

Chapter 5: Linear Relations, Equations, and Inequalities

5.1 (Part 1) Describing Relations Algebraically

Goal: Use symbols to describe a pattern that changes at a constant rate.

Relation:

Ex 1: A cell phone plan has a connection fee of \$15 plus \$2 per minute charge. A relation exists between the number of minutes and the total charges. This relation can be shown using symbols:

Total charge for 1 minute:

Total charge for 2 minutes:

Total charge for 3 minutes:

RATE OF CHANGE: The amount that changes per unit time. In this example, the price increase per minute would represent the rate of change here.

What is the rate of change of the cell phone plan?

How would we calculate the total cost?

We can show the cell phone plan as an equation. Let C represent the total cost and n be the number of minutes.

Now, let's use our equation to determine the total cost after 30 minutes.

How many minutes would have to have been used to obtain a total cost of \$107?

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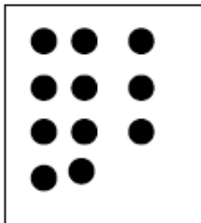
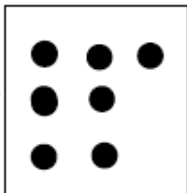
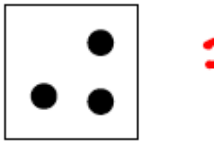
Let's make a table of values from our equation:

n	C
0	
1	
2	
3	

How can we use this table to help us determine the rate of change?

Ex 2; Patterns can be shown in several ways:

a) With a picture:



b) With a table of values:

Fig # (F)	# dots (d)
1	
2	
3	

c) With an equation:

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Practice: Determine the rate of change and the starting number for the following table of values and write an equation.

x	y
0	
1	
2	
3	

x	y
0	
1	
2	
3	

x	y
0	
2	
4	
6	

Practice: Determine the rate of change and the starting number.

$$y = -2x + 7$$

$$y = 5x - 3$$

Practice: Create a table of values for the following equations.

$$y = 4x + 1$$

$$y = \frac{1}{2}x + 3$$

Homework: pg. 204 #1-3, 4c, 6, 11ace, 12ace, 15, Worksheet

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5.1 (Part 2) Describing Relations Algebraically

Formula:

Ex 1: Tables are joined at ends. Each table can seat 2 on each length, and 1 on each end.

- a) Complete a table of values for up to 5 tables.

- b) Determine the rate of change and the starting number.

- c) Write the relation algebraically.

- d) How many chairs would we need for 10 tables?

- e) How many tables would be needed to fit 30 chairs?

Ex 2: David tutors math. He charges a flat fee of \$15 plus \$2.50 per hour.

- a) Create a table of values for up to 4 hours.

- b) Write a relation.

- c) What will David charge for 12 hours of tutoring?

1. Ryan's part time job pays him \$8/h. a) Create a table showing the relationship between hours worked (h), beginning at 0, and total wages (W). b) Write an equation comparing W to h . c) How much will Ryan earn after working 12 hours? d) How many hours must Ryan work to earn \$172?

a)

h	W
0	

b)

c)

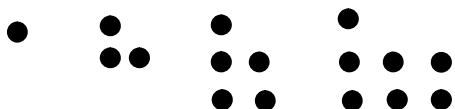
d)

2. Describe the following using an equation.

a) An amusement park charges a \$3 entrance fee plus \$0.50/ride

b) The Perimeter of a square with side length x

c) The number of dots in each of the figures below



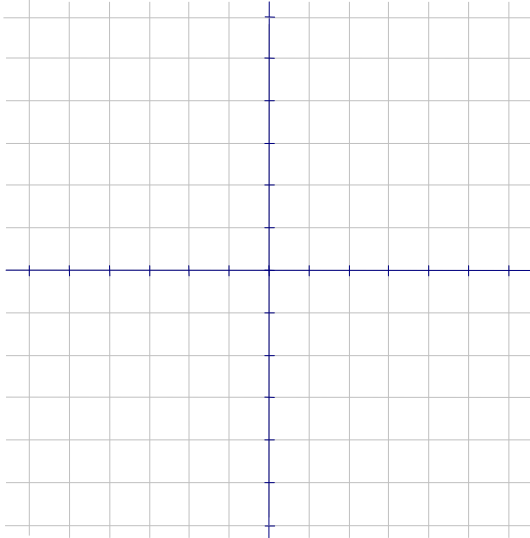
3. This table shows the details of a phone plan. With this pattern, a) Write an equation comparing C to T . b) what is the cost for 120 minutes of calls, and c) how many minutes can be purchased for \$75?

