01 - Calculator Skills - Notes

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This set of notes is part of a series of Numerical Reasoning Test (NRT) preparation resources which you can find at www.numericalreasoningtestsuccess.com.

These resources are organised into a number of different topics. For each topic, there is a set of notes (such as this one) and a question pack.

Each set of notes explains a set of skills, with example questions for each one. Within the question pack for the same topic, you can find practice questions (with answers) for each of these skills.

I advise that you work through the sets of notes in order. Within each set of notes, start by reading the explanation of the first skill. Then go to that skill in the question pack and complete the practice questions. Only once you have mastered a skill should you move onto the next one. And only once you have mastered all the skills in a set of notes should you move on to the next set of notes. This approach is called *mastery learning*.

If you find any errors in this document (including mathematical errors, typos or any other mistakes), please let me know at contact@numericalreasoningtestsuccess.com.

Use 'Ans' on a calculator to carry out multi-step calculations quickly.

Examples

1) You want to multiply 3 by 14 and subtract this from 100. How can you do this in two calculations on the calculator using the minimum number of button presses possible?

2) You want to subtract 9 from 56 and then divide 235 by this. How can you do this in two calculations on the calculator using the minimum number of button presses possible?

3) You want to add 3 to 4, then multiply this by 6, then divide 336 by this. How can you do this in three calculations on the calculator using the minimum number of button presses possible?

Notes

Scientific calculators have something called 'Ans'. Ans is a special value which is always equal to the result of the previous calculation. You can use Ans by pressing the Ans button, which is usually next to =.

For example, if you type 5 + 2 into your calculator and press =, the calculator will show the result, which is 7. The value of Ans is now set to 7. If you now type 10 - Ans and press =,

your calculator will carry out the calculation 10 - 7 and show the result, which is 3. The value of Ans is now set to 3.

If you want to do a calculation which has Ans at the beginning, you don't actually have to press Ans. You can skip straight to the next button and the calculator will put the Ans in for you. For example, after the last calculation Ans was set to 3. If we want to take that 3 and multiply it by 4, we can simply type x 4. As soon as we press x the calculator will display Ans x, so that when we then press 4 the calculator will display Ans x 4. If we then press =, the calculator will carry out the calculation 3 x 4 and display the result, which is 12.

In Example 1, we need to do the following:

- Type 3 x 14 and press =. The calculator will output 42 and the value of Ans will be set to 42.
- Type 100 - Ans and press =. The calculator will carry out 100 - 42 and display the result, which is 58.

In total, that was 11 button presses.

For Example 2, we need to do the following:

- Type 56 - 9 and press =. The calculator will output 47 and the value of Ans will be set to 47.
- Type 235 ÷ Ans and press =. The calculator will carry out 235 ÷ 47 and display the result, which is 5.

In total, that was 11 button presses.

For example 3, we need to do the following:

- Type 3 + 4 and press =. The calculator will output 7 and the value of Ans will be set to 7.
- Type x 6. The calculator will automatically put Ans at the start of the line and will therefore display Ans x 6. Press = and the calculator will carry out 7 x 6 and display the result, which is 42. Ans will be set to 42.
- Type 336 ÷ Ans and press =. The calculator will carry out 336 ÷ 42 and display the result, which is 8.

In total, that was 13 button presses.

State the order of operations used by calculators.

Examples

1) What is the order of operations used by calculators?

Notes

In maths, operations are things like adding (+), subtracting (-), multiplying (x), dividing (÷) and powers (e.g. 5^2). Calculators have a specific order that they will carry out operations in. This is called the order of operations.

Consider the following:

13 - 3 x 4 + 2 =

When carrying out this calculation, there are different orders we could carry out the operations in.

For example, we could do the subtraction first, then the multiplication and then the addition:

((13 - 3) x 4) + 2 = 42

Or we could do the addition first, then the multiplication, then the subtraction:

13 - (3 x (4 + 2)) = -5

Or we could do the multiplication first, then subtraction, then the addition:

(13 - (3 x 4)) + 2 = 3

Or we could do the subtraction and the addition separately and then do the multiplication:

(13 - 3) x (4 + 2) = 60

As we can see, each different order gives a different answer.

To avoid this ambiguity, a conventional order of operations has been agreed by mathematicians. Calculators follow this order of operations.

