Activity worksheet: the atom to scale

Name	Group	Date

What you will learn

With the atom to scale simulation you will travel from the whole atom down to its nucleus, magnifying the image 10 times at each jump. You will find out how tiny the nucleus is, how these sizes are written in scientific notation and which particles make up each atom.

How to work. Each activity has three steps:

1. **Predict.** Before looking at the simulation, write down what you think will happen and why.
2. **Observe.** Set up the simulation, watch what happens and note down the data.
3. **Explain.** Compare what happened with your prediction and explain why.

If your prediction turns out to be wrong, don't rub it out: getting it wrong and understanding why is the best way to learn.

Each activity has a link that opens the simulation already set up. If you have the worksheet on paper, go to **simulaciencia.es/en/simulations/atomo-real** and set it up as described under “Set up the simulation”.

Very small units. 1 picometre (pm) = 10^{-12} m. 1 femtometre (fm) = 10^{-15} m. One picometre is 1000 femtometres.

Before you start

What do you think now? Write T (true) or F (false). You will come back to this table at the end.

Statement	T or F
a) The nucleus takes up about half of the atom.	
b) If we draw an atom on a sheet of paper, the nucleus can be seen with the naked eye.	
c) Electrons are little balls the size of the dots used to draw them.	
d) The more protons an atom has, the bigger it is.	
e) All the atoms of the same element have the same number of protons.	

Activity 1. Where is the nucleus?

Set up the simulation: element **hydrogen**, at natural scale. Open the simulation ready to use

Predict. Draw what you think the nucleus of the hydrogen atom will look like if we magnify it 10, 100, 1000 and 10,000 times. At which jump will you start to see it?

My prediction

Observe. Press “Zoom in →” one jump at a time and write down what you see and what the green scale bar measures.

Jump	Magnification	Can you see the nucleus?	Length measured by the scale bar (D)
0	Natural scale		
1	×10		
2	×100		
3	×1000		
4	×10,000		

Explain. Why can't you see the nucleus at natural scale if it is in the centre of the atom?

My explanation

Activity 2. How many times bigger?

Set up the simulation: element **hydrogen**. Open the simulation ready to use

Predict. How many times bigger do you think the atom is than its nucleus: 2, 100, 25,000?

My prediction

Observe. Read the element's information panel.

Diameter of nucleus	In metres	Diameter of atom	In metres	Atom is bigger than its nucleus

Explain.

1. Divide the diameter of the atom by that of the nucleus, in metres and in scientific notation. Do you get the same number as the simulation?

2. If the nucleus were a 1 cm marble, how big would the atom be? Compare it with something in your neighbourhood.

My answers

Activity 3. A journey in powers of 10

Set up the simulation: element **gold**. Open the simulation ready to use

Predict. The scale bar measures 272 pm at natural scale. What will it measure after one ×10 jump? And after two?

My prediction

Observe. Press "Zoom in →" and write the scale bar in scientific notation at each jump. Once the nucleus can be seen, the scale bar measures the nucleus ("Gold nucleus"): write that down too.

Jump	What does the scale bar measure?	Scale bar (D) in scientific notation
0	The atom	
1		
2		
4		

Explain.

1. While the scale bar measures the atom, what happens to the exponent of 10 at each jump? Why?
2. How many times bigger is the gold atom than its nucleus? Check it with the element's information panel.

My answers

Activity 4. Protons, neutrons and electrons

Set up the simulation: element **sodium**, at the last zoom jump. Open the simulation ready to use

Predict. Sodium has atomic number Z = 11. How many protons does it have? And electrons?

My prediction

Observe. Change the element in the drop-down list and fill in the table using the element's information panel.

Element	Protons (Z)	Neutrons (N)	Mass number (A = Z + N)	Electrons	Electron shells
Carbon					
Oxygen					
Sodium					
Iron					

Explain.

1. Why is the atom electrically neutral?
2. Which number identifies an element: Z, N or A?

My answers

Activity 5. More protons means bigger?

Set up the simulation: element **sodium**, at natural scale. Open the simulation ready to use

Predict. Gold has 79 protons and sodium has 11. Which atom do you think is bigger? And which nucleus?

My prediction

Observe.

Element	Z	Diameter of nucleus (fm)	Diameter of atom (pm)
Sodium	11		
Gold	79		

Element	Z	Diameter of nucleus (fm)	Diameter of atom (pm)
Uranium	92		

Explain. Does the size of the nucleus grow with Z? And the size of the atom? What else do you think affects the size of the atom, apart from the number of protons?

My explanation

Activity 6. Challenge: are electrons really like that?

Set up the simulation: element **gold**. Open the simulation ready to use

Observe. Read the blue box on the drawing and the electron shells of gold.

What does the blue box say?	Shells of gold and electrons in each one

Explain. A classmate says that electrons are little balls going round in circles, as they appear in the drawing. What would you tell them?

My explanation

Apply what you have learnt

Answer without the simulation.

1. Write in metres and in scientific notation: 62 pm, 2.4 fm and 0.15 nm.
2. A carbon atom measures 152 pm and its nucleus 5.49 fm. How many times bigger is the atom? Do the calculation in scientific notation.
3. Aluminium has Z = 13 and A = 27. How many protons, neutrons and electrons does it have?
4. Why do we say that matter is “almost empty”?

Question	Answer
1	
2	
3	
4	

Review your ideas

Go back to the “Before you start” table. Would you change any of your answers? Write which one and explain why, using something you saw in the simulation.

What has changed in my ideas

Going further (Years 11 to 13)

1. The uranium in the simulation is uranium-238. Write its symbol with A and Z. What would be different in uranium-235?
2. In the gear menu, turn on “Show intermediate zoom lines” and look at the bottom strip. How many “1/10 of the atom” bars fit in the atom? And how many nuclei?

My answers

Self-assessment

Put an X to show how confident you feel at the end.

I can...	Yes	Nearly	Not yet
Explain that the nucleus is very, very much smaller than the atom			
Write very small sizes in scientific notation			
Work out protons, neutrons and electrons from Z and A			
Explain what the drawing of an atom shows and what it does not			
Use a prediction and an observation to change an idea I had			

Juan Ramón Grijota · SimulaCiencia. Worksheet published under a CC BY-SA 4.0 licence: you may adapt and share it, crediting the author and keeping the same licence. Simulation at simulaciencia.es/en/simulations/atomo-real/.