2015

Coding to Meeting Math Expectations

PROBLEM SOLVING THROUGH CODING

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Rubric – Applying Mathematical Processes through Coding to Solve Problems

Curriculum Expectation: <Insert expectation here>

The Student…	LEVEL				
Criteria	**4**	**3**	**2**	**1**	**R**
KNOWLEDGE					
Understanding of mathematical concepts (significance of given and required information, comprehension of calculations)	*Demonstrates thorough understanding of math concepts and meaning of the calculations in the code*	*Demonstrates considerable understanding of math concepts and meaning of the calculations in the code*	*Demonstrates some understanding of math concepts and meaning of the calculations in the code*	*Demonstrates limited understanding of math concepts and meaning of the calculations in the code*	
INQUIRY					
Use of critical/creative thinking processes (problem solving, computational strategies, verifying/testing/debugging)	*Uses problem solving skills and selects computational strategies to solve the math problem through coding with a high degree of effectiveness*	*Uses problem solving skills and selects computational strategies to solve the math problem through coding with considerable effectiveness*	*Uses problem solving skills and selects computational strategies to solve the math problem through coding with some effectiveness*	*Uses problem solving skills and selects computational strategies to solve the math problem through coding with limited effectiveness*	
	Tests the program using varying input values and debugs the program with a high degree of effectiveness	*Tests the program using varying input values and debugs the program with considerable effectiveness*	*Tests the program using varying input values and debugs the program with some effectiveness*	*Tests the program using varying input values and debugs the program with limited effectiveness*	
COMMUNICATION					
Expression and organization of ideas and mathematical thinking (meaningful variable names, input/output statements with mathematics vocabulary)	*Expresses and organizes math thinking in interface and code with a high degree of effectiveness*	*Expresses and organizes math thinking in interface and code with considerable effectiveness*	*Expresses and organizes math thinking in interface and code with some effectiveness*	*Expresses and organizes math thinking in interface and code with limited effectiveness*	
APPLICATION					
Transfer of knowledge and skills to new contexts (applies programming through mathematical procedures to real life situation)	*Transfers knowledge and skills of mathematical situations to computer program code with a high degree of effectiveness*	*Transfers knowledge and skills of mathematical situations to computer program code with considerable effectiveness*	*Transfers knowledge and skills of mathematical situations to computer program code with some effectiveness*	*Transfers knowledge and skills of mathematical situations to computer program code with limited effectiveness*	

By: Lisa Floyd(@lisaannefloyd), 2015 – Adapted from: Ministry of Education, Mathematics, Grades 1-8, 2005

A Problem-Solving Model and Coding

How coding incorporates George Poyla's four-step model for solving math problems

Understand the Problem (the exploratory stage)
In this stage, students may:

- ✓ Ensure they can perform the calculations required to solve the problem (i.e., pencil-paper practice of simple problems provided by the teacher)
- ✓ Spend some time reading the problem and restating it
- ✓ Consider what information is being given and the information that needs to be determined (i.e., input/output values)
- ✓ Decide what variables are required
- ✓ Talk about the problem to understand it better

Make a Plan
In this stage, students may:

- ✓ Give variables a meaningful name
- ✓ Write out the algorithm (step-by-step instructions) in English
- ✓ Decide how the calculations will be used in the program
- ✓ Write out the equations/calculations required
- ✓ List the questions that will be asked of the user to obtain the information required
- ✓ Determine what information will be outputted
- ✓ Discuss with others to clarify which strategies would work best
- ✓ Prepare a flow-chart to show plan

Carry Out the Plan
In this stage, students may:

- ✓ Design the interface
- ✓ Declare necessary variables (for known and unknown information), give each a meaningful name
- ✓ Write the code, including necessary calculations
- ✓ Debug (revise or apply different strategies as necessary)
- ✓ Document (comment) their code in English
- ✓ Share results

Look Back at the Solution
In this stage, students may:

- ✓ Continue to debug
- ✓ Check reasonableness of answer by testing the program with different input/data/values
- ✓ Review the method used – Did it make sense? Is there a better or more efficient way to solve the problem?
- ✓ Consider extensions or variations (teacher may suggest extension to program or students come up with their own)
- ✓ Explain their code

Retrieved and adapted from:

Ministry of Education, The Ontario Curriculum, Grades 1-8, Mathematics, 2005

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A Problem-Solving Model and Coding- Grade 5

Grade 5 Measurement Relationships
Specific Expectation:
By the end of Grade 5, students will:
-solve problems involving the relationship between a 12-hour clock and a 24-hour clock (e.g., 15:00 is 3 hours after 12 noon, so 15:00 is the same as 3:00 p.m.)

