

Real World Applications in MTH 05 Problem Book ¹

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Preface

This is a problem book for MTH 05. The intention of the book is to present problems that use real world data that students find interesting. Since real world data is being used, sometimes the calculations can be cumbersome. We suggest two ways to avoid cumbersome calculations: 1) Allow a calculator on some questions, or 2) Tell students to round the data to some precision before doing any calculations (some questions explicitly ask the student to round the number). The topics are numbered so that the numbers match the numbering in the corresponding MTH 05 WeBWork course. Some caveats about this problem book: 1) The problems do **not** cover all the topics in MTH 05; 2) This is only a problem book; it is up to the instructor to incorporate these problems into his/her course.

1

Review of Fractions

No Problems.

2

Real Numbers–Introduction

No Problems.

3

Real Numbers—Adding and Subtracting

For more problems of this type see WeBWork (real world problems).

1. In the year 2014, the highest subway station was the Smith-9 Street station (F and G trains); it is 88 feet *above street level*. The lowest station was the 191st 1 station; it was 180 feet *below street level*. What is the difference in heights between these two stations?

4

Real Numbers—Multiplying and Dividing

No Problems.

5

Exponents and Order of Operations

No Problems.

6

Transition to Algebra

No Problems.

7

Evaluating Algebraic Expressions

1. If you use the MTA (subway or bus) u times in a month, then you would save $2.5u - 112$ dollars if you bought a monthly pass instead of paying the single fare each time (*this works for the year 2014*).
 - (a) If you use the MTA 100 times in a month how much do you save with a monthly pass?
 - (b) If you use the MTA 50 times in a month, how much do you save with a monthly pass?
 - (c) If you use the MTA 11 times, how much do you save with a monthly pass? The answer is negative, right? What does that mean?
2. At Bronx Community College 57.9% of the students are female and 42.1% of the students are male (*in the year 2012*). Thus if there are x students in a room you would expect there to be $x \cdot (57.9\%) - x \cdot (42.1\%)$ more females than males (*remember what percent means; for example 22.13% is the same as 0.2213*).
 - (a) If there are 100 BCC students in your class, how many more women do you expect there to be?
 - (b) If there are 50 BCC students at a meeting, how many more women do you expect there to be?
 - (c) Count the number of BCC students in your class. According to the formula, how many more women are there? In reality, how many more women are there?
 - (d) What factors might make the formula inaccurate?
 - (e) Try out the formula $x \cdot (15.8\%)$ in the questions above. You should get the same answers! Why?

3. The area of The Bronx is 42 square miles. Consider a square plot of land where one of the sides is of length y (measured in miles). The number of such plots that fit into The Bronx is $\frac{42}{y^2}$ (if you somehow used every inch of land in The Bronx).
- How many one mile by one mile square plots fit into The Bronx?
 - How many half mile by half mile plots fit into The Bronx?
 - If the plot has side length 0.1, how many can fit into The Bronx?
 - In New York City the average home size is equivalent to a square plot with a side of length 34 feet. How many average homes could we fit into The Bronx?
(Keep your units straight! A mile is 5280 feet, so f feet is equivalent to $\frac{f}{5280}$ miles).
4. The following are some bridge tolls in New York City (without an EZ pass): The Henry Hudson Bridge costs \$5, the Bronx-Whitestone Bridge costs \$7.5, and the Verrazano Bridge costs \$15.
- Suppose someone used the Henry Hudson Bridge H times, the Bronx-Whitestone Bridge B times, and the Verrazano Bridge V times. Then the average toll paid is given by the following expression: $\frac{5H + 7.5B + 15V}{H + B + V}$
- Suppose you use the Verrazano Bridge 3 times, the Bronx-Whitestone Bridge twice, and the Henry Hudson Bridge 5 times. What is the average toll you paid?
 - Suppose you use the Bronx-Whitestone Bridge 5 times and the Henry Hudson Bridge 15 times; and you did not use the Verrazano Bridge at all. What is the average toll you paid?
 - Suppose you used the Henry Hudson Bridge 4 times, the Henry Hudson Bridge once, and the Verrazano Bridge once. What is the average toll you paid?
5. According to our textbook, if you are driving your car x miles per hour and suddenly hit the brakes, your car will skid about $2\sqrt{5x}$ feet before coming to a stop.
- If you are going 5 miles per hour and hit the brakes, how far will you skid?
 - If you are going 20 miles per hour and hit the brakes, how far will you skid?
 - If you are going 45 miles per hour and hit the brakes, how far will you skid?

6. Which one is correct to say? Grand Central Depot? Grand Central Station or Grand Central Terminal?

Here is a little of history: Grand Central Depot opened in 1871, after renovation and expansion in 1901 it became Grand Central Station, and finally in 1913 Grand Central Terminal unveiled.

Evaluate the three expressions; one will evaluate to 1871, one to 1901, and one to 1913.

(a) $\frac{9b - 15c}{3a} - 87$ for $a = \frac{1}{4}$, $b = 125$, and $c = -25$

(b) $\frac{2a - 2bc}{bc}$ for $a = 187$, $b = -2$, and $c = -1$

(c) $11(a^2 + 7\sqrt{b-c}) + 108$ for $a = -11$, $b = 36$, and $c = -9$

8

Adding and Subtracting Algebraic Expressions

No Problems.

9

Solving Linear Equations

9.1 Solving Given Equations

1. Solve the equation (the solution is the number of cars Kanye West owned in 2012).

$$\frac{2}{5}(x + 3) - \frac{1}{2} = \frac{1}{2}x$$

2. Solve the equation (the solution is the age at which Jennifer Lopez began dancing and singing lessons in pursuit of her career).

$$5.2x - 7 = 2.2x + 8$$

3. Solve the equation (the solution is the number of kids rapper TI has as of 2014).

$$\frac{10}{3}x + \frac{1}{6} = \frac{7}{3}x + \frac{43}{6}$$

4. Solve the equation (the solution is the number of the subway lines Jennifer Lopez would ride between her home in The Bronx and her dance auditions in Manhattan).

$$5(9x - 9) - 4(11x - 11) = 5$$

5. If you find the solution to the following equation and then MULTIPLY BY 3, you will find out how many siblings Michael Jackson had. How many siblings did Michael Jackson have?

$$2x - 3 + 5x = 4 + 4x + 1$$

6. Consider the solution to the following equation. The SUM of 29 and the solution is the total number of Grammy awards won by Michael Jackson. How many Grammys did he win?

$$7x - 4x = 5x + 32$$

7. Consider the solution to the following equation. The SUM OF 68 and the solution is the total number of music videos made by Michael Jackson. How many music videos did he make?

$$\frac{9}{6}x + 5 = \frac{1}{2}x - 7$$

8. The solution (to the following equation) is the number of movies actress Megan Fox has starred in as of 2014. How many movies did she star in?

$$x - 5 = 2x - 24$$

9. The solution (to the following equation) is the number of NBA championships won by Michael Jordan. How many championships did he win?

$$3(x + 3) = 2x + 15$$

10. The solution (to the following equation) is the number of movies actor Will Smith has starred in as of 2014. How many movies did he star in?

$$4(x - 2) + \frac{1}{2}x = x + 104.$$

11. The solution (to the following equation) is the number of movies actor Jamie Foxx has starred in as of 2014. How many movies did he star in?

$$2(x - 4) + \frac{x}{2} = 3(x - 30) + 2x - 3.$$

12. Brad Pitt and Angelina Jolie are one of the most famous Hollywood couples, and still a couple as of 2014. Below are two equations. The solution to the first one is the number of movies Brad Pitt has starred in as of 2014. The solution to the second equation is the number of movies Angelina Jolie has starred in as of 2014. Who starred in more films? How many more?

$$\frac{3}{4}(x - 1) = \frac{1}{8}(x - 5) + 13.$$

$$\frac{(x - 5)}{4} = \frac{(2x - 40)}{6} + 2.$$

9.2 Modeling and Problem Solving

This section also involved solving equations, **but** now the equation is not given, but must be determined. The process of determining finding the equation is called **modeling**.

9.2.1 Sports: Basketball Questions

1. In the 2012-2013 NBA season, Kevin Durant had 15 fewer turnovers than James Harden, but 54 more turnovers than LeBron James. Together, the three players had a total of 801 turnovers. How many turnovers did each player have?
2. In the 2012-2013 NBA season, Dwight Howard and Blake Griffin had the same number of personal fouls. DeAndre Jordan and Amir Johnson both had five personal fouls less than Howard. If the total number of personal fouls of the four players was 762, determine how many fouls each player had at the end of the season.
3. In the 2012-2013 NBA season Dwight Howard had 3 more blocks than Tim Duncan and 85 more blocks than Chris Bosh. If the total number of blocks by the three players was 470, calculate the number of blocks each player had in the season.
4. In the 2012-2013 NBA season Jason Kidd had 4 fewer steals than LeBron James. If the *average* of their total steals is 127, find the total number of steals each player had in the season.
5. In the 2012-2013 NBA season, Carmelo Anthony made 157 three point field goals. However Stephen Curry led the league in three pointers made. The total number of three pointers made by Curry was 42 less than double the number of Anthony's. How many three pointers did Curry make?
6. In the 2012-2013 NBA season Dwayne Wade and LeBron James combined to make 711 free throws. If James made 95 more free throws than Wade, determine how many free throws each player made.

9.2.2 Entertainment Questions

1. As of 2014, the number of Grammy nominations JayZ had was $\frac{3}{2}$ of what Eminem had. If they combine for a total of 100 nominations, determine how many nominations each artist had.
2. As of 2014, artists U2 and Stevie Wonder have won the same number of Grammy awards. Mariah Carey has received a total of five Grammy

awards. If the total number of Grammys won by all three artists is 49, determine how many U2 and Stevie Wonder have won.

