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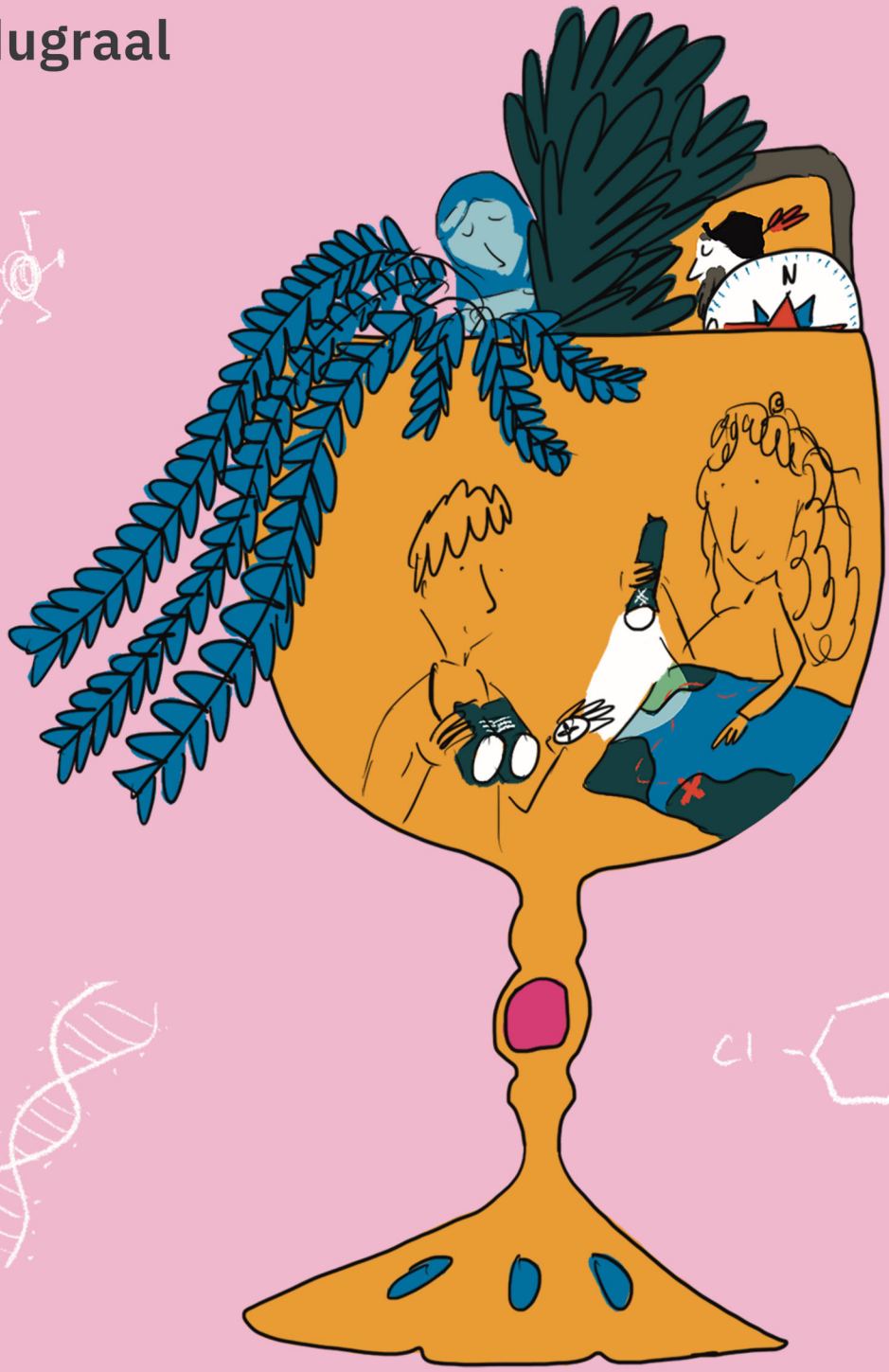


Einstein, the crazy scientist – Chemistry

14-15

Co-funded by the European Union

Einstein, the crazy scientist – Chemistry

Topic: Science – Chemistry

Level: Secondary education (14-15 years old)

