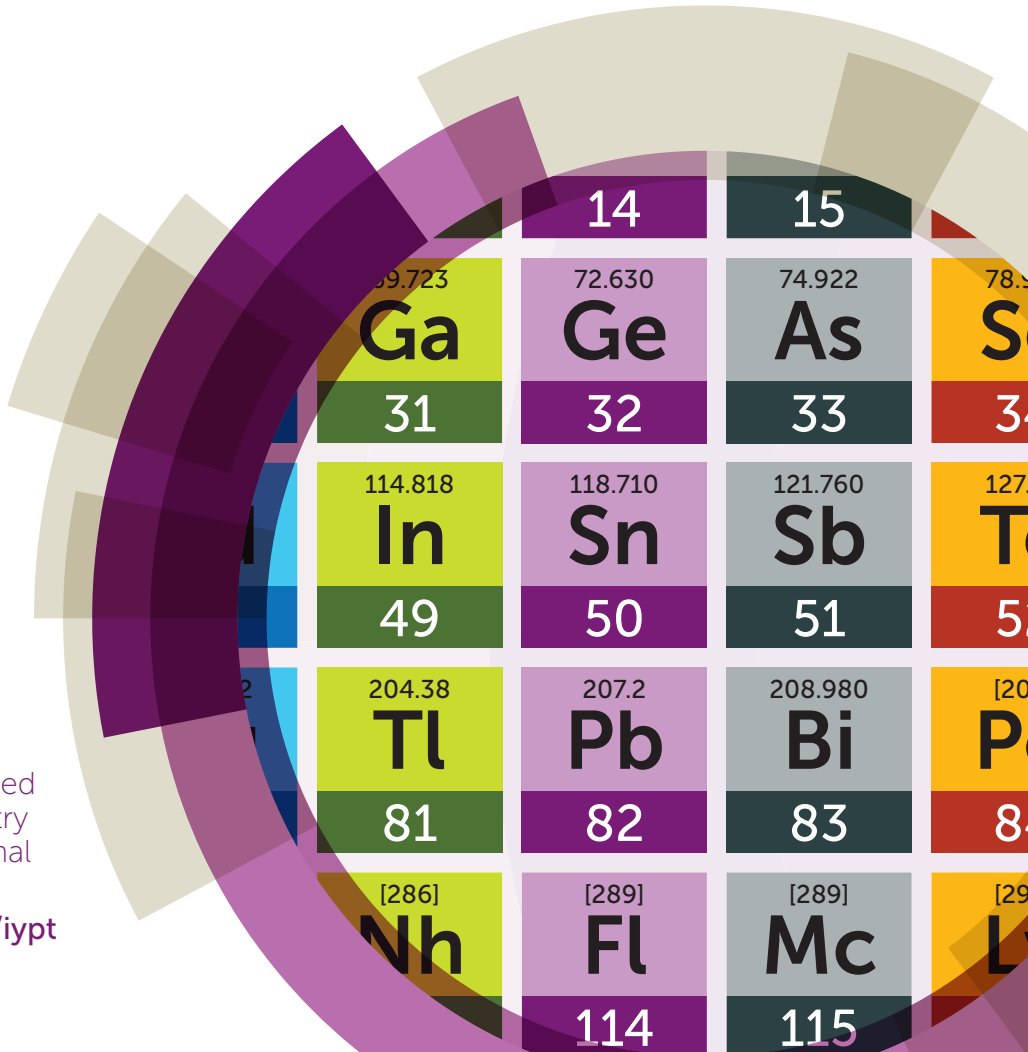
ROYAL SOCIETY OF CHEMISTRY | Celebrating IYPT 2019

History of the Periodic Table



These activities have been created by the Royal Society of Chemistry to help celebrate the International Year of the Periodic Table.

Find out more at: **www.rsc.org/iypt**

Instructions

- Print “blank newspapers”
- Print and cut out “pieces of information”
- In groups, students are to match “pieces of information” to correct “newspaper” timeline.
- For each timeline there are hint cards and stretch and challenge cards.
- Numeracy and literacy challenges embedded
- Each student to use completed “newspapers” to fill in summary sheets.

