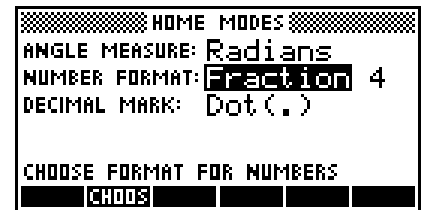## Fractions on the hp 39gs and hp 40gs

The **MODES** view is generally fairly obvious in its use – most people have encountered settings like **Fixed**, **Scientific** and **Engineering** before. The setting of **Fraction** is considerably different and can be a little deceptive. Begin by selecting **Fraction** in the **MODES** view, leaving the accompanying number as the default value of **4**.

Most calculators have a fraction key, often labeled **a$\frac{b}{c}$** , that allows you to input, for example, $1\frac{2}{3}$ as 1¬2¬3 or something similar. What these calculators usually won't do is allow you to mix fractions and decimals. A calculation such as $1\frac{2}{3}+3\cdot7$ will usually give a decimal result: most calculators will not attempt to convert the $3\cdot7$ into a fraction. The reason for this is that while some decimals like 0.25 are easy to convert to a fraction, others, such as recurring ones, are not so easy. Most calculators opt for the easy option of switching to a decimal answer in any mixture of fractions and decimals. When making the hp 39gs and hp 40gs HP took a very different approach. Once you select **Fraction** mode, all numbers become fractions - including any decimals.

The first point to remember is that there is no provision for inputting mixed fractions such as $1\frac{2}{3}$. Fractions are entered using the divide key and, while the calculator is quite happy with improper fractions such as **5/3**, it correctly interprets **1/2/3** as ½ divided by 3 and gives a result of **1/6** . The solution to this is simply to enter mixed fractions as **(1+2/3)**.
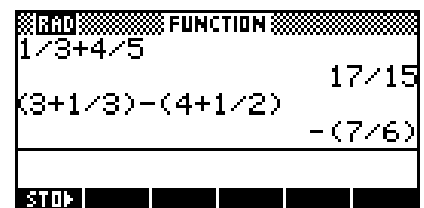
> **Calculator Tip**
> You need to be careful with brackets or else "order of operations" problems may occur, such as $1\frac{2}{3}*\frac{1}{5}$ being interpreted as **1+(2/3*1/5)** rather than as it should be: **(1+2/3)*1/5**.
>
> When in doubt, use brackets for mixed fractions.

Some examples are…   (using a setting of **Fraction 4** or higher)

$$\frac{1}{3}+\frac{4}{5}=\frac{17}{15}$$

$$3\frac{1}{3}-4\frac{1}{2}=-1\frac{1}{6}$$

The second point to remember involves the method the hp 39gs and hp 40gs use when converting decimals to fractions, which is basically to generate (internally and unseen by you) a series of continued fractions which are *approximations* to the decimal entered. The final fractional approximation chosen for display is the first one found which is 'sufficiently close' to the decimal. Look up 'continued fractions' on the web or in a textbook if you don't know what these are.

The trap lies in what constitutes 'sufficiently close', and this is determined by the '**4**' in **Fraction 4**. Very roughly explained, the calculator will use the first fraction it finds in its process of approximation which matches the decimal to that number of significant digits.

For example, a setting in the **MODES** view of…

Fraction 1

$$\text{changes} \quad 0.234 \quad \text{to} \quad \frac{3}{13}$$

which is actually   0.2307692…
        (matching to at least 1 significant figures.)
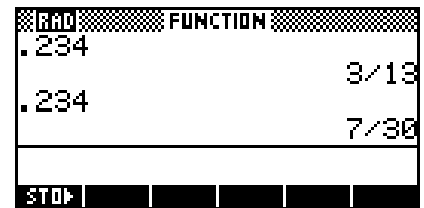
Fraction 2

$$\text{changes} \quad 0.234 \quad \text{to} \quad \frac{7}{30}$$

which is actually   0.2333333…
        (matching to at least 2 significant figures.)
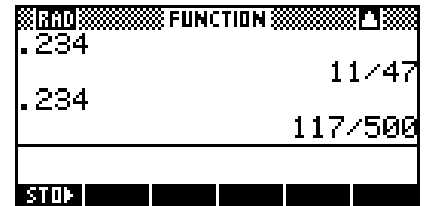
Fraction 3

$$\text{changes} \quad 0.234 \quad \text{to} \quad \frac{11}{47}$$

which is actually   0.2340425…
        (matching to at least 3 significant figures.)

Fraction 4

$$\text{changes} \quad 0.234 \quad \text{to} \quad \frac{117}{500} \left(or \ \frac{234}{1000} \right)$$

which is exactly   0.234
   (thus finally matching to the required 4 significant figures.)

Essentially, the value of **4** in **Fraction 4** affects the degree of precision used in converting the decimal to a fraction. As was said earlier, the calculator will use the first fraction it finds in its process of approximation which matches the decimal to that number of significant digits.