3. President Obama's 2013 salary was approximately 0.6 % of the combined total of Beyonce and JayZ's salary. If Beyonce made \$ 53 million in 2013, and JayZ made four-fifths Beyonce's salary, what was President Obama's salary?

9.2.3 Commuting Questions

Facts:

1. In the year 2014, the cost of a single ride on a MTA subway or bus was \$2.5.
2. In the year 2014, the cost of a monthly pass for the MTA subway or bus was \$112.
3. In the year 2013, the toll for the George Washington Bridge was \$13 (*going from New Jersey to Manhattan; it is free in going from Manhattan to New Jersey*).

Questions:

1. Suppose you do **not** have a monthly pass, so you pay a fare every time you take the MTA. If you take 5 trips on the MTA, how much must you pay?
2. Consider two options: *Option 1*) Pay the single fare each time you ride the MTA, or *Option 2*) Buy a monthly pass.
 - (a) Suppose you take 10 trips in a month. How much do you pay under Option 1? How much do you pay under Option 2?
 - (b) Suppose you take 100 trips in a month. How much do you pay under Option 1? How much do you pay under Option 2?
 - (c) How many trips must you take a month for the monthly pass to save you money?
3. Consider 2 commuters, *Carlos* and *Anna*, who both travel from New Jersey to Bronx Community College.
 - Carlos drives across the George Washington Bridge, parks his car in Washington Heights, and then uses the MTA to get to BCC. To return, he uses the MTA to get back to his car, and then drives across the George Washington Bridge.
 - Anna travels in the same way. The only difference is that Carlos pays for a single MTA fare each time, while Anna buys a monthly pass (30 days).

Answer the following questions about Carlos and Anna (ignore gas, parking fees, etc; just consider bridge tolls and MTA fares).

- (a) How much does one day of travel cost Carlos? Anna?
- (b) How much does 5 days cost, for each person?
- (c) How much does 10 days cost, for each person?
- (d) How much does d days cost, for each person? (d is a variable less than 30)
- (e) How many days can Carlos travel with \$500 dollars? How many days can Anna travel with \$500 dollars?
- (f) How many days of travel must pass before Anna's method pays off?
- (g) (harder) How much does d days cost, for each person? (d can be any value)
- (h) (harder) How many days can Carlos travel with \$1200 dollars? How many days can Anna travel with \$1200 dollars?

10

Formulas

10.1 Body Mass Index

Consider two formulas to calculate *Body Mass Index* (BMI). The BMI is a measure that indicates if someone is overweight, underweight, or just right.

- (Metric Version)

$$BMI = \frac{mass}{height^2}$$

where the mass is measured in kilograms and the height is measured in meters.

- (Non-Metric Version)

$$BMI = \frac{703 * weight}{height^2}$$

where weight is measured in pounds and height is measured in inches.

Based on BMI there are the following four categories:

	<i>BMI</i>
Underweight	Below 18.5
Normal	18.5-24.9
Overweight	25.0 - 29.9
Obese	30.0 and Above

source: <http://hubpages.com/hub/How-to-Calculate-your-Body-Mass-Index-BMI>

1. Calculate the BMI of an individual that weighs 70 kg and is 1.7 m tall and determine in which BMI category that person falls.
2. (a) Using the metric formula, solve for mass. Use your result to answer the next two questions.
(b) Calculate the mass of an individual that has a BMI of 30 and a height of 2 meters.
(c) Calculate the mass of an individual that has a BMI of 16 and a height of 1.5 meters.
3. (a) (harder) Using the metric formula, solve for height. Use your result to answer the next two questions.
(b) Calculate the height of an individual that has a BMI of 23 and weighs 92 kg .
(c) Calculate the height of an individual that has a BMI of 20 and weighs 60 kg (*use a calculator as needed*).
4. Calculate the BMI of a person who weighs 200 pounds and is 5 foot, 10 inches tall (*do it without a calculator, by rounding the number 703 in the formula to 700*). Based on this BMI, is this person overweight or not?
5. (a) Using the non-metric formula, solve for weight. Use your result to answer the next two questions (*you may round the number 703 to 700, or keep the 703 and use a calculator for the next two questions*).
(b) Calculate the weight (in pounds) of an individual that has a BMI of 21 and is 60 inches tall. Round your answer to the nearest pound.
(c) Calculate the weight (in pounds) of an individual that has a BMI of 28 and is 6 feet tall. Round your answer to the nearest pound.
6. (a) (harder) Using the non-metric formula, solve for height. Use your result to answer the next two questions (*use a calculator for the next two questions*).
(b) Calculate the height of a person who weighs 185 pounds and has a BMI of 26.
(c) Calculate the height of a person who weighs 300 pounds and has a BMI of 18. Does such a person exist?
7. Calculate your BMI! (You can keep your answer to yourself ...)

10.2 Body Fat Percentage

There are numerous formulas used to calculate one's Body Fat Percentage. We list three below:

Covert Bailey Method	
<i>Women</i> (age ≤ 30) Fat % = $H + 0.8T - 2C - W$ (age > 30) Fat % = $H + T - 2C - W$ (where H = hips, T = thighs, C = calf, W = wrist, measured in inches)	<i>Men</i> (age ≤ 30) Fat % = $T + 0.5H - 3C - W$ (age > 30) Fat % = $T + 0.5H - 2.7C - W$
Heritage BMI to Body Fat Percentage Method	
<i>Women</i> Fat % = $1.39B + 0.16A - 9$ (where A = age (yrs), B = BMI)	<i>Men</i> Fat % = $1.39B + 0.16A - 19.34$
YMCA Method	
<i>Women</i> Fat % = $\left(\frac{4.15C - 0.082W - 76.76}{W}\right) \times 100$ (where C = waist circumference (in), W = weight (lbs))	<i>Men</i> Fat % = $\left(\frac{4.15C - 0.082W - 98.42}{W}\right) \times 100$

source: [http://hubpages.com/hub/Five-Methods-to-Calculate-your-Body-Fat-Percentage-by-Using-a-Tape-](http://hubpages.com/hub/Five-Methods-to-Calculate-your-Body-Fat-Percentage-by-Using-a-Tape-Measure)

Measure

1. A 26 year old male has a BMI of 23. Calculate his body fat percentage using the *Heritage BMI to Body Fat Percentage Method*.
2. Suppose a 140 pound female has a waist circumference of 30 inches. Calculate her body fat percentage using the *YMCA Method*.

10.3 Estimated Blood Alcohol Concentration

Consider the formula to determine the *Estimated Blood Alcohol Concentration* (EBAC): source: http://en.wikipedia.org/wiki/Blood_alcohol_content

$$EBAC = \frac{0.806 \cdot SD \cdot 1.2}{BW \cdot Wt} - (MR \cdot DP)$$

where

SD is the number of drinks containing 10g of ethanol (a *standard drink*)

Wt body weight in kilograms

BW is the body water constant (females=0.49, males =0.58)

MR is the metabolism constant (females = 0.017, males = 0.015)

DP is the drinking period in hours.

Use a calculator for the following questions.

1. Calculate the *EBAC* of a 75 kg male drinking 3 standard drinks in 2 hours. Round your answer to the nearest tenth.

2. Calculate the *EBAC* of a 60 kg female drinking 3 standard drinks in 3 hours. Round your answer to the nearest tenth.
3. In the USA, in all states it is illegal to drive with a Blood Alcohol Content (BAC) of 0.08% or higher (some states are stricter). In Puerto Rico it is 0.02%. In India it is 0.03%. In the Cayman Islands it is 0.1%. We can use the *EBAC* to estimate the BAC. In the previous problems, determine who would be driving illegally, for each country.
4. To convert between pounds and kilograms you can use the following formula: $kg = \frac{\text{pounds}}{2.2}$.
 - 100 pounds is how many kilograms?
 - 100 kilograms is how many pounds?
5. Suppose a woman who weighs 130 pounds spends 5 hours drinking. How many drinks can she have before being considered drunk in the USA? What about in Puerto Rico? *Round the number of drinks to the nearest tenth.*
6. Suppose a man who weighs 250 pounds spends 5 hours drinking. How many drinks can he have before being considered drunk in the USA? What about in Puerto Rico? *Round the number of drinks to the nearest tenth.*

11

Ratio and Proportion

11.1 Ratios

A *ratio* is simply a quotient of two numbers. A ratio (such as: *the ratio of 27 to 18*, also written 27:18) is typically *reduced*. There are two typical ways to reduce a ratio:

1. Express the ratio as a reduced fraction (in our example: $27/18$ reduces to $3/2$, by dividing top and bottom of $27/18$ by 9; the final answer would be expressed as 3:2). We will call this **reducing a ratio** or **simplifying a ratio**.
2. Express the ratio with a 1 on the bottom. To do this, divide the top and bottom of the fraction by the bottom value (in our example: Dividing top and bottom of $27/18$ by 18 yields $1.5/1$; our final answer would be expressed as 1.5:1). We will call this **expressing the ratio as a unit rate**.

If a question just says to find the ratio of two numbers, the meaning is to find the ratio in simplified form. For example, if you are just asked to find the ratio of 27 to 18, the answer would be 3:2.

11.1.1 Sports: Basketball Questions

1. In the 2012 – 2013 NBA season LeBron James averaged 7.2 assists per game and 1.7 steals per game. Russell Westbrook averaged 7.4 assists per game and 1.8 steals per game. Who has the higher steals to assist ratio?
2. In the 2012 – 2013 NBA season Chris Paul averaged 9.7 assists per game and 2.4 steals per game. Russell Westbrook averaged 7.4 assists per game and 1.8 steals per game. Who has the higher steals to assist ratio?