Objectives of classroom activity:

The timeline for the development of the model of the atom is clearly outlined in many schemes of work, so this activity follows that timeline with the addition of information relating to the development of the periodic table. Students do not necessarily have to know about the existence of atoms, or the atomic model before starting the exercise. Age group KS2 to KS3, there are hint cards for scaffolding (possibly KS4 depending on the group and use of stretch and challenge Qs). The teacher can be more specific with the objectives by using the blank summary sheet at the end.

Main objectives are:

- Timeline- Model of the atom: Dalton, Thomson, Bohr
- Timeline- Periodic table: Mendeleev, idea of atomic number, groups, periods

Extensions available for

Model of the atom:

- Distinguishing between the terms atom, element, compound
- Rutherford experiment
- Charges of sub-atomic particles
- Atomic number
- same group = same chemical properties, same element = same atoms

Periodic table:

- Law of octaves
- Significance of predictive nature of periodic table

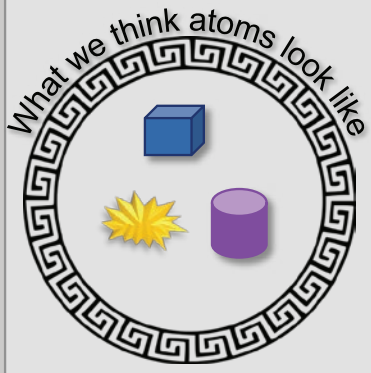
 = numeracy  = literacy

COMPLETED NEWSPAPERS

Pεriodic Taβlε Gazεττε

Ψεar: Around 400 βC

How many years ago is that?



Out and about in Ancient Alexandria?
Why not join us at a public lecture by Hypatia, the famous female mathematician and philosopher.

DEMOCRITUS DECLARES HIS NEW THEORY.

Renowned philosopher now says stuff is made of small particles that have different shapes and sizes. He calls these particles, Atomos.

Plato, celebrity of ancient Greece, has this to say about the new theory:
I don't think so.

Periodic Table Gazette

Year: Between 1800 and 1834

Dear Editor,

My name is John Jacob Berzelius. I think elements should be given letter symbols. For example, oxygen, would have the symbol O.

Many thanks,
John

Latest model of the atom

Scientist now knew that when a water molecule broke down, two atoms of hydrogen were released and only one atom of oxygen. If you split 6 water molecules, then how many hydrogen and oxygen atoms would you have?

Congratulation to Mr and Mrs Mendeleev on the birth of their son, Dmitri, in Siberia.

Beethoven to release rocking new Symphony No. 9

John Dalton: once in a lifetime interview

Well, I agree with the ancient Greeks. Atoms of an element are the same. Different elements have different atoms.

Any other new developments?

I've put known elements in a list and given them shapes for symbols.

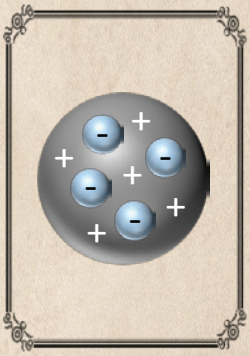
Are they easy to remember?

Not at all!

Then, no thanks!

Periodic Table Gazette

Year: Between 1860-1905



New atomic model looking lumpy!

How would you describe this model?

<u>Electron is discovered!</u>

Congratulations to J.J. Thomson on his Nobel Prize.

***I think I've cracked it!* Says Mendeleev**

Dmitri Mendeleev, scientist extraordinaire, organises the elements into horizontal rows and vertical columns. Leaves gaps for more elements to be discovered!

Can you think of betters names for these rows and columns?

Coming to showrooms near you, world's first car. With state of the art gasoline powered engine. Made by Benz.

Dear Editor,

I don't like the look of this lumpy atomic model. I'm going to come up with an experiment to see what it's really like. Look for me in your next issue.

Love,
Ernest Rutherford

Quiz time! In 1800 there were only 33 known elements. By 1900, this increased to 83. Wow! What percentage increase is that?

