. In addition, the pressure of the air would be strong enough to crush you.

You are probably most familiar with Earth because it is your home planet. It has the perfect conditions for life. Earth's atmosphere and oceans help control the trickiest part of making a planet life-friendly: temperature. Earth is the only planet known to have liquid water.

Mars is the fourth farthest from the sun. Mars has been studied and photographed more than any other planet besides Earth. Some people think it may be possible for life to exist there. Although scientists have not been able to find actual water on Mars, there seems to be evidence of water erosion on its surface. Its canyons and mountains are very similar to those found on Earth. The main difference is that there is no plant life. Some scientists believe that Mars may have been very much like Earth until something happened that made the water supply evaporate.

1) What keeps planets rotating a specific distance from the sun?_____

_____

2) Earth is the only know planet to have what important feature?

_____

3) Why is the atmosphere of Venus more friendly to plants than humans?

_____

_____

4) Why is there such a the huge difference in temperature between the two sides of the planet Mercury? _____

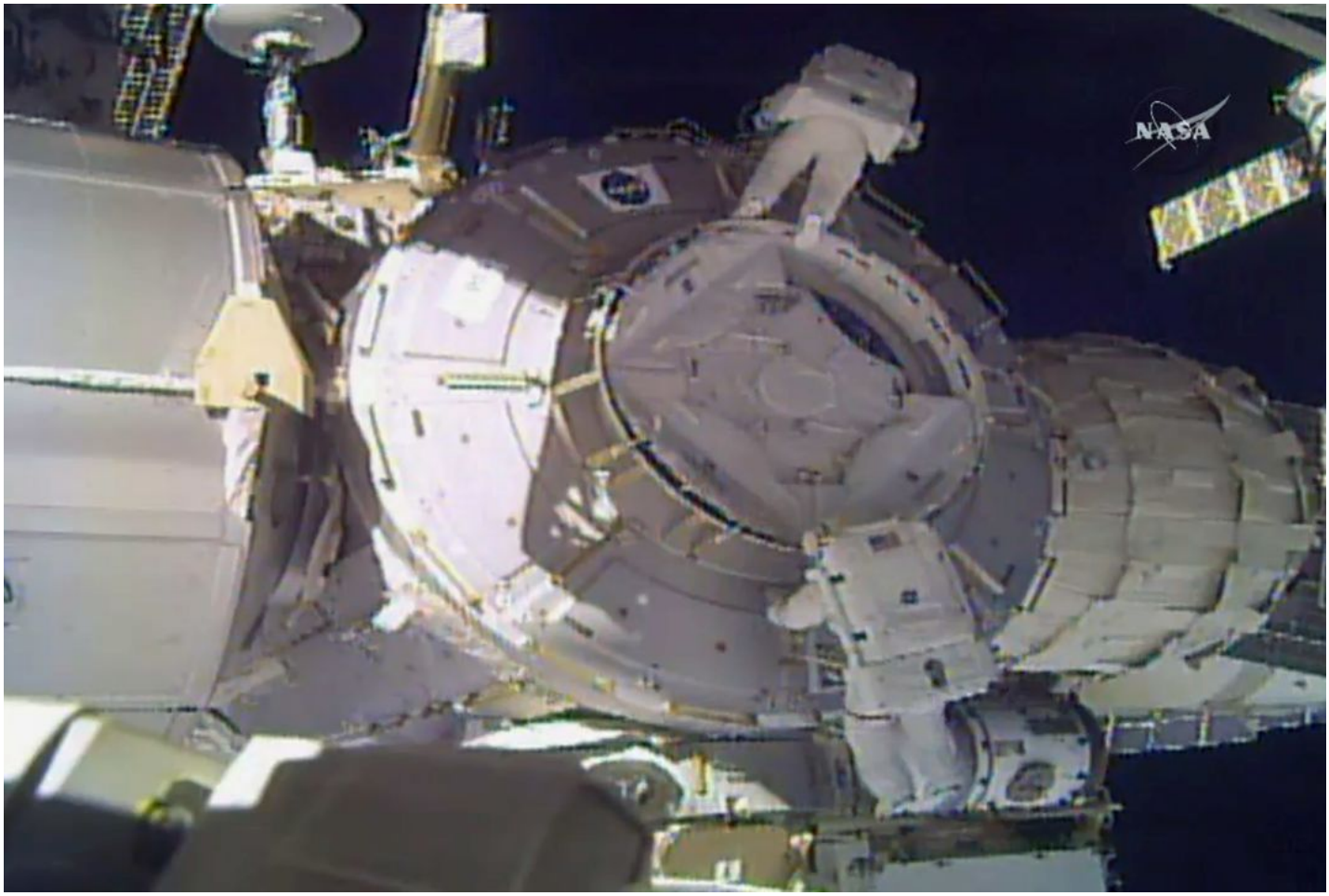
_____

_____

5) Do you think that people will ever be able to colonize other planets in the future? Why or why not? _____

_____

_____



In this image made from video provided by NASA, U.S. astronauts Peggy Whitson, above, and Shane Kimbrough work on the outside of the International Space Station on Thursday, March 30, 2017. (NASA via AP/Thomas Pesquet via AP)

Take a virtual trip to the International Space Station

By Erin Blakemore *Smithsonian.com* | March 20, 2020 |

What's life like aboard the International Space Station? This is a question only a select few can answer. But thanks to a new virtual reality tour, more people than ever can step aboard the floating lab. They can virtually explore the station and its mindboggling views. This is according to Mashable's Adario Strange.

The program was created in cooperation with NASA and the Canadian and European space agencies. It is called Mission: ISS. And it's probably the closest you'll ever come to visiting the space station. The program uses Oculus Rift virtual reality and Oculus Touch motion control. They create a realistic simulation of life aboard the station.

As Oculus writes on its blog, the movie was designed to recreate the ISS "in painstaking detail." It is a free simulation. The program was based on NASA models. It was developed with the input of astronauts and NASA's Virtual Reality Laboratory. The lab uses virtual reality. It can train astronauts for their in-space tasks.

With the help of motion controls, users can try their hand at everything from spacewalks to docking spacecrafts. This is all in a simulated zero-gravity environment. (Strange warns that the simulated weightlessness is so realistic that users might want to sit down before stepping into the virtual world.)

The simulation may be fun, but it is no video game, Strange writes. The program is intended give users a realistic idea of what it's

The simulation may be fun, but it is no video game, Strange writes. The program is intended give users a realistic idea of what it's like to live in space. Users can also learn about individual astronauts and the history of the ISS through a series of video clips. The team is also testing the program as an educational tool. It could teach high school students about the station.

Augmented reality is already being tested in space. This is with the help of Microsoft's HoloLens headset. One day, it will be used to guide repairs and let on-ground techs see exactly what astronauts observe. Virtual reality has yet to make it into space. That's about to change, according to the Oculus blog. An Oculus headset will be sent to space. It will be used by astronaut Thomas Pesquet to test how gravity affects spatial awareness.

You can now go on "mini missions" at Kennedy Space Center

By Tribune News Service, adapted by Newsela staff on 09.12.18
Word Count **586**
Level **810L**

Image 1. Mission Control - make sure everything and everyone gets to its proper destination in this ATX training challenge. Photo by: Samantha Feuss/TNS

Have you ever imagined what it might be like to be an astronaut? Do you dream of rocketing into space and landing on Mars? Now at the Kennedy Space Center Visitor Complex in Florida, you can live it.

Learning about science and space is important. Actively participating in simulations of life on another planet gives education a whole new perspective. There are two parts to the new program at the Kennedy Center. They are called the Astronaut Training Experience (ATX) and Mars Base 1. These both are pretty much all-day events. If you visit, you will want to give yourself plenty of time for each.

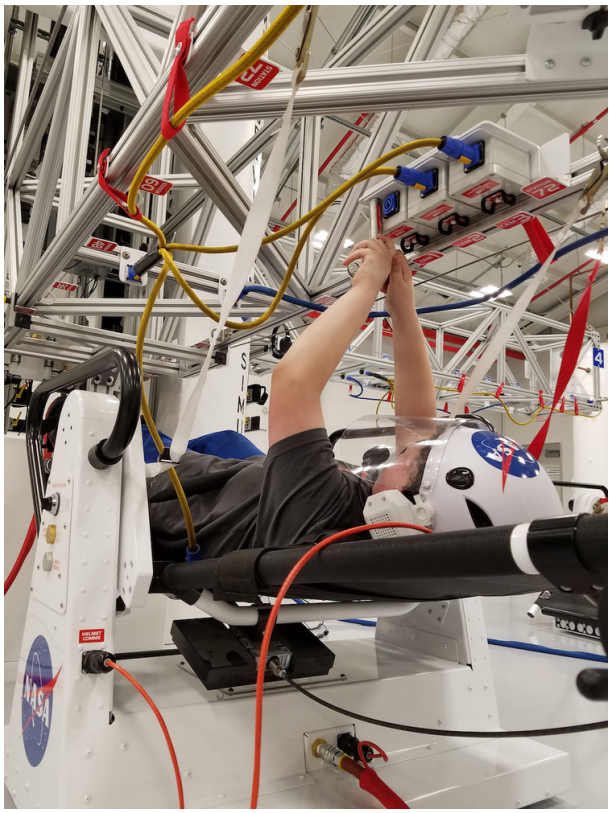
Mini Missions At Kennedy Space Center

The ATX is made up of several "mini missions." They include the Launch Mission, Spacewalk Training, the Land-and-Drive-on-Mars full-motion simulator and Walk-on-Mars. These missions come to life through VR, which stands for virtual reality. VR lets users enter new worlds created by

computers. At Kennedy Space Center, it will make visitors feel like they are really walking on Mars! The experience is hands-on and high-tech. If you already have a fascination with space, ATX will bring that passion to life.

Prepare for your mission to Mars by training like a real astronaut. Ever wanted to take a spacewalk? How about a zero-gravity experience, where you fix space equipment like a real astronaut would? In ATX, you and your team are strapped into special seats. To maintain the equipment you need to survive in space, you are handed special tools. You solve problems using the methods of NASA, the U.S. space group. In another mission, you navigate the rocky surface of Mars to deliver goods in your own space rover. Be careful, because it can get very bumpy. Don't worry too much, though. You will receive all the training you need before you are sent on these challenging missions.

You can do any of these as "mini missions" on their own if you don't have time to do them all. Each one takes about 30-45 minutes.



What could be cooler than a day actually spent on Mars doing real science? If that sounds like a dream, you will love Mars Base 1.

At Mars Base 1, you can become a "rookie astronaut." You take part in simulations and scientific research to grow and study crops in the Mars Botany Lab. As part of these activities, you will get to grow real food. You can also use robots to accomplish tasks. The full program takes about five hours.

No Leaving The Ground

There is so much to learn that goes beyond anything we can imagine. Having the real-life science at your fingertips is especially valuable. It adds a new dimension to that learning. Both the ATX and Mars Base 1 offer the magic of space travel without leaving the ground.

You will also want to save some time to visit Kennedy Space Center. There are endless museums, theaters, shows and hands-on demonstrations. There are also all kinds of artifacts, including satellites and ships that have been to space. Sometimes there are even opportunities to meet astronauts themselves!

Quiz

1 Read the article's introduction [paragraphs 1-2] and the final section "No Leaving The Ground."

What is one connection between these two sections?

(A) The introduction explains what the Kennedy Space Center is, and the final section gives more information about the exhibits there.

(B) The introduction describes the new programs offered at the Kennedy Space Center, while the final section goes into detail about what those new programs offer.

(C) The introduction describes the differences between two programs at the Kennedy Space Center, while the final section discusses the similarities.

(D) The introduction describes earlier educational programs at the Kennedy Space Center, while the final section examines the new programs.

2 The article is mostly organized using a description of the new programs at the Kennedy Space Center. How would the article be different if it were organized using compare and contrast?

(A) It would highlight the ways the Kennedy Space Center solved problems related to the new programs.

(B) It would examine the reasons for why the Kennedy Space Center started new programs.

(C) It would provide a recommended schedule for visitors to follow at ATX and Mars Base 1.

(D) It would specifically discuss the similarities and differences between ATX and Mars Base 1.

3 Read the section "Mini Missions At Kennedy Space Center."

Which sentence shows the author's point of view about the Astronaut Training Experience?

(A) The ATX is made up of several "mini missions."

(B) If you already have a fascination with space, ATX will bring that passion to life.

(C) In ATX, you and your team are strapped into special seats.

(D) What could be cooler than a day actually spent on Mars doing real science?

4 Read the selection from the section “No Leaving The Ground.”

> *There is so much to learn that goes beyond anything we can imagine. Having the real-life science at your fingertips is especially valuable. It adds a new dimension to that learning. Both the ATX and Mars Base 1 offer the magic of space travel without leaving the ground.*

How does this selection communicate the author’s purpose?

(A) It encourages the reader to interact with the astronauts at Kennedy Space Center.

(B) It describes the ways that teachers can use the programs to teach their students about space.

(C) It explains why the programs are unique opportunities for people interested in space.

(D) It shows how ATX and Mars Base 1 first got started by the Kennedy Space Center.

English Language Learners 3-5

Reading

- Read the poem “Making Changes” by yourself or with someone in your family.
- Think about people from history or from your life who have made positive changes to our world.
- Highlight or circle any words in the poem that are new to you.

Speaking

- Read the poem aloud to someone in your family.
- Talk about people you know of who have done positive things to impact our world. What did they do? How do their actions impact you?
- Ask someone in your family to name someone who has positively impacted them.

Listening

- Have someone else in your family read the poem aloud to you.
- Close your eyes while you listen to the poem and imagine pictures in your mind that match the words in the poem.

Writing

- In the box next to the poem, illustrate a picture.
- Answer the prompt that goes with the poem.

Making Changes

Who are the people who have come before,

The people who have struggled to unlock a door.

People who have worked, people who have tried.

People who have fought, people who have died.

Courageous and strong, they took on the fight

To change all the things, they knew were not right.

Many have battled. Books show a few

Who have opened a door for me and for you.

Illustrate a picture of someone you know of who has made positive changes in the world.

Name a person from history or from your life who has made positive changes in the world. Write about what that person did.

_____

_____

_____

_____

_____

_____

_____

Writing Ideas 3-5 Elementary Week #4

Students can compose sentences and/or paragraphs to respond to the prompts and ideas below. This will vary depending on their age/grade level.

Narrative

- Funny things happen all the time! Write a story or personal narrative about something funny that happened to you or someone you know. Be sure to include characters, sequence of events, details, descriptions, and the setting. Establish an introduction, middle, and conclusion.

Opinion/Argument

- Write an opinion piece on which sport or sports team you think is the best! Why is this sport or sports team the best? Add reasons, examples, and/or details to support your opinion. Be sure to have an introduction and a conclusion that relates to the opinion stated.

Informational/Explanatory

- What is a state or place that you have always wanted to visit? Write an informational piece about that state or location. Add enough facts, information, and/or details so your reader can visualize this place and learn about it. Introduce your topic and have a conclusion.

Writing in Response to Reading Bingo

Complete the Bingo board by engaging in various writing ideas from this week's reading selections. Try to get 3-in-a row!

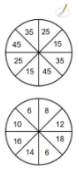
Want to learn more about the moon? Do some research and find more information about our moon. Write an informative piece about your findings.	Create a Prezi, PowerPoint, Poster, and/or infographic about something you learned from the reading selections. Present what you learned to a family member!	Select one of the inner planets you would like to learn more about. Research that planet. In a letter to a friend or family member, describe what you found out about the planet.
If you could design your own space station, what would it look like? Draw a picture of your space station and write a poem, a song, or a play about your space station!	WRITER'S CHOICE	Vocabulary words are fun! Write a poem or create some word art with some new or interesting vocabulary from this week's reading! For extra fun, explore https://wordart.com/create
What are some goods or products that our country imports and exports today? Do some additional research and write an informational piece on the import/export business today.	Write about how the two reading selections **Take a Virtual Trip to the International Space Station** and **You Can Now Go on "Mini Missions" at Kennedy Space Center** are similar and/or different.	Write a story about an outer space adventure! Create characters, a setting, a problem and a solution. Write your story and be sure to add lots of details to bring your space adventure to life!

Double and Halve

Materials: 10 counters per player, 2 paper clips, 2 pencils, Double and Halve board

Double and Halve

30 x 3	50 x 3	70 x 3	90 x 3
30 x 4	50 x 4	70 x 4	90 x 4
30 x 5	50 x 5	70 x 5	90 x 5
30 x 6	50 x 6	70 x 6	90 x 6
30 x 7	50 x 7	70 x 7	90 x 7
30 x 8	50 x 8	70 x 8	90 x 8
30 x 9	50 x 9	70 x 9	90 x 9



1. Work with a partner. Collect 10 counters each.

2. Take turns to spin a paper clip on each spinner. Use the two numbers the paper clips land on to create a multiplication problem.

3. Double one factor and halve the other to change the problem to one with an equivalent product that is easy to solve mentally. Explain your strategy.

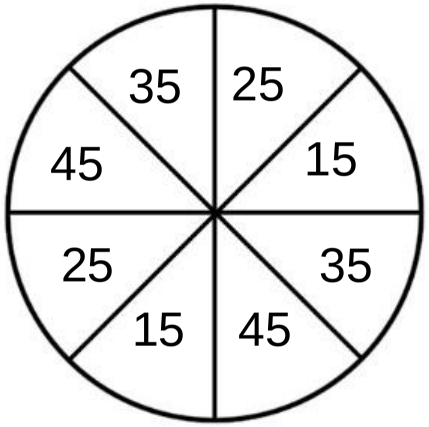
4. Place a counter on the multiplication fact on the board. If the multiplication fact is already covered play passes to the next player.

5. Continue playing until one player has placed all ten counters on the board.

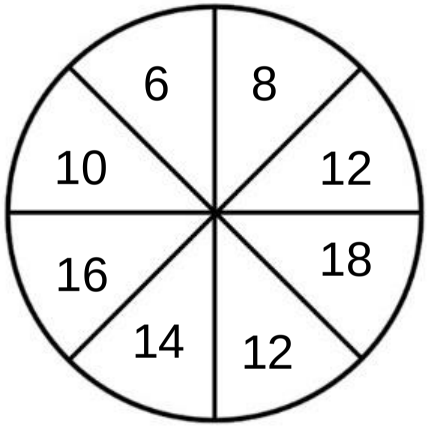
Double and Halve

30 x 3	50 x 3	70 x 3	90 x 3
30 x 4	50 x 4	70 x 4	90 x 4
30 x 5	50 x 5	70 x 5	90 x 5
30 x 6	50 x 6	70 x 6	90 x 6
30 x 7	50 x 7	70 x 7	90 x 7
30 x 8	50 x 8	70 x 8	90 x 8
30 x 9	50 x 9	70 x 9	90 x 9

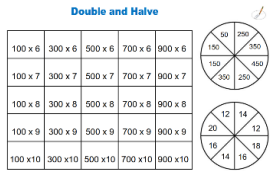
Factor 1



Factor 2



Double and Halve



Materials: 10 counters per player, 2 paper clips, 2 pencils, Double and Halve board

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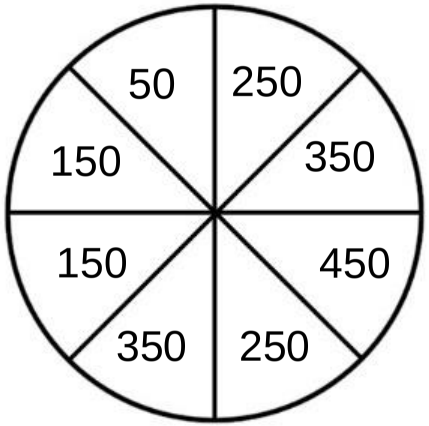
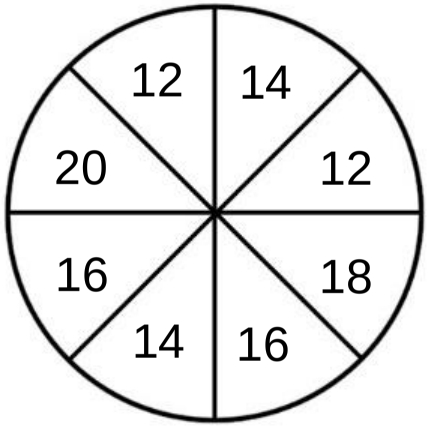
Double and Halve

100 x 6	300 x 6	500 x 6	700 x 6	900 x 6
100 x 7	300 x 7	500 x 7	700 x 7	900 x 7
100 x 8	300 x 8	500 x 8	700 x 8	900 x 8
100 x 9	300 x 9	500 x 9	700 x 9	900 x 9
100 x10	300 x10	500 x10	700 x10	900 x10

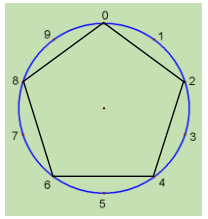
Factor 1



Factor 2



Drawing Multiplication Patterns



Materials: rulers, recording sheets, enlarged circle diagrams numbered 0-9

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1. Choose a number between 1 and 9. Color all multiples of this number on a hundred chart.

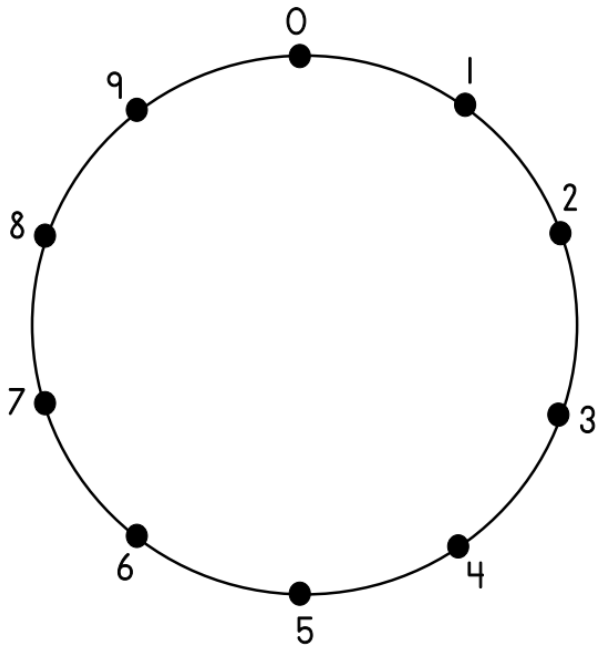
2. Write the multiplication facts to x10 for the number you chose. Write the digit in the ones place in each product.
   Example: If you record multiples of 3 write the ones digits 3, 6, 9, 2, 5, 8, 1, 4, 7, 0.

