

Applied Science Chemistry work to be submitted in the first lesson in September with Mr Boddaert

Hi all

This work needs to be completed and handed in the first lessons in September.

I handed out a paper copy of this document in the taster lessons and have spares, if you come into school and collect one from me.

Many thanks in advance and I look forward to teaching you next year.

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The Periodic Table of Elements

1 2 3 4 5 6 7 0 (8) (18)

1.0
H
hydrogen
1

		Key															
		relative atomic mass															
		atomic symbol															
		name															
		atomic (proton) number															
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
6.9	9.0	45.0	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	10.8	12.0	14.0	16.0	19.0	4.0
Li	Be	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	B	C	N	O	F	He
lithium	beryllium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	boron	carbon	nitrogen	oxygen	fluorine	helium
3	4	21	22	23	24	25	26	27	28	29	30	5	6	7	8	9	2
23.0	24.3	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	27.0	28.1	31.0	32.1	35.5	20.2
Na	Mg	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	Al	Si	P	S	Cl	Ne
sodium	magnesium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	aluminium	silicon	phosphorus	sulfur	chlorine	neon
11	12	39	40	41	42	43	44	45	46	47	48	13	14	15	16	17	10
39.1	40.1	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	69.7	72.6	74.9	79.0	79.9	39.9
K	Ca	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Ga	Ge	As	Se	Br	Ar
potassium	calcium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	gallium	germanium	arsenic	selenium	bromine	argon
19	20	57	72	73	74	75	76	77	78	79	80	31	32	33	34	35	18
85.5	87.6	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	69.7	72.6	74.9	79.0	79.9	83.8
Rb	Sr	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Ga	Ge	As	Se	Br	Kr
rubidium	strontium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	gallium	germanium	arsenic	selenium	bromine	krypton
37	38	57	72	73	74	75	76	77	78	79	80	31	32	33	34	35	36
132.9	137.3	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	69.7	72.6	74.9	79.0	79.9	83.8
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Ga	Ge	As	Se	Br	Kr
caesium	barium	lanthanum	hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	gallium	germanium	arsenic	selenium	bromine	krypton
55	56	57	72	73	74	75	76	77	78	79	80	31	32	33	34	35	36
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]	204.4	207.2	209.0	209.0	[209]	[210]	[222]
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Tl	Pb	Bi	Po	At	Rn	
francium	radium	actinium	rutherfordium	bohrium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium	thallium	lead	bismuth	polonium	astatine	radon	
87	88	89	104	105	106	107	108	109	110	111	81	82	83	84	85	86	

Elements with atomic numbers 112-116 have been reported but not fully authenticated

140	141	144	150	152	157	163	165	167	169	173	175
Ce	Pr	Nd	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu
cerium	praseodymium	neodymium	samarium	europtium	gadolinium	dysprosium	holmium	erbium	thulium	ytterbium	lutetium
58	59	60	62	63	64	66	67	68	69	70	71
232	[231]	238	[242]	[243]	[247]	[251]	[254]	[253]	[256]	[254]	[257]
Th	Pa	U	Pu	Am	Cm	Cf	Es	Fm	Md	No	Lr
thorium	protactinium	uranium	plutonium	americium	curium	californium	einsteinium	fermium	mendelevium	nobelium	lawrencium
90	91	92	94	95	96	98	99	100	101	102	103

* Lanthanide series

* Actinide series

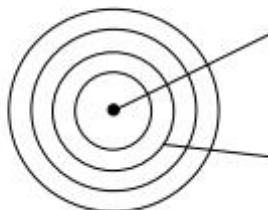
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Atoms consist of a central containing protons and The nucleus is compared to the size of the whole atom. The nucleus is surrounded by in energy levels (also called). Atoms have no electric charge because they contain the same number of protons and

sub-atomic particle	relative mass	relative charge
proton		
neutron		
electron		



Atomic number = number of

Mass number = number of + number of

The number of protons, neutrons and electrons in an atom can be worked out using the atomic number and mass number.

