Name .... Class .... Date ....

Model of an atom

Specification references:

- C1.1.4 Relative electrical charges of subatomic particles
- C1.1.5 Size and mass of atoms
- WS 1.2

Aims

In this activity you will have an opportunity to explore the "nuclear" model of the atom by building your own.

Learning outcomes

After completing this activity, you should be able to:

- describe the location of the protons, neutrons, and electrons in an atom
- use a model to develop scientific understanding.

Setting the scene

In science we use models to help us think about ideas and understand how they work better. The "atomic" model of the atom helps us to increase our knowledge of the structure of atoms and understand why atoms behave in the way they do.

Safety

Be careful not to get cut on the sharp edges of materials such as straws.

Equipment

- cotton wool balls
- coloured paper
- card
- wooden sticks
- pipe cleaners
- straws
- periodic table

Task

In this activity you will use the idea of the 'atomic' model of an atom to produce a model of a particular element. You will then evaluate your model and highlight its good points and its limitations.

Name .... Class .... Date ....

Questions

1 Choose one of the atoms below. Circle the atom you have chosen. Note, the number next to each atom is its mass number.

^{4}He, ^{7}Li, ^{12}C, ^{19}F, ^{16}O, ^{23}Na

2 Work out the number of protons, neutrons, and electrons in your atom.

....

....

....

3 Describe where each type of particle is found within the atom.

....

....

....

4 Use the materials available to produce a model of your atom.

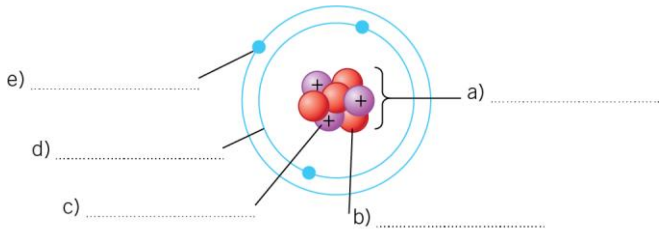
Sketch your model. Make sure it is fully labelled.

5 Explain which parts of your model are accurate when compared to a real atom.

6 Explain which parts of your model do not represent a real atom very well.

Student follow up

1 Add labels to complete the diagram below.



Name .... Class .... Date ....

2 Complete the table to show the number of protons, neutrons and electrons in each of these atoms.

element	proton	neutron	electron
^{4}He	2		
^{7}Li	3		
^{12}C			6
^{19}F			9
^{16}O		8	
^{23}Na		12	
^{31}P	15		
^{35}Cl		18	
^{39}K			19
^{32}S		16	

Ideas about ions

Specification references:

- C1.1.4 Relative electrical charges of sub-atomic particles
- WS 4.1

Aims

Name .... Class .... Date ....

In this activity students have an opportunity to develop their confidence at working out the number of protons, neutrons and electrons in different ions.

Learning outcomes

After completing this activity, you should be able to:

- calculate the number of sub-atomic particles in ions.

Setting the scene

Atoms that have gained or lost electrons are called ions. Ions do not have the same number of positive protons as they do negative electrons, so they have an overall charge.

When metal atoms react they lose electrons and gain a positive charge.

If one electron is lost then the ion will have a 1^+ charge. If two electrons are lost then the ion will have a 2^+ charge. If three electrons are lost then the ion will have a 3^+ charge, and so on.

When non-metal atoms react they gain electrons to form negatively charged ions.

If one electron is gained the ion has a 1^- charge, if two electrons are gained the ions have a 2^- charge, and so on.

Equipment

- periodic table (for reference)

Task

The table below shows the formula of a selection of common ions.

The task is to make a flow chart to explain how you can use the atomic number and mass number to determine the subatomic particles in an ion. When you have completed yours, swap your flow chart with another student and they can use it to determine the subatomic particles in some of the examples given in the table below.

You could develop your flow chart by adding additional branches to explain how to determine the subatomic particles in a negative ion, positive ion and an isotope.

Name .... Class .... Date ....

Ion	Atomic number	Number of protons	Number of neutrons	Number of electrons
$^{7}Li^{+}$	3			
$^{39}K^{+}$	19			
$^{19}F^{-}$	9			
$^{16}O^{2-}$	8			
$^{27}Al^{3+}$	13			
$^{80}Br^{-}$	35			
$^{32}S^{2-}$	16			
$^{24}Mg^{2+}$	12			
$^{14}N^{3-}$	7			
$^{45}Sc^{3+}$	21			

Student follow up

3 Complete the table by filling in the overall charge on each ion.

Ion	Protons	Neutrons	Electrons	Charge
Magnesium ion	12	12	10	
Potassium ion	19	20	18	
Fluoride ion	9	10	10	
Oxide ion	8	8	10	
Sulfide ion	16	16	18	

Name .... Class .... Date ....

4 Circle the correct answers.

a What is the name of the sub-atomic particle with a positive charge?

Proton
Neutron
Nucleus
Electron (*1*)

b What is the name of the sub-atomic particle with a negative charge?

Proton
Neutron
Nucleus
Electron (*1*)

c What is the name of the sub-atomic particle with no charge?

Proton
Neutron
Nucleus
Electron (*1*)

5 Complete the sentence below.

Atoms have no overall electrical charge because they have the same number of

.... (*2*)

6 What is an ion?

....

.... (*2*)

7 Complete the table below to show the number of protons, electrons and neutrons in an oxygen atom and an oxide ion. Oxygen has an atomic number of 8. (*2*)

	Protons	Electrons	Neutrons
^{16}O			
$^{16}O^{2-}$			

Ideas about ions

Specification references:

- C1.1.4 Relative electrical charges of sub-atomic particles
- WS 4.1

Name .... Class .... Date ....

Aims

In this activity students have an opportunity to develop their confidence at working out the number of protons, neutrons and electrons in different ions.

Learning outcomes

After completing this activity, you should be able to:

- calculate the number of sub-atomic particles in ions.

Setting the scene

Atoms that have gained or lost electrons are called ions. Ions do not have the same number of positive protons as they do negative electrons, so they have an overall charge.

When metal atoms react they lose electrons and gain a positive charge.

If one electron is lost then the ion will have a 1^+ charge. If two electrons are lost then the ion will have a 2^+ charge. If three electrons are lost then the ion will have a 3^+ charge, and so on.

When non-metal atoms react they gain electrons to form negatively charged ions.

If one electron is gained the ion has a 1^- charge, if two electrons are gained the ions have a 2^- charge, and so on.

Equipment

- periodic table (for reference)

Task

The table below shows the formula of a selection of common ions.

The task is to make a flow chart to explain how you can use the atomic number and mass number to determine the subatomic particles in an ion. When you have completed yours, swap your flow chart with another student and they can use it to determine the subatomic particles in some of the examples given in the table below.

You could develop your flow chart by adding additional branches to explain how to determine the subatomic particles in a negative ion, positive ion and an isotope.

Name .... Class .... Date ....

Ion	Atomic number	Number of protons	Number of neutrons	Number of electrons
$^{7}Li^{+}$	3			
$^{39}K^{+}$	19			
$^{19}F^{-}$	9			
$^{16}O^{2-}$	8			
$^{27}Al^{3+}$	13			
$^{80}Br^{-}$	35			
$^{32}S^{2-}$	16			
$^{24}Mg^{2+}$	12			
$^{14}N^{3-}$	7			
$^{45}Sc^{3+}$	21			

Student follow up

8 Complete the table by filling in the overall charge on each ion.

Ion	Protons	Neutrons	Electrons	Charge
Magnesium ion	12	12	10	
Potassium ion	19	20	18	
Fluoride ion	9	10	10	
Oxide ion	8	8	10	
Sulfide ion	16	16	18	

Name .... Class .... Date ....

9 Circle the correct answers.

a What is the name of the sub-atomic particle with a positive charge?

Proton
Neutron
Nucleus
Electron (*1*)

b What is the name of the sub-atomic particle with a negative charge?

Proton
Neutron
Nucleus
Electron (*1*)

c What is the name of the sub-atomic particle with no charge?

Proton
Neutron
Nucleus
Electron (*1*)

10 Complete the sentence below.

Atoms have no overall electrical charge because they have the same number of

.... (*2*)

11 What is an ion?

....

.... (*2*)

12 Complete the table below to show the number of protons, electrons and neutrons in an oxygen atom and an oxide ion. Oxygen has an atomic number of 8. (*2*)

	Protons	Electrons	Neutrons
^{16}O			
$^{16}O^{2-}$			

Developing the atomic model

Specification references:

- C1.1.3 Scientific models of the atom
- WS 1.1, 1.2

Aims

Name .... Class .... Date ....

In this activity, you will consider why ideas and models in science often improve over time by exploring how ideas about atoms have changed.

Learning outcomes

After completing this activity, you should be able to:

- describe how and why the atomic model has changed over time
- know that scientific theories are revised or replaced by new ones in light of new evidence.

Setting the scene

Our ideas about atoms have changed a lot over time. In this activity, you will consider how and why scientific ideas change by exploring some of the key developments in our understanding of atoms.

Task

Draw a timeline to show how ideas about atoms have changed from the ancient Greeks to the developments suggested by Bohr. Include diagrams of the atomic models on your timeline.

Some key ideas to be included are shown below. Use these in your timeline and add any further information you know for each idea. Note these developments are not in order.

- Rutherford used the experimental work of two of his students, Geiger and Marsden, to develop the nuclear model in which most of the mass is concentrated in the nucleus, with electrons in shells orbiting the nucleus.
- Thomson carried out experiments that led to the discovery of electrons and proved that atoms could be split.
- Bohr discovered that electrons in atoms could only travel along certain ‘shells’.
- Dalton developed understanding of atomic theory and came up with theories about what made up different elements. He determined that atoms were tiny particles, like hard spheres that couldn’t be split, which made up elements.
- James Chadwick devised an experiment that showed the existence of neutrons.
- Greek philosopher Democritus claimed atoms could not be split.

Name .... Class .... Date ....

Student follow up

13 Suggest why models, such as that of the atom, are useful in science.

....

14 Why have ideas about atoms changed over time?

....

....

15 We now know that atoms contain three types of subatomic particle. Suggest why this would have surprised earlier scientists who first studied atoms.

....

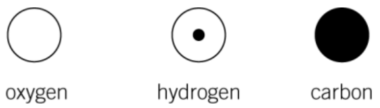
16 Name the three sub-atomic particles and outline where each is found within an atom.

....

....

....

17 In the early 1800s John Dalton used symbols to represent atoms. Each element had a different symbol. The symbols for oxygen, hydrogen and carbon are shown below.



Use these symbols to draw molecules of oxygen (O_2), water (H_2O), and carbon dioxide (CO_2).

Name .... Class .... Date ....

18 Between 1897 and 1906, Thomson carried out a number of experiments and discovered electrons. Thomson used his discovery to devise his plum pudding model of the atom. Outline the main ideas of the plum pudding model.

....

....

19 Which, if any, of Dalton's ideas about the atom do we no longer believe to be correct? Explain your answer.

....

....

....

....

20 Two of Ernest Rutherford's students, Geiger and Marsden, carried out an experiment that helped to disprove the plum pudding model. They fired positively charged alpha particles at a thin layer of gold atoms. Most of the alpha particles travelled straight through but a few were deflected and a tiny number of alpha particles were deflected back towards the source.

a Explain why most of the alpha particles passed straight through the thin layer of gold atoms.

....

....

b Explain why a tiny number of alpha particles were deflected back towards the source.

....

....

Name .... Class .... Date ....

Reaction profiles

Specification references

- C5.1.2 Reaction profiles

Aims

This activity will help you to develop your understanding of reaction profiles, so that you can achieve the highest grade possible in your GCSE examinations.

Learning outcomes

After completing this activity, you should be able to:

- explain what reaction profiles show
- identify the activation energy on a reaction profile.

Task

Answer the questions below.

1 Methane burns in oxygen to make carbon dioxide and water:

methane + oxygen → carbon dioxide + water

For most reactions to happen, the reactant molecules have to collide. But collisions between them might not always cause a reaction.

Why might a collision between a methane molecule and an oxygen molecule *not* always result in a reaction?

(Hint: think about why there might not always be much damage when two cars 'crash'.)

....

.... (*2 marks*)

Name .... Class .... Date ....

2 In a chemical reaction, the amount of energy the particles have changes as the reaction goes on.

Look at Figure 1.

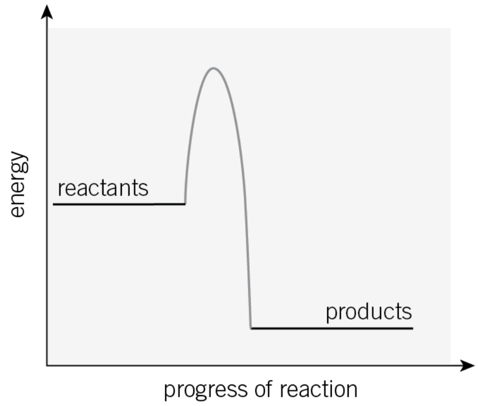


Figure 1

What happens to the amount of energy contained in the particles as products are formed from the reactants?

First: ....

Then: .... (*2 marks*)

3 Suggest why the amount of energy in the reactants first increases.

.... (*1 mark*)

4 The amount of energy needed to start a reaction is called the activation energy.
Draw an arrow on Figure 1 to show the activation energy. (*1 mark*)

5 **a** For the reaction overall, state whether energy is transferred from the surroundings or is transferred to the surroundings.

.... (*1 mark*)

b Explain how you can tell.

.... (*1 mark*)