11.1.2 Entertainment

1. As of 2014, Beyonce has been nominated for 46 Grammy awards and has won 17. Calculate her win to nomination ratio, as a unit rate (round your answers to the nearest tenth).
2. As of 2014, JayZ has been nominated for 60 Grammy awards and has won 19. Calculate his win to nomination ratio, as a unit rate (round your answers to the nearest tenth).
3. As of 2014, Kanye West has been nominated for 53 Grammy awards and has won 21. Calculate his win to nomination ratio, as a unit rate (round your answers to the nearest tenth).
4. As of 2014, U2 has been nominated for 46 Grammy awards and has won 22. Calculate their win to nomination ratio, as a unit rate (round your answers to the nearest tenth).

11.1.3 Admissions to Bronx Community College

The table presents statistics about first time freshmen admissions to Bronx Community College. The admitted students are categorized by gender and by Full-Time (*FT*) versus Part-Time (*PT*).

year	FT men	FT women	FT total	PT men	PT women	PT total
2003	636	957	1,593	207	383	590
2004	673	1,043	1,716	214	401	615
2005	564	681	1,245	83	129	212
2006	558	786	1,344	114	153	267
2007	639	839	1,478	90	129	219
2008	610	725	1,335	115	118	233
2009	773	986	1,759	145	152	297
2010	777	884	1,661	131	119	250
2011	875	931	1,806	134	143	277
2012	724	814	1,538	102	117	219

1. Consider the year 2003. Find the ratio of the number of full-time female students admitted to BCC *compared to* the number of full-time male students admitted to BCC (before finding the ratio, round each number to the nearest ten).
2. Round off the number of full-time male students admitted to BCC in 2005 to the nearest ten, then round off the number of full-time female students admitted to BCC in 2005 to the nearest ten. Find their ratio.

3. Round off the number of full-time female students admitted to BCC in 2007 to the nearest ten, then round off the number of full-time male students admitted to BCC in 2007 to the nearest ten. Find their ratio.
4. Round off the number of full-time male students admitted to BCC in 2009 to the nearest ten, then round off the number of full-time female students admitted to BCC in 2009 to the nearest ten. Find their ratio.
5. Round off the number of full-time female students admitted to BCC in 2012 to the nearest ten, then round off the number of full-time male students admitted to BCC in 2012 to the nearest ten, Find their ratio.
6. Round off the number of part-time male students admitted to BCC in 2009 to the nearest ten, then round off the number of part-time female students admitted to BCC in 2009 to the nearest ten, Find their ratio.
7. Round off the number of part-time female students admitted to BCC in 2008 to the nearest ten, then round off the number of part-time male students admitted to BCC in 2008 to the nearest ten. Find their ratio.
8. Find the only year in which the ratio of part-time male students to part-time female students is greater than one.
9. (harder) What is the reduced ratio of part-time male students *to* full-time female students in the year of 2006?
10. (harder) What is the ratio of part-time female students *to* full-time male students in the year of 2007?
11. (harder) What is the ratio of part-time male students *to* full-time female students in the year of 2012?
12. (harder) What is the ratio of full time female students *to* full-time male students in the year of 2003?
13. (harder) What is the ratio of full time male students *to* full-time female students in the year of 2005?
14. (harder) What is the ratio of full time female students *to* full-time male students in the year of 2006?
15. (harder) What is the ratio of full time male students *to* full-time female students in the year of 2008?

16. (harder) What is the ratio of full time female students *to* full-time male students in the year of 2011?
17. (harder) What is the ratio of full time male students *to* full-time female students in the year of 2012?

11.2 Proportions

1. In the 2012 – 2013 NBA season (82 games), Stephen Curry made 272 three point field goals. In the 2013 – 2014 season, after 53 games, he had made 177 three pointers. Suppose his trend from the 2012-2013 season continued into the 2013-2014 season (i.e. his 3 pointers per a game is the same at the end of each season). How many 3 pointers did he make by the end of the 2013-2014 season? Round your answer to the nearest whole number.

(Since the 2013-2014 season is now over, we can see how our prediction matches reality.)

12

Percentage

12.1 Bronx Community College Questions

12.1.1 Bronx Community College: Gender, Age, and Race

There are a list of facts pertaining to Bronx Community College for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. There were 11287 students at BCC.
2. 42.1% of the students were male, and 57.9% of the students were female (*you may round these percentages to the nearest 10%; for example, 83.7% would round to 80%*).
3. 2.8% of the students were Asian, 32.6% of the students were Black, 61.2% of the students were Hispanic, and 3.2% of the students were White (*you may round these percentages to the nearest percent; for example, 83.7% would round to 84%*).
4. 24.1% of students were less than 20 years old. 3.4% of students were age 45 or older (*you may round these percentages to the nearest percent; for example, 83.7% would round to 84%*).

Questions:

1. How many students were male? How many students were female?
2. How many students were Asian? How many were Black? How many were Hispanic? How many were White?
3. How many students are less than 20 years old?
4. How many students are at least 45 years old?

5. How many students' age is in-between 20 and 45 (i.e. less than 45 and at least 20)?
6. Order the following quantities from smallest to largest (*for this question use the exact percentages; do not round them*):
 - (a) The number of Black students.
 - (b) The number of Asian students.
 - (c) The number of students age 45 or more.
 - (d) The number of Hispanic students.
 - (e) The number of White students.
 - (f) The number of students less than 20 years old.

12.1.2 Bronx Community College: Income Distribution

There are a list of facts pertaining to Bronx Community College for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. There were 11287 students at BCC.
2. 25% of students live in a household with an income less than \$10,000 per year.
3. 45% of students live in a household with an income less than \$15,000 per year.
4. 53% of students live in a household with an income less than \$20,000 per year.
5. 74% of students live in a household with an income less than \$30,000 per year.
6. 85% of students live in a household with an income less than \$40,000 per year.
7. 91% of students live in a household with an income less than \$50,000 per year.

Questions:

1. How many students live in a household with an income less than \$10,000 per a year?
2. How many students live in a household with an income *more than* \$50,000 per a year?

3. What percent of the students live in a household with an income between \$15,000 a year and \$40,000 a year?
4. How many students live in a household with an income *in-between* \$10,000 and \$15,000?

12.1.3 Other Bronx Community College Questions

1. In the year 2012, there were 6498 full-time students and 4789 part-time students. What percent of students are full-time? (*to make the calculation easier, round the two numbers 6498 and 4789 to the nearest 100*)
2. In the year 2012, BCC had 4752 male students and 6536 female students. The size of the male population is what percent smaller than the female population?
3. In the year 2012, BCC had 4752 male students and 6536 female students. The size of the female population is what percent larger than the male population?
4. There are 11287 students at BCC (in the year 2012). 25% of BCC students live in a household with an income less than \$10,000 per year. How many students live in a household with an income less than \$10,000 per a year?

12.2 USA Questions

There are a list of facts pertaining to the USA for the year 2012. Use these facts to answer the questions that follow.

USA Facts:

1. The population of the USA was about 314000000.
2. About 1.7% of the US population were millionaires.
3. The poverty rate was about 15%.
4. What does the term *poverty rate* mean?

The US government sets a certain threshold income (in the year 2012 it was \$11945 for an individual living alone who is under the age 65); if someone's income is below this threshold, that person is considered "poor." The *poverty rate* is the percent of the population whose income is below this threshold income; i.e. the percent of the population considered "poor."

USA Questions:

1. How many millionaires were there in the USA in the year 2012?
(round to the nearest 100,000)
2. How many people in the USA were considered poor in the year 2012?
(round to the nearest 100,000)
3. Let's call somebody "rich" if he or she is a millionaire. In the year 2012, what was the ratio of the number of poor people to the number of rich people?

12.3 Borough Group Project

Split the class into at least 5 groups. Assign each group a borough of New York City, so that each of the 5 boroughs is covered. Give each group the handout for their borough (they follow on the next 5 pages). After all the groups finish their problems, there is a Summary exercise that can be done as a class; the summary questions follow the 5 borough sheets.

Borough Project: The Bronx

Below is a list of facts about The Bronx for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. The population of The Bronx was 1408000.
2. The total area of The Bronx is 42.
3. 43.4% of the population was Black, 10.8% of the population was White, 4.2% of the population was Asian, and 54.3% of the population was Hispanic.
4. 69.2% of the population (of those 25 years and older) have graduated high school.
5. 18% of the population (of those 25 years and older) received a bachelor's degree.

Questions:

1. How many people in The Bronx were Black? How many were White? How many were Hispanic? How many were Asian?
2. What was the population density of The Bronx?
3. What was the ratio of the number of Black people to the number of Hispanic people? Based on this ratio, if you passed 10 Black people in the street, how many Hispanic people would you pass?
4. For every person who received a bachelors degree, how many graduated high school?

Borough Project: Brooklyn

Below is a list of facts about Brooklyn for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. The population of Brooklyn was 2568000.
2. The total area of Brooklyn is 71.
3. 35.8% of the population was Black, 35.8% of the population was White, 11.3% of the population was Asian, and 19.8% of the population was Hispanic.
4. 78% of the population (of those 25 years and older) have graduated high school.
5. 29.8% of the population (of those 25 years and older) received a bachelor's degree.

