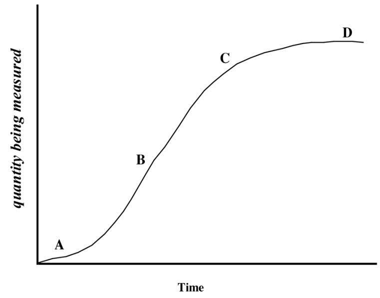
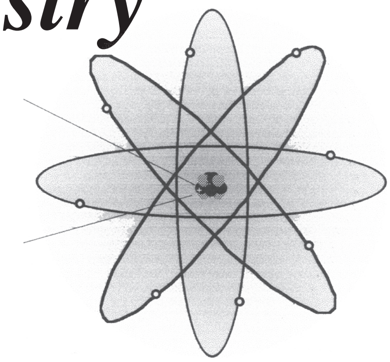
National 5 Chemistry



Unit 1:



Chemical Changes & Structure

Student:

Topic 2
Atomic Chemistry

Topics	Sections		Done	Checked
2.1 *Atomic Structure*	1. Atomic Models			
	2. Important Numbers			
	3. Nuclide Notation			
	4. Isotopes			
	5. Relative Atomic Mass (RAM) & Mass Spectometer			
	6. Isotopic Ions			
	Self -Check Questions 1 - 6	Score: /		
2.2 *Radioactivity*	1. Stability			
	2. Emissions			
	3. Nuclear Equations			
	Self -Check Questions 1 - 8	Score: /		
2.3 *Nuclear Chemistry*	1. Radioactivie Decay			
	2. Using Radioisotopes			
	3. Nuclear Energy			
	Self -Check Questions 1 - 5	Score: /		
2.4 *Electron Arrangements*	1. Electron Shells			
	2. Electrons & The Periodic table			
	3. Electrons & Bonding Powers			
	Self -Check Questions 1 - 8	Score: /		
Consolidation Work	Consolidation A	Score: /		
	Consolidation B	Score: /		
	Consolidation C	Score: /		
	Consolidation D	Score: /		
End-of-Unit Assessment	Score: %	Grade:		

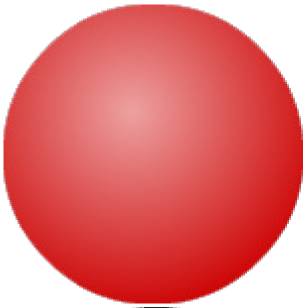
2.1 Atomic Structure

This lesson topic revises and extends your understanding of Atomic Structure.

Atomic Models

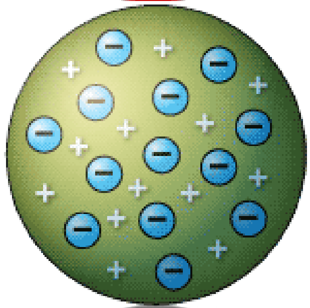
Dalton Model

Early models of the atom imagined hard indestructible spheres similar to "***Snooker Balls***" colliding and bouncing off each other. This Model remains effective as part of our ***Particle Model of Matter***.



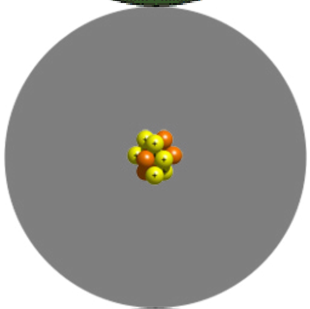
Thompson Model

Scientists such as ***JJ Thompson*** were able to show, firstly, that atoms contained very small ***negatively charged*** particles (***electrons***) and later that they also contained ***positive*** particles (***protons***). The "***Plum Pudding***" model.



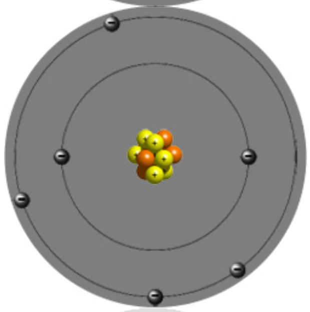
Rutherford Model

Rutherford then showed that all the ***protons*** were concentrated in a tiny ***nucleus*** in the centre of the atom. and that over 99% of an atom was ***empty space***. Finally the presence of ***neutral*** particles (***neutrons***) was proven.



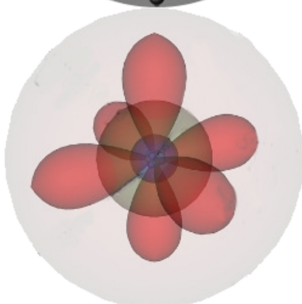
Bohr Model

Bohr put forward the theory that electrons orbited the nucleus in ***shells*** rather like planets around the sun. This is the model most often used, though we now know that electrons do not move like this.



Cloud Model

We can also imagine electrons occupying ***cloud-like regions in space*** called "***orbitals***". This model is particularly useful when trying to visualise the ***shape*** of molecules and when dealing with multiple bonds.



SUMMARY

3 types of particles; ***protons*** (+ve), ***neutrons*** and ***electrons*** (–ve).

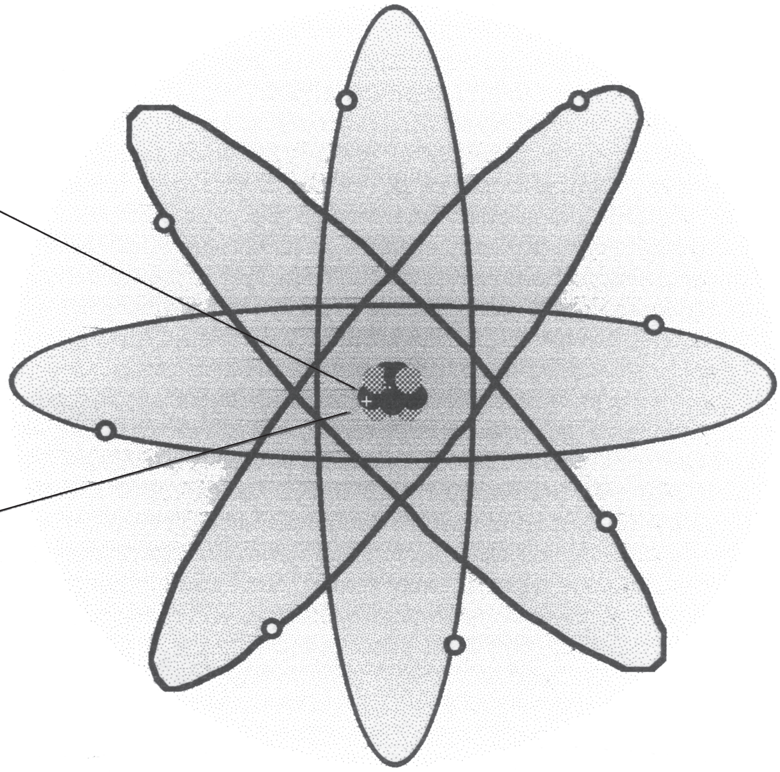
The ***protons*** and ***neutrons*** are squashed together in the ***nucleus***. The ***nucleus*** is extremely small, heavy and ***positively charged***.

The ***electrons*** 'move' around the ***nucleus*** in a complex pattern

Important Numbers

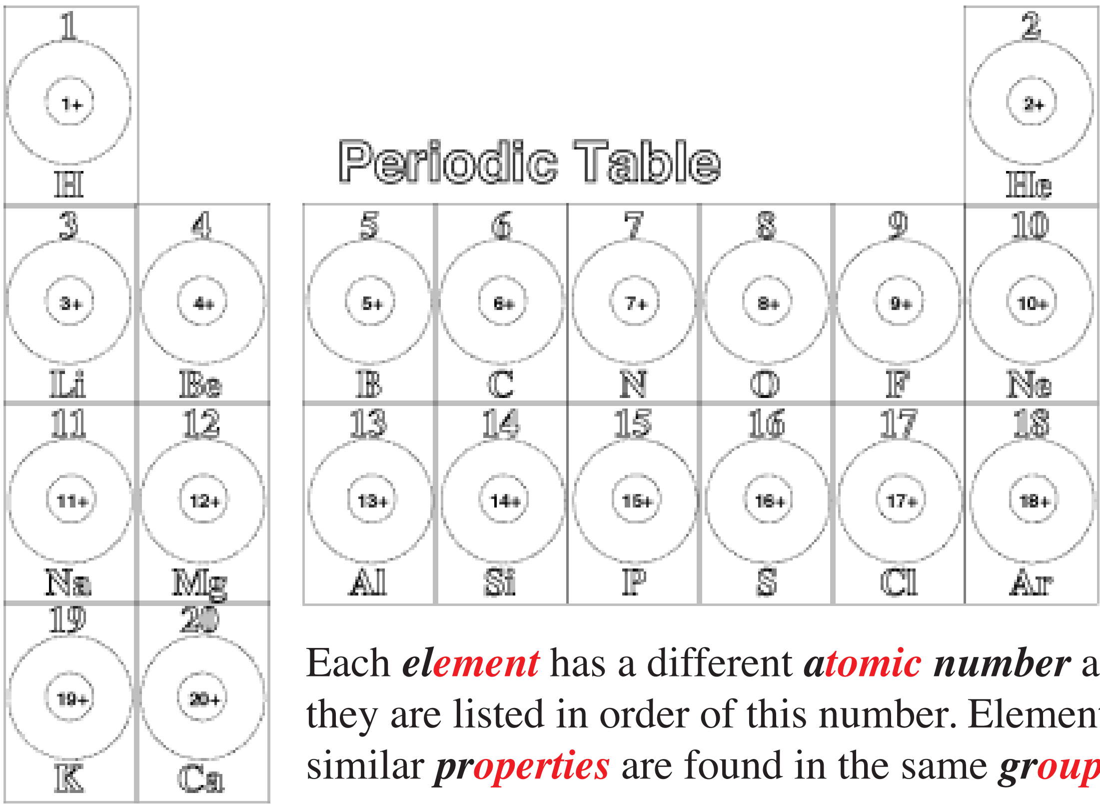
Atomic Number - is the number of ***protons*** in the ***nucleus*** of ***all*** atoms in an element

Mass Number - is the total number of ***protons*** and ***neutrons*** in the ***nucleus*** of ***an*** atom



Electrons - In neutral atoms the number of ***electrons*** is equal to the number of ***protons*** so we can usually use the ***Atomic Number*** to tell us the number of ***electrons*** as well.

Neutrons - The number of ***neutrons*** is simply the number of ***protons*** (***Atomic Number***) subtracted from the ***Mass Number***.



Each ***element*** has a different ***atomic number*** and they are listed in order of this number. Elements with similar ***properties*** are found in the same ***group***.

Element	Symbol	Atomic Number	Mass Number	number of protons	number of electrons	number of neutrons
Nitrogen	N	7	14	7	7	14 - 7 = 7
Oxygen	O	8	16	8	8	16 - 8 = 8
Neon	Ne	10	20	10	10	20 - 10 = 10
Sodium	Na	11	23	11	11	23 - 11 = 12
Magnesium	Mg	12	24	12	12	24 - 12 = 12
Silicon	Si	14	28	14	14	28 - 14 = 14
Phosphorus	P	15	31	15	15	31 - 15 = 16
Sulfur	S	16	32	16	16	32 - 16 = 16
Potassium	K	19	39	19	19	39 - 19 = 20
Nickel	Ni	28	59	28	28	59 - 28 = 21
Zinc	Zn	30	66	30	30	66 - 30 = 36
Silver	Ag	47	108	47	47	108 - 47 = 61
Tin	Sn	50	119	50	50	119 - 50 = 69
Platinum	Pt	78	195	78	78	195 - 78 = 117
Mercury	Hg	80	201	80	80	201 - 80 = 120

Number of protons = Atomic Number

Number of electrons = Number of protons = Atomic Number

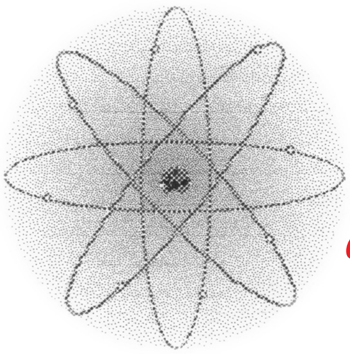
Number of neutrons = Total in nucleus - Number of protons
= Mass Number - Atomic Number

The Mass Number can only ever refer to one particular atom. However, when we want to talk generally about the mass of the atoms of an element, we can usually safely assume that the ***average mass (RAM)*** *rounded to the* ***nearest whole number*** can safely be used as the 'most likely' Mass Number for an atom of this element - but be careful, Br has ***RAM*** 79.9 so we would assume 'most likely' Mass Number = 80, but only ^{79}Br and ^{81}Br exist naturally.

