REVIEW QUESTIONS

Chapter 1: Atomic Structure

1. Complete the following table to summarise the basic structure of the atom.

PARTICLE	LOCATION	RELATIVE MASS (compared to a proton)	RELATIVE CHARGE

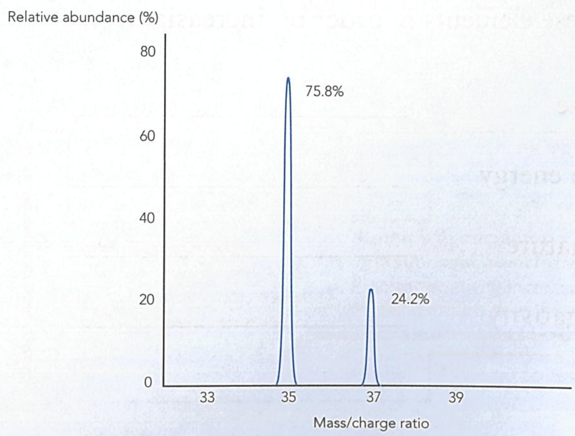
2. State the number of protons, neutrons and electrons in each of the following neutral atoms.

(a) $^{7}_{3}\mathrm{Li}$ (b) $^{23}_{11}\mathrm{Na}$ (c) $^{37}_{17}\mathrm{Cl}$ (d) $^{56}_{26}\mathrm{Fe}$

3. The element boron has 6 known isotopes as listed below. The most abundant boron isotope is boron-11 (80.1%) with the remainder being mostly boron-10 (19.9%). Complete the following table to show the number of protons and neutrons that each isotope possesses.

ISOTOPE	SYMBOL	NUMBER OF PROTONS	NUMBER OF NEUTRONS
Boron-8			
Boron-10			
Boron-11			
Boron-12			
Boron-13			
Boron-14			

4. The graph below shows the relative abundance of the two isotopes of chlorine, $^{35}\mathrm{Cl}$ and $^{37}\mathrm{Cl}$. Their relative isotopic masses are 34.97 and 36.97 respectively. Using the graph and this data determine the relative atomic mass (A_r) for chlorine.



5. The two naturally occurring isotopes of rubidium are ^{85}Rb and ^{87}Rb. Their relative isotopic masses are 84.91 and 86.91. The relative atomic mass for rubidium is 85.468. Determine the percentage abundance of each isotope of rubidium.

6. The electromagnetic spectrum is made up of many types of electromagnetic radiation including visible light, X-rays, microwaves, UV light and radio waves. Place these radiation types in increasing order of wavelength.

7. When the light emitted by a discharge tube containing hydrogen gas is analysed with a spectrometer distinct coloured lines are visible. In terms of atomic structure briefly explain how these spectral colours are produced.

8. Flame tests can be used to help identify the presence of some metal ions due to their characteristic flame colours. Briefly explain the following.

   (a) The origin of the characteristic colours for different metal ions in the flame
   (b) The limitations of simple flame tests.

9. Fluorine has a ground state electron configuration of 2, 7

   In a similar manner write the ground state electron configurations for the following neutral elements:

   (a) He (b) Al (c) Na (d) Mg (e) C (f) Ca

10. How many valence electrons are there in an atom of each of the elements described below?

    (a) An alkali metal from the 5th period.
    (b) The element from group 2 in period 3.
    (c) A noble gas from period 4.
    (d) The element from period 4 that belongs to group 17.
    (e) The element from the third period that belongs to group 16.

11. (a) What is true about the electron configuration of all elements belonging to the same group on the periodic table?
    (b) Apart from helium, what outer energy level electron configuration do all noble gases have?
    (c) What is (chemically) important about this electron configuration?
    (d) When atoms become ions, what general rule appears to be followed?

12. Match the following chemical species to the correct electron configurations.

Al^{3+}	2
S^{2-}	2, 6
O	2, 8
He	2, 4
C	2, 8, 8

13. The electron configuration of a chemical species is 2, 8, 6. Which of the following statements **might** be true about this species?

(a) It belongs to group 14 in the 3rd period
(b) It is a non-metal with a valency of +2.
(c) It can gain two electrons to become more stable.
(d) Ar^{2-} would possess this electron configuration (if it existed).
(e) S^{2-} would possess this electron configuration (if it existed).

