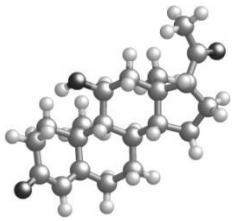

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Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Notes on Atomic Structure – Macroconcept: Models

Learning Outcomes:

- By the end of the unit, students should understand the concept of *atom*.
- Students will demonstrate their understanding of atomic structure by being able to…

(a) State the relative charges and approximate relative masses of a proton, a neutron and an electron.

(b) Describe, with the aid of diagrams, the structure of an atom as containing protons and neutrons (nucleons) in the nucleus and electrons arranged in shells (energy levels).

(c) Define proton (atomic) number and nucleon (mass) number.

(d) Interpret and use symbols such as $^{12}_{6}C$.

(e) Define the term isotope.

(f) Deduce the numbers of protons, neutrons and electrons in atoms and ions given proton and nucleon numbers.

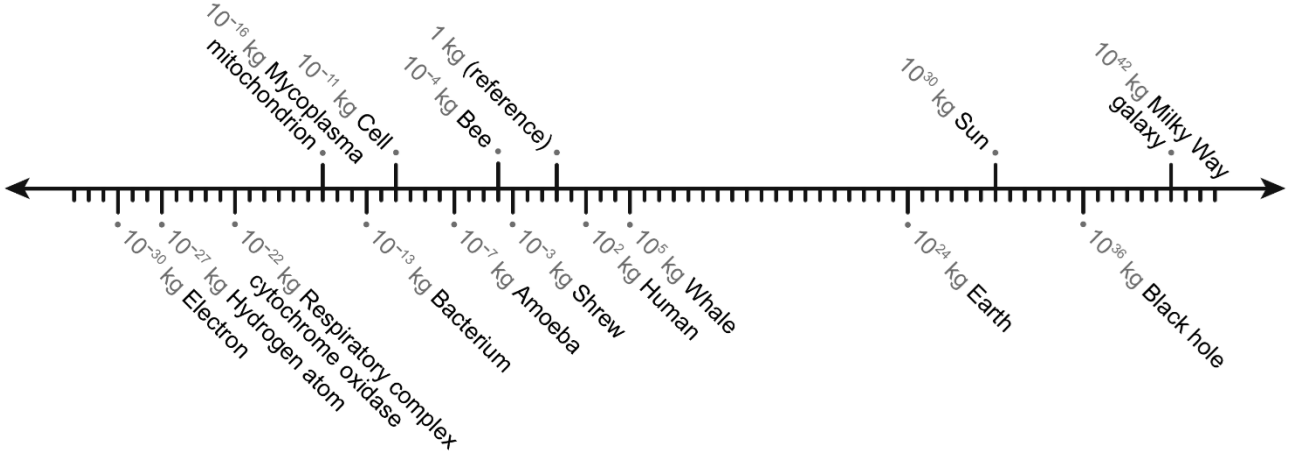
(g) Draw the electronic configurations of the first twenty elements (hydrogen to calcium).

(h) Understand that atoms with noble gas electronic configurations are inert.

(i) Understand that atoms of metallic elements react by losing their valence electrons to form positively charged ions (cations) with a noble gas electronic configuration.

(j) Understand that atoms of non-metallic elements react by gaining electrons into their valence shell to form negatively charged ions (anions) with a noble gas electronic configuration.

(k) Understand generalisations about models and how models are used by scientists to visualise and understand complex ideas.



- The concept of *scale*, from the extremely small to the extremely large.

1. What is the definition of *atom*?

……...

……...

2. Atoms are extremely small (see diagram on page 1). Even with the use of modern technology, it is not possible to observe the detailed structure of an individual atom. On what evidence do scientists base their understanding of atomic structure?

……...

……...

……...

3. Modern understanding of atomic structure is a conceptual *model*. Ideas about atomic structure may change as new evidence is discovered. What are some generalisations about *models*?

