VIRGINIA DEPARTMENT OF EDUCATION
Worksheets to accompany Videos
VIRGINIA STANDARDS OF LEARNING
MATHEMATICS AND THE TEXAS INSTRUMENT GRAPHING CALCULATOR

Worksheets for SIX PROGRAMS

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I. Expressions and Operations

II. Relations and Functions

III. Equations and Inequalities

VI. Statistics

V. Systems of Equations and Inequalities

VI. Geometry

Program I. **EXPRESSIONS AND OPERATIONS**

SOL Topic:

A.12

The student will factor completely first-and second-degree binomials and trinomials in one or two variables. The graphing calculator will be used as both a primary tool for factoring and for confirming an algebraic factorization.

Activity 1 : **Demonstrate how to connect factors, zeros, and graphs using the quadratic equation $x^2 - x - 6 = 0$.**

Instruction :

- Type the quadratic equation into $Y_1 = x^2 - x - 6$
- Typing the factors into $Y_2 = (x - 3)(x + 2)$ (Use the Style key)
- Graph in a Zoom Standard Window
- Observe the tables, are they the same?

Activity 2: **Algebraically determine the factors of other given polynomials, then Support graphically and numerically.**

Review of the different types of factoring such as the Difference of Two Squares, Trinomials, and Monomials

Type the following polynomials in $Y_1 =$,

then type each polynomial in factored form into $Y_2 =$

- $x^2 - 4$
- $x^2 + 10x + 21$
- $x^2 - 9x + 20$
- $6x^2 + 11 x + 3$
- $x^3 + 10x^2 + 21x$

Activity 3: **Determine if an equation, $ax^2 + bx + c = 0$, can be factored using the Discriminant "$b^2 - 4ac$" on the home screen.**

For the equation:

- **$y = x^2 + 7x + 10$**
- Let a = 1, b = 7, c = 10
- Type 1 - > a: 7 - > b: 10 - > c: $b^2 - 4ac$
- If the answer is a positive perfect square, then the trinomial can be factored.
- If the answer is not a positive perfect square, then the trinomial cannot be factored.
- ENTER the answer is "9". (A perfect square numeral)

Now try the equation:

- **$y = x^2 + 2x + 8$**
- 1 - > a: 2 - > b: 8 - > c: $b^2 - 4ac$
- "ENTER", the answer is "- 28"
- The equation cannot be factored.

Activity 4: **Using the Test Menu and Boolean Algebra to support factoring a trinomial graphically . Use the "Y =" window.**

- $Y_1 = (x^2 + 10x + 21) = (x + 3)(x + 7)$ and graph in a Zoom 4 window.

A true statement results in a line at y = 1 and a false statement results in a line at y = 0 for all values of x. This statement is true.

Activity 5: **Use Boolean Algebra to support binomial multiplication numerically on the "home screen".**

Store:

- 10 -> x : $(x + 3)^2 = x^2 + 9$ on the home screen. Press enter.

A true statement results in a value = 1 and a false statement results in a value = 0. This statement is false for all values of x.

Try: $(x + 3)^2 = x^2 + 6x + 9$ This statement is true for all values of x.

Activity 6: **Given the product of two binomials in "Y_1 =" , use FOIL to expand the binomials in "Y_2 =" to obtain the quadratic.**

Type on the "Y =" window:

- $Y_1 = (x - 1)(x + 2)$
- $Y_2 = x^2 + 2x - x - 2$
- $Y_3 = x^2 + x - 2$

Show that the graphs are identical.

On the home screen show the connection between arithmetic and algebra

- $(10 - 1)(10 + 2) = (9)(12)$
- show using FOIL that $100 + 20 - 10 - 2 = 108$ in simplifying the above

Activity 7: **Investigating signed numbers and operations on the Graph Screen. (addition and subtraction)**

Using the cursor keys, we will visually observe the movement of the cursor to be represented on the graph screen as adding or subtracting signed numbers.

- On the graph screen "Y =" clear,
- Zoom 6 (Standard Window),
- Zoom 8 (Integer Window)

- Examples: $-5 - 3 = -8$
  $-5 - (-3) = -2$
- $-5 + 3 = -2$

From the origin, move the cursor to the left five times observing the x-value, then move the cursor to the left three times observing the final x-value. The cursor falls on -8.

Addition is a move to the right and subtraction is a move to the left.