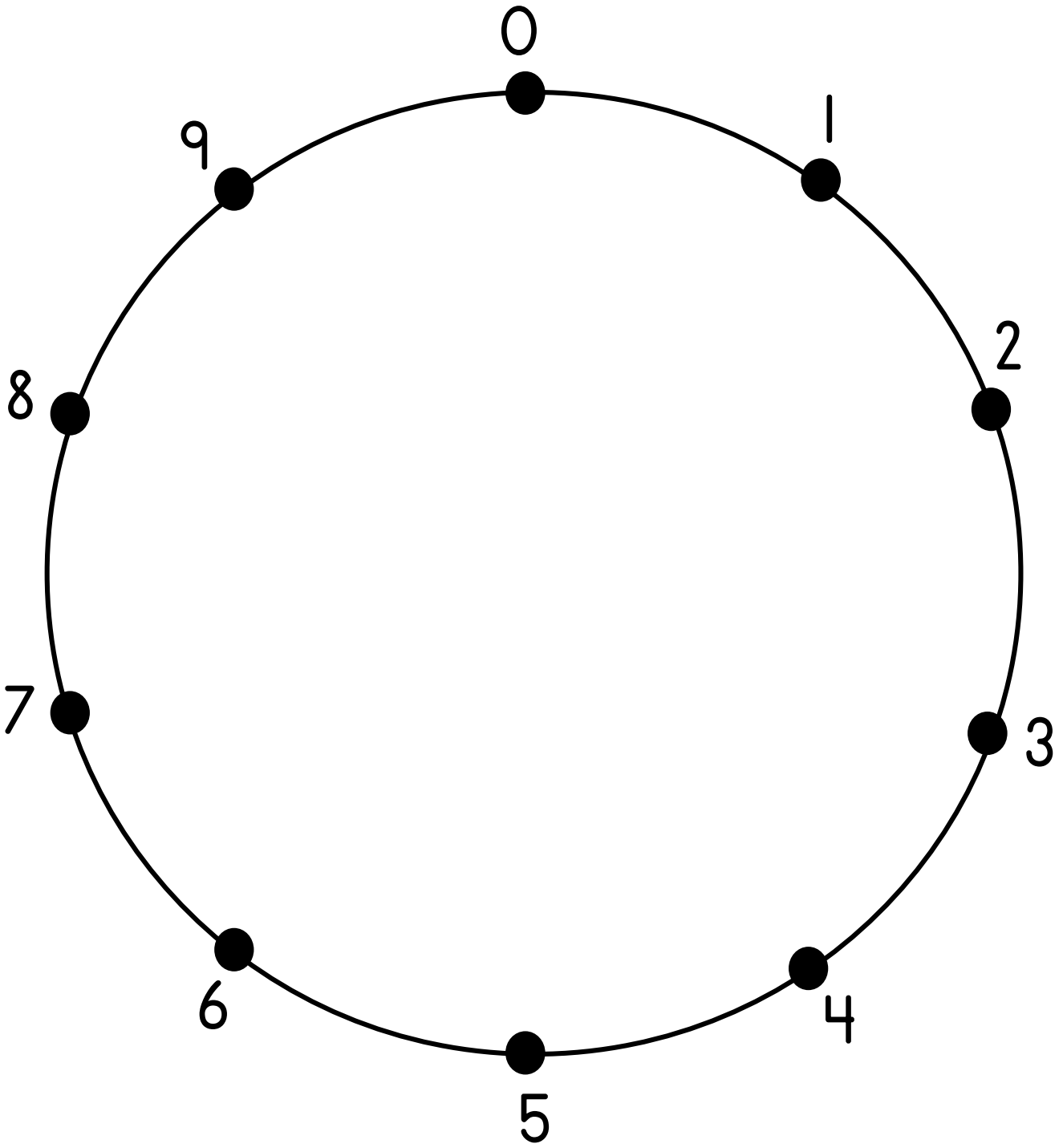
3. Put your pencil at zero on the circle diagram. Use a ruler to draw a line from zero to the first ones digit you recorded. Continue to connect the ones digits in order until you return to zero. Color your multiplication circle.
   Example: For multiples of 3 we start our pencil at 0 on the circle, then draw a line from 0 to 3, then from 3 to 6, then from 6 to 9, then from 9 to 2, then from 2 to 5, and so on.

4. Make circle patterns using other multiplication facts. Record your observations about the patterns you create. Which numbers create the same circle pattern? Do they create it the same way? Is there a relationship between the facts that create the same patterns?

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Multiplication Fact	**Product**	**Ones Digit**

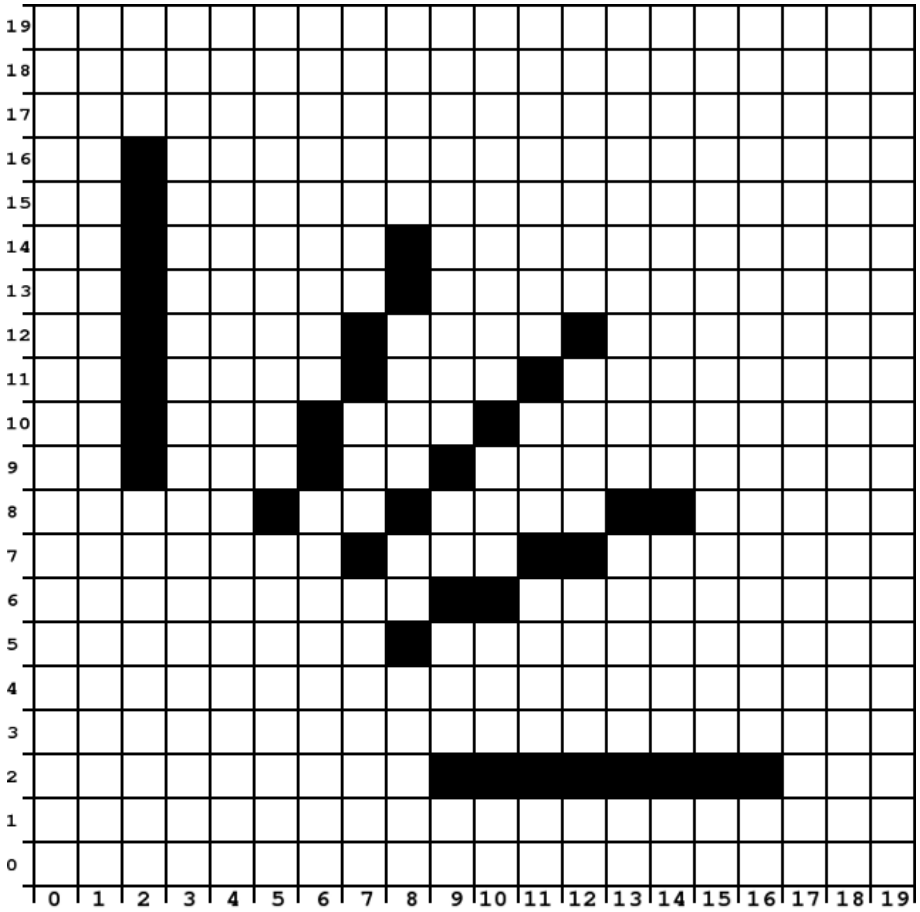




Drawing Lines with Pixels

Joshua Scott

March 2012



Summary

Computers draw lines and circles during many common tasks, such as using an image editor. But how does a computer know which pixels to darken to make a line?

