KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks Scored:

Level : B.Sc.
Year : I
Course : CHEM 102
Semester : II

Exam Roll No. :
Time: 30 mins.
F. M. : 20

Registration No.:
Date :

SECTION "A"
[15Q. × 1 = 15 marks]

Mark [X] in the appropriate option.

1. Which of the following ions exhibits the greatest polarizability?
[ ] $I^-$ [ ] $Br^-$ [ ] $Cl^-$ [ ] $F^-$

2. Which one of the following compounds has lowest bond angle?
[ ] $CH_4$ [ ] $F_2O$ [ ] $NH_3$ [ ] $H_2O$

3. A radioactive isotope with an N/P ratio below the stable value tends to stabilize by ;
[ ] Electron capture [ ] β-emission
[ ] Neutron Activation [ ] None of them

4. Which one of the following is the strongest ligand?
[ ] $F^-$ [ ] CO [ ] $NH_3$ [ ] EDTA

5. The total number of electrons involved for the delocalization of π- bonding in $NO_3^-$ is;
[ ] 1 [ ] 2 [ ] 5 [ ] 6

6. The method by which electrical conduction can occur in lithium metal, is:
[ ] Half- filled band [ ] Impurity band
[ ] Overlapping band [ ] Valence band

7. Which one of the following complexes exhibits ionization isomerism?
[ ] $[Cr(H_2O)_6]Cl_3$ [ ] $[Co(NH_3)_5Br]SO_4$
[ ] $[Pt(NH_3)_2 Cl_2]$ [ ] $K_4[Fe(CN)_6]$

8. In the complex $[Co(NH_3)_6]Cl_3$ , the primary valency and secondary valency of the complex according to Werner's Theory is
[ ] 6 and 9 [ ] 3 and 5 [ ] 4 and 6 [ ] 3 and 6

9. The CFSE for $d^6$ configuration under strong field ligand for octahedral complex is
[ ] $-0.4\Delta o$ [ ] $-2.4\Delta o$ [ ] $-1.2\Delta o$ [ ] $-0.6\Delta o$

10. Consider a nuclear reaction: $^{14}_{7}N + X \longrightarrow {}^{14}_{6}C + {}^{1}_{1}P$. The projectile (X) used in the reaction is :
[ ] a deuteron [ ] a gamma photon [ ] an alpha particle [ ] a neutron

11. Which one of the following species is paramagnetic in nature?
[ ] $O_2^{2-}$ [ ] NO [ ] CO [ ] $O_2^{2+}$

12. Which of the following statement is correct?
[ ] Tetrahedral complexes are always high spin.
[ ] Tetrahedral complexes are always low spin.
[ ] Octahedral complexes are always high spin.
[ ] Octahedral complexes are always low spin.

13. Nuclides that have neutron-to-proton ratios that are too high (compared with stable nuclides) are expected to undergo:
[ ] Alpha decay [ ] Beta decay [ ] Positron decay [ ] Electron capture

14. Consider a nuclear reaction: $^{27}_{13}Al + X \longrightarrow {}^{30}_{15}P + {}^{1}_{0}n$. The projectile (X) used in the reaction is:
[ ] A deuteron [ ] A gamma photon
[ ] An alpha particle [ ] A neutron

15. Which one of the following metals does not cause environmental and health risks?
[ ] Mercury [ ] Arsenic [ ] Calcium [ ] Lead

## SECTION "B"
[5Q. × 1 = 5 marks]

Fill in the blanks with most appropriate value or word.

16. The IUPAC name of the complex , $Na_3[Ag(S_2O_3)_2]$ is _____ .

17. During alpha –particle emission, the mass number is reduced by _____ units.

18. The order of energy of MO for $O_2$ molecule is _____
_____.

19. A molecule having $dsp^2$ hybridization has _____ geometry.

20. Born-lande equation for the calculation of Lattice energy is given by _____
_____.

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SECTION "C"
[5Q. × 6 = 30 marks]

Attempt *ANY Five* questions.

1. a. Consider the following complex compounds.
A. $[Co(NH_3)_5NO_2]Cl_2$ B. $[Pt(NH_3)_2 Cl_2]$
i. Write the IUPAC name of the compounds A and B [1+1]
ii. Write down the geometrical isomers of b. [1]

b. Write down the chemical formula for each following complexes. [1+1+1]
i. Tetrathiocyanato-N-zincate(II).
ii. Triamminechlorocyanonitrocobalt(III).
iii. μ-amidobis[pentaamminecobalt(III)] nitrate.

2. a. Use the given informations to answer the following questions.

| Molecule | Shape | Bond angle |
|---|---|---|
| $CH_4$ | Tetrahedral | $109^0 28'$ |
| $NF_3$ | Tetrahedral | $102^0 30'$ |
| $PCl_5$ | Tetrahedralbipyramidal | $120^0$ and $90^0$ |

i. Why does bond angles in $NF_3$ is less than $CH_4$? [1]
ii. Which position does a lone pair prefer in trigonal bipyramid and why? [1]
iii. Why do the $PCl_5$ has different bond angles? [1]

b. Define " Effective Atomic Number" in coordination compound with suitable examples. [3]

3. a. Distinguish between followings. [1.5 + 1.5]
i. Tetragonal elongation and tetragonal compression in octahedral complexes
ii. Electronegativity and electron affinity

b. Define LCAO Method. Show the p-p combination of atomic orbital resulting BMO and ABMO through σ-verlap and π-overlap [1+2]

4. a. Write a balanced chemical equation for each of the following radioactive decay processes. [3 × 1 = 3]
i. potassium-40 decays by electron capture.
ii. nitrogen-13 decays by positron emission.
iii. thorium-232 decays by alpha-particle emission

b. Consider a reaction for the formation of ionic solid, NaCl from the gaseous ions.
$Na^+(g) + Cl^-(g) \rightarrow NaCl$(ionic crystal)
Where, electronic charge = $4.8\times10^{-10}$e.s.u., Madelung constant = 1.7476
Inter-ionic distance = $2.76\times10^{-8}$ cm., Born exponent = (7+9)/2, Charge = 1.
Then, find lattice energy of NaCl using Born-Lande equation in KJ $mol^{-1}$. [3]

5. a. Discuss briefiy the health and environmental effects of arsenic metal. [3]

b. Explain the delocalization of π-bonding in Ozone($O_3$)on the basis of MOT. [3]

6. a. Draw the Molecular orbital diagram of the complex ion, $[Co(NH_3)_6]^{3+}$ and mention magnetic property and color of this the complex ion with suitable facts. [1+2]

b. $^{210}_{84}Po$ decays with alpha particle to $^{206}_{82}Pb$ with half life of 138.4 days. If 1 gm of Po-210 is placed in a sealed tube , how many He atoms will accumulate in 69.2 days? [3]

7. Write short notes on: [2+2+2]
   i. Chelates and chelating agent
   ii. Isoelectronic principle.
   iii. Magic number

## SECTION "D"
[25 marks]

Attempt *ANY Three* questions. (***Q.N.8 is compulsory***)

8. a. Draw the Molecular Orbital energy level diagram for $N_2$ and NO with their MO configuration. Also predict the bond order and magnetic properties. [4]

b. How does crystal field splitting affect in different parameters like lattice energy and hydration energy of transition metal compounds as well as in ionic radii of transition metal ions? Explain. [3]

c. Define half-life period. Deduce the equation for radioactive disintegration. [0.5+1.5]

9. a. What do you mean by VSEPR theory? How would this theory be able to predict and explain molecular shape and bond angle more exactly? . [1+3]

b. Write short notes on: [2+2]
   i. Nuclear fission ii. Born-Haber cycle

10. a. What are the main assumptions of crystal field theory? How does it explain the bonding in octahedral complex? [4]

b. Define the terms polarizing power and polarizability. Discuss the factors favouring the polarization. [4]

11. a. Explain the bonding in conductors, semiconductor and insulators with help of band theory. [4]

b. What are labile and stable complexes? Explain with suitable examples on the basis of VBT. [2]

c. What is the isoelectronic principle? Give with examples. [2]