Questions:

1. How many people in Brooklyn were Black? How many were White? How many were Hispanic? How many were Asian?
2. What was the population density of Brooklyn?
3. What was the ratio of the number of Black people to the number of Hispanic people? Based on this ratio, if you passed 10 Black people in the street, how many Hispanic people would you pass?
4. For every person who received a bachelors degree, how many graduated high school?

Borough Project: Manhattan

Below is a list of facts about Manhattan for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. The population of Manhattan was 1621000.
2. The total area of Manhattan is 23.
3. 18.4% of the population was Black, 47.6% of the population was White, 12% of the population was Asian, and 25.8% of the population was Hispanic.
4. 85.5% of the population (of those 25 years and older) have graduated high school.
5. 58.1% of the population (of those 25 years and older) received a bachelor's degree.

Questions:

1. How many people in Manhattan were Black? How many were White? How many were Hispanic? How many were Asian?
2. What was the population density of Manhattan?
3. What was the ratio of the number of Black people to the number of Hispanic people? Based on this ratio, if you passed 10 Black people in the street, how many Hispanic people would you pass?
4. For every person who received a bachelors degree, how many graduated high school?

Borough Project: Queens

Below is a list of facts about Queens for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. The population of Queens was 2275000.
2. The total area of Queens is 109.
3. 21% of the population was Black, 27.2% of the population was White, 24.8% of the population was Asian, and 28% of the population was Hispanic.
4. 80% of the population (of those 25 years and older) have graduated high school.
5. 30% of the population (of those 25 years and older) received a bachelor's degree.

Questions:

1. How many people in Queens were Black? How many were White? How many were Hispanic? How many were Asian?
2. What was the population density of Queens?
3. What was the ratio of the number of Black people to the number of Hispanic people? Based on this ratio, if you passed 10 Black people in the street, how many Hispanic people would you pass?
4. For every person who received a bachelors degree, how many graduated high school?

Borough Project: Staten Island

Below is a list of facts about Staten Island for the year 2012. Use these facts to answer the questions that follow.

Facts:

1. The population of Staten Island was 470000.
2. The total area of Staten Island is 58.
3. 11.6% of the population was Black, 63.6% of the population was White, 8% of the population was Asian, and 17.7% of the population was Hispanic.
4. 87.6% of the population (of those 25 years and older) have graduated high school.
5. 29% of the population (of those 25 years and older) received a bachelor's degree.

Questions:

1. How many people in Staten Island were Black? How many were White? How many were Hispanic? How many were Asian?
2. What was the population density of Staten Island?
3. What was the ratio of the number of Black people to the number of Hispanic people? Based on this ratio, if you passed 10 Black people in the street, how many Hispanic people would you pass?
4. For every person who received a bachelors degree, how many graduated high school?

Borough Project: Summary

1. What was the population of New York City in the year 2012?
2. Order the boroughs by each of the following parameters: area, population, and population density.
3. Compare the borough with lowest and highest population. How many times larger (in population) is the borough with the larger population?
4. For the following ratio questions, round the populations to the nearest 100,000.
 - (a) What borough has the largest population? What is the ratio of The Bronx's population to the population of this borough?
 - (b) What is the the ratio the number of New Yorker's living in The Bronx to the number **not** living in The Bronx?
 - (c) Which borough has the highest ratio of Black people to Hispanic people? Discussion:
 - i. Based on this ratio, if you passed 10 Black people in the street, how many Hispanic people would you pass?
 - ii. Why might the answer to the last question not be true in reality?

12.4 New York City Questions

1. The size of Manhattan is 23 square miles. The size of Staten Island is 58 square miles. Staten Island is what percent larger than Manhattan?
2. In the year 2010, the population of New York City was 8200000, and the population of New York State was 19378102. What percent of New York State residents live in New York City?
3. In the year 2010, the population of New York City was 8200000, and the population of New York State was 19378102. The size of New York City is 303 square miles. The size of New York State is 47126 square miles.
 - (a) What is the population density of New York City?
 - (b) What is the population density of New York State?
 - (c) The population density of New York City is how many times larger than the population density of New York State?
4. In the year 1904 there were 28 subway stations. In the year 2014, there were 468 subway stations. What is the percent increase in subway stations?
5. There were 468 subway stations in the year 2014. About 60% of subway stations were underground. How many subway stations were *above ground*? (note: “underground” includes stations like the Parkside Q stop which is below street level, but open to the outside).

12.5 Sports: Basketball Questions

1. In the 2012 – 2013 NBA season (82 games), Kobe Bryant attempted 1595 field goals, while LeBron James attempted 1354. By what percent did Kobe Bryant’s field goal attempts exceed LeBron James’ field goal attempts? Round your answer to the nearest percent.
2. In the 2012 – 2013 NBA season (82 games), Kobe Bryant had attempted 1595 field goals, while Carmelo Anthony attempted 1489. By what percent did Kobe Bryant’s field goal attempts exceed Carmelo Anthony’s field goal attempts? Round your answer to the nearest percent.
3. In the 2012 – 2013 NBA season (82 games), LeBron James attempted 1354 field goals, while Carmelo Anthony attempted 1489. By what percent did Carmelo Anthony’s field goal attempts exceed

LeBron James' field goal attempts? Round your answer to the nearest percent.

4. In the 2012 – 2013 NBA season (82 games), Dwight Howard had 945 rebounds, while Tim Duncan had 686. By what percent did Dwight Howard's rebounds exceed Tim Duncan's? Round your answer to the nearest percent.
5. In the 2012 – 2013 NBA season (82 games), Carlos Boozer had 771 rebounds, while Tim Duncan had 686. By what percent did Carlos Boozer rebounds exceed Tim Duncan's? Round your answer to the nearest percent.
6. In the 2012 – 2013 NBA season Kevin Durant made 90.5 % of his free throw attempts. He attempted a total of 792 free throws. How many free throws did he make?

12.6 Sports: Baseball Questions

1. The data below lists the average Major League Baseball ticket price for all 30 teams in 2013. (Average ticket price is defined as “ *a weighted average of season ticket prices for general seating categories, determined by factoring the tickets in each price range as a percentage of the total number of seats in each venue.*”)
(source: <http://www.kshb.com/sports/baseball/mlb-average-ticket-price-fan-cost-index-for-all-30-baseball-teams>).

Team	Price (\$)
Boston	53.38
NY Yankees	51.55
Chicago Cubs	44.55
Philadelphia	37.42
Toronto	32.98
San Francisco	30.09
Washington	35.24
Chicago White Sox	26.05
St. Louis	33.11
Miami	29.27
Houston	30.09
NY Mets	25.30
Minnesota	32.59
Detroit	26.36
L.A. Dodgers	22.37
Seattle	28.45
Colorado	23.65
L.A. Angels	27.54
Texas	22.54
Oakland	22.12
Milwaukee	24.95
Kansas City	19.38
Atlanta	17.32
Baltimore	23.89
Cincinnati	21.35
Pittsburgh	17.21
Cleveland	19.59
Tampa Bay	20.39
San Diego	15.99
Arizona	16.89

- (a) Yankee tickets cost what percent more than Mets tickets?
- (b) Angels tickets cost what percent more than Dodgers tickets?
- (c) Round each price to the nearest dollar.
- (d) Using the rounded price (to nearest dollar), calculate the ratio of the prices between the following teams:
 - i. Chicago Cubs to San Francisco
 - ii. Atlanta to Arizona
 - iii. Toronto to St. Louis
 - iv. Miami to Oakland

12.7 Entertainment Questions

1. As of 2014, U2 has been nominated for 46 Grammy awards whereas JayZ has been nominated for 60. Calculate by what percent JayZ's nominations exceed U2's.
2. As of 2014, Eminem has been nominated for 40 Grammy awards whereas JayZ has been nominated for 60. Calculate by what percent JayZ's nominations exceed Eminem's.
3. As of 2014, Kanye West has been nominated for 53 Grammy awards whereas Eminem has been nominated for 40. Calculate by what percent Kanye's nominations exceed Eminem's.
4. As of 2014, Beyonce has been nominated for 46 Grammy awards whereas JayZ has been nominated for 60. Calculate by what percent JayZ's nominations exceed Beyonce's.
5. As of 2014, Beyonce has won a total of 17 Grammy awards whereas JayZ has won 19. Calculate by what percent JayZ's wins exceed Beyonce's.
6. As of 2014, Kanye West has won a total of 21 Grammy awards whereas JayZ has won 19. Calculate by what percent Kanye's wins exceed JayZ's.
7. As of 2014, Stevie Wonder has won a total of 22 Grammy awards whereas JayZ has won 19. Calculate by what percent Stevie Wonder's wins exceed JayZ's.
8. As of 2014, Kanye West has won a total of 21 Grammy awards whereas Beyonce has won 17. Calculate by what percent Kanye's wins exceed Beyonce's.
9. As of 2014, Beyonce has won a total of 17 Grammy awards whereas Mariah Carey has won 5. Calculate by what percent Beyonce's wins exceed Mariah Carey's.
10. As of 2013, Michael Jackson's *Thriller* album sold 50000000 copies, while his *Bad* album sold 30000000 copies. Calculate the percent decrease in record sales. Round your answer to the nearest percent.
11. As of 2013, Beyonce's *I am Sasha Fierce* album sold 1500000 copies in the UK, while her *Beyonce* album sold only 300000 copies. Calculate the percent decrease in record sales. Round your answer to the nearest percent.

