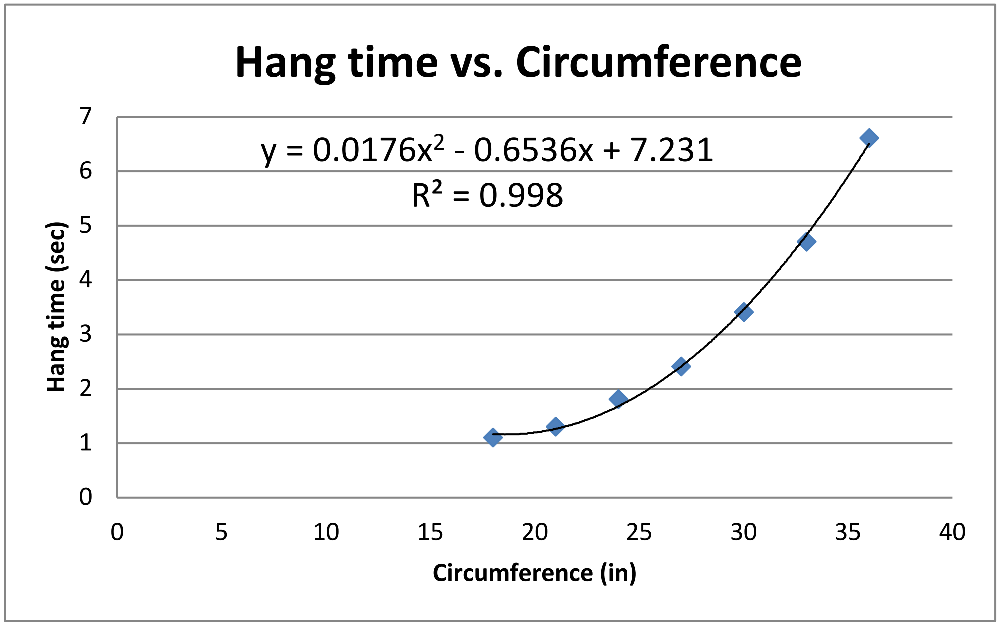
MAT 121 LAB Manual

Algebra & Trigonometry I

Fall 2021 - Spring 2022 - Summer 2022



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Solving Equations

Learning Objectives:

- Given a multistep equation, solve for the variable.
- Given a multistep equation with fractions, solve for the variable.
- Given an application, write an equation to represent the situation and solve.

Problems:

Unless otherwise instructed, all answers should be expressed in simplified form.

Part 1

Solve each equation.

1. $5x-(3x-1)=2$
2. $2x+1-5(x+1)=-7x-1$
3. $5(2x-31)=10x-155$
4. $8(x-7)-16x=-8(x+4)+16$

Part 2

Solve each equation by clearing out fractions/decimals. When applicable, state any values that must be excluded.

5. $\dfrac{x-8}{2}=\dfrac{x+8}{7}$
6. $\dfrac{x+1}{2}=7$
7. $\dfrac{x}{7}=\dfrac{x}{9}+8$
8. $1-\dfrac{6}{8x}=\dfrac{2}{5}$
9. $\dfrac{7}{x}=\dfrac{3}{2x}+22$
10. $\dfrac{x-12}{4}+\dfrac{x+7}{7}=x+6$
11. $\dfrac{x-7}{4x}+6=\dfrac{x+3}{x}$
12. $0.25x+0.35=-0.29$
13. $1.75x+4=6.2$
14. $-2.5x+4.67=2.881$

Part 3

Write an equation using the given information and solve the equation. If necessary, round to two decimal places.

15. Levi borrowed $5007 at 6% simple interest for 5 months.

    a. Since simple interest is calculated by the formula
    Interest = Principal x Rate x Time, where time is in years, what will be the total interest accumulated at the end of 5 months?

    b. What is the total amount that Levi must repay?

16. The distance, rate, and time formula is distance = rate x time. If a truck traveled 988.6 miles at an average rate of 69.5 miles/hour, what is the amount of time the truck traveled?

17. The formula for electrical power is V = W/A where V is voltage, W is wattage and A is amperage. Find the voltage needed for a circuit of 425 W with a current of 1.9 A.

Solving Inequalities

Learning Objectives:

- Given an inequality, solve the inequality.
- Graph inequality solution.
- State inequality solution in interval notation.

Problems:

Solve the following inequalities. State your answer graphically (number line) and in interval notation.

1. $5x + 3 > 7$

2. $5 \leq 6x + 9$

3. $-6 > 4x + 10$

4. $7x + 4 \leq 18$

5. $11x - 8 > 80$

6. $15x + 8 \geq -22$

Compound Inequalities & Applications

Learning Objectives:

- Given a compound inequality, solve the inequality.
- Given an application, construct an inequality and solve.
- State solution graphically and in interval notation.

Problems:

Solve each compound inequality. State your answer graphically and in interval notation.

1. $-9 < 3x + 12 < 8$

2. $-2 < 3x + 4 < 25$

3. $-3 \le 2x + 5 \le 11$

4. $2x - 1 \le 7$ or $3x \ge 15$

5. $x - 7 < 4$ or $x + 3 > 8$

6. $3x < -4$ or $2x - 1 > 9$

Applications:

Write an inequality to represent the situation and solve. State your answer in interval notation ***and*** *in context to the problem.*

7. A trip to Marbles Kids Museum costs $5 per person and a family membership costs $80. We can represent the cost to go to marbles using $C = 5p$ where *C* is the cost to go to Marbles and *p* is the number of times a person can enter Marbles. How many times can a person enter Marbles before you have spent more than the cost of a family membership?

8. An electrician is considering two similar jobs, each of which will take h hours to complete. The first job pays $250 plus $35 per hour. The second job pays $100 plus $75 per hour. The first job can be represented by the expression $35h+250$ and the second job can be represented by the expression $75h+100$. For what values of *h* will the contractor make more at the first job?

9. A local parking garage charges a flat fee of $3 to park for the first two hours and $0.50 per hour (or part of an hour) after that. Assuming that you only use this parking deck when you know you will need to park for more than two hours, we can represent this scenario with $C=0.50t+3$ where *t* represents the number of hours over two hours that you parked your car and *C* is the total cost of parking your car. What range of values for t gives a total cost of at least $7.50 and no more than $10?

10. You purchased a new car for $16,000 and you know that on average, it will be worth $2,400 less each year you own the car and can be represented by $V=-2400t+16000$ where *V* is the value of the car and *t* is the number of years that you owned the car. For what years will the value of the car be between $11,200 and $4,000?

Functions

Learning Objectives

- Evaluate a function for given value.
- Perform addition, subtraction, multiplication, and division on functions.

Problems:

State all answers in simplified exact form.

Part 1. Evaluating Functions

Given $f(x)=x^2-4$, $g(x)=3x+1$, $h(x)=x^2+4x-2$, and $j(x)=2-7x$

1. $f(2)$
2. $h(-3)$
3. $g(0.5)$
4. $j(-5)$

Part 2. Function Operations

Function rules can be added, subtracted, multiplied and divided to create new functions.

$$(f+g)(x)=f(x)+g(x)$$
$$(f\cdot g)(x)=f(x)\cdot g(x)$$
$$\left(\frac{f}{g}\right)(x)=\frac{f(x)}{g(x)} \qquad g(x)\neq 0$$

Given $f(x)=x^2-4$, $g(x)=3x+1$, $h(x)=x^2+4x-2$, and $j(x)=2-7x$, perform the following operations. Provide your answer in simplest form.

1. $(f+h)(x)$
2. $(g+j)(x)$
3. $(g-h)(x)$
4. $(h-g)(x)$

5. $(f \cdot j)(x)$

6. $\left(\frac{f}{j}\right)(4)$

7. $(h-f)(-1)$

8. $(g \cdot j)(5)$

9. $(f+g)(3)$

10. $\left(\frac{g}{j}\right)(x)$

Excel Lab 1 – Introduction to Excel

Introduction to Excel

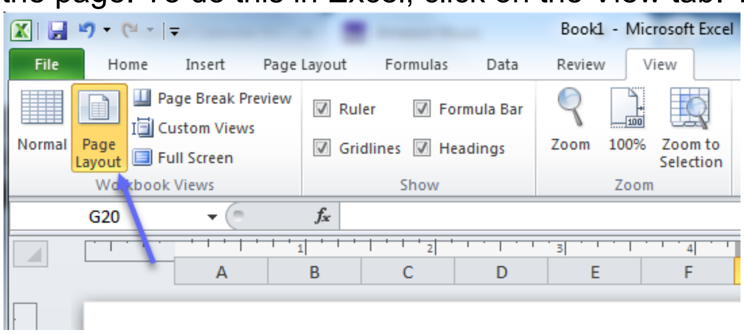
In this class we will be using electronic spreadsheets to explore some of the mathematical concepts and applications that we are studying in class. The goal of the use of the spreadsheet is to enable you to solve mathematical problems using up-to-date technology that is commonly used in business today.

Purpose: The purpose of this lab is to get you acquainted with rows, columns, cells, and excel formulas.

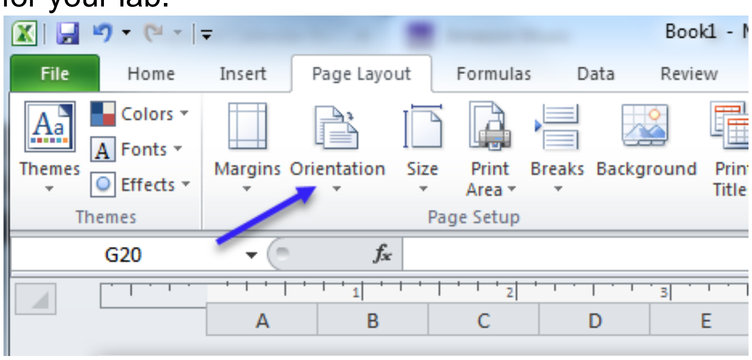
Directions: Complete the **Practice Problems and Exercises** by working through this entire lab. Students must complete the Practice Problems and the Exercises to get full credit for this lab. Please make sure you are carefully following all instructions throughout the lab so that you will have proper formatting and labeling throughout the lab. To open excel on your computer; go to Start, Programs, Microsoft Office, and Microsoft Excel. *Note: The pictures provided on this lab are to help guide you through the lab but may not exactly match your version of Microsoft Excel.*

Lab Set-Up:

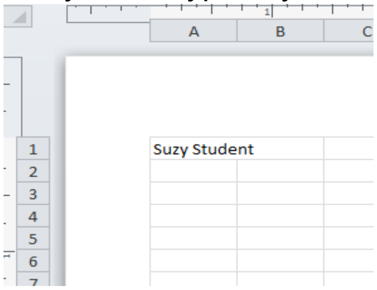
1. Before you start working, it is best to change your view to Page Layout. This enables you to see all page breaks while you are working so that your graphs and tables don't "hang off" the page. To do this in Excel, click on the View tab. Then click Page Layout.



2. If you want to change from portrait to landscape orientation, click on the page layout tab, then click Orientation and choose Landscape or Portrait. Use the orientation that best works for your lab.



3. In cell A1, type your first and last name (you may have to use wrap-text). This is the cell that you will type in your name for each lab.



4. We will use multiple sheets in this lab. To keep them organized, we will name them as we go. To rename a sheet in Excel, right click on the tab at the bottom that says, “Sheet 1” and then rename the sheet as instructed.

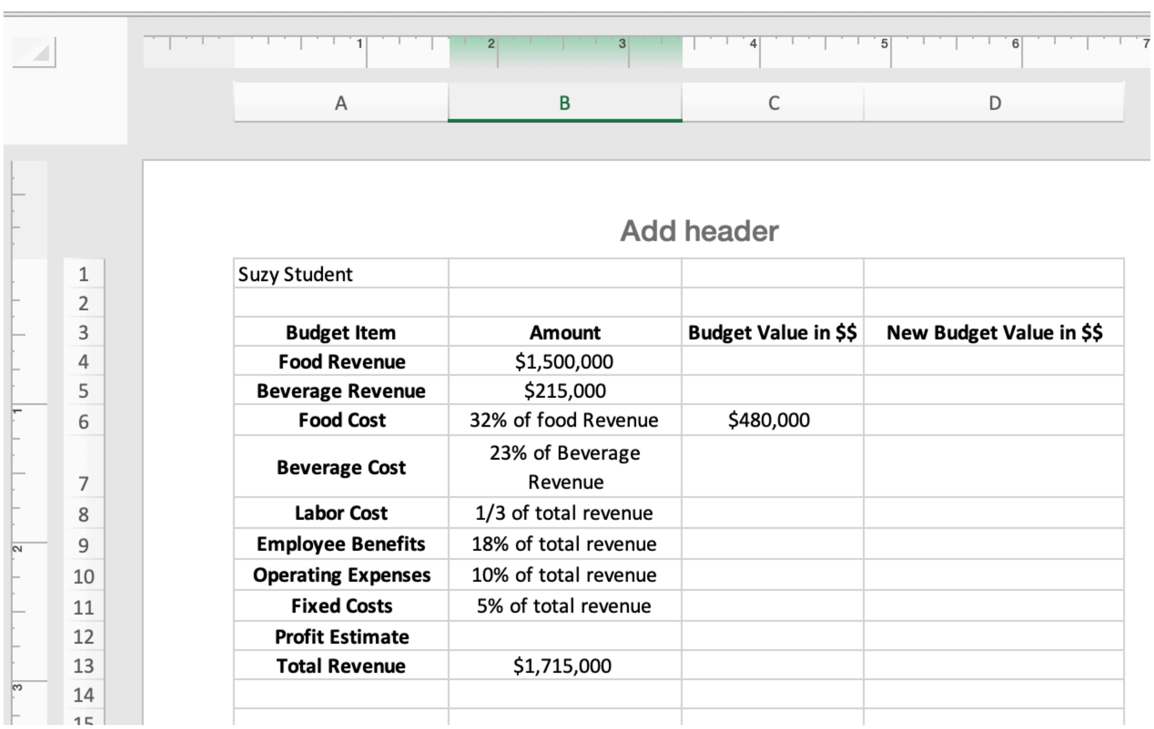
Problem 1: Restaurant Budget

Based on the previous year revenue and costs, a projected budget for a local restaurant is being developed. Using the given budgeted items in the table below, develop the initial budget for the coming year by completing the third column in the table below.