Concepts: Chemical equation – chemical function – valence

Time required: +/- 30 min

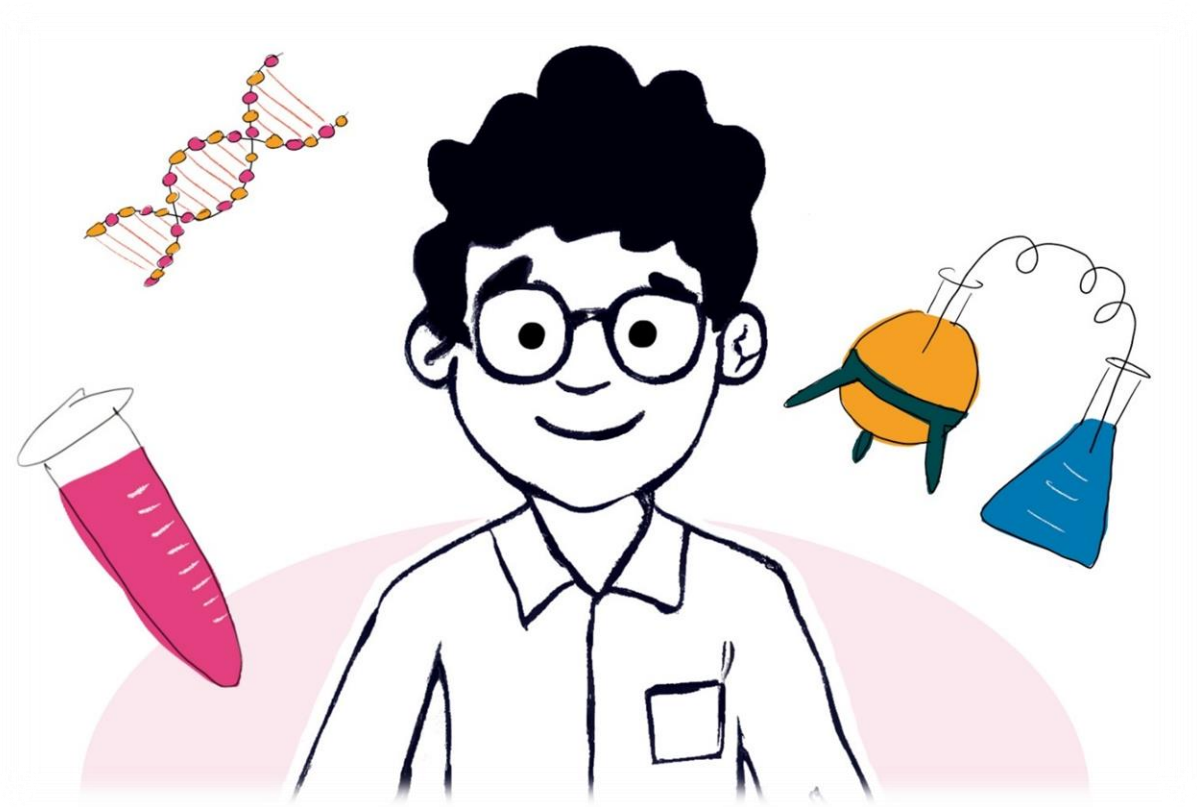
Summary of the activity: A small scientist who suffers from amnesia needs your help to find a neurological helmet to recover memory.

Material needed: Paper, pen, the periodic table of elements, the table of chemical functions and …. motivation!

Paths/mechanisms summary: This is a classical path with multiple choices. The right choice leads to the continuity of the story. Generally, the wrong choice leads to an explanation and goes back to the previous paragraph to try again. Sometimes, the wrong answer leads to another exercise to solve before joining the right answer path.

Practical advice: Given the level of difficulty of this adventure, it would be most effective if used towards the end of a sequence as an interactive application after studying the topic during a set of lessons.

1



This is Einstein, a clever little scientist who already has a lot of inventions to his credit, usually to make family life easier.

He invented the autonomous vacuum cleaner and also created a machine that prepares breakfast and serves it in bed, perfect for Sunday mornings!

Nothing scares this little genius and he always has an answer for everything!

However, one day, something terrible happened …

Go to paragraph 13.

2

Behind the poster of Marie Curie, you find a strange drawing:

"It looks like atoms!" exclaims Thales.

What molecule can we form with these different atoms?

- Al_3O_2 → **Go to paragraph 12.**
- Al_2O_3 → **Go to paragraph 43.**
- O_3Al_2 → **Go to paragraph 21.**

3

Thales remembers the safe under his brother's desk. He has seen Einstein type in a code before. He can no longer visualise the number he entered but remembers that it is a two-digit code between two hashtags...

"But of course!" says Thales. "Just add up the weighting numbers!"

You add up the different weighting numbers, it gives you 41. You enter the code #41# on the safe.

→ **Go to paragraph 15.**

4

Exactly! This gives Manganese dioxide and hydrochloric acid.

Go to paragraph 30.

5

How can you solve and weigh this equation?

- $2\ HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\ H_2O$

Go to paragraph 26.

- $HCl + 2\ Ca(OH)_2 \rightarrow 2\ CaCl_2 + 2\ H_2O$

Go to paragraph 55.

- $3\ HCl + 2\ Ca(OH)_2 \rightarrow 2\ CaCl_2 + 2\ H_2O$

Go to paragraph 46.