Activity 8: **Investigating signed number operations on the Home Screen.**

Addition, subtraction, multiplication and division using order of operations and signed numbers. Type the same examples on the home screen.

- Examples: -5 - 3 = - 8
  -5 - (-3) = - 2
- -5 + 3 = - 2

Program II. **RELATIONS AND FUNCTIONS**

SOL Topic:

A. 16

The student will, given a rule, find the values of a function for elements in its domain and locate the zeros of the function both algebraically and with a graphing calculator. The value of f(X) will be related to the ordinate on the graph.

Activity 1: **Solve the equation 3x - 15 = 12 on the graphing calculator using four methods of inquiry:**

- Let $Y_1 = 3x - 15$, **Trace** on an integer window (zoom 8) until y = 12, read the x-value
- Examine the **table values** where y= 12, READ the corresponding x element
- Using the **multi-graph method**, let $Y_1 = 3x - 15$, $Y_2 = 12$, using the multi-graph method find the point of intersection, read the x-value for the solution to the equation
- Subtracting 12 from both side of the equation, we obtain 3x - 27 = 0. Let $Y_1 = 3x - 27$. Observe where the equation crosses the x- axis. The x-value is the solution to the equation. This is the **x-intercept method**.

SOL Topic:

A. 14

The student will solve quadratic equations in one variable both algebraically and graphically. Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

Activity 2: **Solving quadratic equations: Using the same four methods of solution on the Graphing calculator, Solve $x^2 - 2x - 13 = 2$.**

- Trace Method
- Multigraph Method
- Table Values Method
- X-intercept Method

SOL Topic:

AII.8

The student will recognize multiple representations of functions (linear, quadratic, absolute value, step, and exponential functions) and convert between a graph, table, and symbolic form. A transformation approach to graphing will be employed through the use of graphing calculators.

Activity 3: **Transformations of quadratic equations:**
Question--How does the graph change in shape, domain and range?

- Investigate the role of "K" in $Y = X^2 + K$
- Investigate the role of "H" in $Y = (X - H)^2$
- Investigate the role of "A" in $Y = A*X^2$
- Predict and describe the graph of $Y = 2(X + 4)^2 - 8$

Activity 4: **Transformations of Absolute Value Equations**

type these into Y_1 = and Y_2 = respectively

- Show: $Y_1 = abs\ (X)$
- $Y_2 = A*Y_1\ (X - H) + K$

Use this to generalize transformations. Store values for A, H, and K from the home screen. This is also know as Composition of Functions.

Examine:

- Exponential $Y = A*B^{(X - H)} + K$
- Logarithmic $Y = A*\log\ (X - H) + K$
- Step (Greatest Integer Function) $Y = A*INT\ (X - H) + K$

SOL Topic:

AII.15

The student will recognize the general shape of polynomial functions, locate the zeros, sketch the graphs, and verify graphical solutions algebraically. The graphing calculator will be used as a tool to investigate the shape and behavior of polynomial functions.

Activity 5: **Investigate the general shape of polynomial functions.**

The domain of all nonrestricted polynomials is negative infinity to positive infinity.

- $Y_1 = x$
- $Y_2 = x^2$
- $Y_3 = x^3 - 4x$
- $Y_4 = x^4 + x^3 - 4x^2 - 4x$

Range for odd degree polynomial is negative infinity to positive infinity

Range for even degree polynomial is:

- from the minimum point to positive infinity or
- from negative infinity to the maximum point

Activity 6: **Locating the zeros, sketch the graphs, and verify graphical solutions algebraically.**

For : $y = x^3 - 3x^2 - 4x + 12$ use the Rational Root Theorem to find the zeros.

P = { -12, -6, -4, -3, -2, -1, 1, 2, 3, 4, 6, 12}

Q = {-1, 1}

P/Q = { 12, 6, 4, 3, 2, 1, -1, -2, -3, -4, -6, -12} are the possible rational roots

Use the Graph to eliminate some roots and to estimate possible rational roots :

- $Y_1 = x^3 - 3x^2 - 4x + 12$, observe where f(x) = 0
- Use the CALC menu to find the zeros.
- Verify zeros algebraically on the home screen using $Y_1(x)$.
- Explore the TABLE values, show where y = 0.
- $Y_2 = (x - 2)(x - 3)(x + 2)$

Investigate non-complex, irrational roots using the graphing calculator.