The order of operations is as follows:

- **B**rackets (work out anything in brackets)
- **I**ndices - another name for powers
- **D**ivision and **M**ultiplication (these are given equal priority)
- **A**ddition and **S**ubtraction (these are given equal priority)

This is often summarised as BIDMAS. Although it might actually be more helpful to think of it as BI(DM)(AS) since division and multiplication have equal priority and so do addition and subtraction (but division and multiplication are higher in priority than addition and subtraction).

Going back to our calculation from above:

13 - 3 x 4 + 2 =

We have three operations to carry out: subtraction, addition and multiplication.

Because multiplication is higher priority than subtraction and addition, the multiplication will be carried out first. Therefore, we get:

13 - 3 x 4 + 2 =
13 - 12 + 2 =

Subtraction and addition are equal priority. In situations of equal priority, we simply work from left to right. So in this case we do the subtraction first and then the addition:

13 - 12 + 2 =
1 + 2 =
3

Therefore, if you type 13 - 3 x 4 + 2 into your calculator and press =, the calculator will show the result as 3.

Of course, if we were trying to demonstrate this calculation to someone else (for example, in a presentation), we could make it a lot clearer by adding brackets:

(13 - (3 x 4)) + 2 =

Adding brackets essentially removes the need for the order of operations, because the brackets tell you in which order to carry out the operations. However, adding brackets makes it slower to type into a calculator. Knowing the order of operations allows us to know when we do and when we don't need to use brackets, allowing us to carry out the calculation quickly.

So the answer to Example 1 is:

The order of operations used by calculators is:

- **B**rackets
- **I**ndices
- **D**ivision and **M**ultiplication
- **A**ddition and **S**ubtraction

Which can be summarised as: BI(DM)(AS).

Use the order of operations to carry out calculations in one step on a calculator quickly.

Examples

1) You want to multiply 3 by 14 and subtract this from 100. How can you do this in one calculation on the calculator using the minimum number of button presses?

2) You want to subtract 9 from 56 and then divide 235 by this. How can you do this in one calculation on the calculator using the minimum number of button presses?

3) You want to add 3 to 4, then multiply this by 6, then divide 336 by this. How can you do this in one calculation on the calculator using the minimum number of button presses?

Notes

Knowing the order of operations allows us to know when we do and don't need to use brackets when doing a calculation in one step. By avoiding unnecessary use of brackets, we can minimise the number of button presses needed, which could save us time.

The example questions above are the same questions that we answered previously when we were looking at using Ans. This time, instead of doing multi-step calculations using

Ans, we will do everything in one step, using the order of operations to help us. We will then be able to compare the two approaches.

Let's start with Example 1. If we wanted to communicate this calculation very clearly, we could write the following:

100 - (3 x 14) =

The brackets make it clear that the multiplication should be carried out before the subtraction.

However, when entering the calculation into the calculator, these brackets are not actually necessary. Multiplication has higher priority than subtraction (remember BI(D**M**)(A**S**)), so the calculator will automatically do the multiplication first.

Therefore, we can simply enter 100 - 3 x 14 and press =. The calculator will display the result, which is 58.

In total, that was 9 button presses. When we did it as a multi-step calculation using Ans it took 11 button presses. Therefore, for this calculation, doing it in one step requires fewer button presses.

In Example 2, we need to carry out a subtraction followed by a division. Because subtraction is lower priority than division in the order of operations (BI(**D**M)(A**S**)), we need to use brackets to tell the calculator to do the subtraction first:

235 ÷ (56 - 9)

When we press =, the calculator shows the result, which is 5.

In total, that was 11 button presses. That is the same number of button presses that it took when we did it as a multi-step calculation using Ans.

In Example 3, we need to carry out an addition, followed by a multiplication, and then a division. We need to use brackets twice, like so:

336 ÷ (6 x (3 + 4))

We need to put brackets around the 3 + 4 to make the calculator do the addition first. Addition is lower priority than division and multiplication, so without these brackets the addition would be done last.

We also need brackets around the 6 x (3 + 4). This is to force the calculator to do the multiplication before the division. Multiplication and division have equal priority, so without the brackets the calculator would work from left to right, doing the division first.

When we press =, the calculator shows the result, which is 8.

In total, that was 14 button presses. When we did it as a multi-step calculation using Ans it took 13 button presses. Therefore, for this calculation, doing it in multiple steps requires fewer button presses than doing it in one step.