Skills

- 2D coordinates
- Using an algorithm
- Geometry

Materials

- Pen or pencil
- Worksheet
- Ruler and compass (to check lines and circles after drawing them)

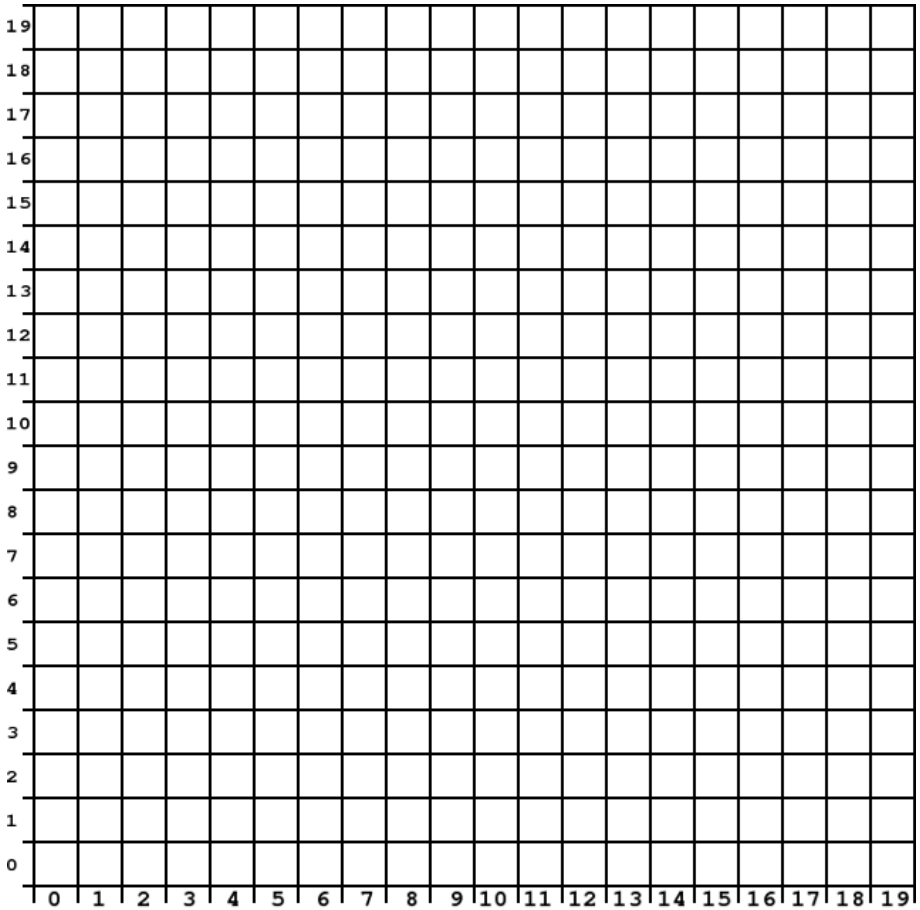
1 Some easy lines

Computers draw images using pixels. Pixels are the tiny squares that make up the image you see on computer monitors. If you look carefully at a computer screen with a magnifying glass, you can see the individual pixels.

To draw a line, a computer must work out which pixels need to be filled so that the line looks straight. We can try this by colouring in squares on a grid.

On the following grid, try to draw these straight lines by filling in pixels in the grid:

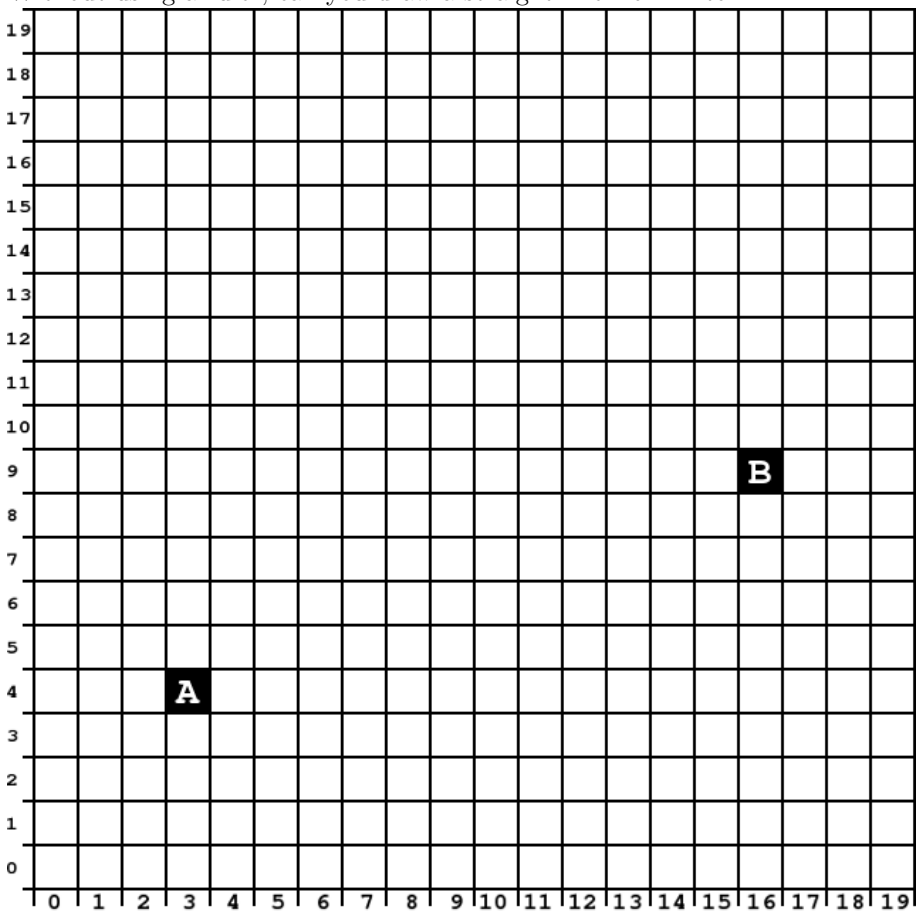
- (2, 17) → (10, 17)
- (18, 2) → (18, 14)
- (1, 5) → (8, 12)



Check with a ruler. Are your lines straight?

2 A more difficuilt line

Without using a ruler, can you draw a straight line from A to B?



Once you have finished drawing your line, try checking it with a ruler. Place the ruler so that it goes from the centre of A to the centre of B. Does it cross all of the pixels that you have coloured?