- $Y_1 = x^3 - 3x^2 - 4x + 11$
- Let $Y_2 = 0$
- Show where does $Y_1 = Y_2$, using the INTERSECT feature.

SOL Topic:

AII.9

The student will find the domain, range, zeros and inverse of a function, the value of a function for a given element in its domain, and the composition of multiple functions. Functions will include those that have domains and ranges that are limited and/or discontinuous. The graphing calculator will be used as a tool to assist in investigation of functions, including exponential and logarithmic.

Activity 7: **Introduce Parametric Equations to show restrictions on the Domain and to show the inverse of functions. Comparisons will be made to show the advantages of using parametric mode to show inverse functions.**

- **Graph $F(x) = x^2 - 4$ in Function Mode**
- **Graph $F(t) = t^2 - 4$ in Parametric Mode**

Investigate: In Parametric Mode, show Domain and Range Restrictions

- $X_{1t} = T$
- $Y_{1t} = T^2 - 4$

Where $T_{min} = 0$, $T_{max} = 4$, $T_{step} = .1$, the domain is restricted,
$X_{min} = -10$, $X_{max} = 10$, $X_{scl} = 1$, $Y_{min} = -10$, $Y_{max} = 10$, $Y_{scl} = 1$
denoted by $T : [0, 4]_{.1}$ $X : [-10, 10]_1$ $Y: [-10, 10]_1$

- Discuss domain and range
- . Observe graphs and numerical representations
- Change T_{min} to - 3. Observe the changes in the graph.
- Discuss new graphs and tables.

Investigate inverse of function. For $T:[-10,10]_1$, $X: [-10, 10]_1$, $Y: [-10, 10]_1$

- Let $Y_3 = T^2 - 4$
- Let $Y_4 = T$

Show the parametric equivalent to the function "Y = X" line, the axis of symmetry.

- Let $Y_5 = T$
- Let $Y_6 = T$

Activity 8: **Investigate Composition of Functions:**

For $f(x) = x - 5$
$g(x) = x^2 + 3$
Investigate: $f \circ g(3) = f(g(3))$

- $Y_1 = x - 5$
- $Y_2 = x^2 + 3$

On home screen show that $Y_1(Y_2(3)) = 7$

On the graph screen: Show that these statements are equivalent.

- $Y_3 = Y_1 (Y_2(x))$
- $Y_4 = ((x^2 + 3) - 5)$ or $Y_4 = x^2 - 2$
- Show the commutative properties of "f + g" and "g * f"
- Show the noncommutative properties of "f - g" and "g/f".

In the Zoom INTEGER Window:

- Emphasize the discontinuity in composition of "g / f".

Program III. **EQUATIONS AND INEQUALITIES**:

SOL Topic:

A.1

The student will solve linear equations and inequalities in one variable, solve literal equations (formulas) for a given variable and apply these skills to solve practical problems. Graphing calculators will be used to confirm algebraic solutions.

Activity 1: **Solving linear inequalities in one variable.**

Solve: $2x - 7 < 0$ in Zoom-4 window (Decimal Window) and identify the x-values for which $y < 0$.

- Graph: $Y_1 = 2x - 7$
- "2nd TRACE" ("2nd CALC") find the zero.
- The solution is $x < 3.5$

Show Boolean Representation:

- Graph: $Y_2 = 2x - 7 < 0$
- Observe the horizontal line through $y = 1$, representing where the statement is true.

Activity 2: **Solve literal equations (formulas) for a given variable and apply these skills to solve practical problems.**

Margaret is traveling from Norfolk, VA to Williamsburg, VA. She knows that the store opens at 9am, and she wants to know what time she has to leave home in order to make the sale at the Outlet Mall. The distance from Norfolk to the Outlet Mall is 50 miles. If she travels at an average rate of 47.5 mph, what is the elapsed time for travel and what time does she have to leave home?

Using the MATH menu, “Solver...”, go to equation solver and enter the formula for TIME-RATE-DISTANCE problems.

- equ: 0 = T * R - D
- T = ?
- R = 47.5
- D = 50

Press “ALPHA”, “ENTER” when the cursor is placed on the “T =”
T = 1.0526315789474 hours for elapsed time
Go to home screen:

- “Clear”, “Alpha” , "T", “ENTER”
- Subtract 1 , “ENTER”
- Multiply by 60, “ENTER”
- Subtract 3, “ENTER”
- Multiply by 60, “ENTER”

The result is 1: 03: 09 for the elapsed time.

