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We recommend using these slides in 'Presenter view' in class, so you can see the speaker notes for each slide.

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	Presenter view Present with audience Q&A and view speaker notes						
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3A The structure of the atom



All matter is made of atoms which are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms.

Elaborations

- describing and modelling the structure of atoms in terms of the nucleus, protons, neutrons and electrons
- comparing the mass and charge of protons, neutrons and electrons

Learning intention

I will be able to describe the structure of the atom.

Success measure

I can use protons, neutrons, and electrons to model the structure of the atom.



Atoms make up everything. What makes an atom?



The development of the atomic model

Current knowledge of the atom comes from the work of many scientists, including:

Dalton (1803) stated that **atoms** are **indivisible** and indestructible.

••••

Thomson (1904) produced the 'plum pudding' model – showing that the atom is comprised of electrons spread throughout a positive sphere.



Rutherford (1911) proposed the nuclear model – the atom is mostly empty space with a positive centre called the **nucleus**.



Bohr (1913) proposed the planetary model – modelling that electrons **orbit** the nucleus in different energy levels.



Schrödinger (1926) stated that electrons move in waves – orbiting in a cloud around the nucleus.

KEY TERMS

atoms the smallest unit of matter

indivisible cannot be divided into smaller parts

nucleus the core of an atom, made up of protons and neutrons

orbit move in a circle

WATCH ME

The 2400 year search for the atom

Atoms are made up of subatomic particles

The research of previous scientists has led to our current model of the atom. This model shows the atom is made up of three subatomic particles. These are outlined below.



KEY TERMS

electron negatively charged particle orbiting the nucleus

proton positively charged particle located inside the nucleus

neutron particle of no charge located inside the nucleus

Bohr-Rutherford model of the atom

Proton number determines the element

Atoms are the smallest units of an **element** that retain the element's properties. Each element is defined by the number of protons in the nucleus of the atom. For example, oxygen has 8 protons, and so it is number 8 on the periodic table. Elements can be represented in two key ways:



Atomic number = number of protons

In an atom with overall zero charge the number of protons equals the number of electrons.

Mass number = number of protons + number of neutrons



Symbolic representation

KEY TERMS

element atoms with the same characteristics and number of protons

atomic number the number of protons in an element

mass number a sum of the number of neutrons and protons in an element

DON'T GET TRICKED

The number of protons and neutrons are not always the exact same.

Periodic table representation

The periodic table

1 H 1.0 hydrogen	gen Periodic table of the elements								2 He 4.0 helium									
3 Li 6.9 lithium	4 Be 9.0 beryllium		5 6 7 8 9 10 B C N 16.0 16.0 19.0 20.2 boron carbon nitrogen oxygen fluorine reconstruction										10 Ne 20.2 neon					
11 Na 23.0 sodium	12 Mg 24.3 magnesium												13 Al 27.0 aluminiur	n 14 Si 28.1 silicon	15 P 31.0 phosphore	16 S 32.1 sulfur	17 Cl 35.5 chlorine	18 Ar 39.9 argon
19 K 39.1 potassium	20 Ca 40.1 calcium	s	21 Sc 45.0 scandium	22 Ti 47.9 titanium	23 V 50.9 vanadium	24 Cr 52.0 chromium	25 Mn 54.9 manganese	26 Fe 55.8 iron	27 Co 58.9 cobalt	28 Ni 58.7 nickel	29 Cu 63.5 copper	30 Zn 65.4 zinc	31 Ga 69.7 gallium	32 Ge 72.6 germaniu	33 As 74.9 arsenic	34 Se 79.0 selenium	35 Br 79.9 bromine	36 Kr 83.8 krypton
37 Rb 85.5 rubidium	38 Sr 87.6 strontium		39 ¥ 88.9 yttrium	40 Zr 91.2 zirconium	41 Nb 92.9 niobium	42 Mo 96.0 molybdenum	43 Tc (98) technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 5b 121.8 antimor	52 Te 127.6 tellurium	53 1 126.9 iodine	54 Xe 131.3 xenon
55 Cs 132.9 caesium	56 Ba 137.3 barium		57-71	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 197.0 gold	80 Hg 200.6 mercury	81 TI 204.4 thallium	82 Pb 207.2 lead	83 Bi 209.0 bismut	84 Po (210) polonium	85 At (210) astatine	86 Rn (222) radon
87 Fr (223) francium	88 Ra (226) radium		89-103	104 Rf (261) rutherfordium	105 Db (262) dubnium	106 Sg (266) seaborgium	107 Bh (264) bohrium	108 Hs (267) hassium	109 Mt (268) meitnerium	110 Ds (271) darmstad	111 Rg (272) roentgenium	112 Cn (285) copernicium	113 Nh (280) nihoniur	114 Fl (289) fleroviur	115 Mc (289) moscoviu	116 Lv (292) mlivermoriur	117 Ts (294) tennessine	118 Og (294) oganesson
Lanthanoids		anoids	57 La 138.9 Ianthanum	58 Ce 140.1 cerium	59 Pr 140.9 praseodymium	60 Nd 144.2 neodymium	61 Pm (145) promethi	62 Sm 150.4 samarium	63 Eu 152.0 europium	64 Gd 157.3 gadolinium	65 Tb 158.9 terbium	66 Dy 162.5 dysprosium	67 Ho 164.9 holmium	68 Er 167.3 erbium	69 Tm 168.9 thulium y	70 Yb 173.1 tterbium	71 Lu 175.0 utetium	
Actinoids		inoids	89 Ac (227) actinium	90 Th 232.0 thorium	91 Pa 231.0 protactinium	92 U 238.0 uranium	93 Np (237) neptunium	94 Pu (244) plutonium	95 Am (243) americium	96 Cm (247) curium	97 Bk (247) berkelium	98 Cf (251) californium e	99 Es (252) insteinium	100 Fm (257) fermium	101 Md (258) nendelevium n	102 No (259) obelium	103 Lr (262) wrencium	

Electrons orbit the nucleus in shells

Electrons can be found in different orbits around the nucleus (also known as shells or **energy levels**). Each orbit is often represented as a circle.

The arrangement of electrons in an atom is known as its **electron configuration**. Electrons usually fill the closest shell to the nucleus first before occupying the next shell. Up to element 20, each shell of an atom has a maximum capacity of electrons it can hold. The maximum number of electrons for each shell is:



KEY TERMS

energy levels distances from the nucleus where electrons can be found

electron configuration the arrangement of electrons in each level around a nucleus

DID YOU KNOW?

Atoms with full outer shells of electrons are far more stable than those without, which are more reactive.

Electrons can be lost or gained

An atom is more stable when its outer shell has a full **octet** of electrons. Electrons can be lost or gained (from another atom) in order to achieve this.

When an atom gains electrons it becomes an **ion** with a negative overall charge (an **anion**). When an atom loses electrons it becomes an ion with a positive overall charge (a **cation**).



KEY TERMS

octet atoms tend to prefer 8 electrons in the outer shell

ion an atom that has a positive or negative charge

anion negatively charged ion

cation positively charged ion

DON'T GET TRICKED

Helium is a special case which prefers 2 electrons in its outer shell.

MEMORY DEVICE Cations are 'pawsitive'.

Sum it up



- can be lost or gained by other atoms
- lighter than protons and neutrons

• similar mass to neutrons

• determines the atomic number

• similar mass to protons

Skill sharpener: Processing and analysing

Representing the atom

1. Choose an element from the first 20 and design a model using everyday objects.





Include in your model

- the subatomic particles proton, neutron, and electron
- the location of each subatomic particle
- the position of electrons on each shell.
- 2. Submit a labelled photo of your model.

Extension

Analyse the model you have developed. Come up with a list of advantages and disadvantages of the model when considering all the information and models known about the atom.

Achievement standards

Year 8: Select and construct appropriate representations to organise and process data and information.

Year 9: Select and construct appropriate representations to organise, process and summarise data and information.

Year 10: Select and construct effective representations to organise, process and summarise data and information.

Example answer

Representing a Carbon atom



Extension

Advantages	Disadvantages
 shows the electron cloud as an area where the electrons exist nucleus is placed in the middle displays electrons on different levels based on scattered placement 	 no display of the protons and neutrons in the nucleus – can't count to make sure that there are the correct number of each subatomic particle not in motion so the electron movement in the cloud is not modelled no electron orbits shown either – making it difficult to check the right number of electrons are placed based on 2, 8, 8, 18 rule

Question 1

Which description best fits the current model of the atom?



negative electrons contained within a positive sphere

- B electrons and neutrons contained within a nucleus, protons surrounding the nucleus
- c negative protons and positive neutrons inside a nucleus, neutral electrons orbiting in shells
- D positive protons and neutral neutrons inside a nucleus, negative electrons orbiting in shells



Question 1 – answer

Which description best fits the current model of the atom?



negative electrons contained within a positive sphere

- B electrons and neutrons contained within a nucleus, protons surrounding the nucleus
- c negative protons and positive neutrons inside a nucleus, neutral electrons orbiting in shells



positive protons and neutral neutrons inside a nucleus, negative electrons orbiting in shells

Protons are positive, neutrons are neutral, and electrons are negative.



Question 2

Determine the mass number and atomic number of an atom with 5 protons and 5 neutrons.



В

D

- Mass number: 5, Atomic number: 10
- Mass number: 10, Atomic number: 5
- Mass number: 15, Atomic number: 5
- Mass number: 5, Atomic number: 15





Question 2 – answer

Determine the mass number and atomic number of an atom with 5 protons and 5 neutrons.



Mass number: 5, Atomic number: 10



Mass number: 15, Atomic number: 5



Mass number: 5, Atomic number: 15



The mass number is the sum of the number of protons and neutrons.



Atoms make up everything. What makes an atom?



Atoms make up everything. What makes an atom?

Subatomic particles make up an atom: protons, neutrons, and electrons. The number of each determines the properties of an atom.



Success measure

I can use protons, neutrons, and electrons to model the structure of the atom.