Time (min)	0	5	10	15
Cost (\$)	15	17	19	21

4. For each of the following, a) complete a table of values b) graph c) determine the rate of change

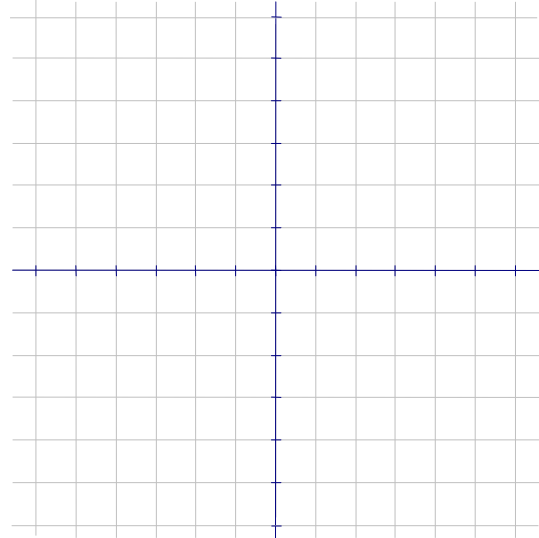
A) $y = 2x - 5$

x	y
0	
1	
2	
3	



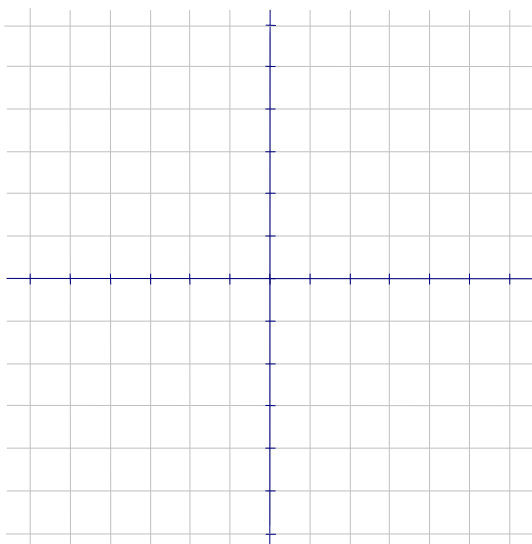
B) $y = 2 - 3x$

x	y
-1	
0	
1	
2	



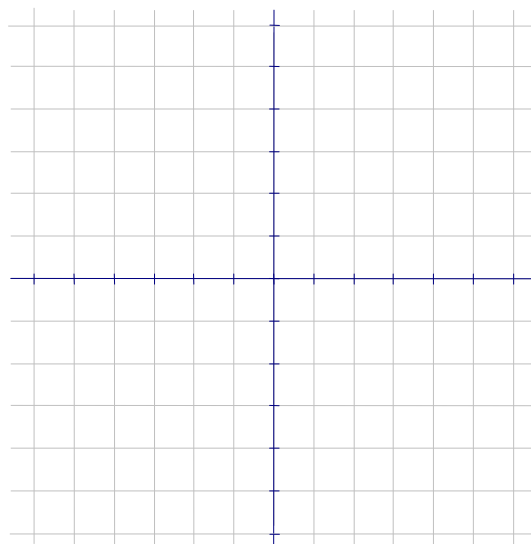
C) $y = \frac{x}{2} + 1$

x	-4	-2	-2	0
y				



D) $y = 1.5x + 2.5$

x	y
-3	
-1	
1	
3	

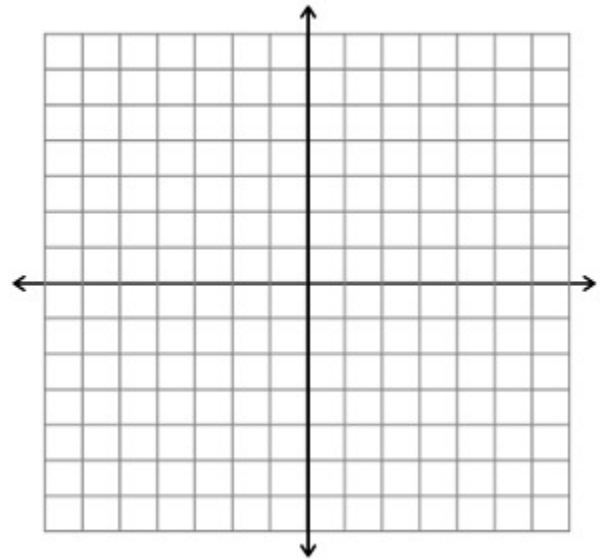


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5.2 Graphing Linear Relations

in section 5.1, we learned that relations can be shown as equations (2 variables) or as a table. If these ordered pairs are joined on graph paper, and the line is straight, then it is a LINEAR RELATION.

Ex 1: Create a table of values and graph $y = 2x - 1$



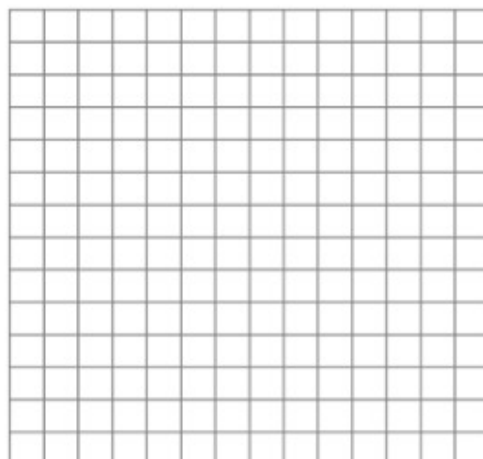