Subtract this answer from 9am to find departure time.

- 85960 (represents 9 am)
- subtract 10309 , “ENTER”

The result is 75651.

Margaret needs to leave at 7: 56 : 51 am. For our purpose 8am is good enough. (Note: Use twenty-four hour clock for extensions)

SOL Topic:

A.6

The student will select, justify, and apply an appropriate technique to graph a linear function in two variables. Techniques will include slope-intercept, x- and y-intercepts, graphing by transformation, and the use of the graphing calculator.

Activity 3: **Graphing a a linear function in two variables using the slope-intercept format. For the formula y = mx + b.**

Examples of linear transformations may be shown by:
Same m, different b:

- $Y_1 = x + 3$
- $Y_2 = x + 1$
- $Y_3 = x - 2$

Same b, different m:

- $Y_1 = 2x + 3$
- $Y_2 = -3x + 3$
- $Y_3 = 0.5x + 3$

Using lists in "Y =":

- Y1 = x + {3, 1, 2}
- Y2 = {2, -3, 0.5} x + 3

SOL Topic:

AII.4

The student will solve absolute value equations and inequalities graphically and algebraically. Graphing calculators will be used both as a primary method of solution and to verify algebraic solutions.

Activity 5: **Solve absolute value equations and inequalities**

Solve: $|x| = 3$ in a Zoom-4 (Decimal window), find two points of intersection

- $Y_1 = abs(x)$
- $Y_2 = 3$

Solve: $|x| < 3$

- $Y_1 = abs(x)$
- $Y_2 = 3$
- $Y_3 = Y_1 - Y_2$
- $Y_4 = Y_1 < Y_2$

Solve: | x + 2 | < | x |

- $Y_1 = | x + 2 |$
- $Y_2 = | x |$
- $Y_3 = Y_1 - Y_2$
- $Y_4 = Y_1 < Y_2$

SOL Topic:

AII.7

The student will solve equations containing rational expressions and equations containing radical expressions algebraically and graphically. Graphing calculators will be used for solving and confirming algebraic solutions.

Activity 6: **Graph rational expressions and solve rational equation problem. Introduce a mixture problem.**

Graph:

- $Y_1 = ((x + 3)(x - 3)) / (x + 4)$ observe asymptotic behavior for x = -4
- Y2 = $((x + 3)(x - 3)) / (x - 3)$ show a "hole" in the graph at x = 3

A "Mixture" Problem:

Ozzie likes the red M&M candies and would like for every 1 out of 4 to be red. As a birthday treat for Ozzie, we are going to mix 5 pounds of regular M&M's (8% red) with some holiday M&M's (48% red) in order to have a mixture where the concentration of red candies is 25%. How many pounds of the holiday M&M's must we add to the regular candy?

concentration is a function of x (the amount added)

AII.6

The student will select, justify, and apply a technique to solve a quadratic equation over the set of complex numbers. Graphing calculators will be used for solving and confirming algebraic solutions.

Activity 7: **Solve quadratic equations over the set of complex numbers in a graphing environment.**

Graph individually in a Zoom-4 window and observe where the graph crosses the x-axis.

- $Y_1 = x^2$ tangent to the x-axis
- $Y_2 = x^2 - 1$ crosses the x-axis twice
- $Y_3 = x^2 + 1$ does not cross the x-axis
- $Y_4 = x^2 + x + 1$ does not cross the x-axis

Look at the table values where $Y_1 = 0$, $Y_2 = 0$, $Y_3 = 0$, and $Y_4 = 0$ to find the roots.

- Use TRACE on the graph screen, type an x-value to find where Y = 0.
- Use the 2nd CALC menu to find the zeros, show how the roots cannot be found when the roots are complex.
- Discuss the meaning of "estimate, approximate, guess"
- Use the board to show the quadratic formula method for finding complex roots for "$x^2 + x + 1 = 0$"

Show the Rectangular Complex Mode, Change MODE to "a + bi".

- Add complex numbers (3 + 6i) + (4 - 8i)
- Subtract complex numbers
- Multiply complex numbers
- Divide complex numbers

Show the iterating powers of "i" on the home screen:

- 1 ENTER
- press * i , ENTER
- ENTER
- ENTER...

Program IV. **STATISTICS**

SOL Topic:

A.4

The student will use matrices to organize and manipulate data, including matrix addition, subtraction, and scalar multiplication. Data will arise from business, industrial, and consumer situations.

Activity 1: **Show matrix data entry, matrix addition, matrix subtraction, and scalar multiplication.**

In the matrix menu enter the following data for a 2 X 2 matrix

Return to the home screen and perform the following operations:

- [A] + [B]
- [A] - [B]
- 2 [A]
- 2 [A] - 3 [B]

Activity 2: **Organize data into matrices to find the inventory of 2 shoe stores. Show matrix addition to show total inventory of the shoe store chain such that inventory does not fall below 30 of each size.**

Data for Store Alpha:

Styles	**Sizes**	**Inventory**
Loafers	10	30
	11	70
	12	90
Sneakers	10	120
	11	200
	12	50
Oxfords	10	40
	11	70
	12	33

Data for Store Beta:

Styles	Sizes	Inventory
Loafers	10	80
	11	10
	12	100
Sneakers	10	200
	11	185
	12	150
Oxfords	10	75
	11	80
	12	106

Sizes

Store Alpha:

Store Beta:

Store [Alpha] + Store [Beta] = [Total Inventory] -> [Gamma]

- Show how to store a matrix
- Show how to "fill" a matrix with the numeral "30" = [Minimum Inventory]

[Total Inventory] - [Minimum Inventory] = [Quantity Sold Prior to Reordering]

SOL Topic

A.17

The student will, given a set of data points, write an equation for a line of best fit, using the median fit method, and use the equation to make predictions.

Activity 3: **<u>CLASSROOM VIDEO</u> of collection of data from "The WAVE"**

Procedure:

- Select the number of persons for each group.
- The first person will stand up, say "START", his first and last name, sit down.
- The last person must say "STOP" after saying his first and last name.
- Record the time in seconds.
- Increase the number of groups with each pass.
- Save data as an ordered pairs (number of people, time).
- Enter the data in lists (L_1 and L_2).
- Graph the data as a scatter plot.
- Estimate a line of best fit with a piece of spaghetti.
- Find the slope of that line.
- Derive an equation and place in "Y_1 ="
- In "Y_2 =" find the line of best fit using Linear Regression "LinReg (ax+b)".
- Compare the two lines.
- Predict how long it would take to "Do the WAVE Twice"

SOL Topic:

A.18

The student will compare multiple one-variable data sets, using statistical techniques that include measures of central tendency, range, stem-and-leaf plots, and box-and-whisker graphs.

***Activity 4:* *CLASSROOM VIDEO:* The Birthday Problem collecting one-variable data showing, central tendency, range, and a box-and-whisker graph.**

Procedure for Box and Whisker Graphs:
Using a Julian Calendar and the home screen of the calculator students will compute the Julian Calendar Day on which they were born.

- Students will form a line in ascending order using their calendar day.
- Find the middle (Median) of that line.
- Find the Minimum day, Maximum day, compute the Range, the First Quartile, the Third Quartile, and the Mean (a useless quantity)
- Go to "STAT PLOT" (2nd Y=), press ENTER.
- **E**nter the data into the calculator in L_1.
- Turn Plot 1...On, Highlight Box and Whisker, press ENTER, let Xlist : L_1, Freq: 1
- For WINDOW let : Xmin = - 10, Xmax = 400, Ymin = - 3, Ymax = 10, Yscl = 1.
- GRAPH and TRACE find : MinX, Q1, Med, Q3 , MaxX.

Activity 4:* *CLASSROOM VIDEO:* *Derive a Histogram and Stem and Leaf Plot from the Birthday Data

Procedure for Histogram:

- Using the "Birthday Program" previously linked into the calculators, students will find the day of the week on which they were born.
- Students will line up in seven lines representing each day of the week.
- Teacher will assign a position number to each student.
- **E**nter the position numbers into the calculator in L_1.
- Turn Plot 1...On, Highlight Histogram, press ENTER, let Xlist : L_1, Freq: 1
- For WINDOW let : Xmin = 0, Xmax = 100, Xscl = 10, Ymin = -3, Ymax = 10, Yscl = 1.
- GRAPH and TRACE.
- Show Stem and Leaf Plot from the data extracted from the Histogram.

SOL Topic:

AII.19

The student will collect and analyze data to make predictions, write equations, and solve practical problems. Graphing calculators will be used to investigate scatter plots to determine the equation for a curve of best fit.

Activity 5: <u>CLASSROOM VIDEO</u>: The M&M problem showing exponential decay will be explored

Procedure and Student Activity:

- Instructor will place the students into groups of four.
- Distribute one small bag of M&M's and cup.
- Give instructions to students to count the total number of pieces.
- Place in cup. Roll onto table and separate into two groups.
- Count the ones **WITHOUT** "M's" showing.
- Record the data (Two column data...Number of Trials vs. Number of pieces without "M's").
- Place the pieces **WITH** "M's" back in the cup.
- Repeat the roll until none of the pieces are remaining.
- Record data after each trial.

On the calculator:

- Collect the data from each group by recording the sum of each trial and placing in a LIST---remembering that the "MMS" cannot equal zero.
- Show how to "Name" a list ("TRIAL" and "MMS").
- Show how to set up the STAT PLOT, WINDOW, and GRAPH in a "Scatter Plot" mode.
- Discuss the meaning of the scatter plots as they relate to Exponential Decay.
- Find the line of best fit using the "ExpReg" and place equation in "Y_1=".

Program V. **Systems of Equations and Inequalities**

SOL Topic:

A.9

The student will solve systems of two linear equations in two variables, both algebraically and graphically, and apply these techniques to solve practical problems. Graphing calculators will be used as both a primary tool of solution and to confirm an algebraic solution.

Activity 1: **Solve the following system graphically, numerically, and confirm analytically.**

Place both equations into slope-intercept form:

- $Y_1 = (-1/2)\ x + 4$
- $Y_2 = 2x + 12$
- Use 2nd CALC, "intersect" to determine where the lines cross.
- The graphical solution is (x, y) = (-3.2, 5.6)
- Examine table values with TblStart = -4 , *d* tbl = .2
- On the table find : X = -3.2, $Y_1 = 5.6$, $Y_2 = 5.6$
- Show algebraic solution using linear combination. (x, y) = (-16/5, 28/5)

Activity 2: **Solving practical problems using systems of equations.**

The Video Club of Virginia advertises a membership fee of $20.00 per year and allows its members to rent each video for $1.50 each. Write an equation for the problem: How many videos rentals can you get for $29?

- Let $Y_1 = 20 + 1.5x$
- In Zoom 8, trace to find where Y = 29, Solution is X = 6 videos.
- Show table values.

Video Club of America is a competitor which advertises a membership fee of $25.00 per year and allows its members to rent each video for $1.25 each. Write a linear function for Video Club of America's rental in Y_2.

- $Y_2 = 25 + 1.25x$

Questions:

- When is Video Club of America the least expensive?
- For the memberships to be equal how many videos do you have to rent ?
- Solve the equation **20 + 1.5x = 25 + 1.25x.**
- If your parents allow you to rent four videos per month, and this was a Christmas present, on July 31st how much have you spent if you joined Video Club of Virginia? How much have you spent if you joined Video Club of America?

SOL Topic:

AII.11

The student will use matrix multiplication to solve practical problems. Graphing calculators will be used or computer programs with matrix capabilities will be used to find the product.

Activity 3: **Demonstrate weighted averages using Matrix Multiplication.**

A grading system is establishes in a math class with the following criteria:
Tests are 50%, Homework 20%, and Quizzes 30%. The following table gives the average scores for four students in each of the three areas.

Name	Examination	Homework	Presentation
Ellen	71.2	82.86	80
Gene	71.4	81.43	83.33
Mike	69.8	72.9	81.7
Christine	88	84.29	91.67

Place the average scores in matrix A. Place the weights in matrix B. Multiply [A] [B].

[A] * [B] = [Weighted averages]

[A] [B]

- How would you establish, on a scale of 90%-A, 80%-B, 70%-C, 60%-D, and below 60% an F, a grade for Ellen, Gene, Mike and Christine?
- Calculate their grades.

Emphasize that for a class of 30, the first matrix has a dimension of "30 by 3", and the second matrix still has a dimension of "3 by 1".

SOL Topic:

AII.12

The student will represent problem situations with a system of linear equations and solve the system using the inverse matrix method. Graphing calculators or computer programs with matrix capability will be used to perform computations.

Activity 4: **Solving systems of equations using matrix multiplication and examining the "reduced row echelon format" on the calculator.**

Use matrices to solve:

- **[A] [X] = [B]**
- **$[A]^{-1}[A][X] = [A]^{-1}[B]$**
- **$[X] = [A]^{-1}[B]$**

Where [A] is the matrix of coefficients, [X] is the matrix of Variables, and [B] is the matrix of constants.

For the Reduced Row Echelon Form use:

- "MATRX", "MATH", "rref ([A])"

SOL Topic:

AII.13

The student will solve systems of linear inequalities and linear programming problems and describe the results both orally and in writing. A graphing calculator will be used to facilitate solutions to linear programming problems.

Activity 5: **Describe use of a linear programming activity.**

A computer manufacturing plant can assemble computer parts using two processes. Hours of unskilled labor, skilled labor, and machine time per computer are given. You can use up to 4200 hours of unskilled labor and up to 2400 hours each of machine time and skilled labor. How many computers should you assemble by each process to obtain a maximum profit?

Process **A** earns a profit of $125 per computer, and Process **B** earns a profit of $160 per computer. 0bjective is to obtain a maximum profit **P.**

P = 125A + 160B

The vertices at the points of intersection of the graph are:

- (0, 1200) P = $192,000
- (400, 1000) P = $210,000 Max Profit
- (1000, 400) P = $189,000
- (1200, 0) P = $150,000
- (0, 0) P = $0

There for the maximum profit is obtained by making 400 component parts using process A and 1000 component parts using process B.

SOL Topic

AII.14

The student will solve nonlinear systems of equations, including linear-quadratic and quadratic-quatratic, algebracially and graphically. The graphing calculator will be used as a tool to visualize graphs and predict the number of solutions.

Activity 5: **Demonstrate a projectile motion problem (quadratic equation) as it relates to a real world situation.**

For a Linear /Quadratic System:

A CO_2 rocket is launched straight up from ground level with an initial velocity ($V_{0)}$ of 150 feet per second. At what time will the rocket be at least 200 feet above the ground? (S_0 =0). What is the maximum height? When will it occur?

The formula for projectile motion is $\mathbf{s = -.5gt^2 + v_0t + s_{0,}}$ **where g = -32ft/sec^2**

Show Algebraic Solution:

- **-16 x2 + 150x = 200**
- **-16x2 +150x - 200 = 0**

In Function mode:

- Let $Y1 = -16x^2 + 150x$:
- $Y2 = 200$
- Using 2nd CALC, intersect, compute the two points of intersection which represents time (x-values).
- The solutions are x = 1.6097 seconds and x = 7.7653 seconds.
- The maximum height = 351.56 feet, when x = 4.688 seconds.

Graph in Parametric Mode, Simultaneous Mode:

- Let: $X_{1T} = T$
- $Y_{1T} = -16T^2 + 150T$
- $X_{2T} = 4.688$ (Change style of the equation)
- $Y_{2T} = -16T^2 + 150T$

Window :

- T: [0, 10] $_{.1}$
- X: [-2, 10] $_{1}$
- Y: [-100, 500]$_{100}$

Program VI. **GEOMETRY**

SOL Topic:

G.7

The student will solve practical problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry. Calculators will be used to solve problems and find decimal approximations for the solutions.

Activity 1: Use the Pythagorean Theorem to explore Algebraic relationships in Geometry.

The hypotenuse of a right triangle is 13 units. The difference of the lengths of the legs is 7 units. Find the length of each leg. Explore analytically, graphically, and numerically.

ANALYTICALLY :

Let:

- One leg = x
- Second leg = (x - 7)
- Hypotenuse = 13
- Equation to solve analytically is "$x^2 + (x - 7)^2 = 13^2$
- Solution: first leg is x = 12, second leg (x - 7) is 5.

GRAPHICALLY:

- $Y_1 = X^2 + (X - 7)^2$
- $Y_2 = 13^2$
- Use "2nd Calc", "Intersect" to find solutions
- Solutions are x = -5, and x = 12, when y = 169 but a side of a triangle cannot be negative, therefore x = 12 is the solution.