Step 1: Rename sheet 1 “Restaurant Budget”

Step 2: Set up the table in Excel.

- Put the column headings in cells A3 – D3
- Put the row headings in cells A4 – A13
- Fill in the “Amount Column” cells B4 – B11 with the information given in the table below.


Add header

	A	B	C	D
1	Suzy Student			
2				
3	**Budget Item**	**Amount**	**Budget Value in $$**	**New Budget Value in $$**
4	**Food Revenue**	$1,500,000		
5	**Beverage Revenue**	$215,000		
6	**Food Cost**	32% of food Revenue	$480,000	
7	**Beverage Cost**	23% of Beverage Revenue		
8	**Labor Cost**	1/3 of total revenue		
9	**Employee Benefits**	18% of total revenue		
10	**Operating Expenses**	10% of total revenue		
11	**Fixed Costs**	5% of total revenue		
12	**Profit Estimate**			
13	**Total Revenue**	$1,715,000		
14				

Step 3: Complete column C using the information from column B. The good news is that Excel will do these calculations for us. However, in order to be successful at this we need to keep a few things in mind:

- When using Excel, you must start all calculations with =
- use an * between numbers for multiplication (Excel does not understand implied multiplication), and
- use / for division

Food Cost is 32% of the Food Revenue. Food Revenue is located in cell B4 and in mathematics, of means multiply. Therefore, to calculate the Food Cost, type the following into cell C6: =32%*B4 and press enter. This will give you Food Cost of $480,000.

Complete cells C5 – C11 on your own.

Step 4: We need to calculate the Profit. Profit is Total Revenue minus the total Costs. We need to follow the order of operations and add all the costs together before we subtract. We can have Excel help us with this by putting the sum of the costs in parenthesis in our formula. In cell C12, type: =B13-(C6+C7+C8+C9+C10+C11) and press enter.

Step 5: In an attempt to increase the profit from the initial budgeted profit, the manager will take the following measures to increase the total profit. Using the changes outlined below, recalculate each budgeted item to arrive at a new projected profit estimate and record the values in column D.

- New advertisements developed will increase the additional customers by 10 per month. The average per customer ticket is $19.50. This will increase the total Revenue for the year to $1,717,340.00. Add this value to your spreadsheet in cell D13.
- Food Revenue and Beverage Revenues are 87.46% and 12.54% of the total Revenue respectively.
- New Food and Beverage suppliers have been found and the new supply company costs 10% less than the previous suppliers.
- Labor and Employee benefits will not change in dollar value, as no new employees will be hired.
- Operating Expenses and Fixed Costs will remain as the same percentage of total revenue.
- Calculate the new total profit.

Solving Radical Equations

Learning Objectives:

- Given an equation with a radical, solve for the variable.
- Determine if a solution to a radical equation is extraneous.

Problems:

Solve each equation. All answers should be expressed in simplified exact form. Remember to check for extraneous solutions.

1. $\sqrt{3x+4}=8$

2. $2\sqrt{3x-1}=16$

3. $\sqrt{5x-1}+3=0$

4. $\sqrt{3x+1}-4=0$

5. $4-\sqrt{x-2}=0$

6. $10\sqrt{x-4}=20$

7. $\sqrt[3]{x-1}=2$

8. $\sqrt[3]{3x-6}+3=0$

9. $\sqrt[4]{8x-3}-2=0$

10. $\sqrt[4]{3x}-3=0$

Applications:

Solve each word problem and state your answer with appropriate units. If necessary, round final answers to two decimal places.

11. The Pacific Tsunami Warning Center is responsible for monitoring earthquakes that could potentially cause tsunamis in the Pacific Ocean. Scientists can predict arrival times of tsunamis by measuring the depth of the ocean and then calculating the speed of a tsunami. The speed s (in meters per second) at which a tsunami moves is determined by the depth d (in meters) of the ocean using the following function: $s = \sqrt{g \cdot d}$ What is the speed of a tsunami if the depth of the ocean is 4,000 meters? The acceleration due to gravity, g is 9.81 m/s^2.

12. A plural birth is a live birth to twins, triplets, and so forth. The formula $R = 26\sqrt[10]{t}$ models the plural live birth rate R (live births per 1000 live births), where t is the number of years since 1995. Use the model to predict the year in which the plural birth rate will be 39.

13. An object falls from the top of a building 50 feet tall. The object will be h feet above the ground after t seconds. This relationship is modeled using the formula below. How many feet above the ground will the object be after 1 second?

$$t = \frac{\sqrt{50 - h}}{4}$$

Literal Equations & Formulas

Learning Objectives:

- Evaluate formulas using given value(s).
- Solve literal equation for any variable.

A formula is a rule, empirical or theoretical, relating several quantities to each other. For instance, the circumference of a circle, C, can be related to the radius, r, by the formula $C = 2\pi r$

Example 1: To find the amount of money that would accumulate over time in an interest bearing account, you would need a formula. The formula that might be used is $A = P + Prt$, solve for P.

In this formula, P is the principal, or the original amount invested. The other variables, r and t, stand for the yearly interest rate and the number of years, respectively. This formula is "solved for" A in terms of P, r and t; since, in many cases, a person would know P, r and t and want to know A. But in some cases, you might know r, t and how much money you wanted to accumulate, A, and want to know P. In this case, you would want to calculate P, given A, r, and t. A formula that was "solved" for P in terms of A, r, and t would make this easy. Beginning with the formula that is solved for A, we solve for P by isolating P on one side of the equation with A, r, and t on the other side.

$A = P + Prt$

$A = P(1 + rt)$ Factor out the P

$\dfrac{A}{1 + rt} = P$ Divide both sides by $1 + rt$

And now we have P in terms of A, r, and t. Knowing A, r and t you could find out how much principal, P, to invest.

Example 2: Given the formula $A = \pi r^2$ where A is the area of a circle of radius r, solve for r.

$A = \pi r^2$

$\dfrac{A}{\pi} = r^2$ Divide by π

$\sqrt{\dfrac{A}{\pi}} = r$ Take the square root of both sides.

Notice that we only use the positive root for r since the radius of a circle is not negative.

Problems:

Given the literal equations below, solve for the indicated variable.

1. The force F of an electric field E acting on a particle of charge q is given by $F = qE$.
   Solve the formula for E.

2. The force F needed to accelerate a body of mass m to an acceleration a, is $F = ma$.
   Solve the formula for a.

3. The perimeter P of a rectangle with length L and width W is given by $P = 2W + 2L$.
   Solve for the formula for L.

4. The volume of a right circular cylinder is given by $V = \pi r^2 h$ where V is volume, r is the radius, and h is the height.
   a) Solve for the height (h).
   b) Solve for the radius (r).

5. The position of an object, x, as a function of time, t, is given by $x = x_0 + v_0 t + \frac{1}{2} a t^2$, where x_0 is the initial position, v_0 is the initial velocity and a is the acceleration.
   a) Solve for x_0.
   b) Solve for v_0.

6. If you are at a position d_1 at time t_1 and a position d_2 at time t_2, then the average speed while traveling from d_1 to d_2 is $s = \frac{d_2 - d_1}{t_2 - t_1}$ where s is the speed.
   a) Solve for t_2
   b) Solve for d_1.

7. The force of gravity, F, between the earth, mass M, and a satellite, mass m, is given by $F = \frac{GMm}{r^2}$. G is called the gravitational constant and r is the distance from the center of the earth to the center of the satellite.
   a) Solve for m.
   b) Solve for r.

8. The torsional deflection of a solid shaft is given by $\theta = \frac{32TL}{\pi G D^4}$. Here θ is the angle of twist, T is the torsion, L is the length of the shaft being twisted, D is the diameter of the shaft and G is the shear modulus of elasticity.
   a) Solve for D.
   b) Solve for G.
   c) Solve for T.

9. The ideal gas law states that the pressure, P, volume, V, and temperature, T, of n moles of a gas are related by $PV = nRT$. R is a special constant.
   a) Solve for T.
   b) Solve for P.

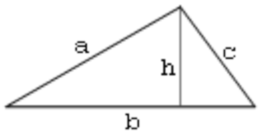
10. If a closed flexible container of an ideal gas, say a balloon filled with helium, starts off at room temperature and is placed in a refrigerator (at a colder temperature), then the balloon will shrink. The relation between the pressure, volume and temperature beforehand, P_1, V_1 and T_1 and the pressure, volume and temperature afterward, P_2, V_2 and T_2 is given by $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$.
    a) Solve for T_1.
    b) Solve for V_1.
    c) Solve for P_2.

11. The power in an electrical circuit, P, can be given by $P = \frac{V^2}{R}$ where V is the voltage and R is the resistance.
    a) Solve for R.
    b) Solve for V.

12. The power in an electrical circuit, P, can be given by $P = I^2R$ where I is the current in the circuit and R is the resistance.
    a) Solve for R.
    b) Solve for I.

Geometry Formula Sheet

Triangle

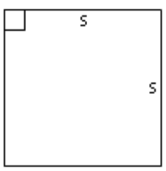


$P = a + b + c \quad A = \frac{1}{2}bh$

$s = \frac{a+b+c}{2}$

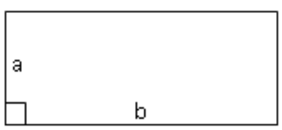
$A = \sqrt{s(s-a)(s-b)(s-c)}$

Square



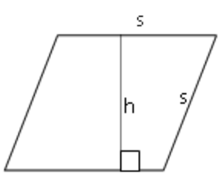
$P = 4s \quad A = s^2$

Rectangle



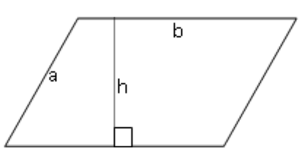
$P = 2(a+b) \quad A = ab$

Rhombus



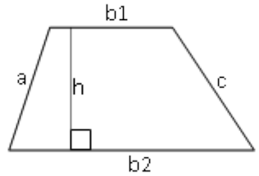
$P = 4s \quad A = sh$

Parallelogram



$P = 2(a+b) \quad A = bh$

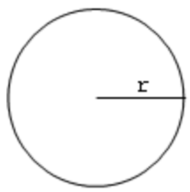
Trapezoid



$P = a + b_1 + c + b_2$

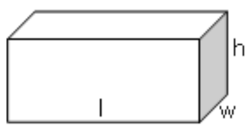
$A = \frac{1}{2}(b_1 + b_2)h$

Circle



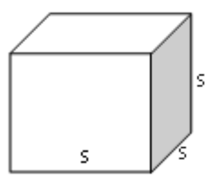
$C = 2\pi r \quad A = \pi r^2$

Rectangular Prism



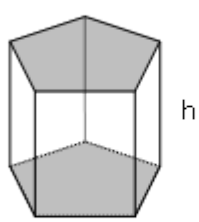
$V = lwh$

Cube



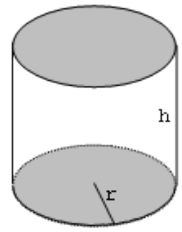
$V = s^3$

Prism



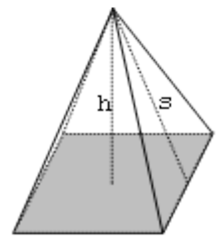
$V = Bh$

Circular Cylinder



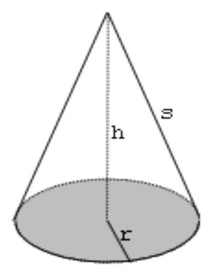
$V = \pi r^2 h$

Pyramid



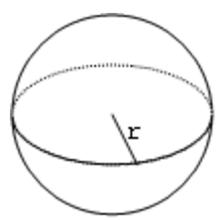
$V = \frac{1}{3}Bh$

Circular Cone



$V = \frac{1}{3}\pi r^2 h$

Sphere



$V = \frac{4}{3}\pi r^3$

Pythagorean Theorem

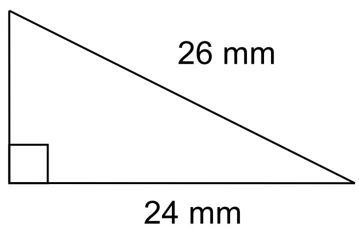
Learning Objectives:

- Determine the missing side of a right triangle using the Pythagorean Theorem
- Find the missing side of a right triangle in application problems using the Pythagorean Theorem

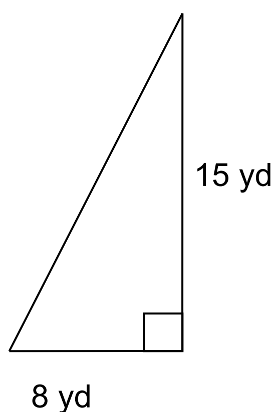
Problems:

Unless otherwise instructed, round all final answers to two decimal places and include units.