Ex 2: A car can carry a maximum of 90L of fuel. While driving, the car burns 12L/h.

Create a table of values. What is the rate of change?

The rate of change is _____ and is _____. If the RATE OF CHANGE is constant, then the graph is a _____ line and is called a _____.

Time (h)	Fuel Remaining
0	
1	
2	
3	
4	
5	

Let's graph:



Equation?

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The SLOPE (how steep the graph is) of the graph represents the rate of change. The bigger the slope, the more steep the graph is. Slopes can be _____, _____, or _____.

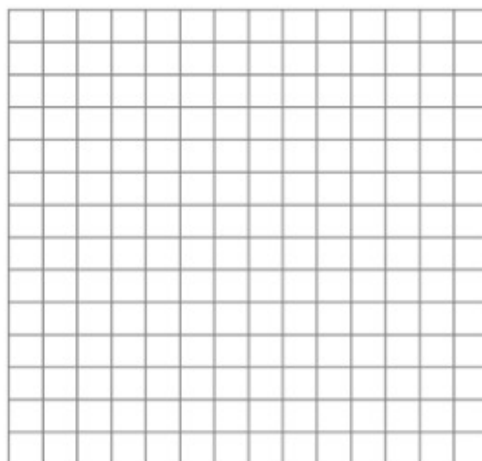
In our example, the rate of change or slope is _____ so the graph moves down and to the right. To calculate slope or rate of change, we can use the following formula:

We can use our graph to INTERPOLATE and EXTRAPOLATE data.