6

Almost! In this case, you did not look at the valence of the atoms. Indeed, hydrogen has a valence of 1 and oxygen a valence of 2. Using the chiasmus rule, this gives H_2O.

Go to paragraph 31.

7

This is not the right weighting. Look at the number of atoms on the left and the number of atoms on the right.

Left:	3 Ca	2 P	7 Si	22 O	5 C
Right:	5 Ca	24 P	5 Si	17 O	2 C

It is not the same number for each atom. The Lavoisier principle is not respected.

Go to paragraph 27.

8

First of all, you need to be able to determine the different chemical symbols.

What is the chemical symbol for **sodium**?

- S → **Go to paragraph 41.**
- Na → **Go to paragraph 23.**
- Si → **Go to paragraph 39.**

9

Not quite! Beware of weighting!

→ **Go to paragraph 30.**

10

You look for it in the cabinets, in the office, on the desk ... Nothing. Yes, there is a computer and a small safe but they are both locked.

However, 3 posters catch your attention: one of Marie Curie, one of Isaac Newton and one of Leonardo da Vinci. It seems that these posters have been removed and reattached several times.



Which poster should we turn over to find a possible clue?

- Marie Curie → **Go to paragraph 19.**
- Isaac Newton → **Go to paragraph 25.**
- Leonardo da Vinci → **Go to paragraph 34.**

11

Not quite! Look at the valence of sulfur and nitrogen. Don't forget to look at your chemical function chart and use the chiasmus rule.

→ **Go to paragraph 31.**

12

If we bind three aluminium atoms to two oxygen atoms, there will be 5 branches left that cannot cling.

Moreover, aluminium has a valence of 3 and oxygen has a valence of 2, so by practising the chiasmus rule, it gives Al_2O_3.

Here is another exercise to better understand:

What molecule can we form with this?

- H_2O → **Go to paragraph 33.**
- HO_2 → **Go to paragraph 24.**
- H_3O → **Go to paragraph 6.**

13

Einstein is passionate about chemistry. He loves mixing reagents together to create new products. His dream? Finding a cure for cancer.

However, one day, an experiment goes wrong. Einstein put too many reagents in his Becher and the whole thing exploded! He was thrown against the wall, hitting his head hard. The room was filled with smoke and set off the fire alarms!

→ **Go to paragraph 20.**

14

This is not the right weighting. Look at the number of atoms on the left and the number of atoms on the right.

Left:	4 Fe	6 O	3 C
Right:	2 Fe	4 O	4 C

It is not the same number for each atom. The Lavoisier principle is not respected.

Go to paragraph 59.

15

In the safe, you find sodium, an oxygen tank and a digital tablet. You quickly realise that you have to solve the equation for the reaction between the sodium and the oxygen bottle and write the complete result on the tablet. It would be too much trouble if you had to do it under real conditions.

Go to paragraph 8.

16

Not quite! According to the chemical function table, it is a metal oxide, so MO. With the chiasmus rule, we invert the valences, so Na_2O. But be careful with the weight!

Go to paragraph 65.

17

Well done! You enter the code on the safe, the door opens very slowly and little by little, you discover the neurological helmet.

"FINALLY! The helmet!" exclaims Thales, filled with joy! "We'll be able to use it on Einstein!"

Once the helmet is recovered, you run to the hospital where you find Einstein sitting on the bed.

"Here is the helmet, do you remember it?" asks Thales.

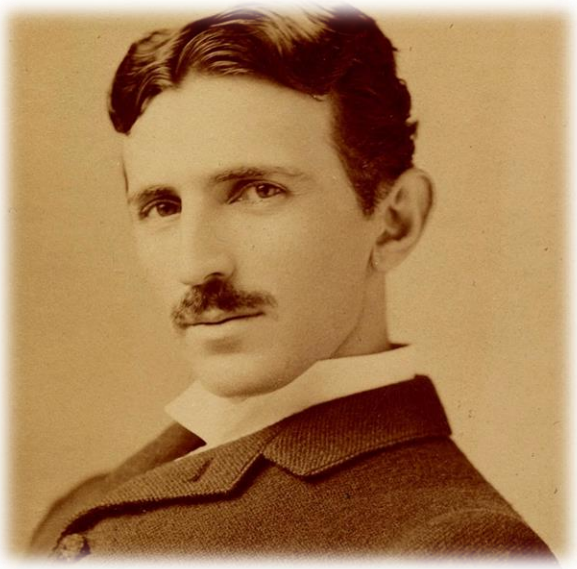
"Absolutely not," replies Einstein, looking doubtful.

"It doesn't matter, just trust us!" replies Thales.

You put the helmet on him and turn it on. You start to hear a small electronic noise and a reddish light appears. After about ten minutes, the helmet turns off by itself.

Amazing! Einstein has recovered his entire memory! Now he can resume his work as if nothing happened, but in the future, he will be careful not to mix too many reagents at the same time!

