FOR GOD AND COUNTRY

ST. LAWRENCE HIGH SCHOOL

A JESUIT CHRISTIAN MINORITY INSTITUTION

1st TERM EXAMINATION – 2018

CLASS – XI AL

F.M.- 70
DATE -01.08.18

SUBJECT – CHEMISTRY
DURATION – 3 Hours 15mins

GROUP-A (TOTAL MARKS-14)

MARKS – 1X14=14

1.1 Which of the following is iso-electronic?

(a) CO_2 and NO_2 (b) NO_2^- and CO_2 (c) CN^- and CO (d) SO_2 and CO_2

1.2 Number of unpaired electrons in Ni^{2+}

(a) 3 (b) 2(c) 1 (d) 5

1.3 According to Bohr's theory, the angular momentum of an electron in 5^{th} orbit is-

(a) $2.5h/\pi$ (b) $25h/\pi$ (c) $1.0h/\pi$ (d) $10h/\pi$

1.4 The maximum number of electrons that can have principal quantum number, n=3 & spin quantum number, s=-1/2

(a) 4 b) 7 c) 9 d) 16

1.5 Who modified Bohr's theory by introducing elliptical orbits for electron path?

(a) Rutherford (b) Thomson (c) Hund (d) Sommerfield

1.6 The orientation of an atomic orbital is governed by-

(a) Principal quantum number (b) Azimuthal quantum number

(c) Magnetic quantum number (d) Spin quantum number

1.7 The energy of an electron in the nth Bohr orbit of hydrogen atom is-

(a) $13.6/n^4$ eV (b) $13.6/n^3$ eV (c) $13.6/n^2$ eV (d) 13.6/n eV

1.8 Which of the following ion is the largest in size?

(a) K^+ (b) Ca^{2+} (c) Cl^- (d) S^{2-}

1.9 Which of the following is the correct order of the size of iodine species?

(a) $I^+ > I^- > I$ (b) $I^- > I > I^+$ (c) $I > I^- > I^+$ (d) $I > I^+ > I^-$

1.10 Which one is most acidic among the following?

(a) As_2O_3 (b) P_2O_5 (c) Sb_2O_3 (d) Bi_2O_3

1.11 Among the following which one has the highest cation to anion ratio?

(a) CsI (b) CsF (c) LiF (d) NaF

1.12 The pair of amphoteric hydroxides is-

(a) $Al(OH)_3$,LiOH (b) $Be(OH)_2$,$Mg(OH)_2$ (c) $B(OH)_3$,$Be(OH)_2$ (d) $Be(OH)_2$,$Zn(OH)_2$

1.13 In the periodic table metals used as catalyst belong to-

(a) f-block (b) s-block (c) p-block (d) d-block

1.14 The electronegativity of the following elements increase in the order-

(a) C,N,Si,P (b) N,Si,C,P (c) Si,P,C,N (d) P,Si,N,C

TOTAL MARKS-56(GROUP-B, C, D, E)

GROUP – B

2. Answer the following questions. (Alternatives are to be noted) : 1X4=4

2.1 How many nodal planes are there in 3p-orbital?

2.2 Why are electron gain enthalpy of Be and Mg are positive?

Or

Among alkali metals which element do you expect to be least electronegative and why?

2.3 Explain why a pair of electrons present in an orbital have opposite spin?

Or

Which group of the periodic table contains solid, liquid and gaseous elements? What are those elements?

2.4 Why is the size of F^{1-} ion smaller than that of O^{2-} ion?

GROUP-C

3. Answer the following questions. (Alternatives are to be noted): 2X5=10

3.1 If an electron is promoted from first orbit to the third orbit of a hydrogen atom, by how many times will the radius of the orbit be increased?

Or

Mention the name of the factors that affect the Ionisation energy.

3.2 Calculate the wavelength of the spectral line obtained in the spectrum of Li^{+2} ion when the transition takes place between two levels whose sum is **4** and the difference is **2**.

3.3 Why is the **1st** electron affinity of Sulphur is more than that of oxygen?

Or

Explain the Aufbau principle.

3.4 Ionisation potential of hydrogen in $KJmol^{-1}$ unit is **1312.0**. What will be its value in unit of $eVatom^{-1}$? (**$1eV = 1.6X10^{-19}$ J**)

Or

Draw the shapes of d- orbitals.

3.5 First electron affinity of oxygen is negative but second electron affinity is positive-explain.

Or

Which one between **MgO** and Al_2O_3 is more basic and why?

GROUP-D

4. Answer the following questions. (Alternatives are to be noted): 3X9=27

4.1 According to de-Broglie, matter should exhibit dual behavior that is both particle and wave like properties. However, a cricket ball of mass **100g** doesn't move like a wave when it is thrown by a

bowler at a speed of **100Km/h**.Calculate the wavelength of the ball and explain why it doesn't show wave nature.

Or

Account for the following:

(i) Chromium has electronic configuration $3d^5\ 4s^1$ and not $3d^4\ 4s^2$

(ii) What is the number of emission lines when the excited electron of H-atom in **n=6** drops to the ground state? 1.5x2= 3

4.2 Account for the following as stated:

(i) Which is more basic: $Mg(OH)_2$ or $Al(OH)_3$?

(ii) Which is more stable: Sn^{2+} or Sn^{4+}?

(iii) Which is more acidic: P_2O_5 or SiO_2?

3x1= 3

4.3 Explain why the ionization potentials of inert gases are very high while that of alkali metals are very low. 3x1= 3

Or

Write down the differences between the electronegativity and electron affinity. 1+2= 3

4.4 Derive the expression for angular momentum of Bohr electron from de-Broglie equation. 3

4.5 Write down the electronic configurations of the following:

$_{45}Rh$, $_{58}Ce$ and $_{41}Nb$ 3X1=3

4.6 Explain in brief the Planck's quantum theory. 3

4.7 Mention the limitations of Rutherford's atomic model and the rectifications made by Niels Bohr. 3

Or

State and explain Pauli's exclusion principle. 3

4.8 What is diagonal relationship? Name two transuranic elements. 2+1=3

Or

Comment on each of the following statement:

(1) The ionic mobilities of the alkali metal ions in aqueous solution are

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$

(2) What is meant by effective nuclear charge? 2+1=3

4.9 Mention the factors controlling electronegativity of an element. Mention the names of different scales for measuring electronegativity of an element. 2+1=3

GROUP- E

5. Answer the following questions. (Alternatives are to be noted): **5X3=15**

5.1 (i) The uncertainty in the position and velocity of a particle are 10^{-10} m and $5.27X10^{-24}$ ms^{-1} respectively. Calculate the mass of the particle.

(ii) Wave number of a spectral line in the Lyman series of H-atom is **82260 cm^{-1}**. Show that this line has appeared in the series due to the jump of electron from second to first orbit. 2+3=5

5.2 Elements A,B and C have atomic numbers **(Z-2),Z** and **(Z+1)** respectively. Of these B is an inert gas element.

(i) Which one of these has the highest electronegativity?

(ii) Which one of these has the highest ionisation potential?

(iii) What is the formula of the compound produced by the combination of A and C?

(iv)What is the nature of the bond in this compound? 5

5.3 (i) Both K and Cu atoms have $4s^1$ electron in their outermost shells, yet Cu has higher ionization enthalpy than K-Why?

(ii) Electron affinity of sodium is negative but magnesium has positive value-Why?

(iii) Predict the electron affinity order among the halogens. 2+2+1=5

Or

(i) If uncertainties in position and momentum of a moving object are same, find the uncertainty in its velocity.

(ii) Show that the sum of energies for the transition from **n=3** to **n=2** and from **n=2** to **n=1** is equal to the transition energy from **n=3** to **n=1** in case of a H-atom.

Are the wavelength and frequencies of the emitted spectrum also additive as their energies are? 2+3=5

Arnab Paul Chowdhury 02.08.18

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Model Answer of 1st TERM EXAMINATION – 2018

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MARKS – 1X14=14

1.1 (c) CN^- and CO

1.2 (a) 3

1.3 (a) $2.5h/\pi$

1.4 (c) 9

1.5 (d) Sommerfield

1.6 (c) Magnetic quantum number

1.7 (c) $13.6/n^2$ eV

1.8 (d) S^{2-}

1.9 (b) $I^- > I > I^+$

1.10 (b) P_2O_5

1.11 (b) CsF

1.12 (d) $Be(OH)_2, Zn(OH)_2$

1.13 (d) d-block

1.14 (c) Si,P,C,N

TOTAL MARKS-56(GROUP-B, C, D, E)

GROUP – B

2. Answer the following questions. (Alternatives are to be noted) : **1X4=4**

2.1 Two

2.2 The process of addition of electron is disfavoured in two ways: addition of a new electron destroys the full-filled sub-shell structure and accommodation of the new electron occurs in the p-orbital which is less penetrating

Or

Fr_{87} (Francium). As electronegative decreases down the group.

2.3 To avoid resultant magnetic repulsion.

Or

Group number 17.The elements are F, Cl, Br and I.

2.4 The magnitude of nuclear attractive force acting on the electrons of F^{1-} ion is greater than that on the electrons of O^{2-} ion

GROUP-C

3. Answer the following questions. (Alternatives are to be noted): **2X5=10**

3.1 Working formula: $r_n=n^2h^2/4\pi^2me^2$; the radius of the orbit will be increased by 9(nine) times.

Or

1) Nuclear charge,2) Atomic size,3)Half filled-full filled orbital stability,4)penetration effect,5)shielding effect

3.2 Wavelength=$1.14X10^{-6}$ cm

3.3 2p orbital of oxygen atom is smaller than 3p orbital of the outermost shell of Sulphur atom. Therefore the additional repulsive force generated due to addition of an extra electron is less for Sulphur.

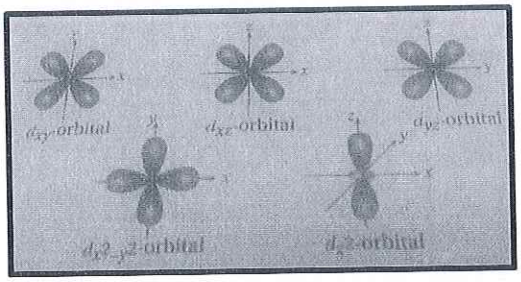
Or

Electrons are added progressively to the various orbitals in order of increasing energy starting with the orbital of lowest energy.

3.4 **13.61** eVatom^{-1}

Or

Shapes of d- orbitals



3.5 Due to half-filled orbital stability.

Or

MgO is more basic than Al_2O_3. Because across the period from left to right metallic character decreases.

GROUP-D

4. Answer the following questions. (Alternatives are to be noted): **3X9=27**

4.1 According to de-Broglie, matter should exhibit dual behavior that is both particle and wave like properties. However, a cricket ball of mass **100g** doesn't move like a wave when it is thrown by a bowler at a speed of **100Km/h**.Calculate the wavelength of the ball and explain why it doesn't show wave nature.

Or

Account for the following:

(i) Factors: 1)Exchange energy and 2) Half filled and full-filled orbital stability.

(ii) **15**[number of emission lines=n(n-1)/2]

4.2 Account for the following as stated:

(i) **$Mg(OH)_2$** is more basic than **$Al(OH)_3$**. (Across the period from left to right basic character decreases creases)

(ii) **Sn^{2+}** is more stable than **Sn^{4+}**(Due to in inert pair effect)

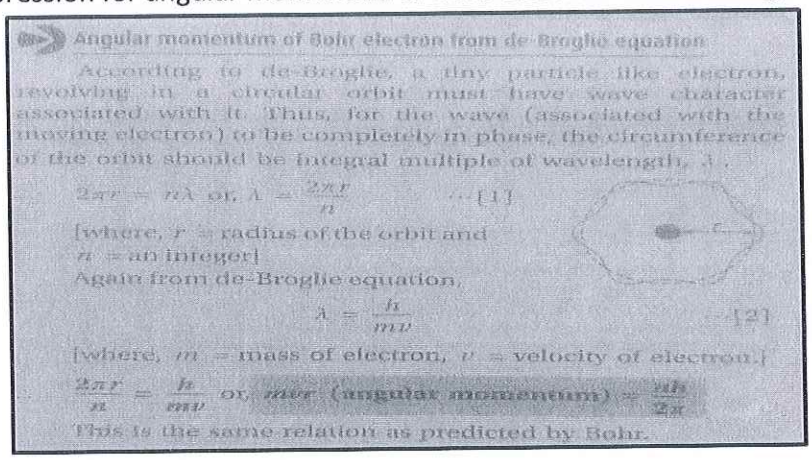
(iii) **P_2O_5** is more acidic than **SiO_2**.(Across the period from left to right acidic character increases)

4.3 Because they have **ns^1** like electronic configuration. Thus by donating only a single electron they can achieve the stable electronic configuration of their nearest inert element.

Or

Electronegativity is not an inherent property of an element but electron affinity is an inherent property.

4.4 Derive the expression for angular momentum of Bohr electron from de-Broglie equation.



Angular momentum of Bohr electron from de Broglie equation

According to de-Broglie, a tiny particle like electron, revolving in a circular orbit must have wave character associated with it. Thus, for the wave (associated with the moving electron) to be completely in phase, the circumference of the orbit should be integral multiple of wavelength, λ.

$$2\pi r = n\lambda \text{ or, } \lambda = \frac{2\pi r}{n} \quad \ldots [1]$$

[where, r = radius of the orbit and n = an integer]

Again from de-Broglie equation,

$$\lambda = \frac{h}{mv} \quad [2]$$

[where, m = mass of electron, v = velocity of electron.]

$$\frac{2\pi r}{n} = \frac{h}{mv} \text{ or, } mvr \text{ (angular momentum)} = \frac{nh}{2\pi}$$

This is the same relation as predicted by Bohr.

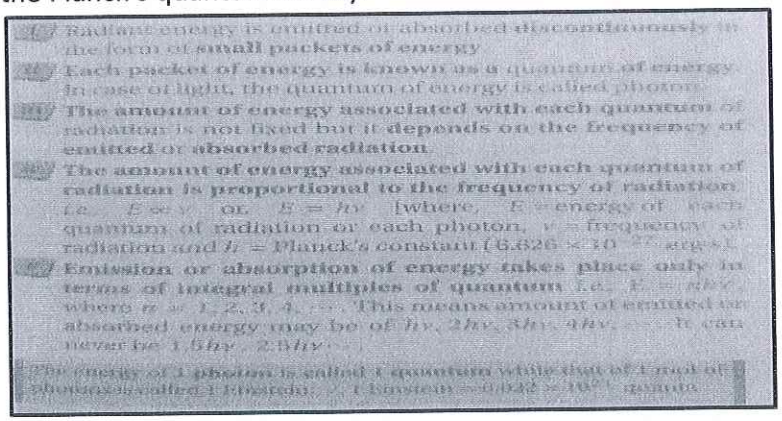
4.5 Write down the electronic configurations of the following:

$_{45}Rh$: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^8 5s^1$

$_{58}Ce$: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{10} 5s^2 5p^6 6s^2$

$_{41}Nb$: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^4 5s^1$

4.6 Explain in brief the Planck's quantum theory.



(i) Radiant energy is emitted or absorbed discontinuously in the form of small packets of energy.

(ii) Each packet of energy is known as a quantum of energy. In case of light, the quantum of energy is called photon.

(iii) The amount of energy associated with each quantum of radiation is not fixed but it depends on the frequency of emitted or absorbed radiation.

(iv) The amount of energy associated with each quantum of radiation is proportional to the frequency of radiation i.e. $E \propto \nu$ or, $E = h\nu$ [where, E = energy of each quantum of radiation or each photon, ν = frequency of radiation and h = Planck's constant (6.626×10^{-27} erg-sec)]

(v) Emission or absorption of energy takes place only in terms of integral multiples of quantum i.e. $E = nh\nu$ where $n = 1, 2, 3, 4, \ldots$. This means amount of emitted or absorbed energy may be of $h\nu$, $2h\nu$, $3h\nu$, $4h\nu$, ... It can never be $1.5h\nu$, $2.5h\nu$, ...

The energy of 1 photon is called 1 quantum while that of 1 mol of photons is called 1 Einstein. 1 Einstein = 6.022×10^{23} quanta

4.7 Mention the limitations of Rutherford's atomic model and the rectifications made by Niels Bohr.

Rutherford's atomic model suffers from two main defects:

(i) According to Maxwell's theory of electrodynamics, moving charged particles emit energy in a continuous manner. So in accordance with the Rutherford's opinion, **if the negatively charged electron revolves round the positively charged nucleus, it will continuously emit electromagnetic radiations.** As a result of this continuous emission of energy, the velocity of the electron will decrease and the radius of the electronic orbit will also decrease steadily. **Electron will thereby follow a spiral path and eventually fall on the nucleus, resulting in complete collapse of the atom** *[Fig 2.8]*. However, in practice, this does not happen and the atom is quite stable.

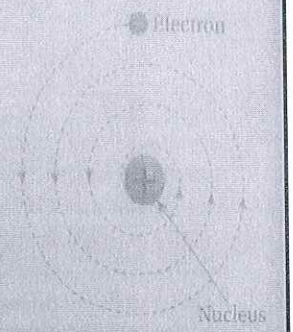


Fig 2.8 Spiral path of electron approaching towards nucleus

(ii) If the electron emits energy continuously, the **spectra of the atom should be continuous** (*i.e.*, **band spectra**) but in reality, an atom produces line or **discontinuous spectra.** Thus, it is seen that Rutherford's atomic model cannot explain the discontinuous nature of the atomic spectra.

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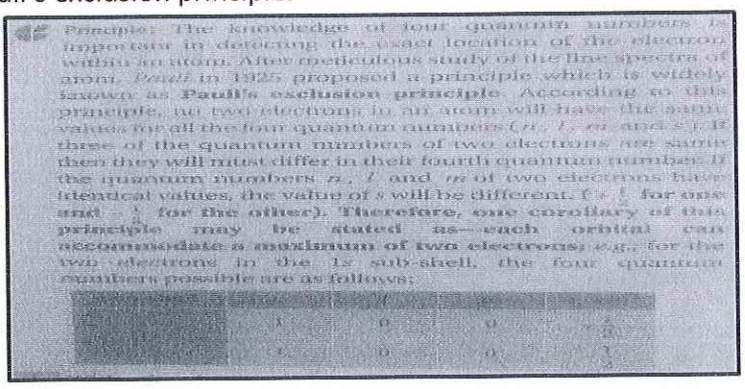
Fig 2.8 Spiral path of electron approaching towards nucleus

Or

State and explain Pauli's exclusion principle.


Principle: The knowledge of four quantum numbers is important in detecting the exact location of the electron within an atom. After meticulous study of the line spectra of atom, *Pauli* in 1925 proposed a principle which is widely known as **Pauli's exclusion principle**. According to this principle, no two electrons in an atom will have the same values for all the four quantum numbers (*n*, *l*, *m* and *s*). If three of the quantum numbers of two electrons are same then they will must differ in their fourth quantum number. If the quantum numbers *n*, *l* and *m* of two electrons have identical values, the value of *s* will be different. (+ ½ for one and − ½ for the other). **Therefore, one corollary of this principle may be stated as—such orbital can accommodate a maximum of two electrons;** *e.g.*, for the two electrons in the 1*s* sub-shell, the four quantum numbers possible are as follows:

4.8 **<u>Diagonal relationship:</u>**

Certain pair of elements which are positioned diagonally opposite with respect to each other in the 2nd and 3rd period in the periodic table show similar physical and chemical properties. The elements are called bridge elements and exhibit diagonal relationship between them. Eg. Li,Mg and Be,Al

<u>Two transuranic elements</u>: **Np_{93},Pu_{94}** etc..i.e. elements that come after Uranium can be considered as transuranic elements.

Or

Comment on each of the following statement:

(1) **Factor:** 1) Size of the cation and 2) Nuclear charge density

(2) Due to screening effect, the valance shell electrons do not feel the full charge of the nucleus. The actual charge experienced by the valence shell electrons is called the effective nuclear charge.

4.9 1) Atomic size,2) Hybridisation state,3) Oxidation number.4) Bond length, bond energy and bond order

Different scales for measuring electronegativity of an element:

1) Pauling scale, 2) Mulliken-Jaffe scale, 3) Allred Rochow scale

GROUP- E

5. Answer the following questions. (Alternatives are to be noted): **5X3=15**

5.1 (i) Mass= **0.1Kg**

(ii)n_2=**2**; Therefore, the electron has returned from the second orbit to the first orbit.

5.2 i) Since element B (atomic number=Z) is an inert gas, so the element A with atomic no. (Z-2) is an electronegative element (nonmetal).On the other hand, the element C, having atomic no. (Z+1) must belong to group -1A(Alkali Metal).Hence the electronegativity of the element A is the maximum.

ii) The element B, being an inert gas, has the highest value of ionization potential.

iii) The valency of the element A belonging to group VIA is 2 and that of the element C,being an element of group IA,is 1.Therefore, the formula of the compound formed by A and C will be C_2A.

iv) Electrovalency

5.3 (i) Copper has 3d suborbital and due to presence of 3d electrons it experiences poor shielding effect. Thus the effective nuclear charge acting on the 4s electron of Cu is greater than that acting on the 4s electrons of K.

(ii) Negative EA value indicates affinity of an atom to accept electron, whereas positive EA value indicates reluctancy towards accepting electron. Mg, due to full-filled orbital stability doesn't want to accept electrons easily.

(iii) I<Br<Cl<F

Or

(i) According to uncertainty principal, $\Delta x.\Delta p=h/4\pi$.

$(\Delta p)^2= h/4\pi$, Therefore, $\Delta v= 1/2m\sqrt{(h/\pi)}$

(ii) By the problem,

$\Delta E = R_H[1/n_1^2-1/n_2^2]$

For transition from n=3 to n=2

$\Delta E(3 \text{ to } 2)= R_H[1/2^2-1/3^2]$.....(1), $\Delta E(2 \text{ to } 1)= R_H[1/1^2-1/2^2]$.....(2), $\Delta E(3 \text{ to } 1)= R_H[1/1^2-1/3^2]$....(3)

From equation (1),(2) and (3) we can obtain,

$$\Delta E(3 \text{ to } 1)= \Delta E(3 \text{ to } 2) + \Delta E(2 \text{ to } 1)$$

Since, $E=h\gamma$ hence frequencies are also additive but $E=hc/\lambda$ and thus wavelengths are not additive.