12. As of 2013, Whitney Houston's *My love is your love* album sold 672200 copies in France and 670000 copies in Germany. Calculate by what percent her sales in Germany are lower than those in France. Round your answer to the nearest percent.
13. As of 2013, Whitney Houston's *My love is your love* album sold 13000000 copies, whereas Mariah Carey's *Music Box* album sold 32000000 copies. Calculate by what percent Mariah Carey's record sales exceed Whitney Houston's for these albums. Round your answer to the nearest percent.
14. As of 2013, Rihanna sold 200,000 copies of her 2011 *Talk that Talk* album, in France. Her *Unapologetic* album, released in 2012, sold 240,000 copies in France. Calculate the percent increase in record sales (round to nearest percent).

12.8 Criminal Justice Questions

1. Since the USA re-instated the death penalty in 1976, there have been a total of 510 executions in Texas and 5 executions in Maryland. Calculate by what percent the number of executions in Texas exceeds those in Maryland.
2. Since the USA re-instated the death penalty in 1976, there have been a total of 110 executions in Virginia and 5 executions in Maryland. Calculate by what percent the number of executions in Virginia exceeds those in Maryland.
3. Since the USA re-instated the death penalty in 1976, there have been a total of 470 Black defendants executed and 767 White defendants executed. Calculate by what percent the number of White defendants executed exceeds Black defendants executed. Does this mean White people are being treated unfairly? Explain.
4. Since the USA re-instated the death penalty in 1976, there have been a total of 470 Black defendants executed and 108 Latino defendants executed. Calculate by what percent the number of Black defendants executed exceeds Latino defendants executed.
5. The table below gives the Stop and Frisk data of individuals in NYC based on innocence and ethnicity from 2003 to 2013.

	Total	Innocent	Black	Latino	White
2003	160, 851	140, 442	77, 704	44, 581	17, 623
2004	313, 523	278, 933	155, 033	89, 937	28, 913
2005	398, 191	352, 348	196, 570	115, 088	40, 713
2006	506, 491	457, 163	267, 468	147, 862	53, 500
2007	472, 096	410, 936	243, 776	141, 868	52, 887
2008	540, 302	474, 387	275, 588	168, 475	57, 650
2009	581, 168	510, 742	310, 611	180, 055	53, 601
2010	601, 285	518, 849	315, 083	189, 326	54, 810
2012	532, 911	473, 644	284, 229	165, 140	50, 366
2013	191, 558	169, 252	104, 958	55, 191	20, 877

- Calculate the percent increase of individuals stopped and frisked from 2003 to 2010.
- Calculate the percent decrease of people stopped and frisked from 2012 to 2013.
- Of those Stopped and Frisked in 2012, what percent were Latino?
- Of those Stopped and Frisked in 2012, what percent were White?
- Of those Stopped and Frisked in 2012, what percent were Black?
- What percent of those Stopped and Frisked in 2003 were “guilty?” What about in 2013? Did NYPD get better at detecting “guilt?”

12.9 Comparing the Nations

12.9.1 Human Development Index

The *Human Development Index* gives a number (between 0 and 1) to each country. This number is meant to be a measure of human well-being in that country (the closer to 1, the better). In the year 2012, the top five countries (*not in order*) along with their indexes were as follows:

Australia: 0.938

Germany: 0.92

Netherlands: 0.921

Norway: 0.955

USA: 0.937

Questions:

- Put the five countries in order from highest to lowest.

2. What is the difference between the highest and lowest? What is the percent increase from the lowest to the highest?

The Human Development Index has been modified to take into account economic inequality. In the year 2012, the *inequality-adjusted* Human Development Index for the countries was given as follows:

Australia: 0.864

Germany: 0.856

Netherlands: 0.857

Norway: 0.894

USA: 0.821

Questions (for the new inequality-adjusted measure):

1. Put the five countries in order from highest to lowest.
2. What is the difference between the highest and lowest? What is the percent increase from the lowest to the highest?
3. What percent did Germany decrease in going from the regular HDI to the inequality-adjusted version?
4. What percent did the USA decrease in going from the regular HDI to the inequality-adjusted version?

12.9.2 Homicide Rates

Homicide rates are usually given as the number of homicides per 100,000. For example, if the homicide rate of a city is 2.5, that means that for every 100,000 people, we expect 2.5 homicides. The homicide rates of some countries are as follows (in the year 2010):

Canada: 1.6

China: 1

Dominican Republic: 24.9

Mexico: 22.7

South Africa: 31.8

USA: 4.2

Questions:

1. Put the homicide rates in order from largest to smallest.
2. What percent of people in the USA die of homicide?

3. What is the ratio of China's homicide rate to the US homicide rate?
4. What is the ratio of Canada's homicide rate to the US homicide rate?
5. Going from the Dominican Republic to Mexico, what is the percent decrease in homicide rate?

12.9.3 Other International Questions

1. The *Human Development Index* (HDI) is meant to measure the human well-being in a country. The USA (ranked third) has an HDI of 0.937, and Norway (ranked first) has an HDI of 0.955 (in the year 2012). What is the percent increase in HDI, going from the USA to Norway?
2. The homicide rate in the Dominican Republic (in the year 2010) was 24.9 (per 100,000). What percent of the population died by homicide?
3. In the year 2010, the homicide rate in the USA was 4.2 and the homicide rate in the Dominican Republic was 24.9 (both rates are per 100,000). The homicide rate in the Dominican Republic is how many times larger than the homicide rate in the USA?

13

Solving Linear Inequalities

1. Consider the following tables with the number of defendants executed in the USA since 1976, based on race and state.

Race	Executed
Black	470
Latino	108
White	767
Other	24
Total	1369

State	Executed
Texas	510
Virginia	110
Florida	84
California	13
Illinois	12
Maryland	5

- (a) Solve the following inequality:

$$5x + 2(2x + 5) < 8 + 2(3x - 1)$$

Is the inequality true or false if x is replaced by the number of White individuals executed?

- (b) Solve the inequality:

$$\frac{z + 2}{4} + \frac{2z - 1}{2} \leq \frac{1}{4}$$

If the variable z is replaced by the number of individuals executed in Maryland, is it true or false?

- (c) Solve the inequality:

$$3w + 4(w - 5) + 2 > 7(w + 4) + w - (2 + w).$$

Consider the number individuals whose race is characterized as "other." If we substitute this number for w , is the inequality true or false?

(d) Solve the inequality:

$$\frac{x}{13} + \frac{x+1}{26} \leq \frac{2(x-1)}{13}$$

Consider the difference between the number of defendants executed in Florida and Virginia. If we substitute this number for x , does that make the inequality true or false?

14

Two Variable Equations

No Problems.

15

The Cartesian Coordinate System

In problems that deal with two quantitative variables we can present the data pictorially as a **scatter diagram** (also called a **scatter plot**). For example, the following table shows the number of graduates at Bronx Community College, from the year 2003 to 2012. For each year the total number of graduates is given, as well as a breakdown into the three kinds of degrees: Associate in Arts (AA), Associate in Applied Sciences (AAS), and Associate in Science (AS).

Year	AA	AAS	AS	Total
2003	267	288	170	725
2004	201	281	172	654
2005	269	334	216	819
2006	226	325	166	717
2007	223	367	233	823
2008	214	324	198	736
2009	245	336	231	812
2010	294	341	235	870
2011	410	441	269	1,120
2012	529	426	301	1,256

Suppose we are interested in comparing *year* to *total* graduates. We can make a 2-dimensional plot on a **Rectangular Coordinate System** (also called a **Cartesian Coordinate System**), making the year the x -value, and the total number of degrees the y -value. For example, we would plot the 10 points: the point (2003, 725), the point (2004, 654), and so on. Why would we do this? We might want to answer questions about the data such as the following:

- How do the number of graduates change over time?

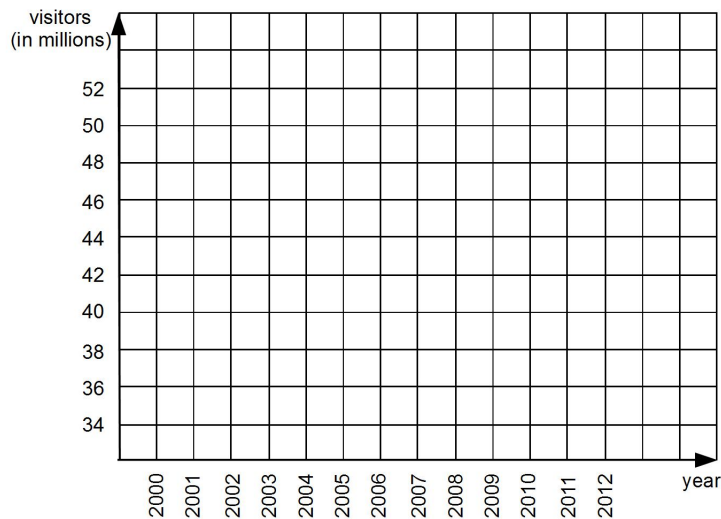
- Do the number of graduates mostly increase or decrease?
- Is there a “dependency” between year and number of degrees awarded?

In this section we will make scatter diagrams and ask general questions about data. In chapters 16 and 18 we will see how lines can help us understand the data even better.