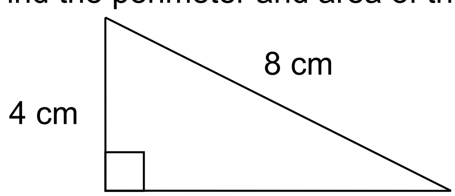
1. Find the value of the missing side.



2. Find the value of the missing side.



3. Find the perimeter and area of the triangle below.



4. The width of a house is 48 feet wide and the height (rise) of the roof is 10 feet. Find the length of the roof if the rafter does not go beyond the side the house.

5. A 26 foot pole will be braced with a wire that connects to the top of the pole and the ground. How long is the wire if it is 18 feet from the base of the pole? Hint: Draw and label your diagram.

6. The diagonal distance in a square room is 23 feet. What are the dimension of the square room?

7. If the base of a ladder is placed on the ground 4 feet from a wall. How long is the ladder if it reaches the top of the wall that is 18.5 feet?

Perimeter and Circumference of Two Dimensional Shapes

Learning Objectives:

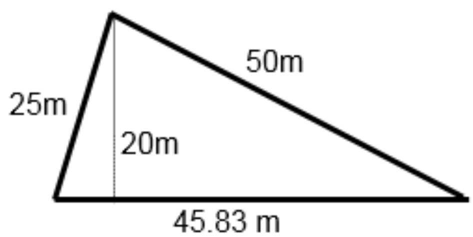
- Determine the perimeter of 2-D figures given perimeter formulas
- Solve application problems using perimeter

Problems:

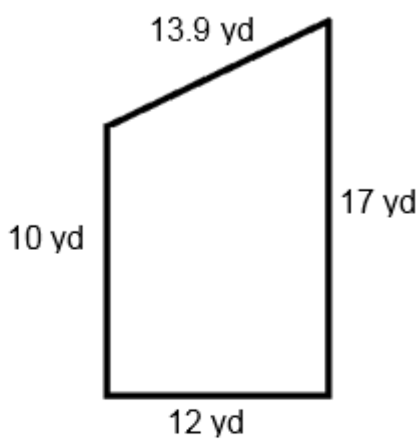
Unless otherwise instructed, round all final answers to two decimal places and include units.

1. A rectangular parking lot is 250 feet by 185 feet. What is the perimeter of the parking lot?

2. Find the perimeter of the triangle below.

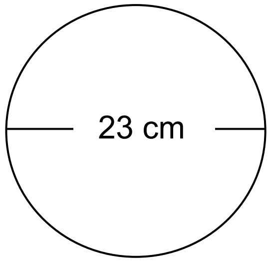


3. Find the perimeter of the following figure.



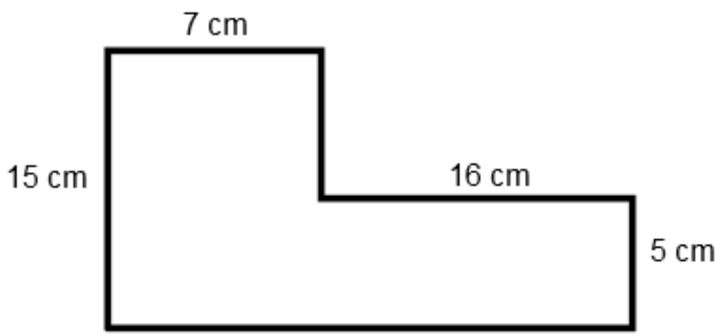
4. The circumference of a circle is 13.53 cm, when measured with a tape measure. Find the diameter of the circle.

5. Find the circumference of the circle with given diameter.



6. How many feet of molding are needed around the baseboards of a room that is 14 feet by 20 feet, if there are three 3.5 feet wide doorways?

7. How many centimeters of string are needed to outline the figure below?



8. A circular swimming pool has a diameter of 16 feet. There is a sidewalk around the outside of the pool that is 5 feet wide.
   a. Draw and label a diagram of the pool.

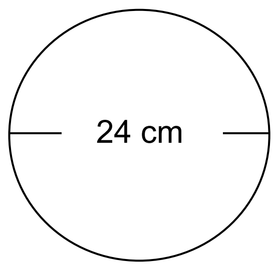
   b. How much fencing is needed to go around the outside edge of the sidewalk?

Area of Two Dimensional Shapes
Learning Objectives:

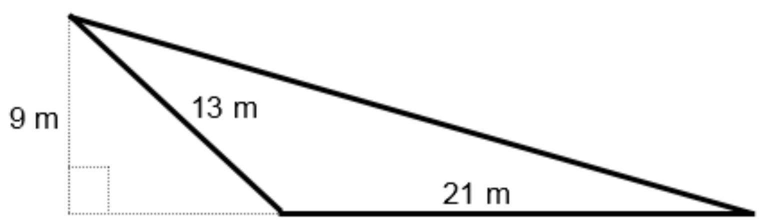
- Determine the area of 2-D figures given area formulas
- Use Heron's formula to determine the area of an oblique triangle
- Solve application problems using area formulas

Problems:
Unless otherwise instructed, round all final answers to two decimal places and include units.

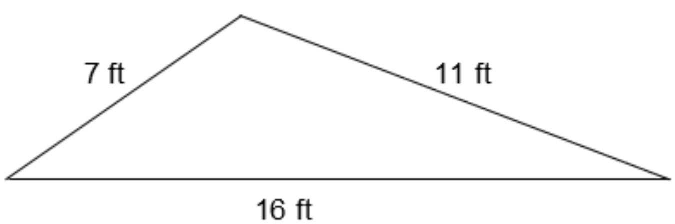
1. Find the area of the circle with the given diameter.



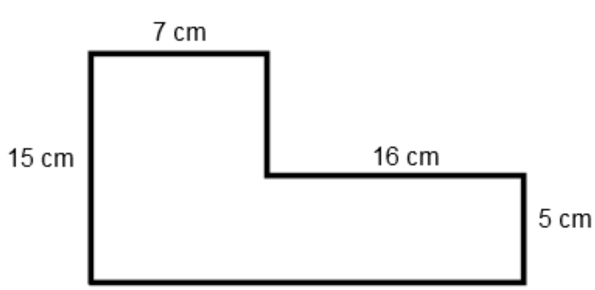
2. Find the area of the triangle below.



3. Find the area of the triangle below.



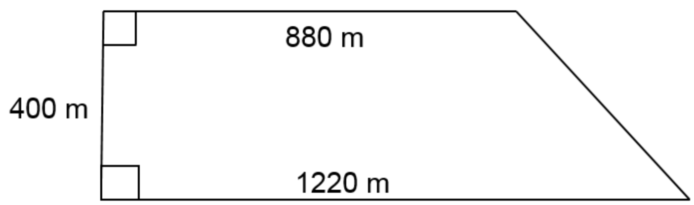
4. How many square centimeters of paint are needed to fill in the figure below?



5. A rectangular parking lot is 250 feet by 185 feet.
    a. What is the area of the parking lot?

    b. The parking lot is going to be paved. The asphalt to be used costs $6 per square foot. How much will it cost to pave the parking lot?

6. Find the cost of the parcel of land shown below if land sells for $2000 per square meter.



7. A circular swimming pool has a diameter of 16 feet. There is a sidewalk around the outside of the pool that is 5 feet wide.
    a. Draw and label a diagram of the pool.

    b. What is the area of the pool?

    c. What is the area of the sidewalk?

Volume of Three Dimensional Shapes

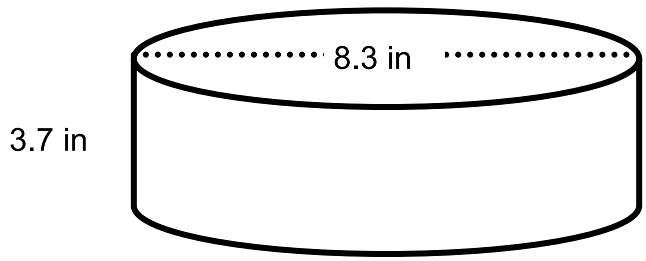
Learning Objectives:

- Determine the volume of 3-D objects given volume formulas
- Solve application problems using volume formulas

Problems:

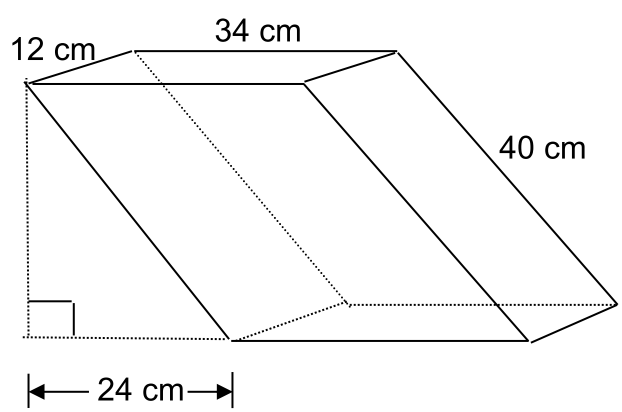
Unless otherwise instructed, round all final answers to two decimal places and include units.

1. Find the volume of the cylinder.



2. Find the volume of the right circular cone if the radius is 1.6 feet and the height is 1.8 feet.

3. If the height of the rectangular prism shown below is 32 cm, find the volume of the prism.



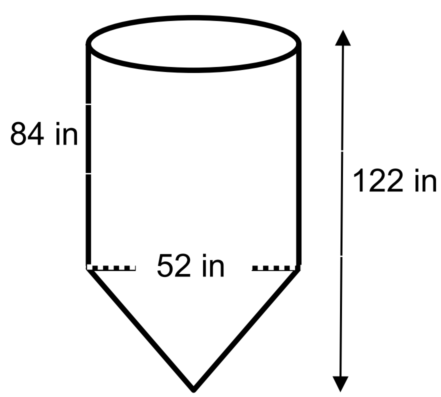
4. A right prism is 10 meters tall and the area of the base is 32 square meters. What is the volume of this right prism?

5. A spherical balloon has a diameter of 36 inches. What is its volume in in^3?

6. What is the volume of a family sized box of cereal that is 8 in long, 1.75 inches wide, and 12.13 inches tall?

7. How much ice cream will it take to fill a waffle cone that is 6 inches tall with a diameter of 2.63 inches at the top? Hint: You are making a flat top, not overfilling the cone.

8. As shown in the image below, a fermentation tank is cylindrical with a conical bottom. The diameter is 52 inches. What is the maximum capacity of this tank?



Excel Lab 2

Learning Objectives:

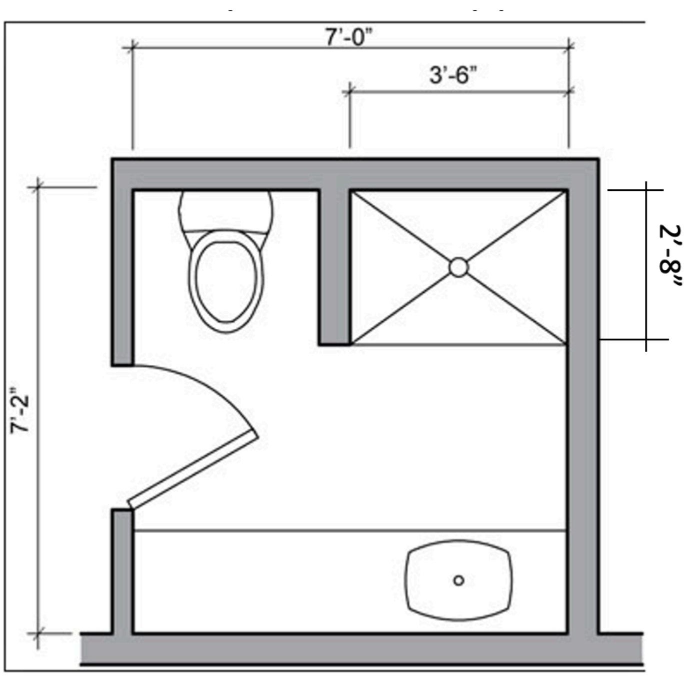
- Use Excel to perform operations involving area.

We can use Excel to help us solve geometric problems in the real world. For example, if you are going to remodel part of your house and you are on a budget, a spreadsheet is an excellent way to manage your budget and finances. In this problem, you are going to remodel a bathroom in your home. The floor plan of the bathroom is pictured below and the bathroom has a wall height of 10 ft. You must use Excel to perform all calculations on this lab.

Before you begin, put your name in cell A1.

You are going to replace everything in this bathroom! New floors, toilets, bathtubs, showers, and wallpaper! The company that is redoing your bathroom will tile under the vanity in all the bathrooms, up to the 4" PVC pipe for the toilet but will not tile under the shower.

1. Determine the area of the bathroom that needs to be tiled. In cell A3, type "Bathroom Area". In order to calculate the total area of the bathroom, you need the following measurements. Length and width of the bathroom, the radius of the PVC pipe for the toilet, and the length and width of the shower. In cells A4 – A8, type Length, Width, Radius, Length of Shower, Width of Shower and in cells B4 – B8 type the corresponding measurement in feet.



	A	B
1	Suzy Student	
2		
3	**Bathroom Area**	
4	Length	7
5	Width	7.166667
6	Radius	0.166667
7	Shower Length	3.5
8	Shower Width	2.666667
9		

The Total Area of the bathroom can be found by calculating the Area of the rectangular bathroom, subtracting the Area of the PVC pipe for the toilet, and subtract the area of the shower. In cell A9, type “Total Area” and in cell B9, calculate the Area.