Nuclide Notation

Nuclide Notation is the system which adds information about an atom to its ***Symbol***.

Name of particle	*Where found in atom*	*Relative mass*	*Charge*
proton	*in the nucleus*	1	+ 1
neutron	*in the nucleus*	1	0
electron	*orbiting around the nucleus*	0	- 1

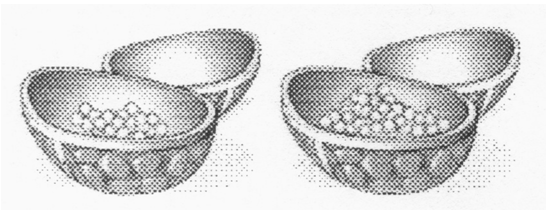


mass number ⟶ 7

atomic number ⟶ 3

$$^{7}_{3}\text{Li}$$

Isotopes



$^{1}_{1}\text{H}$

Ordinary hydrogen

$^{2}_{1}\text{H}$

Heavy hydrogen (deuterium)

$^{3}_{1}\text{H}$

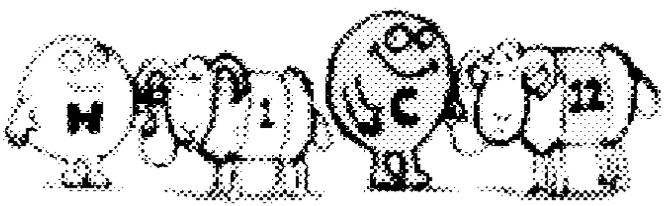
Very heavy hydrogen (tritium)

Isotopes are atoms of the ***same*** element which have the ***same*** number of ***protons*** but have ***different*** numbers of ***neutrons***.

This means that atoms of the ***same element*** can have ***different masses*** .

> ***Iso*** are atoms of the ***same at*** ***number*** but ***different m*** ***numbers*** .

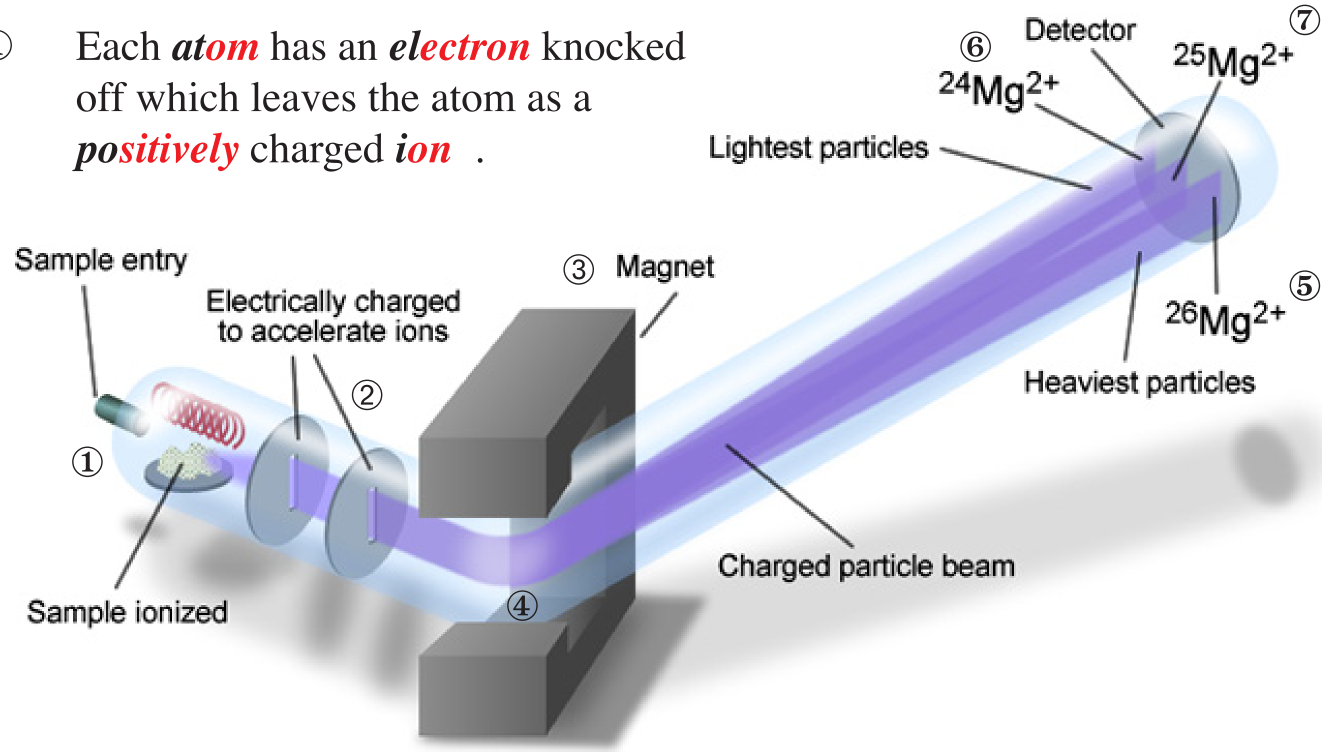
Relative Atomic Mass (RAM)



Since atoms of the ***same element*** can have ***different masses***, it is necessary to know the ***average*** mass - the ***relative atomic mass*** of an element.

Information provided by a machine called a ***mass spectrometer*** can be used to calculate the ***RAM*** of an element.

① Each ***atom*** has an ***electron*** knocked off which leaves the atom as a ***positively*** charged ***ion*** .



② The ***ions*** are ***accelerated*** by an ***electric*** field; repelled by a ***positive*** plate, attracted towards a ***negative***.

③ The strength of the ***magnetic*** field is gradually ***increased***.

④ Any ***ions*** that are of the correct ***mass*** will be deflected ‘round the corner’.

⑤ Any ***ions*** which are still too ***heavy*** for the ***magnetic*** field will crash into the wall of the chamber. They will be ***detected*** later when the field is ***stronger***.

⑥ Any ***ions*** which are too ***light*** will be deflected too far. They would have been ***detected*** earlier when the field was ***weaker***.

⑦ Any ***ions*** arriving here are ***detected*** and ***counted***.

The ***mass spectrometer*** is able to tell us 3 things about an element:

1. the ***number*** of ***isotopes*** that element has,
2. the ***mass number*** of each ***isotope***, and
3. the ***relative amounts*** of each ***isotope***.

The information is printed out in the form of a ***mass spectrum***.

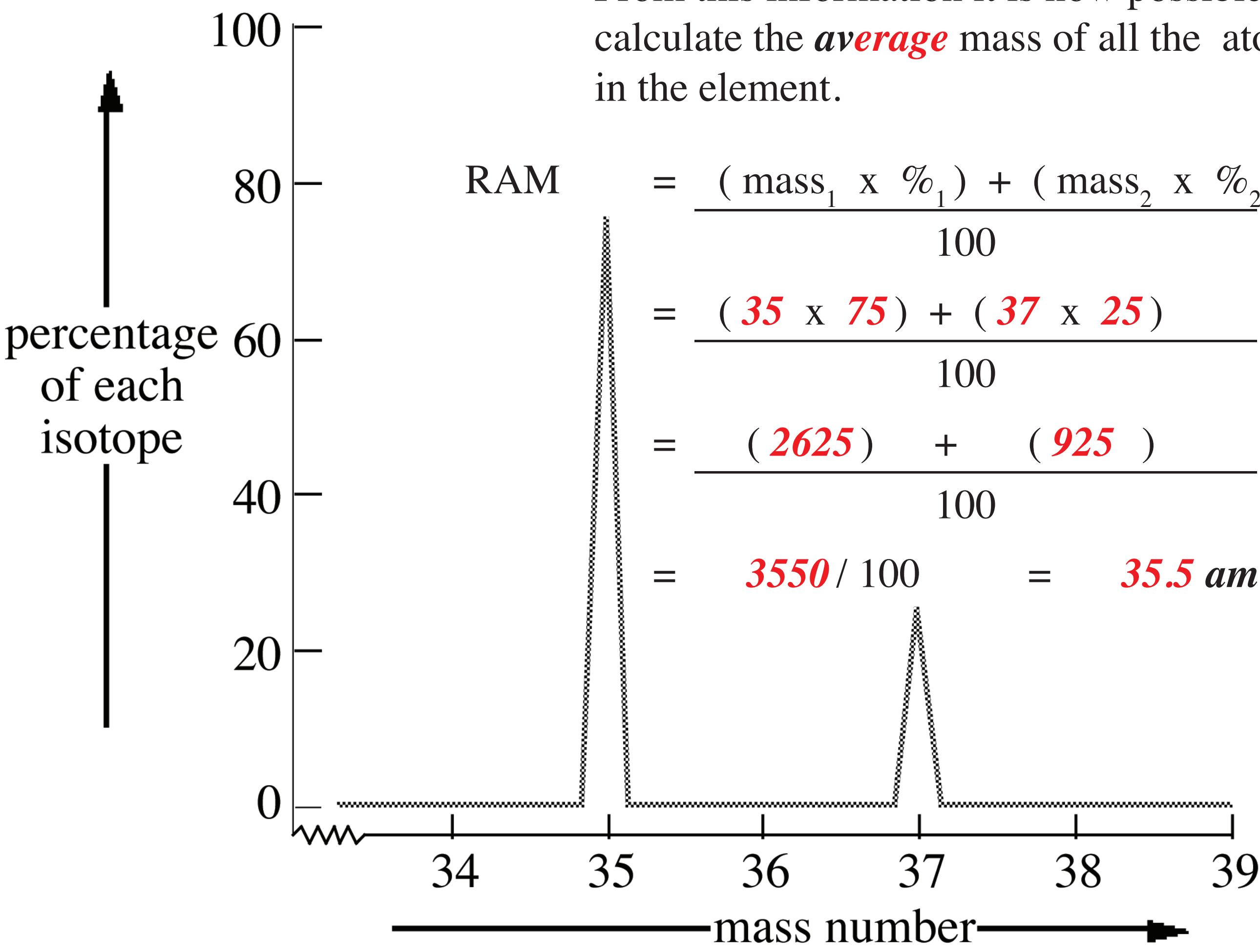
From this information it is now possible to calculate the ***average*** mass of all the atoms in the element.

$$\text{RAM} = \frac{(\text{mass}_1 \times \%_1) + (\text{mass}_2 \times \%_2)}{100}$$

$$= \frac{(\mathbf{\mathit{35}} \times \mathbf{\mathit{75}}) + (\mathbf{\mathit{37}} \times \mathbf{\mathit{25}})}{100}$$

$$= \frac{(\mathbf{\mathit{2625}}) + (\mathbf{\mathit{925}})}{100}$$

$$= \mathbf{\mathit{3550}} / 100 = \mathbf{\mathit{35.5}}\ \mathbf{\mathit{amu}}$$



Atomic No. (Z)	Name	Symbol	% Abundance	RAM (Relative Atomic Mass)
3	Lithium	^{6}Li	7.59	
		^{7}Li	92.41	
5	Boron	^{10}B	19.90	
		^{11}B	80.10	
12	Magnesium	^{24}Mg	78.99	
		^{25}Mg	10.00	
		^{26}Mg	11.01	
14	Silicon	^{28}Si	92.23	
		^{29}Si	4.68	
		^{30}Si	3.09	
24	Chromium	^{50}Cr	4.35	
		^{52}Cr	83.79	
		^{53}Cr	9.50	
		^{54}Cr	2.36	

* Some values within this table have been rounded / modified for simplicity

Isotopic Ions

It is not just the ***number of neutrons*** that can be different in atoms of the ***same element***. Atoms can also change their ***number of electrons***.

${}^{7}_{3}\mathrm{Li}$	${}^{6}_{3}\mathrm{Li}$	${}^{7}_{3}\mathrm{Li}^{+}$	${}^{6}_{3}\mathrm{Li}^{+}$
protons = ***3***	*protons* = ***3***	*protons* = ***3***	*protons* = ***3***
neutrons = ***4***	*neutrons* = ***3***	*neutrons* = ***4***	*neutrons* = ***3***
electrons = ***3***	*electrons* = ***3***	*electrons* = ***2***	*electrons* = ***2***

The ***number of protons*** never changes. This is why the ***Atomic Number*** for an element is defined as the ***number of protons***.