15.1 NYC Visitors

Here is a table of visitors, international and domestic, to New York City over the years.

year	2000	2001	2002	2003	2004	2005	2006	2007
visitors to NYC in millions	36.2	35.2	35.3	37.8	39.9	42.7	43.8	46
year	2008	2009	2010	2011	2012			
visitors to NYC in millions	47.1	45.8	48.8	50.9	52.7			



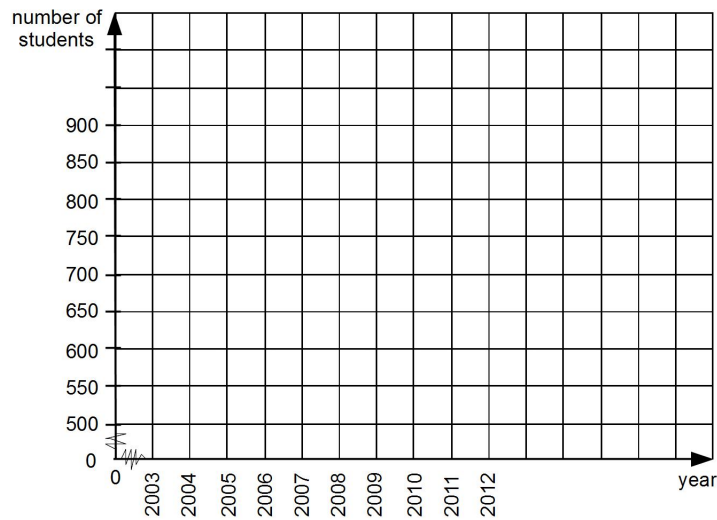
1. Plot the presented data as points on a scatter diagram, with x -axis denoting the year and y -axis denoting the number of people in millions (use the above axes).
2. Which year had the most visitors?
3. Which year had the least visitors?
4. What is the general shape of the points? Do the points form a shape that is close to a straight line?

15.2 Admissions to Bronx Community College

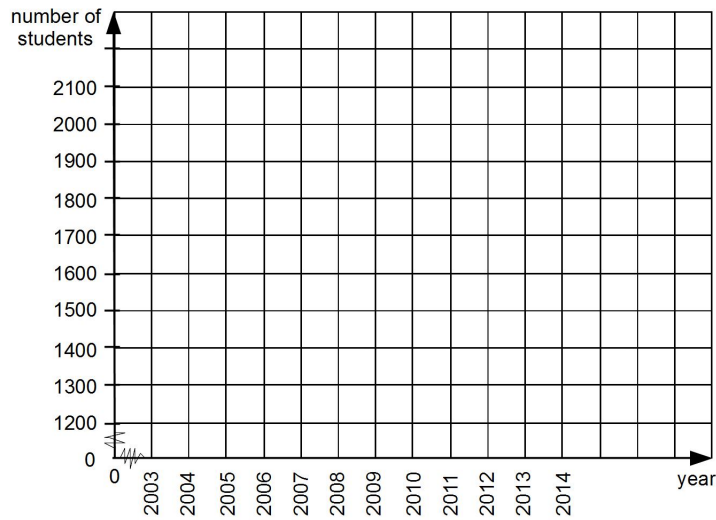
The table presents statistics about first time freshmen admissions to Bronx Community College. The admitted students are categorized by gender and by Full-Time (*FT*) versus Part-Time (*PT*).

year	FT men	FT women	FT total	PT men	PT women	PT total
2003	636	957	1,593	207	383	590
2004	673	1,043	1,716	214	401	615
2005	564	681	1,245	83	129	212
2006	558	786	1,344	114	153	267
2007	639	839	1,478	90	129	219
2008	610	725	1,335	115	118	233
2009	773	986	1,759	145	152	297
2010	777	884	1,661	131	119	250
2011	875	931	1,806	134	143	277
2012	724	814	1,538	102	117	219

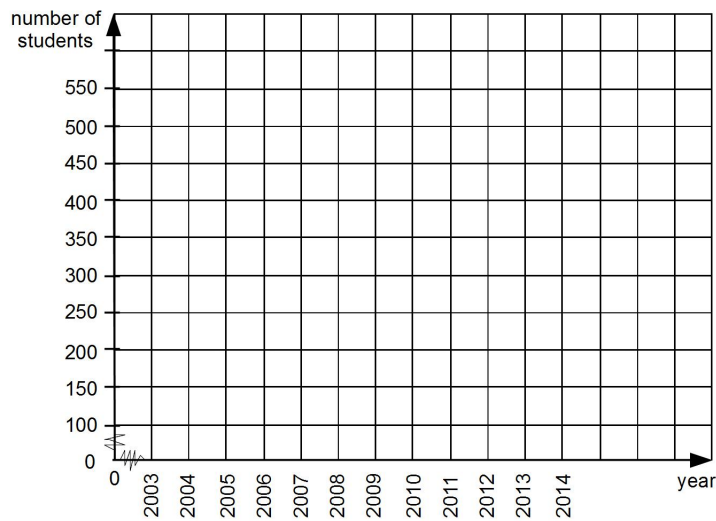
1. Draw the scatter diagram representing dependency between *year* and *full-time freshmen admission of male students*. Use the axes below.



2. Draw the scatter diagram representing dependency between *year* and *full-time freshmen students admissions*. Use the axes below.



3. Draw the scatter diagram representing dependency between *year* and *part-time freshmen admission of female students*. Use the axes below.



4. Consider the year 2003. Find the ratio of the number of full-time female students admitted to BCC *compared to* the number of full-time male students admitted to BCC (before finding the ratio, round each number to the nearest ten).
5. Round off the number of full-time male students admitted to BCC in 2005 to the nearest ten, then round off the number of full-time female students admitted to BCC in 2005 to the nearest ten. Find their ratio.

6. (harder) What is the ratio of part-time male students *to* full-time female students in the year of 2006?
7. What percent of full-time students admitted to BCC in 2004 were men (use a calculator and round off your answer to the nearest tenth) ?
8. (harder) What percent of the students admitted to BCC in 2006 were full-time women (use a calculator and round off your answer to the nearest whole number) ?

15.3 New York City Housing

Some rentals are classified as *luxury rentals* because they are sufficiently nice. Some rentals are classified as *over-crowded* because the space is not considered adequate for the number of people living in the space. The following table gives the percentage of housing in each category by borough (in the year 2011). **Create a scatter plot of the data (use graph paper).**

	Luxury Rentals	Over-Crowded Rentals
Bronx	3.8 %	13.7 %
Brooklyn	9.4 %	12.1 %
Manhattan	38.4 %	6.7 %
Queens	9.3 %	12.5 %
Staten Island	11.4 %	9.3 %

15.4 Yankees: Runs versus RBIs

Consider the following data for the Yankees 2011 starting lineup. For each player, the table gives the number of runs the player had during the season, and the number of RBIs (i.e. *Runs Batted In*) during the season. **Create a scatter plot of the data (use graph paper).**

	Runs	RBIs
Russell Martin	57	65
Mark Teixeira	90	111
Robinson Cano	104	118
Derek Jeter	84	61
Alex Rodriguez	67	62
Brett Gardner	87	36
Curtis Granderson	136	119
Nick Swisher	81	85
Jorge Posada	34	44

15.5 Yankees: Ticket Prices

The table below shows the average price of New York Yankee field box tickets in dollars, from the year 1970 to 2008. For each year, two prices are given: The *actual* price paid at the time and the *adjusted* price. The adjusted price is how much the ticket would cost nowadays, when adjusted for inflation. For example, from the table we see that in 1972 the actual price of a ticket was \$4, but in terms of today's dollars the price would be \$20.26.

(source:

<http://riveraveblues.com/2008/03/the-economics-of-yankee-tickets-2327/>)

Year	Actual	Adjusted	Year	Actual	Adjusted	Year	Actual	Adjusted
1970	4.00	21.82	1980	7.50	19.27	1990	12.00	19.44
1971	4.00	20.91	1981	7.50	17.47	1991	12.50	19.43
1972	4.00	20.26	1982	8.50	18.65	1992	14.50	21.88
1973	4.00	19.07	1983	9.00	19.13	1993	16.00	23.44
1974	4.00	17.18	1984	9.00	18.34	1994	17.00	24.28
1975	5.00	19.67	1985	9.75	19.18	1995	25.00	34.73
1976	5.50	20.46	1986	9.75	18.83	1996	25.00	33.73
1977	6.00	20.96	1987	10.00	18.63	1997	35.00	46.16
1978	6.50	21.10	1988	11.00	19.68	1998	45.00	58.44
1979	7.00	20.41	1989	12.00	20.49	1999	50.00	65.53

Year	Actual	Adjusted
2000	55.00	67.61
2001	62.00	74.11
2002	62.00	72.96
2003	72.00	82.84
2004	80.00	89.65
2005	90.00	97.55
2006	110.00	115.51
2007	150.00	153.15
2008	250.00	250.00

1. Plot the actual price versus the year, just using years 1970 to 1979. What is the shape of the plotted points?
2. Plot the actual price versus the year, just using years 1980 to 1989. Interpret the plot.
3. Plot the actual price versus the year, just using years 1990 to 1999.
4. Plot the actual price versus the year, just using years 2000 to 2008.

5. Discuss a possible reason for the spike in ticket prices in the mid to late 1990's.
6.
 - (a) Calculate the percent increase in the actual ticket price from 1970 to 1979.
 - (b) Then draw a vertical line on your plot that represents this increase.
 - (c) How does the length of this vertical line relate to the percent increase?
7. Calculate the percent increase in actual ticket price from 2000 to 2008.
8. Repeat questions 1, 2, 3, and 4 with *actual price* replaced by *adjusted price*. Interpret your graphs.