	A	B	C
1	Suzy Student		
2			
3	**Bathroom Area**		
4	Length	7	
5	Width	7.166667	
6	Radius	0.166667	
7	Shower Length	3.5	
8	Shower Width	2.666667	
9	**Total Area**	=B4*B5-pi()*B6^2-B7*B8	
10			

	A	B
1	Suzy Student	
2		
3	**Bathroom Area**	
4	Length	7
5	Width	7.166667
6	Radius	0.166667
7	Shower Length	3.5
8	Shower Width	2.666667
9	**Total Area**	40.74607
10		

The new flooring needs to cover an area of 40.74607 square feet.

2. You found a very nice grey tile at the hardware store that measures 12” by 24” and costs $1.99 per square foot. These tiles do not come in boxes and have to be purchased individually.

   a. How many tiles will you need to tile the floor of the bathroom? Remember that you cannot purchase part of a tile.

   b. To account for errors in measurement and during installation, it is recommended that you purchase 10% more flooring than you calculated based on your measurements. If you add 10% to your order, how many tiles will you order now?

   c. If the tiles cost $3.98 each, how much will the tiles cost?

3. You are going to tile your shower as well, both the floor and the shower walls all the way up to the ceiling. You found a nice, lighter grey tile of the same size as the flooring for $1.48 per square foot.

   a. What is the area of the shower needing to be tiled?

   b. How many tiles are needed to tile the shower if you account for the additional 10%?

   c. How much will the shower tiles cost?

4. Finally, you would like to put wallpaper in your bathroom.
   a. What is the area of the walls needing wallpaper?

   b. How many rolls of wallpaper do you need?

   c. How much will the wallpaper cost?

What is the total cost of your bathroom remodel?

Systems of Two Equations in Two Variables

Learning Objectives:

- Given a system of two equations with two variables, solve for each variable.
- Given an application involving a system of equations, solve for each variable.

Problems:

Solve the following systems of equations using substitution or elimination. Write your answers as an ordered pair.

1. $\begin{cases} 15x+6y=-4 \\ 12x+2y=-6 \end{cases}$

2. $\begin{cases} -5x+7y=-19 \\ 10x=-21+14y \end{cases}$

3. $\begin{cases} 29P=136-Q \\ 18P+20Q+90=0 \end{cases}$

4. $\begin{cases} 40s-30t=50 \\ 20s-70t=-184 \end{cases}$

5. $\begin{cases} 0.02x+0.03y=-0.03 \\ -0.08x+y=-3.24 \end{cases}$

Applications:

For each of the problems below, complete the let statement and then solve the system. Write your answer as a complete sentence.

6. Susie deposits $6,700 into two different savings accounts. The first account earns 2% interest and the second account earns 1.5% interest. At the end of one year, she had earned $114 in interest.

a. Complete the let statement below:

Let: x = ______________________________
y = ______________________________

b. Use the system of equations below to determine how much money she had deposited into each account.

$$\begin{cases} x+y=6700 \\ 0.02x+0.015y=114 \end{cases}$$

7. A total of 83 seats to a school play are sold. Some of the seats are student tickets and some of the seats are adult tickets. If student tickets cost $7 each, adult tickets cost $12 each, and altogether the school made $746, how many of each type of ticket were sold?

a. Complete the let statement below:

Let: x = ________________________________

y = ________________________________

b. Use the system of equations below to help you solve the problem.

$$\begin{cases} x + y = 83 \\ 7x + 12y = 746 \end{cases}$$

8. An airplane flying to Florida from North Carolina is traveling against the wind on the trip there and it takes 2 hours to make the 600 mile trip to Florida. Coming home, the airplane is flying with the wind and it only takes 1.5 hours to make the trip back to North Carolina from Florida.

a. Complete the let statement below:

Let: x = ________________________________

y = ________________________________

b. Determine the speed of both the wind and the airplane. Use the system of equations below to help you solve the problem.

$$\begin{cases} 2x - 2y = 600 \\ 1.5x + 1.5y = 600 \end{cases}$$

Systems of Three Equations in Three Variables

Learning Objectives:

- Given a system of three equations with three variables, solve for each variable.
- Given an application involving a system of equations, solve for each variable.

Problems:

Solve the following systems of equations using substitution or elimination. Write your answers as an ordered triple.

1. $\begin{cases} 2x - 2y + 7z = 9 \\ 2x + y - 2z = -1 \\ 10x - y - 7z = 0 \end{cases}$

2. $\begin{cases} -2x + 2y - 8z = -6 \\ x - y + 4z = 3 \\ 3x - 3y + 12z = 9 \end{cases}$

3. $\begin{cases} x - y + 5z = 17 \\ -4x + 4y - 20z = 4 \\ x + 3y + z = -5 \end{cases}$

4. $\begin{cases} x + y + z = 3 \\ x - y + 4z = 4 \\ 5x + y + z = -13 \end{cases}$

5. $\begin{cases} x + y + z = 6 \\ x - z = 1 \\ x + y = 2 \end{cases}$

Applications:

For each of the problems below, complete the let statement and then solve the system. Write your answer as a complete sentence.

6. Joe borrowed $35,000 to start his own company. He borrowed some of the money at 6%, some at 7% and some at 8% and paid $2,530 in interest at the end of the first year. He also borrowed twice as much from the account that charges him 8% interest as he did from the account that charged him 6% interest.

a. Complete the let statement below:

Let: x = ______________________________

y = ______________________________

z = ______________________________

b. Determine how much he borrowed from each lender.

$$\begin{cases} x+y+z=35000 \\ 0.06x+0.07y+0.08z=2530 \\ 2x=z \end{cases}$$

7. Mr. Miller's daughter is selling chocolate bars for her school. She has three kinds of chocolate bar: milk chocolate, chocolate crunch, and caramel. She sells a total of 46 chocolate bars. The milk chocolate bars are $1.00 each, the crunch bars are $1.50 each, the caramel bars are $2.00 each, and she has a total of $74.50. She sold five fewer milk chocolate bars than chocolate crunch.

a. Complete the let statement below:

Let: x = ______________________________

y = ______________________________

z = ______________________________

b. Use the system of equations below to determine how many of each type she sold.

$$\begin{cases} x + y + z = 46 \\ x + 1.5y + 2z = 74.5 \\ x + 5 = y \end{cases}$$

8. The sum of three numbers is 11. The first, plus the second, minus 2 times the third, is -4. The second, plus 4 times the first, plus the third, is 23. What are the numbers?

9. A grain dealer sold to one customer 5 bushels of barley, 2 of oats, and 3 of rice, for $154; to another 2 of barley, 3 of oats, and 5 of rice, for $154; and to a third, 3 of barley, 5 of oats, and 2 of rice for $154. What was the price per bushel for barley?

Operations with Complex Numbers

Learning Objective:

- Simplify radicals with negative radicands.
- Given two complex numbers, perform addition, subtraction, and multiplication

Problems:

Unless otherwise instructed, state your answer in simplified exact form.

Part 1.

Simplify each radical.

1. $\sqrt{-68}$

2. $\sqrt{-98}$

3. $\sqrt{-60}$

4. $\sqrt{-18}\cdot\sqrt{-36}$

5. $\sqrt{-21}\cdot\sqrt{27}$

6. $\sqrt{-28}\cdot\sqrt{-48}$

Part 2

Perform the indicated operations and simplify each expression completely.

7. $(-4-9i)+(6-9i)$

8. $\left(-2-\sqrt{-147}\right)\left(8+\sqrt{-27}\right)$

9. $(6-9i)-(7-3i)$

10. $(-4-9i)(7-3i)$

11. $(8+3i)+(-2-7i)$

12. $\left(6-\sqrt{-81}\right)+\left(7-\sqrt{-9}\right)$

13. $\left(9i-3\sqrt{6}\right)-\left(3i-3\sqrt{6}\right)$

14. $(6-9i)-(-4-9i)$

15. $\left(7-\sqrt{-36}\right)+\left(-8+\sqrt{-64}\right)$

16. $(-8+8i)-(7-6i)$

Solving Quadratic Equations

Learning Objectives:

- Given a quadratic equation, find all real solutions by using the quadratic formula.
- Given a quadratic application problem, solve using the quadratic formula.
- Given a quadratic equation with complex solutions, solve the equation using the quadratic formula.

Problems:

Solve the following quadratic equations. Unless otherwise specified, give your answer in simplified exact form.

1. $-5x-6=x^2$
2. $-5=2x^2-3x$
3. $x^2=4x-5$
4. $x^2+6x=-11$
5. $16x=6x^2+5$
6. $x^2+10x+28=0$
7. $x=x^2+1$
8. $16x^2-40x+25=0$
9. $5x^2=8x-3$
10. $3x^2+4x+7=0$
11. $x^2-25=0$
12. $5x^2-8x=-7$
13. $4x^2+9=x$
14. $25x^2-3=0$
15. $x^2-45=0$
16. $-3x^2-4x=-7$
17. Suppose you are trying to toss a basketball to your friend who is sitting in a tree. The height of the ball (in feet) is a function of the time the ball was in the air (in seconds) and can be modeled by the function $h(t)=-16t^2+30t+3$.
    a. If the basketball missed the tree and returned to the ground, how long was the basketball in the air? (Round answer to 2 decimal places.)
    b. If your friend catches the ball after 1 second, how high is your friend in the tree?

18. Jessica owns a local art gallery. She has determined that her revenue can be modeled by the equation, $R(a)=-5a^2+1255a+5100$ where a is the number of art pieces that she sells.

a. What is her revenue if she sells 40 pieces of art?

b. How many pieces of art would she need to sell to break even (have a revenue of $0)?

19. John is standing on top of a building and tosses a penny into the air. The height of the penny (in meters) is a function of the time (in seconds) the penny was in the air and can be modeled by the equation $P(t)=-9.8t^2+15t+100$.

a. How long is the penny in the air? (Round answer to 2 decimal places.)

b. What is the height of the penny after two seconds?

c. What is the initial height of the penny?

20. Suppose you launch a rocket with an upward initial velocity of 275 ft/s from 5 feet above the ground. The function $h(t)=-16t^2+275t+5$ models the rockets height as a function of time in the air.

a. How high is the rocket after 1.5 seconds?

b. When will the rocket hit the ground? (Round answer to 2 decimal places.)

Excel Lab 3 – Using Excel to Model and Solve Quadratic Equations

Learning Objectives:

- Create a table of values
- Create a scatterplot
- Given a quadratic equation, find all real solutions by using Goal Seek

In this lab, you will use data collected from the North Carolina Department of Health and Human Services website to plot COVID-19 vaccination rates, determine a **quadratic** model that fits the given data, and answer questions related to the data. Prior to investigating the COVID-19 vaccination rates, we will practice by investigating COVID-19 cases from the start of the pandemic.

Practice: COVID-19 Cases in North Carolina

The data that follows is a random selection of the number of positive cases taken from the NCDHHS COVID-19 Dashboard. All dates chosen were Wednesdays and are counted as weeks after March 4, 2020. The first Wednesday chosen was March 24, 2020 and is 3 weeks after March 4, 2020. In total, data from 20 Wednesdays was randomly selected. The table below contains the data. *Note: The pictures provided on this lab are to help guide you through the lab but may not exactly match your version of Microsoft Excel.*

Weeks since 3/4/20	3	5	7	8	10	13	14	24	25	35
Number of Cases Reported	101	183	394	388	502	497	1,185	1,826	1,694	2,202

Weeks since 3/4/20	46	48	52	53	58	59	72	73	74	75
Number of Cases Reported	4,670	6,900	5,098	4,058	3,916	3,346	1,394	969	525	448

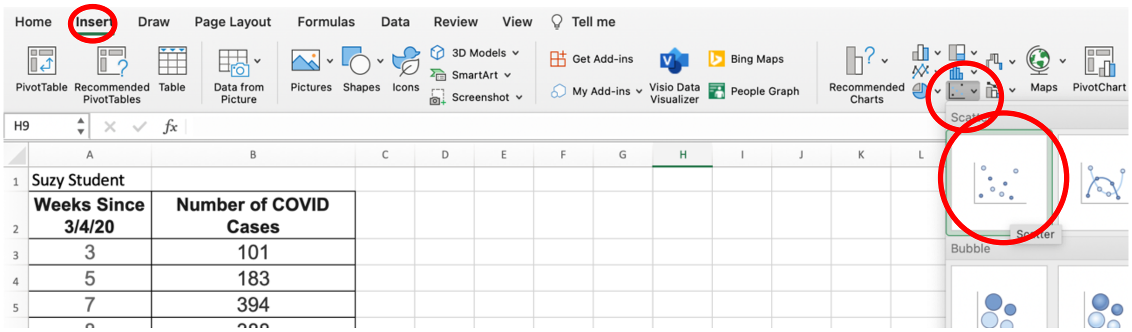
Step 1: Data

Enter the data into excel in columns A and B.

