This is a lesson covering *the use of scientific notation on a calculator*.

I will guide you step-by-step.

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I will be asking you many questions along the way.

Each time I ask a question, **you should attempt to answer the question on your own** before you scroll down to view my answer.

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This is a lesson in the chapter "Scientific notation and units",
which is the first chapter in the series, "Chemistry, Explained Step by Step".

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This lesson builds on the material covered in the previous lesson, "Scientific Notation".

You should complete that lesson before working on this lesson.

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This lesson was written by Freelance-Teacher.

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In this lesson, for concreteness, I will discuss the TI-84 Plus scientific calculator, but I believe that most other calculators will handle scientific notation similarly.

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1. If your calculator displays the number `9.46ᴇ18`, what does that mean?

On a calculator, `ᴇ` means scientific notation.

So, `9.46ᴇ18` means 9.46×10^{18}

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2. If your calculator displays the number `5.1ᴇ-29`, what does that mean?

On a calculator, `ᴇ` means scientific notation.

So, `5.1ᴇ-29` means 5.1×10^{-29}

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3. True or false? If false, how would you rewrite the statement so that it is true? If your calculator displays the number `2ᴇ6`, that means 2^6

False.

On a calculator, `ᴇ` does not simply mean "exponent"; instead, `ᴇ` means scientific notation.

`2ᴇ6` does *not* mean 2^6
Instead, `2ᴇ6` means 2×10^6

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From the previous lesson, "Scientific Notation",

you should know that 2×10^6 can be written in ordinary notation as 2,000,000.

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4. If your calculator displays the number `10ᴇ10` **, what does that mean?**

On a calculator, `ᴇ` means scientific notation.

So, `10ᴇ10` means 10×10^{10}.

Notice that `10ᴇ10` does *not* mean 10^{10}.

***

When your calculator displays a long decimal, watch out!

Make sure that you check the far right of the calculator display,
otherwise *you might not notice that the number is in scientific notation.*

For example, suppose that the display shows:
`1.42857143ᴇ26`

If you're not careful, you might look only at the left side of the calculator display
and think that the number is approximately 1.43 (an ordinary-sized number)
when, in reality, because of the `ᴇ` at the far right of the display,
the number is actually approximately 1.43×10^{26} (a huge number).

Moral:
When your calculator displays a long decimal,
make sure that you check the far right of the calculator display;
otherwise you might not notice if the number is in scientific notation.

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Consider the calculation
$\frac{3.5 \times 10^8}{6.022 \times 10^{23}} = ?$

Do you know how to perform this calculation *in one step* on your calculator?

There are two methods for performing scientific notation calculations in *one step* on a calculator.

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On a TI-84, the scientific notation function is accessed
by hitting the $\boxed{2ND}$ key
and then the $\boxed{,}$ key
to access the [EE] function.

Here's how the calculation
$\frac{3.5 \times 10^8}{6.022 \times 10^{23}} = ?$
can be performed in one step on a TI-84 calculator,
using Method 1:

calculator key presses	calculator display
3.5 $\boxed{2ND}$ [EE] 8 ÷ 6.022 $\boxed{2ND}$ [EE] 23	3.5E8/6.022E23
$\boxed{ENTER}$ ↓	5.81202258E−16

Notice that no parentheses are necessary when performing this calculation using this method.

Our result, rounded to two digits, is that:
$\frac{3.5 \times 10^8}{6.022 \times 10^{23}} = 5.8 \times 10^{-16}$

The advantage of Method 1 is that it allows you to perform this calculation, and similar calculations,
in *one step* on your calculator
without having to use parentheses.

***

Method 2

I think that this method is inferior to Method 1, but I will mention it for the sake of completeness.

This method involves using the *power key* on your calculator.

On a TI-84, the power key is the $\boxed{\hat{}}$ key.

To perform this calculation,
$$\frac{3.5\times10^8}{6.022\times10^{23}} = ?$$
in one step using the power key,

you will have to enclose the denominator in *parentheses*:
$$\frac{3.5\times10^8}{6.022\times10^{23}} = \frac{3.5\times10^8}{(6.022\times10^{23})}$$

The purpose of the parentheses is to let the calculator know where the denominator begins and ends.

If you omit the parentheses, the calculator will think that only the 6.022 belongs in the denominator, and it will leave the 10^{23} out of the denominator.

Here's how to apply Method 2 on a TI-84 calculator:

calculator key presses	calculator display
3.5 × 10 $\boxed{\hat{}}$ 8 $\boxed{\blacktriangleright}$ ÷ (6.022 × 10 $\boxed{\hat{}}$ 23 $\boxed{\blacktriangleright}$)	$3.5*10^8/(6.022*10^{23})$
$\boxed{\text{ENTER}}$	$5.81202258\text{E}{-16}$

Notice that, after entering a power using the $\boxed{\hat{}}$ key,
you have to hit the Right-Arrow key, $\boxed{\blacktriangleright}$,
in order to get the cursor back down from the superscript level to the baseline.
(I'm assuming that your TI-84 is in MathPrint mode, rather than in Classic mode.)

Our result, rounded to two digits, is that:
$$\frac{3.5\times10^8}{6.022\times10^{23}} = 5.8 \times 10^{-16}$$

The disadvantage of Method 2 is that
when using Method 2,
you must enclose any denominator that is expressed in scientific notation inside parentheses.

The advantage of Method 1 is that
when using Method 1,
you do not need to enclose denominators with scientific notation inside parentheses.

***

4. Perform the following calculation in one step on your calculator.

$$3.7 \times 10^{-11} \times \frac{3.1 \times 10^{-14}}{4.2 \times 10^{-3}} \times \frac{6.2 \times 10^{19}}{4.8 \times 10^{-15}} = ?$$

Answer:

$$3.7 \times 10^{-11} \times \frac{3.1 \times 10^{-14}}{4.2 \times 10^{-3}} \times \frac{6.2 \times 10^{19}}{4.8 \times 10^{-15}} = 3.5 \times 10^{12}$$

Calculator solution:

Here's how the calculation

$$3.7 \times 10^{-11} \times \frac{3.1 \times 10^{-14}}{4.2 \times 10^{-3}} \times \frac{6.2 \times 10^{19}}{4.8 \times 10^{-15}} = ?$$

can be performed in one step on a TI-84 calculator, using Method 1:

calculator key presses	calculator display
3.7 2ND [EE] -11 × 3.1 2ND [EE] -14 ÷ 4.2 2ND [EE] -3 × 6.2 2ND [EE] 19 ÷ 4.8 2ND [EE] -15	3.7ᴇ-11*3.1ᴇ-14/4.2ᴇ-3*6.2ᴇ19/4.8ᴇ-15
ENTER	3.527480159ᴇ12

Notice that no parentheses are necessary when using this method for this calculation.

Rounded to two digits our result is:

$$3.7 \times 10^{-11} \times \frac{3.1 \times 10^{-14}}{4.2 \times 10^{-3}} \times \frac{6.2 \times 10^{19}}{4.8 \times 10^{-15}} = 3.5 \times 10^{12}$$

***

5. Perform the following calculation in one step on your calculator.

$$9.15 \times 10^{10} - \frac{1 \times 10^5}{2.21 \times 10^{-5}} = ?$$

Answer:

$$9.15 \times 10^{10} - \frac{1 \times 10^5}{2.21 \times 10^{-5}} = 8.70 \times 10^{10}$$

Calculator solution:

Here's how the calculation

$$9.15 \times 10^{10} - \frac{1 \times 10^5}{2.21 \times 10^{-5}} = ?$$

can be performed in one step on a TI-84 calculator, using Method 1:

calculator key presses	calculator display
9.15 2ND [EE] 10 - 1 2ND [EE] 5 ÷ 2.21 2ND [EE] -5	9.15E10−1E5/2.21E−5
ENTER	8.697511312E10

Rounded to three significant figures, our result is:

$$9.15 \times 10^{10} - \frac{1 \times 10^5}{2.21 \times 10^{-5}} = 8.70 \times 10^{10}$$

***

Suppose you're dealing with ten raised to a power, but with no coefficient.
For example, suppose you're dealing with 10^{11}.

How should you enter ten raised to a power, but with no coefficient, into your calculator?

There are two good ways to enter ten raised to a power, but with no coefficient, into your calculator.

You can enter the number using the power key:

calculator key presses	calculator display
10 $\boxed{\char94}$ 11 $\boxed{\blacktriangleright}$	10^{11}

Or you can rewrite the number in scientific notation:
$$10^{11} = 1 \times 10^{11}$$

Now number *does* have a coefficient,

so now you can enter the number using the scientific notation function:

[Generate a table:

calculator key presses	calculator display
1 $\boxed{\text{2ND}}$ [EE] 11	1ᴇ11

Either of these is a good way to deal with ten raised to a power, but with no coefficient, on your calculator.

For simplicity, in the rest of this lesson I will focus on the *first* approach,
whereby you enter the number using the power key;
but the second approach is also acceptable.

***

6. Perform the following calculation in one step on your calculator.

$$\frac{7.9}{10^{-5}} = ?$$

Answer:

$$7.9 \div 10^{-5} = 790000$$

Calculator solution:

Here's how you can do the calculation using the power key:

calculator key presses	calculator display
7.9 ÷ 10 $\boxed{\wedge}$ -5	7.9/10⁻⁵
ENTER	790000

Our result is:

$$\frac{7.9}{10^{-5}} = 790000$$

***

7. Perform the following calculation in one step on your calculator.

$$3.9 \times 10^{-4} \times \frac{10^7}{8.47 \times 10^{12}} \times \frac{4777}{10^{-10}} = ?$$

Answer:

$$3.9 \times 10^{-4} \times \frac{10^7}{8.47 \times 10^{12}} \times \frac{4777}{10^{-10}} = 2.2 \times 10^8$$

Calculator solution:

We will use the *scientific notation function* for entering 3.9×10^{-4} and 8.47×10^{12}. This allows us to do the calculation in one step without having to use parentheses.

We will use the power key to enter 10^7 and 10^{-10}:

calculator key presses	calculator display
3.9 2ND [EE] –4 × 10 ^ 7 ▶ ÷ 8.47 2ND [EE] 12 × 4777 ÷ 10 ^ –10	3.9ᴇ–4*10⁷/8.47ᴇ12* 4777/10⁻¹⁰
ENTER	2.201439046ᴇ8

Our result is:

$$3.9 \times 10^{-4} \times \frac{10^7}{8.47 \times 10^{12}} \times \frac{4777}{10^{-10}} = 2.20 \times 10^8$$

***

Suppose you're dealing with a power of some number other than 10.
For example, say you're dealing with 11^7.

How should you enter a power of some number other than 10 into your calculator?

In this case there's only one approach;
in this case, you *must* use the power key:

calculator key presses	calculator display
11 [^] 7 [▶]	11^7

***

8. Perform the following calculation in one step on your calculator.
$$\frac{4.3}{4^{-5}} = ?$$

Answer:
$$\frac{4.3}{4^{-5}} = .0042$$

Calculator solution:

You *must* use the power key to enter 4^{-5}.

calculator key presses	calculator display
4.3 ÷ 4 [^] -5	$4.3/4^{-5}$
ENTER	0.0042

Our result is:
$$\frac{4.3}{4^{-5}} = .0042$$

***

9. Perform the following calculation in one step on your calculator.

$$4.4^{-5} \times \frac{8.6}{3^6} \times \frac{10^{-18}}{5.1 \times 10^{-3}} = ?$$

Answer:

$$4.4^{-5} \times \frac{8.6}{3^6} \times \frac{10^{-18}}{5.1 \times 10^{-3}} = 2.9 \times 10^{-19}$$

Calculator solution:

We will use the *scientific notation function* for entering 5.1×10^{-3}.

This allows us to do the calculation in one step without having to use parentheses.

We will use the *power key* to enter 4.4^{-5} and 10^{-18} and 3^6:

calculator key presses	calculator display
4.4 `^` -5 `▶` × 8.6 ÷ 3 `^` 6 `▶` × 10 `^` -18 `▶` ÷ 5.1 `2ND` [EE] -3	4.4⁻⁵*8.6/3⁶*10⁻¹⁸/5.1ᴇ-3
`ENTER`	2.92317313ᴇ-19

Our result is:

$$4.4^{-5} \times \frac{8.6}{3^6} \times \frac{10^{-18}}{5.1 \times 10^{-3}} = 2.9 \times 10^{-19}$$

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Let's review the material that we've discussed in this lesson.

***

10. If your calculator displays the number `1.7E−6` **, what does that mean?**

On a calculator, `E` means scientific notation.

So, `1.7E−6` means 1.7×10^{-6}.

`1.7E−6` does *not* mean 1.7^{-6}.

***

11. What's the best way to enter numbers in scientific notation on your calculator? What's the advantage of this approach?

***

The best way to enter numbers in scientific notation
is to use the *scientific notation function* on your calculator
(instead of using the power key).

On a TI-84, the scientific notation function is accessed
by hitting the $\boxed{\text{2ND}}$ key
and then the $\boxed{,}$ key
to access the [EE] function.

The advantage of the scientific notation function is that,
when you use the scientific notation function,
you don't need to put parentheses around denominators that contain scientific notation.

(This rule applies to any denominator that contains a single number written in scientific notation.
If a denominator contains multiple numbers, parentheses are still required around the denominator.)

***

12. What's the best way to enter ten raised to a power with no coefficient (for example, 10^{-6}), on your calculator?

***

There are two good ways to deal with ten raised to a power with no coefficient (for example, 10^{-6}) on your calculator.

You can enter the number using the power key:

calculator key presses	calculator display
10 $\boxed{\wedge}$ -6 $\boxed{\blacktriangleright}$	10^{-6}

Or you can rewrite the number in scientific notation:
$$10^{-6} = 1 \times 10^{-6}$$

Now the number *does* have a coefficient,

so now you can enter the number using the scientific notation function:

[Generate a table:

calculator key presses	calculator display
1 $\boxed{\text{2ND}}$ [EE] -6	$1\text{E}{-6}$

Either of these is a good way to enter 10^{-6} on your calculator.

For simplicity, in this lesson we focused on the first approach, using the power key, in all our examples.

***

13. How should you enter some number other than 10 raised to a power, such as 12^6, in your calculator?

***

In this case there's only one approach;
in this case, you *must* use the power key:

calculator key presses	calculator display
12 ^ 6 ▶	12^6

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You have reached the end of the lesson.

The next lesson for this chapter, "Unit Conversion and Metric Prefixes", is not yet available.

I will be posting the next lesson for this chapter soon."