SAMPLE PROGRAM:

Create a program that will convert the 24 hour clock time entered by the user to 12 hour clock time (hours only). The program will also indicate whether the time is in the morning (AM) or afternoon (PM).

Applying George Poyla's four-step model to solving this problem:

Understand the Problem (the exploratory stage)

Teacher ensures students can convert from 24 hour to 12 hour clock time (suggest backward approach… give students answer, they determine rules):

How to change the hour from a 24 Hour Clock time to 12 Hour Clock time:

If the number is above 12, then it is afternoon. We also need to subtract 12 from the time.

If the number is 12 or less, then it is morning. We do not need to subtract 12 from the time.

E.g. 14:00

14 is greater than 12, so it is PM
14 – 12 = 2
14 hours in a 24 hour clock is 2 PM in 12 hour clock time.

E.g. 3:00

3 is less than 12, so it is AM
3 hours in a 24 hour clock is 3 AM in 12 hour clock time.

INPUT Value(s):

-24 Hr Clock Time (variable)

OUTPUT Value(s):

-12 Hr Clock Time (variable)
-AM or PM (variable)

Make a Plan

Algorithm (in pseudocode):

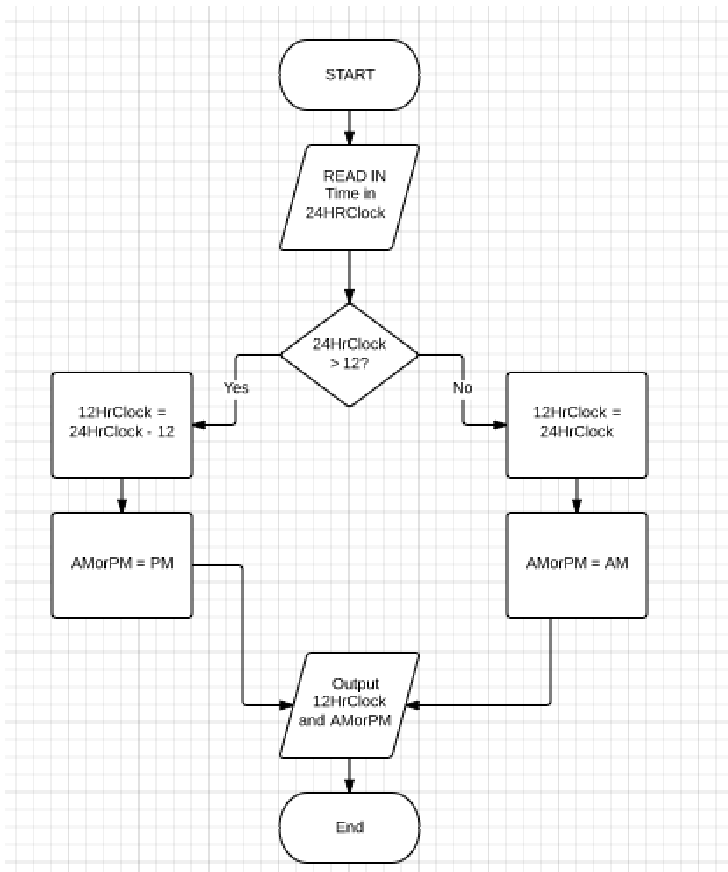
```
Declare variables:  24hourclocktime, 12hourclocktime, AMorPM

Ask user for time in 24 hour clock
Store user answer in 24hourclocktime

If 24hourclocktime > 12 then
   12hourclocktime = 24hourclocktime – 12
   AMorPM = PM
Else
   12hourclocktime = 24hourclocktime
   AMorPM = AM
End If

Output to user the time in the 12 Hour Clock Time as well as whether it is
AM or PM.
```

Flowchart:



Carry Out the Plan

Actual coding here!