Element	*Symbol*	*Atomic Number*	*Mass Number*	*number of protons*	*number of neutrons*	*number of electrons*
Lithium	${}^{7}_{3}\mathrm{Li}^{+}$	***3***	***7***	***3***	***4***	***2***
Oxygen	${}^{16}_{8}\mathrm{O}^{2-}$	***8***	***16***	***8***	***8***	***10***
Chlorine	${}^{37}_{17}\mathrm{Cl}^{-}$	***17***	***37***	***17***	***20***	***18***
Sodium	${}^{23}_{11}\mathrm{Na}^{+}$	***11***	***23***	***11***	***12***	***10***
Phosphorus	${}^{31}_{15}\mathrm{P}^{3-}$	***15***	***31***	***15***	***16***	***18***
Iron (II)	${}^{56}_{26}\mathrm{Fe}^{2+}$	***26***	***56***	***26***	***30***	***24***
Iron (III)	${}^{58}_{26}\mathrm{Fe}^{3+}$	***26***	***58***	***26***	***32***	***23***
Hydrogen	${}^{2}_{1}\mathrm{H}^{+}$	***1***	***2***	***1***	***1***	***0***
Tin (II)	${}^{116}_{50}\mathrm{Sn}^{2+}$	***50***	***116***	***50***	***66***	***48***
Tin (IV)	${}^{119}_{50}\mathrm{Sn}^{4+}$	***50***	***119***	***50***	***69***	***46***

Q1. SC

The grid shows information about some particles.

	Number of		
Particle	***protons***	***neutrons***	***electrons***
A	**11**	**12**	**11**
B	**9**	**10**	**9**
C	**11**	**13**	**11**
D	**19**	**20**	**18**
E	**9**	**10**	**10**

a) Identify the particle which is a negative ion.

____

a) Identify the ***two*** particles which are isotopes.

_______ and _______

Q2. Int2

An atom has 26 protons, 26 electrons and 30 neutrons. The atom has.

A atomic number 26, mass number 56

B atomic number 26, mass number 52

C atomic number 30, mass number 56

D atomic number 30, mass number 82

Q3. Int2

Which line in the table describes a ***neutron***?

	Mass	***Charge***
A	1	- 1
B	negligible	0
C	1	+ 1
D	1	0

Q4. Int2

The isotopes of carbon and oxygen are given in the table.

Isotopes of carbon	${}^{12}_{6}C$	${}^{13}_{6}C$	${}^{14}_{6}C$
Isotopes of oxygen	${}^{16}_{8}O$	${}^{17}_{8}O$	${}^{18}_{8}O$

A molecule of carbon dioxide with mass 46 could contain

A one ${}^{12}C$ atom and two ${}^{16}O$ atoms

B one ${}^{14}C$ atom and two ${}^{18}O$ atoms

C one ${}^{12}C$ atom, one ${}^{16}O$ atoms and one ${}^{18}O$ atom

D one ${}^{14}C$ atom, one ${}^{16}O$ atoms and one ${}^{18}O$ atom

Q5. Int2

In the manufacture of glass, other chemicals can be added to alter the properties of the glass. The element boron can be added to glass to make oven proof dishes.

Information about an atom of boron is given below.

Particle	***Number***
proton	*5*
electron	*5*
neutron	*6*

Use this information to complete the nuclide notation for this atom of boron.

$${}^{\dots\dots}_{\dots\dots}\mathbf{B}$$

Atoms of boron exist which have the same number of protons but a different number of neutrons from that shown in the table.

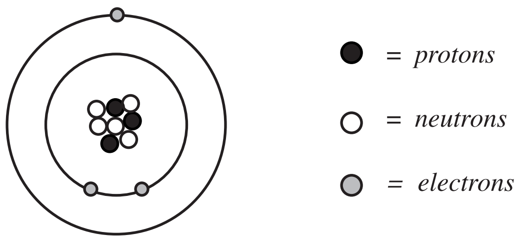
What name can be used to describe the different atoms of boron?

____

Q6. Int2

Elements are made up of atoms.

An atom of an element is represented by the diagram below.



What name is given to the part of the atom which contains protons and neutrons?

____

Using the information in the diagram:

a) state the mass of this atom;

____

b) explain why this atom is electrically neutral;

____

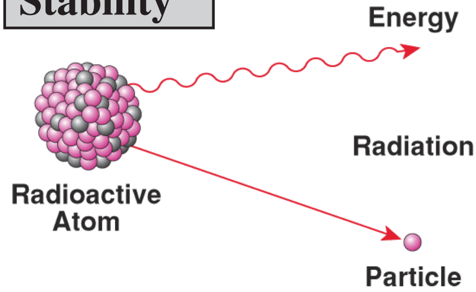
____

c) name the ***family*** of elements to which this atom belongs.

____

2.2 Radioactivity

Stability



Most elements have ***isotopes***, most of which are ***unstable***.

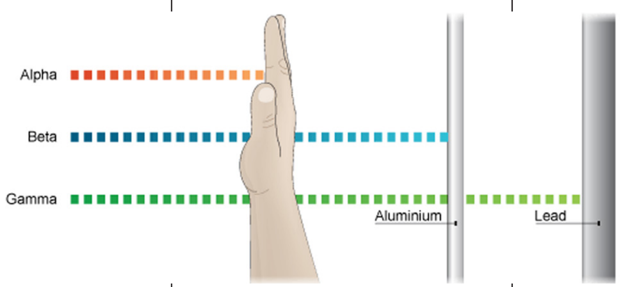
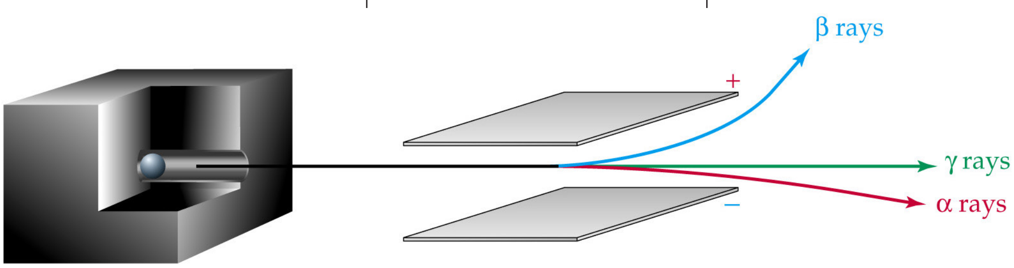
Radioactivity is the result of ***unstable nuclei*** (***radioisotopes***) *rearranging* to form ***more stable nuclei*** .

Energy is always released and, often, a small ***particle*** is also ***emitted*** from the nucleus.

Emissions

α-particles
β-particles
γ-rays

Most radioactivity involves the ***emission*** of α- and β-particles but ***energy***, in the form of *high frequency electromagnetic radiation* is also released.These γ-rays are the same as other ***electromagnetic radiation*** such as *radio-waves*, *visible light* and *x-rays* but are of ***higher energy*** and, therefore, ***more dangerous***.

Property	*Type of emission*		
	α-particle	*β-particle*	*γ-rays*
nature	2 ***protons***, 2 ***neutrons*** (He nucleus)	***electron*** (n → p + e)	high ***frequency*** radiation
charge	2 +	1 -	0
mass	1 amu	0 amu	0
stopped by	***paper***	***aluminium*** foil	***lead*** sheet
			
electric field	*slightly* towards ***negative*** plate	*greatly* towards ***positive*** plate	no effect
			

All 3 types of ***radiation*** are capable of knocking ***electrons*** off any atoms they ***collide*** with so are sometimes referred to as ***ionising radiation***.

The ***ionising*** effect of the ***radiation*** is used to both ***detect*** and ***count*** radiation - each particle entering the *detector* triggers an ***electron*** and the ***flow of electrons*** (*current*) determines the ***amount***.

The ***ionising*** effect of the ***radiation*** can lead to ***harmful*** changes in ***human tissue*** - hence the protective clothing.

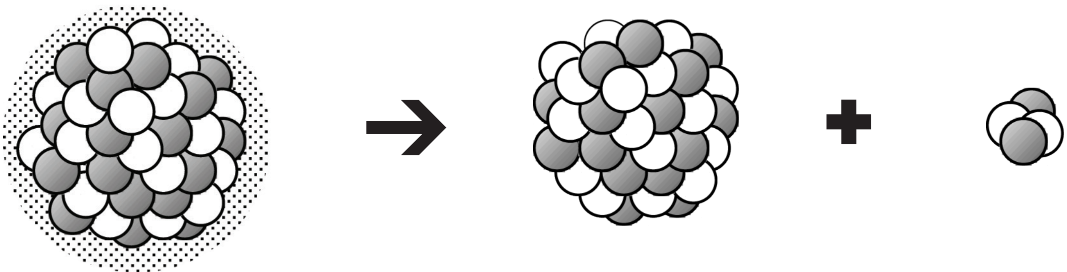
Nuclear Equations

With the exception of γ-rays, all nuclear reactions involve particles with mass and charge so we can continue to write equations to represent these processes.

$$\textit{mass} \rightarrow \; {}^{206}_{82}\mathrm{Pb} \; \leftarrow \textit{charge}$$

Most atoms continue to be represented by their usual ***symbols*** except that ***mass numbers*** are now *essential* and the ***'atomic number'*** now represents the *'charge on the particle'*

For example:



an ***unstable*** *polonium* nucleus — a ***stable*** *lead* nucleus — an α-*particle*

$${}^{210}_{84}\mathrm{Po} \qquad {}^{206}_{82}\mathrm{Pb} \qquad {}^{4}_{2}\mathrm{He}$$

The main particles that ***need to be learnt*** are:-

${}^{4}_{2}\alpha$	${}^{4}_{2}\mathrm{He}$	α - ***particles***	(strictly speaking ${}^{4}_{2}\mathrm{He}^{2+}$)
${}^{0}_{-1}\beta$	${}^{0}_{-1}e$	β - ***particles***	(slow moving electrons emitted from the nucleus.)

neutrons ${}^{1}_{0}n$ ***protons*** ${}^{1}_{1}p$

As with all other ***equations***, these must be ***balanced***. This means that the *overall mass* on both sides must be the ***same*** and the *overall charge* on both sides must be the ***same***.

e.g. $^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

mass = 14 *mass* = 14 + 0 = 14

charge = 6+ *charge* = 7+ + (-1) = 6+

Typical processes include:-

Alpha decay $^{230}_{92}U \longrightarrow {}^{226}_{90}Th + {}^{4}_{2}He$

Beta decay $^{216}_{84}Po \longrightarrow {}^{216}_{85}At + {}^{0}_{-1}e$

Gamma decay *this is the emission of energy so no equation possible*

Nuclear Fusion *in suns, at temperatures of about 10 million K, small atoms can fuse together*

$^{2}_{1}H + {}^{3}_{1}H \longrightarrow \quad + {}^{1}_{0}n$

'Man-made' processes include:-

Nuclear Fission *in power stations atoms are bombarded with neutrons to form unstable nuclei which then split apart to form smaller atoms*

$^{235}_{92}U + {}^{1}_{0}n \longrightarrow \quad \longrightarrow {}^{140}_{54}Xe + {}^{235}_{92}U + 2\,{}^{1}_{0}n$

$^{206}_{84}Po \rightarrow {}^{202}_{82}Pb + {}^{4}_{2}\alpha$

$^{124}_{51}Sb \rightarrow {}^{124}_{52}Te + {}^{0}_{-1}\beta$

$^{129}_{53}I \rightarrow {}^{0}_{-1}e + {}^{129}_{54}Xe$

$^{255}_{104}Rf \rightarrow {}^{4}_{2}\alpha + {}^{251}_{102}No$

$^{216}_{86}Rn \rightarrow {}^{4}_{2}\alpha + {}^{212}_{84}Po$

$^{85}_{35}Br \rightarrow {}^{0}_{-1}e + {}^{85}_{36}Kr + {}^{0}_{0}\gamma$

$^{235}_{95}Am \rightarrow {}^{4}_{2}\alpha + {}^{239}_{97}Bk$

$^{32}_{15}P \rightarrow {}^{0}_{-1}e + {}^{32}_{16}S + {}^{0}_{0}\gamma$

$^{52}_{22}Ti \rightarrow {}^{0}_{-1}e + {}^{52}_{23}V$

$^{257}_{101}Md \rightarrow {}^{4}_{2}\alpha + {}^{4}_{2}\alpha + {}^{249}_{97}Bk$

Q1. H

Phosphorus-32 and strontium-89 are two radioisotopes used to study how far mosquitoes travel.

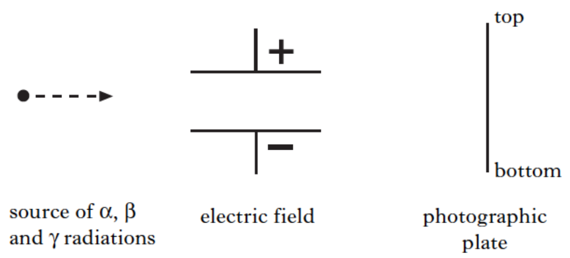
Strontium-89 decays by emission of a beta particle.

Complete the nuclear equation for the decay of strontium-89.

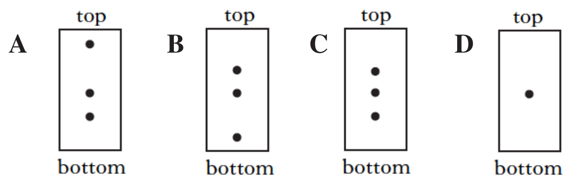
$$^{89}\text{Sr} \rightarrow$$

Q2. H

Alpha, beta and gamma radiation is passed from a source through an electric field onto a photographic plate.



Which of the following patterns will be produced on the photographic plate?



Q3. H

From which of the following could $^{32}_{15}\text{P}$ be produced by neutron capture?

A $^{33}_{15}\text{P}$

B $^{32}_{16}\text{S}$

C $^{31}_{15}\text{P}$

D $^{31}_{16}\text{S}$

Q4. H

Carbon-13 NMR is a technique used in chemistry to determine the structure of organic compounds.

Calculate the neutron to proton ratio in an atom of carbon-13.

Q5. H

Which particle will be formed when an atom of $^{211}_{83}\text{Bi}$ emits an α-particle and the decay product then emits a β-particle?

A $^{207}_{82}\text{Pb}$

B $^{208}_{81}\text{Tl}$

C $^{209}_{80}\text{Hg}$

D $^{210}_{79}\text{Au}$

Q6. H

The element iodine has only one isotope that is stable. Several of the radioactive isotopes of iodine have medical uses. Iodine-131, for example, is used in the study of the thyroid gland and it decays by beta emission.

a) why are some atoms unstable?

____

____

b) complete the balanced nuclear equation for the beta decay of iodine-131.

$$^{131}_{53}\text{I} \rightarrow$$

Q7. H

Thorium-227 decays by alpha emission.

a) Complete the nuclear equation for the decay of thorium-227.

$$^{227}\text{Th} \rightarrow$$

b) A sample of thorium-227 was placed in a wooden box. A radiation detector was held 10 cm away from the box.

Why was alpha radiation not detected?

____

____

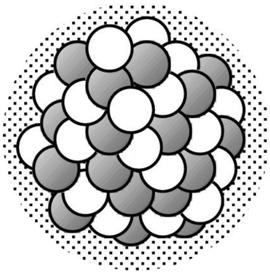
Q8. H

An atom of ^{227}Th decays by a series of alpha emissions to form an atom of ^{211}Pb. How many alpha particles are released in the process?

____

2.3 Nuclear Chemistry

Radioactive Decay



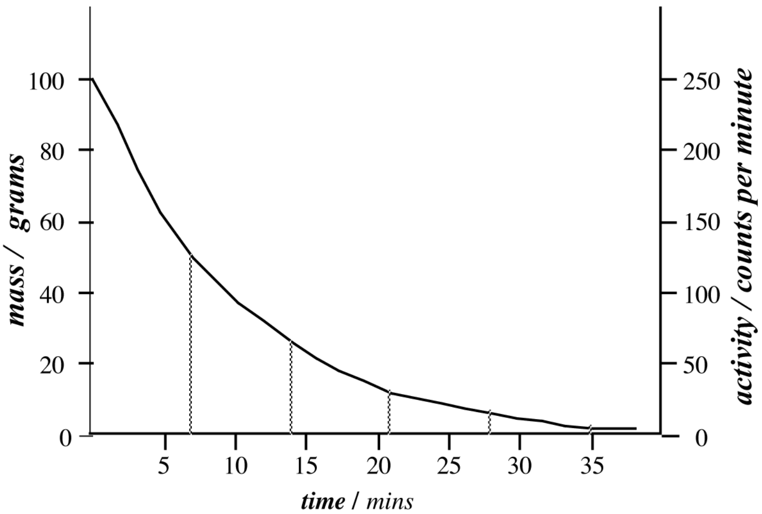
The breakdown of the ***nuclei*** of ***unstable*** atoms is known as ***decay***.

It is a totally ***random*** process, i.e it is ***impossible*** to predict exactly when a *particular* **nucleus** will break apart.

It is also a purely ***nuclear*** reaction i.e. it is not affected by most of the factors that affect normal chemical reactions such as:-

state	solid , liquid, gas, solution, lump, powder etc. makes no difference
temperature	do not decay faster when hot
form	atoms, ions, single or in molecules makes no difference
pressure	has no effect
catalysts	have no effect

Though ***random***, the ***decay*** will still follow a ***predictable pattern***.

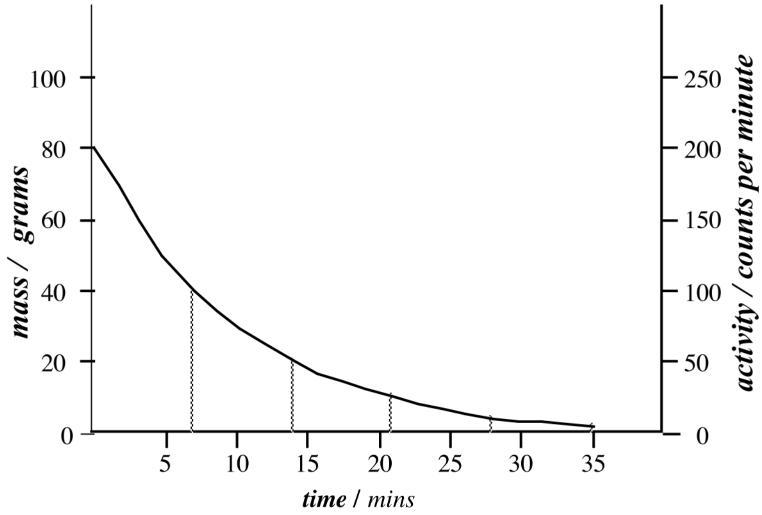


Starting with 100g of radioactive material, a ***geiger counter*** could detect 250 particles being ***emitted*** every minute.

The ***mass*** of radioactive material ***decreases***, as does the ***activity***.

The ***decrease*** is not ***constant***, (i.e. not a ***straight line***), but it does follow a ***pattern***.

After a *certain time* the ***mass*** of radioactive material will fall to *half its original value*. The ***activity*** will also be *halved*. It will then take the *same length of time* for the ***mass***, and the ***activity***, to *half again*. This time is known as the ***half-life*** ($t_{½}$). In the example above, the half-life, $t_{½}$, = 7 minutes.



Starting with a ***different*** ***mass***, **80**g, of radioactive material, a ***geiger counter*** would detect a *lower* ***activity***,only 200 particles being ***emitted*** every minute.

However the ***half-life*** remains at 7 minutes.

The ***pattern*** for the ***decay*** remains the same *regardless of the mass you start with*.

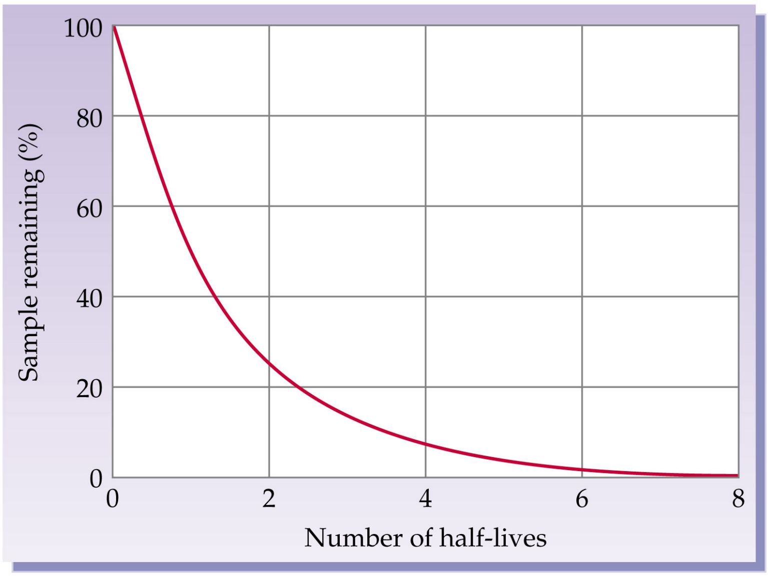
Different *isotopes* ***decay*** at *different* ***rates*** but all show this pattern:-

some have a *very* ***short*** half-life e.g ^{220}Ra $t_{½}$ = 55 seconds

others have a *very* ***long*** half-life e.g ^{238}U $t_{½}$ = 4.51 x 10^9 years

Radioisotope	**Symbol**	**Radiation**	**Half-Life**	**Use**
Tritium	$^{3}_{1}H$	β^-	12.33 years	Biochemical tracer
Carbon-14	$^{14}_{6}C$	β^-	5730 years	Archaeological dating
Phosphorus-32	$^{32}_{15}P$	β^-	14.26 days	Leukemia therapy
Potassium-40	$^{40}_{19}K$	β^-	1.28×10^9 years	Geological dating
Cobalt-60	$^{60}_{27}Co$	β^-, γ	5.27 years	Cancer therapy
Technetium-99*m**	$^{99m}_{43}Tc$	γ	6.01 hours	Brain scans
Iodine-123	$^{123}_{53}I$	γ	13.27 hours	Thyroid therapy
Uranium-235	$^{235}_{92}U$	α, γ	7.04×10^8 years	Nuclear reactors

*The *m* in technetium-99*m* stands for *metastable*, meaning that it undergoes γ emission but does not change its mass number or atomic number.



We consider that an ***isotope*** is ‘safe’ when the level of its ***activity*** falls to the level of normal ***background radiation***.

Generally it takes about 6 to 8 half-lives.

We are all exposed to ***radiation*** all the time. About 85% of this is natural due to radioisotopes in rocks and radiation from the sun.

About 15% is man-made resulting from ***medical uses*** and, *more controversially*, from *leakages* from ***nuclear power stations*** and the ***disposal of nuclear waste***.

Using Radioisotopes

There are very many uses for radioisotopes, these are a few.

Medical ***examining body tissues or organs***

e.g ^{132}I and ^{125}I are used to test the health of the ***thyroid*** gland

emits γ-radiation - ***high penetration*** - escapes body to be detected $t_{½}$ = 13.27 hrs - ***short half-life*** - become safe within days

cancer treatments

e.g ^{60}Co is a powerful γ-emitter used to treat deep-seated ***tumours***

emits γ-radiation - ***high penetration*** - enters body to reach tumours $t_{½}$ = 5.27 yrs - ***medium half-life*** - machine emits constant level

e.g ^{32}P is a weak β-emitter which can be applied directly to treat ***skin cancer***

emits β-radiation - ***medium penetration*** - only has to go 'skin deep' $t_{½}$ = 14.26 days - ***short half-life*** - become safe within months

e.g. wires of ^{198}Au can be placed inside ***tumours*** to dose them with radiation whilst minimising damage to surrounding healthy cells.

emits β-radiation - ***medium penetration*** - won't escape from tumour $t_{½}$ = 2.7 days - ***short half-life*** - become safe within weeks

Industrial ***detecting flaws***

e.g ^{60}Co can be used to take 'X-ray pictures' of ***welds*** and castings

measuring engine wear

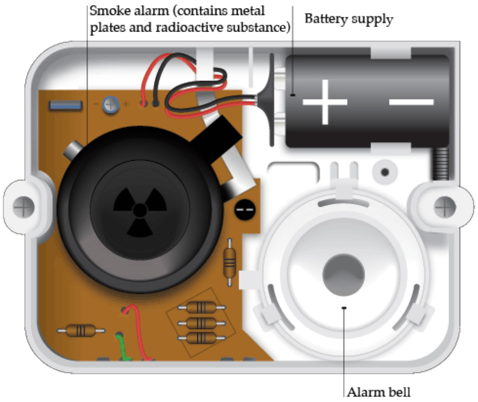
e.g. engine/oil makers used ***piston rings*** with a thin layer of radioactive material on the surface to monitor wear without ***dismantling*** the engine

detecting cracks in jet engines

e.g γ-radiation from ^{192}Ir is used to detect ***cracks*** in jet turbines

domestic smoke detectors

e.g. ^{241}Am emits α-particles that even a small amount of ***smoke*** blocks

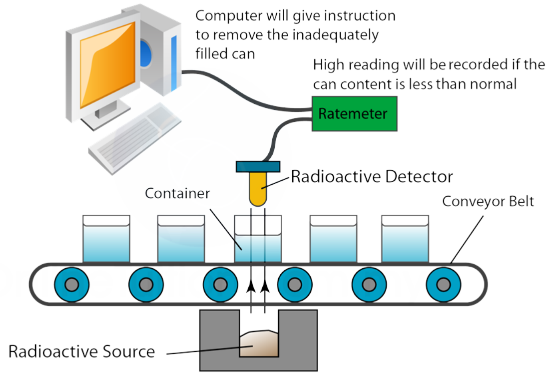


emits α-radiation - ***short penetration*** - won't escape from detector $t_{½}$ = 432 yrs - ***medium half-life*** - level of radiation won't drop in lifetime of detector.

small quantity minimises disposal problem.

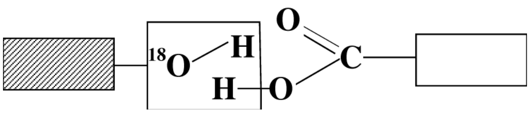
measuring thickness/checking contents

e.g. the thickness of ***steel*** sheet or the level of ***beer*** in a can can be monitored

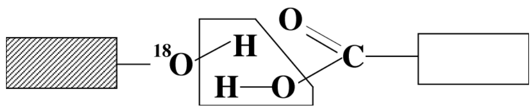


Scientific ***reaction pathways - using isotopic labelling***

e.g ^{18}O was used to determine the *mechanism* of the ***esterification*** reaction



predicted mechanism



actual mechanism

radioactive ^{18}O should have been part of the H_2O molecule formed

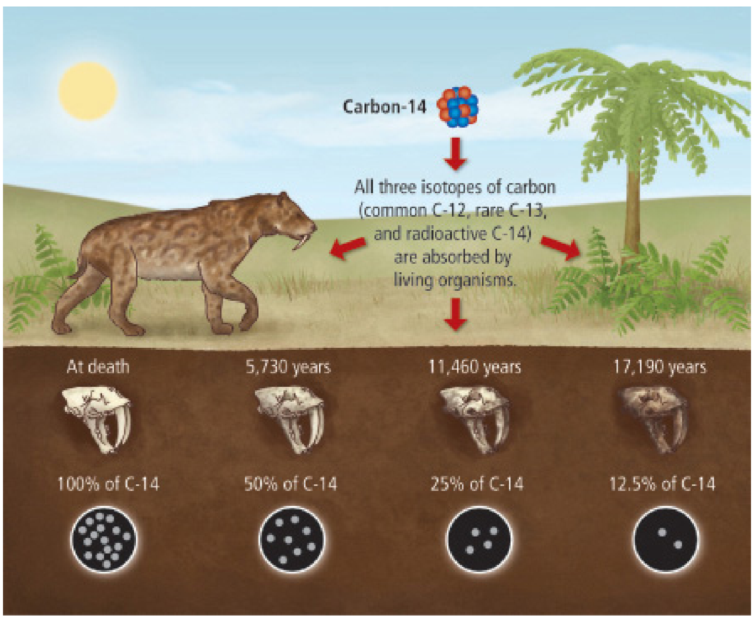
in fact, ^{18}O remained as part of the ester molecule.

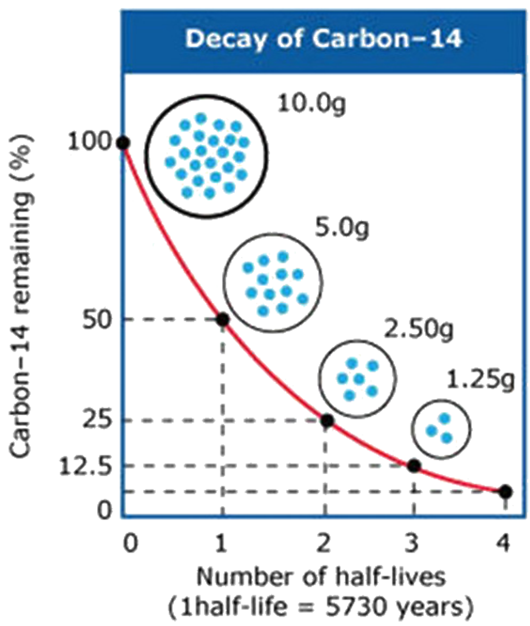
e.g ^{32}P was used to follow the routetaken through plants by ***phosphorous***
ADP → ATP etc

dating

e.g. ^{14}C is produced naturally in the upper ***atmosphere***. While alive, ***plants*** and ***animals*** have a constant ratio of ^{12}C : ^{14}C. Once they die the ^{14}C ***decays***.

The half-life for ^{14}C is about 5,730 years so the age of any object made from a living organism can be ***estimated*** by comparing it with a similar object today.

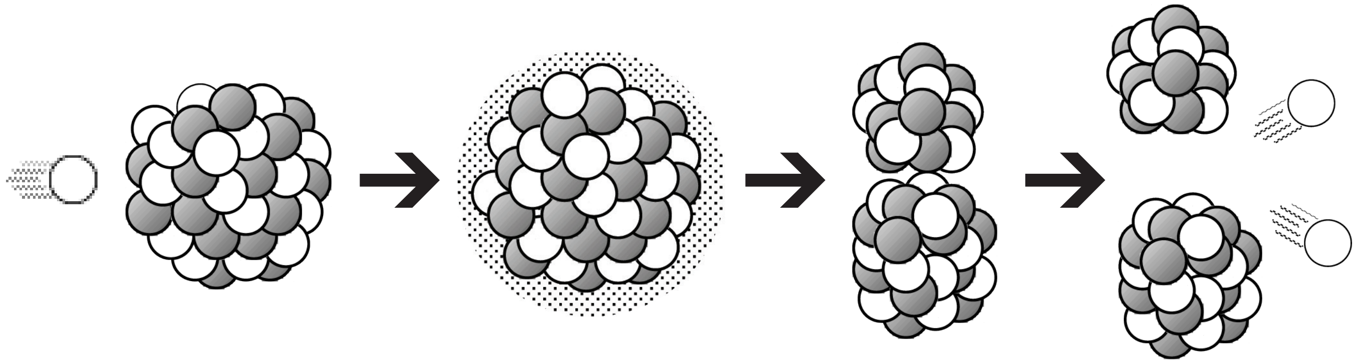




Nuclear Energy

*Both the **fusion** (smashing together) and the **fission** (splitting apart) of atoms provide potential for generating large amounts of energy.*

Nuclear Fission



One of the possible reactions that could take place in a ***nuclear*** power station is:-

$$^{1}_{0}n \quad + \quad ^{235}_{92}U \longrightarrow \qquad\qquad \longrightarrow \; ^{140}_{54}Xe \quad + \quad ^{235}_{92}U \quad + \quad 2\,^{1}_{0}n$$

A slow moving ***neutron*** is ***captured*** by a ***Uranium*** atom which then ***splits*** apart to produce two smaller *'daughter'* atoms. The ***two*** neutrons produced can then go on to react with other ***Uranium*** atoms leading to a ***chain reaction***.

A mole of Uranium, 235 g, yields as much energy as 60 tonnes of high quality coal which would also release 220 tonnes of CO_2 into the ***atmosphere***. Nuclear power stations could replace conventional ***fossil fuel*** power stations but....

Advantages

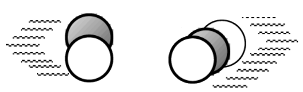
- no '***greenhouse***' gases emitted
- no SO_2 to add to '***acid rain***'
- safer ***mining*** uranium than ***mining*** coal
- uranium reserves will last longer than ***fossil fuel*** reserves
- less ***visual*** impact than coal- or oil-fired power stations or wind farms etc
- fewer ***stations*** needed

Diadvantages

- possibility of ***disastrous*** accident
- increase in '***background***' radiation
- problems ***storing*** long term waste
- slow to change output levels to respond to peaks of demand
- ***plutonium*** produced may lead to increase in nuclear ***weapons***
- much more ***expensive*** to build
- more ***expensive*** to decommission

Nuclear Fusion

This is many peoples hope for the ***future***. The main ***raw material*** would be ***hydrogen*** atoms extracted from ***water*** and it would produce no ***dangerous*** (long $t_{½}$) ***radioactive*** products. It would replicate one of the main reaction that powers a ***star*** .



$$^{2}_{1}H \quad + \quad ^{3}_{1}H \quad \longrightarrow \quad ^{4}_{2}He \quad + \quad ^{1}_{0}n$$

Q1. H

$${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$$

The above process represents

A nuclear fusion

B nuclear fission

C neutron capture

D proton capture

Q2. N5

Americium-241, a radioisotope used in smoke detectors, has a half-life of 432 years.

a) The equation for the decay of americium-241 is

$${}^{241}_{95}Am \longrightarrow {}^{4}_{2}He + X$$

Name element X. ________________

b) Name the type of radiation emitted by the americium-241 radioisotope.

____

c) Another radioisotope of americium exists which has an atomic mass of 242.

Americium-242 has a half-life of 16 hours.

A sample of americium-242 has a mass of 8 g. Calculate the mass, in grams, of americium-242 that would be left after 48 hours.

________ g

Q3. H

Phosphorus-32 and strontium-89 are two radioisotopes used to study how far mosquitoes travel.

In an experiment, 10 g of strontium-89 chloride was added to a sugar solution used to feed mosquitoes.

a) The strontium-89 chloride solution was fed to the mosquitoes in a laboratory at 20 °C. When the mosquitoes were released, the outdoor temperature was found to be 35 °C.

What effect would the increase in temperature have on the half-life of the strontium-89?

____

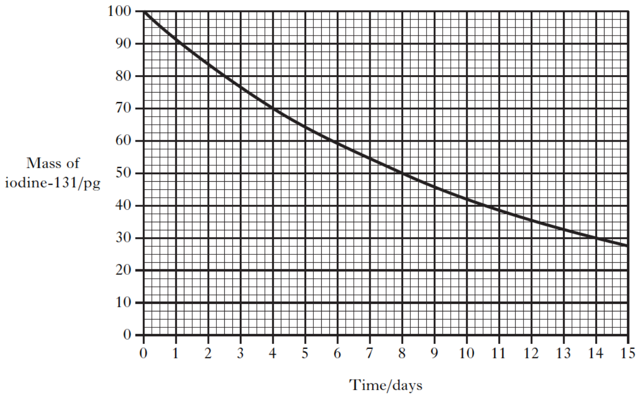
b) A mosquito fed on a solution containing phosphorus-32 is released. Phosphorus-32 has a half-life of 14 days.

When the mosquito is recaptured 28 days later, what fraction of the phosphorus-32 will remain?

____

Q4. H

The graph shows how the mass of iodine-131 in a sample changes over a period of time.



What is the half-life of this isotope?

____

Q5. H

Positron emission tomography, PET, is a technique that provides information about biochemical processes in the body.

Carbon-11, ^{11}C, is a positron-emitting radioisotope that is injected into the bloodstream.

A positron can be represented as ${}^{0}_{1}e$

a) Complete the nuclear equation for the decay of ^{11}C by positron-emission.

$${}^{11}C \rightarrow$$

b) A sample of ^{11}C had an initial count rate of 640 counts min^{-1}. After 1 hour the count rate had fallen to 80 counts min^{-1}.

Calculate the half-life, in minutes, of ^{11}C.

__________ minutes

c) ^{11}C is injected into the bloodstream as glucose molecules ($C_6H_{12}O_6$). Some of the carbon atoms in these glucose molecules are ^{11}C atoms.

The intensity of radiation in a sample of ^{11}C is compared with the intensity of radiation in a sample of glucose containing ^{11}C atoms. Both samples have the same mass.

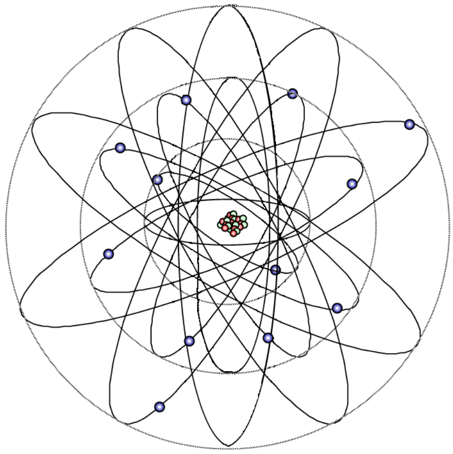
Which sample has the higher intensity of radiation? Give a reason for your answer.

____

____

2.4 Electron Arrangement

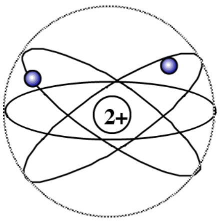
Electron Shells



Charge - ***electrons*** are ***charged*** particles.
They carry one unit of ***negative*** charge.

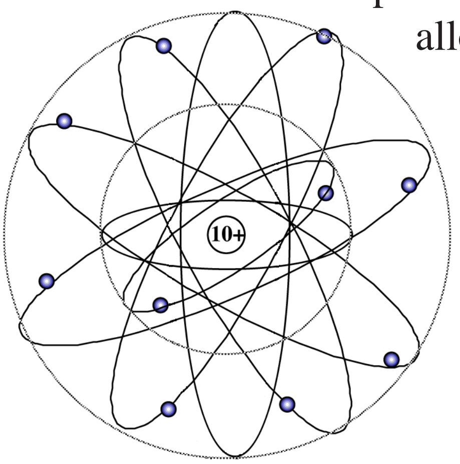
Position - they are found in the ***space*** around the ***nucleus*** in *regions* called ***orbitals***

Mass - they are extremely ***small and light*** .
(About 1/2000th as heavy as a ***proton***).



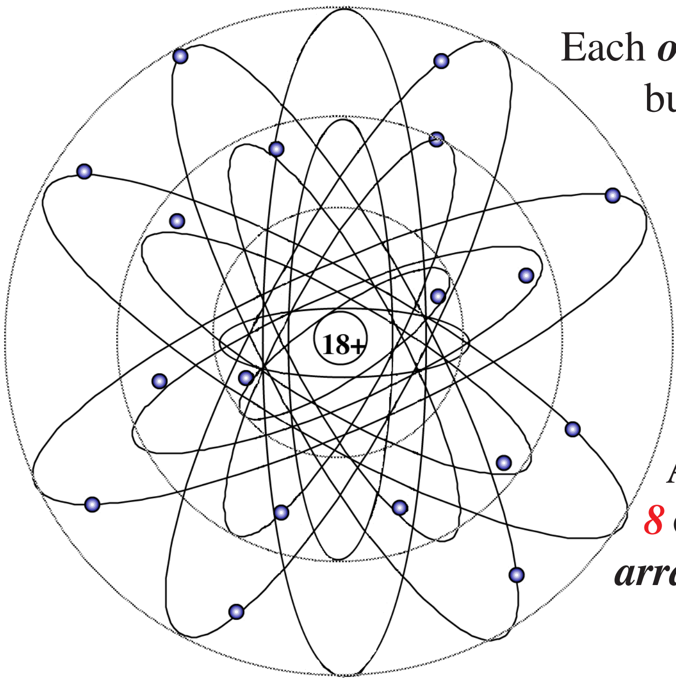
Some of the ***electrons*** are found quite close to the ***nucleus*** in what we call the ***First Shell***. These electrons have ***least energy***.

There is only room for ***2*** electrons in the ***First Shell***, (the repulsive forces between the ***electrons*** are too strong to allow any more).



The next group of electrons are found ***further*** out from the nucleus in what we call the ***Second*** Shell. These electrons have ***more energy***.

There is room for ***8*** electrons in this shell. There are ***4*** possible paths (***orbitals***) that the electrons can follow.



Each ***orbital*** is able to hold ***2*** electrons, but they will not '***pair up***' until there are no more ***empty*** orbitals available. i.e. after ***4*** electrons.

The ***Third Shell*** is even ***further out*** from the nucleus. These electrons have even ***more energy***.

Again, there are ***4 orbitals*** and room for ***8*** electrons in total. We write this ***electron arrangement*** as:-

2, 8, 8

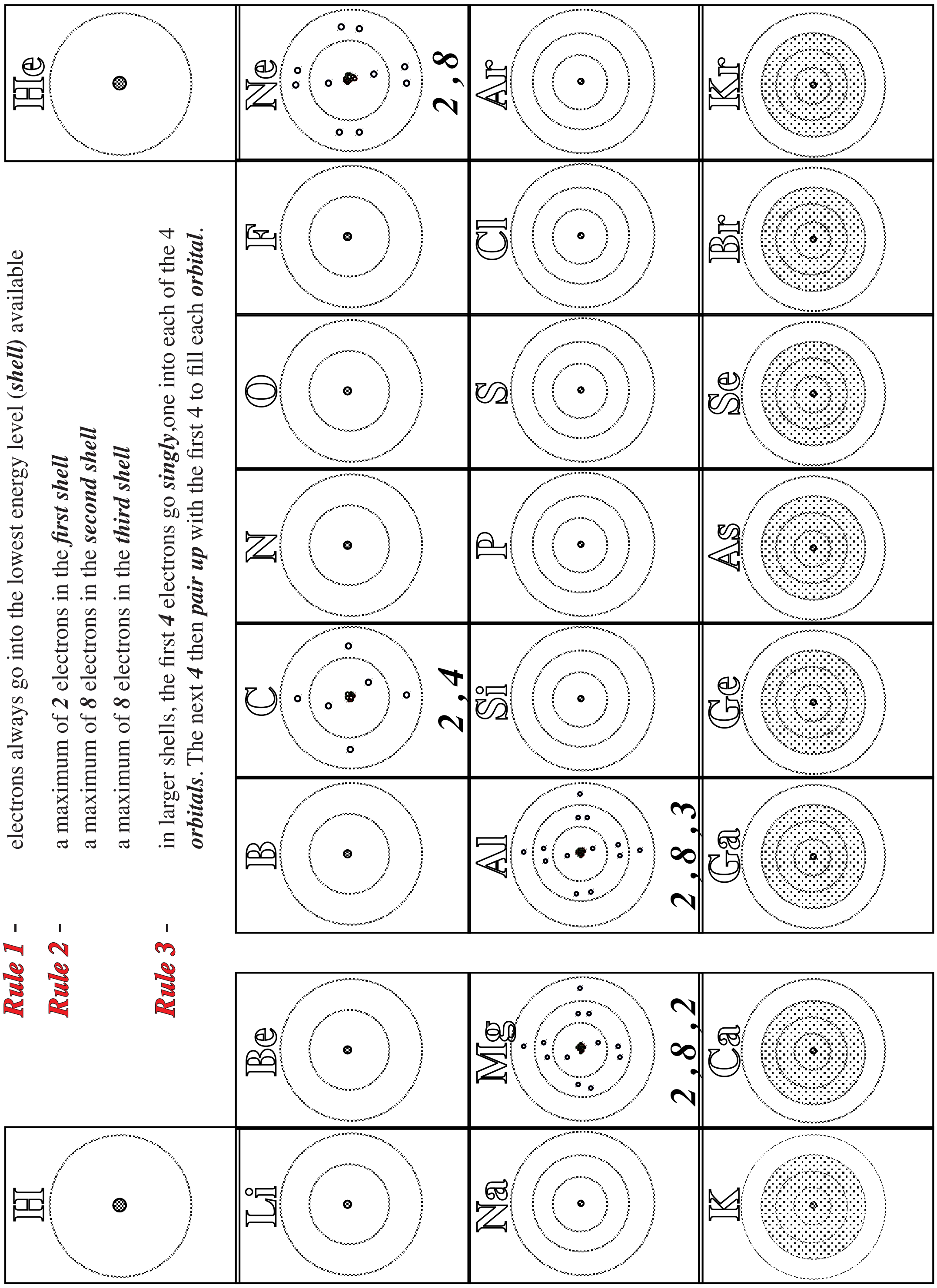
Electrons & The Periodic Table

Electron Arrangements

Rule 1 - electrons always go into the lowest energy level (*shell*) available

Rule 2 - a maximum of *2* electrons in the ***first shell***
a maximum of *8* electrons in the ***second shell***
a maximum of *8* electrons in the ***third shell***

Rule 3 - in larger shells, the first ***4*** electrons go ***singly***,one into each of the 4 ***orbitals***. The next ***4*** then ***pair up*** with the first 4 to fill each ***orbital***.



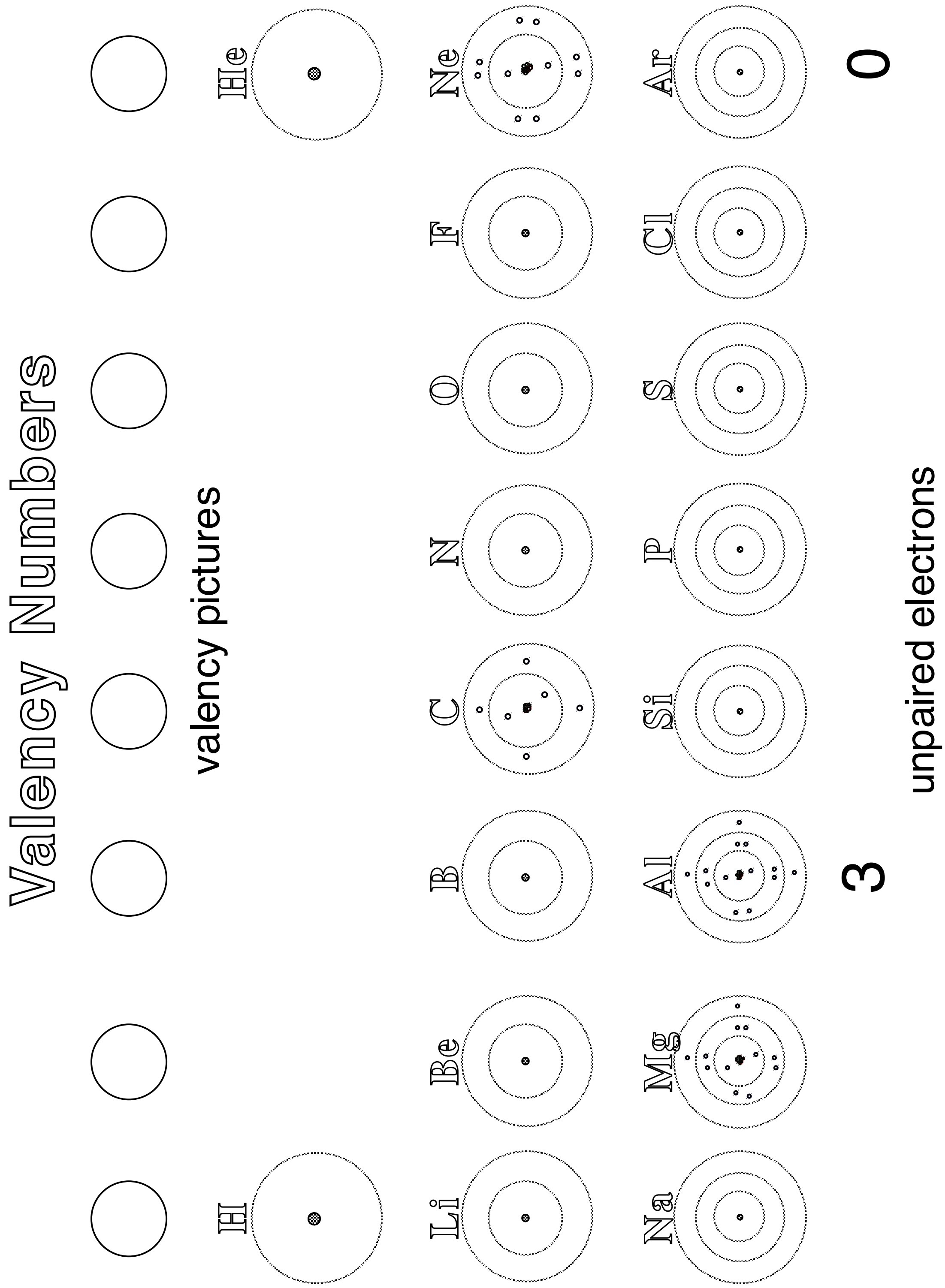
Each new row (***Period***) in the ***Periodic Table*** represents the start of a new ***shell*** . As you move from ***left*** to ***right*** the ***shell*** is being ***filled***, and the elements change from ***metals*** to ***non -metals***.

The ***Alkali metals*** all have ***1*** electron in their ***outer shell***. The ***Halogens*** all have ***7*** , while the ***Noble gases*** all have a ***full outer shell***. Elements which are in the ***same Group*** will have the ***same number of electrons*** in their ***outer shell*** and will have ***very similar properties***.

Electrons & Bonding Powers

When ***atoms*** get involved in ***reactions*** they have to physically touch, (***collide*** with), each other. This really only affects the ***electrons*** in the ***outer shell***. Not surprisingly then, the ***number of electrons*** an atom has in its ***outer shell*** is all important.

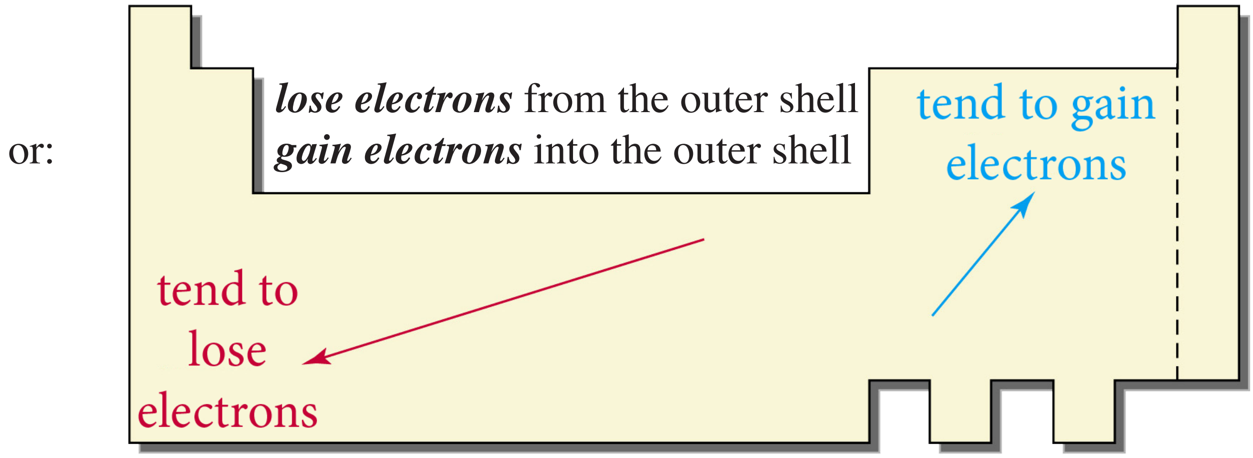
There are various methods for learning ***Formula Writing*** but most involve some idea of ***Bonding Power*** (*Valency Number*) which is determined by the ***number of electrons*** in the ***outer shell***.



Only ***unpaired electrons*** in the ***outer shell*** of an atom can get involved in reactions, and form ***bonds*** with other atoms.

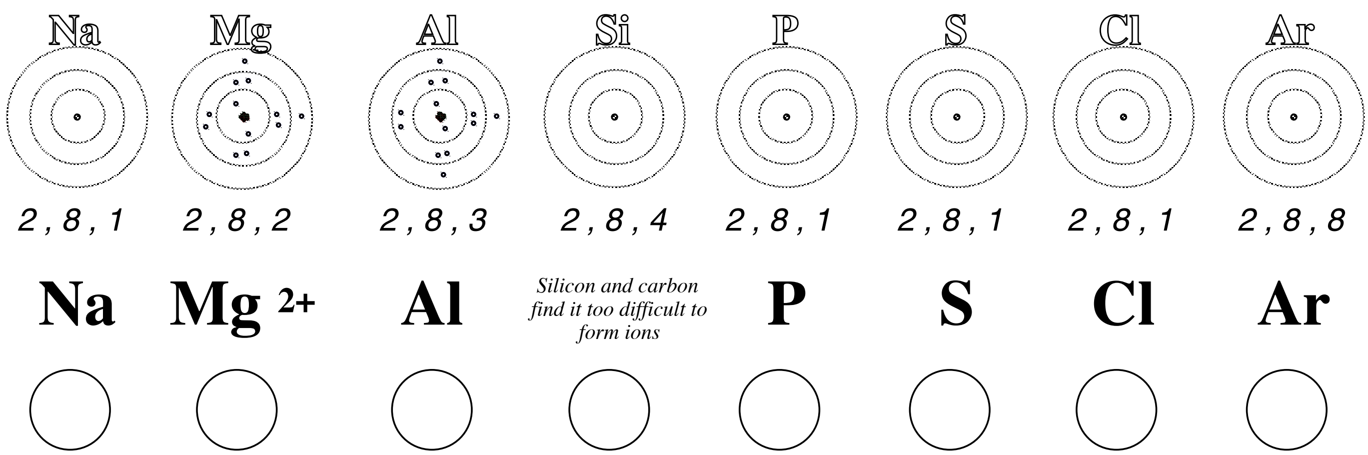
The ***Noble gases*** are very ***unreactive***because they have <u>no</u> ***unpaired electrons***.

One of the *driving forces* behind ***bonding*** will be the *advantages* that can be gained by achieving a ***stable electron arrangement***, like the ***Noble gases***. The 'easiest' way of doing this is to either:



Metal atoms tend to form ***positive ions*** by ***giving away*** their ***outermost electrons*** to achieve the ***same electron arrangement*** as the nearest ***noble gas***.

Non-metal atoms tend to form ***negative ions*** by ***gaining*** extra ***outermost electrons*** to achieve the ***same electron arrangement*** as the nearest ***noble gas***.



valency pictures

The ***size of the charge*** on an ***ion*** depends on the ***number of electrons*** given away or gained.

The ***charge number*** on an *ion* is the same as its ***valency number***.

Q1. Int2

Which of the following numbers is the same for lithium and oxygen atoms?

A Mass number

B Atomic number

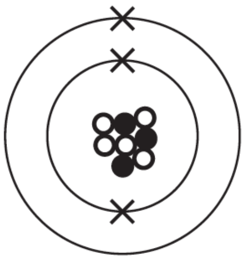
C Number of outer electrons

D Number of occupied energy levels

Q2. Int2

Elements are made up of atoms.

An atom of an element is represented by the diagram below



● = protons

○ = neutrons

✕ = electrons

a) explain why this atom is electrically neutral

____

b) name the ***family*** of elements to which this atom belongs.

____

Q3. SC

Identify the ***two*** elements which can form ions with the same electron arrangement as argon.

A oxygen

B potassium

C phosphorus

D aluminium

E fluorine

F bromine

Q4. SC

Identify the particle which has the same electron arrangement as neon.

A $^{23}_{11}Na$

B $^{18}_{8}O$

C $^{40}_{19}K^{+}$

D $^{24}_{12}Mg^{2+}$

E $^{35}_{17}Cl^{-}$

F $^{16}_{8}O$

Q5. SG

Identify the ***two*** elements which have similar chemical properties

A gold

B magnesium

C carbon

D nitrogen

E calcium

F iodine

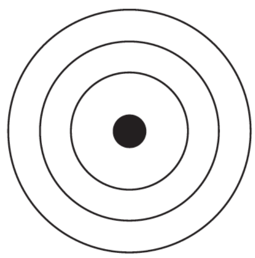
Q6. Int2

Atoms contain particles called protons, neutrons and electrons. Electrons are arranged in energy levels.

The nuclide notation of the sodium atom is shown.

$$^{24}_{11}Na$$

a) complete the diagram to show how the electrons are arranged in a sodium atom.



● = nucleus

X = electron

b) explain what holds the negatively charged electrons in place around the nucleus.

____

____

Q7. Int2

Atoms of an element form ions with a single positive charge and an electron arrangement of 2, 8.

The element is

A fluorine

B lithium

C sodium

D neon

Q8. SG

Identify the symbol for the element which has similar chemical properties to oxygen.

The element is

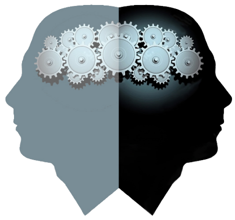
A Mg

B N

C S

D F

Learning Outcomes Section 1



Knowledge Met in this Section

Atoms

- Every element is made up of small particles called ***atoms***.
- Atoms of different.elements are different.
- Atoms of different elements are given a different number called the ***atomic number***.
- The atoms of different elements differ in size and mass.

Atomic structure

- All atoms have an extremely small positively charged central part called the ***nucleus***.
- Negatively charged particles, called ***electrons***, move around outside the nucleus.
- All atoms are electrically ***neutral*** because the ***positive charge*** of the nucleus is ***equal*** to the ***negative charges*** of all the electrons added together.

Protons, Neutrons, Mass numbers, etc.

- The ***nucleus*** of every atom is ***positively charged*** due to the presence of ***protons.***
- The atoms of ***different elements*** have ***different numbers of protons***
- Almost all atoms have ***neutrons***, which have ***no charge***, in their nucleus
- Protons and neutrons are much heavier than electrons.

particle	***charge***	***mass***
proton	+ 1	1
neutron	0	1
electron	— 1	0

- The number of ***protons*** in the atoms of a particular element is ***fixed***.
- The number of ***neutrons*** in the atoms of an element can ***vary***.
- Most elements are made up of more than one kind of atom.
- The ***atomic number*** of an atom is the ***number of protons*** in its nucleus.
- The ***mass number*** of an atom is the ***total number of protons and neutrons*** in its nucleus.
- ***Isotopes*** are atoms of the same element that have different numbers of neutrons. They have the ***same atomic number*** but ***different mass numbers***

- For any ***isotope***, a special symbol, using ***nuclide notation***, can be written to show its mass number and atomic number, e.g.:

$$\underset{\textit{atomic number}\longrightarrow}{\overset{\textit{mass number}\longrightarrow}{}}\ {}^{7}_{3}\mathrm{Li}$$

- ***Nuclide notation*** can also be used to represent ***ions*** - atoms which have ***gained*** or ***lost*** some of their ***electrons*** and become ***charged*** e.g.

$${}^{37}_{17}\mathrm{Cl}^{-} \longleftarrow \textbf{\textit{charge on ion}} \qquad \textit{1 electron } \textbf{\textit{gained}}$$

$${}^{25}_{12}\mathrm{Mg}^{2+} \longleftarrow \textbf{\textit{charge on ion}} \qquad \textit{2 electrons } \textbf{\textit{lost}}$$

Relative Atomic Mass (RAM)

- The relative atomic mass of an element is the ***average of the mass numbers*** of its isotopes, taking into account the ***proportions of each***.
- The relative atomic mass of an element is rarely a whole number.
- The relative atomic mass of an element can be calculated using information from a ***Mass Spectrometer***.

$$\textbf{\textit{RAM}} = \frac{(\text{mass}_1 \times \%_1) + (\text{mass}_2 \times \%_2) + \ldots..}{100}$$

Stability

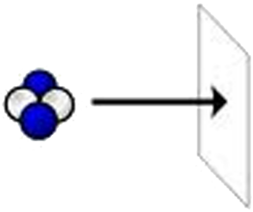
- Radioactive decay involves changes in the ***nuclei*** of atoms
- Unstable nuclei (***radioisotopes***) are transformed into more stable nuclei by the ***emission*** of small particles and the ***release of energy***.
- The stability of nuclei depend on the ***neutron: proton ratio*** which can be calculated as

  neutrons / protons
- As you go through the Periodic Table larger numbers of neutrons are needed and the ***neutron : proton ratio increases*** from 1 to 1.5.

Emissions

- There are 3 main types of emissions referred to as ***alpha*** *(α) particles*, ***beta*** *(β) particles* and ***gamma*** *(γ) rays*

- ***alpha*** *(α) particles* -

α  paper

nature - like a helium nucleus

symbol - $^{4}_{2}He^{2+}$

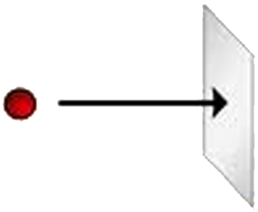
mass - 4

charge - positively charged

deflection - towards negative plate

penetration - low

- ***beta*** *(β) particles* -

β  aluminium

nature - high energy electron

symbol - $^{0}_{-1}e^{-}$

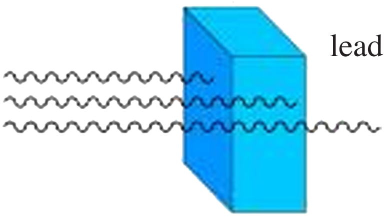
mass - 0

charge - negatively charged

deflection - towards positive plate

penetration - medium

- ***gamma*** *(γ) rays* -

γ  lead

nature - electromagnetic radiation

symbol - 

mass - 0

charge - 0

deflection - not deflected

penetration - high

Nuclear Equations

- ***Balanced*** nuclear equations can be written involving:

  neutrons - $^{1}_{0}n$

  protons - $^{1}_{1}p$

  α particles - $^{4}_{2}He$

  β particles - $^{0}_{-1}e$

- During nuclear reactions:

  overall ***mass*** is conserved

  overall ***charge in nuclei*** is conserved

Radioactive Decay

- The decay of individual nuclei within a sample is ***random*** and is ***independent of chemical or physical state***.
- ***Nuclear*** chemistry is not affected by the same factors as 'normal' (*electron*) chemistry such as:
  temperature, concentration, particle size, atom or ion, physical state, etc
- The ***half-life*** is the time taken for the *activity* or *mass* of a radioisotope to halve
- Given the values of two of these variables, the value of the other can be ***calculated***:

  quantity of radioisotope,
  half-life,
  time elapsed.