Number of protons =

Number of neutrons =

Number of electrons =

Atoms can be represented as follows:

$\begin{matrix} \text{mass number} \\ \text{atomic number} \end{matrix} \text{Symbol}$ e.g. ${}_{9}^{19}\text{F}$ protons = neutrons = electrons =

Atoms of the same element have the same number of In fact, it is the number of that determines what type of atom it is (e.g. all atoms with 6 protons are carbon atoms). Atoms of different elements have different numbers of

Isotopes are atoms with the same number of but a different number of This means they are atoms of the same with the same number but a different number.

	${}_{17}^{35}\text{Cl}$	${}_{17}^{37}\text{Cl}$
protons		
neutrons		
electrons		

Atom	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
${}_{11}^{23}\text{Na}$					
Li	3	7			
Ar		40	18		
K			19	20	
Al				14	13
${}_{92}^{235}\text{U}$					
${}_{92}^{238}\text{U}$					

Atoms are neutral because they contain the same number of positive protons as negative electrons. For example, the atom ${}_{11}^{23}\text{Na}$ is neutral because it contains 11 protons (11+ charges) and 11 electrons (11- charges).

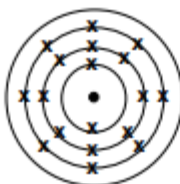

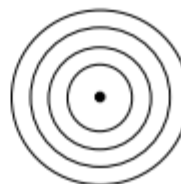
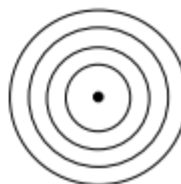
Ions are particles that contain a different number of protons and electrons. For example, an ion with 11 protons (11+ charges) and 10 electrons (10- charges) has an overall charge of 1+.



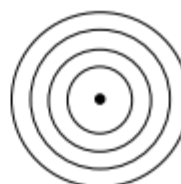
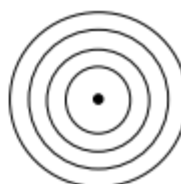
The noble gas elements (Group 0 elements) have very stable electron arrangements. Ions also have the electron structure of the noble gases (group 0 elements), except H^+ which has no electrons at all.

- 1) Complete the table below to show whether particles are atoms or ions, and for ions their charge.

Number and overall charge of protons	11+	11+	16+	4+	13+	18+	17+	15+	21+	1+	32+	35+
Number and overall charge of electrons	11-	10-	18-	2-	10-	18-	18-	18-	18-	0-	32-	36-
Atom or ion?	atom	ion	ion									
Overall charge		1+	2-									

- 2) Complete the table below to show the electronic structure of some common ions. The first one has been done for you. You will need to use the Periodic Table to help.

Ion	Cl^-	Li^+	F^-	Mg^{2+}
Protons	17			
Electrons	18			
Electron structure				
Electron structure	2,8,8			

Ion	K^+	S^{2-}	H^+	P^{3-}
Protons				
Electrons				
Electron structure				
Electron structure				

Ionic bonding

1. Watch each of these short videos on ionic bonding:
 - Formation of ions. <https://youtu.be/900dXBWgx3Y>
 - Ionic bonding <https://youtu.be/zpaHPXVR8WU>
 - Giant ionic compounds and their melting and boiling points <https://youtu.be/PNKsbnH1vw8> properties of ionic compounds. <https://youtu.be/TxHi5FtMYKk>
2. Make key notes on the following using KS4 Bitesize <https://www.bbc.co.uk/bitesize/guides/z6k6pbk/revision/1>

What an ionic bond is

Example of how a metal and non-metal bond ionically

Properties of ionic compounds, with an explanation of each.

3. Answer the following exam questions on ionic bonding and use the mark scheme attached to the online resources to mark them.

Exam questions in Ionic Bonding

Q1.

This question is about calcium.

- (b) Ionic compounds, such as calcium oxide, have high melting points.

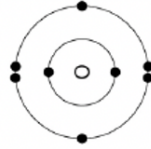
Complete the sentences. Use words from the box.

bonds	forces	ions	layers
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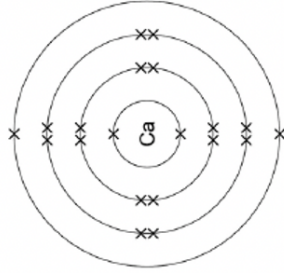
Calcium oxide has a giant ionic lattice in which there are strong electrostatic _____ of attraction in all directions. (1)

- (c) The figure below shows the electronic structure of an oxygen atom and a calcium atom.