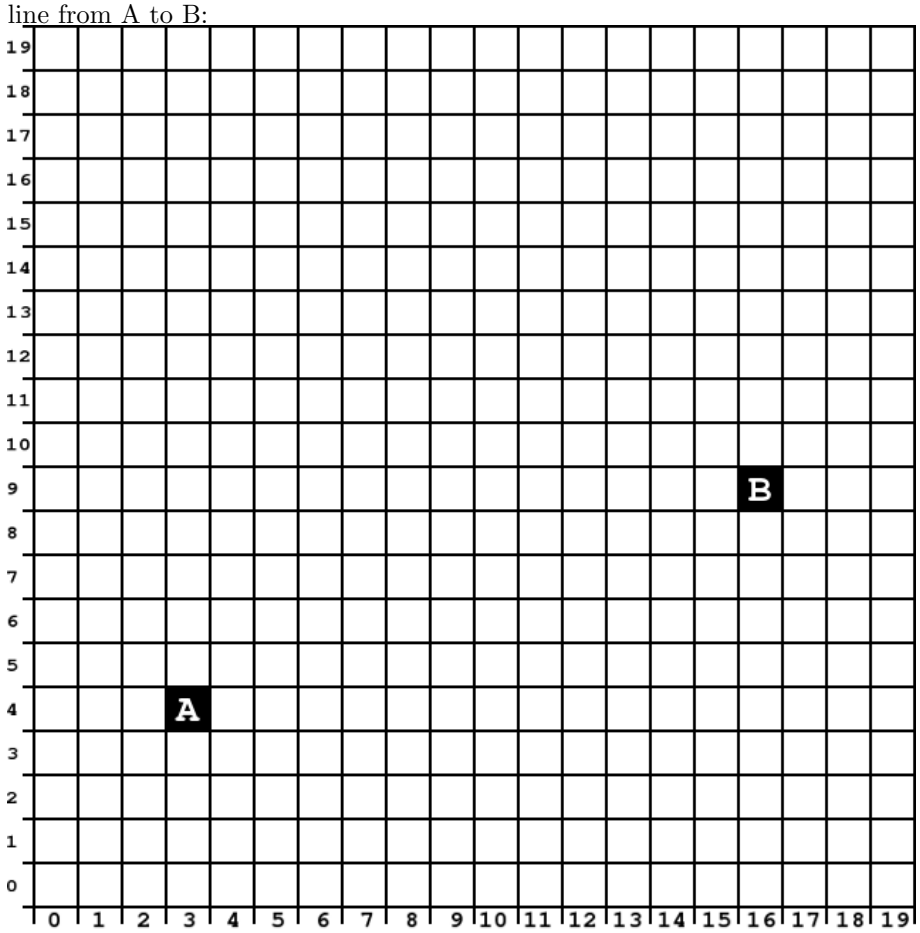
3 Bresenham's Line Algorithm

One way that a computer can know which pixels to colour, is with Brensenham's Line Algorithm. It follows these simple rules:
$A = 2\times$ change in Y value
$B = A - 2\times$ change in X value
$P = A-$ change in X value

Fill the starting pixel. Then for every position along the X axis:

- if P is less than 0, draw the new pixel on the same line as the last pixel, and add A to P.
- if P was 0 or greater, draw the new pixel one line higher than the last pixel, and add B to P.
- continue this process until we reach the end of the line.

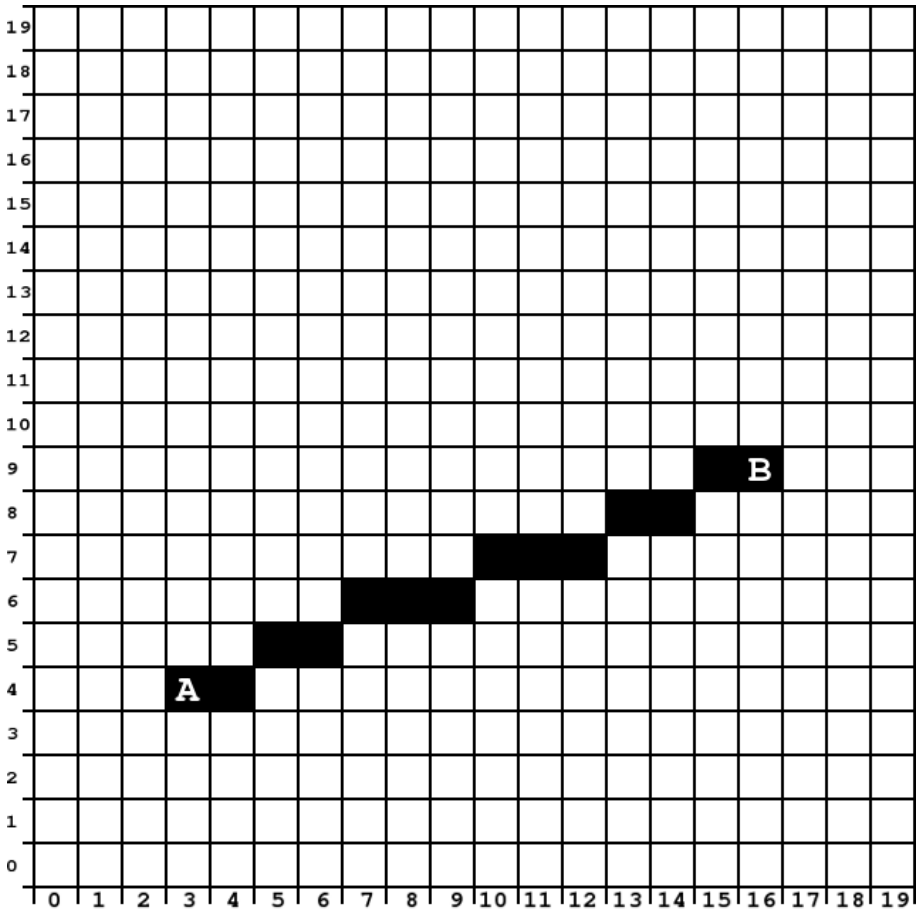
Without using a ruler, use Bresenham's Line Algorithm to draw a straight line from A to B:



Once you have completed the line, check it with a ruler. How does it compare to your first attempt?

