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Incorporating the TI-92 into a high school classroom

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INCORPORATING THE TI-92 INTO A HIGH SCHOOL CLASSROOM

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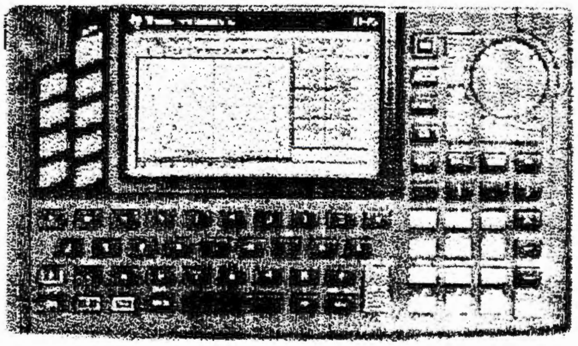


Calculators have been a part of mathematics for years. More recently, the graphing calculator has been widely accepted as a mathematical tool. The TI-92 has the capability to take this technology integration a step further. It has been described as having "the power of a computer with the independence of a graphing calculator." With the geometry package and the symbolic manipulation unique to the TI-92, the question becomes, how should this technology be coordinated with the existing curricula in high school classrooms to make the learning and teaching of mathematics as exciting and relevant as possible?

History

To begin this discussion, I will give a brief history of the TI-92. The TI-92 is Texas Instrument's latest graphing calculator. Pilot programs were run with it during the fall of 1994. However, it didn't become available in stores until 1996. Currently the calculators cost about $200 each. From private dealers, one can be obtained in a few days for only $170. This price is obviously quite steep for a school. However, once it is considered how much a computer for each student would cost, the $200 doesn't sound so bad.

The Nine Screens

As an introduction to the TI-92, I will describe each of its nine screens. Pictures of each of the screens can be found in Figure A. The first screen is the Home Screen. This is the screen where mathematical operations are performed. The Home Screen is seen when the calculator is first turned on. The second screen is the Y = Editor. As in other TI calculators, the Y = Editor is the place where functions are entered before they can be graphed. The third screen is the Window Editor. Again, this screen is found in the other TI graphing calculators. It is where the window for viewing a graph is chosen. Next is the Graph Screen. This screen is, just as the name says, where the graphs are displayed. The Table is the fifth screen. In this screen, the numerical values for the entries in the Y = Editor are listed. The sixth screen is the Data/Matrix Editor. From this screen, lists and matrices can be created. The Program Editor is the next screen. Here programs can be written and edited. The eighth screen is the Geometry Screen. In this screen, geometrical figures can be created and changed. The final screen is the Text Editor. In the Text Editor, reports or commands can be written.

Each of these nine screens can be easily accessed through the blue application button located in the upper right hand corner of the calculator. When the application button is pressed, a pull down menu is displayed with the nine screens as the options. The first five screens can also be accessed by green diamond shortcuts. For example, the user can get to the

Y= Editor by pressing green diamond and W.

Differences

The TI-92 is different from the other TI graphing calculators in several ways. The first of these ways is in the split screen function. The TI-92 allows not only for an up/down split but also for a left/right split. The following ratios can be chosen when viewing the split screen: 1:1, 2:1, 1:2. These options allow the user a variety of choices when viewing two different screens. The TI-92 also allows two independent graphs to be viewed in the split screen mode. Each of these graphs has its own Y = Editor and Window Editor. This viewing of two graphs on separate axes was not possible in the previous TI graphing calculators. See Figure B.

The next difference comes in the Home Screen. The TI-92 has a mode known as "pretty print." When pretty print is on, exponents, roots, fractions, derivatives, integrals, etc. are displayed in the form in which they are usually written. Radical notation, stacked fractions and superscript exponents are three examples of pretty print. See Figure C. The entry line does not use pretty print. However, once enter is pushed, the entry line appears in the history area in pretty print. This is a great way to check to be sure that you typed in what you meant to. When several parentheses are used, the entry line sometimes gets quite confusing. With pretty print, the user can push enter and see the entry as if it were written on paper. Since pretty print is a mode, it can also be turned off.

When it is off, results are displayed as they are in the other TI graphing calculators.

The third difference is the one for which the TI-92 is probably most famous. That is, 3D graphing with a trace. The TI-92 has the capability to graph any 3D equation. Many of the graphing characteristics are the same as for the graphing of functions. For example, the zoom and trace features are still available. However, there are some differences too. One such difference occurs in the Window Editor. In addition to the regular xmin, xmax, ymin, and ymax, 3D graphs also have options called eyeθ and eyeΦ. These represent angles used to view the graph. Eyeθ is the angle of rotation in degrees from the positive x-axis. EyeΦ is the angle of rotation in degrees from the positive z-axis. These angles allow the user to view the graph from several different points. See Figure D. Another thing unique to 3D graphing is the box axes. In 3D graphing, the user can choose between displaying the standard XYZ axes and a 3D box axes. Only one 3D graph can be displayed at a time so it is not necessary to have different display styles. However, a 3D graph can be displayed as either a wire frame or a hidden surface. The only difference between the two is that the hidden surface uses shading to distinguish between the front and back of a shape.

The next difference between the TI-92 and the other TI calculators is the capability of the TI-92 to do symbolic manipulation. The TI-92 contains a somewhat simplified version of the algebra from the DERIVE program. The TI-92 can solve an equation such as $2x - 6 = 10$ in one step with the SOLVE function. Also, it can expand expressions. For example, when expand((x+5)(x+6)) is entered, the TI-92 multiplies the expressions and returns $x^2 + 11x + 30$. The TI-92 will also factor. If factor($x^3 - 5x$) is typed in, the TI-92 will give the rational result of $x(x^2 - 5)$. If instead, the user enters factor($x^3 - 5x$, x), the real result will be calculated. $x(x + \sqrt{5})(x - \sqrt{5})$ will appear. When cfactor($x^3 + 5x$, x) is entered, the complex result of $x(x + \sqrt{5}i)(x - \sqrt{5}i)$ is returned. Obviously, the possibilities of the FACTOR function are endless. The TI-92 will also simplify expressions by combining like terms. It will do more symbolic manipulation with derivatives, integrals, limits, and matrices. See Figure E. Symbolic manipulation is unique to the TI-92 and is a quite desirable quality.

The next distinguishing feature of the TI-92 arises through development with the authors of Cabri Geometry II software. This is the interactive geometry section. In this section, the user can construct everything from circles to perpendicular lines to polygons with any number of sides. See Figure F. The program also features measurements, transformations, and animations. It has a dragging hand which can select and move an object anywhere in the plane. The user's manual contains 63 pages on the geometry section and a separate geometry index. The ability to investigate geometric situations cannot be done anywhere except on the TI-92 or a computer.

The TI-92 also has some special features which set it apart from the other TI graphing calculators. It contains a full QWERTY keyboard as well as a numeric keypad. It also has an eight direction cursor with a mouse like control. It has a total of three enter keys, one on each section of the keyboard. A picture of the TI-92 can be found in Figure G. The screen has 8 drop down menus which are reminiscent of a computer. It can save, copy and create files much like a computer too.

Use in the Classroom

The TI-92 has numerous differences from the other TI graphing calculators. Now the question becomes, how can we use these differences to benefit the high school classroom?

Geometry

In Geometry, the interactive geometry application can be used to allow students to explore geometrical situations. There are two routes which are possible. First, the students could be given the theorem and be required to verify it with several examples. This can be done simply with the TI-92. The students can construct the situation using the many tools available on the TI-92. They can then use the dragging hand to move an object to view another case. An example of a worksheet of this type can be found as Figure H. Mary Staniger and Barb Koble of Cedar Falls High School developed many such worksheets to accompany their Geometry text.

A second option is to give the students the situation and have them investigate several cases until they are able to develop the theorem for themselves. Again, a worksheet is included in Figure I. Either way, the students feel an ownership of the theorems. They have had the chance to experiment with various cases and insure that the theorems do indeed hold. This leads to a much deeper understanding of Geometry.

Algebra

The symbolic manipulation of the TI-92 allows it to do much of the algebra present in high school. So, the teacher must be careful not to allow the TI-92 to take over. The students may not see the point of learning how to factor or F.O.I.L. if they can do it with a series of keystrokes on a calculator. However, if properly introduced, the TI-92 can be quite helpful in the Algebra classroom. It can be used to solve real life problems where the numbers may not be nice to work with. In Algebra textbooks, oftentimes problems are set up to have "pretty" answers. Students need to realize that in real life, the answers are not always $x = 5$ or $x = 8$. In these cases, it is good to have technology to help with the computations. That is not to say that the students cannot do them by hand.

It is just more realistic to have a tool such as the TI-92 do the work.

Another means of incorporating the TI-92 into the Algebra classroom is through the proof. There are two ways of solving equations on the TI-92. The first way is to type in solve(2x - 6 = 10, x). The second way is to do it step by step. 2x - 6 = 10 is first typed in. Then, the first step to solve this equation is done. +6 is entered. The TI-92 displays 2x = 16. It has added 6 to both sides of the equation. Then, the next step can be completed by entering ÷2. x = 8 is displayed. So, not only can students solve an equation in one step using the solve function, they can also walk through each step one at a time. In this way, students can practice their equation solving skills without letting arithmetic get in the way.