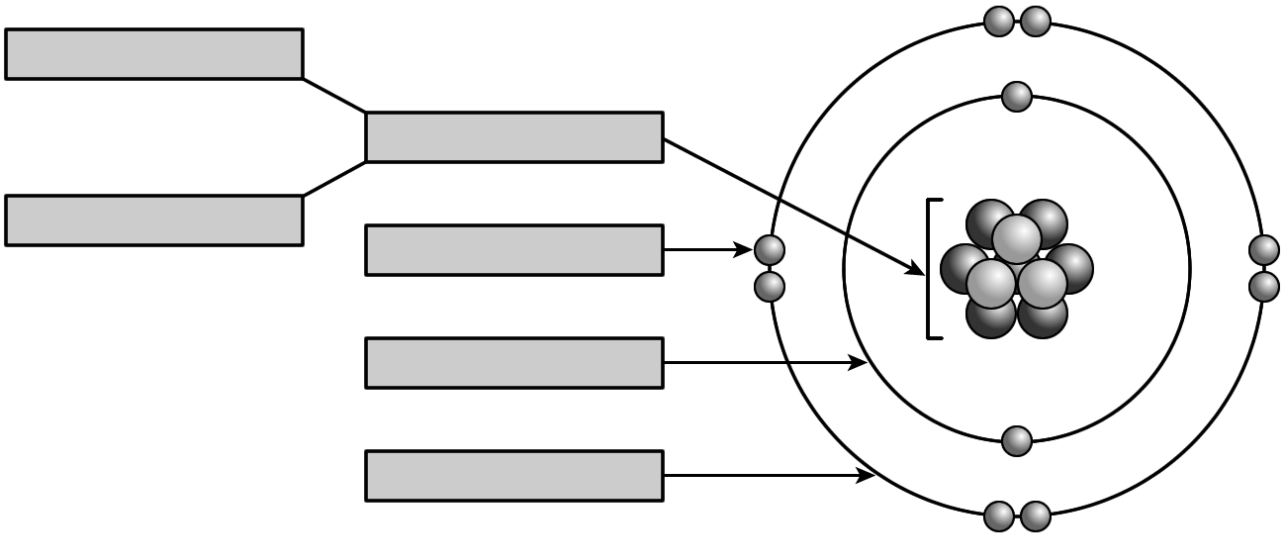
……...

……...

4. At the centre of every atom is a small dense …… This is composed of two sub-atomic particles known as …… (which carry a charge of +1) and …… (which carry a charge of 0)*. A third sub-atomic particle known as an …… (which carries a charge of –1) orbits around the centre of the atom in energy levels that are often referred to as …… …… The inner shell (closest to the centre) can hold a maximum number of …… …… while the second and third shells can hold a maximum number of …… …… each.

*Note: There is one exception. The nucleus of a hydrogen atom does not contain any neutrons.

5. Label the diagram shown below to summarise the fundamental structure of an atom.



6. Complete the table shown below to summarise the fundamental properties of protons, neutrons and electrons.

Name of Sub Atomic Particle	Particle's Location in Atom	Particle's Relative Charge	Particle's Relative Mass
Proton			
Neutron			
Electron			

7. Explain why atoms are electrically neutral.

……...

……...

8. **(a)** Define the term *atomic number*.

……...

(b) Define the term *mass (nucleon) number*.

……...

(c) How are the number of neutrons in an atom calculated?

……...

9. Which particle, the proton, neutron or electron, determines which chemical element an atom belongs to (*i.e.* the number of which particle is unique for each chemical element)?

……...

……...

10. How many protons, neutrons and electrons do the atoms of the following elements contain?

(a) $^{7}_{3}$Li protons = …… neutrons = …… electrons = ……

(b) $^{19}_{9}$F protons = …… neutrons = …… electrons = ……

(c) $^{23}_{11}$Na protons = …… neutrons = …… electrons = ……

11. **(a)** What is the relationship between an element's position in the Periodic Table and the total number of electrons contained within a single atom of that element?

……...

……...

(b) What is the relationship between an element's position in the Periodic Table and the number of *electron shells* in an atom of that chemical element?

……...

……...

(c) What is the relationship between an element's position in the Periodic Table and the number of electrons in the *valence shell* of an atom of that chemical element?

……...

……...

12. Based upon its electronic configuration, how can you determine whether an atom belongs to a metallic element or a non-metallic element?

……....

……...

13. In the space provided below, draw the full electronic configuration of **(a)** an atom of oxygen **(b)** an atom of aluminium.

(a) Electronic configuration of a single oxygen atom.	**(a)** Electronic configuration of a single aluminium atom.

14. **(a)** Define the term *isotope*.

……...

……...

(b) Complete the table below to show the numbers of each sub-atomic particle present in the three isotopes of carbon; $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$.

Isotope of Carbon	**Number of Protons**	**Number of Electrons**	**Number of Neutrons**
$^{12}_{6}C$			
$^{13}_{6}C$			
$^{14}_{6}C$			

(c) There are two isotopes of the chemical element chlorine. 75% of naturally occurring chlorine is $^{35}_{17}Cl$ and 25% of naturally occurring chlorine is $^{37}_{17}Cl$. Use this information to explain why the relative atomic mass of chlorine is *not* a whole number.

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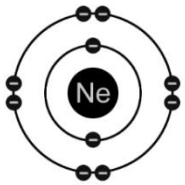
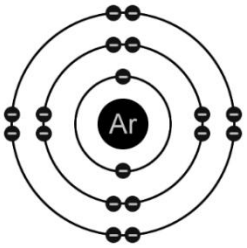
15. The electronic configurations of helium, neon and argon are given below.

Helium – He	Neon – Ne	Argon – Ar
		

(a) What is unique about the electronic configurations of helium, neon and argon?