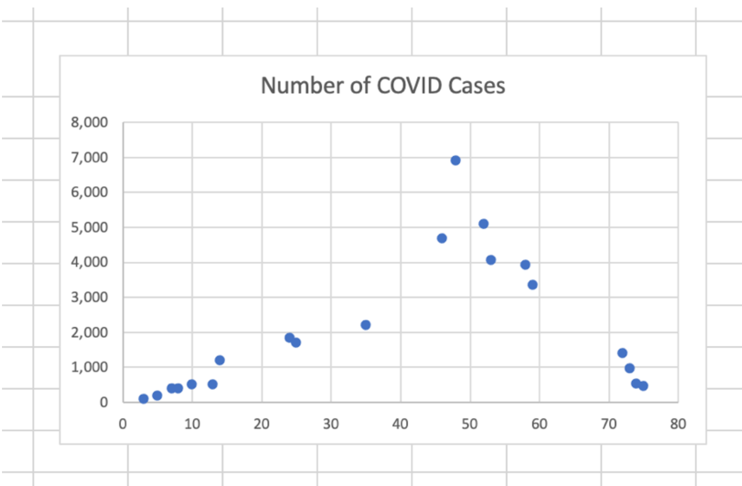
	A	B
1	Suzy Student	
2	Weeks Since 3/4/20	Number of COVID Cases
3	3	101
4	5	183
5	7	394
6	8	388
7	10	502
8	13	497
9	14	1,185
10	24	1,826
11	25	1,694
12	35	2,202
13	46	4,670
14	48	6,900
15	52	5,098
16	53	4,058
17	58	3,916
18	59	3,346
19	72	1,394
20	73	969
21	74	525
22	75	448

Step 2: Insert Scatterplot

Highlight the data, click insert, open the scatterplot drop down menu, and choose the scatterplot with only markers.

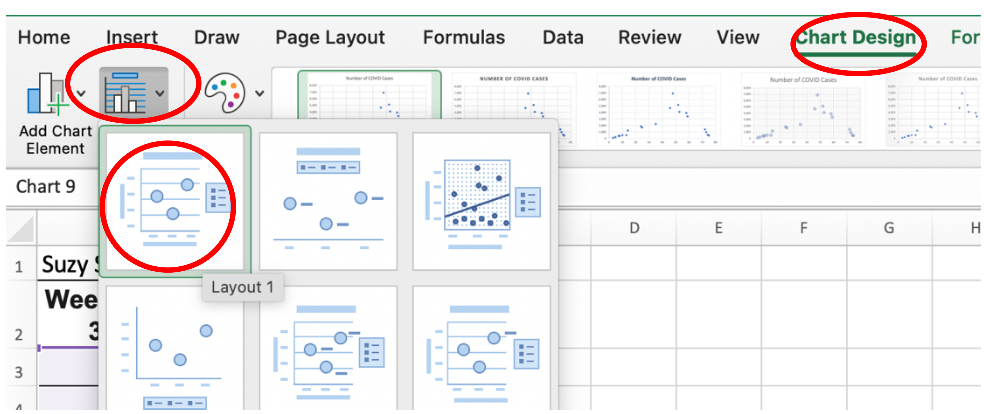


Your scatterplot should look like the picture below.

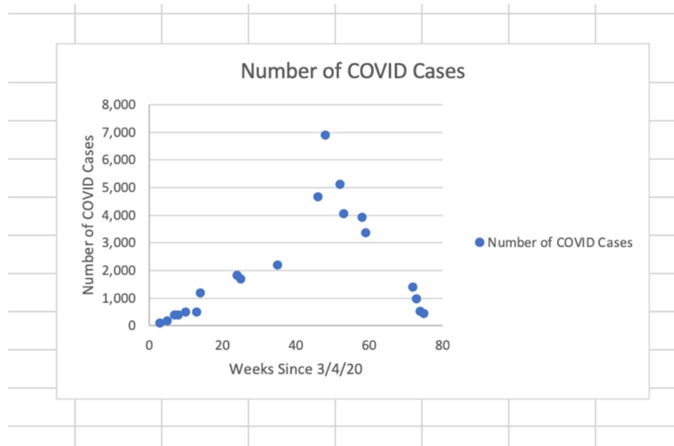


Step 3: Title and Axis Labels

Click chart design, then quick chart layout, and choose the first layout.

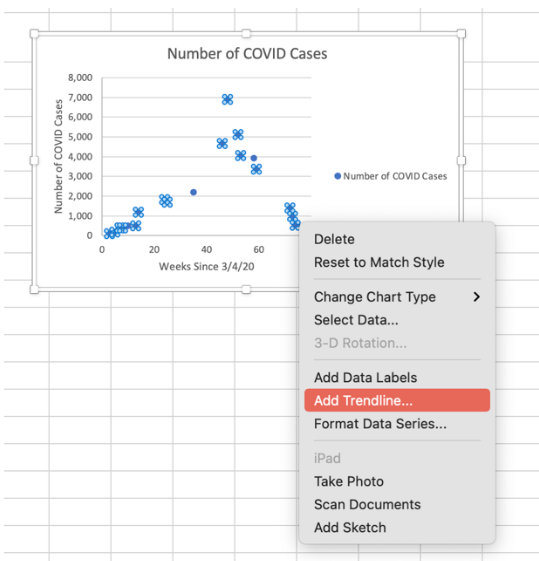


If an accurate title did not appear when the graph was created, click on the generic title, and type a title that describes your graph. Click on the horizontal axis label and type, "Weeks since 3/4/20" and then click on the vertical axis label and type, "Number of COVID Cases".

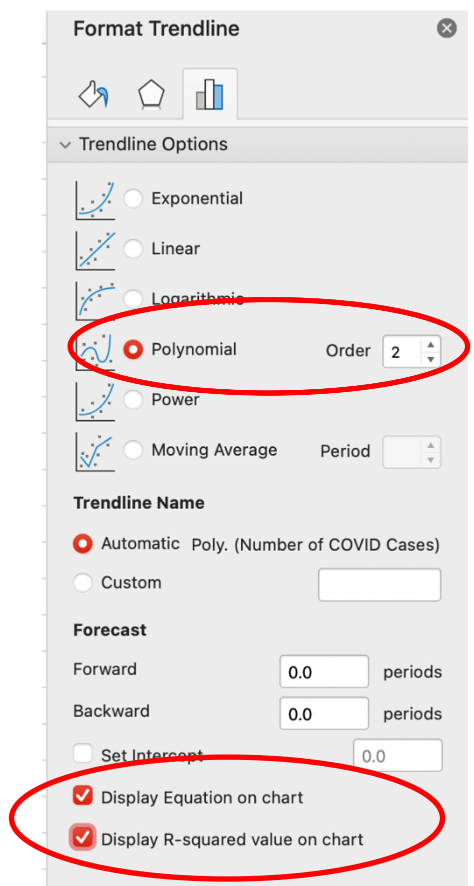


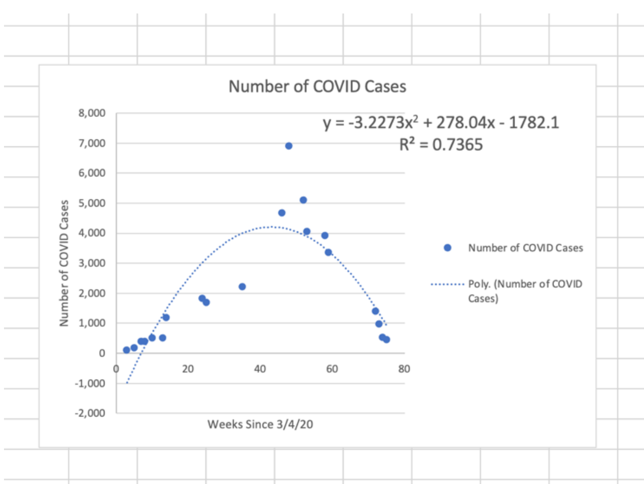
Step 4: Trendline

Right click on any one of the points on your graph and choose, "add trendline".



We are going to model this data with a quadratic trendline. Choose polynomial with order 2 and then click "Display equation on chart" and "Display R-squared value on chart".





Step 5: Create a Prediction Column

In cell C2, type “Predicted COVID Cases” and in cell C3, type “=-0.0611*a2^2+35.453*a2-1524.4” and then press enter.

	A	B	C	D	E
1	Suzy Student				
2	**Weeks Since 3/4/20**	**Number of COVID Cases**	**Predicted COVID Cases**		
3	3	101	=-3.2273*A3^2+278.04*A3-1782.1		
4	5	183			
5	7	394			
6	8	388			
7	10	502			
8	13	497			
9	14	1,185			
10	24	1,826			

	A	B	C	D
1	Suzy Student			
2	**Weeks Since 3/4/20**	**Number of COVID Cases**	**Predicted COVID Cases**	
3	3	101	-977.0257	
4	5	183		
5	7	394		
6	8	388		
7	10	502		
8	13	497		
9	14	1,185		

Move your mouse to the bottom right-hand corner of cell C3 until you see a skinny + sign, hold the left-click down and drag to the end of the data set.

	A	B	C
1	Suzy Student		
2	**Weeks Since 3/4/20**	**Number of COVID Cases**	**Predicted COVID Cases**
3	3	101	-977.0257
4	5	183	-472.5825
5	7	394	6.0423
6	8	388	235.6728
7	10	502	675.57
8	13	497	1287.0063
9	14	1,185	1477.9092
10	24	1,826	3031.9352
11	25	1,694	3151.8375
12	35	2,202	3995.8575
13	46	4,670	4178.7732
14	48	6,900	4128.1208
15	52	5,098	3949.3608
16	53	4,058	3888.5343
17	58	3,916	3487.5828
18	59	3,346	3388.0287
19	72	1,394	1506.4568
20	73	969	1316.5383
21	74	525	1120.1652
22	75	448	917.3375

Step 6: Answer the Questions

With every set of data, there are always questions to answer. For this set of data, answer the following questions.

1. According to your prediction equation,
   a. How many COVID cases were there 50 weeks after 3/4/20?

   Answer: To answer question 1, click and drag the predicted column down 6 cells.

16	53	4,058	3888.5343
17	58	3,916	3487.5828
18	59	3,346	3388.0287
19	72	1,394	1506.4568
20	73	969	1316.5383
21	74	525	1120.1652
22	75	448	917.3375
23			-1782.1
24			-1782.1
25			-1782.1
26			-1782.1
27			-1782.1
28			-1782.1

   Next, in cell A23, type 50 and the answer will appear in cell C23.

17	58	3,916	3487.5828
18	59	3,346	3388.0287
19	72	1,394	1506.4568
20	73	969	1316.5383
21	74	525	1120.1652
22	75	448	917.3375
23	50		4051.65
24			-1782.1
25			-1782.1

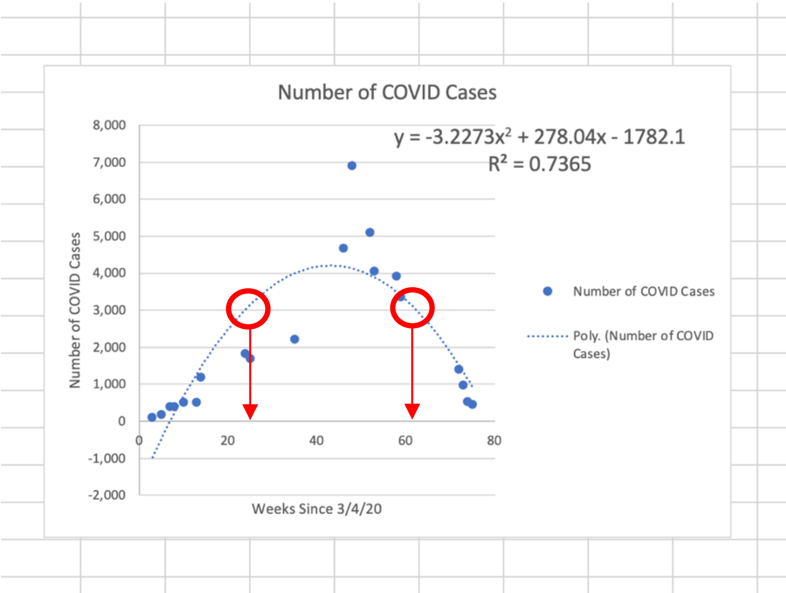
   b. How many COVID cases were there 65 weeks after 3/1/20?

   Answer: In cell A24, type 65 and the answer will appear in cell C24.

17	58	3,916	3487.5828
18	59	3,346	3388.0287
19	72	1,394	1506.4568
20	73	969	1316.5383
21	74	525	1120.1652
22	75	448	917.3375
23	50		4051.65
24	65		2655.1575
25			-1782.1
26			-1782.1
27			-1782.1
28			-1782.1
29			

c. When were there 3000 cases of COVID?

Answer: To calculate the missing days, we need to use a function called “Goal Seek”. To determine when there will be 3000 cases of COVID, we need to estimate using our graph first.



Notice the picture to the left. The red circles represent the two places where the number of COVID cases equals 3000. When we follow the red arrows down to the x-axis, we can see that this happens around 25 weeks after 3/4/20 and again around 60 weeks after 3/4/20. We will use these as our estimates to aid goal seek in finding the actual week.

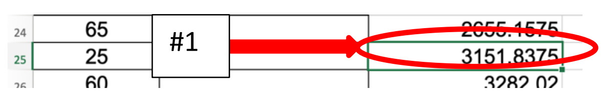
In cells C25 and C26, type 25 and 60 respectively.

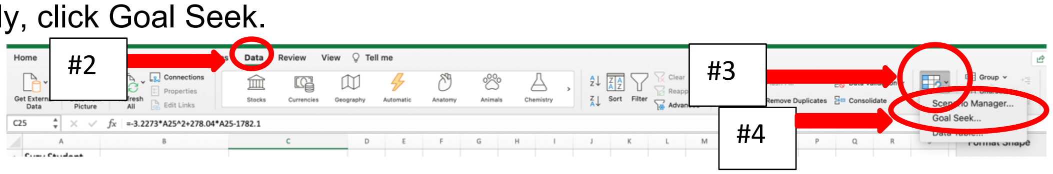
25	25		3151.8375
26	60		3282.02

Because estimating from the graph does not provide us with the solution to the equation, we need to use a program in Excel called goal seek.