Calculus

The symbolic manipulation of derivatives and integrals is the key use of the TI-92 in Calculus classes. Again, the calculator can be abused if not properly monitored. However, as in algebra, it allows students to do problems which may not have easy solutions. Also in Calculus, the 3D graphing of surfaces can be done using the TI-92. With the overhead attachment, students will be able get a much better grasp of the concept by seeing an actual graph rather than a chalkboard sketch.

My Experience with the TI-92

I incorporated the TI-92 as a teaching tool in my student teaching of a Geometry class. Unfortunately, the school I was student teaching at did not have a classroom set of TI-92s. However, they did have the overhead LCD panel. So, I demonstrated theorems to the students. I had previously drawn triangles in the Geometry screen. Together, the students and I investigated different cases of theorems by dragging vertices around with the hand feature.

Before I left that half of my student teaching, I gave all of the students a survey about my strengths and weaknesses. The last question asked them to comment on what they liked or disliked about a lesson I had taught. Some sample answers were as follows: "I liked it when she brought in the big calculator, TI-92 or something." "She showed us things (technology) like the TI-95." "I liked that she used things like the TI-92 and made things interesting." These three responses sum up the feelings of the classes about my use of the TI-92. They liked it because it was new and interesting. For at least those days, I know for sure that the students were paying attention and were interested in what I was teaching.

Pros and Cons

The TI-92 has many advantages over the computer. The first is quite obviously the price. For about the same amount of money spent on one computer for a classroom, a TI-92 could be put into the hands of every student. Another advantage is the portability of the TI-92. It is free from plug-ins and fits in a school bag. Students can take the TI-92 with them on vacation, to their mom's for the weekend, etc. It is not possible to have this type of versatility with a computer.

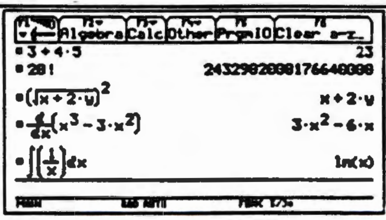
An issue to be faced with such a high power machine is testing. Teachers have to be careful that they are testing what they want to be testing. If the students learned pencil and paper skills as well as calculator skills, both should be tested. If necessary, two separate pages of a test could be created. On one page students would be allowed to use a calculator while on the other they would have to go without. It is a good idea to put the two parts on different colors of paper. That way with one glance, the teacher can tell whether or not a student should be using the calculator on the part he/she is on.

If put into the right hands, the TI-92 can be a great mathematical tool. However, if it falls into the wrong hands, just like any technology, it can be misused. Teachers must do their part to stress that the calculator is just an instrument to help with math. It is still important to learn mathematical skills and be able to solve problems without the aid of a calculator.

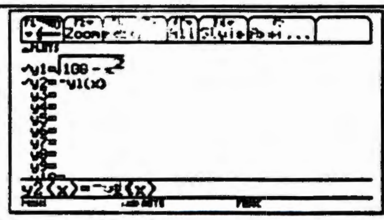
Future

I see the TI-92 as being an integral part of every secondary math class in the future. Just as the other TI graphing calculators have found a place in the mathematics classroom, so will the TI-92. It will add a new dimension to high school math if teachers are willing and able to let it. In order to do so, teachers must learn about the machine and its many uses in the math classroom. I have reviewed several uses for the TI-92. However, as it begins to become more popular and available, the TI-92 will be the subject of many workshops where teachers can share their ideas and experiences. Hopefully math teachers everywhere will be inserviced about this calculator and its power. Once introduced to the machine, teachers will come up with many more new and exciting ways of integrating it into their curriculums.

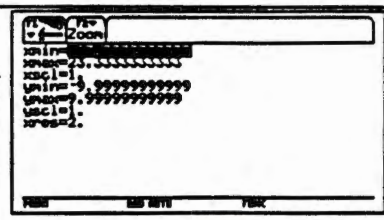
Figure A



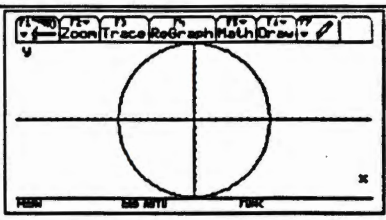
The Home Screen
Most mathematical operations get performed here.



The *Y*= Editor
Functions to be graphed are entered here.



The Window Editor
The parameters for the graphing screen are entered here.



The Graph Screen
This is where graphs and draw commands are displayed.