Teacher's answer sheet for the line A→B

Correct pixels



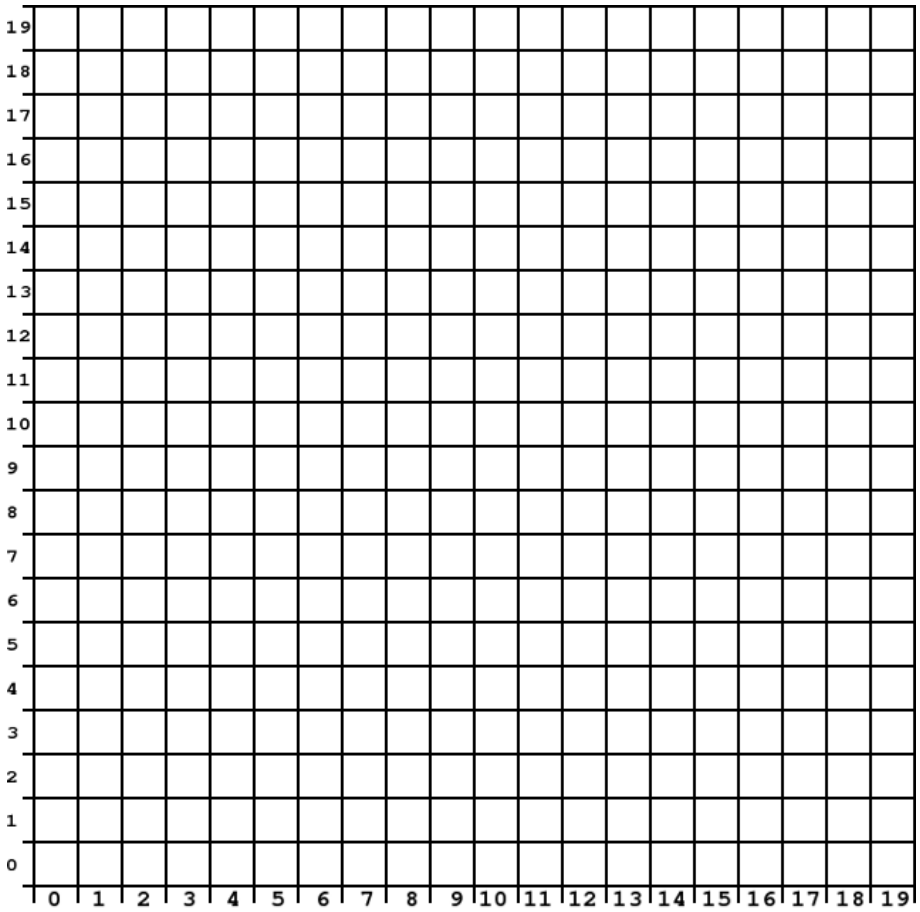
Correct values during calculation

A = 10, B = -16
P_0 = -3, Draw the next pixel along on the same row as the starting pixel.
P_1 = 7, Draw the next pixel along on the row above the previous pixel.
P_1 = -9, Draw the next pixel along on the same row as the previous pixel.
P_3 = 1, Draw the next pixel along on the row above the previous pixel.
P_4 = -15, Draw the next pixel along on the same row as the previous pixel.
P_5 = -5, Draw the next pixel along on the same row as the previous pixel.
P_6 = 5, Draw the next pixel along on the row above the previous pixel.
P_7 = -11, Draw the next pixel along on the same row as the previous pixel.
P_8 = -1, Draw the next pixel along on the same row as the previous pixel.
P_9 = 9, Draw the next pixel along on the row above the previous pixel.
P_{10} = -7, Draw the next pixel along on the same row as the previous pixel.
P_{11} = 3, Draw the next pixel along on the row above the previous pixel.
P_{12} = -13, Draw the next pixel along on the same row as the previous pixel.

4 Lines on other angles

So far, the version of Bresenham's line drawing algorithm that you have used only works for lines that have a gradient (slope) between 0 and 1. To make this algorithm more general, so that it can be used to draw any line, some aditional rules are needed:

- If a line is sloping downward instead of sloping upward, then when P is 0 or greater, draw the next column's pixel one row below the previous pixel, instead of above it.
- If the change in Y value is greater than the change in X value, then the calculations for A, B, and the initial value for P will need to be changed. When calculating A, B, and the initial P, use X where you previously would have used Y, and vice versa. When drawing pixels, instead of going across every column in the X axis, go through every row in the Y axis, drawing one pixel per row.



In the grid above, draw your own personal line. For the start point of the line, choose the X value as the first letter in your first name converted to a number (Eg, Caren would be 3, because C is the third letter in the alphabet). If the number is greater than 19, subtract 20 from it. For the Y value of the start point, choose the number made with the second letter of your first name.

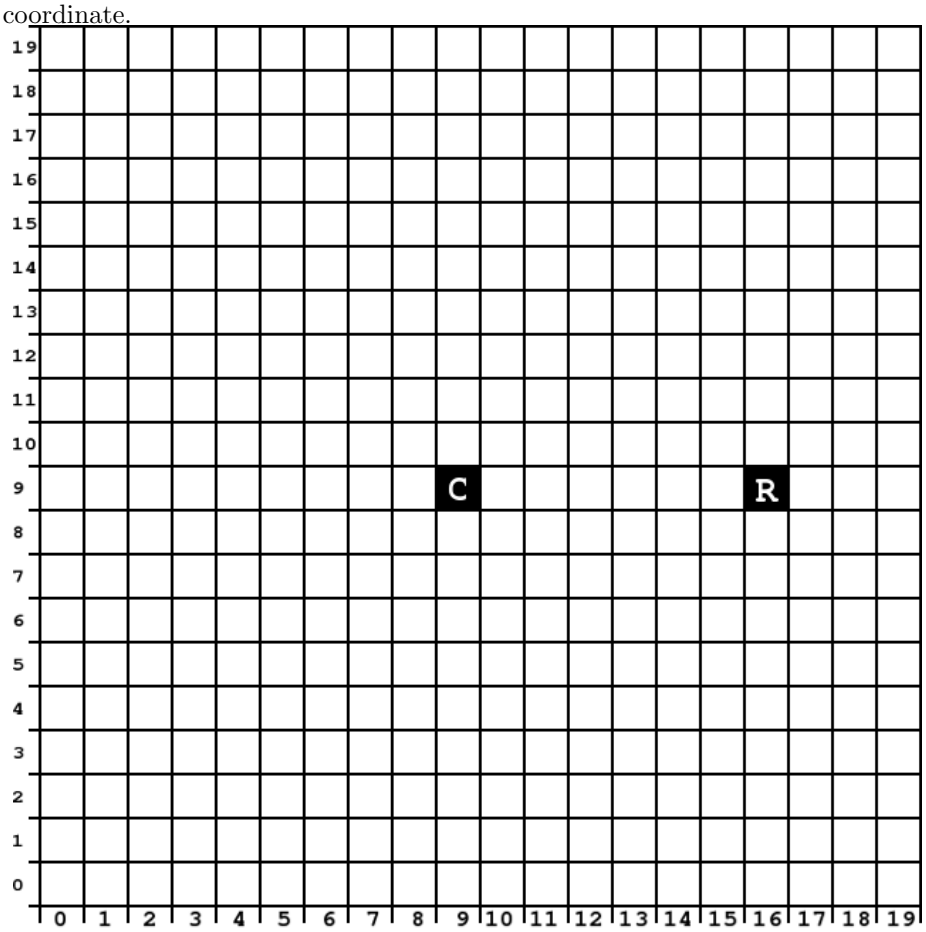
For the end point of the line, use the first and second letters of your last name. For example: If your name was John Smith, you would use the 'Jo' in John to choose the starting point (10, 15). You would then use the 'Sm' in Smith to choose the ending point (19, 13).

Use Bresenham's algorithm to draw the line.

5 Circles

As well as straight lines, another common shape that computers often need to draw are circles. An algorithm similar to Bresenham's line drawing algorithm, called the Midpoint Circle Algorithm, has been developed for drawing a circle efficiently.

A circle is defined by a centre point, and a radius. Points on a circle are all the radius distance from the centre of the circle. The centre point has an X and Y coordinate.



Try to draw a circle by hand by filling in pixels (without using a ruler or compass). Note how difficuilt it is to make the circle look round.

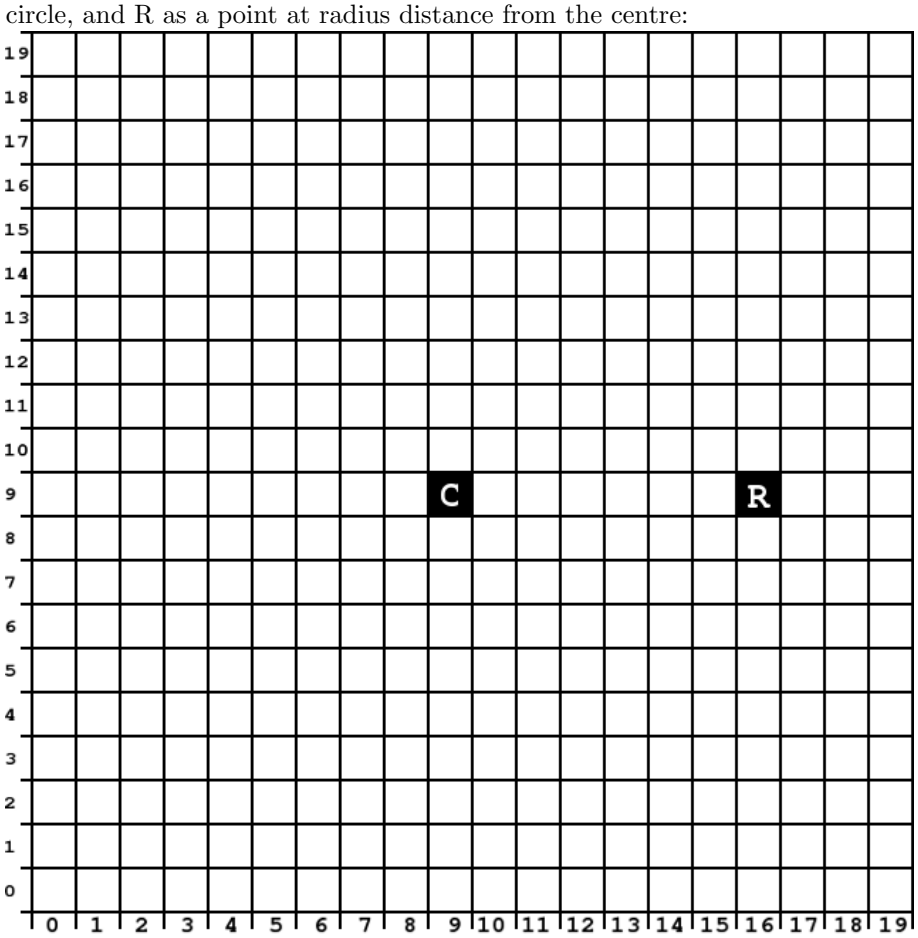
6 Midpoint Circle Algorithm

Here are the rules for the Midpoint Circle Algorithm:
E = -Radius
X = Radius
Y = 0

Until Y becomes greater than X, repeat the following rules in order:

- Fill the pixel at coordinate (X + Centre_X, Y + Centre_Y)
- Increase E by 2 × Y + 1
- Increase Y by 1
- If E is greater than or equal to 0, subtract (2X - 1) from E, and then subtract 1 from X.

Follow the rules to draw a circle on the grid, using C as the centre of the circle, and R as a point at radius distance from the centre:



When Y becomes greater than X, one eighth (an octant) of the circle is drawn. The remainder of the circle can be drawn by reflecting the octant that

you already have. Reflect pixels along the X and Y axis, such that the line of reflection crosses the middle of the centre pixel of the circle. Half of the circle is now drawn, the left and the right half. To add the remainder of the circle, another line of reflection must be used. Can you work out which line of reflection is needed to complete the circle? Think about thq reflection required before turning the page to check the answer.

To complete the circle, you need to reflect along the diagonal. The line of reflection should have a gradient of 1 or -1, and should cross through the middle of the centre pixel of the circle.

While using a line of reflection on the octant is easier for a human to understand, a computer can draw all of the reflected points at the same time it draws a point in the first octant.

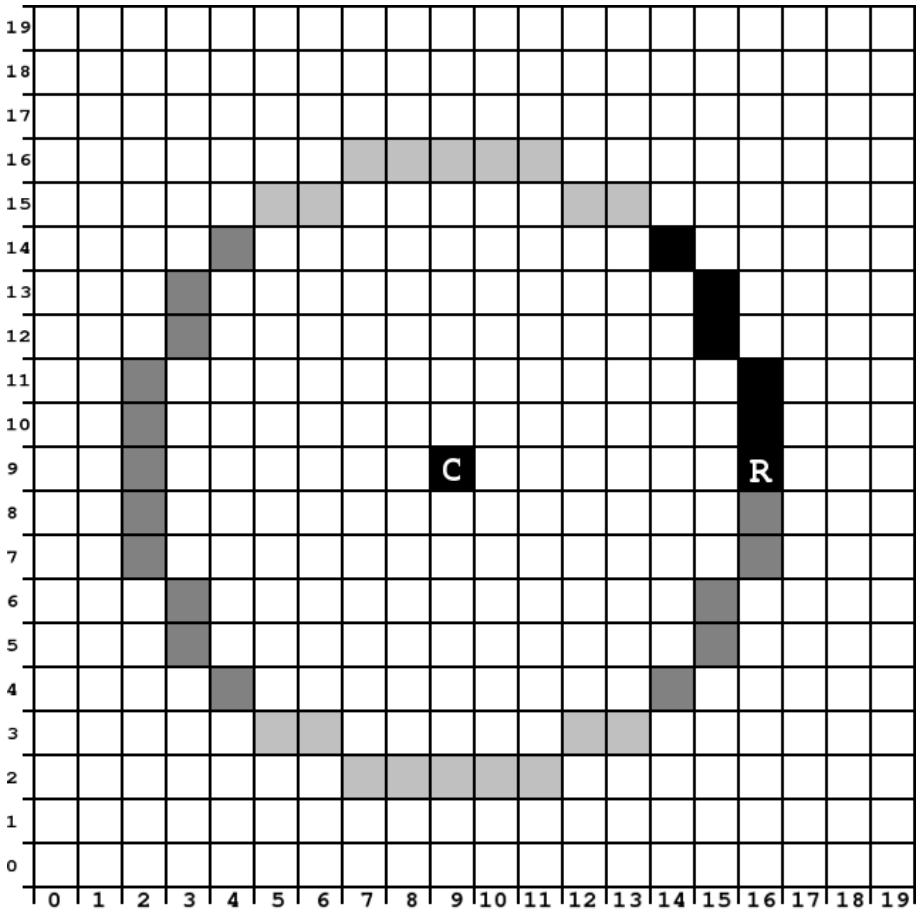
7 What's it all about?

Computers need to draw lines and circles for a wide variety of tasks. From game graphics to lines in an archetect's drawing and even to a tiny circle for the dot on the top af the letter 'i' in a word processor. By combining line and circle drawing with filling and antialiasing, computers can draw smooth, clear images. When an image on a computer is described as an outline and fill colours it is called vector graphics. Vector graphics can be re-drawn at any resolution. This means that with a vector image, zooming into the image will not cause the pixelation seen when zooming in to bitmap graphics.

Outline fonts are one of the most common uses for vector graphics. Allowing the text size to be increased to very large sizes, with no loss of quality to the letter shapes.

Teacher's answer sheet for the Midpoint Circle Algorithm

Correct pixels



The black pixels represent the initial octant of the circle drawn by the algorithm. The darker gray pixels represent reflection along the X and Y axis. The lighter gray pixels represent the reflection along a diagonal.

Correct values during calculation

E_0 = -7, X_0 = 7, Y_0 = 0; Plot pixel (16, 9).
E_1 = -6, Y_1 = 1; Plot pixel (16, 10).
E_2 = -3, Y_2 = 2; Plot pixel (16, 11).
E_3 = 2, Y_3 = 3;
E_4 = -11, X_4 = 6; Plot pixel (15, 12);
E_5 = -4, Y_5 = 4; Plot pixel (15, 13);
E_6 = 5, Y_6 = 5;
E_7 = -6, X_7 = 5; Plot pixel (14, 14);
E_8 = 5, Y_8 = 6; Y is greater than X, so we can now reflect our octet.