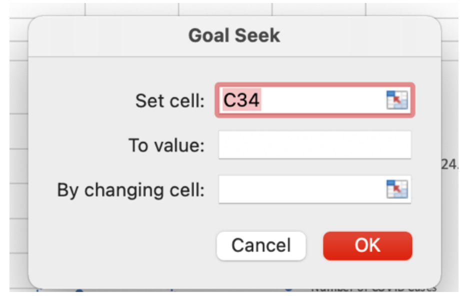
Steps for using Goal Seek to determine a missing x-value:

1. Click cell C25
2. Click the Data tab
3. Then click the “what-if analysis” drop down menu
4. Finally, click Goal Seek.



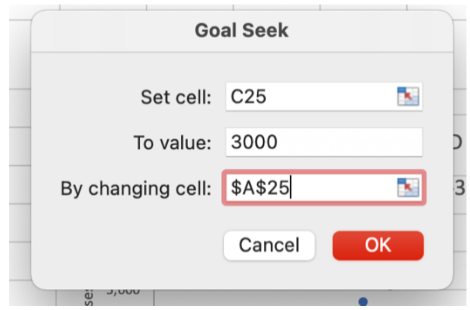


- When the Goal Seek dialogue box pops up, you will have to fill in three boxes: “Set Cell”, “To Value”, and “By changing cell”



- Set Cell will automatically populate with the correct cell if you chose the cell that contains the y value for your first predicted x-value

- To Value will change depending on what our goal is. In this case, it is our goal to determine when the number of cases equals 3000 so our “To Value” is going to be 3000 for this problem.



- By Changing cell will be the cell containing your estimated x-value. For this example, the cell we are changing is A25. If you put your curser in the By Changing cell and then click into the cell A25, Excel will automatically populate A25 into the box for you.

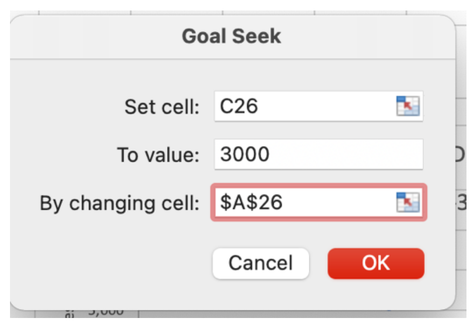
- Finally, click ok twice. The solution will show up in cell A25. According to our equation, there will be 3000 COVID cases during the 23rd week of the pandemic.

25	23.7423779		3000.000104

- Now, you must repeat these steps for the second estimated solution to the equation.

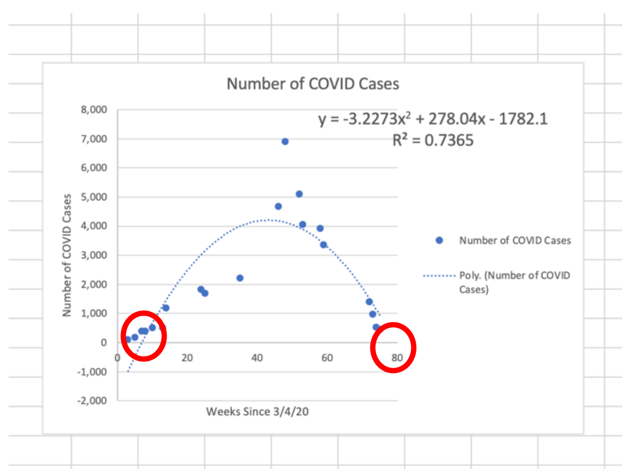
  According to our model, there will be 3000 cases again during the 62nd week of the pandemic.

26	62.4101343		3000



d. When will there be 0 cases of COVID?

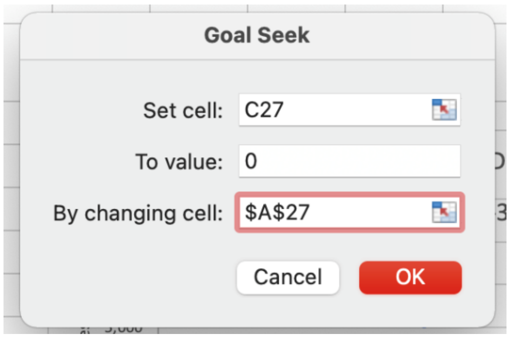
Answer: To determine when there will be 0 cases of COVID, we are looking for when the graph crosses the x-axis. The first time the graph crosses the x-axis is around 10 weeks into the pandemic. Notice that our trendline doesn’t go far enough to show us where the graph crosses the x-axis again. But we can estimate that it will be close to 80 weeks into the pandemic.

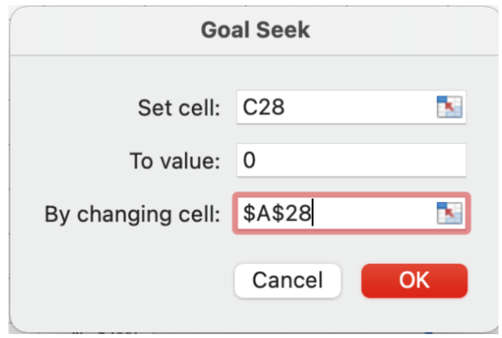


In cell C27, type 10 and in cell C28, type 80.

27	10		675.57
28	80		-193.62

Then, call up Goal Seek, the To Value will be 0 because we are looking for when there are not any COVID cases.





The two solutions we get will look something like this image below.

27	6.97406295		0.000484113
28	79.1784506		-1.68504E-05

Notice the right column “0.000484113” and “-1.68504E-05”, this is essentially 0. The first number is just a very small decimal and can be considered 0. The second number is scientific notation -1.168504E-05 = $-1.168504 \times 10^{-05}$ = -0.0000168504 which is a value that is very small, nearly 0. So, we can assume that our x-values, 6.97 and 79.18 do tell us where our model will predict there are 0 cases of COVID. That is to say that 6 weeks and 79 weeks after the start of the Pandemic there were 0 cases of COVID.

2. How reasonable are your answers to question 1? How do you know?

   To answer question 2, we need to simply look at the data given and compare it to the function excel generated for us and use our reasoning skills to explain whether or not the function models the data well. Here are some guiding points:

   - The R-squared value indicates how well our data fits the model and our R-squared value is 0.7365. 1 is a perfect fit and 0 doesn’t fit at all. Based on that number alone, it is a good fit.
   - Notice though that in just the dates chosen, the data gets VERY large 48 weeks into the pandemic. What week was that peak? It was a few weeks after Christmas. It is possible that this peak has an effect on the trendline Excel gave us.
   - If we considered more than just 20 days of data, the model would most certainly be different. It is likely that there would be dips to pull the curve down and other highs to pull the curve up. Real data isn’t perfect, and this is an example of just that.
   - For the data we randomly selected, this is a good fit.

Exercise: Vaccination Data in North Carolina

Now it is your turn. Consider the sample of data below from the NCDHHS website of vaccinations given weekly beginning 12/14/20.

Weeks since 12/14/20	1	2	8	9	11	12	15	17	19	25
Vaccines Given	20,481	43,614	324,564	424,707	442,662	476,167	603,085	684,563	422,009	52,744

On Sheet 2 of your Excel Workbook, complete the following tasks.

1. Enter the data into Excel and create a scatterplot graph for the data, including applicable title and axis labels.

2. Create a quadratic trendline for the data, make sure to include the equation and the R-square value on your chart.

3. Create a prediction column using the quadratic trendline generated by Excel.

For questions 4 and 5, place your final answers in a textbox using complete sentences.

4. According to your model,
   a. How many vaccines were administered during week 10?
   b. How many vaccines were administered during week 20?
   c. During what week(s) were there 300,000 vaccines administered?
   d. When were 0 vaccines administered?

5. Describe the accuracy of Excel's model? Support your claim with evidence from the questions, asked, the table, and the graph.

Save your file as **lastname-firstname-excel-lab2** (example: student-suzie-excel-lab2) and submit your file via the Blackboard link.

Trigonometry Ratios

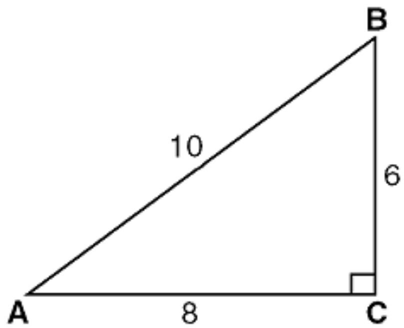
Learning Objectives:

- Given a right triangle, use trigonometry functions to write sine, cosine, and tangent ratios for designated angle.

Problems:

Unless otherwise instructed, all answers should be in simplified exact form.

1. Using the right triangle below, write each trig ratio.



a. $\sin(A°) =$

d. $\sin(B°) =$

b. $\cos(A°) =$

e. $\cos(B°) =$

c. $\tan(A°) =$

f. $\tan(B°) =$

Trigonometry Functions

Learning Objectives:

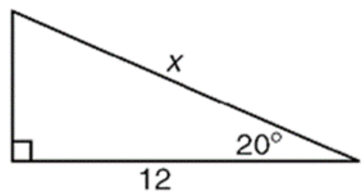
- Given a right triangle, use trigonometry functions to find a missing side length.

Problems:

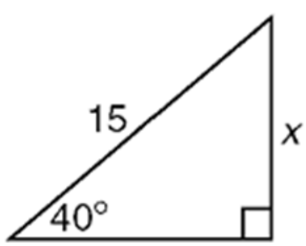
Round final answers to two decimal places if necessary.

Find the value of x in each figure below.

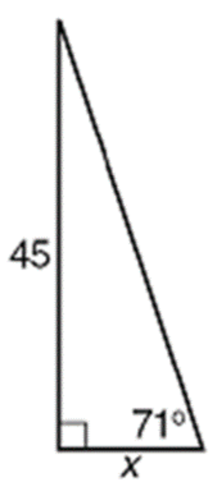
1.



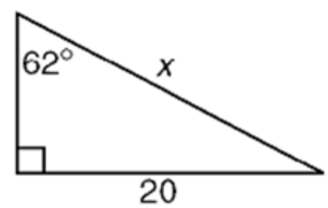
2.



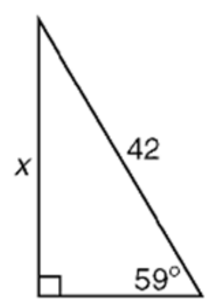
3.



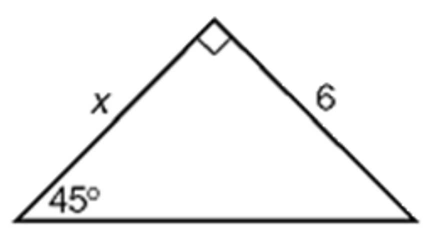
3.



4.



5.



Inverse Trigonometry Functions

Learning Objectives:

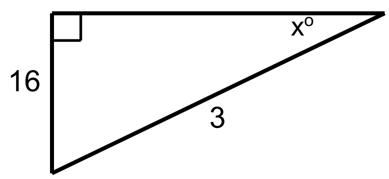
- Given a right triangle, use trigonometry functions to find a missing angle value.

Problems:

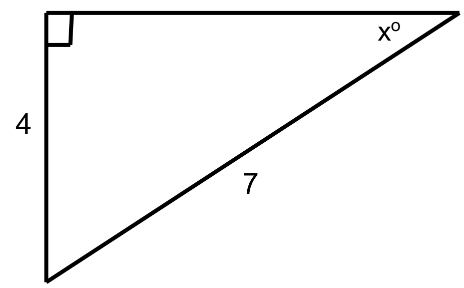
Round final answers to two decimal places if necessary.

Find the value of x in each figure below.

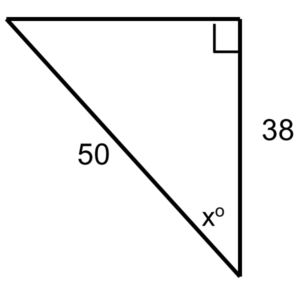
1.



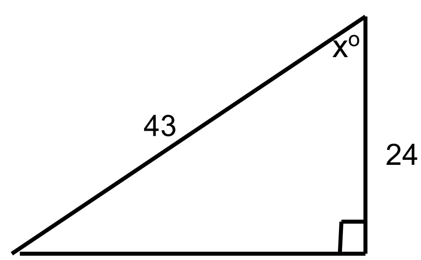
3.



2.



4.



Trigonometry Mixed Practice

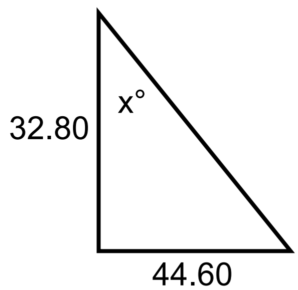
Learning Objectives:

- Given a right triangle, use trigonometry functions to find a missing side length, angle value, or height.

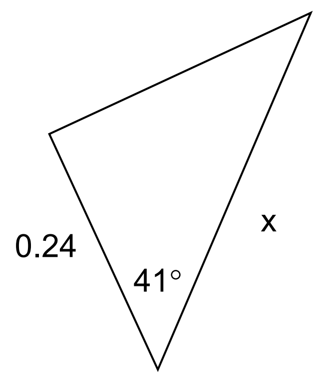
Problems:

Find the value of x in each of the right triangles shown below. Round final answers to two decimal places if necessary.

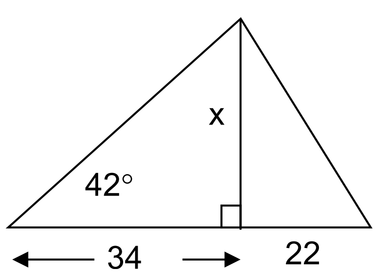
1.



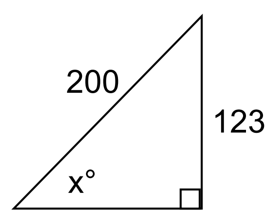
3.



2.



4.



Right Triangle Trigonometry Applications

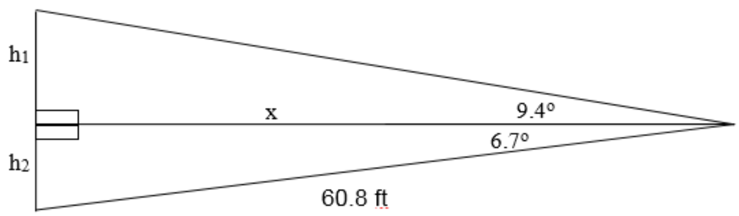
Learning Objectives:

- Identify the angle of Elevation and Angle of depression and understand the relationship between them.
- Solve angle of depression and angle of elevation application problems based on using Sine, Cosine, and Tangent functions.
- Solve right triangle application problems based on using Sine, Cosine, and Tangent functions.

Problems:

Unless an image is provided, draw and label a picture for each problem. Round final answers to two decimal places and include units.

1. Use trig functions to find the lengths of x, h_1, and h_2, given the figure below.



2. From the top of a vertical cliff 164 meters above the water, the angle of depression to a boat is 85.83°. How far away is the boat from the foot of the cliff?

3. The angle of elevation to the top of a radio tower is 34.33° from a point 270 meters from the foot of the tower. How high is the tower?

4. A rectangular piece of sheet metal is 12 cm by 19 cm. Find the angle the diagonal makes with the longer side.

5. A ladder leaning against a building makes an angle of 27.5° with the side of the building. If the foot of the ladder is 2.1 meters from the base of the building, how long is the ladder?

6. A surveyor using a transit notes that the angle of elevation to the top of a tree is 18.17° as measured from a point 150 m from its base. How tall is the tree?

7. A 32 foot long guy wire, which runs from the top of a pole to a stake in the ground, makes an angle of 38° with the ground. What is the height of the pole?

8. Find the height of a TV tower if the angle of elevation is 50° from a point 200 ft. from the base of the TV tower.

9. One end of a plank, that is 13 feet long, rests on the back of a pickup truck while the other end rests on level ground 12 feet from the back of the truck. Find the angle that the plank makes with the ground.

10. Sgt. York looks out of his foxhole, with his eyes at ground level, and spies the Red Baron directly over the allied headquarters, which is 300 yards away. He estimates, from the height of a large tree near the headquarters, that the Baron is 40 yards up in the air.

    a. At what angle of elevation should Sgt. York aim in order to hit the Baron?

    b. How long a shot will it be, to the nearest yard?

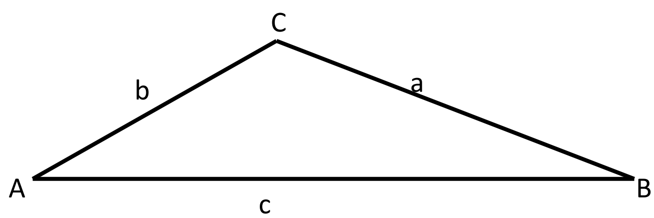
Law of Sines and Law of Cosines

Learning Objectives:

- Given an oblique triangle, use the law of sines to determine missing side lengths and angle measures.
- Given an oblique triangle, use the law of cosines to determine missing side lengths and angle measures.
- Given an application involving an oblique triangle, determine the missing information using the law of sines or law of cosines.

Problems:

Draw and label a picture for each problem. Solve each triangle by finding all missing side(s) and/or angle measure(s). If necessary, round final answers to one decimal place and include units. Use the picture below to help you visualize the triangle.

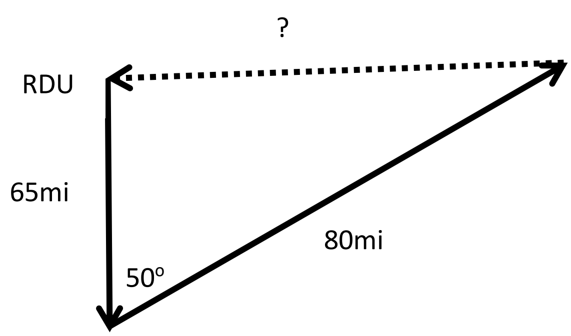


1. A = 55°, b = 20.2 m, c = 25.0 m
2. A = 61.5°, B = 75.6°, b = 255 ft
3. A = 130.0°, b = 15.2 km, c = 9.50 km
4. a = 38,500 mi, b = 67,500 mi, c =47,200mi
5. C = 108.5°, a = 415 m, b = 325 m
6. A = 54°, C = 43.1°, a = 26.5 m
7. a = 207mi, b = 106mi, c = 142mi
8. B = 41.8°, C = 59.3°, c = 24.7km

9. A piece of sheet metal is to be cut in the shape of a triangle with sides of 20in, 10in, and 23in. Find the measure of the largest angle.

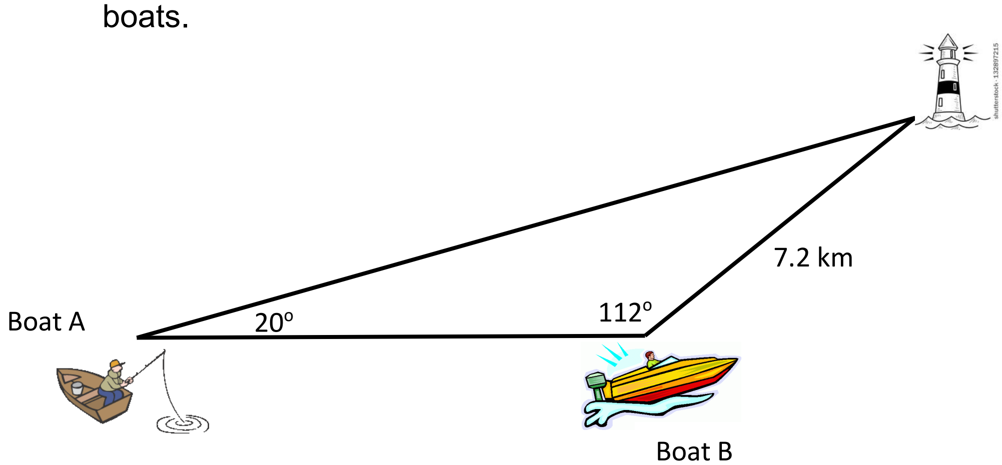
10. A hot air balloon is sighted from points A and B, which are 6.00km apart on level ground. The angle of elevation of the balloon from point A is 35° and from point B is 55°. How far from the balloon are you if you are at point A?

11. A plane takes off from RDU and follows the flight pattern shown below in solid lines. At the end of the trip, how many miles will the plane have to fly to get directly back to RDU.



12. Three streets in a neighborhood in Fuquay Varina, NC form a triangle. One street is 172.77 meters long, another is 157.34 meters long, and the angle between them is 62°. What is the length of the third street?

13. Two boats are out at sea and both spot a lighthouse. Boat A cannot determine the distance from it to the lighthouse, but boat B has better equipment and can knows that it is 7.2 km away from the lighthouse. Both boats are able to determine the angle they make with the lighthouse which are shown in the picture below. Determine the distance between the two boats.



Excel Lab 4 –Excel and Mean Radiant Temperature (MRT)

Learning Objectives:

- Given information about a triangle, use excel and trigonometry to solve problems.

When Mechanical Engineers design an HVAC system and determine the location of duct work and outlets, their goal is to equalize the temperature throughout the room. So, no matter where you sit, the temperature across the entire room could be conditioned to be the same at all locations.

If you have ever watched, “The Big Bang Theory”, you may have heard Sheldon refer to his spot. For this lab you will use the process described above to determine the MRT of both specified locations in Sheldon’s apartment shown below. At the end of this lab, you should be able to answer the question: Does Sheldon actually sit in the best spot in the apartment with respect to the MRT? To understand Sheldon’s spot, watch [Sheldon explain his spot (opens in a new window)] [plain text link: https://www.youtube.com/watch?v=I2hIIvF5gJI]

Practice: Center of Room

The diagram of Leonard and Sheldon’s apartment is below (figure 1). We will start by calculating the Mean Radiant Temperature at the center of the apartment. Over the living room of the apartment is a series of angle measures and distances to the edge of the room. Together, we will calculate the MRT of Leonard and Sheldon’s apartment.

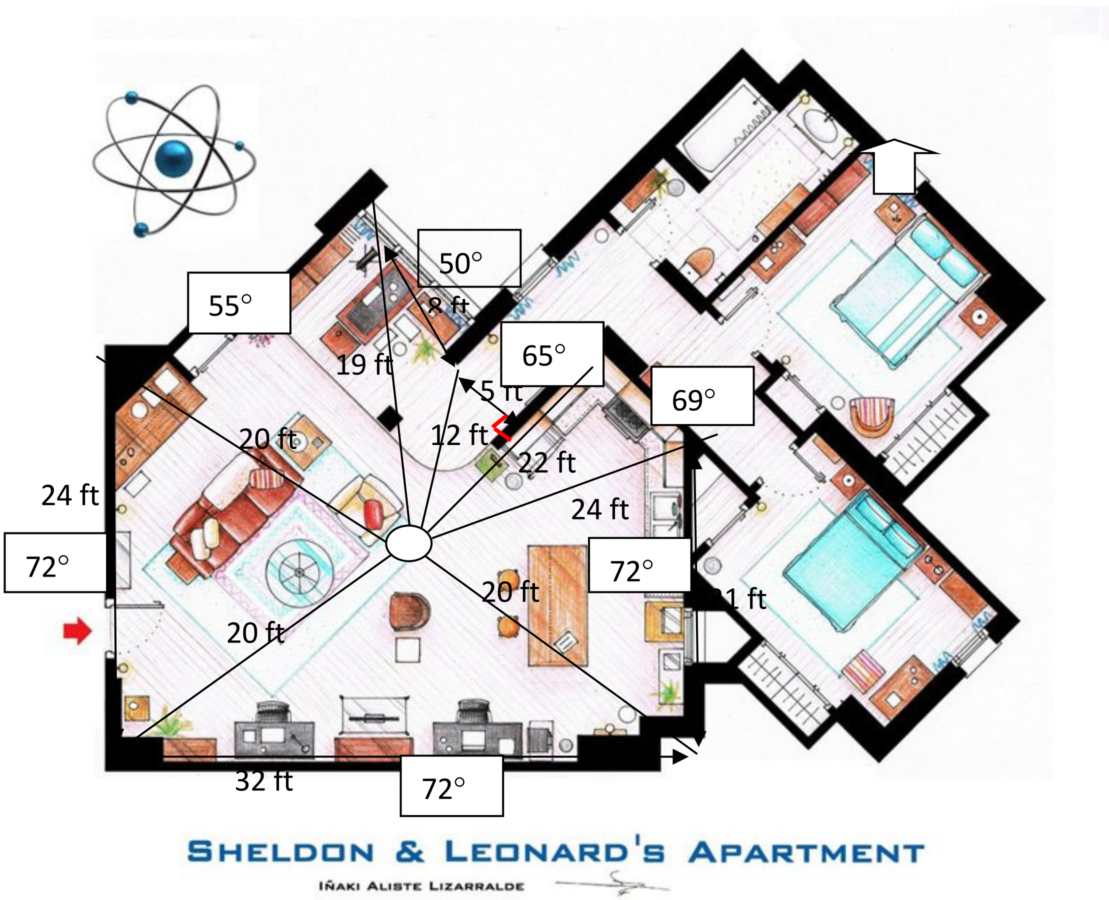


Figure 1

In figure 2, below, the layout of Leonard and Sheldon's apartment is gone so we can clearly see the information given to us. The living room has been divided into 7 triangles, 4 of them have central angles given, of the three without central angles given, one has three sides given and two have just two sides given. One of the triangles with just two given sides is a right triangle so we can use inverse trig functions for that one. For the triangle that has three sides given and is not a right triangle, we will use the Law of Cosines.

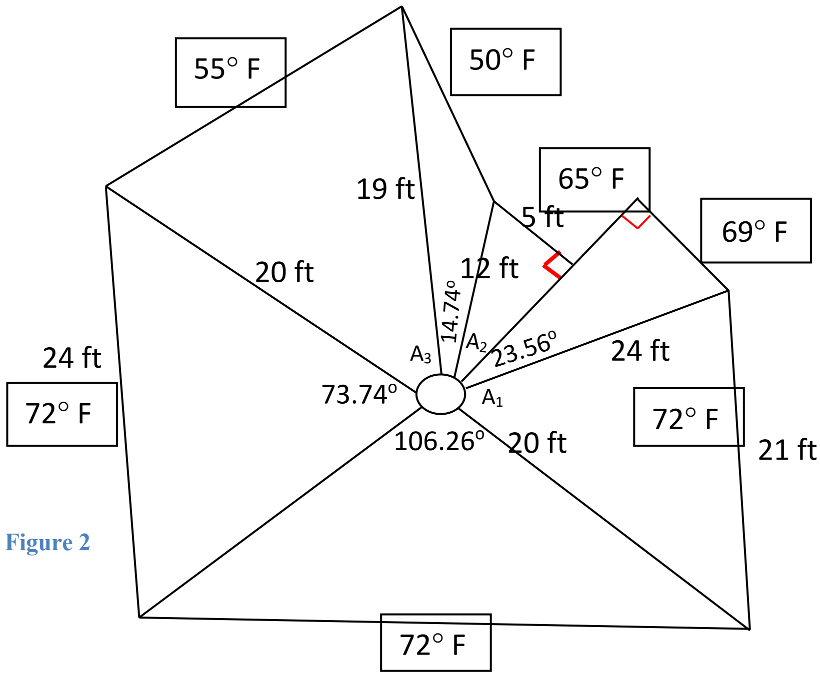


Figure 2

In order to calculate the Mean Radiant Temperature, we will need a column for the angles. In cell A2, type "Angle". In cells A3:A4 type 73.14 and 106.26. In cell A6 type 23.56 and in cell A8 type 14.74. We need to find the missing angles, A_1, A_2, and A_3. We will calculate A_1 in cell A5, A_2 in cell A7, and A_3 in cell A9.

	A
2	Angle
3	73.74
4	106.26
5	
6	23.56
7	
8	14.74
9	
10	

One thing to know about excel when using inverse trig functions, is that the angle will be reported out in radians as the unit of measure. Knowing that π radians is equal to 180°, you can multiply the radian measure of an angle by $\frac{180}{\pi}$ to convert the angle to a degree measure.

To determine the measure of angle A_1 we need to use the Law of Cosines.

The Law of Cosines is:

$a^2 = b^2 + c^2 - 2bc*\cos(A_1)$.	We need to rewrite this so that we are finding angle A.
$a^2 - b^2 - c^2 = - 2bc*\cos(A_1)$	Subtract both squared terms over to the left side
$(a^2 - b^2 - c^2)/(-2bc) = \cos(A_1)$	Divide both sides by -2bc
$(-a^2 + b^2 + c^2)/(2bc) = \cos(A_1)$	Divide each term in the numerator by -1
$\cos^{-1}((-a^2 + b^2 + c^2)/(2bc)) = A_1$	Take the inverse cosine of the expression on the left

This is the formula we will use to solve for angle A in radians. Recall that we will need to multiply this by $\frac{180}{\pi}$ to get angle A in degrees: $\cos^{-1}((-a^2 + b^2 + c^2)/(2bc))*(180/pi()) = A$.

In cell A5 type =acos((-1*21^2+20^2*24^2)/(2*20*24))*(180/pi()) and press enter.

	A
2	Angle
3	73.74
4	106.26
5	=acos((-1*21^2+20^2+
6	24^2)/(2*20*24))*(180/
7	pi())
8	14.74
9	
10	

	A	B
2	Angle	
3	73.74	
4	106.26	
5	56.1312954	
6	23.56	
7		
8	14.74	
9		

In the next triangle, we are given the side opposite angle A_2 and the hypotenuse so we will use sine to determine the measure of angle A_2. To Determine the measure of A_2, type =asin(5/12)*(180/pi()) in cell A7 and press enter.

	A
2	Angle
3	73.74
4	106.26
5	56.1312954
6	23.56
7	=ASIN(5/12)*(180/PI())
8	14.74
9	

	A
2	Angle
3	73.74
4	106.26
5	56.1312954
6	23.56
7	24.62431835
8	14.74
9	

Now we are only missing angle A_3. Because all of these angles together sum to 360, we can find the measure of the missing angle by adding all the angles we are given and subtracting from 360. In cell A9, type =360-(sum(A2:A8)) and press enter.

	A
1	Suzy Student
2	Angle
3	73.74
4	106.26
5	56.1312954
6	23.56
7	24.62431835
8	14.74
9	=360-(SUM(A2:A8))

	A
1	Suzy Student
2	Angle
3	73.74
4	106.26
5	56.1312954
6	23.56
7	24.62431835
8	14.74
9	60.94438625
10	

We can calculate the Mean Radiant Temperature (MRT) using the formula MRT = $\frac{\sum(T \cdot \theta)}{360}$, where T is the temperature at the wall corresponding to the central angle, θ, that encloses the wall.

In cell A2, we already have typed “Angle”, now in Cell B2, type “Temp”, and in cell C2, type “Angle*Temp. In our previous work, we recorded all the angles in cells A3:A9. In cells B3:B9 enter the corresponding temperatures for each of the angles.

	A	B	C
1	Suzy Student		
2	Angle	Temp	Angle*Temp

	A	B	C
1	Suzy Student		
2	Angle	Temp	Angle*Temp
3	73.74	72	
4	106.26	72	
5	56.1312954	72	
6	23.56	69	
7	24.62431835	65	
8	14.74	50	
9	60.94438625	55	
10			

In cell C3, type =A3*B3 and then press enter. Just as we did in Excel Lab 3, drag the formula down from cell C3 to cell C9.

	A	B	C
1	Suzy Student		
2	Angle	Temp	Angle*Temp
3	73.74	72	=A3*B3
4	106.26	72	

	A	B	C
1	Suzy Student		
2	Angle	Temp	Angle*Temp
3	73.74	72	5309.28
4	106.26	72	7650.72
5	56.1312954	72	4041.45327
6	23.56	69	1625.64
7	24.62431835	65	1600.58069
8	14.74	50	737
9	60.94438625	55	3351.94124

In cell C10 type “=sum(C3:C9)/360” which will evaluate the MRT for the occupant’s location.

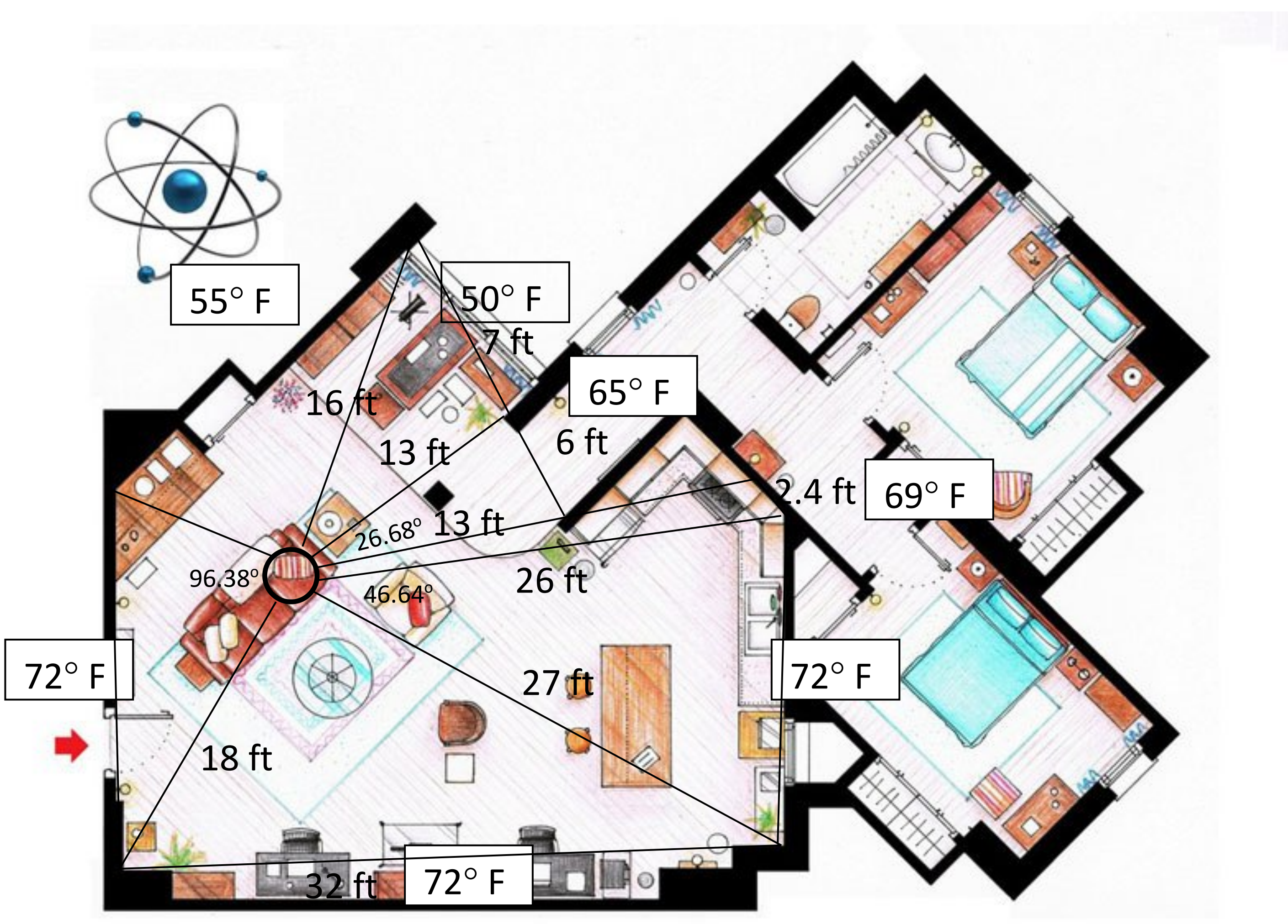
	A	B	C	D
1	Suzy Student			
2	Angle	Temp	Angle*Temp	
3	73.74	72	5309.28	
4	106.26	72	7650.72	
5	56.1312954	72	4041.45327	
6	23.56	69	1625.64	
7	24.62431835	65	1600.58069	
8	14.74	50	737	
9	60.94438625	55	3351.94124	
10			=sum(C3:C9)/360	

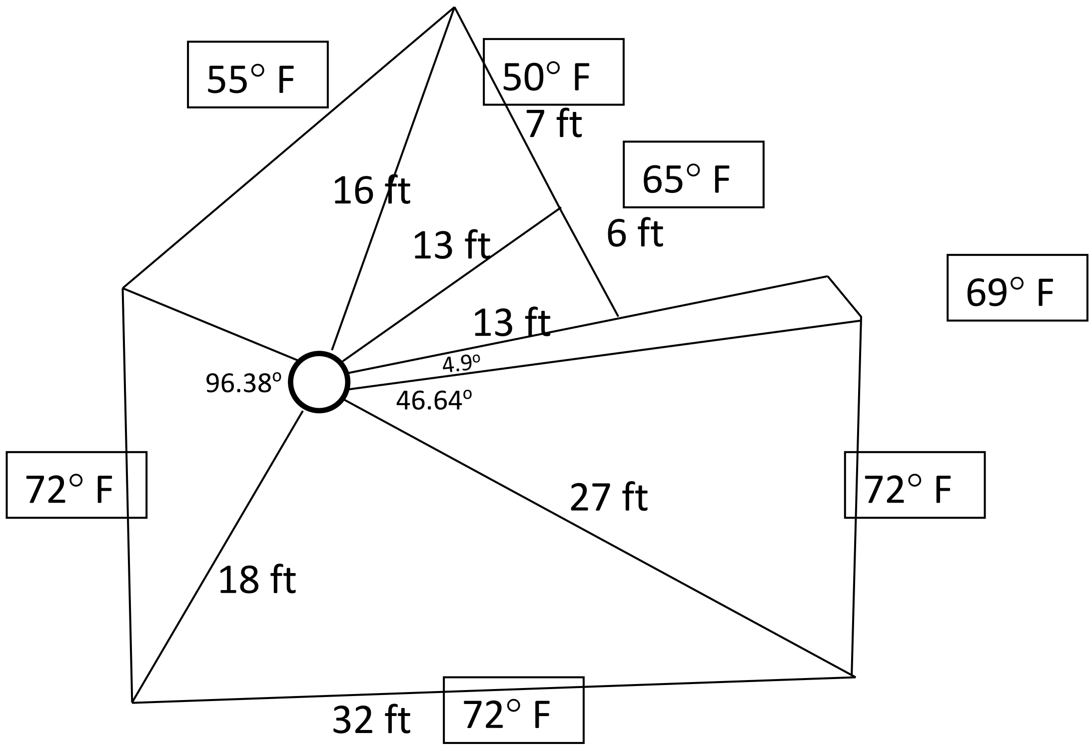
	A	B	C
1	Suzy Student		
2	Angle	Temp	Angle*Temp
3	73.74	72	5309.28
4	106.26	72	7650.72
5	56.1312954	72	4041.45327
6	23.56	69	1625.64
7	24.62431835	65	1600.58069
8	14.74	50	737
9	60.94438625	55	3351.94124
10			67.5461533
11			

The Mean Radiant Temperature of Leonard and Sheldon’s apartment when measured from the center is 67.55°.

Exercise: Sheldon’s Spot

The diagram of Leonard and Sheldon’s apartment is below. Now, calculate the MRT of Sheldon’s Spot. Set up a table on the second spreadsheet similar to the one we did in the practice problem. If you scroll to the next page, Sheldon and Leonard’s apartment is removed from the background and only the diagram remains. When you have calculated the MRT, place it in a textbox on your spreadsheet and label it. Include in your textbox your answer to the question, “Did Sheldon choose the right spot?” and explain how you know.




55° F
50° F
7 ft
16 ft
65° F
13 ft
6 ft
69° F
13 ft
4.9°
96.38°
46.64°
72° F
27 ft
72° F
18 ft
32 ft
72° F