Here is the link to a tutorial explaining how to create this program:
https://www.youtube.com/watch?v=2ca96J_9UcA&feature=youtu.be

Look Back at the Solution

Try different values (e.g., 1, 5, 13, 22) to ensure it works

Extensions:

- Include error checking – ensure user cannot enter a negative number or a number higher than 24
- Include minutes
- Output images of daylight/night time depending on if the time is AM or PM
- Output images of clock times, depending on time entered by user
- Create a program that will ask the user for the time in eastern standard time zone and convert it to another time zone, indicated by the user

Model retrieved and adapted from:

Ministry of Education, The Ontario Curriculum, Grades 1-8, Mathematics, 2005

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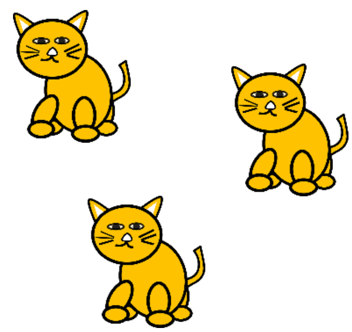
Grade 4 - Coding Patterns

Patterning and Algebra
Patterns and Relationships - Specific Expectations
By the end of Grade 4, students will:

– extend, describe, and create repeating, growing, and shrinking number patterns (e.g.,"I created the pattern 1, 3, 4, 6, 7, 9, ... I started at 1, then added 2, then added 1, then added 2, then added 1, and I kept repeating this.");
– connect each term in a growing or shrinking pattern with its term number (e.g., in the sequence 1, 4, 7, 10, ..., the first term is 1, the second term is 4, the third term is 7, and so on), and record the patterns in a table of values that shows the term number and the term;
– create a number pattern involving addition, subtraction, or multiplication, given a pattern rule expressed in words (e.g., the pattern rule "start at 1 and multiply each term by 2 to get the next term" generates the sequence 1, 2, 4, 8, 16, 32, 64, ...)

Part A Basic Understanding of Patterns

Show the pattern that is described in each situation by drawing pictures and/or using numbers. The first one has been done for you.



1) Cindy draws a picture of a cat every day.
   On the first day, she draws 1 cat.
   On the second day, she draws another cat, making it 2 cats in total.

   How many cats will Cindy have drawn after 8 days?

   Answer:

Day	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Number of Cats	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*

   After 8 days, Cindy will have drawn 8 cats.

2) Cindy draws two pictures of cats every day.
   On the first day, she draws 2 cats.
   On the second day, she draws 2 more cats, making it 4 cats in total.

   How many cats will Cindy have drawn after 6 days?

PART B The Basic Program

Create a program that does the following:

- ✓ Asks the user for the number of cats that Cindy draws each day
- ✓ Outputs the number of cats after each day for 5 days
- ✓ Test your program with the following numbers entered by the user: 1,2,4,5.

Here is a video tutorial link that shows you how to create this program. You may adjust the sprites, colours, etc., to your liking:

The Basic Program Link (https://www.youtube.com/watch?v=ZBDRzoTbY_k&feature=youtu.be)

PART C The Challenge Program

Roger has 2 pet rabbits.

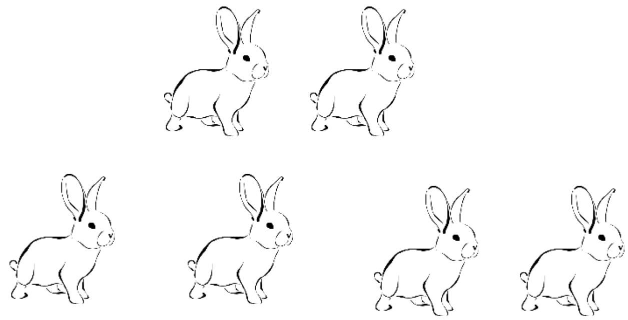
One month later, he has 4 pet rabbits.