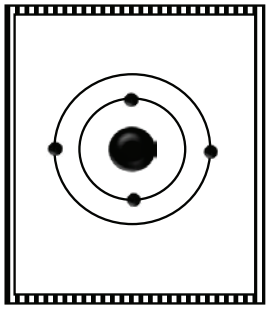
Periodic Table Gazette

Year: Between 1909 and 1913

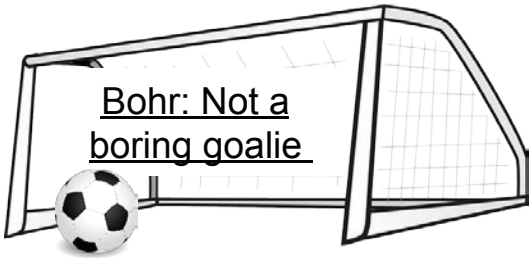
Elements should be arranged by Atomic Number

Henry Moseley, only 24 years old, has given us the final piece of the periodic table puzzle. Elements should be arranged by atomic number. After this discovery, he is off to fight in World War 1.

Latest atomic model

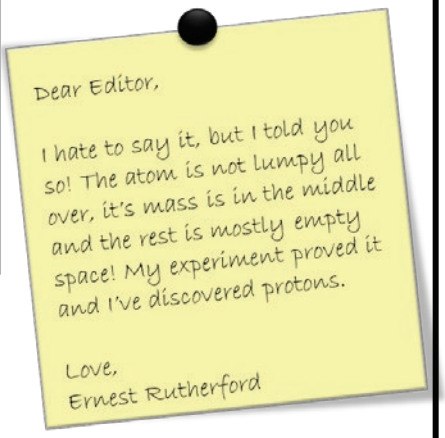


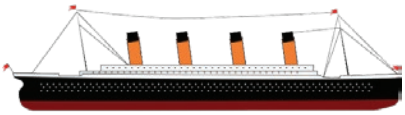
How would you describe this model?



Bohr: Not a boring goalie

Niels Bohr, scientist and goalkeeper for a Danish team improves on the model of the atom. Electrons are not just whizzing around, they have paths or orbits.





The Titanic: Built in Belfast, sinks in the Atlantic Ocean.

How big is an atom? You will need to use your imagination! If a carbon atom was the same size as you (a human), then you would be as tall as all of the people on earth stood on top of each other! There are 7 billion people on Earth, how many zeros is that?

Breaking news

Dmitri Mendeleev, creator of the Periodic table, dies of influenza in Russia.

Periodic tables- now with 86 elements

Today 09:46

Periodic Table Gazette

Incredible 118 elements discovered and named!

NASA lands Curiosity Rover on Mars

The curious robot identifies the elements sulphur, nitrogen, hydrogen, oxygen, phosphorus and carbon in the Martian soil. Excitement as these elements are considered the building blocks of life!

The Chemistry World remembers Erwin Schrodinger

and his contribution to the model of the atom with clouds of electrons- the most complicated model to date.

Discovery of the Neutron

Nearly 90 years ago, James Chadwick discovers the final subatomic particle.

From the name, what charge do you think a neutron might have?

Re-arrange these symbols to make a word that relates to the structure of the atom

238	32.1	35.5	14.0	152
U	S	Cl	N	Eu
Uranium	Sulphur	Chlorine	Nitrogen	Europium
92	16	17	7	63

BLANK NEWSPAPERS

To be printed and given to the students

ROYAL SOCIETY OF CHEMISTRY | Celebrating IYPT 2019

Periodic Table Gazette

Year: Around 400 BC

How many years ago is that?

What we think atoms look like

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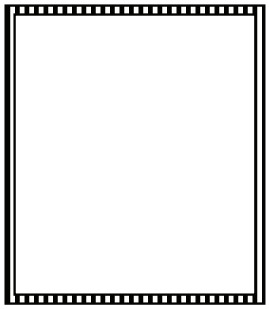

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PIECES OF INFORMATION

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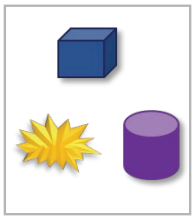

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Stretch and challenge (Year: Around 400 BC)

Q: Some ancient Greek philosophers thought everything was made up of four "elements"; Fire, Water, Air and Earth. We now know that is not true, but how would you describe water using your scientific knowledge?