18



The board opens from the bottom to the top, but, unfortunately, there is nothing inside. Indeed, **Nikola Tesla** is known for his contributions to the design of the modern alternating current (AC) electricity supply system. He is thus a scientist, but he has no relation with chemistry.

This isn't the correct button… Try again!

Go to paragraph 62.

19

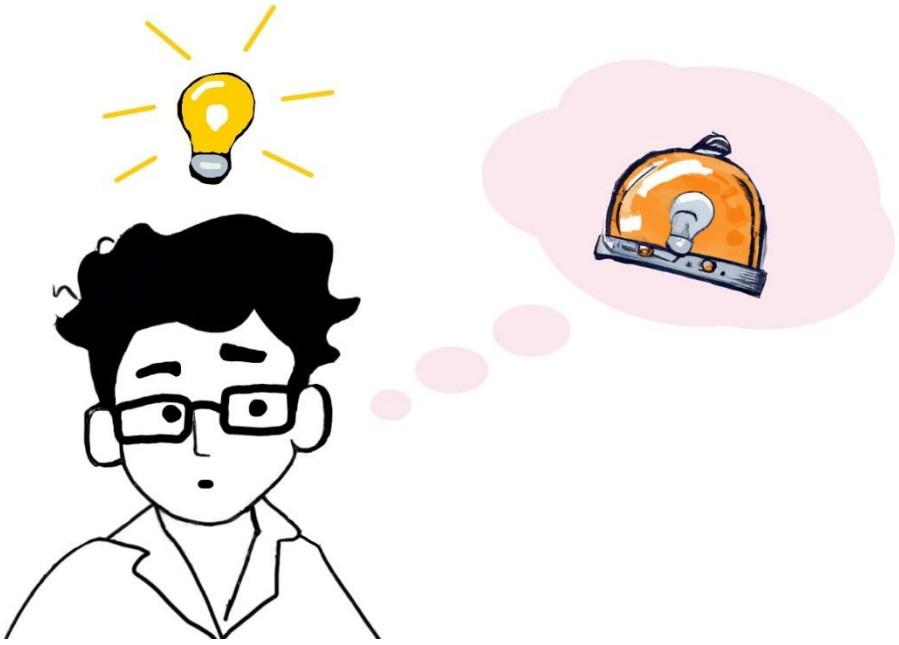
Well done! It is indeed **Marie Curie** for her link with chemistry. Marie Skladowska-Curie is an exceptional scientist; she is the first woman to have received the Nobel Prize and, to date, the only woman to have received two. She remains the only person to have been awarded in two distinct scientific fields. She was also the first woman to win, with her husband, the Davy Medal in 1903 for her work on radium.

Go to paragraph 2.

20

After extensive examinations, doctors discovered that Einstein has had retrograde amnesia for several years. He has forgotten everything he knew about science and all his inventions. His memory will come back on its own, but the doctors can't determine if it will come back in several months or years...

This is a problem for the continuation of his research. Thales, his brother, remembers a helmet that Einstein invented for Alzheimer's patients. It is a neurological helmet that stimulates the nerve cells in the brain to reconnect the neurons to each other and thus recover memory. If we could use it on him, he might recover his memory faster!



Go to paragraph 22.

21

If we link three aluminium atoms to two oxygen atoms, there will be 5 branches left that cannot cling.

Moreover, according to the chemical function table, we are dealing with a metal oxide (M+O), so the result is MO.

Finally, aluminium has a valence of 3 and oxygen has a valence of 2, so by practising the chiasmus rule, gives Al_2O_3.

Here is another exercise to better understand:

What molecule can we form with this?

- H_2O → **Go to paragraph 33.**
- HO_2 → **Go to paragraph 24.**
- H_3O → **Go to paragraph 6.**

22

However, one problem remains. Since the helmet is very valuable, Einstein hid it in a secret place. Thales knows that he has planted clues all over his room to find this place. These clues have to do with chemistry, of course! Thales asks for your help because he has very little knowledge of chemistry...

Are you ready to help Thales find this helmet and help Einstein recover his memory?

Let's go!

Go to paragraph 32.

23

Exactly! The chemical symbol for sodium is Na. The S stands for Sulfur and the Si stands for Silicon.

Go to paragraph 44.

24

Almost! In this case, you did not apply the chiasmus rule. Indeed, hydrogen has a valence of 1 and oxygen, a valence of 2. Using the chiasmus rule, this gives H_2O.

Go to paragraph 31.

25

You turn the poster over but there is nothing behind it ... **Isaac Newton** is an English, then British mathematician, physicist, philosopher, alchemist, astronomer and theologian. An emblematic figure of science, he is best known for founding classical mechanics, for his theory of universal gravitation and for creating, in competition with Gottfried Wilhelm Leibniz, infinitesimal calculus.

This isn't the correct poster… Try again!

Go to paragraph 10.

26

Indeed! When we look at the number of atoms on the left and the number of atoms on the right, we see that it is the same number for each atom. The principle of Lavoisier is thus respected.

Go to paragraph 59.

27

After solving the first equation, a second one must be solved to go further.

Here it is: **$Ca(PO_4)_2 + SiO_2 + C \rightarrow CaSiO_3 + P_4 + CO$**

- $2\ Ca_3(PO_4)_2 + 6\ SiO_2 + 10\ C \rightarrow 6\ CaSiO_3 + P_4 + 10\ CO$

  Go to paragraph 36.

- $3\ Ca(PO_4)_2 + SiO_2 + 14\ C \rightarrow 7\ CaSiO_3 + 2\ P_4 + 11\ CO$

  Go to paragraph 63.

- $Ca_3(PO_4)_2 + 7\ SiO_2 + 5\ C \rightarrow 5\ CaSiO_3 + 6\ P_4 + 2\ CO$

  Go to paragraph 7.

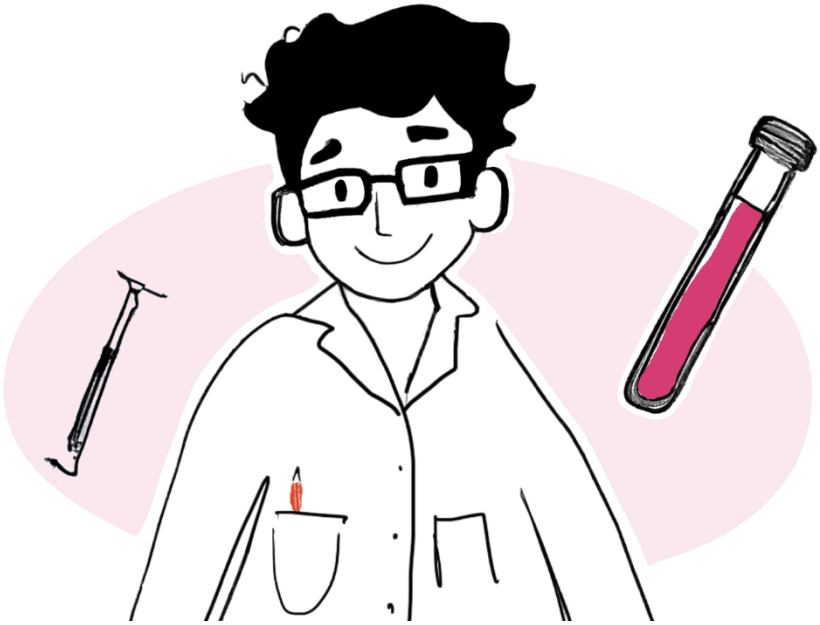
28

Exactly! The chemical formula of oxygen is O_2. It thus includes 2 atoms of oxygen.

Go to paragraph 65.

29

Absolutely! It is indeed salt and water, and it is correctly weighted.



Go to paragraph 62.

30

Now that we have the reactants, we need to solve the equation!

Which result is the right one?

- $MnCl_2 + H_2O + Cl_2$ **Go to paragraph 9.**
- $MnCl_2 + 2\ H_2O + Cl_2$ **Go to paragraph 17.**
- $3\ MnCl_2 + H_2O + 4\ Cl_2$ **Go to paragraph 49.**

31

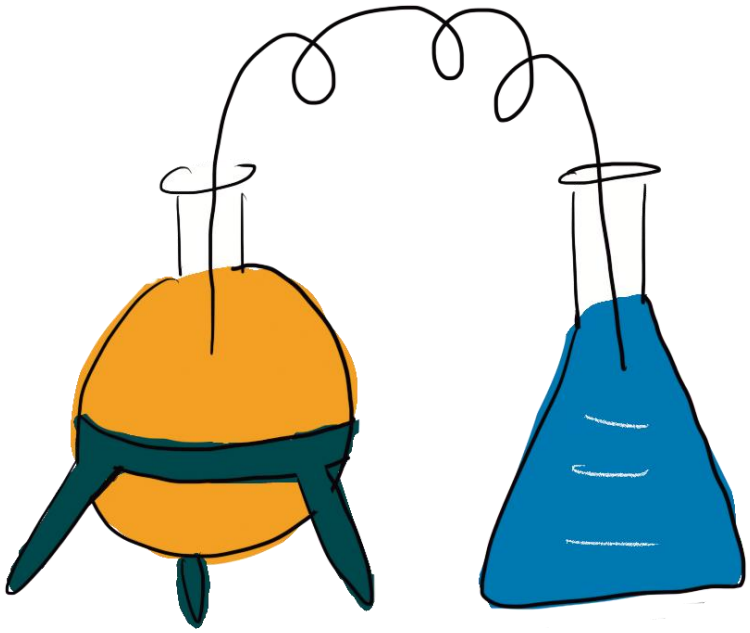
With this chemical formula, Al_2O_3, you manage to unlock the computer on Einstein's desk.