14. Why do elements belonging to group 2 tend to form ions with a valency of +2?

15. Write the electron configuration of each of the following:

(a) Mg^{2+} (d) Ar

(b) Cl^{-} (e) H

(c) S^{2-} (f) Be^{2+}

16. Draw electron dot diagrams for the following atoms:

(a) Ca (c) O

(b) F (d) Ne

17. Define the term **ionisation energy**.

18. The following table shows the first ionisation energy for some of the elements belonging to groups 17 and 18.

GROUP 17 ELEMENT	IONISATION ENERGY OF GROUP 17 ELEMENT
Fluorine	1680 kJ
Chlorine	
Bromine	1140 kJ
Iodine	1010 kJ

GROUP 18 ELEMENT	IONISATION ENERGY OF GROUP 18 ELEMENT
Neon	2080 kJ
Argon	1520 kJ
Krypton	
Xenon	1170 kJ

(a) Complete the table by estimating the ionisation energies for Cl and Kr.

(b) What trend in ionisation energy of elements down a group, does this table show?

(c) Write an equation (including energy) for the first ionisation of fluorine.

19. (a) Which element has the lowest first ionisation energy of all elements in the third period?

(b) Which element has the second highest first ionisation energy of all the elements belonging to the 2nd period?

(c) For any period, which element has the highest first ionisation energy?

20. (a) Why does first ionisation energy decrease down a group in the periodic table?

(b) Why does first ionisation energy increase from left to right across a period in the periodic table?

21. Explain the following trend in successive ionisation energies for any individual element:

1st ionisation energy < 2nd ionisation energy < 3rd ionisation energy, etc.

22. Complete the following table by predicting the valency and the group number of each of the elements listed:

NUMBER OF IONISATIONS AND IONISATION ENERGY IN kJ						GROUP NUMBER	VALENCY
	1st	2nd	3rd	4th	5th		
X	578	1817	2745	11577	14842		
Y	590	1145	4912	6490	8153		
Z	1086	2256	4620	6223	37831		

23. If you were told that elements X, Y and Z (question 22) belonged to different periods, which do you think belongs to:

(i) period 2? (ii) period 3? (iii) period 4?

Justify your answers.

FOR THE EXPERTS

The Carbon-14 Isotope

24. Carbon has several isotopes, the three most abundant are listed below. The most common carbon isotope is carbon-12 (98.93%) with the remainder being mostly carbon-13 (1.07%). The relative isotopic masses of the ^{12}C and ^{13}C are 12.000 and 13.003 respectively.

Very small traces of carbon-14 occur in the atmosphere. Carbon-14 is continually produced in the atmosphere due to the action of neutrons with nitrogen-14 atoms. However, carbon-14 decays back to nitrogen-14 at the same rate as its formation leaving a constant small presence of this isotope in the air.

Carbon-14 is present in all living things through the formation of carbon dioxide which is then absorbed during photosynthesis. The resulting sugars and starches are eaten by animals. When an organism dies, the presence of the carbon-14 isotope is reduced since it is no longer being replaced. The reduced presence of carbon-14 in dead organisms can be used to date them. The half-life of C-14 is 5715 years.

Complete the following table to show the number of protons and the number of neutrons for each isotope.

(a)

ISOTOPE	SYMBOL	NUMBER OF PROTONS	NUMBER OF NEUTRONS
Carbon-12			
Carbon-13			
Carbon-14			

(b) The relative atomic mass for carbon (atomic weight) is given as 12.01 (see periodic table). Show, using the data above, how this value can be verified.

(c) The processes for the formation and decay of carbon-14 in the atmosphere are as follows:

$$^{14}_{7}N + ^{1}_{0}n \rightarrow ^{14}_{6}C + X$$

$$^{14}_{6}C \rightarrow ^{14}_{7}N + Y$$

What is the likely identity and nature of particles X and Y?

(d) Carbon dioxide molecules in the atmosphere may contain carbon-14 atoms (about 1 in 10^{12}) instead of carbon-12 atoms.

(i) In what way would the properties of the gases made up of these different molecules vary?

(ii) In what way would they be the same?

1.11
The energy levels of different metallic ions are unique since their atomic structures are also all different. Hence the electron transitions possible, and the resulting colours visible, are unique to each metallic ion.

1.12
The colours observed are dependent only on the metallic ion. In this case they are both sodium salts and a yellowish flame will result.

1.13
Place a small sample of one of the salts in a colourless Bunsen flame. A reddish colour would indicate a calcium salt while a pale green colour a barium salt.

1.14
(a) The prism disperses the light into its component colours.
(b) The monochromator allows only one colour (or wavelength) to pass through to the detector at a time.

1.15
(a) The metal coating of the cathode lamp allows it to produce light containing the specific wavelength that can be absorbed by the metal sample being analysed.
(b) The light from the lamp is pulsed so that the detector can distinguish it from the light emitted by the flame containing the sample. In this way the detector can determine if any of the lamp light has being absorbed and if so to what extent.