Oxygen atom



Calcium atom



Describe how the calcium atom and the oxygen atom forms calcium oxide.

You should give the charge on each ion formed.

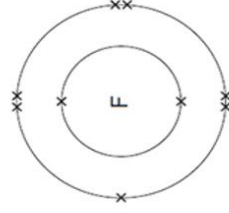
(4)
(Total 6 marks)

Q2.

This question is about fluorine.

- (a) **Figure 1** shows the arrangement of electrons in a fluorine atom.

Figure 1



- (i) In which group of the periodic table is fluorine?

Group _____ (1)

- (ii) Complete the table below to show the particles in an atom and their relative masses.

Name of particle	Relative mass
Proton	
Neutron	1
	Very small

- (iii) Use the correct answer from the box to complete the sentence.

alkalis	alloys	isotopes
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Atoms of fluorine with different numbers of neutrons are

called _____.

(1)

- (b) Sodium reacts with fluorine to produce sodium fluoride.

- (i) Complete the word equation for this reaction.

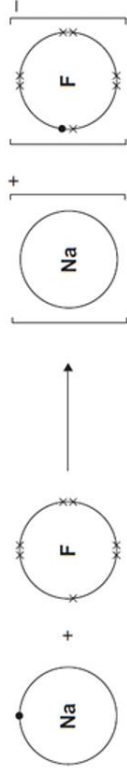
sodium + _____ → _____

(1)

- (iv) **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

(4)

- (v) Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

Tick (✓) **two** boxes.

Dissolve in water

Gas at room temperature

High melting point

Low boiling point

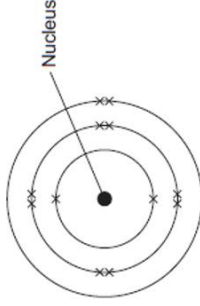
(2)

(Total 13 marks)

Q3.

This question is about magnesium.

- (a) (i) The electronic structure of a magnesium atom is shown below.



Use the correct answer from the box to complete each sentence.

+

electrons	neutrons	protons	shells
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The nucleus contains protons and _____.

The particles with the smallest relative mass that move around the nucleus are called _____.

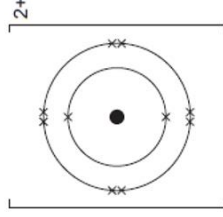
Atoms of magnesium are neutral because they contain the same number of electrons and _____.

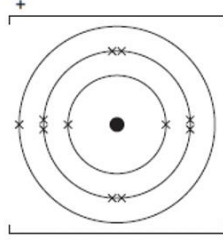
(3)

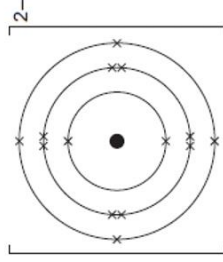
- (ii) A magnesium atom reacts to produce a magnesium ion.

Which diagram shows a magnesium ion?

Tick (✓) **one** box.







(1)

Covalent bonding

1. Watch each of these short videos on covalent bonding:

- Covalent bonding <https://youtu.be/h24UmH38 LI>
- Dot and cross diagrams covalent bonding <https://youtu.be/QzytnZY67J8>
- Covalent bonding of hydrogen, oxygen and nitrogen <https://youtu.be/OHfN3CvXP2M>
- Covalent bonding in methane, water and ammonia <https://youtu.be/7mBokkBENWE>

2. Make key notes on the following using KS4 Bitesize

<https://www.bbc.co.uk/bitesize/guides/zxxn82p/revision/1>

What a covalent bond is

Properties of **simple covalent** compounds, including an explanation of these properties

Drawing stick diagrams & dot-cross diagrams

Stick diagrams – these show each covalent bond as a stick.

