Graphing Calculator Workshop

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POWER ON/OFF

- Press [ON] to turn on calculator.
- Press [2nd] [OFF] to turn off calculator.

SCREEN CONTRAST

- Press [1] [7]
- Press [2nd] [△] to make screen darker.
- Press [2nd] [▽] to make screen lighter.

KEY STRUCTURE

- Press 2nd [LOG] to get 10^x on the screen.
- Press [ALPHA] [LOG] to get N on the screen.
- Press [CLEAR].

MODE

- Press [MODE]. The selected items are the highlighted ones. To select a specific item, use arrow keys to highlight the item. To activate the selection, press [ENTER].

HOME SCREEN/SCIENTIFIC CALCULATOR

- Press 2nd QUIT to arrive at the Home Screen.
- Calculate: $-e\sqrt{17}+\pi^3-\left|\dfrac{17.2^2-296}{3\cdot 4}\right|$
- Press (-) 2nd e 2nd $\sqrt{}$ 1 7) + 2nd π $\wedge$ 3 $-$ MATH NUM abs ((1 7 $\cdot$ 2 x^2 $-$ 2 9 6) $\div$ (3 $\times$ 4)) ENTER.
  What you should see on the home screen:

$$-\mathrm{e}\sqrt{(17)}+\pi\text{^}3-\mathrm{abs}((17.2\text{^}2-296)/(3*4))$$

- Your answer should be 19.78518025. NOTE: (-) is for negation and $-$ is for subtraction.

ALGEBRAIC EXPRESSIONS and FUNCTIONS

PROBLEM: Let $f(x)=x^3-4x^2+4x+2$. Find $f(\pi^2)$.

- Press Y= to go to the Function Screen. Note that your cursor is at the $\mathtt{Y_1}=$ line. Press CLEAR if necessary.
- Enter the expression x^3-4x^2+4x+2, i.e. key in $\mathtt{Y_1}=\mathtt{X}^3-4\mathtt{X}^2+4\mathtt{X}+2$.
- Press 2nd QUIT to return to the Home Screen. Press CLEAR to erase the Home Screen.
- Enter $\mathtt{Y_1}$ variable on the Home Screen by pressing VARS Y-VARS Function $\mathtt{Y_1}$ ENTER.
- Evaluate $\mathtt{Y_1}$ at π^2 by typing $\mathtt{Y_1}$ (π^2). Press ENTER.
- Answer: 613.231247

GRAPHING FUNCTIONS

PROBLEM: Graph: $f(x)=x^2+2$ and $g(x)=(f(x))^{1/3}$.

- Press Y= to go to the Function Screen.
- Key in $\mathtt{Y_1}=\mathtt{X}^2+2$, $\mathtt{Y_2}=(\mathtt{Y_1})\text{^}(1/3)$.
- Press ZOOM ZStandard (or press ZOOM 6). Set the window size and graph.

- ZOOM Zstandard sets X-values and Y-values as Xmin $= -10$ and Xmax $= 10$, i.e., $-10 \leq$ X ≤ 10 and Ymin $= -10$ and Ymax $= 10$, i.e., $-10 \leq$ Y ≤ 10.

USING THE TRACE FEATURE

- Using the same function in $Y_1 =$ as above, press TRACE. Move cursor to the right and left using the right and left arrow keys. Move from the graph of one function to another by using the up and down arrow keys. The function being traced is indicated by the number in the upper-right corner. (1 = Y_1, 2 = Y_2, etc.).
- Move cursor until X $= 1.4893617$.
- Y $= 4.2181983$ corresponds to $Y_1(1.4893617)$.
- Press ZOOM ZDecimal (or ZOOM 4).
- You have changed the WINDOW to $-4.7 \leq$ X ≤ 4.7 and $-3.1 \leq$ Y ≤ 3.1.
- Press TRACE. Move cursor until X = .6 to find that $Y_1(.6) = 2.36$.

FINDING ROOTS, INTERSECTIONS AND EXTREMA

PROBLEM: Graph: $Y_1 =$ X^(3.1) + 1.5X^(1.9) − 3X^(0.7). Find the roots.

1. Change Window to $0 \leq$ X ≤ 1.88 and $-3.1 \leq$ Y ≤ 3.1 GRAPH.
2. Press 2nd CALC zero (or 2nd CALC 2).
3. Move cursor to the left of the root; press ENTER.
4. Move cursor to the right of the root; press ENTER.
5. Move cursor close to the root; press ENTER.
6. The bottom of the screen should read X $= 1.113302$ Y $= 0$.
7. (The X value may be accurate to only 5 decimal places.)

PROBLEM: Graph: $Y_1 =$ X^(3.1) + 1.5X^(1.9) − 3X^(0.7) and $Y_2 =$ X − 1. Find the intersection points.

1. Press 2nd CALC intersect (or 2nd CALC 5).
2. Press ENTER to indicate the first curve.
3. Press ENTER to indicate the second curve.

4. Move cursor to the left most intersection point; Press [ENTER].
5. The bottom of the screen should read X = .17462943 Y = −.8253706 for the left most intersection point. Repeat the same process to find the second intersection point.

PROBLEM: Graph: $Y_1 = X\hat{}(3.1) + 1.5X\hat{}(1.9) - 3X\hat{}(0.7)$. Find the minimum point.

- Method 1: Using [ZOOM]
  1. Change Window to $0 \leq X \leq 1.88$ and $-3.1 \leq Y \leq 3.1$
  2. Move cursor close to the minimum value. Use [ZOOM] key to get approximate answer. Zoom again and again until answer with the desired accuracy is obtained.
- Method 2: Using [2nd] CALC
  1. Change Window to $0 \leq X \leq 1.88$ and $-3.1 \leq Y \leq 3.1$ [GRAPH].
  2. Press [2nd] CALC minimum (or [2nd] CALC [3]).
  3. Move cursor to the left of the minimum point; press [ENTER].
  4. Move cursor to the right of the minimum point; press [ENTER].
  5. Move cursor close to the minimum point; press [ENTER].
  6. The bottom of the screen should read X = .54532248 Y = −1.335785.
- Method 3: Using the TABLE
  1. [2nd] TblSet Set TblStart = 0 and ΔTbl = .1. (Note that for the TI-83, the TblStart is called TblMin.)
  2. [2nd] TABLE Use up and down arrow keys to check through the Y_1-values. Note that the minimum occurs for $.5 \leq X \leq .6$.
  3. [2nd] TblSet Set TblStart = .5 and ΔTbl = .01.
  4. [2nd] TABLE Use up and down arrow keys to check through the Y_1-values. Note that the minimum occurs for $.54 \leq X \leq .55$.
  5. [2nd] TblSet Set TblStart = .54 and ΔTbl = .001.
  6. Continue until you get the accuracy that you need.

FINDING THE GRAPH: DETERMINING THE WINDOW

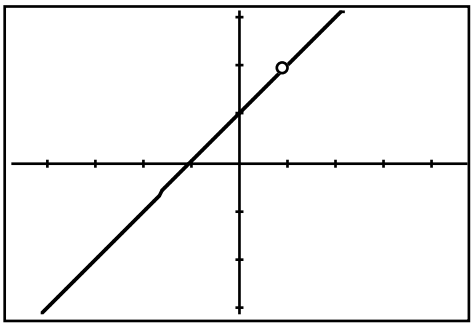
PROBLEM: Graph and find minimum value of $Y_1 = .0045e\hat{}X - 89X + 987$ for $0 \leq X \leq 20$.

- Press [WINDOW]. Change the window to $0 \leq X \leq 20$, $-10 \leq Y \leq 10$.

- Press [GRAPH] and we get a blank screen! What to do?
- Use [TRACE] to get $\texttt{Y}_1 = 196.1190961$. Now we have a ball-park idea of the range.
- Change window to $100 \leq \texttt{Y} \leq 300$, $\texttt{Yscl} = 0$.
- Find minimum value using [2nd] CALC.
- Answer: $\texttt{X} = 9.892312$, $\texttt{Y} = 195.58403$.

GRAPHS WITH HOLES

- Graph: $f(x) = \dfrac{x^2-1}{x-1}$ using [ZOOM] ZDecimal.
- Screen Display:



- Use [TRACE] to obtain the Y-value when $\texttt{X} = 1$.
- Comment: This illustrates that $f(x) = \frac{x^2-1}{x-1}$ and $g(x) = x+1$ are **not** the same function because $f(1)$ is undefined and $g(1) = 2$ is defined. This shows that the two functions have different domains.
- Another approach is to use the table feature. Key in [2nd] TblSet. Set TblStart = 1 and $\Delta\texttt{Tbl} = .01$. Note that at $\texttt{X} = 1$ the $\texttt{Y}_1$ value is shown as ERROR. Use the up and down arrow keys to analyze the behavior of $\texttt{Y}_1$ near $\texttt{X} = 1$.

GRAPHING PIECEWISE-DEFINED FUNCTIONS

PROBLEM: Graph the piecewise-defined function

$$f(x) = \begin{cases} .3e^{x^2} & x < 1 \\ 2x - \frac{5}{2} & x \geq 1 \end{cases}$$

- In [Y =] graph $\texttt{Y}_1 = (.3\texttt{e}\hat{}(\texttt{X}\hat{}2))/(\texttt{X} < 1)$ and $\texttt{Y}_2 = (2\texttt{X} - 5/2)/(\texttt{X} \geq 1)$ using ZDecimal window.
- Use [TRACE] and TABLE to obtain the Y-values for $\texttt{X} = -1, 0, 1, 2$.

PROBLEM: Graph

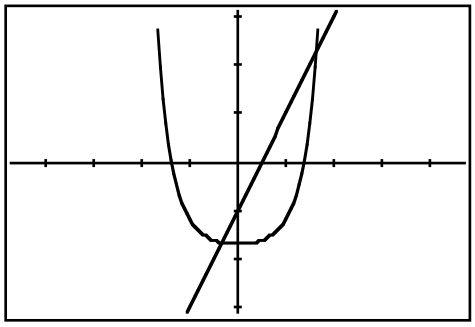
$$f(x) = \begin{cases} 3x^2 - 1 & -2 \leq x < 2 \\ 5 - x & 2 \leq x \leq 5 \end{cases}$$

- Where is the function increasing/decreasing? What is the largest value on $-2 \leq x \leq 5$?
- Hint: Graph $\texttt{Y}_1 = (3\texttt{X}\hat{}2 - 1)/((-2 \leq \texttt{X})(\texttt{X} < 2))$ and $\texttt{Y}_2 = (5 - \texttt{X})/((2 \leq \texttt{X})(\texttt{X} \leq 5))$ on $-3 \leq \texttt{X} \leq 6$, $-5 \leq \texttt{Y} \leq 15$.

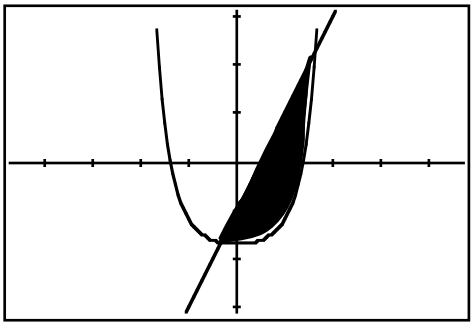
SOLVING INEQUALITIES

PROBLEM: Solve $.3e^{x^2} - 2 \leq 2x - 1$.

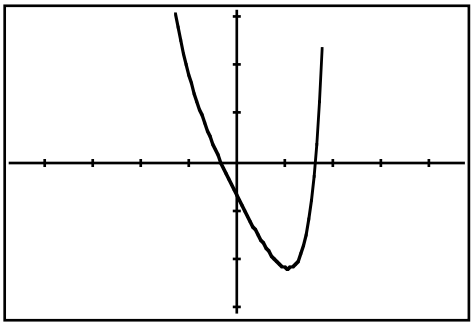
- Graph $\texttt{Y}_1 = .3\texttt{e}\hat{}(\texttt{X}\hat{}2) - 2$ and $\texttt{Y}_2 = 2\texttt{X} - 1$ using ZDecimal window.
- Screen Display:



- Find the coordinates of the left intersection point using [2nd] CALC intersect. The answer: $\texttt{X} = -.3324686$ and $\texttt{Y} = -1.664937$. Find the coordinates of the right intersection point. The answer: $\texttt{X} = 1.6286884$ and $\texttt{Y} = 2.2573769$.
- Solution to inequality: $-.3324686 \leq \texttt{X} \leq 1.6286884$. How does one check the answer?
- Shade between the two functions $\texttt{Y}_1 = .3\texttt{e}\hat{}(\texttt{X}\hat{}2) - 2$ and $\texttt{Y}_2 = 2\texttt{X} - 1$. Key the Shade entry under [2nd] Draw to get $\texttt{Shade}\ (\texttt{Y}_1, \texttt{Y}_2)$ on the Home Screen. Press [ENTER].
- Screen Display:



- Do not erase the two equations in $\texttt{Y}_1$ and $\texttt{Y}_2$ from above. Another method to solve the inequality is to graph $\texttt{Y}_1 = (.3\texttt{e}\hat{}(\texttt{X}\hat{}2) - 2) - (2\texttt{X} - 1)$ using the `ZDecimal` window or graph $\texttt{Y}_3 = \texttt{Y}_1 - \texttt{Y}_2$.
- Screen Display:



- Find the left root. Key the `Zero` (or `Root`) entry under `CALC`. Move cursor to left of left root and press [ENTER]. Move cursor to right of left root and press [ENTER]. Move cursor close to left root and press [ENTER]. Left Root: $\texttt{X} = -.3324686$, $\texttt{Y} = 0$.
- Repeat above to find right root. $\texttt{X} = 1.6286884$, $\texttt{Y} = -4\texttt{E} - 13$.
- Answer: $-.3324686 \leq \texttt{X} \leq 1.6286884$.
- EXERCISE: Write the solution of $|3x + 2| < 5$ in interval notation. Graph $\texttt{Y}_1 = |3\texttt{X} + 2| < 5$ on `ZDecimal` Window. Look for where the graph is above the x-axis. The answer: On the interval with approximate end points $(-2.4, 1)$.
- EXERCISE: What is the domain of $g(x) = \sqrt{4 - 6x + x^2}$? Hint: Graph $h(x) = 4 - 6x + x^2$ and solve $4 - 6x + x^2 \geq 0$.

COMPUTING A DERIVATIVE

PROBLEM: Compute the derivative of $f(x) = \pi^{.3X}$ at $x = 1.9$.

- Method 1:
  1. Graph $\texttt{Y}_1 = \pi\texttt{\^{}(.3X)}$ using the `zDecimal` window.
  2. Press 2nd `CALC` 6 to get `dy/dx`.
  3. Type in the number 1.9. Press ENTER to get `dy/dx=.65947709`.
- Method 2.
  1. Type $\texttt{Y}_1 = \pi\texttt{\^{}(.3X)}$ into the Y= menu.
  2. Return to the Homescreen. Press Math 8 so that `nDeriv(` appears on the screen.
  3. Type in `nDeriv`,($\texttt{Y}_1$, X, 1.9).
  4. Press ENTER to get .6594770885

TANGENT LINES

PROBLEM: Let $f(x) = \sqrt{x+3}$. Find an equation of the line tangent to the graph of f at $x = -1$.

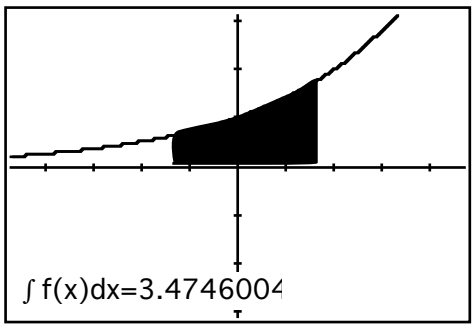
- Graph $\texttt{Y}_1 = \sqrt{(\texttt{x}+3)}$ using the `zDecimal` window.
- Press 2nd `DRAW` 5 to select `Tangent(`. This will return you to the graph.
- Enter -1 and press ENTER.
- The calculator will draw the tangent line at $x = -1$ and give the equation of the tangent line in the form $y = mx + b$ at the bottom of the screen.

COMPUTING A DEFINITE INTEGRAL

PROBLEM: Compute $\int_{-1.2}^{1.8} \pi^{.3X}\, dx$

- Method 1:
  1. Graph $\texttt{Y}_1 = \pi\texttt{\^{}(.3X)}$ using the `zDecimal` window.
  2. Press 2nd `CALC` 7 to get $\int$`f(x)dx`.

3. Type in -1.2 as the lower limit and press [ENTER]. Then type the upper limit 1.8 and press [ENTER] again.
4. The calculator will shade in the area under the graph between $x = -1.2$ and $x = 1.8$ and give the numeric value of the integral at the bottom of the screen.



- Method 2:

1. Enter $Y_1 = \pi\hat{}(.3X)$.
2. Press [MATH] [7] to get fnInt(on the screen.
3. Then type fnInt(Y_1, X,$-1.2, 1.8$).
4. Press [ENTER] to get 3.474600363.

REGRESSION

PROBLEM: Consider the following population (in millions) data of the world.

Year:	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Population:	1650	1750	1860	2070	2300	2520	3020	3700	4450	5300	6100

Graph as a scattered plot. Use regression to find an exponential model and cubic model for population growth.

- To enter the data in the lists, press [STAT] EDIT Edit. Enter the years in L1 and the populations in L2. Press [2nd] STAT PLOT [ENTER]. Turn on plot; select the scatter plot from the pictures, L1 for X-list, L2 for Y-list, and a square for the mark. Key [ZOOM] ZoomStat to get a scatter plot of the population growth in the world for the last century.

- For the TI-83 Plus and TI-84: Press [Y=]. Clear Y_1 and Y_2. To find an exponential model, key the CALC entry under [STAT]. Now key in ExpReg (which sends you back to the Home Screen); press L1 [,] L2 [,] Y_1. The Home Screen should look like this:

  ExpReg L1, L2, Y_1

- Press [ENTER].
- The Home Screen should read:

  $y = a \times b^x$

  $a = 7.7913892E - 9$

  $b = 1.01374896$

  $r^2 = .9693660871$

  $r = .984563907$.

- Press [Y=]. Note that $Y_1 = (7.7913892195333E - 9)(1.0137489599052)\hat{}X$. The equation for the regression line has automatically been entered into Y_1. Press [GRAPH] and note how closely the exponential model reflects the data.
- For the TI-83: Press [Y=]. Clear Y_1 and Y_2. To find an exponential model, key the CALC entry under [STAT]. Now key in ExpReg (which sends you back to the home screen); press L1 [,] L2. Your Home Screen should read

  ExpReg L1, L2

- Press [ENTER].
- The Home Screen should show the same information as above.
- To graph the regression equation on the TI-83, go to Y_1; press [VARS] Statistics EQ RegEq. Press [ENTER]. The regression equation will be automatically entered into $Y_1 =$. Press [GRAPH] and note how closely the exponential model reflects the data.
- To find a cubic model, key the CALC entry under [STAT]. Now key in CubicReg (back to the home screen) then repeat the above.
- Be sure to turn plots off after graphing a statistical plot so that your calculator is returned to function graphing mode. This can be accomplished by pressing [2nd] [Y=] STATPLOT [ENTER]. Select the plot that is on, select off with the arrow key, then press [ENTER].