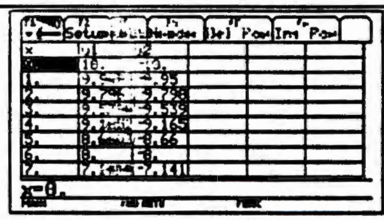
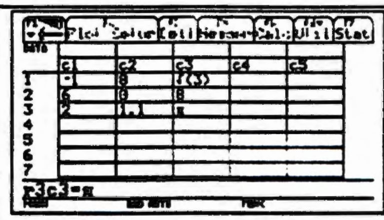
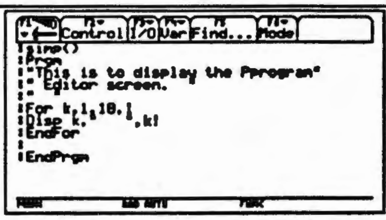


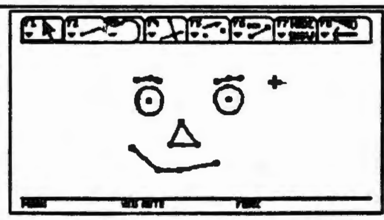
Table
Numerical values of the entries in the *Y* = Editor are listed here.



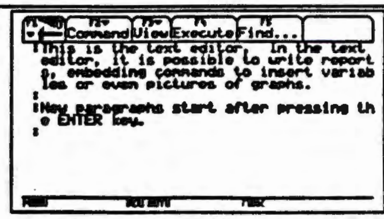
The Data/Matrix Editor
Lists and matrices can be created or edited from this screen.



The Program Editor
Programs (using ***TI-92*** syntax) are written and edited here.



The Geometry Screen
Geometric constructions are created in this screen.



The Text Editor
Enables you to write reports or command scripts.

Figure B

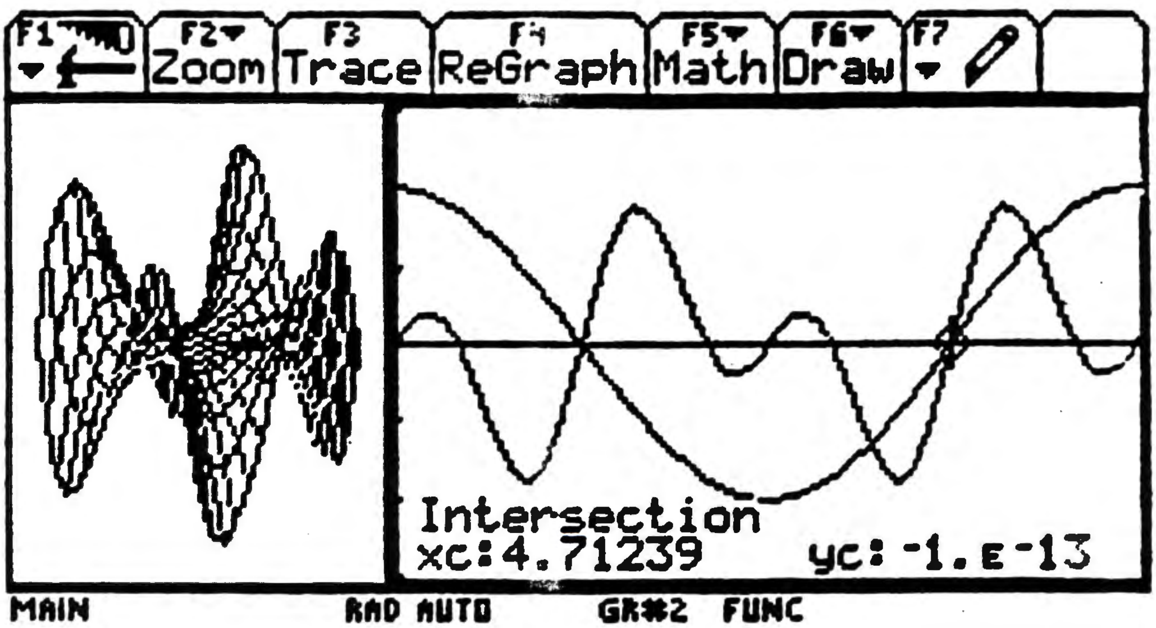

F1
F2
Zoom
F3
Trace
F4
ReGraph
F5
Math
F6
Draw
F7
Intersection
xc:4.71239
yc: -1.E-13
MAIN
RAD AUTO
GR#2
FUNC