Every month for 10 months, the rabbit population DOUBLES.

Write a program that shows the user how many rabbits Roger will have after 10 months if he starts out with two rabbits at month 1.

E.g.

Month	Number of Rabbits
1 (starting month)	2 **
2	4 ** **
3	8 ** ** ** **
4	16 ** ** ** ** ** ** ** **



Possible Answer (link to video Tutorial):

The Challenge Program Link (https://www.youtube.com/watch?v=sQN4kJqkrdM)

PART D Further Extensions

a) Adjust your Part C program to allow the user to enter the number of months.
b) Write a program that will also draw the number of rabbits for each month on the screen.
c) Write a program that uses lists as well as variables and displays the output in a table format.
d) Write a scenario for a pattern and create a program to go with it.

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Grade 6 Mathematics – Understanding the Significance of Large Numbers

Grade 6: Number Sense and Numeration: - Quantity Relationships ***Curriculum Expectation:*** *By the end of Grade 6, students will:* – solve problems that arise from real-life situations and that relate to the magnitude of whole numbers up to 1 000 000 (Sample problem: How would you determine if a person could live to be 1 000 000 hours old? Show your work.);

PART A Basic Understanding of Magnitude of Whole Numbers

1) a) If a chick is 48 hours old, how many days old is it?

   b) If a dog is 1 095 days old, how many years old is it?

   c) If a cat is 113 880 hours old, how many years old is it?

First determine, number of days old by dividing by 24, since there are 24 hours in one day.

Then, determine number of years old by dividing by 365, since there are 365 days in one year.

2) Determine how old you were in hours on your most recent birthday.

3) Can someone live to be 1 000 000 hours old? Show your work.

4) Ronald runs across Canada and records the total number of steps on his stepper app. He takes 13 042 000 steps and each step is about 0.5 m long. What is the distance in kilometers that he ran?

PART B The Basic Program

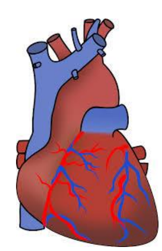
Create a program that:

- ✓ Asks the user how many years old they were on their last Birthday
- ✓ Calculates the approximate number of hours old they were on their last Birthday and outputs this information to the user

Basic Program Link:

https://www.youtube.com/watch?v=o5cCRiOjJe4

PART C The Challenge Program



Create a program that:

- ✓ Tells the user the program will calculate how many litres of blood their heart will pump over a given period of time

- ✓ Asks the user for the number of days they would like to know the amount of blood their heart will pump
- ✓ Calculates the approximate amount of blood in litres their heart will pump for the number of days indicated by the user and outputs this information
  NOTE: An average adult heart pumps about 280 L per hour

Possible Challenge Program Answer Link:

https://www.youtube.com/watch?v=yjUBM6o7mok

PART D Further Extensions

Create programs or add to your current programs:

- ✓ Ask the user for the number of years old they are and the number of months since their last Birthday. Calculate the number of hours old they are and the amount of blood (in litres) that their heart has pumped in their lifetime.
- ✓ If the length of each of Joe's steps is about 0.5 m and he walks across Canada, how many steps will it take? Calculate the same information for each province. Adjust the program to allow the user to indicate the length of their step.
- ✓ If a tower as high as the CN tower is built using Lego blocks, how many Lego blocks would be needed?
- ✓ How many football fields would span the circumference of Earth?

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Grade 6 - Coding Unit Conversions

Grade 6: Measurement Relationships
Curriculum Expectation
By the end of Grade 6, students will:
– solve problems requiring conversion from larger to smaller metric units (e.g., metres to centimetres, kilograms to grams, litres to millilitres)

Part A Basic Understanding of Unit Conversions

Complete the following practice questions. The first one has been done for you.

1) Convert 10 Kg to grams (Note: There are 1000 g in 1 Kg).

To go from kilograms to grams, multiply by 1000.

