Guidelines for Graphing Calculator Use at the Commencement Level

Introduction

Graphing calculators are instrumental in the teaching and learning of mathematics. The use of this technology should be encouraged and used as an investigative tool at both the intermediate and commencement levels. Through its targeted use, students' conceptual understanding of mathematics will be increased, and the connections between graphical and algebraic representation will be enhanced. Algebraic and analytical solutions (pencil & paper techniques) to solving problems should still be stressed.

An integral part of the Mathematics B Curriculum is the use of the graphing calculator. The calculator should be used extensively for all types of classroom activities and homework, whenever possible. A graphing calculator must be made available for use by each student while taking the Mathematics B Regents examination. Graphing calculators are permitted, but not required, on the Mathematics A Regents examination. Scientific calculators are required on the Mathematics A Regents examination. Please note that calculators with symbolic manipulation capabilities (built-in computer algebra systems), QWERTY keyboards, portable computers, handheld electronic devices capable of infrared electronic transmission and devices capable of wireless communication are not permitted for use during these examinations. **The memory of any calculator with programming capability should be cleared or reset prior to the administration of both examinations**.

For questions in which the graphing calculator can be used, students should be trained to show enough of their work so that their thinking can be easily followed. For students to be awarded the maximum points allowable for a particular constructed response question, they must be able to communicate the method employed by illustrating their graph, table, or setup (equation); followed by the result of their investigation(s). The answer to the question should also be clearly identified, often by using a sentence response. Whenever appropriate, complete sentences should also be used to support their results so that their mathematical reasoning can be easily interpreted. **Encourage the use of a "rule of three"– setup, method, response (answering in sentence form when appropriate).**

It is expected that students are capable of performing the following tasks using a graphing calculator:

- Performing basic arithmetic and algebraic operations as found on a scientific calculator
- Graphing algebraic, trigonometric, exponential, and logarithmic functions in an appropriate viewing window
- Determining roots of functions and the points of intersection(s) of curves
- Solving linear and quadratic inequalities graphically
- Finding the inverse of a function
- Creating scatterplots
- Determining an equation of the curves of best fit: linear, logarithmic, exponential, or power
- Determining a linear correlation coefficient, r (Please note that r, r^2 and R^2 cannot be directly compared when calculating certain regression models.)
- Determining the variance and standard deviation of a set of data (population and/or sample)
- Determining the appropriate MODE
- Using the full potential of the technology by storing all of the digits produced by the calculator during computation. Rounding to the specified degree of accuracy should be done only at the end of all computation when the final answer is found.

Sketches and graphs should contain the following:

- The labeled graph of each equation when more than one function is graphed (no deduction if only one of two is not labeled)
- Axes appropriately labeled – variables identified
- Intercepts noted, where appropriate
- Points of intersection labeled
- Indicate window used by showing any of the following:
  - Intercepts
  - Scale on both axes
  - Maximum and minimum values of x and y
- In the graphs of nonlinear functions at least three points should be indicated. Intercepts are acceptable, and when appropriate, the turning point should also be indicated in the graph of the parabola

If a student sketches a graph not on a grid for problems where grid use is optional, the above criteria for sketches and graphs still hold.

Work for statistics questions should contain the following:

- For standard deviation questions, indicate the number of scores, the mean, and the appropriate standard deviation. The standard deviation for a population, (σ), is calculated by using "n", whereas the standard deviation for a sample (s) is calculated by using "$n - 1$". Students should be able to differentiate between a population and a sample.
- **Please note that the Normal Curve provided on the formula sheet contains the only values that should be used. The calculator should *not* be used to obtain percentages (normal curve probabilities); it can be used to check responses after using the curve provided. Not all graphing calculators have this capability.**
- For regression lines, write the regression equation, and, if needed, show the substitution in that equation for interpolations or extrapolations.
- For linear correlation coefficient items that call for an explanation, include the equation of the regression line, and specify how you used the linear correlation coefficient in your solution.

Examples

The problems that follow illustrate what students should show in order to be awarded the maximum points allowable on the rubric for each question. Please note that each sample shown is not the only method that can be used by a student with their calculator.

1) Math A – June '00 #21 – Two Point Question

The formula for changing Celsius (C) temperature to Fahrenheit (F) temperature is $F = 9/5\ C + 32$. Calculate, to the *nearest degree*, the Fahrenheit temperature when the Celsius temperature is (-8).

Sample Solution:

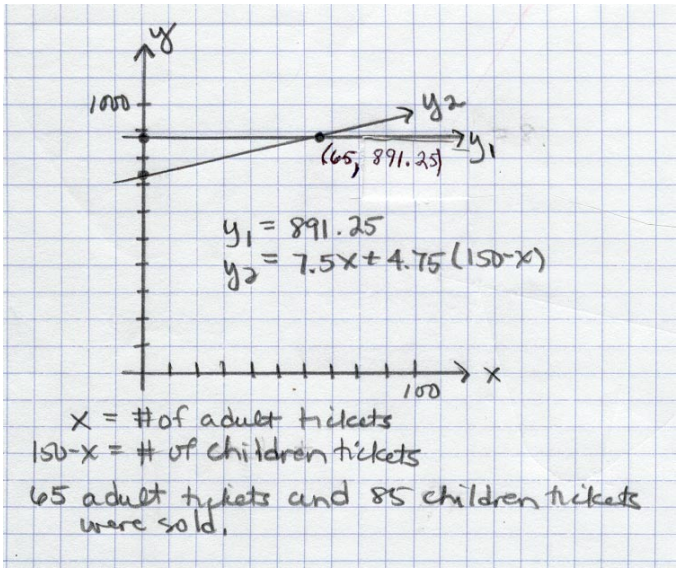
$$F = 9/5\ (-8) + 32$$
$$F = 18$$

Substitution is shown. All necessary work can be done using the calculator.

2) Math A – June '00 #31 – Four Point Question

The owner of a movie theater was counting the money from 1 day's ticket sales. He knew that a total of 150 tickets were sold. Adult tickets cost $7.50 each and children tickets cost $4.75 each. If the total receipts for the day were $891.25, how many of *each* kind of ticket were sold?

Sample Solution:



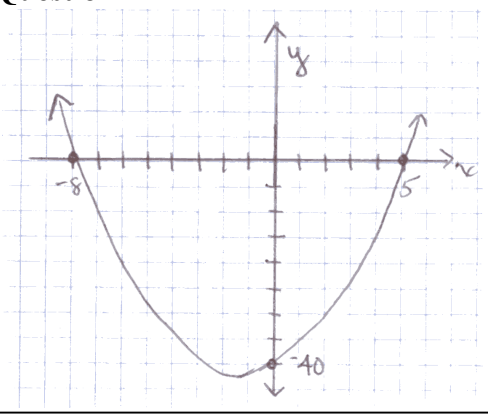
Student has shown a setup of the original equation used, has shown a graph as support of the method used, and has clearly indicated the answer.

3) Math A – Aug '99 #26 – Three Point Question

Solve for x: $x^2 + 3x - 40 = 0$

Sample Solution:

x= {-8, 5}



Student has shown the roots, intercepts, and axes are labeled. Note also that 3 values on the parabola are indicated

Sample Solution:

I entered $x^2+3x-40$ into Y_1 and using the table feature I found those values of x for which Y = 0

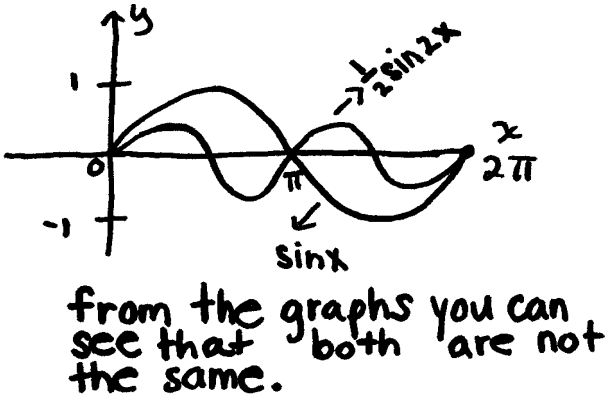
$x = \{-8, 5\}$

Student may also use the table feature of the calculator after entering the left side of the equation into Y^1. In using the table, the student finds those values of X for which Y is 0. The student should show the work above to justify this process.

4) Math B – June '02 #21 – Two Point Question

Is ½ sin 2*x* the same expression as sin *x*? Justify your answer.

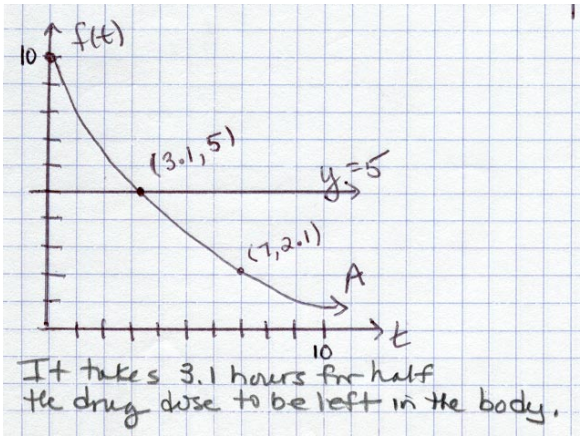
Sample Solution:



Student shows a sketch of each function on the same set of axes and makes a statement that both graphs are not the same; therefore the expressions cannot be the same.

5) Math B – Aug '01 #32 – Four Point Question
The amount A, in milligrams, of a 10-milligram dose of a drug remaining in the body after t hours is given by the formula $A = 10(0.8)^t$. Find, to the nearest tenth of an hour, how long it takes for half of the drug dose to be left in the body.

Sample Solution:



Student has indicated the point of intersection, has labeled each function, and has indicated a scale on both axes.

6) Math B – Example of a Four Point Question
A test in an English class produced the set of scores listed below. Find the standard deviation to the nearest tenth. What percent (to the nearest tenth) of the scores fall below the median score?

100, 60, 60, 72, 88, 40, 88, 75, 98, 95, 65, 84, 83, 87, 78, 79, 80, 81, 91, 92, 68

Sample Solution:

$n = 21$
$\text{mean} = 79.2381$
$\sigma = 14.3$

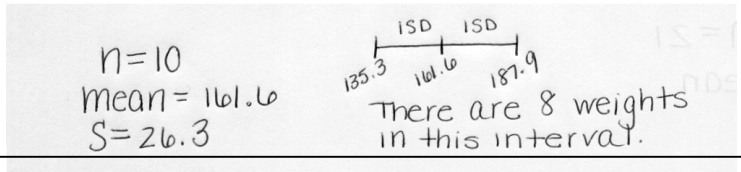
$\text{median} = 81$
$10/21 = 47.6\%$ of the scores were below the median

Student has used the appropriate *population* standard deviation and has shown the required work..

7) Math B – Example of a Four Point Question
The weights, in pounds, of randomly selected members of a fitness club are listed below. Find the standard deviation of this data to the nearest tenth. How many of these weights fall within one standard deviation from the mean?

158, 123, 187, 169, 142, 181, 211, 137, 147, 161

Sample Solution:

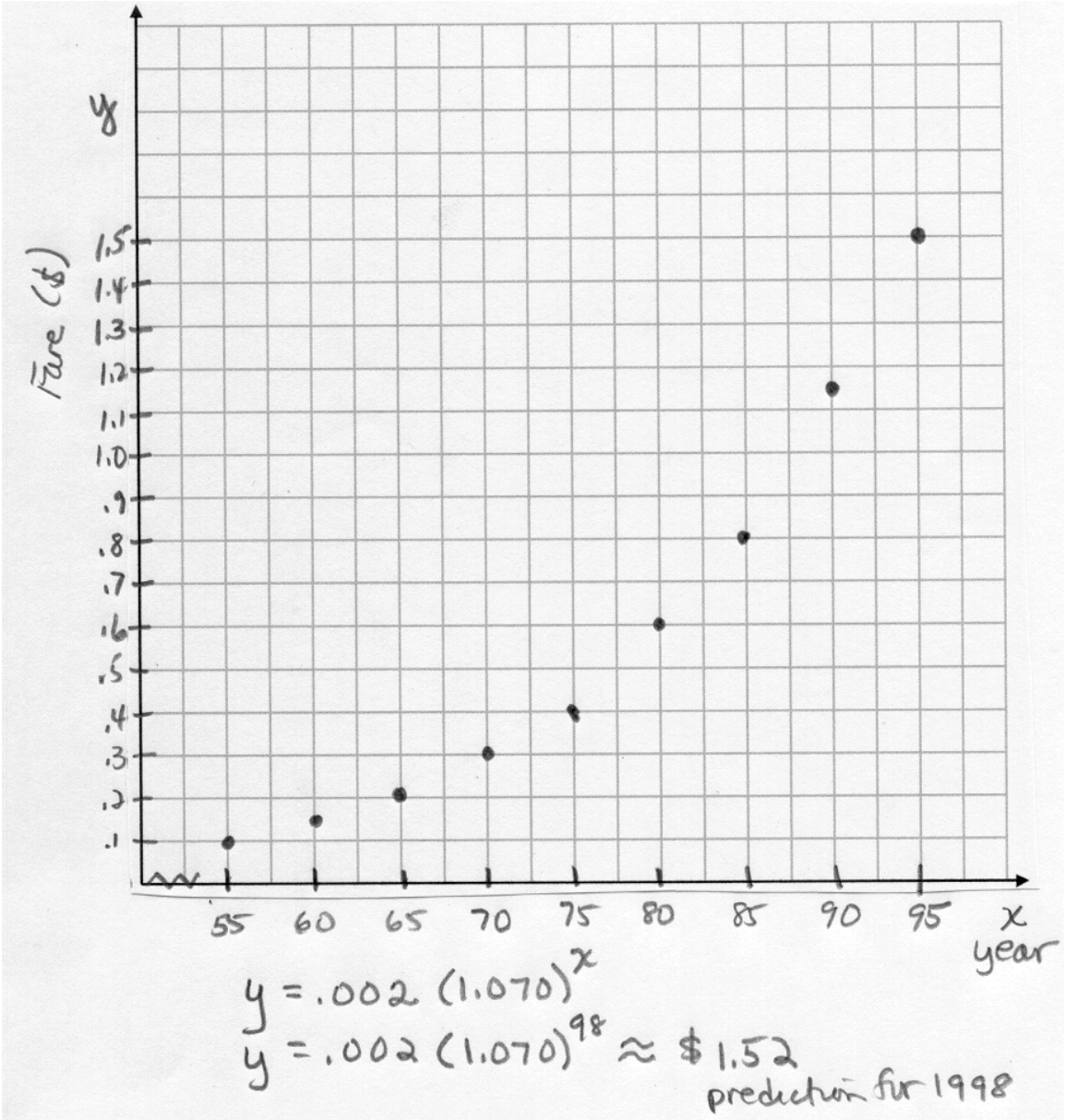


Student has used the appropriate *sample* standard deviation and has shown the required work.

8) Math B – June '02 #34– Six Point Question

The table below, created in 1996, shows a history of transit fares from 1955 to 1995. On the accompanying grid, construct a scatter plot where the independent variable is years. State the exponential regression equation with the coefficient and base rounded to the *nearest thousandth.* Using this equation, determine the prediction that should have been made for the year 1998, to the *nearest cent.*

Year	55	60	65	70	75	80	85	90	95
Fare ($)	0.10	0.15	0.20	0.30	0.40	0.60	0.80	1.15	1.50



Student has used appropriate labels, scales, and regression equation. The substitution into the required equation is shown, producing the indicated value rounded correctly.