1.16
One electron in outer level

1.17
(a) 2 (b) 7 (c) 8

1.18
(a) S (b) Ca (c) Ar

1.19
(a) :Ar: *(c)* • B •
(b) :Cl • *(d)* • N •

1.20 *Nitrogen*

1.21
Li 2 , 1 Li • *N 2 , 5* • N •
Be 2 , 2 • Be • *O 2 , 6* :O •
B 2 , 3 • B • *F 2 , 7* :F •
C 2 , 4 • C • *Ne 2 , 8* :Ne:

1.22
(a) Si, C, N. (b) K, Na, Mg.

1.23
(a) 5th ionisation energy → electron is being removed from a lower energy level..
(b) 4 electrons

1.24
(a) 2 (b) +2
(c) Metal
- relatively low 1st and 2nd ionisation energies
- has only 2 valence electrons.

1.25
An atom of chlorine has a much greater number of protons than an atom of sodium. This means that the electrons of the chlorine atom are much more strongly attracted by the nucleus and a smaller radius for the chlorine atom results.

1.26
Oxygen will be more electronegative than sulfur since electronegativity decreases as we go down a group of the periodic table. This can also be explained by the fact that the outer level of a sulfur atom is further out than that for oxygen and the attraction for electrons would be weaker.

1.27 *(a) Ca (b) K (c) Cs (d) Ca*

1.28
Calcium is more metallic than magnesium since it is lower in group 2 of the periodic table and hence has a lower ionisation energy. This indicates that electrons are more easily removed from calcium and a more metallic character results.

1.29
(a) P, Si, Al (c) P, Si, Al
(b) Al, Si, P (d) Al. Si, P

Review Questions

1.

PARTICLE	PROBABLE LOCATION	RELATIVE MASS	RELATIVE CHARGE
proton	nucleus	1	+1
neutron	nucleus	1	0
electron	electron cloud	$\frac{1}{1836}$	−1

2. *(a) 3 protons, 4 neutrons, 3 electrons*
(b) 11 protons, 12 neutrons, 11 electrons
(c) 17 protons, 20 neutrons, 17 electrons
(d) 26 protons, 30 neutrons, 26 electrons

3.

ISOTOPE	SYMBOL	NO. OF PROTONS	NO. OF NEUTRONS
Boron-8	$^{8}_{5}B$	5	3
Boron-10	$^{10}_{5}B$	5	5
Boron-11	$^{11}_{5}B$	5	6
Boron-12	$^{12}_{5}B$	5	7
Boron-13	$^{13}_{5}B$	5	8
Boron-14	$^{14}_{5}B$	5	9

4.
A_r (Cl) = ∑ (isotopic mass × abundance %)/100

= ∑ ((34.97 × 75.8) + (36.97 × 24.2))/100

= 35.45

5. *Let % abundance of ^{85}Rb be x. Hence % abundance of ^{87}Rb will be (100-x).*

Now

A_r (Rb) = ∑ (isotopic mass × abundance %)/100
= 85.468

So

∑ ((84.91)(x) + (86.91)(100 - x))/100
= 85.468
84.91x + 8691 - 86.91x
= 8546.8

2.00x = 144.4

Hence % abundance of ^{85}Rb is = 72.2%
and % abundance of ^{87}Rb is = 27.8%

6. *Order of increasing wavelength:*
X-rays, UV light, visible light, microwaves, radio waves.

7. *In the discharge tube the electrons of the hydrogen atoms are being continually excited from their stable state to higher energy levels. As the electrons return to lower energy levels they emit photons whose energies are equal to the difference between the two levels involved. Since only specific transitions are possible then only photons of specific energy are emitted. These correspond to different wavelengths of radiation, some of which are in the visible light range.*

8.
(a) *Flame colours are the result of visible radiation emitted by the excited electrons falling to their original ground state within the metallic ions. Different atoms have different possible energy levels and hence any energy level transitions are unique. This results in different colours being observed.*
(b) *Flame tests are only qualitative. Colours may be masked by impurities. A Bunsen burner flame is not suitable for many metals due to its relatively low temperature.*

9.
(a) 2 (d) 2, 8, 2
(b) 2, 8, 3 (e) 2, 4
(c) 2, 8, 1 (f) 2, 8, 8, 2

10.
(a) 1 (d) 7
(b) 2 (e) 6
(c) 8

11.
(a) *They have the same valence electron configuration.*
(b) 8
(c) *It is chemically stable or inert.*
(d) *They try to get the same configuration as their nearest noble gas.*

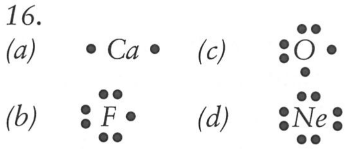
12.