Quickly decide which method to use when doing a calculation that involves multiple operations.

Examples

1) Using your calculator, add 5 to 17 and then multiply this by 15. Use any method of your choice.

Notes

We have seen that when you are doing a calculation that involves multiple operations, you can choose to either do it in multiple steps or to do it in one step.

In a numerical reasoning test, you are being tested on both accuracy and speed. Therefore, just like in many real world situations, your goal is to carry out the calculation correctly in the minimum amount of time possible. You must therefore choose the method that allows you to do this.

We have seen that for some calculations, using multiple steps results in fewer button presses, whereas for other calculations, doing it in one step results in fewer button presses.

It may be possible to guess which method will require fewer button presses. When doing the calculation in one step, the number of button presses depends on the extent to which you need to use brackets. If you need to carry out the operations in an order which goes against the order of operations (BI(DM)(AS)) then you will need to use brackets, and this means more button presses. In these situations, it is fairly likely that doing it in multiple steps using Ans will result in fewer button presses.

However, when it comes down to it, actually taking the time to think about that may waste more time than it saves. You might be better off just picking a method and getting on with it.

Also, using fewer button presses doesn't necessarily mean that you do the question in a shorter amount of time. This is because the time taken depends not only on how many buttons you press, but also on how quickly you press them. If the method which has more button presses is also the simpler method, then using it may mean that you spend less time thinking and get the question done more quickly overall.

There is also the issue of accuracy to consider. If one method requires more thinking than the other, then it may carry a higher risk of making a mistake. It is better to do the question slightly more slowly and get the answer right than to do it slightly more quickly and get the answer wrong.

Again, it is of course a complete waste of time to be thinking about any of this during the test. You don't want to waste time agonising over what is the best method. You just want to get on with it using a method that works and is fast enough. Therefore, I strongly recommend that as you do practice questions you develop your own personal style.

My personal recommendation is given below. However, you should feel free to ignore this and do things your own way.

My recommendation is to use multiple steps for the majority of calculations, using one step only in situations where it is obvious that this can be done simply. To be more specific:

- For calculations that involve 2 operations (which could be 2 of the same operation):
  - If it is immediately obvious (without needing to waste time thinking about it) that the calculation can be done in one step without using brackets, then do it in one step (e.g. *"Multiply 5 by 63 and then add 7"*, which can be done as 5 x 63 + 7).
  - For anything else, do it in multiple steps.

- For calculations that involve 3 or more operations (which could include 2 or more of the same operation):
  - If the calculation is simply a sum of several numbers (which could include negative numbers) then do it in one step (e.g. *"Find the sum of 634, 1022, -856 and 94"*, which can be done as 634 + 1022 - 856 + 94).
  - If the calculation is simply multiplying several numbers then do it in one step (e.g. *"Multiply the following numbers: 16, -12, 54, 107"*, which can be done as 16 x -12 x 54 x 107).
  - For anything else, do it in multiple steps.

My reasons for preferring multiple steps in most situations are as follows:

- Using multiple steps only requires you to think about one part of the calculation at a time, which is simpler and therefore allows you to work more quickly (even if you have to press more buttons).

- This simplicity also means you are less likely to make a mistake.

- You have multiple opportunities to check whether your answer seems reasonable. After each step you have the option to look at the result and see if you think it seems right (you might even do the calculation in your head before you press = and see if the answer on the screen matches your mental calculation). Of course, you may not always want to spend time on this, but at least you have the option.

- Doing the calculation in one step requires you to think about the order of operations and whether to use brackets. This is complicated and takes time. It is also very easy to make mistakes with. You might even find yourself deciding to add in brackets just to be safe, which consumes even more time.

Example 1 asks us to add 5 to 17 and then multiply this by 15. I would do this in multiple steps:

- First, I would type in 5 + 17.
- Since this is fairly easy to do mentally, I would do it in my head (5 + 17 is 22) before pressing =.
- I would then press = and the calculator would confirm that the result was 22. The calculator would also set the value of Ans to 22.
- I would then press x 15 (allowing the calculator to automatically add in Ans and therefore display Ans x 15).

- I would then press =, to get the answer: 330.

You do not have to use this method. The important thing is to practice many calculations and develop your own personal style.