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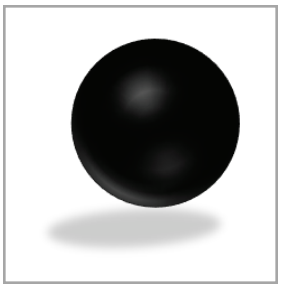

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Stretch and challenge (Year: 1800-1834)

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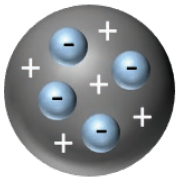

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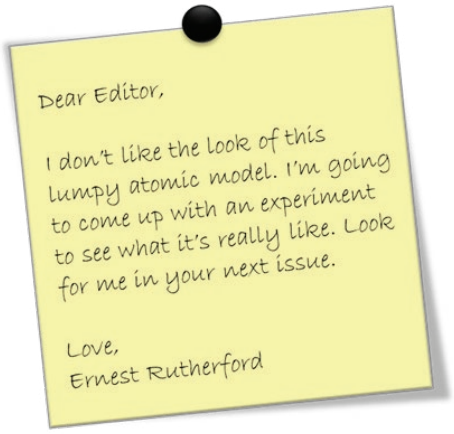

Coming to showrooms near you, world's first car. With state of the art gasoline powered engine. Made by Benz.

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Q: What charge do electrons have?

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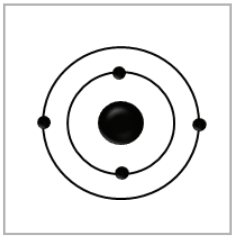

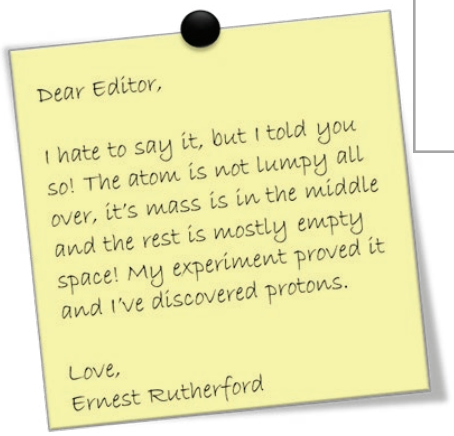

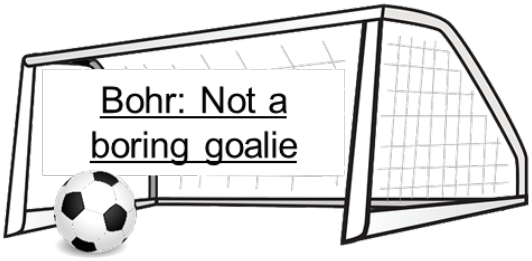

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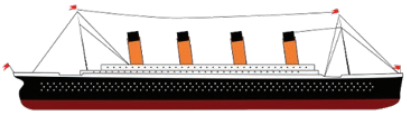

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Breaking news

Dimitri Mendeleev, creator of the Periodic table, dies of influenza in Russia.

Elements should be arranged by Atomic Number

Henry Moseley, only 24 years old, has given us the final piece of the periodic table puzzle. Elements should be arranged by atomic number. After this discovery, he is off to fight in World War 1.

Periodic tables- now with 86 elements

Stretch and challenge (Year: 1909-1913)

Q: How did Rutherford's experiment (otherwise known as the Geiger–Marsden experiment, the gold leaf, or gold foil experiment) prove the existence of protons in the nucleus?

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NASA lands Curiosity Rover on Mars

The curious robot identifies the elements sulphur, nitrogen, hydrogen, oxygen, phosphorus and carbon in the Martian soil. Excitement as these elements are considered the building blocks of life!

Stretch and challenge (Year: Today)

Q: In honour of Dmitri Mendeleev, the element with atomic number 101 was named Mendelevium. Can you spot elements in your periodic table that are named after other scientists or places?

Q: The journey of the periodic table has taken hundreds of year. Why do you think it may have taken so long to discover 118 known elements?

As scientists discovered more about atoms, the atomic model got more and more complex.

Around the time Mendeleev died, scientists knew of the existence of more than 80 elements.

When Mendeleev was born, Beethoven's music was recent and popular.

Electrons were discovered first, then protons and finally neutrons.

This token entitles you to ask your teacher one question.

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Hint tokens to be used by the teacher, suggested questions included or students can ask their own questions.

This is to help scaffold the activity.

SUMMARY SHEETS

One per student

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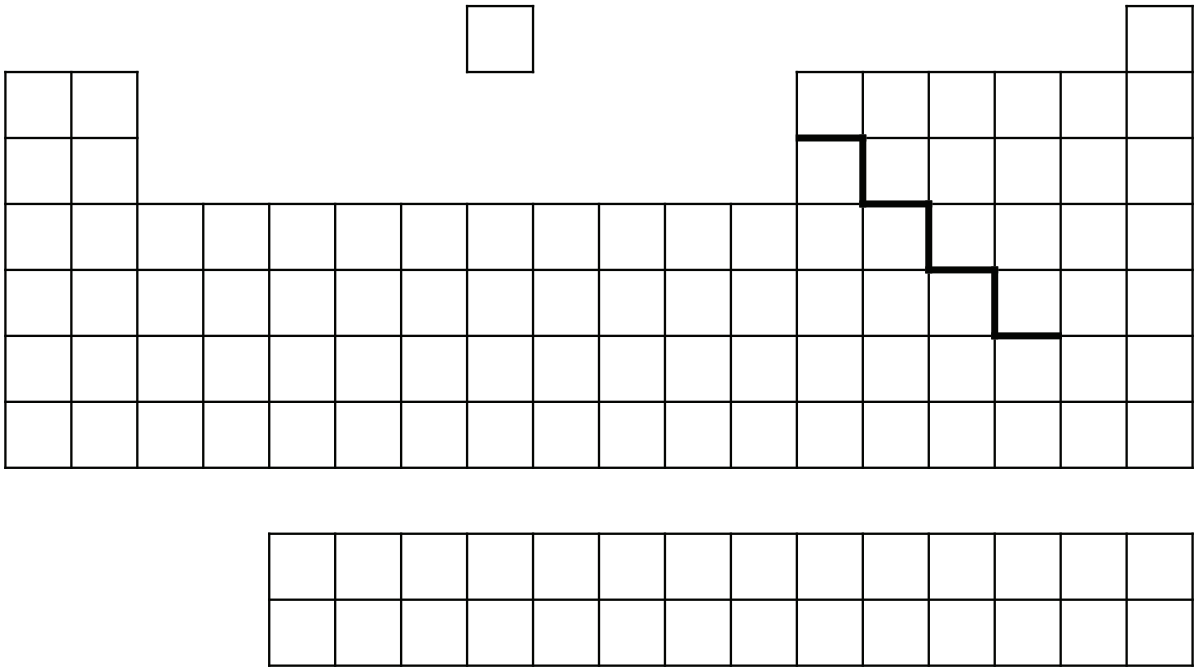
Summary Sheet Name:

Timeline for the development of

The Periodic Table



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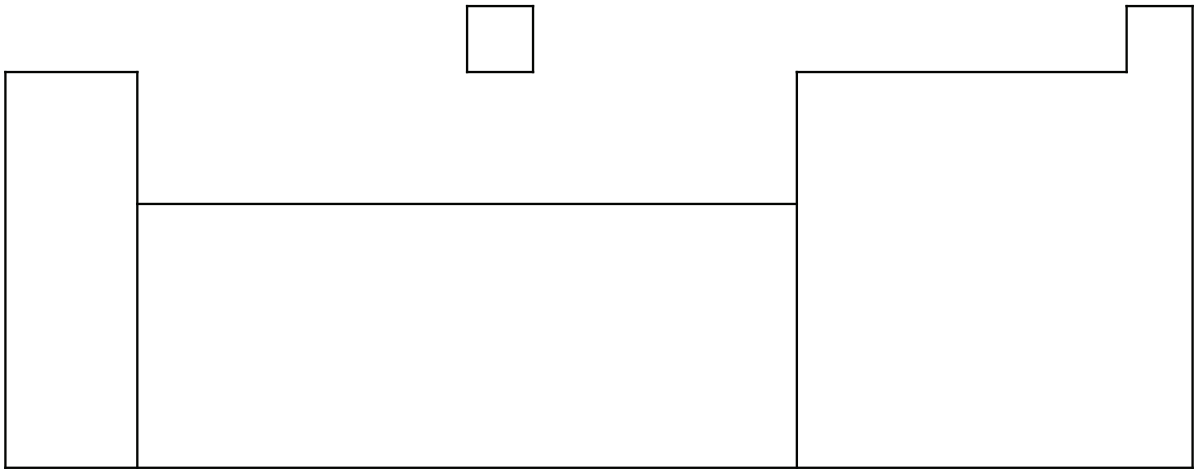

Summary Sheet Name:

Follow up questions:

1) Label the periodic table with: group, period, metals, non-metals, metalloids (semi-metals), transition metals
2) Why was Mendeleev's periodic table so special?
3) How would you define an element?
4) What are the subatomic particles present in an atom.
5) Can you draw and label Bohr's model of the atom.
6) What do elements in the same group have in common?
7) How are the elements in the periodic table organised?

Homework activity:

Use your periodic table to identify an element to research. Research the element to find out:

1) How many electrons, protons and neutrons does it have?
2) What group does it belong to?
3) What is it commonly used for?
4) When was it discovered?

In-depth background information and answers for teachers, links to additional resources

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Year: Around 400 BC

- 400 BC is (2019+400) = 2419 years ago.
- Hypatia actually dates from around 400 AD, but is one of the few known female philosophers [Learn more: *https://www.smithsonianmag.com/history/hypatia-ancientalexandrias-great-female-scholar-10942888/*].
- Democritus (460-370 BC) postulated that all matter is made up of small indivisible particles [Learn more: *https://www.chemteam.info/AtomicStructure/Greeks.html*].
- Plato (427-347 BC) his idea of what made up matter differed from Democritus' idea of small particles [Learn more: *http://abyss.uoregon.edu/~js/glossary/plato.html*].

Stretch and challenge:

Q: **Some ancient Greek philosophers thought everything was made up of four "elements"; Fire, Water, Air and Earth. We now know that is not true, but how would you describe water using your scientific knowledge?**
Idea that water is a molecule made up of the atoms of two elements in a specific ratio.

Year: Between 1800 and 1834

- 6 molecules of water produces (2x6)= 12 atoms of hydrogen and (1x6)= 6 atoms of oxygen.
- John Jacob Berzelius (1779–1848) [Learn more: *http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives?cmpid=CMP00002843*].
- John Dalton (1766–1844), proposed his atomic theory of matter in 1803-1807. He also suggested using symbols to represent elements [Learn more: *http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives?cmpid=CMP00002843* and *https://www.compoundchem.com/2016/09/06/dalton/*].
- Dmitri Mendeleev was born in 1834 in the town of Tobolsk in Siberia, Russia [Learn more: *http://www.rsc.org/periodic-table/history/about*]
- Ludwig van Beethoven composed his Symphony Number 9 between 1822 and 1824. It is also known as "Ode to Joy" [Learn more: *https://www.bbc.co.uk/music/works/c35b4956-d4f8-321a-865b-5b13d9ed192b*]

Stretch and challenge:

Q: Atoms cannot be created or destroyed. What is the difference between atoms, compounds and elements?

Atoms are the smallest part of an element that can exist. Elements are pure substances with only one type of atom. Compounds are substances where atoms of two or more elements are bonded.

For additional resources on this question: [*http://www.rsc.org/education/teachers/resources/aflchem/resources/25/index.htm*] [*http://www.rsc.org/learn-chemistry/resource/res00000617/atoms-elements-moleculescompounds-and-mixtures*]

Year: Between 1860 and 1905

- Thomson's model of the atom from 1904 is described as the "plum pudding model" or a chocolate chip cookie [Learn more: https://www.compoundchem.com/2016/10/13/ atomicmodels/].
- Joseph John Thomson (1856–1940) discovered the electron in 1897 and was awarded the Nobel prize in 1906 [Learn more: http://www.rsc.org/learn-chemistry/resource/res00000049/anecdotes-thomsonsdiscoverers-of-the-electron#!cmpid=CMP00001634 and https://www.compoundchem.com/2018/04/30/electron/]
- Dmitri Mendeleev discovered the modern day periodic table in 1869, arranging the elements into periods and groups [Learn more: http://www.rsc.org/periodic-table/history/about]
- Ernest Rutherford (1871-1937)
- From 1800 to 1900, the percentage of known elements increased by 152% [Learn more: https://www.bbc.com/bitesize/articles/zpkcsrd]
- Carl Benz was the first to apply for a patent for a "vehicle powered by a gas engine." (1885-1886) [Learn more: https://www.daimler.com/company/tradition/companyhistory/1885-1886.html]

Stretch and challenge:

Q: What charge do electrons have?
Negative.