Dot-cross diagrams – these show the outer shell electrons only

- 1 Draw a stick diagram
- 2 Re-draw the stick diagram without the sticks
- 3 Replace the stick with a **X●** which represents the two electrons in the bond (**X** represents electrons from one atom, and **●** represents the electron from the other atom).
- 4 Add in any other outer shell electrons from each atom (electrons are always in pairs)
- 5 CHECK that there are 8 electrons around each atom (except H where there should be 2 electrons)

Stick diagram	Molecule	Dot-cross diagram
	H ₂ O	
	CO ₂	
	N ₂	
	H ₂ O	

Covalent bonding exam questions

Q1.

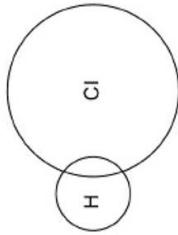
This question is about hydrogen chloride.

- (a) A hydrogen atom contains 1 electron and a chlorine atom contains 17 electrons.

Complete **Figure 1** to show a dot and cross diagram for a hydrogen chloride molecule.

Show the outer electrons only.

Figure 1



(2)

Hydrogen gas (H₂) reacts with chlorine gas to produce hydrogen chloride.

- (b) Complete the balanced chemical equation for the reaction between hydrogen and chlorine.



(2)

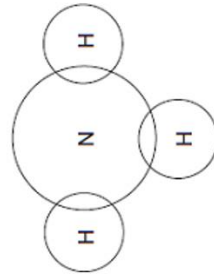
Q2.

- (b) Hydrogen is used to make ammonia (NH₃).

Complete the diagram to show the bonding in ammonia.

Use dots (•) and crosses (x) to show electrons.

Show only outer shell electrons.



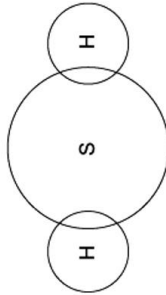
(2)

- (b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

- (i) Hydrogen sulfide has the formula H₂S. The bonding in a molecule of hydrogen sulfide can be represented as:



Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide. Use dots (•) and crosses (x) to represent the electrons. You need only show the outer shell electrons. (Atomic numbers: H = 1, S = 16.)



(1)

- (ii) Hydrogen sulfide has a low boiling point.

Explain why.

(2)

- (iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

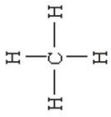
The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H₂O₂).



(1)

Q5. (b) The diagram shows the structure of a molecule of methane.

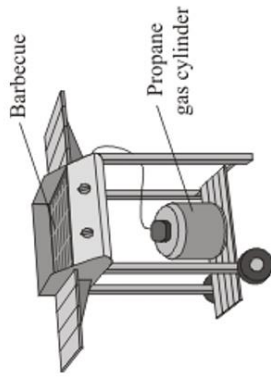


Write down everything that this diagram tells you about a methane molecule.

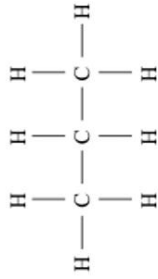
To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

(4)

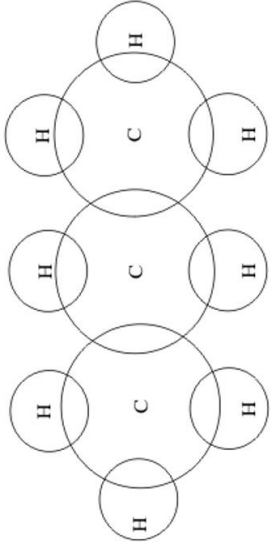
Q6. This barbecue burns propane gas.



The structure of propane is shown below.



(a) Complete the diagram to show how the outer energy level (shell) electrons of hydrogen and carbon are arranged in a molecule of propane.

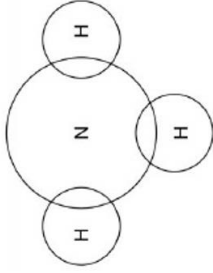


(1)

Q7.

This question is about ammonia (NH₃).

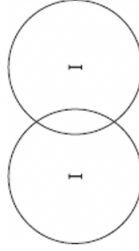
(a) Complete the diagram to show the bonding electrons in ammonia. Show the outer electrons only.



(2)

Q8. (d) The bonding in iodine is similar to the bonding in chlorine.

(i) Complete the diagram below to show the bonding in iodine. Show the outer electrons only.



(2)

(ii) Explain why iodine has a low melting point.

(3)