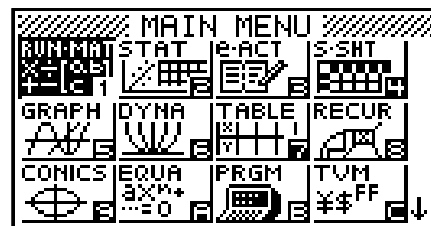# Numerical iterations on the FX9860Giii

1. From the **Main Menu**, enter into **RUN-MAT** mode by using the arrow keys to highlight the **RUN-MAT** icon or pressing 1.

   Heron's Algorithm is a simple and fast-converging method for approximating square roots. The algorithm is iterative and takes an approximate value and returns a new approximate value which is closer to the square root than the previous answer. This can be repeated over and over until the desired accuracy is reached.

   The formula is: $x_{n+1} = ½ (x_n + a/x_n)$, where a is the square root to be found.

Example 1: Find $\sqrt{200}$
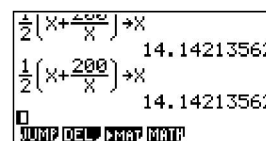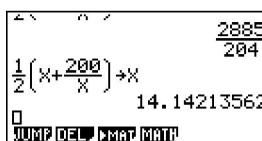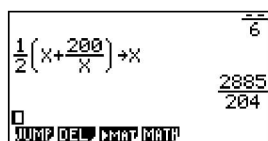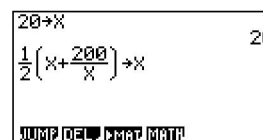
Solution: $x_0 = 20$ [Initial guess!]

$$x_1 = ½ (20 + 200/20) \qquad\qquad = 15$$

$$x_2 = ½ (15 + 200/15) \qquad\qquad = 14.16666667$$

$$x_3 = ½ (14.16666667 + 200/14.16666667) \quad = 14.14215686$$

$$x_4 = ½ (14.14215686 + 200/14.14215686) \quad = 14.14213562$$

$$x_5 = ½ (14.14213562 + 200/14.14213562) \quad = 14.14213562$$
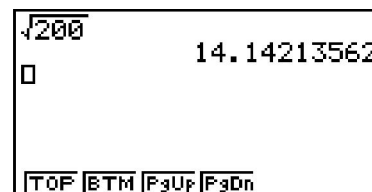
$$\sqrt{200} = 14.14213562 \text{ (8 d.p.)}$$
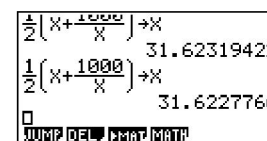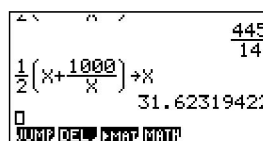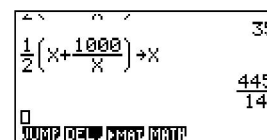
On the calculator:

a) Assign 20 to the variable 'x' and press [**EXE**] to store.

b) Enter the iteration formula

c) Press [**EXE**] until you have the desired accuracy in the solution.
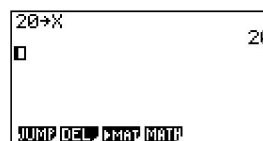
Example 2: Find $\sqrt{1000}$

Solution: $x_0 = 20$ [Initial guess!]

$$x_1 = ½ (20 + 1000/20) = 35$$

$$x_2 = ½ (35 + 1000/35) = {}^{445}/_{14}$$

$$x_3 = ½ ({}^{445}/_{14} + 1000/{}^{445}/_{14}) = 31.62319422$$

$$x_4 = ½ (31.62319422 + 1000/31.62319422) \ = 31.6227766$$

$$x_5 = ½ (31.6227766 + 1000/31.6227766) = 31.6227766$$
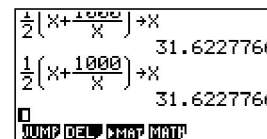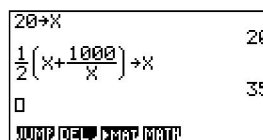
Note: The assign key [→] is found above the [**AC/ON**] key.

2.

2. From the **Main Menu**, enter into **PRGM** mode by using the arrow keys to highlight the **PRGM** icon or pressing [**log**] for '**B**'.
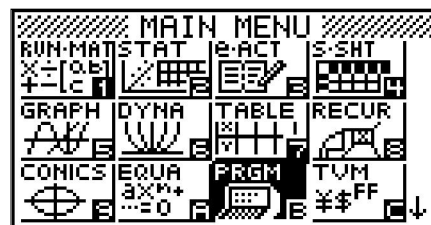
If there are no programmes present, this screen will be present. Select [**F3**] for '**NEW**'.

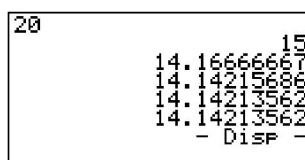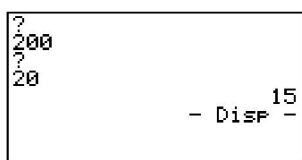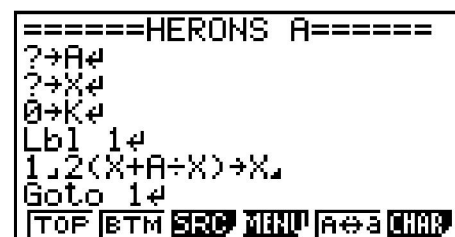Give the programme a name (Character limit = 8), then press [**EXE**].

Start programming! [**SHIFT**] [**VARS**] for PRGM commands.

? → A [**EXE**]
? → X [**EXE**]
0 → K [**EXE**]
Lbl 1 [**EXE**]
For K < 10 then   Via **JUMP**, press [**F3**]
½ (X + A/ X) → X ◄
Goto 1 [**EXE**]

Press the [**AC/ON**] key, then [**EXIT**] to 'abort' the programme.

3. In Python: On entry into the **PYTHON** icon, press [**S↔D**] 'H' from the **MAIN MENU**.

On entry you will see one of these screens below, depending on whether there are no or other '.py' programmes (.py is the file name extension).

When no py file* or folder is in memory   When there are py files or folders in memory

Give the programme a name (Character limit = 8), then press [**EXE**]. Start programming! Note that when you begin to programme the keys are set for lower case for the alphabet. The commands are via the **F1** ~ **F6** keys. Here is a programme that will complete Heron's Algorithm for **finding square roots.**

```
==heronalg   001/011 →
s = input()
x = input()
k = 0
while k < 100 :
  new = 0.5*(float(x) +float(s)/float(x))
  print(s, x, new)
  x = new
  k = k+1
else :
  print("square root of", s, "is", new)
```

For further tips, more helpful information and software support visit our website
www.monacocorp.co.nz/casio