RADLEY

2023 Scholarship Examination Paper

CHEMISTRY

22 February – 23 February 2023

Time allowed – 30 minutes

Instructions:

- Read the information given for each question carefully.
- Answer all the questions in the spaces provided
- If more space is required, please use the additional space at the end of the paper ensuring that you clearly number your answers.
- A Periodic Table is provided at the end of the paper.

Marks: ……. / 30

1. Elements are made up of atoms.

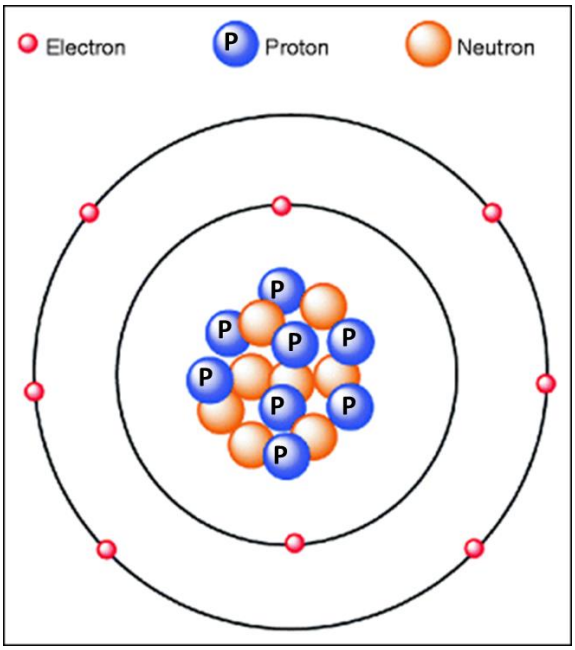
a) Define the term *element*.

……..

……..

(2)

Atoms are made up of three (so-called subatomic) particles: neutrons, protons and electrons. As atoms are very very small, we cannot see them with our eyes (or even under a microscope). Scientists have therefore made a model of the atom. A drawing of an oxygen atom as shown below should illustrate this model.



Using this very simple model the neutrons and protons form the nucleus of the atom and the electrons are said to revolve around the nucleus a bit like planets revolve around the sun (the nucleus). Protons all have a positive charge and the electrons a negative charge. For each atom the number of electrons is always the same as the number of a proton. Neutrons have no charge (they are neutral).
The electrons are arranged around in nucleus in shells (rings). There is a limit on how many electrons each shell can take at most:

1st shell: 2 electrons, 2nd shell: 8 electrons, 3rd shell: 8 electrons.

b) Suggest a reason why the electrons revolve around the nucleus and do not fly off into the distance.

……

……

(2)

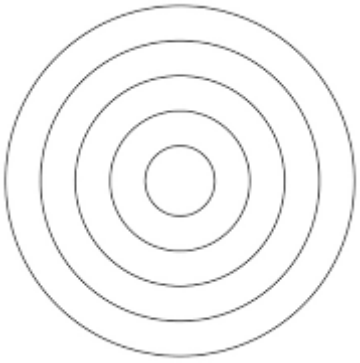
c) What must be the overall charge of an atom? Explain your answer.

……

……

(2)

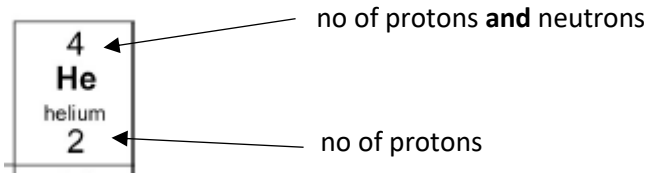
d) Sodium has 11 electrons. Complete the shell diagram below by adding the electrons to the correct rings. The nucleus is not shown.



(1)

2. Very helpfully, the periodic table (which you can find at the end of this paper) tells us a lot about the numbers of these subatomic particles of an atom.

For example helium has the following entry:



The top number denotes the number of protons and neutron, the *atomic mass number*. It is called the atomic mass number because almost all of the mass of an atom is located in the nucleus. Electrons do not count towards the total mass of an atom since their mass is far too small. The bottom number represents the number of protons only, the *atomic number*. Each element therefore has its own atomic number.

a) The mass of an atom is expressed by the atomic mass number. What is the mass number of an oxygen atom?

…….

(1)

b) Yellow sulfur has the formula S_8 which means it has eight sulfur atoms bonded together. What would be the total mass of sulfur, S_8?

…….

(1)

c) Oxygen is a gas and sulfur is a solid. In the boxes below sketch the arrangement of particles in oxygen and sulfur. You can abbreviate the particles with a circle.

(i) oxygen

b) sulfur

(2)

(ii) Explain in your own words the difference in the arrangement of a gas and a solid.

……

……

……

(4)

d) The table below shows the atomic mass and atomic number of a chlorine atom. Without using the periodic table but with your knowledge you gained from the previous paragraph, complete the table.

Symbol	Number of protons	Number of neutrons	Number of electrons	Atomic mass number
$^{35}_{17}Cl$				

(4)

e) Work out the atom for the particle with 13 protons and 14 neutrons. Clearly write the chemical symbol, atomic number and mass number.

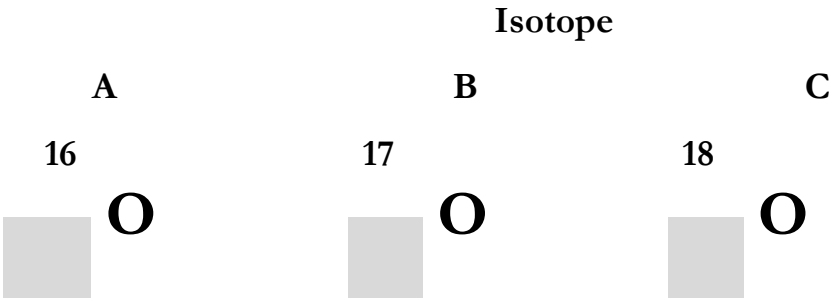
(2)

f) Work out the symbol, including atomic number and mass number for the atom with three more protons and three more neutrons as the chlorine atom in the table above (question part d) above).

(2)

3. Sometimes the number of neutrons in an atom can vary. We call atoms with the same number of protons (the same element) but different number of neutrons **isotopes**. For example oxygen has three isotopes.

a) Complete the atomic number in the shaded boxes below.



(1)

b) For each isotope in part a) above give the number of neutrons.

	Isotope		
	A	**B**	**C**
no of neutrons			

(1)

c) In the periodic table chlorine's an atomic mass is listed as 35.5. You cannot have a half of a subatomic particle. This number comes about as the weighted average of two isotopes of chlorine: ^{35}Cl and ^{37}Cl. The two isotopes do not have the same abundance, which means that they naturally occur in different proportions/amounts.

(i) Suggest a reason which of the two isotopes must be more abundant (must be more of).

……

……

……

(2)

(ii) Given that the average atomic mass is 35.5 of a mixture of the two, can you work out the relative abundances, in percent, of the two isotopes?

……

……

……

(3)

End of paper

1	2											3	4	5	6	7	0
							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	139 **La*** lanthanum 57	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	[227] **Ac*** actinium 89	[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] **Uut** ununtrium 113	[289] **Fl** flerovium 114	[289] **Uup** ununpentium 115	[293] **Lv** livermorium 116	[294] **Uus** ununseptium 117	[294] **Uuo** ununoctium 118

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.