

# MEMORIES!

## ALL THE FORGOTTEN FUNCTIONS ON THE CASIO SCIENTIFIC CALCULATOR

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*The memory function on a scientific calculator is one of its many powerful features. Being able to use these features, can be very helpful in tests and exams. This workshop shows how to use the memory functions to make problem solving easier with some interesting and fun activities. In the final activity, we calculate the date of Easter using all nine memories. The workshop is based on the CASIO fx-82ZA PLUS, but the features and mathematical principles can be applied to other CASIO scientific calculators too.*

### EFFECTIVELY USING THE CALCULATOR MEMORIES

The memory function on a calculator is not essential, but it does help to store numbers to use later in a multi-step calculation or for very long numbers that will be used more than once. It is particularly useful when you want to calculate values of several expressions that have a common part. For example, if we were calculating the difference in volume of cans with the same height:

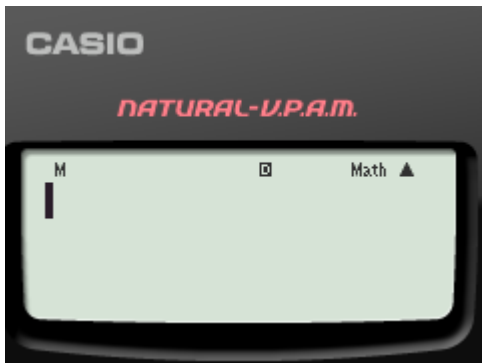
$$V = h \times d^2 \times \frac{1}{4\pi}$$

The value  $\frac{h}{4\pi}$  will be used for all the calculations and could be stored in the memory.

The memory keys include  $\boxed{\text{SHIFT}} \boxed{\text{RCL}}$  (STO) for “store” and  $\boxed{\text{RCL}}$  for “recall”. Most scientific calculators have a  $\boxed{\text{M}+}$  and  $\boxed{\text{SHIFT}} \boxed{\text{M}+}$  (M-) key. These keys allow you to add or subtract to the value in the memory.

### Clearing the calculator memory

It is good practice to clear the memories before starting a new calculation. The CASIO fx-82ZA PLUS retains data in the memory after the calculator is switched off. Turning off the calculator or switching modes will not clear the memory. To check whether data has been stored, look at the top left of the calculator screen. If there is an “M” visible, there is data stored in the M memory, but it will not indicate whether there is data stored in any of the other memories.



You can use the key sequence  $\boxed{\text{SHIFT}} \boxed{9} \boxed{2} \boxed{=}$   $\boxed{\text{AC}}$  This will clear all the calculator memories.

To change the value stored in a particular memory, you can simply store a new number into the memory because the new number will replace the old number.

### Storing the result of a calculation

There are two types of memories on the calculator: an independent memory (labelled M) and the variable memories (Labelled A to F and X and Y) are available on the calculator.

When you want to store the result of a calculation in the 'M' memory, do the following:

$\boxed{\text{SHIFT}} \boxed{\text{RCL}} (\text{STO}) \boxed{\text{M}+}$  (M). This means that the answer that is on the screen will be stored into the M memory.

As soon as  $\boxed{\text{SHIFT}} \boxed{\text{RCL}} (\text{STO})$  has been entered, the display at the top of the screen will show STO while it waits for the user to show which memory it should store the value in.



If you want to store a result in the variable memory, press  $\boxed{\text{SHIFT}} \boxed{\text{RCL}} (\text{STO})$  and then the memory key for the variable you wish to use. For B, press  $\boxed{\text{B}}$ . You do not need to press the  $\boxed{\text{ALPHA}}$  key nor the  $\boxed{=}$  key to access the B memory.

### Displaying the contents of a memory

Press **RCL** **M+** (M) to recall the value that was stored in the memory. You can also use the value in other calculations by pressing **ALPHA** **M+**. For example,  $\sqrt[3]{M}$  finding the cube root of the number in M can be found by: **SHIFT** **√** **ALPHA** **M+** **=**

### Activity 1

Investigate how changing the diameter of a can of height 11 cm will affect the volume. Use the formula  $V = h \times d^2 \times \frac{1}{4\pi}$  to calculate the volumes for cans with the following diameters. (Hint: Find a value for  $\frac{h}{4\pi}$  that can be entered into the calculator memory and re-used for each calculation.)

diameter, $d$	volume, $V$
9	
18	
27	

Table 1: Calculate the volume for the diameters given

### More operations with the M memory

You can change the value of the M memory by adding (use the **M+** key) or subtracting (use the **M-** key) the answer of a subsequent calculation.