NUMERICALLY:

- INVESTIGATE THE TABLES:
- When x = -5 and x = 12

Activity 2: **Graph in Polar Mode, the Unit Circle with degree increments as the x and y coordinates correspond to the special right triangle values .**

Mode:

- Polar
- Degree

Window:

- Zoom Decimal, divided by 3;

Graph and trace when:

- r1 = 1

To observe the special properties of right triangles note the X and Y coordinates, when theta = 0, 30, 45, 60, 90 degrees with an added bonus of 15 and 75 degrees at no charge.

Questions:
In which quadrant does a 120 degree angle fall?
What is the coterminal angle of -67.5 degrees?
In which quadrant does a -128.5 angle fall?
Can you find the sine, cosine, and tangent of 128.5 degrees?
What is the tangent of 45 degrees?
What is the sine of 30 degrees?
What is the cosine of 60 degrees?
When are the sine and cosine equal?

Activity 3: **Graphing Simultaneously the Unit Circle and Sine Wave in Parametric Mode.**

Mode:

- Parametric
- Simul
- Radian

- $X_{1T} = \cos(T) - 1$
- $Y_{1T} = \sin(T)$
- $X_{2T} = T$
- $Y_{2T} = \sin(T)$

Window:

Graph and Trace when T = 1.57, T = 3.14, T = 4.71, T = 6.28
View the circle and the sine curve using the "up" cursor when tracing.

Activity 4: **Solving word problems in trigonometry using the home screen of the graphing calculator.**
Problem:
A person is 6 feet tall and casts a shadow of 8 feet on the ground. At what angle is the sun above the horizon?
Is it morning, noon or evening? Explain.

Solution to finding the angle of the sun above the horizon:

- Degree Mode
- Home Screen
- Tan $^{-1}$(6/8) = 36.86989765 degrees

Change into degrees-minutes-seconds:

- 2nd ANGLE , #4: DMS
- ENTER
- Solution is 36 degrees 52 minutes, 11.632 seconds

G.13

The student will use formulas for surface area and volume of three dimensional objects to solve practical problems. Calculators will be used to find decimal approximations for results.

Activity 5: **Solving a practical problem in three dimensional geometry.**

Find the amount of material required to construct a cone-shaped drinking cup for the Granby Elementary School water fountain. The slant height of the cone must be 5 inches, the radius of the cone is 4 inches. What is the height of the cone? What is the lateral area? What is the amount of water which the cone will hold?

Solution: From a 3-4-5 right triangle, if the radius = 4, then the height = 3.
Use the Formulas for finding the Lateral Area and the Volume of a cone :

On the home screen:

SOL Topic:

G.15

The student will draw a system of vectors and find the resultant graphically, write the components of a vector as a column matrix, and find the resultant by matrix addition; and solve practical problems using a system of vectors.

Activity 6: **Given a system of vectors find the resultant with vector addition on the graph screen of the calculator.**

Problem:

- Add the vectors $v_1(2,5)$, $v_2(4,3)$ to find the resultant $v_r(6,8)$ geometrically.

New Activity:

Window:

- X: [-10, 84] $_{10}$
- Y: [-10, 52] $_{10}$

Using the LINE command on the DRAW MENU:

- Draw a line segments (representing a vectors) on the home screen.
- Line (0, 0, 10, 25)
- Line (0, 0, 20, 15)
- Algebraically find the resultant.
- (10, 25) + (20, 15) = (10+20, 25+15) -> (30, 40)
- Graph the translation of the resultant using DRAW, "Line (
- Begin at the endpoint (10, 25), press Enter.
- Move the cursor on the graph screen right 20 units then move up 15 units, then press ENTER.
- Graph the resultant.
- Line (0, 0, 30, 40)

Activity 7: **Writing the components of vectors in a column matrix then find the resultant by matrix addition within a practical problem applications.**

The problem:
A tourist takes a taxi to go to the nearest pizza parlor in New York City. The taxi driver takes him 10 blocks east and 25 blocks north of his original location. He says, "This taxi driver is nuts" and gets out of the taxi and flags another. He says, "Please take me to your nearest pizza parlor." The new taxi takes him 20 blocks west and 15 blocks north. When they arrived at the pizza parlor, how much did he pays both taxi drivers, and how many blocks from his point of origin had he traveled? (east-west, north-south)

Represent the vectors in a 2 by 1 column matrix.

Solution:
He had traveled 10 blocks west and 40 blocks north of his original location.
(Teacher can assume a charge per block in making an extension).