The **Fraction** setting is thus far more powerful than most calculators but can require that you understand what is happening. It should also be clear now why a special fraction button was not provided: the 'fractions' are never actually stored or manipulated as fractions at all!
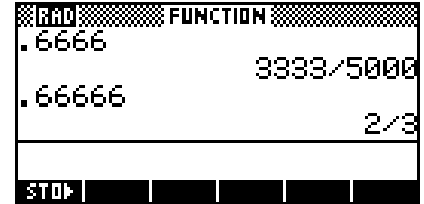
As you can see above right, a setting of **Fraction 4** produces a strange (but actually correct) result for 0.666, while adding one more 6 (to take the decimal beyond 4 d.p.) will give the desired result of **2/3**. In other words, so long as you understand the approach taken by the hp 39gs and hp 40gs it is capable of producing results which are closer to what was probably intended by the user in entering 0.66666.

You may have noticed that all the results so far have been improper fractions. For example the first calculation shown right gives the answer as 22/15 rather than $1\frac{7}{15}$. The fraction setting of **Mixed Fraction** is essentially the same but answers are given as mixed fractions instead of improper fractions, as shown.
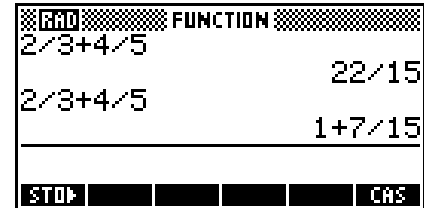
If you want to use the **Fraction** setting to convert decimals to fractions, here are some tips…

- if converting a recurring decimal to a fraction, then make sure you include at least one more digit in the decimal than the setting of **Fraction** in **MODES**. As you can see right, failing to include enough decimal places does not produce the desired result.
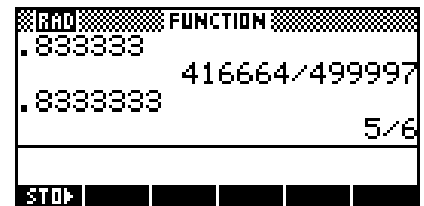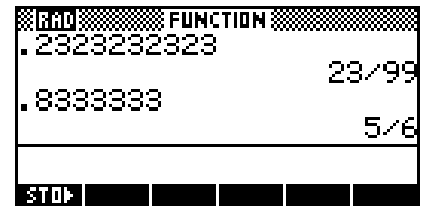
- if you are converting an exact decimal to a fraction, then set a **Fraction n** value of at least one more than the number of decimal places in the value entered. Both examples in the third screen shot to the right were done at **Fraction 6**.
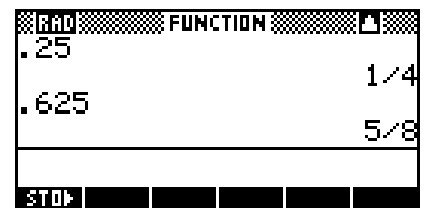
Not understanding the significance of the setting of **Fraction** can produce some unfortunate effects. For example, at Fraction **2**, the value of **123.456** becomes **123**, with the 0.456 dropped entirely.

An example of this is shown right. If you use a setting of only **Fraction 2** to perform the calculation shown, you will find to your amazement that **1/3 + 4/5 = 8/7** , whereas using **Fraction 6** gives the correct answer.
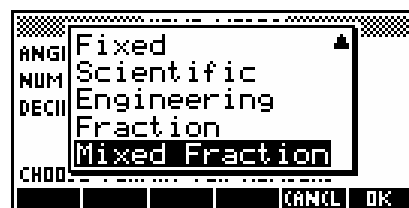
```
RAD         FUNCTION
1/3+4/5
                    8/7
1/3+4/5
                  17/15

STO▶
```
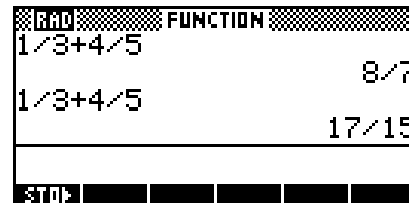
The reason for this 'error' is that the **1/3** and **4/5** were converted to decimals and added to give **1.133333**…. This was converted back to a fraction using **Fraction 2** to give **8/7** (**1.1428**..).

This may seem odd but it does match sufficiently closely in **Fraction 2** to be accepted.

Generally it is not a good idea to go below the default setting of **Fraction 4**. In fact, a **Fraction 6** setting tends to be more reliable.

A new feature of the hp 39gs and hp 40gs is the setting of **Mixed Fraction** in the **MODES** view.

```
          Fixed
ANG       Scientific
NUM       Engineering
DECI      Fraction
          Mixed Fraction
CHOO
                    CANCL   OK
```

The results of this new setting can be seen in the image to the right. Using the setting of **Mixed Fraction** the result is **4+1/7** ($4\frac{1}{7}$) whereas the answer of **29/7** is obtained using the old **Fraction** setting.

```
RAD         FUNCTION
5-6/7
                  4+1/7
                   29/7

STO▶
```

> **Calculator Tip**
> If you scroll back through the History and re-use a result such as the **4+1/7** shown above then don't forget to put brackets around it to ensure that no 'order of operations' errors occur.