Using Radioisotopes

- ***Radioisotopes*** are used in:

  medicine - tracers, cancer treatments, imaging *etc*

  industry - tracers, measuring, imaging, energy *etc*

  science - tracers, measuring, imaging, dating *etc*
- ***Radioisotopes*** with ***long half-lives*** give 'constant' readings over large time periods but can require expensive arrangements for disposal / storage.
- ***Radioisotopes*** with ***short half-lives*** should decay to 'safe' levels quickly.
- ***Radioisotopes*** with ***low penetration*** are easier to shield and can be used within a person with little risk of exposure for people coming into contact.
- ***Radioisotopes*** with ***high penetration*** are useful for imaging and treatments from outside the body, but have to be carefully screened.

Nuclear Energy

- ***Nuclear fission*** inolves creating unstable nuclei by neutron bombardment which then '***split***' to produce smaller '*daughter*' nuclei
- During nuclear fission, neutrons are produced which can lead to a '***chain reaction***' and, if not controlled, a nuclear explosion or meltdown.
- Nuclear fuels and fossil fuels can be compared in terms of *safety*, *pollution* and use of *finite resources*.
- Elements are created in the stars from simple elements by ***nuclear fusion***.
- All naturallv occuring elements, including those found in our bodies, originated in the stars.
- Nuclear fusion has the potential to be a safe, non-polluting source of energy but there are enormous engineering problems to be overcome.

Electron Shells

- Electrons are arranged in special layers (called ***shells***) around each nucleus. ***Electron arrangements*** are given in the data booklet.
- ***Electron arrangements*** for the first 20 elements in the Periodic Table can be worked out on the basis of

first shell	-	maximum **2** electrons
second shell	-	maximum **8** electrons
third shell	-	maximum **8** electrons

- Larger shells are divided into *regions* called ***orbitals*** which can each hold a ***pair*** of electrons
- *Each* orbital in a shell must have one electron before any ***pairing*** of electrons takes place

Electrons & The Periodic Table

- Each row (***Period***) represents a new shell, and the shell is gradually filled as we move across the ***period***.
- As we move across the period, ***properties gradually change*** from '*typically metallic*' to '*typically non-metallic*'.
- Elements in the same column (***Group***) have the ***same number of outer electrons*** and have ***similar chemical properties***.

Electrons & Bonding

- The ***number of outer electrons*** determines the ***bonding power*** of an atom.
- Atoms can become more stable by ***losing*** or ***gaining electrons*** to form ***ions***.
- The ***number of outer electrons*** determines the ***charge on the ion*** most likely to be formed from a particular atom.

CONSOLIDATION QUESTIONS A

Q1. Int2/H

Atoms and ions contain particles called protons, neutrons and electrons.

The nuclide notation of a phosphide ion is shown.

$$^{32}_{15}P^{3-}$$

a) Complete the table to show the number of each type of particle in this phosphide ion.

Particle	***Number***
electron	
proton	
neutron	

b) Phosphorus-32 decays by beta-emission. Write the nuclear equation for the decay of phosphorus-32.

Q2. Int2

The table shows information about an ion.

Particle	***Number***
protons	16
neutrons	17
electrons	18

The charge on the ion is

A - 2

B - 1

C + 1

D + 2

Q3. Int2

Which of the following particles contains a different number of electrons from the others?

A Cl^-

B O^{2-}

C Ne

D Na^+

Q4. Int2

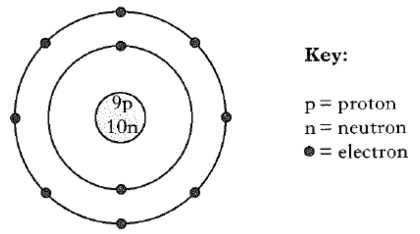
The alkali metals, the halogens and the noble gases are the names of groups of elements in the Periodic Table.

Complete the table by circling a word in each box to give correct information about each group.

(*Two pieces of correct information have already been circled.)*

Group		
alkali metals	metals / non-metals	reactive / non-reactive
halogens	metals / non-metals	reactive / non-reactive
noble gases	metals / non-metals	reactive / non-reactive

Complete the table for the particle shown below.



Atomic number	**Symbol for the element**	**Mass number**	**Overall charge of the particle**

Q5. Int2

Atoms and ions contain particles called protons, neutrons and electrons.

The nuclide notation of a sodium ion is shown.

$$^{24}_{11}Na^+$$

a) What is the difference between an atom and an ion?

____

b) Complete the table to show the number of each type of particle in this sodium ion.

Particle	***Number***
electron	
proton	
neutron	

CONSOLIDATION QUESTIONS B

Q1. N5

When an atom *X* of an element in Group 1 reacts to become X^+

A the mass number of *X* decreases

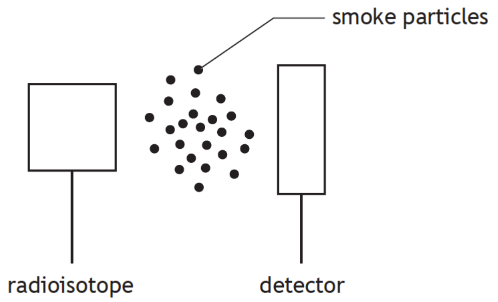
B the atomic number of *X* increases

C the charge of the nucleus increases

D the number of occupied energy levels decreases

Q2. N5

Some smoke detectors make use of radiation which is very easily stopped by tiny smoke particles moving between the radioactive source and the detector.



The most suitable type of radioisotope for a smoke detector would be

A an alpha-emitter with a long half-life

B a gamma-emitter with a short half-life

C an alpha-emitter with a short half-life

D a gamma-emitter with a long half-life

Q3. N5

Which particle will be formed when an atom of $^{234}_{90}Th$ emits a β-particle?

A $^{234}_{91}Pa$

B $^{230}_{88}Ra$

C $^{234}_{89}Ac$

D $^{238}_{92}U$

Q4. N5

^{14}C has a half life of 5600 years. An analysis of charcoal from a wood fire shows that its ^{14}C content is 25 % of that in living wood. How many years have passed since the wood for the fire was cut?

A 1400

B 4200

C 11 200

D 16 800

Q5. Int2

In which of the following compounds do ***both*** ions have the same number of electrons as neon?

A calcium fluoride

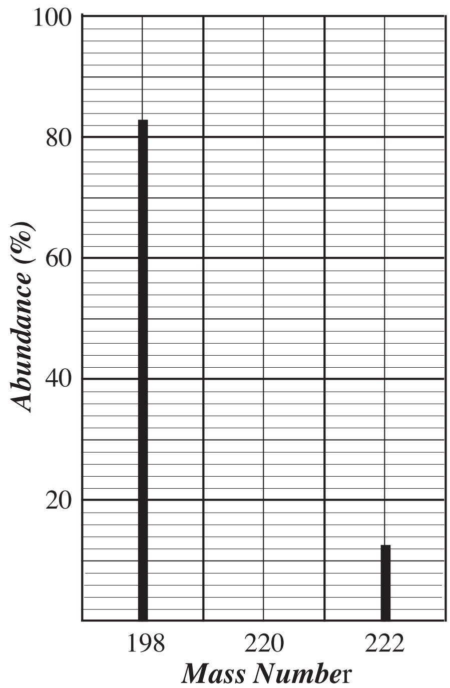
B magnesium chloride

C sodium oxide

D aluminium bromide

Q6. H

The chart was obtained from a 24-day old sample of an α-emitting radioisotope of Radon.



a) What is the half-life of the isotope?

A 2 days

B 4 days

C 8 days

D 12 days

b)

$$^{222}_{86}Rn \longrightarrow {}^{a}_{b}X + {}^{4}_{2}He$$

Identify element **X** and the values of ***a*** and ***b***.

c) Radon-222 can be produced from another radioisotope after ***six α-emissions*** amd ***two β-emissions***. Identify the starting radiosisotope.

____

CONSOLIDATION QUESTIONS C

Q1. Int2

Which of the following is the electron arrangement for an alkali metal?

(You may wish to use your Data Book to help)

A 2 , 1

B 2 , 2

C 2 , 3

D 2 , 4

Q2.

a) Complete each line below by providing the correct symbol and electron arrangement for each ***atom***.

(You may wish to use your Data Book to help)

e.g	sodium atom	Na	2,8,1
	oxygen atom		
	lithium atom		
	chlorine atom		
	sulphur atom		
	magnesium atom		
	nitrogen atom		
	aluminium atom		

b) Complete each line below by providing the correct symbol and electron arrangement for each ***ion***.

e.g	sodium ion	Na^+	2,8
	oxygen atom		
	lithium atom		
	chlorine atom		
	sulphur atom		
	magnesium atom		
	nitrogen atom		
	aluminium atom		

c) What do you notice about the electron arrangements of these ions ?

____

____

Q3. Int2

The table shows the numbers of protons, electrons and neutrons in four particles, W, X, Y and Z.

Particle	Protons	Electrons	Neutrons
W	17	17	18
X	11	11	12
Y	17	17	20
Z	18	18	18

Which pair of particles are isotopes?

A W and X

B W and Y

C X and Y

D Y and Z

Q4. H

Give the symbol for each of these particles

alpha particle

beta particle

neutron

proton

electron

Which two particles are the same ?

____

Q5. H

Which of the following equations represents nuclear fusion ?

A $^{40}_{19}K + ^{0}_{-1}e \longrightarrow ^{40}_{18}Ar$

B $^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n$

C $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{90}_{38}Sr + ^{144}_{54}Xe + 2\,^{1}_{0}n$

D $^{14}_{7}N + ^{1}_{0}n \longrightarrow ^{14}_{6}C + ^{1}_{1}p$

CONSOLIDATION QUESTIONS D

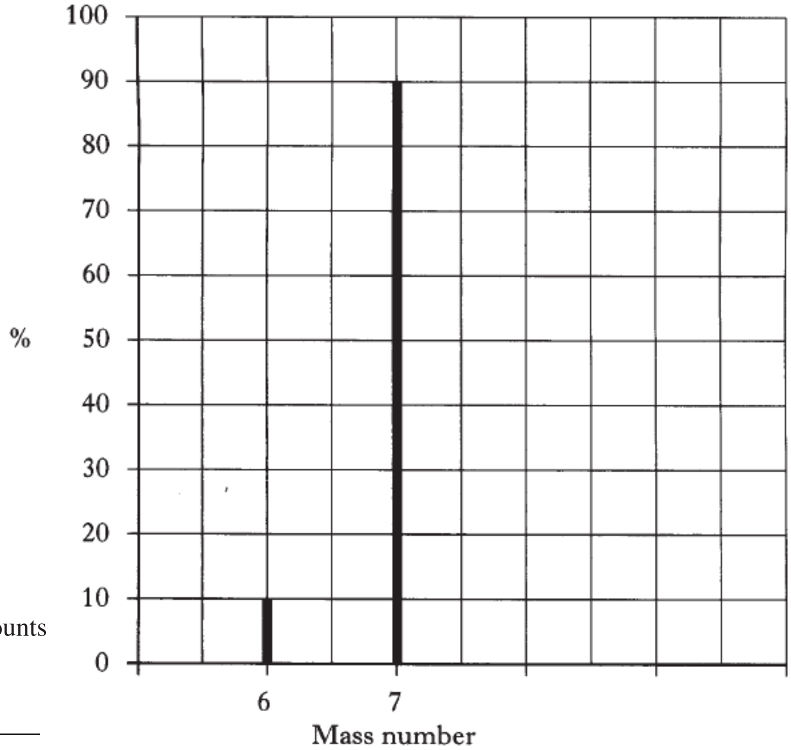
Q1. SGC

The following graph was obtained for a sample of lithium.

a) How many isotopes are present in the sample of lithium?

____

b) Using the information in the graph, calculate the relative atomic mass of lithium.



c) ***If*** the relative atomic mass of lithium was 6.5 what would that suggest about the relative amounts of the two isotopes.

____

d) ***If*** the relative atomic mass of lithium was 6.80, ***calculate*** the % abundance of each isotope.

Hint 1: let **x** = % abundance of ^{6}Li

let **y** = % abundance of ^{7}Li

Hint 2: In maths, you can solve ***two unknowns*** (x and y) if you have ***two equations*** that link x and y.