10 ~~kg~~ x 1000g/~~kg~~ = 10 000 g

2) Convert 5 m to centimetres (Note: There are 100 cm in 1 m).

3) Convert 0.5 L to millimetres (Note: There are 1000 mL in 1 L).

4) Convert 0.23 Kg to grams.

Part B The Basic Program

Create a program that does the following:

- ✓ Asks the user for the number of metres
- ✓ Calculates and outputs the number of centimeters

Here is a video tutorial link that shows you how to create this program. You may adjust the sprites, colours, etc. to your liking:

The Basic Program Link (https://www.youtube.com/watch?v=2q9Wc3Vm8nM)

Part C The Challenge Program

You will create a program that asks the user if they would like to convert from kilograms to grams or grams to kilograms and will output the result.

The program will:

- ✓ Determine if the user would like to convert from kilograms to grams or grams to kilograms
- ✓ Calculate the conversion
- ✓ Output the proper conversion to the user

Possible Answer (link to video tutorial):

The Challenge Program Link (https://www.youtube.com/watch?v=4Uq7RARmTWE)

Part D **Further Extensions**

a) Give the user multiple unit conversion options (m to cm, L to mL).
b) Give the user the option to calculate the unit rate, given a certain price.

Grade 6 – Coding Unit Rates

Grade 6: Number Sense and Numeration - Proportional Relationships ***Curriculum Expectation*** *By the end of grade 6, students will:* – represent relationships using unit rates (Sample problem: If 5 batteries cost $4.75, what is the cost of 1 battery?).

PART A  Basic Understanding of Unit Rate Calculations

Complete the following practice questions. The first one has been done for you.

1) If 5 apples cost $5.00, how much does one apple cost?  

```
Divide the dollar amount by the number of apples:

$5.00/5 = $1.00

One apple will cost $1.00
```

2) If 6 large yogurt tubes cost $12.00, how much does one large yogurt tube cost?

3) If 4 rulers cost $16.00, how much does one ruler cost?

4) If 5 batteries cost $4.75. What is the cost of 1 battery?

PART B The Basic Program

Create a program that does the following:

- ✓ Asks the user for the cost
- ✓ Asks the user for the number of items they get for that amount of money
- ✓ Calculates and outputs the unit rate

Here is a video tutorial link that shows you how to create this program. You may adjust the sprites, colours, etc. to your liking:

The Basic Program Link (https://www.youtube.com/watch?v=uU9slffoF38&feature=youtu.be)

PART C The Challenge Program

You will create a program that asks the user for prices and number of items of products at two different stores. The program will then determine the unit rate for the products at both stores and tell the user which is the better deal.

The program will…

- Ask the user for the cost of the item from store #1
- Ask the user for the number of items included for that price
- Ask the user for the cost of the item from store #2
- Ask the user for the number of items included for that price
- Calculate the unit price for each store
- Output the unit prices for each store
- Determine which is the better deal (the smaller unit price)
- Output to the user which item is a better deal

Possible Answer (link to video tutorial):

The Challenge Program Link (https://www.youtube.com/watch?v=9OPSS-xIlic)

PART D **Further Extensions**

a) Ask user for dollar amount they would like to pay with, determine change.
b) Add a third store for price comparison.
c) Round the answer to two decimal places.
d) Create a receipt button for the user's purchase that includes change given.

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Coding a Star

Grade 7 Curriculum Expectations: Geometry (and a little Number Sense)

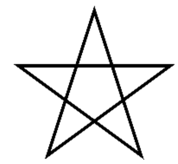
By the end of grade 7, students will:

-plot points using all four quadrants of the Cartesian coordinate plane

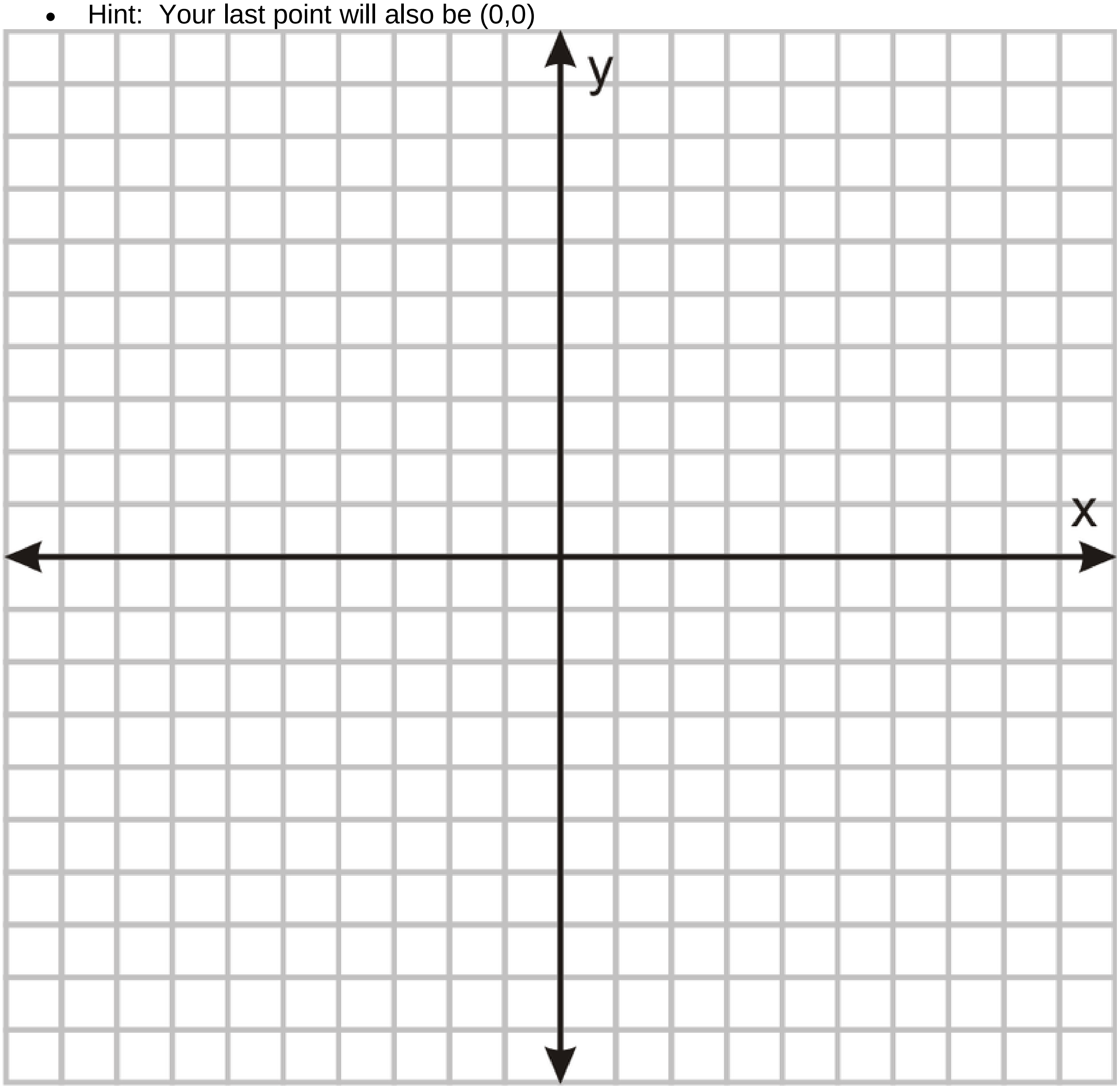
-represent, compare and order numbers, including integers

Here are the sets of (x,y) coordinates you can use (they are not in order):

(0, 0)	(75, 60)
(60, 0)	(30, 90)
(-15, 60)	(0, 0)



- Plot the points
- Start at 0,0
- Label your coordinates in order from A to F (starting with 0,0) to make a star (you'll need to determine the proper order)
- Hint: Your last point will also be (0,0)



Go to this link: **http://tinyurl.com/startvdsb**
Move the sets of blocks into the code in order, based on your diagram above (from A to F).
Click on the green flag to check if you've made a star with the correct points!