Name: _____

Education Extravaganza 2022
GCSE Science Trilogy

Do Now:

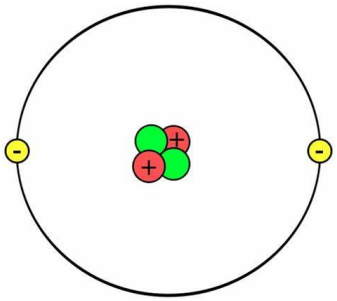
1	What bonding occurs between metals and non-metals?	
2	What is the chemical formula of methane?	
3	What does DNA stand for?	
4	What is the constant speed equation?	
5	What is the chemical formula for an alkane with 117 carbon atoms?	
6	What is the atomic number of the largest predicted element?	

Lesson 1 (Physics): The Atom and Advanced Analysis Techniques

Topics: 5.1.1.4, 5.1.1.5, 5.1.1.7, 6.4.1.1, 6.4.1.2, 6.6.2.1, 6.6.2.2, 6.6.2.3

Class Discussion: Atomic Structure Recap

- The atom has two parts: electron shells or energy levels and the nucleus.
- The electron shells or energy levels form "rings" around the dense nucleus and fill up with electrons in the order of 2,8,8.
- The nucleus contains protons and neutrons in a tight arrangement.
- Protons carry a +1 charge and have a mass of 1, electrons carry a charge of -1 and have a negligible (close to 0) mass and neutrons have a neutral (0) charge and a mass of 1.



A helium atom contains 2 protons, 2 electrons and 2 neutrons.

Key Knowledge: Atomic Structure Extended

- The electron has a mass of about $\frac{1}{1840}$.
- If the nucleus of a hydrogen atom is the size of a tennis ball, the atom's diameter would be 8 km.

Name: _____

- Neutrons are in the nucleus of an atom to stop the protons from repelling each other, causing the atom to fall apart.

Key Knowledge: Flame Test for Metal Ions

- The flame test is a chemical analysis technique in which a metal ion is held over a flame.
- When the element burns it emits a specific colour of light. For example, lithium burns with a red colour.
- However, for some elements, it is difficult to distinguish one from another. For example, both indium and selenium burn with a blue colour.
- Furthermore, not all elements produce a change in colour, only metal ions can be tested, and some compounds are unsafe to test. For example, lithium chloride produces chlorine gas when burnt.
- The flame test produces qualitative results as a colour is difficult to accurately measure.

Common metal ion flame test results.

Name: _____

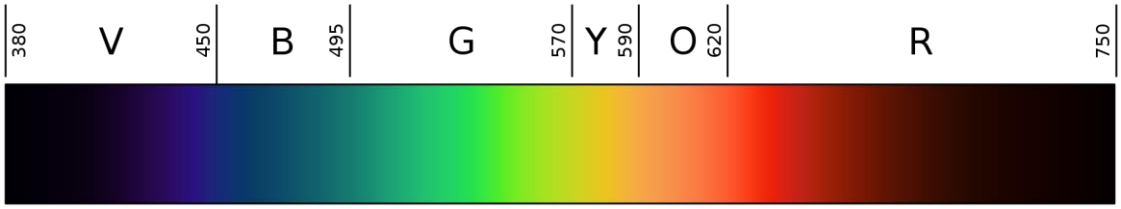
Progress Check

Match the metal ion with its flame colour.

Sodium	Green
Lithium	Light Blue
Boron	Light Green
Selenium	Yellow
Barium	Red

Key Knowledge: Spectroscopy

- Spectroscopy is a chemical analysis technique in which light is split by a prism or grating and passed through a sample.
- This uses the same principle as the flame test, where each element produces its own colour or wavelength of light.
- A prism or grating is used to split the light into its component colours before being passed through a sample – a technique first developed by Isaac Newton.
- Spectroscopy produces a pattern of different wavelengths of light called a spectrum – this is unique to each element.
- Each coloured line represents a different wavelength of light on the electromagnetic spectrum.
- Violet has the shortest wavelength and red has the longest.
- Spectroscopy produces quantitative results as a wavelength can be measured.



The visible spectrum – the numbers correspond to the wavelength of light in nanometres (nm).

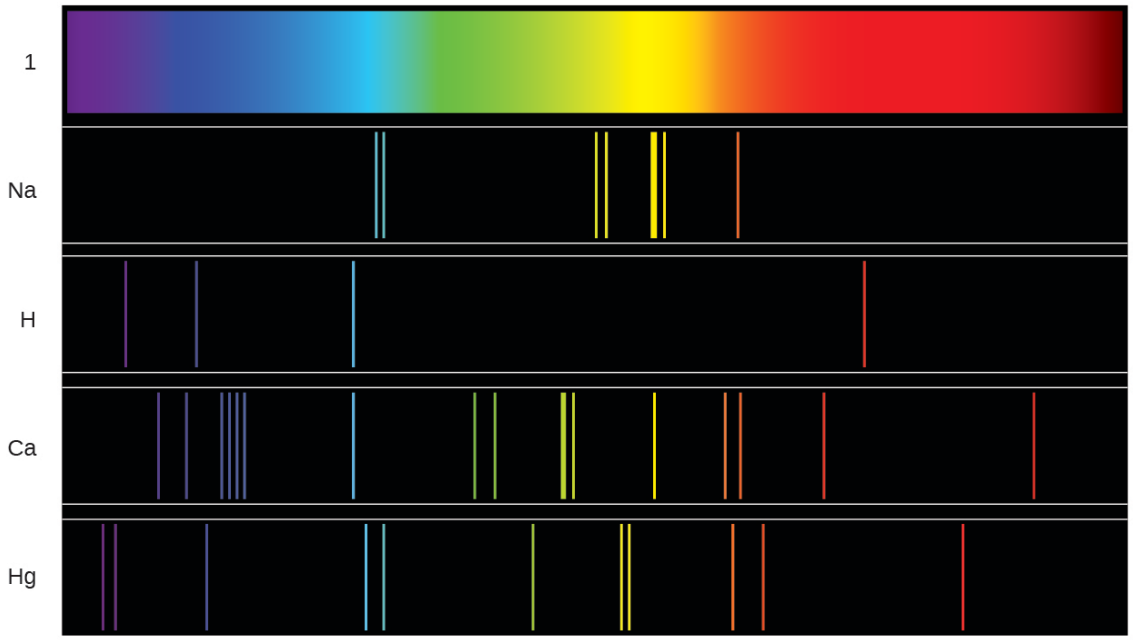
Mastery Questions

1. What can split white light into its component colours? [1 mark]
2. What is the longest wavelength of visible light? [1 mark]
3. What are some of the problems with the flame test? [3 marks]
4. Why is spectroscopy more accurate than the flame test? [5 marks]

Name: _____

Key Knowledge: The Emission Spectrum

- Spectroscopy and the flame test both use the wavelength of light emitted from an element to identify it.
- As mentioned previously, every element produces a unique spectrum of light, this is referred to as the emission spectrum (plural spectra).
- The emission spectrum is produced when light interacts with the element, or it is combusted.



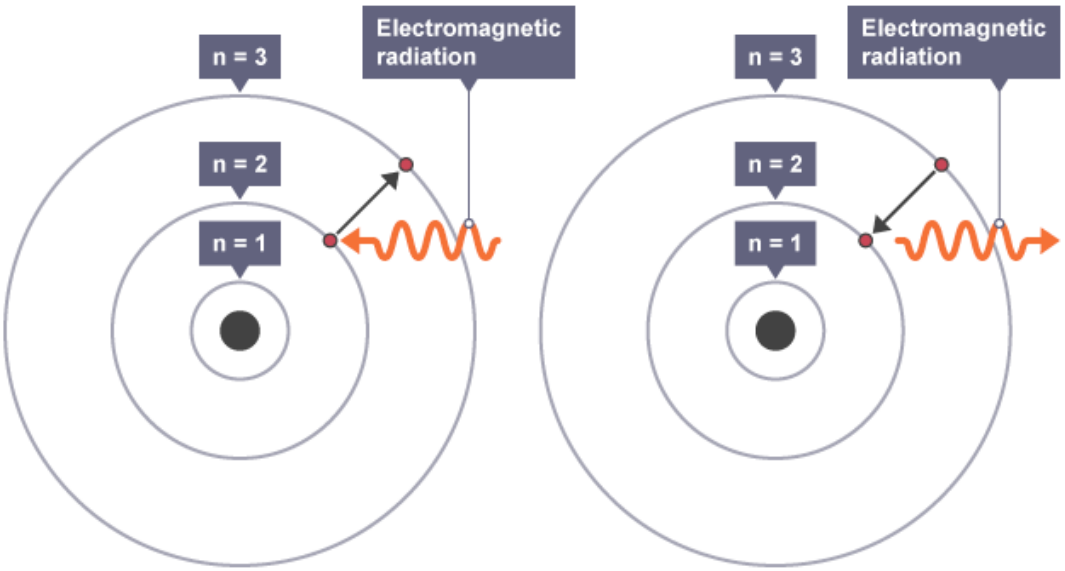
The emission spectrum of various elements.

Key Knowledge: Electron Excitation

- Different elements have different emission spectra. This is due to their unique electron arrangement.
- When light is directed onto an atom, the electrons are excited. Excitement is the technical term for when electrons gain energy.
- Electrons gain energy because light contains energy which is absorbed by electrons.
- When electrons are excited, they move up energy levels because they have more energy.
- However, electrons will eventually emit this energy and move back to their original energy level.
- When this happens, the energy is emitted as an electromagnetic wave (light).
- This emitted light is what causes emission spectra.
- The emitted light is unique as energy levels have different energy values, so each of the possible electron transitions within an atom will produce different energy.

Name: _____

- An electron's initial position within an atom is known as the ground state and its new position is called the excited state.



An electron absorbs and emits electromagnetic radiation.

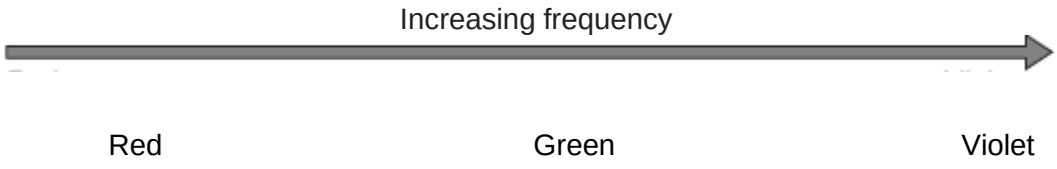
Deliberate Practice

Q1.

(a) The visible light spectrum has a range of frequencies.

Figure 1 shows that the frequency increases from red light to violet light.

Figure 1



Use the correct answers from the box to complete the sentence.

decreases	**stays the same**	**increases**

As the frequency of the light waves increases, the wavelength

of the light waves _____ and

the energy of the light waves _____ .

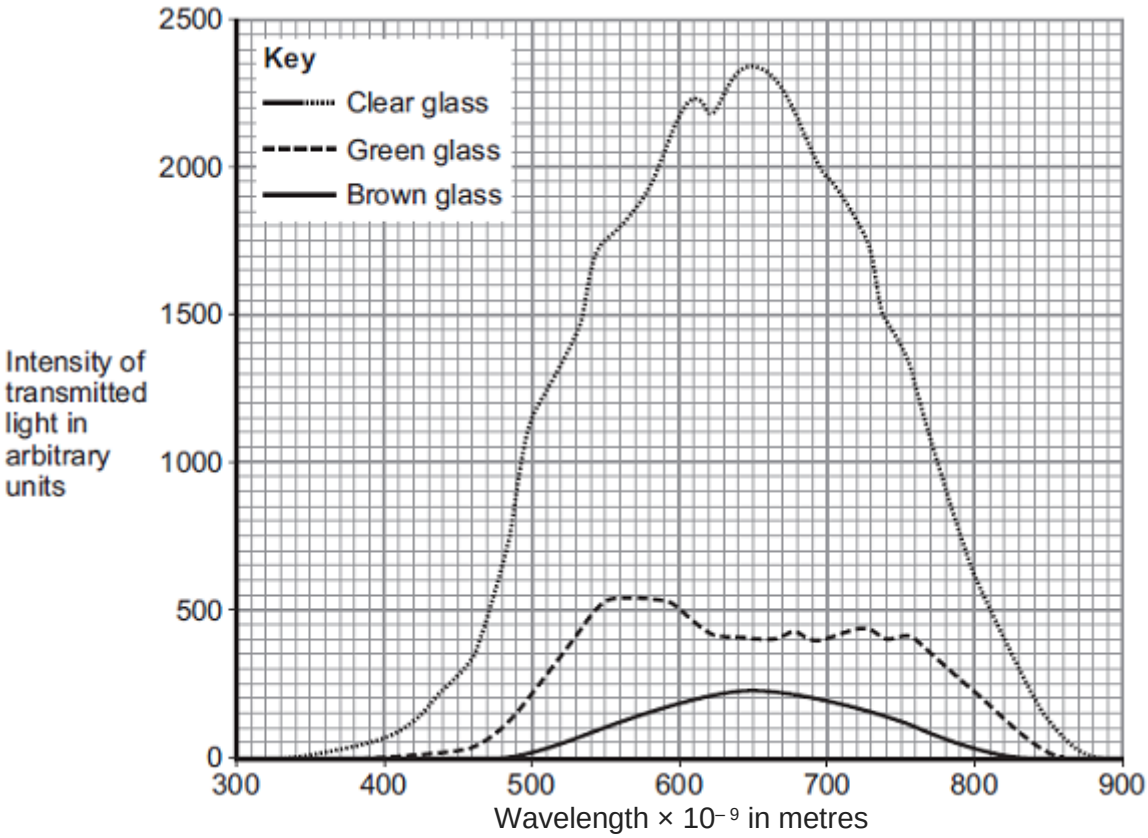
(2)

Name: _____

(b) Bottled beer will spoil if the intensity of the light passing through the glass bottle into the beer is too high.

Figure 3 shows the intensity of the light that is transmitted through three different pieces of glass.

Figure 3



(i) The pieces of glass all had the same thickness.

Suggest why.

_____

_____

(1)

(ii) Bottles made of brown glass are suitable for storing beer.

Suggest why.

_____

_____

(1)

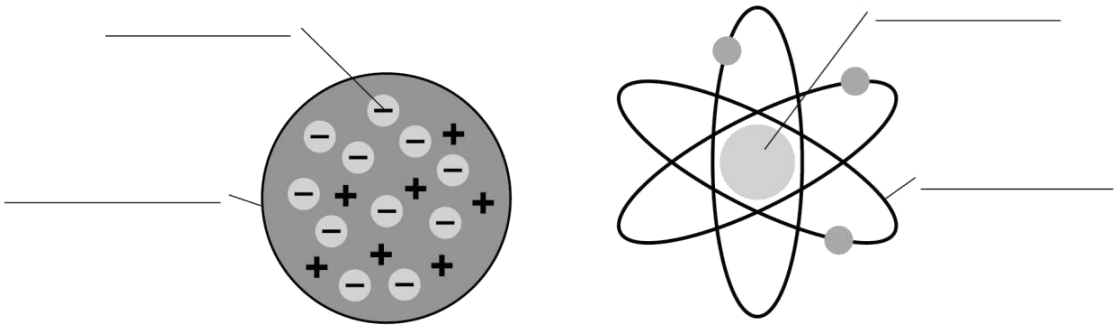
(Total 4 marks)

Name: _____

Q2.

Figure 1 shows two models of the atom.

Figure 1



Plum pudding model

Nuclear model

Write the labels on **Figure 1**

Choose the answers from the box.

(Total 4 marks)

atom	**electron**	**nucleus**
neutron	**orbit**	**proton**

Q3.

Some street lamps contain sodium.

Figure 5 shows two isotopes of sodium.

Figure 5

$^{23}_{11}Na$ $^{24}_{11}Na$

(a) What are isotopes?

_____

_____

_____

_____

(2)

Name: _____

(b) How many protons and neutrons are in a nucleus of $^{23}_{11}Na$?

Number of protons = _____

Number of neutrons = _____

(2)

(c) The sodium atoms emit light.

What would cause light to be emitted from a sodium atom?

Tick **one** box.

Electrons being emitted from the nucleus. ☐

Electrons falling to a lower energy level. ☐

Electrons leaving the atom when it is ionised. ☐

Electrons moving to a higher energy level. ☐

(1)

(Total 5 marks)

Name: _____

Do Now:

1	How many chambers does the heart have?	
2	What is Avogadro's constant?	
3	What protein naturally seals cuts, creating scabs?	
4	What form of current is distributed through the UK mains power grid?	
5	What is the largest particle accelerator?	
6	What is the category of particle that pions are a part of?	

Lesson 2 (Chemistry): The Periodic Table

Topics: 5.1.1.1, 5.1.1.4, 5.1.1.5, 5.1.1.7, 5.1.2.1, 5.1.2.2, 5.1.2.3, 5.1.2.4, 5.1.2.5, 5.1.2.6, 5.4.1.2

Class Discussion: The Periodic Table Structure

- The periodic table is a chart of all the chemical elements.
- The table is split into rows called periods and columns called groups.
- There are 7 periods and 8 groups (technically 18).
- There are metals on the left and nonmetals on the right.
- Between the metals and nonmetals there are the metalloids which have properties of both.
- Some groups have names: Group 1 is the Alkali Metals, Group 7 is the Halogens and Group 0 is the Noble Gases.

Alkali Metals															Halogens	Noble Gases
1	2										3	4	5	6	7	0/8
1 H Hydrogen 1																4 He Helium 2
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	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	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	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	[98] Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	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	175 Lu Lutetium 71	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	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	[266] Lr Lawrencium 103	[261] Rf Rutherfordium 104	[262] Db Dubnium 105	[266] Sg Seaborgium 106	[264] Bh Bohrium 107	[277] Hs Hassium 108	[268] Mt Meitnerium 109	[271] Ds Darmstadtium 110	[272] Rg Roentgenium 111	[285] Cn Copernicium 112	[286] Nh Nihonium 113	[289] Fl Flerovium 114	[289] Mc Moscovium 115	[293] Lv Livermorium 116	[294] Ts Tennessine 117	[294] Og Oganesson 118

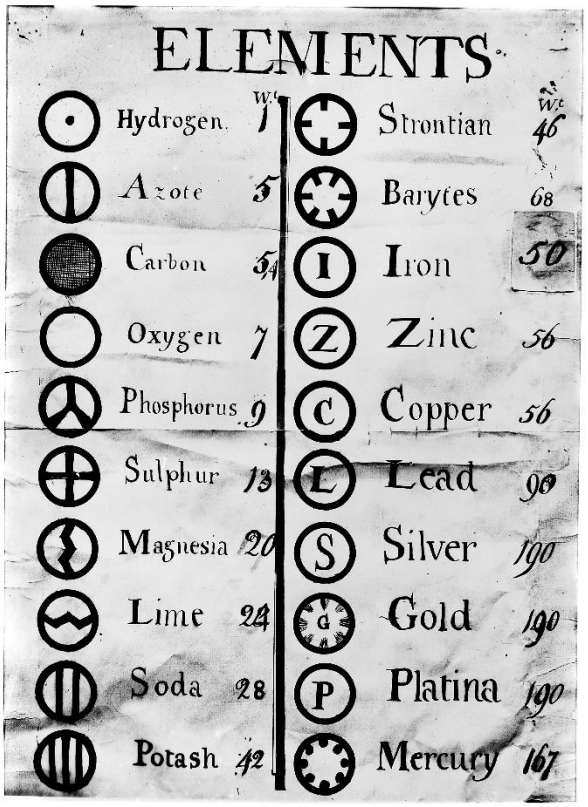
Lanthanides	139 La Lanthanum 57	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	[145] Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70
Actinides	[227] Ac Actinium 89	232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	[237] Np Neptunium 93	[244] Pu Plutonium 94	243 Am Americium 95	[247] Cm Curium 96	[247] Bk Berkelium 97	[251] Cf Californium 98	[252] Es Einsteinium 99	[257] Fm Fermium 100	[258] Md Mendelevium 101	[259] No Nobelium 102

The Periodic Table.

Name: _____

Key Knowledge: The Development of the Periodic Table

- The modern periodic table was first created by Dmitri Mendeleev in 1869.
- However, this does not mean that it was the first…
- In 1806, John Dalton created the first periodic table.



Dalton's 1806 table.

- Then, Johann Wolfgang Döbereiner discovered the law of triads in 18229. Triads are groups of three elements that have similar properties, much like the modern periodic table groups.
- In total, five triads were discovered: lithium, sodium and potassium; calcium, strontium and barium; chlorine, bromine and iodine; sulfur, selenium and tellurium; and iron, cobalt and nickel.
- The law of triads stated that in each triad, the smallest and largest element's masses should mean average to the middle element.
- The next development was a much larger table by Alexandre Emile Béguyer de Chancourtois in 1862.
- Then came John Newlands, who based his table on his new law of octaves, in 1864.
- There were several problems with Newlands' table: due to a lack of known elements, mistakes were often found as elements were placed in inappropriate groups to follow the rule of increasing atomic weight and the rule of octaves strictly.

Name: _____

No.		No.		No.		No.		No.		No.		No.	
H	1	F	8	Cl	15	Co & Ni	22	Br	29	Pd	36	I	42	Pt & Ir	50
Li	2	Na	9	K	16	Cu	23	Rb	30	Ag	37	Cs	44	Os	51
G	3	Mg	10	Ca	17	Zn	24	Sr	31	Cd	38	Ba & V	45	Hg	52
Bo	4	Al	11	Cr	19	Y	25	Ce & La	33	U	40	Ta	46	Tl	53
C	5	Si	12	Ti	18	In	26	Zr	32	Sn	39	W	47	Pb	54
N	6	P	13	Mn	20	As	27	Di & Mo	34	Sb	41	Nb	48	Bi	55
O	7	S	14	Fe	21	Se	28	Ro & Ru	35	Te	43	Au	49	Th	56

Newlands' 1864 table.

- Finally, in 1869 Dmitri Mendeleev published his first table building upon the past ideas of Dalton and Newlands (Chancourtois' did not prove very popular) but ensuring to leave gaps for undiscovered elements where others did not fit with trends.

Reihen	Gruppe I. — R^1O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2O^7	Gruppe VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=86	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9		(—)	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

A newer revision of Mendeleev's table published in 1871.

- In later years, many new elements were discovered that slotted into the table – such as gallium. However, a few were discovered which did not fit. These became known as the Noble Gases and were placed in Group 0.

Series	Zero Group	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
0	x								
1		Hydrogen H=1·008							
2	Helium He=4·0	Lithium Li=7·03	Beryllium Be=9·1	Boron B=11·0	Carbon C=12·0	Nitrogen N=14·04	Oxygen O=16·00	Fluorine F=19·0	
3	Neon Ne=19·9	Sodium Na=23·05	Magnesium Mg=24·1	Aluminium Al=27·0	Silicon Si=28·4	Phosphorus P=31·0	Sulphur S=32·06	Chlorine Cl=35·45	
4	Argon Ar=38	Potassium K=39·1	Calcium Ca=40·1	Scandium Sc=44·1	Titanium Ti=48·1	Vanadium V=51·4	Chromium Cr=52·1	Manganese Mn=55·0	Iron Fe=55·9 Cobalt Co=59 Nickel Ni=59 (Cu)
5		Copper Cu=63·6	Zinc Zn=65·4	Gallium Ga=70·0	Germanium Ge=72·3	Arsenic As=75·0	Selenium Se=79	Bromine Br=79·96	
6	Krypton Kr=81·8	Rubidium Rb=85·4	Strontium Sr=87·6	Yttrium Y=89·0	Zirconium Zr=90·6	Niobium Nb=94·0	Molybdenum Mo=96·0	—	Ruthenium Ru=101·7 Rhodium Rh=103·0 Palladium Pd=106·5 (Ag)
7		Silver Ag=107·9	Cadmium Cd=112·4	Indium In=114·0	Tin Sn=119·0	Antimony Sb=120·0	Tellurium Te=127	Iodine I=127	
8	Xenon Xe=128	Cesium Cs=132·9	Barium Ba=137·4	Lanthanum La=139	Cerium Ce=140	—	—		— — — (—)
9		—	—		—	—	—	—	
10	—	—	—	Ytterbium Yb=173	—	Tantalum Ta=183	Tungsten W=184	—	Osmium Os=191 Iridium Ir=193 Platinum Pt=194·9 (Au)
11		Gold Au=197·2	Mercury Hg=200·0	Thallium Tl=204·1	Lead Pb=206·9	Bismuth Bi=208	—	—	
12	—	—	Radium Rd=224	—	Thorium Th=233	—	Uranium U=239		

A 1904 version of Mendeleev's table showing the noble gases in group 0.

Name: _____

Progress Check

Write which years the below scientists created a periodic table.

John Newlands	
Dmitri Mendeleev	
John Dalton	

Key Knowledge: Reading the Periodic Table

- The periodic table is arranged in order of atomic number (how many protons/electrons there are)
- The period number is the number of electron shells an atom of that element has and the group number is how many electrons are in the outer shell.
- Using this information, you can draw a diagram of an atom.
- You can quickly find elements if you know their atomic number.
- Simply identify which period the element is in using the below diagram.

Atomic Number Range	Period	Elements in Period
0-2	1	2
2-10	2	8
11-18	3	8
19-36	4	18
37-54	5	18
55-86	6	32
87-118	7	32

Element period diagram.

- To find what ion an element will form, you can use the group number. Elements in Group 1 will form +1 ions as it loses an electron. This rule holds true until Group 4 – where atoms behave differently. Elements in Group 5 will form -3 ions – for all future groups add 1 to the number.
- To find what elements are diatomic – form molecules of two atoms. Use the acronym BrINClHOF or the mnemonic “Have (Hydrogen) No (Nitrogen) Fear (Fluorine) Of (Oxygen) Ice (Iodine) Cold (Chlorine) Beer (Bromine)” which lists all the diatomic elements.

Mastery Questions

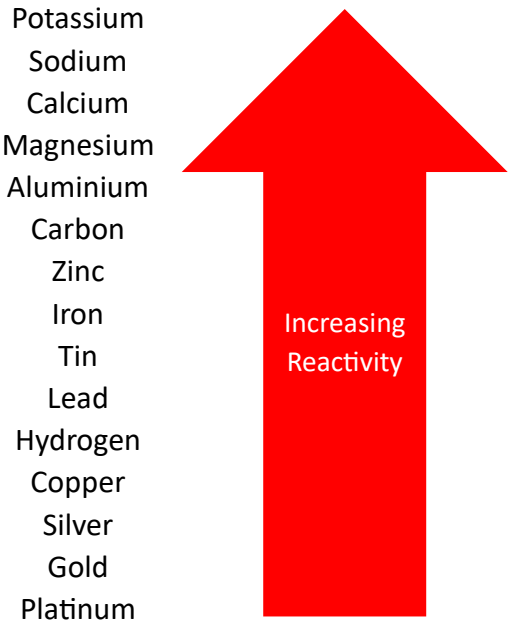
1. Who created the modern periodic table? [1 mark]
2. How are the elements of a period arranged in the modern periodic table, from left to right? [1 mark]

Name: _____

3. What period is rhodium – atomic number 45 – in? [1 mark]
4. What are three differences between John Newland's table and the modern version? [3 marks]

Key Knowledge: The Reactivity Series

- The reactivity series lists elements in order of their reactivity – starting with the most reactive.
- The mnemonic "Please Stop Calling Me A Careless Zebra Instead Try Learning How Copper Saves Gold Pencils" is helpful when remembering the reactivity series.



The Reactivity Series.

Deliberate Practice

Q1.

Some theories suggest that the Earth's early atmosphere was the same as Mars' atmosphere today.

The table below shows the percentage of four gases in the atmosphere of Mars today and the atmosphere of Earth today.

Gases	The atmosphere of	
	Mars today	Earth today
Carbon dioxide	95.00%	0.04%

Name: _____

Nitrogen	3.50%	78.00%
Argon	1.00%	0.96%
Oxygen	0.50%	21.00%

(a) Which **one** of the gases in the table is a noble gas?

_____

(1)

(b) Draw a ring around the correct answer to complete each sentence.

(i) Noble gases are in Group

0
1
7

(1)

(ii) Noble gases are

slightly reactive.
unreactive.
very reactive.

(1)

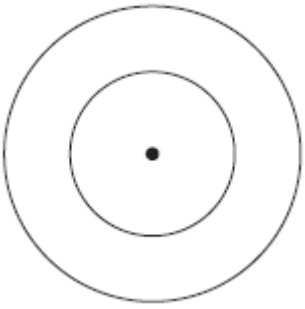
(Total 3 marks)

Q2.

Fossil fuels contain carbon and hydrogen.

(a) (i) Use the Chemistry Data Sheet to help you to answer this question.

Complete the figure below to show the electronic structure of a carbon atom.



(1)

(ii) Complete the word equation for the oxidation of hydrogen.

hydrogen + oxygen ⟶ _____

(1)

Name: _____

(Total 2 marks)

Q3.

Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

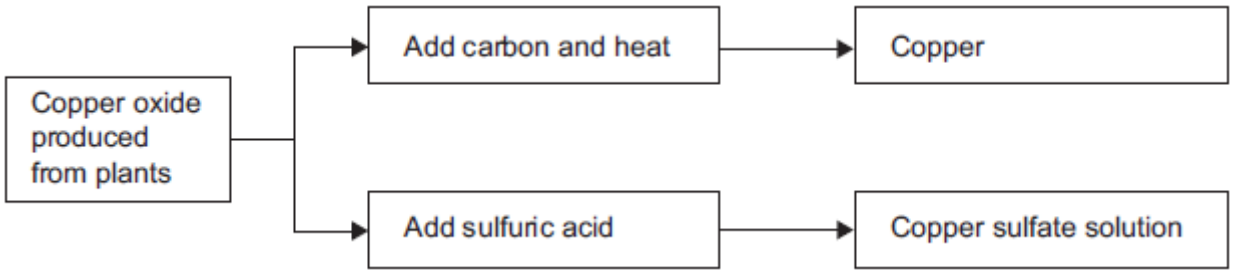
One way to extract the copper is to grow plants on the land.

The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 1**.

Figure 1



(a) Complete and balance the chemical equation for the reaction of copper oxide with carbon.

____CuO + C ⟶ _____ + CO_2

(2)

(b) Copper is produced from copper sulfate solution by displacement using scrap iron or by electrolysis.

(i) Use the Chemistry Data Sheet to help you to answer this question.

Give **two** reasons why scrap iron is used to displace copper.

_____

_____

_____

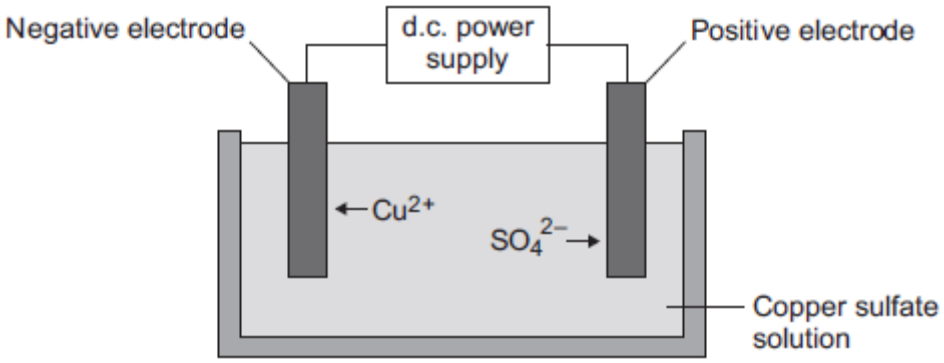
_____

(2)

(ii) **Figure 2** shows the electrolysis of copper sulfate solution.

Figure 2

Name: _____



Describe what happens to the copper ions during electrolysis.

_____

_____

_____

_____

(2)
(Total 6 marks)

Name: _____

Periodic Table Development Timeline

Watch the documentary and use information from the lesson to fill-in the years on the timeline of the development of the periodic table. Some have been done for you.

Ancient: The first elements are discovered.

1789: Antoine-Laurent de Lavoisier complies the first list of the elements. At the time only 33 were known.

1806:

1828: Jöns Jacob Berzelius compiles a list of relative atomic weights, where oxygen was set to 100. He also invented chemical symbols.

1829:

1862:

1864:

1868: Julius Lothar Meyer complies his first periodic table, with features similar to Mendeleev's – it wasn't published until 1870.

1869:

1875: Gallium is discovered by Paul Émile Lecoq de Boisbaudran in Paris – it proves Mendeleev's predictions about the element made using his table.

1894: William Ramsay discovers the noble gases – these would later be added to the table as a new group.

1904:

1913: Henry Moseley discovers atomic number – the number now used to arrange the elements in the periodic table.

1944: Glenn Seaborg proposes the Lanthanide and Actinide series on the periodic table.