### Reducing key strokes

The answer to a calculation can be stored into the memory by pressing the **SHIFT** **RCL** (STO) **M+**. This replaces using the **=** key.

### Clearing a specific memory

To clear a specific memory, store zero in it. For example, to clear memory A:

**0** **SHIFT** **RCL** **(←)**

### Eight other memories

The calculator has eight other memories apart from the M memory. These are A, B, C, D, E, F, X, Y. Each memory name is printed in red above the key that is used to access it. Unlike the M memory, there is no display indicators on the screen. Also, you cannot use M+ or M- with these memories.

### The Ans and PreAns key

**Ans** is a very useful calculator memory. The **Ans** key retains the last calculated answer and is a type of memory too. In multi-step calculations, you could write down

the answer to the first part of the calculation, but you could make an error. The calculator retains the last calculated answer and it can be inserted into the next calculation by using the **Ans** key. Remember that the **Ans** key only remembers the result of your last calculation.

The **Ans** key is very useful for recursion, sequences and series.

The *fx-82ZA PLUS* has the ability to recall a second answer. For example in the calculation:

$$\sqrt{(3 + 4) \times (5 + 6)}$$

You can key in **3** **+** **4** **=** and **5** **+** **6** **=**

Now key in **√** **Ans** **×** **ALPHA** **Ans** (PreAns) **=**

## Recursion

The idea of recursion is to use the same process repeatedly to produce a succession of numbers. Counting is the most fundamental form of recursion, where the process is to add one more to the previous number to reach the next number. The **Ans** key can be used to generate these sequences.

Key in the first number and press **=**. For example, start with **5**. The recursive process in this case will be to 'add three'. Enter **+** **3**. The calculator memory **Ans** and a **+** sign appear immediately after entering the **+**. Complete the process by keying in **3** **=** and the answer  $5 + 3 = 8$  will appear. If you now just keep entering the **=** key, the calculator will continue to add three and generate the sequence: 5; 8; 11; 14; ... .

**Try this:** start with 10 and subtract  $\frac{2}{11}$  .

Recursion is also possible with multiplication and division. This can be applied to population growth rates for example.

### Activity 2

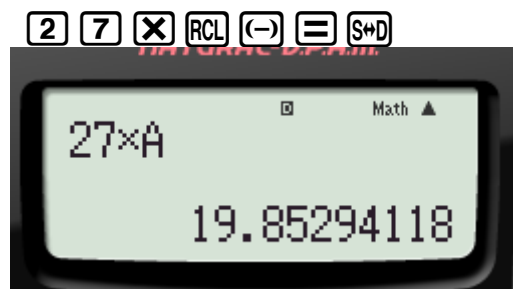
The estimate for the annual population growth rates for 2013 to 2014 is 1,71 for males, 1,45 for females and 1,58 for the total population. If the total population is 54 001 953, what will the population be in 2020? (From Statistical release P0302, Mid-year population estimates 2014 <http://beta2.statssa.gov.za/publications/P0302/P03022014.pdf>)

### Constant ratios

We often have to scale assessments to different values. For example, if the test was actually out of 34 and it needs to be scaled to a mark out of 25, we would be dividing the mark by 34 and multiplying by 25. If we then store this value in one of the memories, we don't have to retype the ratio each time.

**2** **5** **÷** **3** **4** **=** **SHIFT** **RCL** **(←)**

We can now scale the mark  $\frac{27}{34}$  as follows:



(If you would like to round this to the closest whole number, press **SHIFT** **MODE** **6** **0**)

### Activity 3

Scale these marks:

<b>34</b>	<b>25</b>
32	
24	
17	

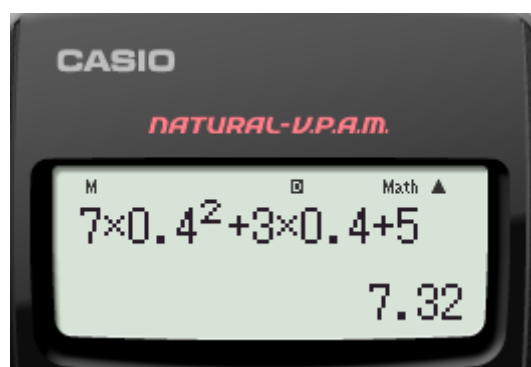
Table 2: Marks to be scaled using a constant ratio

### Evaluating expressions and functions

If  $f(x) = 7x^2 + 3x + 5$

You can find  $f(0,4)$  by

7 × 0 . 4 x<sup>2</sup> + 3 × 0 . 4 + 5 = S+D



To prevent keying in errors, you can store the value in memory.

If  $f(x) = 7x^2 + 3x + 5$

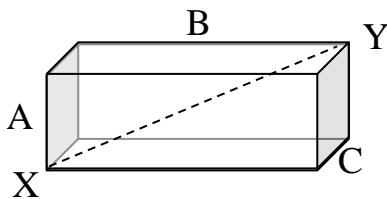
$f(0,45)$

0 . 4 5 = SHIFT RCL )  
 7 ALPHA ) x<sup>2</sup> + 3 ALPHA ) + 5 = S+D

### Activity 4

- 1 Store the value 0,34 in the X memory. Find the value of  $f(x) = x^3 - 3x^2 + 4x - 2$
- 2 Store the value 0,24262 in the X memory. Find the value of  $f(0,24262)$ .

3



You can calculate the value of the diagonal XY by using the expression  $\sqrt{A^2 + B^2 + C^2}$ . Use the A, B and C memories to find the diagonal for:

- a  $A = 3,2$  m;  $B = 4,5$  m and  $2,1$  m
  - b  $A = 6,4$  m;  $B = 9,0$  m and  $4,2$  m
- 4 Give memory variables D, E, and F the values of 8; 7; and 6 respectively. Evaluate  $DE^2F$ .

### Calculating the date of Easter

Easter Sunday, from 326 A.D., is always one of the 35 dates from March 22 to April 25. It falls on the first Sunday after the first full moon on or after the autumnal (in the southern hemisphere) Equinox.

The first correct mathematical procedure was given by an anonymous American in 1876 in the scientific journal *Nature*. The procedure that we will use was described by Thomas H. O’Beirne in 1965 in his book *Puzzles and paradoxes*.

### Activity 5

We will use the year 2015 to calculate the date of Easter, but the process should work for most years since 326 A.D.

- 1 Divide 2015 by 19 to get a quotient and a remainder. Subtract the quotient. Multiply the remainder by 19. Store the answer in memory A.  $((2015 \div 19) - 106) \times 19$

2 0 1 5 ÷ 1 9 = SHIFT S+D - 1 0 6 = X 1 9 = SHIFT RCL (←)

(Answer: 1)

A lunar month is about 29.53 days long, and the solar year is about 365.24 days long. This gives 12.37 lunar months per year, which is not an integer. However, 235 lunar months are very close to 19 solar years, so we divide by 19.

- 2 Divide 2015 by 100. Store the quotient in memory B and the remainder in memory C.

**2 0 1 5**  $\div$  **1 0 0**  $=$  **SHIFT** **S+D** **-** **3**  $\frac{\square}{\square}$  **2 0**  $=$  **SHIFT** **RCL** **□□□**

(Answer: 20)

**2 0 1 5**  $\div$  **1 0 0**  $=$  **SHIFT** **S+D** **-** **2 0**  $=$  **X** **1 0 0**  $=$  **SHIFT** **RCL** **hyp**

(Ans: 15)

This gives the leap year rule for the Gregorian calendar. B increases by 1 for every century.

- 3 Divide B by 4 to get a quotient D and a remainder E.

**RCL** **□□□**  $\div$  **4**  $=$  **SHIFT** **RCL** **sin** **0**  $=$  **SHIFT** **RCL** **cos**

(Answer: D = 5; E = 0)

D increases in century years that are leap years and E gives the number of century years that have not been leap years, e.g. 1900.

- 4 Complete the expression  $(8B + 13) \div 25$  and store the quotient as F.

**(** **8** **X** **RCL** **□□□** **+** **1 3** **)**  $\div$  **2 5**  $=$  **SHIFT** **S+D** **-** **2 3**  $\frac{\square}{\square}$  **2 5**  $=$  **SHIFT** **RCL** **tan**

(Answer: F = 6)

F gives the month correction to the epact.

- 5 Divide  $(19A + B - D - F + 15)$  by 30 to get a quotient (which we ignore) and a remainder. Store the remainder as X.

**(** **1 9** **X** **RCL** **(-)** **+** **RCL** **□□□** **-** **RCL** **sin** **-** **RCL** **tan** **+** **1 5** **)**  $\div$  **3 0**  $=$  **-** **1**  $=$  **X** **3 0**  $=$  **SHIFT** **RCL** **)**

(Answer: X = 13)

X is equivalent to the epact (which is  $23 - X$  or  $53 - X$  whichever  $> 0$ ).

- 6 Divide  $(A + 11X)$  by 319. Store the quotient as Y.

**(** **RCL** **(-)** **+** **1 1** **X** **RCL** **)**  $\div$  **3 1 9**  $=$  **0**  $=$  **SHIFT** **RCL** **S+D**

(Answer: Y = 0)

Y deals with an exceptional case related to the epact.

- 7 We will have used all but the constant memory M, so we will be re-using the memories from A onwards. Divide C by 4 to get a quotient A' and a remainder B'.

**RCL** **hyp**  $\div$  **4**  $=$  **S+D** **SHIFT** **S+D** **-** **3**  $\frac{\square}{\square}$  **4**  $=$  **SHIFT** **RCL** **(-)**  
**RCL** **hyp**  $\div$  **4**  $=$  **SHIFT** **S+D** **-** **3**  $=$  **X** **4**  $=$  **SHIFT** **RCL** **□□□**

(Answer:  $A' = 3$ ;  $B' = 3$ )

The beginning of the calculation for the day of week for the Easter full moon. It deals with the ordinary leap years.

- 8 Complete  $(2E + 2A' - B' - X + Y + 32) \div 7$ . Subtract the integer and store the remainder as  $C'$ .

$($   $2$   $\times$   $RCL$   $\cos$   $+$   $2$   $\times$   $RCL$   $(-)$   $-$   $RCL$   $\circ\circ''$   $-$   $RCL$   $)$   $+$   $RCL$   $S\div D$   $+$   $3$   $2$   $)$   
 $\div$   $7$   $=$   $-$   $3$   $=$   $\times$   $7$   $=$   $SHIFT$   $RCL$   $hyp$

(Answer:  $C' = 1$ )

This algorithm calculates the date of the full Moon from the epact.

- 9 Complete  $(X - Y + C' + 90) \div 25$ . Store the quotient as  $D'$ .

$($   $RCL$   $)$   $-$   $RCL$   $S\div D$   $+$   $RCL$   $hyp$   $+$   $9$   $0$   $)$   $\div$   $2$   $5$   $=$   $SHIFT$   $S\div D$   $-$   $4$   $\frac{\square}{\square}$   $2$   
 $5$   $=$   $SHIFT$   $RCL$   $\sin$

(Answer:  $D' = 4$ )

Gives the month of Easter.

- 10 Complete  $(X - Y + C + D + 19) \div 32$ . Store the remainder as  $E'$ .

$($   $RCL$   $)$   $-$   $RCL$   $S\div D$   $+$   $RCL$   $hyp$   $+$   $RCL$   $\sin$   $+$   $1$   $9$   $)$   $\div$   $3$   $2$   $=$   $SHIFT$   $RCL$   $\cos$

Gives the day of the month for Easter Sunday.

(Answer:  $E' = 5$ )

Easter Sunday is the on the  $D'$ 'th day of the  $E'$ 'th month. So in 2015, Easter Sunday is on 5 April.

This is quite a challenging activity on the calculator because it does not have the Quotient and Mod functions that MsExcel has. It is useful to write the answers down for each step, because the memories have to be re-used, so checking will not be easy. Although it is easier to use MsExcel to do this calculation, it is also useful and challenging to do some multi-step activities on the calculator using all the memories.

Stewart, I. (2006). How to cut a cake: and other mathematical conundrums. Oxford University Press.

Kissane, B & Kemp, M ( 2013) Learning Mathematics with EX PLUS Series Scientific Calculator. Casio.