16

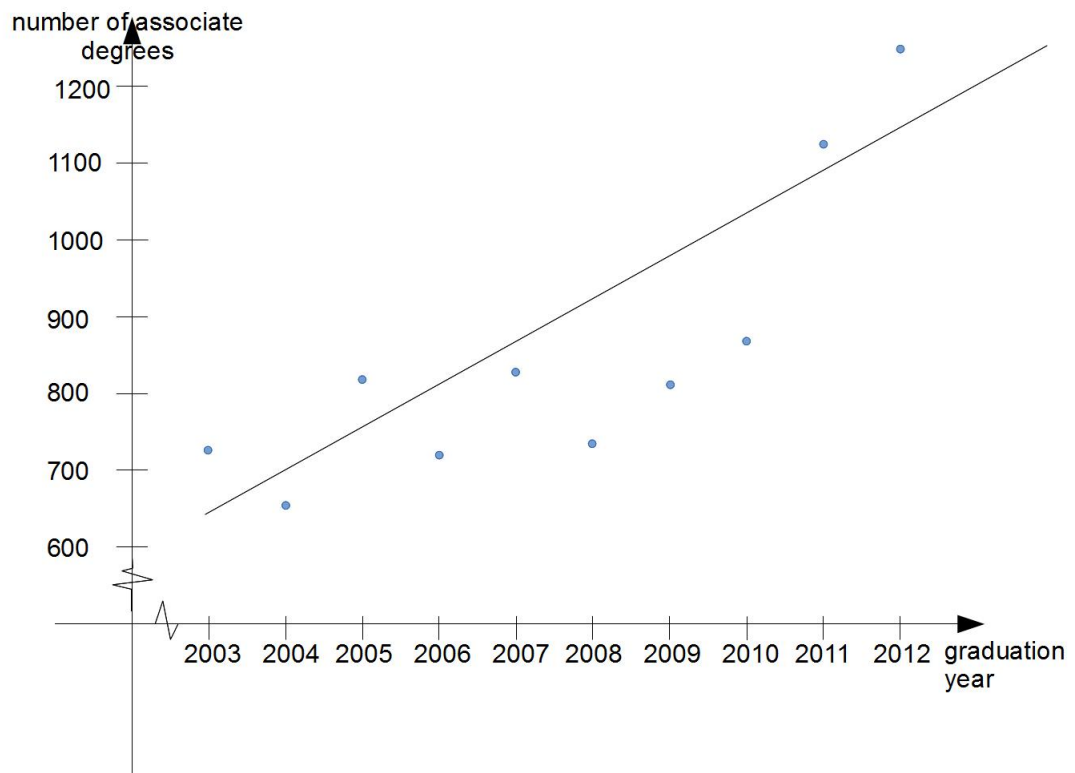
Lines–Graphing

16.1 Best-Fit Lines: Introduction

We now consider how to use lines to understand data. Given a scatter plot of some data, a **Best-Fit Line**, is a line which approximates the data. For example, recall the following data from the beginning of chapter 15, which gives the number of degrees awarded at Bronx Community College for various years, broken down into various degree types: AA degrees, AAS degrees, and AS degrees.

Year	AA	AAS	AS	Total
2003	267	288	170	725
2004	201	281	172	654
2005	269	334	216	819
2006	226	325	166	717
2007	223	367	233	823
2008	214	324	198	736
2009	245	336	231	812
2010	294	341	235	870
2011	410	441	269	1,120
2012	529	426	301	1,256

In chapter 15, we made a scatter plot of the *year* versus the *total*. In the next diagram, we have drawn the scatter plot again, *but now we have drawn a best-fit line of top of the data*.



As you can see on the picture, the points seem to be heading up and more or less along the line that is drawn. This line is called **the best-fit line** (also called **the line of best fit**). In this course we will not be precise about best-fit lines: when a problem asks you to draw a best-fit line, just use your instincts to draw a *single straight line* which seems to follow the data as well as possible. This topic is covered in a more precise way in a statistics course (for example, MTH 23) in a topic called **regression**. Why do we care about best-fit lines? The best-fit line can help us understand and summarize the data. For example in the above data, we see that the line goes up, indicating that as time proceeds, there are more graduates (if the line had gone down, that would tell us that we were having less graduates). The best-fit line can also help us to **predict** unknown values. For example, based on our best-fit line, in the year 2013, we expect to have about 1200 graduates, and in the year 2002, we expect there were about 600. These are only guesses, but they are reasonable guesses based on the data. Using a best-fit line to make educated guesses is called **prediction**.

Another use of best-fit lines is to determine if two quantities are in some way dependent on one another. In the above plot, we see that as one quantity (the year) goes up, the other quantity (the number of graduates)

also goes up; or we could say that as the year goes down, the number of graduates goes down. We see that there is a dependency between the two quantities, so we say that the year and the number of graduates are **correlated**. Furthermore, we say that the year and the number of graduates are **positively** correlated, since as one quantity goes up, so does the other. In a different situation, suppose that as one quantity went up, the other went down; in that case we would say that the quantities were **negatively correlated**. If two quantities do *not* seem to have any sort of dependence, we say that there is **no correlation** between the quantities. For our class, we will not be precise, and just use our instincts: if the data looks like a line that goes up, the quantities are positively correlated; if the data looks like a line that goes down, the quantities are negatively correlated; if the data does not look enough like a line, the quantities have no correlation. There are in fact a lot of precise issues we ignore here that could be discussed in a statistics course (like MTH 23); we are in fact only thinking about *linear correlation*, since we only consider matching data to lines; one could in fact try matching data to other kinds of shapes in a more advanced course.

16.2 NYC Housing

Some rentals are classified as *luxury rentals* because they are sufficiently nice. Some rentals are classified as *over-crowded* because the space is not considered adequate for the number of people living in the space. The following table gives the percentage of housing in each category by borough (in the year 2011).

	Luxury Rentals	Over-Crowded Rentals
Bronx	3.8 %	13.7 %
Brooklyn	9.4 %	12.1 %
Manhattan	38.4 %	6.7 %
Queens	9.3 %	12.5 %
Staten Island	11.4 %	9.3 %

1. Create a scatter plot of the data (**use graph paper**).
2. Draw an approximate best-fit line on top of your scatter plot.
3. How good is your line at approximating the data? Does your line indicate a *positive correlation*, a *negative correlation*, or *no correlation*? What does this tell us about our society?
4. Use the graph of your best-fit line to answer the following questions.
 - (a) If a region has 10% luxury rentals, then what percent of its rentals do you expect are overcrowded?

- (b) If a region has 5% over-crowded rentals, then what percent of its rentals do you expect to be luxury?

16.3 Runs versus RBIs

Consider the following data for the Yankees 2011 starting lineup. For each player, the table gives the number of runs the player had during the season, and the number of RBIs (i.e. *Runs Batted In*) during the season.

	Runs	RBIs
Russell Martin	57	65
Mark Teixeira	90	111
Robinson Cano	104	118
Derek Jeter	84	61
Alex Rodriguez	67	62
Brett Gardner	87	36
Curtis Granderson	136	119
Nick Swisher	81	85
Jorge Posada	34	44

1. Create a scatter plot of the data (**use graph paper**).
2. Draw an approximate best-fit line on top of your scatter plot.
3. How good is your line at approximating the data? Does your line indicate a *positive correlation*, a *negative correlation*, or *no correlation*? Explain why the correlation does or does not make sense.
4. Use the graph of your best-fit line to answer the following questions.
 - (a) A player who gets 70 RBIs should get how many runs?
 - (b) A player who gets 150 RBIs should get how many runs?
 - (c) A player who gets 50 runs should get how many RBIs?
 - (d) A player who gets 10 runs should get how many RBIs?

16.4 Bronx Economics

The following table gives the *median household income* and *adult unemployment rate* for the neighborhoods in The Bronx (in the year 2008).

	Median Household Income	Adult Unemployment Rate
Mott Haven (B01)	\$30,552	19.90%
Hunts Point (B02)	\$30,552	20.10%
Morrisania (B03)	\$24,441	18.40%
Concourse/Highbridge (B04)	\$26,478	15.20%
University Heights (B05)	\$29,533	16.80%
East Tremont (B06)	\$24,441	17.50%
Fordham (B07)	\$34,727	12.40%
Riverdale (B08)	\$71,287	7.90%
Unionport/Soundview (B09)	\$40,736	11.70%
Throgs Neck (B10)	\$56,011	5.30%
Pelham Parkway (B11)	\$45,828	7.00%
Williamsbridge (B12)	\$50,919	8.70%

1. Choose any 7 neighborhoods from the above table.
2. Create a scatter plot of the data for your 7 neighborhoods (**use graph paper**).
3. Draw an approximate best-fit line on top of your scatter plot.
4. How good is your line at approximating the data? Does your line indicate a *positive correlation*, a *negative correlation*, or *no correlation*? Explain any correlation and why you think it would be positive or negative.
5. Use the graph of your best-fit line to answer the following questions.
 - (a) In a neighborhood with a median income of \$20,000, what do you expect the unemployment rate to be?
 - (b) In a neighborhood with an unemployment rate of 3% what do you expect the median income to be?
 - (c) Test how good your best-fit line is by considering the 5 neighborhoods you did **not** pick. For each of the 5 neighborhoods, use your best-fit line to find the unemployment rate that is predicted by the median income. Compare the actual unemployment rate with the predicted unemployment rate. How good is your best-fit line at prediction?

16.5 Music

Consider the following table listing Beyonce's grammy nominations and wins by year (in case you do not know, Beyonce is a rather well known musician/singer).

(source:
http://en.wikipedia.org/wiki/List_of_awards_and_nominations_received_by_Beyonce)

Year	Nominations	Wins
2000	2	0
2001	5	2
2002	2	1
2004	6	5
2005	1	0
2006	6	1
2007	4	1
2008	2	0
2009	5	2
2010	6	4
2011	3	0
2012	2	0
2013	1	1
2014	1	0

1. Plot the nominations versus year. Then draw a best-fit line on top of your data.
2. Is there a correlation between the number of nominations and the year? If there is a correlation, is it positive or negative? Give a possible explanation of these results.
3. Plot the wins versus year. Then draw a best-fit line on top of your data.
4. Is there a correlation between the number of wins and the year? If there is a correlation, is it positive or negative? Give a possible explanation of these results.
5. Make a scatter diagram of wins versus nominations. Then draw a best-fit line on top of your data.
6. Is there a correlation between the number of nominations and wins? If there is a correlation, is it positive or negative? Give a possible explanation of these results.