You begin to search through the various folders. After searching through all the documents, you come to a folder called "chemistry".

However, this folder is also locked, which gives you a hint. A pop-up window appears and asks you to associate sulfur with nitrogen.

What is the result of this equation?

- S_2N_3 → **Go to paragraph 42.**
- S_4N_3 → **Go to paragraph 11.**
- S_3N_2 → **Go to paragraph 37.**



32

Thales is aware that this helmet is stored in a safe. But where to start? There are several rooms in the house that can hide clues, but according to Thales, the best place to start would be in his bedroom, since that's where he spends most of his time.

So you head to Einstein's room. You start looking everywhere...

Go to paragraph 10.

33

Well done! You need two hydrogen atoms to attach to one oxygen atom.

Indeed, hydrogen has a valence of 1 and oxygen a valence of 2. Using the chiasmus rule, this gives H_2O.

Go to paragraph 31.

34

You turn the poster over but there is nothing behind it ... **Leonardo da Vinci** is an Italian polymath, artist, show and party organiser, scientist, engineer, inventor, anatomist, sculptor, painter, architect, town planner, botanist, musician, philosopher and writer. He has many strings to his bow... but he is not a chemist!

This isn't the correct poster… Try again!

Go to paragraph 10.

35

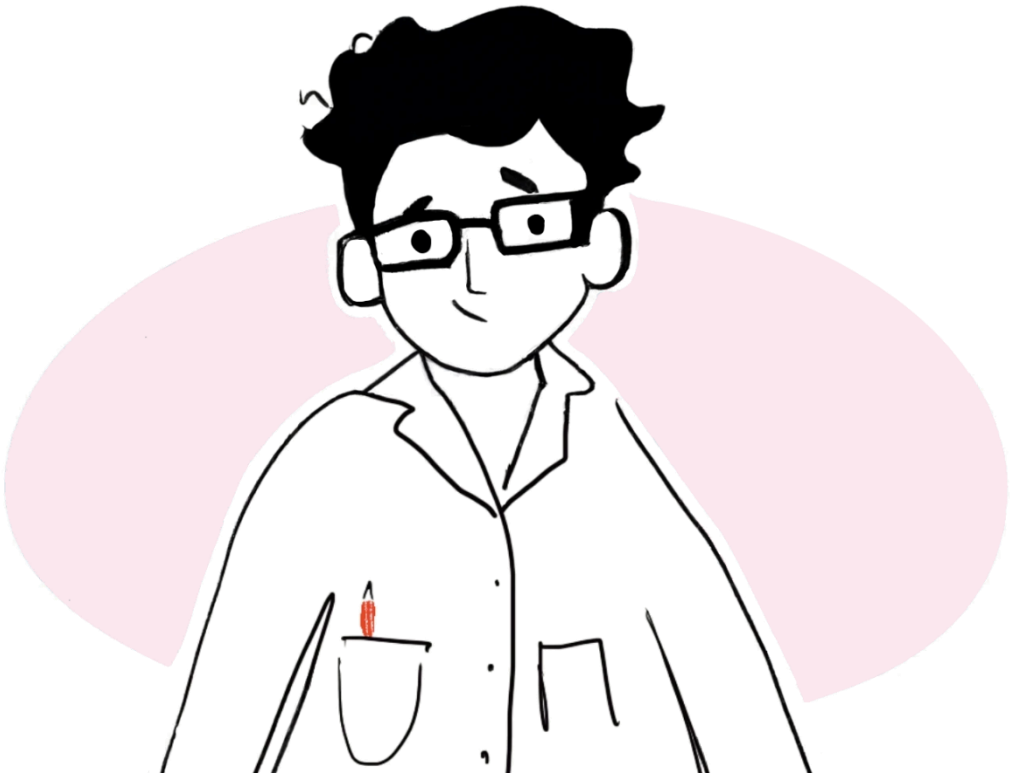
Once the file is unlocked, you start to search through all the documents but after a good ten minutes, you don't find anything interesting...

Suddenly, Thales notices that one of the documents is titled with an equation:

$$HCl + Ca(OH)_2 \rightarrow CaCl_2 + H_2O$$

He finds it appealing. Why do you think?

- It is wrong. **Go to paragraph 48.**
- It is not weighted. **Go to paragraph 45.**
- These reagents don't exist. **Go to paragraph 51.**



36

Indeed! When we look at the number of atoms on the left and the number of atoms on the right, we see that it is the same number for each atom. The principle of Lavoisier is thus respected.

Go to paragraph 3.

37

Well done! The valence of sulfur is 2 and the valence of nitrogen is 3. As it is a binary salt and using the chiasmus rule, it gives S_3N_2.

Go to paragraph 35.

38

Not quite! Pay attention to the chemical functions!

Go back to paragraph 64.

39

No, it is the chemical symbol for silicon. Don't forget to look at your periodic table of elements.

Go back to paragraph 8.

40

No, it is the right symbol but not the right "quantity".

Go back to paragraph 44.

41

No, it is the chemical symbol for sulfur. Don't forget to look at your periodic table of elements.

Go back to paragraph 8.

42

Not quite! Look at the valence of sulfur and nitrogen. Don't forget to look at your chemical function chart and use the chiasmus rule.

Go back to paragraph 31.

43

Exactly! We can "hook" three oxygen atoms to two aluminum atoms.

In addition, according to the chemical function table, we are dealing with a metal oxide (M+O), so the result is MO with the aluminium atom having a valence of 3 and the oxygen atom having a valence of 2. If we apply the chiasmus rule, this gives Al_2O_3.

Go to paragraph 31.

44

Secondly, it must be possible to determine the chemical formula of oxygen molecule.

- O_2 **Go back to paragraph 28.**
- O_3 **Go back to paragraph 47.**
- O **Go back to paragraph 40.**

45

Exactly! This equation is not weighted according to the Lavoisier principle. According to this principle, how can you weigh this equation?

Go to paragraph 5.

46

This is not the right weighting. Look at the number of atoms on the left and the number of atoms on the right.

Left:	5 H	3 Cl	2 Ca	2 O
Right:	4 H	4 Cl	2 Ca	2 O

It is not the same number for each atom. The Lavoisier principle is not respected.

Go back to paragraph 5.

47

No, it is the right symbol but not the right "quantity".

Go back to paragraph 44.

48

Technically, this equation is indeed false. However, it is false for a particular reason (remember Lavoisier's principle).

Go back to paragraph 35.

49

Not quite! Beware of weighting!

Go back to paragraph 30.

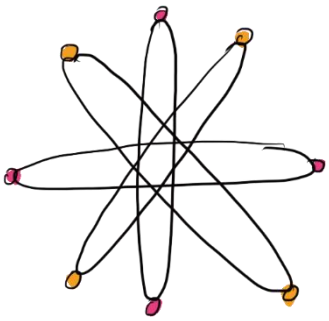
50

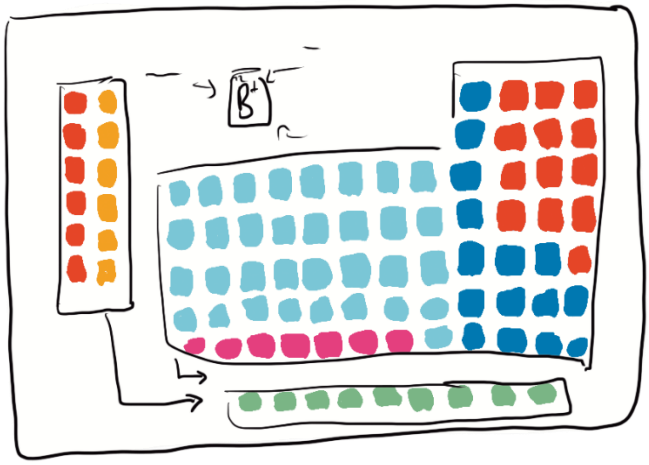
You enter the result of the equation (2 Na_2O) on the digital tablet.

Suddenly, a picture appears! In this picture, you can see a small rock. Thales immediately recognises this rock: "It's the rock next to his hut! This hut was once the laboratory of the little Einstein. You go into the garden and at the end of it, you find the hut with the small rock next to it. As you approach it, you notice yet another equation to solve:

$NaOH + H_2SO_4 \rightarrow$

- $Na_2H_3SO_5$ **Go to paragraph 53.**
- $Na_2SO_4 + H_2O$ **Go to paragraph 60.**
- $Na_2SO_4 + 2\ H_2O$ **Go to paragraph 29.**





51

These reagents exist! They are hydrogen chloride and calcium hydroxide. These two products react together.

Go back to paragraph 35.

52

This is not the right weighting. Look at the number of atoms on the left and the number of atoms on the right.

Left:	2 Fe	3 O	2 C
Right:	2 Fe	4 O	4 C

It is not the same number for each atom. The Lavoisier principle is not respected.

Go back to paragraph 59.

53

Not quite! Look closely at your chemical function chart. The right answer is hydroxide.

Go back to paragraph 50.

54

Not quite! Pay attention to the chiasm rule!

Go back to paragraph 64.

55

This is not the right weighting. Look at the number of atoms on the left and the number of atoms on the right.