Q: Mendeleev is famous for creating the modern Periodic Table. A previous suggestion for how the elements should be organised was called the Law of Octaves, proposed by John Newlands. From the name, can you guess what that meant?
John Newlands (1837-1898). Law of Octaves (reference to music octaves) refers to similarities in elements that differ by 7 in their atomic weights [Learn more:http://www.rsc.org/periodic-table/history/about]

Year: Between 1909 and 1913

- Bohr's atomic model often referred to as the planetary model.
- Henry Moseley (1887-1915) in 1913 suggested that the elements in the periodic table should be arranged in order of proton (atomic) number [Learn more: *http://www.rsc.org/periodic-table/history/about*].
- Ernest Rutherford (1871-1937) used the gold foil (also known as the gold leaf) experiment to show in 1911 that most of the atom consisted of empty space, with a concentrated positive charge (the nucleus) in the middle [Learn more: *https://www.compoundchem.com/2016/08/30/today-in-chemistry-history-ernestrutherfords-birthday/* and *https://www.compoundchem.com/wp-content/uploads/2016/10/The-History-of-the-Atom-%E2%80%93-Theories-and-Models.png*]
- Niels Bohr (1885-1962) in 1912 suggested that electrons are arranged in energy levels, he was awarded a Nobel prize in 1922. He was also a goal keeper for the Danish team Akademisk Boldklub [Learn more: *http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives?cmpid=CMP00002843* and *https://www.compoundchem.com/wp-content/uploads/2016/10/The-History-of-the-Atom-%E2%80%93-Theories-and-Models.png*]
- Construction began on the Titanic in Belfast in 1909, and the ship sank on the 15th of April 1912. Over 1,500 people died in the tragedy. The equivalent cost of the tickets to board the Titanic in today's money ranges from £190 for 3rd class up to £41,250 for the most expensive 1st class accommodation [Learn more: *http://www.bbc.co.uk/history/histories/titanic*]
- Dmitri Mendeleev died in February 1907.
- Scale of the atom: 7,000,000,000 people on earth [Learn more: *http://scaleofuniverse.com/*]
- By 1913, there were 86 known elements [Learn more: *http://www.rsc.org/periodic-table/history*]

Stretch and challenge:

Q: How did Rutherford's experiment (otherwise known as the Geiger–Marsden experiment, the gold leaf, or gold foil experiment) prove the existence of protons in the nucleus?

By firing positively charged (alpha) particles at a thin layer of gold. Most particles went straight through, but some were deflected. Proving a small positive charge concentrated in the centre of the atom (nucleus).

Q: What is the Atomic number of an element?

The number of protons in the nucleus.

Q: Can you label the parts Bohr's model of the atom?

Central nucleus, with electrons orbiting in energy levels.

Year: Today

- There are 118 elements in the most up to date periodic table [Learn more: *http://www.rsc.org/periodic-table*]
- The Curiosity Rover landed on Mars on the 6th of August 2012 [Learn more: *https://www.nasa.gov/mission_pages/msl/index.html*]
- James Chadwick (1891-1974) discovered the neutron (neutral charge) in 1932 [Learn more: *https://www.nobelprize.org/prizes/physics/1935/chadwick/biographical/*]
- Erwin Schrodinger (1887-1961) suggested the Quantum model of the atom in 1926, and it is still accepted as the most accurate model to date. The image of the cat is in reference to Schrodinger's cat thought experiment [Learn more: *https://www.compoundchem.com/wp-content/uploads/2016/10/The-History-of-the-Atom-%E2%80%93-Theories-and-Models.png*]

Stretch and challenge:

Q: In honour of Dmitri Mendeleev, the element with atomic number 101 was named Mendelevium. Can you spot elements in your periodic table that are named after other scientists or places?

Full list can be found here [*http://www.rsc.org/periodic-table* or *https://www.compoundchem.com/wp-content/uploads/2016/06/The-Periodic-Table-Element-Name-Origins-L.png*]

Q: The journey of the periodic table has taken hundreds of year. Why do you think it may have taken so long to discover 118 known elements?

Example answers:

Some elements are very reactive so are not found pure in nature, need to be extracted.
Abundance very low for some elements.
A number of elements have been synthesized so technological developments were needed to achieve this