17

Lines–Slope

No Problems.

18

Lines—Equations

18.1 More on Best-Fit Lines

The notion of a Best-Fit Line will continue to be used, but now we can find the equation of a line (in chapter 16 we only used the graph of a line). Also, now, using the notion of *slope*, we can see that in a Best-Fit Line, a positive slope corresponds to positive correlation and a negative slope corresponds to negative correlation.

18.2 NYC Housing

Some rentals are classified as *luxury rentals* because they are sufficiently nice. Some rentals are classified as *over-crowded* because the space is not considered adequate for the number of people living in the space. The following table gives the percentage of housing in each category by borough (in the year 2011).

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Staten Island	11.4 %	9.3 %

1. Create a scatter plot of the data (**use graph paper**).
2. Draw an approximate best-fit line.
3. What is the slope and y-intercept of the line? Use this information to find the equation of the line.
4. Use your equation (*not the graph*) to answer the following questions.

- (a) If a region has 10% luxury rentals, then what percent of its rentals are overcrowded?
- (b) If a region has 5% over-crowded rentals, then what percent of its rentals are luxury?

18.3 Runs versus RBIs

Consider the following data for the Yankees 2011 starting lineup. For each player, the table gives the number of runs the player had during the season, and the number of RBIs (i.e. *Runs Batted In*) during the season.

	Runs	RBIs
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Brett Gardner	87	36
Curtis Granderson	136	119
Nick Swisher	81	85
Jorge Posada	34	44

1. Create a scatter plot of the data (**use graph paper**).
2. Draw an approximate best-fit line.
3. What is the slope and y-intercept of the line? Use this information to find the equation of the line.
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Throgs Neck (B10)	\$56,011	5.30%
Pelham Parkway (B11)	\$45,828	7.00%
Williamsbridge (B12)	\$50,919	8.70%

1. Choose any 7 neighborhoods from the above table.
2. Create a scatter plot of the data for your 7 neighborhoods (**use graph paper**).
3. Draw an approximate best-fit line.
4. What is the slope and y-intercept of the line? Use this information to find the equation of the line.
5. Use your equation (*not the graph*) to answer the following questions.
 - (a) In a neighborhood with a median income of \$20,000, what is the unemployment rate?
 - (b) In a neighborhood with an unemployment rate of 3% what is the median income?
 - (c) Test how good your equation is by considering the 5 neighborhoods you did **not** pick. For each of the 5 neighborhoods, find the unemployment rate that is predicted by the median income.

19

Linear Inequalities in Two Variables

No Problems.

20

Graphing Systems of Linear Equations

No Problems.

21

Solving Systems of Linear Equations

1. The Verrazano bridge charges a toll of \$15. The Bronx-Whitestone bridge charges \$7.5. Suppose you use each bridge some number of times, for a total of 11 uses. If you spent \$105 in total on tolls, how many times did you use each bridge?
2. Every time you use the subway or bus, \$2.5 is deducted from your card. However, if you lose your card, you must buy a new card and pay an extra \$1. Suppose you have a kid who loses her card a lot. You give her a metro card (her first card is free), but then she pays for any new cards. If she takes a total of 22 trips and spends \$64, how many cards did she lose?
3. Suppose you are a clever MTA employee. You caught a less clever high school kid hopping the turnstyle. A fare on the subway costs \$2.5. Suppose he took 25 rides, but only paid \$47.50. How many times did he hop the turnstyle?

22

Positive Integer Exponents

No Problems.

23

Negative Integer Exponents

No Problems.

24

Scientific Notation

24.1 Entertainment: Salaries

1. The table below consists of the annual salaries of a select group of celebrities in 2013.

Celebrity	Salary
Oprah Winfrey	\$ 77000000
Lady Gaga	\$ 80000000
Beyonce	\$ 53000000
Madonna	\$ 125000000
Taylor Swift	\$ 55000000
Justin Bieber	\$ 58000000
Ellen Degeneres	\$ 56000000
Jennifer Lopez	\$45000000
Rihanna	\$ 43000000
Simon Cowell	\$ 95000000
Katy Perry	\$ 39000000
Donald Trump	\$ 63000000
JayZ	\$ 42000000
Will Smith	\$ 23000000
Angelina Jolie	\$ 33000000
Sofia Vergara	\$ 30000000
Kanye West	\$ 20000000
George Lopez	\$ 12000000
Cristiano Ronaldo	\$ 24000000
Usain Bolt	\$ 24000000

2. Convert all celebrity salaries in to scientific notation.
3. Given the annual salary, calculate the DAILY salary of each celebrity and write your answer in scientific notation.

4. Calculate the SUM and the DIFFERENCE of the following salaries in scientific notation. Write your answer in scientific notation.
 - Oprah Winfrey and Madonna
 - Simon Cowell and Madonna
5. Calculate the PRODUCT and QUOTIENT of the following salaries in scientific notation. Write your answer in scientific notation.
 - Ellen Degeneres and Rihanna
 - Usain Bolt and Madonna
 - Lady Gaga and Madonna
6. The following is the number of Facebook fans of select celebrities as of 2014.

Celebrity	Facebook Fans
Rihanna	85965983
Shakira	85258859
Eminem	83309093
Katy Perry	65133464
Will Smith	63597739
Lady Gaga	63555818
Beyonce	57536045
Adele	53575957
Nicki Minaj	41466509
Drake	33177171
Jennifer Lopez	32240698
Alicia Keys	32525492
Pitbull	46100227
Bruno Mars	49015235
Jackie Chan	53595859

7. Write the number of Facebook fans of all celebrities in scientific notation.
8. Calculate the SUM and DIFFERENCE of the following celebrity's Facebook fans in scientific notation. Write your answer in scientific notation.
 - Rihanna and Adele
 - Bruno Mars and Pitbull

24.2 Entertainment: Fancy Rings

1. Write the value of the following celebrities engagement rings in scientific notation:
 - (a) Kate Middleton : \$ 137,200.00
 - (b) Jennifer Lopez: \$ 2, 500, 000.00
 - (c) Beyonce: \$ 5, 000, 000.000
2. Calculate the sum of the value of Kate Middleton's and Beyonce's rings, using scientific notation. Write your answer in scientific notation
3. Calculate the product of the value of Jennifer Lopez's and Beyonce's ring, using scientific notation. Write your answer in scientific notation.

24.3 Criminal Justice

1. The table below gives the mortality rate per 100,000 local jail inmates, by selected characteristics. (source: <http://www.bjs.gov/content/pub/pdf/mljsp0011.pdf>)

Characteristic	2008	2009	2010	2011
Male	123	129	125	123
Female	120	120	124	122
White	185	202	199	204
Black	109	100	100	89
Latino	70	71	60	71
Age 45-54	259	255	256	231
Age 55 or older	666	707	641	650
Convicted	69	87	81	77
Unconvicted	154	148	148	151

2. Write the mortality rate of convicted individuals in 2011, in scientific notation. (In 2008, the mortality rate of convicted individuals was $69/100,000 = 6.9 \times 10^{-4}$)
3. Write the mortality rate of individuals aged 55 or older in 2008, in scientific notation.
4. Using scientific notation, compute the quotient of the mortality rate of Black individuals to Latino individuals in 2010.
5. Using scientific notation, compute the sum of the mortality rates of convicted and unconvicted individuals in 2008.

25

Polynomials—Introduction

No Problems.

26

Polynomials—Adding, Subtracting, Multiplying, Dividing

No Problems.

27

Factoring–Introduction

No Problems.

28

Factoring–Special Products

No Problems.

29

Factoring–Trinomials

No Problems.

30

Factoring–Solving Quadratic Equations

1. The positive solution to the following equation is the number of cars rapper Kanye West owned as of 2012:

$$x^2 - 4x - 21 = 0$$

How many cars did he own?

2. The smaller of the two solutions is the age at which Jennifer Lopez began dancing and singing lessons:

$$x^2 - 16x + 60 = 0$$

When did she begin her lessons?

3. The product of the two solutions is the number of children rapper TI has:

$$x^2 - 5x + 6 = 0$$

How many children does he have?

4. The difference of the two solutions is the number of siblings Michael Jackson had:

$$x^2 - 12x + 20 = 0$$

How many siblings did he have?

5. The product of 13 and the positive solution is the total number of Grammy awards Michael Jackson has won:

$$13x^2 + 25x - 2 = 0$$

How many Grammys did he win?

6. The product of the two solutions is the total number of movies Will Smith has appeared in as of 2014:

$$2x^2 - 24x + 64 = 0$$

How many movies has he been in?

7. The positive root is the total number of movies Brad Pitt has appeared in as of 2014:

$$x^2 - 19x - 42 = 0$$

How many movies has he been in?

8. The product of 82 and the positive solution is the total number of movies Angelina Jolie has appeared in as of 2014:

$$6x^2 + 5x - 4 = 0$$

How many movies has she been in?

9. The product of -17 and the smaller of the two solutions is the total number of movies Jamie Foxx has appeared in as of 2014:

$$3x^2 + 7x + 2 = 0$$

How many movies has he been in?

10. The sum of the two solutions is the total number of movies Megan Fox has appeared in as of 2014:

$$x^2 - 19x + 84 = 0$$

How many movies has she been in?