Figure C

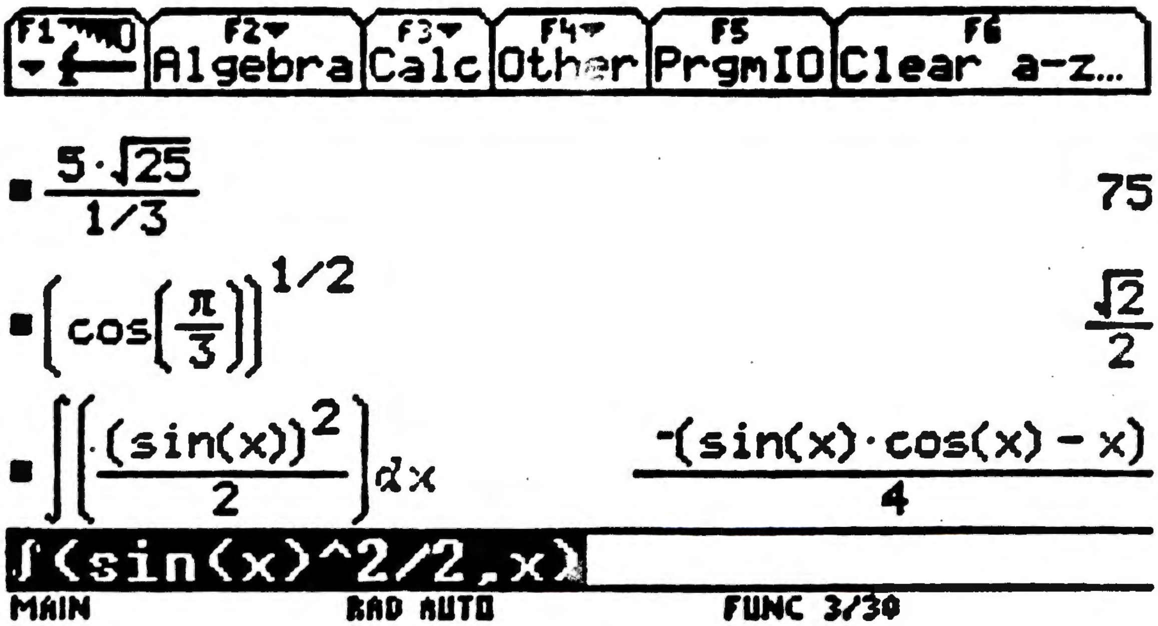
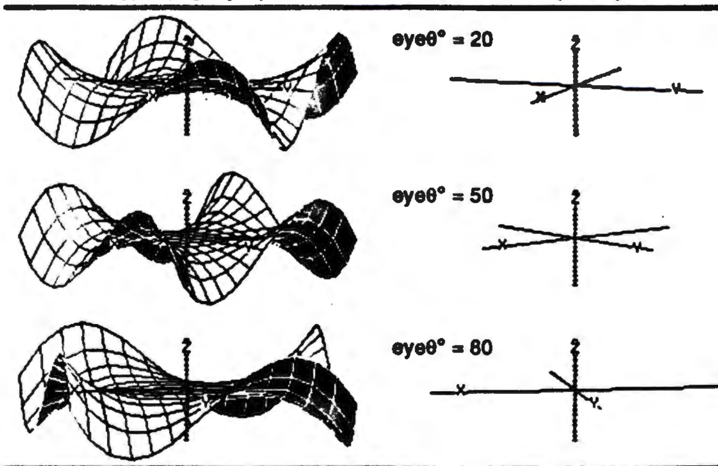

F1
F2 Algebra
F3 Calc
F4 Other
F5 PrgmIO
F6 Clear a-z...
5·√25 / 1/3
75
(cos(π/3))^1/2
√2 / 2
∫((sin(x))^2 / 2) dx
-(sin(x)·cos(x) - x) / 4
∫(sin(x)^2/2,x)
MAIN
RAD AUTO
FUNC 3/30

Figure D

$z1(x,y) = (x^3y - y^3x) / 390$ **In this example, eyeφ° = 70**



$z1(x,y) = (x^3y - y^3x) / 390$ **In this example, eyeθ° = 20**

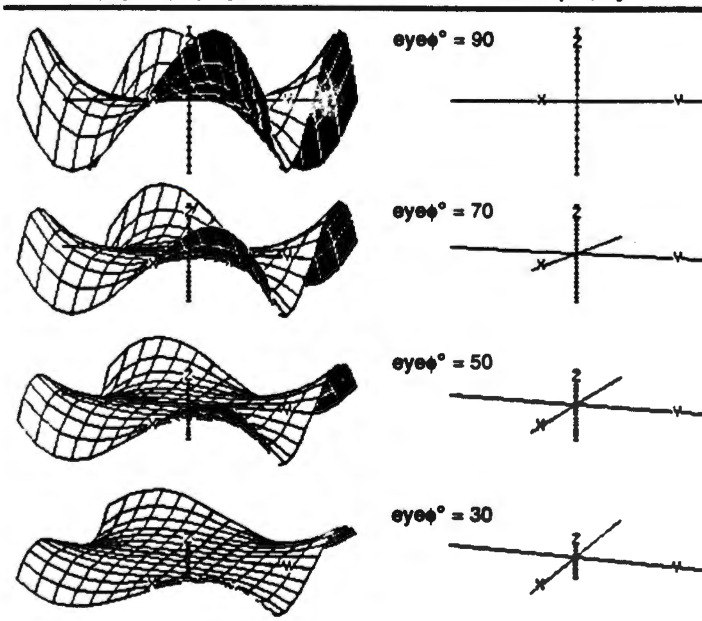
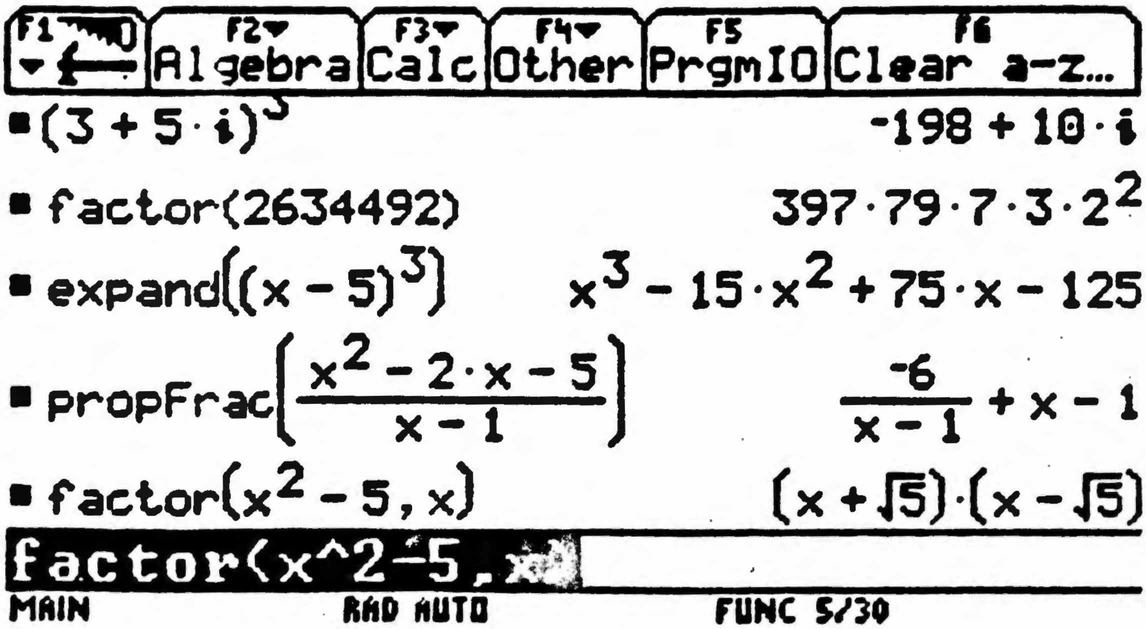


Figure E


F1 F2 Algebra F3 Calc F4 Other F5 PrgmIO F6 Clear a-z...
(3 + 5·i)^3
-198 + 10·i
factor(2634492)
397·79·7·3·2^2
expand((x - 5)^3)
x^3 - 15·x^2 + 75·x - 125
propFrac((x^2 - 2·x - 5)/(x - 1))
-6/(x - 1) + x - 1
factor(x^2 - 5, x)
(x + √5)·(x - √5)
factor(x^2-5,x)
MAIN
RAD AUTO
FUNC 5/30