Al^{3+}	2
S^{2-}	2,6
O	2,8
He	2,4
C	2,8,8

13. (c)

14. *They have 2 loosely held electrons in their outermost energy level.*

15.
(a) Mg^{2+} 2, 8
(b) Cl^- 2, 8, 8
(c) S^{2-} 2, 8, 8
(d) Ar 2, 8, 8
(e) H 1
(f) Be^{2+} 2

16.


17. *Energy required to remove the most loosely held electron from an atom in the gaseous state.*

18.
(a) *Approximate ionisation energies:*
Cl: 1300 kJ ; Kr: 1320 kJ
(b) *Ionisation energy decreases down a group.*
(c) $F_{(g)}$ + 1680 kJ → $F^+_{(g)}$ + e^-

19.
(a) Na
(b) F
(c) *The noble gas of that period.*

20.
(a) *Increased distance between nucleus and*

outermost electrons plus increase in number of electrons between nucleus and outermost electron (shielding).

(b) *Although the outermost electrons are all on the same principal energy level the nuclear charge increases. This means that the electrons are more strongly attracted to the nucleus.*

21. *As each electron is removed the distance between the nucleus and the "outermost" electron decreases and so electrostatic attraction increases. Also, electrons are being removed from an increasingly positive ion rather than a neutral atom.*

22.

	GROUP NUMBER	VALENCY
X	3	+3
Y	2	+2
Z	4	+4 or −4

23.

i) Z ; ii) X ; iii) Y : magnitude of the 5th ionisation energy indicates the relative energy level – the higher the 5th ionisation energy the lower the energy level.

24.

(a) ***For the Experts***

ISOTOPE	SYMBOL	NUMBER OF PROTONS	NUMBER OF NEUTRONS
Carbon-12	$^{12}_{6}C$	6	6
Carbon-13	$^{13}_{6}C$	6	7
Carbon-14	$^{14}_{6}C$	6	8

(b) A_r *(carbon)* $= \dfrac{98.89}{100}$ *(12.000)* $+ \dfrac{1.11}{100}$ *(13.003)*

$= 12.01$

(c) *X is* $^{1}_{1}P$ *or* $^{1}_{1}H$

Y is $^{0}_{-1}e$ *(Beta particle)*

(d)

(i) *Carbon-14 atoms would be slightly heavier and radioactive.*

(ii) *Both would undergo the same chemistry because both have the same number (i.e. 4) valence electrons.*

CHP 2: MATERIALS

Chapter Questions

2.1 *Elements: cannot be separated into simpler substances.*
: gold, oxygen, aluminium.
Compounds: two or more elements chemically combined.
: sugar, water, rubber, salt.
Homogeneous mixture: uniform composition throughout (solutions)
: sea water, air, solder, brass, petrol.
Heterogeneous mixture: non uniform composition.
: limestone, rock, cement.

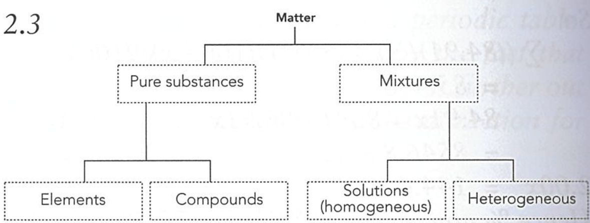
2.2

(a) *A solution is a mixture and its constituents are not chemically combined. A compound is pure.*

(b) *Mixtures are either homogeneous or heterogeneous. A solution is a homogeneous mixture.*

(c) *The salt is a compound since it can be broken into simpler substances.*

2.3



2.4

- *Elements: oxygen gas, zinc, gold*
- *Compounds: pure water, sugar, carbon dioxide*
- *Mixtures: sea water, vinegar, air*

2.5

(i) *distillation*

(ii) *evaporation/crystallisation*

(iii) *fractional distillation*

(iv) *filtration*

(v) *filtration and fractional crystallisation.*

2.6

(a) *Cooling water causes the vapour to condense quickly.*

(b) *Allows water jacket to fill, increases cooling effect and minimises water use.*

(c) *Simple distillation separates a single liquid from a solution containing only dissolved salts, whereas fractional distillation can separate two or more different liquids from solution.*

2.7 *Place the mixture in water after first removing the iron filings with a magnet. The leaves will float and can be removed with a small sieve or floated off and filtered. The sand can*