……...

……...

(b) How do the unique electronic configurations of helium, neon and argon affect their reactivity?

……...

……...

16. Atoms react to lose or gain electrons so that they can obtain the electronic configuration of a Noble gas. Atoms do this to become chemically stable. During a chemical reaction, the number of protons and neutrons in the nuclei of the atoms remains the same.

(a) What happens to the charge on a neutral atom if it *gains* electrons to complete its valence electron shell?

……...

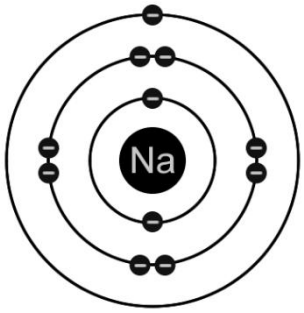
……...

(b) What happens to the charge on a neutral atom if it *loses* electrons to complete its valence electron shell?

……...

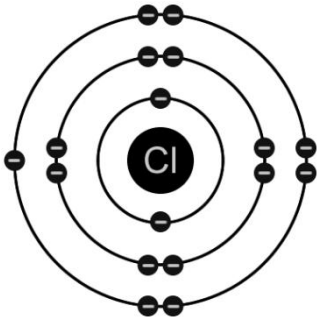
……...

17. The diagram below shows the full electronic configuration of a sodium atom.



With the aid of a diagram, explain how a sodium atom reacts to obtain a noble gas electronic configuration.

18. The diagram below shows the full electronic configuration of a chlorine atom.



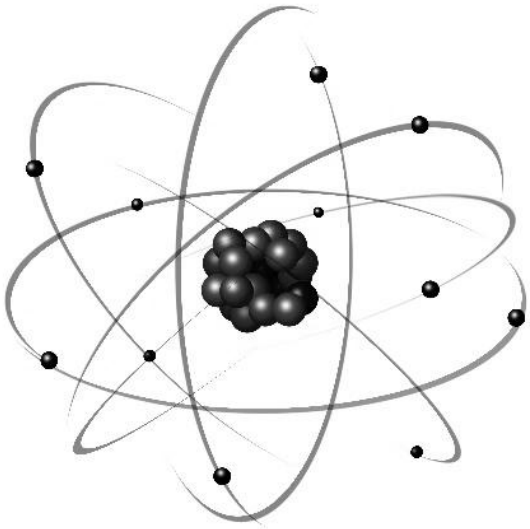
With the aid of a diagram, explain how a chlorine atom reacts to obtain a noble gas electronic configuration.

Self-checklist on Atomic Structure

	Aspect of atomic structure:	Yes, I understand	No, I need more help
1.	I understand that Scientists use models to represent and understand things that are complex and / or cannot be observed directly (because they are either extremely small or extremely large).	☐	☐
2.	I understand that atoms are the building-blocks of all matter; solids, liquids and gases. A knowledge and understanding of atoms helps to explain how the world around us works.	☐	☐
3.	I understand that atoms are made-up of smaller (sub-atomic) particles called *protons*, *neutrons* and *electrons*.	☐	☐
4.	I understand that, although atoms, protons, neutrons and electrons are too small to be observed, there is strong experimental evidence to support their existence.	☐	☐
5.	I can recall the relative masses and charges of protons, neutrons and electrons.	☐	☐
6.	I am able to draw the basic structure of an atom, clearly showing the locations of the protons, neutrons, electrons and electron shells.	☐	☐
7.	I can define the terms *atomic number* and *mass number*, and I can interpret symbols such as $^{23}_{11}Na$ to state how many protons, neutrons and electrons there are in a particular atom.	☐	☐
8.	I am able to define the term *isotope*, and I understand why the relative atomic mass of an element is not always a whole number.	☐	☐
9.	I understand that atoms of the different chemical elements have different numbers of protons and different numbers of electrons (in different electronic configurations).	☐	☐
10.	I am able to draw the electronic configurations of the first 20 chemical elements (when given an element's atomic number or allowed to reference the *Periodic Table*).	☐	☐
11.	I know that the *Noble gases* (Group 18) have a complete valence shell, and this makes them chemically stable.	☐	☐
12.	I understand that *metals* can obtain the same electronic configurations as Noble gases, and hence become chemically stable, by *losing* all of their valence electrons and forming positively charged ions (*cations*).	☐	☐
13.	I understand that *non-metals* can obtain the same electronic configurations as Noble gases, and hence become chemically stable, by *gaining* electrons to complete their valence electron shells and forming negatively charged ions (*anions*).	☐	☐

- Scan the QR code below for the answers to this assignment.

http://www.chemist.sg/chemical_bonding/notes_atomic_structure/notes_atomic_structure_ans.pdf



Periodic Table of the Chemical Elements (2017)

Group 1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –