Ministry of education

Musanze district

Ecole des sciences de Musanze

EXERCISES FOR SELF PREPARATION SENIOR FOUR CHEMISTRY

UNITS 1, 2, 3, 4.

1. An element with three stable isotopes has 82 protons. The separate isotopes contain 124, 125, and 126 neutrons. Identify the element and write symbols for the isotopes.
2. The figures below represent the mass spectrum of mercury and Molybdenum respectively
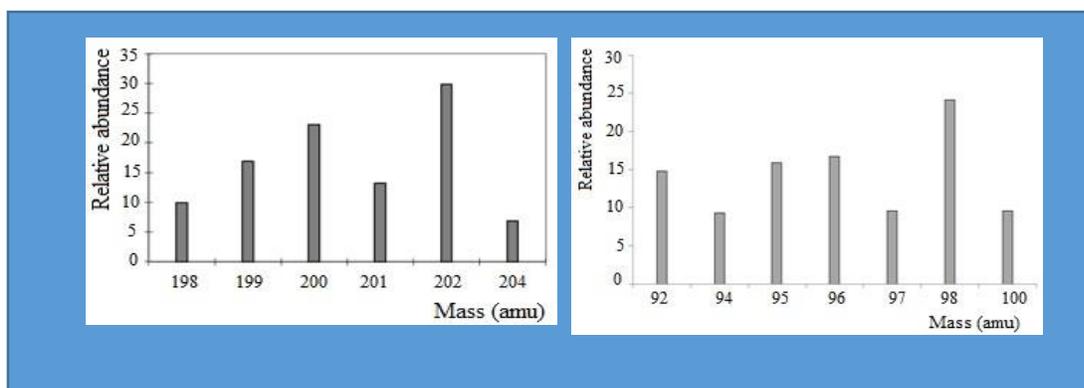
a) Calculate the atomic masses of mercury, and molybdenum from your data.

b) Compare your results to the actual atomic weights of these elements found on the periodic table. Calculate the percent difference for each

3. The mass spectrum of ethanol (CH_3CH_2OH) contains 1 prominent peak for a "parent" ion and other 4 peaks for "fragment" ions. (The figure of the mass spectrum of ethanol is shown below)
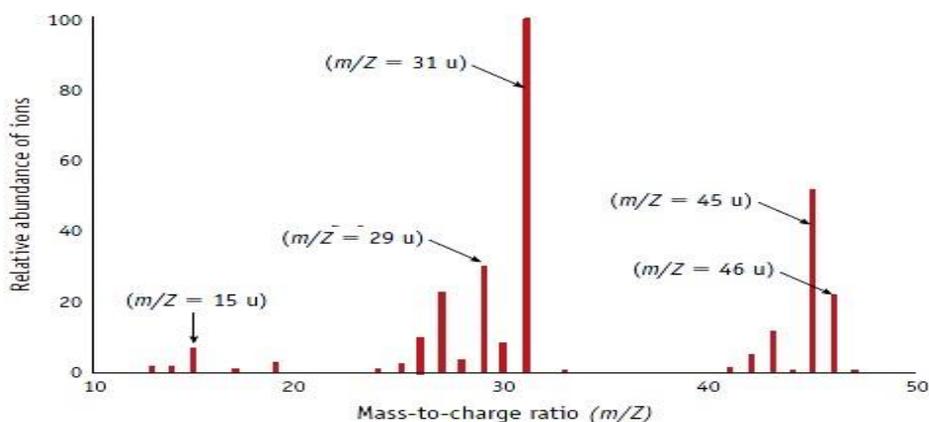
4. The mass spectrum of CH_3Cl is illustrated here. You know that carbon has two stable isotopes, ^{12}C and ^{13}C with relative abundances of 98.9% and 1.1%, respectively, and chlorine has two isotopes, ^{35}Cl and ^{37}Cl with abundances of 75.77% and 24.23%, respectively.

    a. What molecular species gives rise to the lines at m/Z of 50 and 52? Why is the line at 52 about 1/3 the height of the line at 50?

    b. What species might be responsible for the line at $m/Z = 51$?
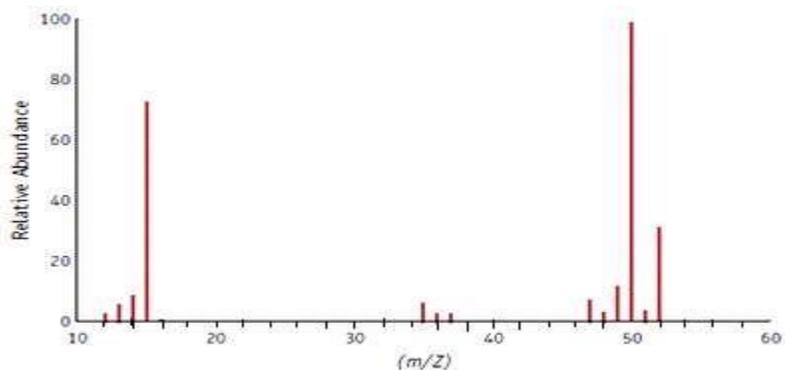
5. A molecule with an empirical formula CH_2O has the simplified mass spectrum below. Deduce the molecular formula and possible structure of the compound.
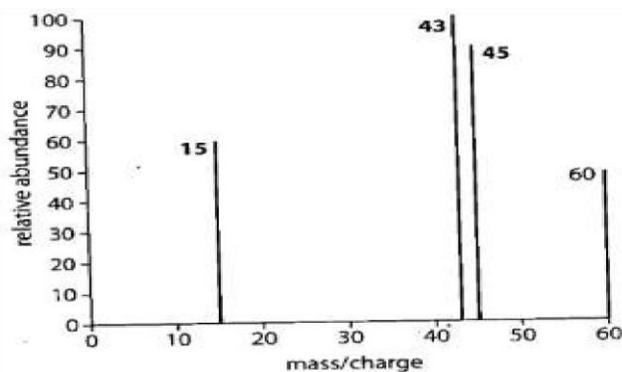
6. The simplified mass spectrum of a compound with empirical formula C_2H_5 is shown below.

    a. Explain which ions give rise to the peaks shown.

    b. Deduce the molecular structure of the compound.
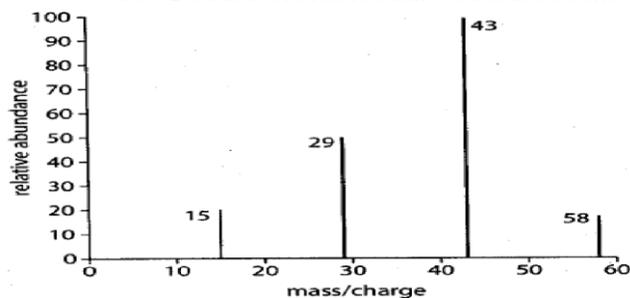
7. Which of the following statements about atomic orbitals is False?
   Orbitals are:
   a) Distributed in space around the nucleus
   b) Regions in which electrons are likely to be found
   c) Of different shapes and size

d) Used to show the path of electrons

e) Part of one model for atomic structure

8. Consider the two electron populations for neutral elements atoms

A. $1s^2 2s^2 2p^6 3s^1$

B. $1s^2 2s^2 2p^6 6s^1$

Which of the following statements is False?

a) Energy is required to change A to B

b) A and B represent different elements

c) A represent Sodium atom

d) Less energy is required to remove one electron from B than from A.

9. An anonymous element Y has the last electron represented by the following quantum numbers n, l, ml, ms: (3,2,1,1/2).

a) What is the element, show its symbol and atomic number if you know that it possesses 5 degenerate electrons?

b) Predict the electronic configuration of valence electrons

c) Represent these electrons on energy diagram

10. The first four ionization energies of an unknown element in the 6ᵗʰ periods in kcal/mol are given below

IE1	IE2	IE3	IE4
141	471	687	1171

Suggest the formulae for its bromide salts

11. The mass spectrum of chloromethane show preeminent peaks at m/z equals to: 15, 35, 37,50 and 52.

a) Draw this mass spectrum

b) Show the ions responsible for these peaks

12. Write the electronic configuration of Fe^{2+} and Fe^{3++} and. Which one is more stable and explain why?

13. Arrange the following elements according to their increasing ionization energies

a) $Al,\ B, C, K, and\ Na$

b) $Ca, Rb, P, Ge, and\ Sr$

14. The energies of orbitals have been determined in many elements. For the first two periods, they have the following value

ELEMENT	1s (kJ/Mol)	2s (kJ/mol)	2p (Kj/mol.)
H	-1313		
He	-2373		
Li		-520	
Be		-899	
B		-1356	-800
C		-1875	-1029
N		-2466	-1272
O		-3124	-1526
F		-3876	-1799
Ne		-4677	-2083

a) Explain why the energy of orbital generally became more negative on proceeding across the period

b) How are these energies values related to the ionization energies of the elements?

c) Use these values to explain the variation of successive ionization energies
d) Explain the order of first ionization energies from Li to C
e) Plot the graph of first ionization energy against the element across the second period

15. The table below gives the frequencies for the lines in the Balmer series in the spectrum of hydrogen

| Line number	Frequency $v/10^{14}s^{-1}$
1	4.568
2	6.167
3	6.907
4	7.309
5	7.551
6	7.709
7	7.817
8	7.894

Δv for lines 1 and 2 is $1.599*10^{-14}s^{-1}$. Calculate Δv for all other pairs of lines, i.e. 2 and 3, 3 and 4, etc.

Plot a graph of Δv against the smaller frequency of each pair of lines. Use the graph to find the frequency of convergence limit for this series of line (i.e the frequency when $\Delta v=0$). Using the equation $E=h\,v$, what ionization energy does this correspond to:

(a) In joules per atom
(b) In kJ/mol

In the Balmer series, electron fall back to level 2. The ionization energy for level 1 is 1312kJ/mol. What is the energy difference between levels 1 and 2 in the hydrogen atom?

16. a) the diagram below represents part of a sodium chloride with the position of one ion shown by a plus (+) sign in a circle.
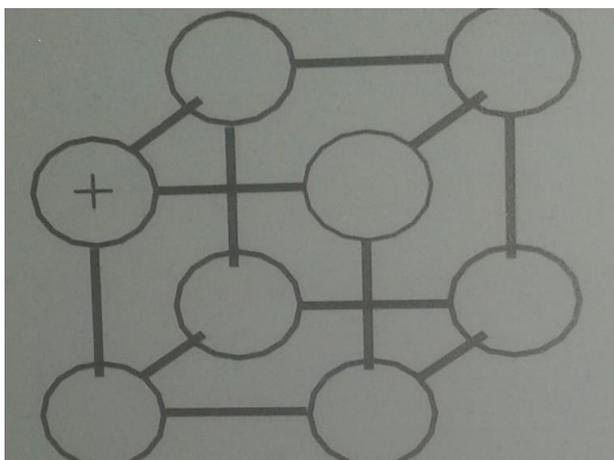
(i)   Mark with minus (-) signs all circles in a copy of the diagram which show the positions of chloride ions
(ii)   How many nearest sodium ions surround each chloride ion in a sodium chloride crystal?

b) Describe a simple test to show that sodium chloride is ionic

c) A crystal of aluminum chloride vaporizes when heated to a relatively low temperature. In the gas phase, aluminum chloride exists as a mixture of $AlCl_3$ and Al_2Cl_6 molecules.

(i) explain the meaning of the term co-ordinate bond

(ii) show the structure of Al_2Cl_6 and indicate the co-ordinate bond

17. What is the arrangement of bonds around the central atom in each of the following species? And predict the hybridization of the bonds in the central atom, are these molecules polar or non- polar? If polar show the direction of polarity: CH_4 , BF_3 , NF_4 , ICl_4^-, $CHCl_4$