- Interpolate:
 - Ex:
- Extrapolate:
 - Ex:

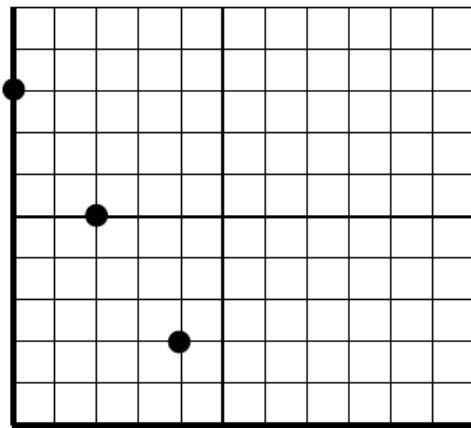
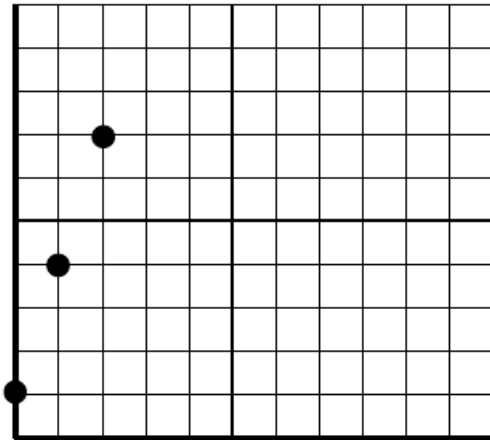
Ex 3: A taxi charges a start up fee of \$2.50 and a 50cent per minute charge.

- a) Write an equation to represent this relation.
- b) Graph the relation using a table of values.
- c) What is the rate of change?
- d) Interpolate: How much would a 2.5 minute taxi ride cost?
- e) Extrapolate: How much would a 11 minute taxi ride cost?



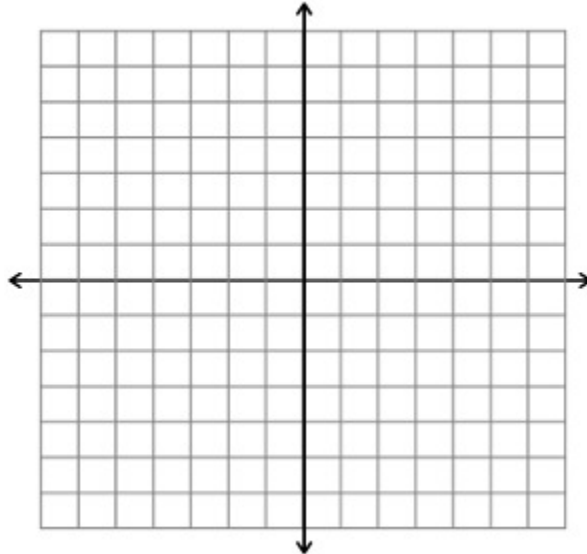
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Ex 4: Find the rate of change and the starting point for the following:



Ex 5: We can use the rate of change to find another point on the line.

a) Draw a line with a starting point of $P(2,1)$ with a rate of change of $\frac{2}{5}$.



b) What are the coordinates for 3 other points on the graph?

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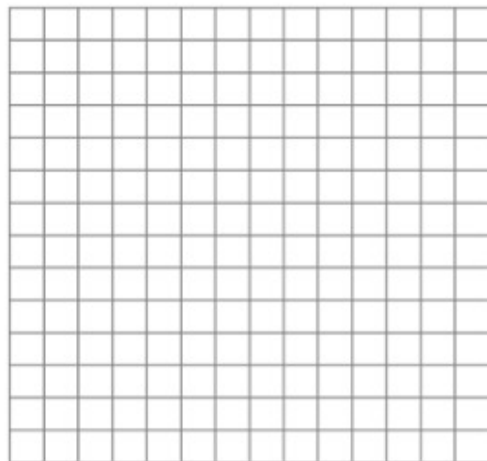
5.3 Interpreting the Solution of a Linear Equation

Ex 1: A cell phone company offers a set up fee of \$20 plus \$1.50/minute. How many minutes can we get for \$60?

There are 3 ways to answer this question:

a) Estimate the solution using a table of values:

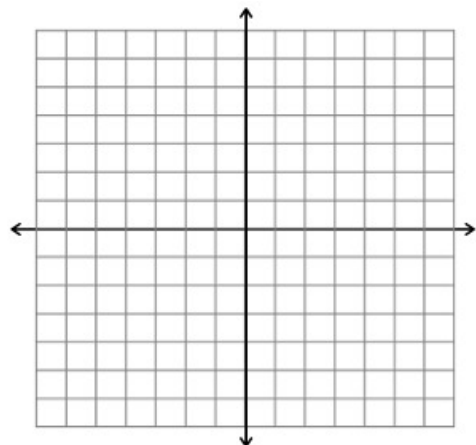
b) Estimate the solution by graphing:



c) Solve using an equation:

Ex 2: Estimate the solution to $\frac{2}{5}x + 1 = 4$, by using a table.

Ex 3: Estimate the solution $2x - 3 = 4$ by graphing.



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5.4 Solving Linear Equations

Review: Algebra – Solving for a variable

Rules:

1. Use reverse operations
2. Do BEDMAS in REVERSE
3. Do the same thing to both sides

Remember:

1. We don't like brackets. Get rid of them.
2. Collect like terms!

Practice:

1. $\frac{x}{4} = -7$

2. $-3a = -15$

3. $n - 6 = -5$

4. $5 = -4x + 3$

5. $4(x+1) + 6 = 22$

6. $\frac{2x}{3} + 4 = 10$

Ex 1: The Anderson's spent \$30.00 to enter the PNE fair. Each ride cost \$1.50. How many rides can they go on for \$48.00?

Step 1: Write an equation.

Step 2: Replace variables with numbers given in the question.

Step 3: Solve for the unknown.

Ex 2: Art is paid \$5000 + \$1.25/book that he sells. How many books does he need to sell to earn \$10,000?

Translating English into Math

English	Math
7 more than a number	
Twice a number	
4 less than a number	
3 more than one-half a number	
John's age in 5 years, if John is j years now	
Rachel's age last year if she is r years now	
If the width is w , find the length if the length is 4 more than twice the width	
If the length is L , find the width if the width is 5 less than the length	

- ✓ Sketch a diagram or create a chart
- ✓ Identify the UNKNOWN or UNKNOWNS, for example Mary's age now or the width
- ✓ Create an equation that describes the story
- ✓ Solve the equation
- ✓ Answer the question in a sentence

EXAMPLES

Jesse is 1 year older than three times as old as Ryan. In 6 years, the sum of their ages will be 61. How old are they now?

	Now	In 6 years
Jesse		
Ryan	r	
Total		

A number is doubled, and then decreased by 5. If the result is 9, find the original number.

The perimeter of a rectangle is 46 cm. If the length is 5 cm less than three times the width. What are the dimensions

1. John is three times as old as Amy now. In 4 years the sum of their ages will be 36, find their ages now.

	Now	In 4 years
John		
Amy	a	
Total		

2. Paul is 11 years older than Rennie now. In 5 years the sum of their ages will be 23. Find their ages today.

	Now	In 5 years
Paul		
Rennie	r	
Total		

3. A number is tripled, and then decreased by 7. The result is 32. What is the number? **Let x be the number**

4. A number is added to three times itself. Then, then decreased by 6. The result is 38. What is the number? **Let x be the number**

5. A rectangle has a perimeter of 60 cm. The length is 3 cm more than twice the width. What are the dimensions? **Sketch and label a diagram.**
Let w = the width

6. The width of a rectangle is 3 less than the length. If the perimeter is 34 cm, what are the dimensions? **Sketch and label a diagram.**
Let l = the length

7. When 8 is added to three times a number, the result is 41. What is the number?
Let x be the number

8. Next year, Paul will be twice as old as Francis. And the sum of their ages is 42.
Find their ages today

	Now	Next year
Paul		
Francis	f	
Total		

9. The perimeter of a rectangle is 126 cm. If the length is five times the width, find the dimensions of the rectangle. **Let the width be w**

10. The width of a rectangle is 3 cm more than one-half the length. If the perimeter is 54 cm, find the dimensions. **Let the length be L**

11. A number is doubled, and then increased by 5. That value is the same as the same number tripled then decreased by 2. What is the number?
Let x be the number

12. Teresa is 1 year older than twice Alex's age. In 7 years, the sum of their ages will be 57. How old are they now?

	Now	In 7 years
Teresa		
Alex	a	
Total		

An inequality is 'like' an equation, but uses symbols such as

$>$, $<$, \geq , and \leq

$>$ means greater than

$<$ means less than

\geq greater than = to

\leq less than or = to

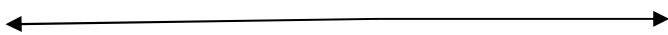
Shane wished to purchase a cell phone plan. The plan had an activation fee of \$20 plus \$0.50/minute. He had a maximum of \$24 to spend.

Inequality

$$20 + 0.50x \leq 24$$

Solve

Graph



Inequalities can be graphed for different set of numbers...

Natural numbers (N)

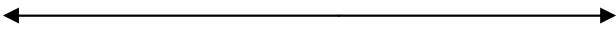
Whole Numbers (W)

Integers (I)

Rational numbers (Q)

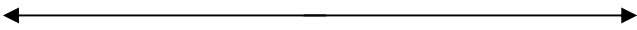
To graph Natural, Whole, and Integers, USE DOTS

$$x \geq 2$$

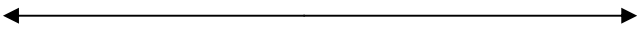


To graph Rational numbers, USE AN ARROW

$$x \geq 2$$



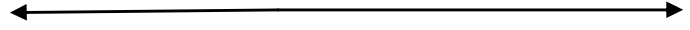
$$x < -1$$



Practice: Graph and label

$$x \leq 4, x \text{ is an integer}$$

$$x > -3, x \text{ is a rational number}$$



$$x < 5, x \text{ is an integer}$$



An inequality can have 2 'endpoints'

$$-3 < x \leq 2, x \text{ is an integer}$$



$$-3 < x \leq 2, x \text{ is a Rational number}$$



Practice: Graph

$$-2 \leq x < 4, x \text{ is an integer}$$



$$0 < x \leq 4, x \text{ is a Rational number}$$



Write 2 possible inequalities for the following. x is an integer



Graph $x < -1$ **or** $x \geq 3$, x is an integer



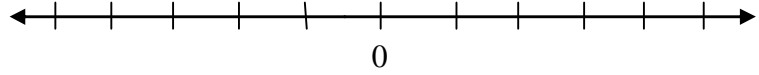
Now graph $x < -1$ **or** $x \geq 3$, x is a rational number



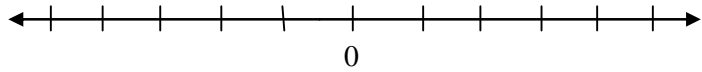
C/w p. 254 # 1, 2, 4ace, 6ac

Graph the following

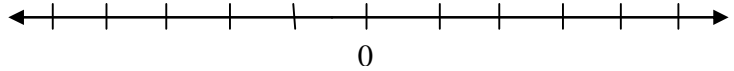
1. $x < 3$, for integers



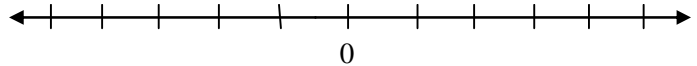
2. $x \geq \frac{5}{2}$, for rational numbers



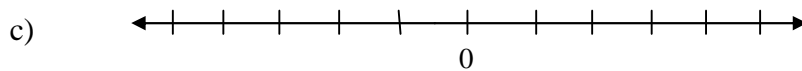
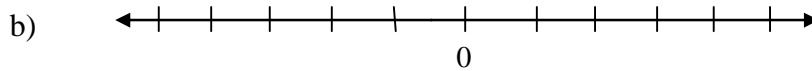
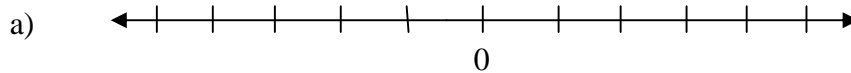
3. $x \leq 5$, for whole numbers



4. $-3 < x \leq 2$, for rational numbers



5. Write a possible inequality sentence for each of the following



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5.5 Equation Solving Strategies

A. Equations Involving Fractions

Ex 1: $\frac{x}{5} + 3 = \frac{1}{2}$

Ex 2: $\frac{x+2}{5} + \frac{1}{4} = 5$

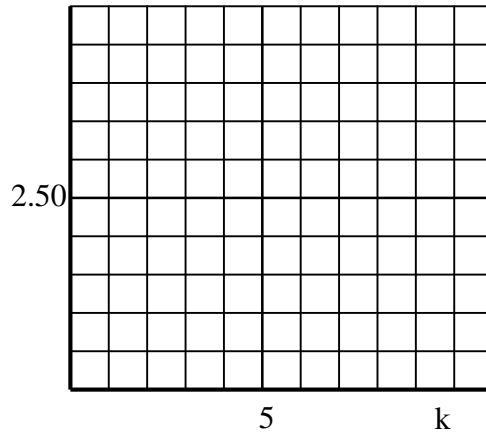
B. Equations with a) Like Terms and b) Variables on Both Sides

Ex 1: $3x + 5x - 2 = 4x + 10$

Ex 2: $8a + 1 = 5a - 4$

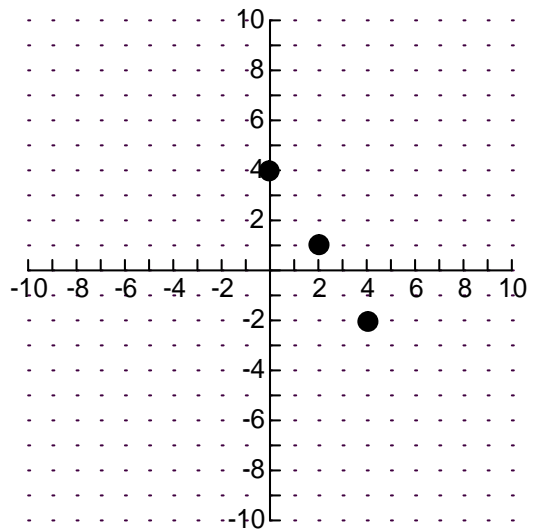
1. A taxi charges \$ 0.50/km plus a flat fee of \$2.50. If k represents the number of kilometers, and C represents his total cost of the ride, determine the equation relating the total charges to the number of kilometers and graph

n	C
0	
1	
2	
3	
4	
5	



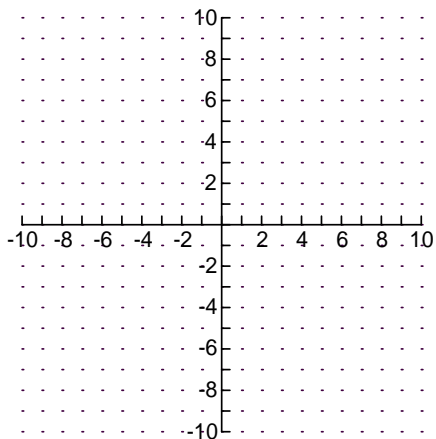
2. Determine the rate of change, start #, and equation for the following.

x	3	6	9
y	7	9	11



3. Determine the rate of change and starting number for the relation $y = -3x + 7$.
4. Graph and label $y = -2x + 4$ using a table of values

x	y
-3	
-1	
0	
1	
2	



5. Solve the following equations

a) $2(3x - 1) + 4x = 5x + 6$ b) $\frac{x}{4} + \frac{2}{3} = 2$ c) $\frac{x-1}{2} + \frac{3}{2} = 5$

6. Helen is 3 older than twice Keith's age. In 5 years the sum of their ages will be 49. Create and solve an equation. Determine their ages now

Keith		
Helen		
Total		

7. The length of a rectangle is 1 cm less than twice the width. If the perimeter is 82 cm, write, solve an equation and determine the dimensions

8. Solve and graph the following inequalities.

a) $3x - 1 \leq 11$, for integers b) $\frac{2a}{5} + 4 > 7$, for rational numbers



c) $-2x > -10$, for whole numbers



9. Identify two possible inequality sentences for the following graph, for integers