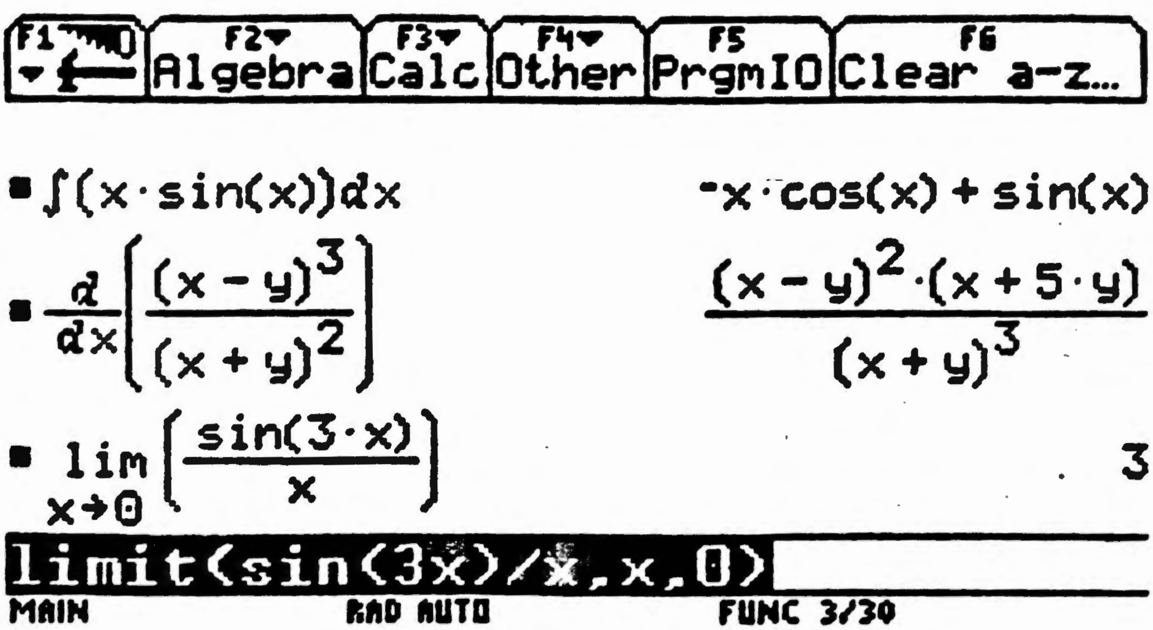

F1 F2 Algebra F3 Calc F4 Other F5 PrgmIO F6 Clear a-z...
∫(x·sin(x))dx
-x·cos(x) + sin(x)
d/dx((x - y)^3/(x + y)^2)
(x - y)^2·(x + 5·y)/(x + y)^3
lim x→0 (sin(3·x)/x)
3
limit(sin(3x)/x,x,0)
MAIN
RAD AUTO
FUNC 3/30

Figure F

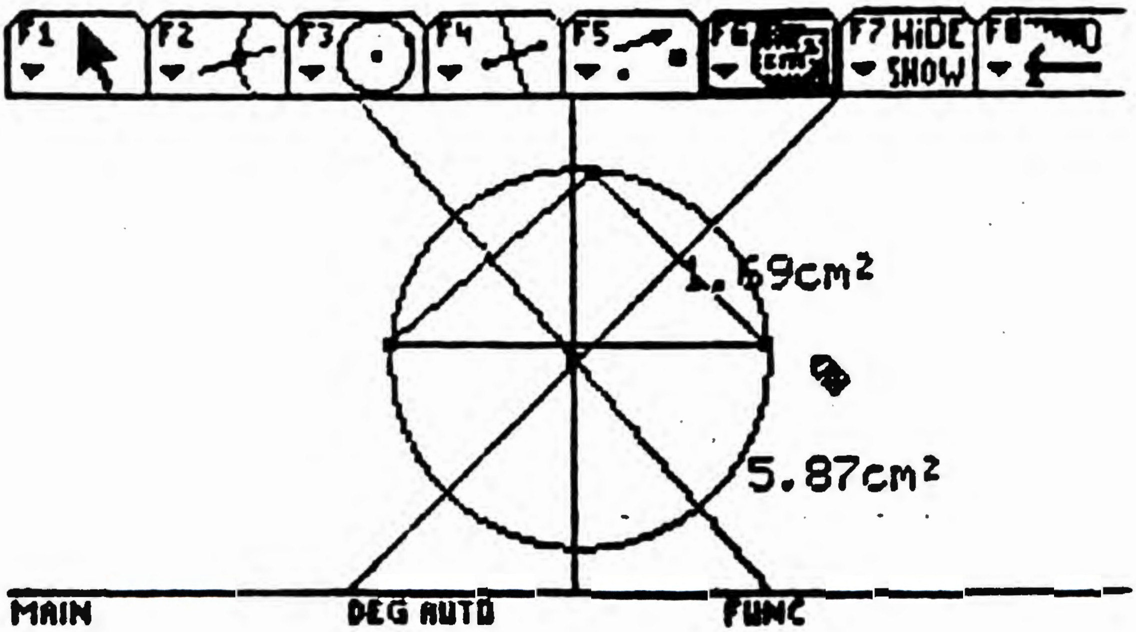


Figure G

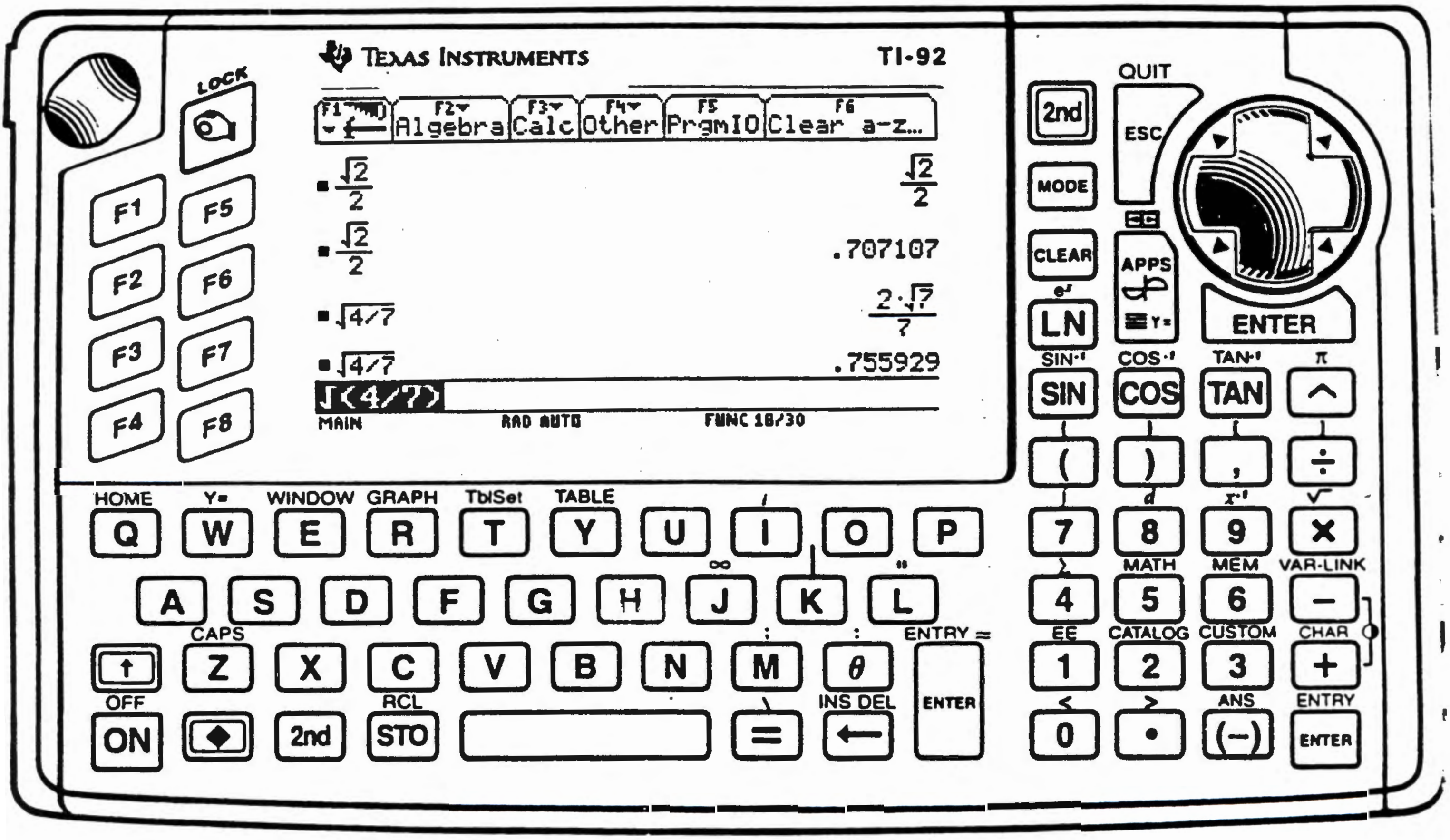

TEXAS INSTRUMENTS
TI-92
LOCK
Algebra
Calc
Other
PrgmIO
Clear a-z...
.707107
.755929
MAIN
RAD AUTO
FUNC 18/30
F1
F2
F3
F4
F5
F6
F7
F8
2nd
MODE
CLEAR
LN
QUIT
ESC
APPS
ENTER
SIN
COS
TAN
HOME
WINDOW
GRAPH
TblSet
TABLE
MATH
MEM
VAR-LINK
CAPS
ENTRY
EE
CATALOG
CUSTOM
CHAR
OFF
RCL
INS DEL
ANS
ON
STO

Figure H

GEOMETRY STUDENT WORKSHEET
Chap. 2 Verification 1: Midpoint Thm. (2-1)

In this verification, you are asked to examine the Midpoint Theorem.

If M is the midpoint of segment AB, then AM = 1/2 AB and MB = 1/2 AB.

SKETCH:

Step 1: Construct segment AB.

Step 2: Construct the midpoint of segment AB. Label the midpoint M.

Step 3: Measure AM, MB, and AB.

VERIFICATION:

Verify that AM = 1/2 AB and MB = 1/2 AB.

Record at least 3 observation.

AM								
MB								
AB								

Figure I

GEOMETRY STUDENT WORKSHEET
Chap. 3 Investigation 2

In this investigation you are asked to discover properties about the measures of the angles of a triangle.

SKETCH

Step 1: Construct triangle ABC.

Step 2: Measure all the angles of triangle ABC.

Step 3: Calculate the sum of the measures of the angles

INVESTIGATION

Investigate the sum of the measures of the angles as you drag the vertices to change the angle measures.

Record at least 3 observations.

m/A								
m/B								
m/C								
m/A+m/B+m/C								

Investigate the number of obtuse, acute and right angles possible in a triangle.

Investigate the sum of the measures of the acute angles of a right triangle.

CONJECTURE: