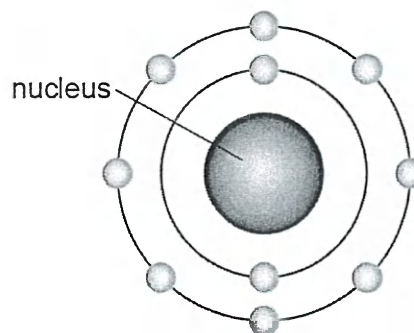


- 1 Write a description of the atomic model shown in this diagram. Your description should include an explanation of:



- where the protons and neutrons are found
- how the electrons are arranged
- the charges on the different subatomic particles
- where the mass of the atom is concentrated
- how the model could be improved so that it would describe our ideas about atoms better.

- 2 Work out what numbers and symbols should be written in **a i** to **e iii** to complete the table below. (You will need a copy of the **periodic table** to answer some of these questions.)

	Atom symbol	Atomic number	Mass number	Number of ...		
				protons	neutrons	electrons
a	${}^{19}_{9}\text{F}$	9	19	i	ii	iii
b	i	2	4	ii	iii	2
c	${}^{235}_{92}\text{U}$	i	ii	92	iii	92
d	i	ii	iii	53	74	53
e	i	2	5	ii	3	iii

- 3 Use this table to answer the questions below.

Atom	Atomic number	Mass number	Number of ...		
			protons	electrons	neutrons
A	5	11	5	5	6
B	10	20	10	10	10
C	48	110	48	48	62
D	10	22	10	10	12

- Which atom has the greatest mass? Explain your answer.
- Which two atoms are of the same element? Explain your answer.
- Which atom has twice the mass of atom **A**? Explain your answer.
- If you had 10 g of atom **D**, what mass of atom **C** would contain the same number of atoms? Explain your answer.

Extra challenge

- 4 Atoms contain three subatomic particles – protons, neutrons and electrons. The relative mass of a proton and a neutron is 1, while the mass of an electron can be regarded as negligible. The relative charge of a proton is +1 and that of an electron is –1.
- Explain why the mass of an electron can be regarded as ‘negligible’.
 - Explain what the final sentence tells us about the charges on a proton and an electron.

Use this short form periodic table to help you answer the questions. It shows symbols and atomic numbers.

		group numbers							
		1	2	3	4	5	6	7	0
period numbers	1	H 1							He 2
	2	Li 3	Be 4	B 5	C 6	N 7	O 8	F 9	Ne 10
	3	Na 11	Mg 12	Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
	4	K 19	Ca 20						

- State what is meant by the term '**electronic configuration**'.
- Write the electronic configurations for helium, carbon, oxygen, chlorine and calcium.
- Draw the electronic configurations for nitrogen and argon.
- The electronic configuration of an element is related to its position in the periodic table.
 - Explain how the group in which an element is placed is related to its electronic configuration. In your answer, refer to the elements in groups 1 and 0.
 - Explain how the period in which an element is placed is related to its electronic configuration. In your answer, refer to the elements in period 2.
- After calcium, the third shell can contain up to 18 **electrons**. An element, which we will call X, is placed after calcium in the periodic table. Element X has the electronic configuration 2.8.18.7.

Use your knowledge and understanding of atomic structure, and the relationship between the electronic configuration of an element and its position in the periodic table, to answer the following questions.

- Explain which group element X is placed in.
- Explain which period element X is placed in.
- Calculate the atomic number of element X, showing clearly how you obtained your answer.
- Atoms of element X exist as two naturally occurring isotopes. One has 44 neutrons in its nucleus and the other has 46 neutrons in its nucleus.

Write the full chemical symbols for these two isotopes.

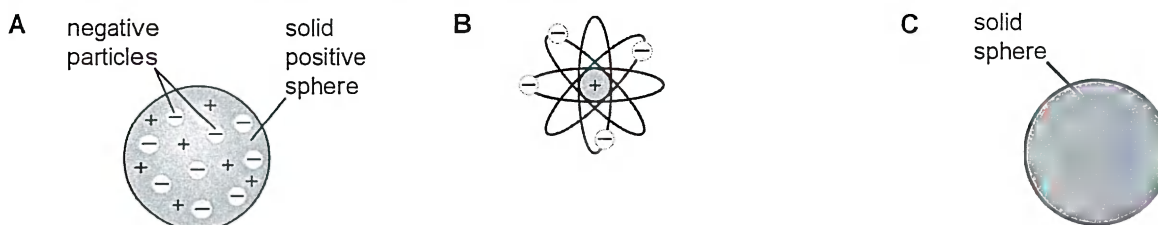
Extra challenge

- In reactions, metal atoms can lose electrons and non-metal atoms can gain electrons. When this happens, charged particles called 'ions' form. Enough electrons are lost or gained so that the ion has the same electronic configuration as the nearest element in group 0.

For example:

- Sodium atoms (2.8.1) lose one electron to become sodium ions (2.8) – the same electronic configuration as neon in group 0.
 - Sulfur atoms (2.8.6) gain two electrons to become sulfide ions (2.8.8) – the same electronic configuration as argon in group 0.
- Work out how many electrons each atom in period 2 (Li to F) must lose or gain to obtain the same electronic configuration as the nearest group 0 element.
 - Describe how carbon and other elements in group 4 are unusual in the way they can form ions.

- 1 Describe the plum pudding model of the **atom**.
- 2 Ernest Rutherford's team of scientists carried out experiments between 1909 and 1913.
 - a Describe the results that Rutherford's team obtained when they fired **alpha particles** at gold foil.
 - b Explain what results they would have expected if the plum pudding model were correct.
 - c Describe the model of the atom that Rutherford suggested following these experiments.
 - d How does this model explain the results of the alpha-scattering experiment?
- 3 These diagrams show three different models of the atom.



The bullet points below give some information about the different models.

- Ernest Rutherford carried out experiments to investigate the structure of the atom.
- J.J. Thompson suggested the plum pudding model of the atom in 1904.
- John Dalton suggested his model of the atom in 1805. It has sometimes been called a billiard ball model.
- Rutherford's model describes atoms as consisting of ...
- Rutherford's model explains the results of the alpha-scattering experiments by saying that ...
- Rutherford's team fired alpha particles at thin gold foil, and found that ...
- The plum pudding model describes an atom as ...
- This model explained how **electrons** might be part of the atom.
- This model helped scientists to explain some of the properties of matter.

Put the sentences in the bullet points into a sensible order and use them to help you to write one or two paragraphs to describe how and why the atomic model has changed over time.

A good answer will link ideas in a sensible order and use correct grammar, spelling and punctuation. You can change the wording in the bullet points if you wish.

Extra challenge

- 4 Dalton's model of atoms as spheres is still used to explain observations such as substances expanding when they are heated. Suggest why this model is still used even though we now have more detailed atomic models.

Appendix 3: Periodic table

The Periodic Table of the Elements

	1	2	3	4	5	6	7	0	
	7 Li lithium 3	9 Be beryllium 4		11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
	23 Na sodium 11	24 Mg magnesium 12		27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
	39 K potassium 19	40 Ca calcium 20		70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
	85 Rb rubidium 37	88 Sr strontium 38		115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
	133 Cs caesium 55	137 Ba barium 56		204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
	[223] Fr francium 87	[226] Ra radium 88		201 Hg mercury 80	201 Hg mercury 80	197 Au gold 79	[272] Rg roentgenium 111		
				59 Co cobalt 27	59 Ni nickel 28	59 Co cobalt 27	59 Ni nickel 28		
				103 Rh rhodium 45	106 Pd palladium 46	103 Rh rhodium 45	106 Pd palladium 46		
				192 Ir iridium 77	195 Pt platinum 78	192 Ir iridium 77	195 Pt platinum 78		
				[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[268] Mt meitnerium 109	[271] Ds darmstadtium 110		
				[277] Hs hassium 108	[277] Hs hassium 108	[277] Hs hassium 108	[277] Hs hassium 108		
				[264] Bh bohrium 107	[264] Bh bohrium 107	[264] Bh bohrium 107	[264] Bh bohrium 107		
				[266] Sg seaborgium 106	[266] Sg seaborgium 106	[266] Sg seaborgium 106	[266] Sg seaborgium 106		
				[262] Db dubnium 105	[262] Db dubnium 105	[262] Db dubnium 105	[262] Db dubnium 105		
				[261] Rf rutherfordium 104	[261] Rf rutherfordium 104	[261] Rf rutherfordium 104	[261] Rf rutherfordium 104		
				[227] Ac actinium 89	[227] Ac actinium 89	[227] Ac actinium 89	[227] Ac actinium 89		
				45 Sc scandium 21	48 Ti titanium 22	55 Mn manganese 25	56 Fe iron 26		
				91 Zr zirconium 40	93 Nb niobium 41	[98] Tc technetium 43	101 Ru ruthenium 44		
				178 Hf hafnium 72	181 Ta tantalum 73	186 Re rhenium 75	190 Os osmium 76		
				139 La lanthanum 57	141 Ce cerium 58	142 Pr praseodymium 59	144 Nd neodymium 60		
				89 Y yttrium 39	90 Zr zirconium 40	91 Zr zirconium 40	91 Zr zirconium 40		
				139 La lanthanum 57	141 Ce cerium 58	142 Pr praseodymium 59	144 Nd neodymium 60		
				137 Ba barium 56	138 La lanthanum 57	139 La lanthanum 57	139 La lanthanum 57		
				89 Y yttrium 39	90 Zr zirconium 40	91 Zr zirconium 40	91 Zr zirconium 40		
				137 Ba barium 56	138 La lanthanum 57	139 La lanthanum 57	139 La lanthanum 57		
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				137 Ba barium 56	138 La lanthanum 57	139 La lanthanum 57	139 La lanthanum 57		
				89 Y yttrium 39	90 Zr zirconium 40	91 Zr zirconium 40	91 Zr zirconium 40		
				137 Ba barium 56	138 La lanthanum 57	139 La lanthanum 57	139 La lanthanum 57		
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				137 Ba barium 56	138 La lanthanum 57	139 La lanthanum 57	139 La lanthanum 57		
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