Left:	3 H	1 Cl	2 Ca	2 O
Right:	4 H	4 Cl	2 Ca	2 O

It is not the same number for each atom. The Lavoisier principle is not respected.

Go back to paragraph 5.

56

Not quite! It is indeed a metal oxide according to the chemical function table but beware of the chiasmus rule!

Go back to paragraph 65.

57

The board opens from the bottom to the top but, unfortunately, there is nothing inside. Indeed, **Maria Montessori** was an Italian physician and educator best known for the philosophy of education that bears her name, and her writing on scientific pedagogy. She is thus a scientist but she has no relation with chemistry.

This isn't the correct button… Try again!

Go to paragraph 62.

58

Exactly! According to the chemical function table, it is a metal oxide, so MO. With the chiasmus rule, we reverse the valences so Na_2O. Then we weigh the equation. This gives 2 Na_2O.

Go back to paragraph 50.

59

Now that you have weighted this equation, it is finally balanced and respects the Lavoisier principle. So you decide to change the name of the file with the correct weighting of the equation.

Suddenly, just after pressing the "enter" button, the printer starts up and pulls out a paper with writing on it.

"More equations?!" Thales is astonished. "He must really love chemistry..."

Here is the first equation to be weighted:

Fe_2O_3 + C → CO + Fe

- 2 Fe_2O_3 + 3 C → 4 CO + 2 Fe

Go to paragraph 14.

- Fe_2O_3 + 3 C → 3 CO + 2 Fe

Go to paragraph 61.

- Fe_2O_3 + 2 C → 4 CO + 2 Fe

Go to paragraph 52.

60

Not quite! It is indeed salt and water but be careful with the weighting!

Go back to paragraph 50.

61

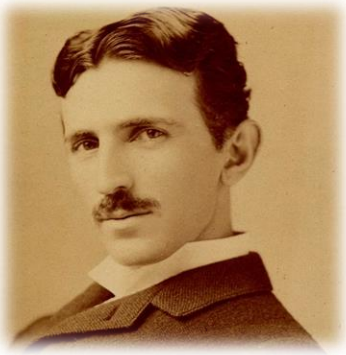
Indeed! When we look at the number of atoms on the left and the number of atoms on the right, we see that it is the same number for each atom. The principle of Lavoisier is thus respected.

Go back to paragraph 27.

62

With this result, you head to the cabin and notice that the door is locked with a code. You decide to enter the result of the equation you just solved. The door opens to a large, almost empty room.

You decide to look around the room. In a corner, you find 3 pictures hanging on the wall with a button on each of them.



On which board should the button be pushed?

- Dmitri Mendeleev → **Go to paragraph 64.**
- Nikola Tesla → **Go to paragraph 18.**
- Maria Montessori → **Go to paragraph 57.**

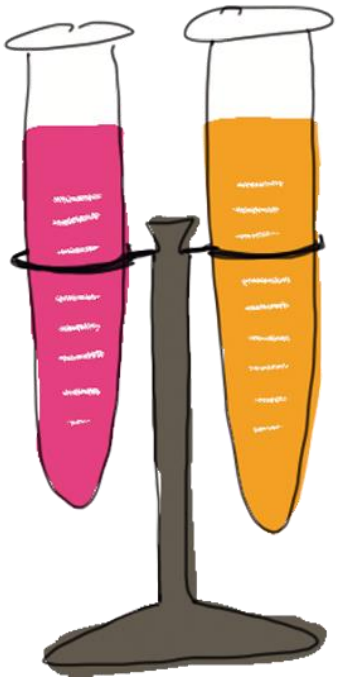
63

This is not the right weighting. Look at the number of atoms on the left and the number of atoms on the right.

Left:	3 Ca	6 P	1 Si	26 O	14 C
Right:	7 Ca	8 P	7 Si	32 O	11 C

It is not the same number for each atom. The Lavoisier principle is not respected.

Go back to paragraph 27.



64

Great job! **Dmitri Mendeleev** was a chemist, creator of the Periodic table!

The board opens and a safe comes forward. "Obviously, the door is still locked," grumbles Thales. You notice an inscription on this box: "Manganese dioxide with hydrogen chloride gives Manganese chloride, water and chlorine."

"The code corresponds to the equation in the chemical symbol, it is still necessary to solve this equation! Thalès moaning.

How to write the reagents?

- $MnO_2 + HCl$ → **Go to paragraph 4.**
- $O_2Mn + ClH$ → **Go to paragraph 38.**
- $Mn_2O + HCl_2$ → **Go to paragraph 54.**

65

We now have the chemical formulas of the different reactants. What is the result of this equation?

$Na + O_2 \rightarrow$

- $2\ Na_2O$ → **Go to paragraph 58.**
- $2\ NaO_2$ → **Go to paragraph 56.**
- Na_2O → **Go to paragraph 16.**

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