

**लोक सेवा आयोग**  
नेपाल इन्जिनियरिङ्ग सेवा, केमिष्ट्री समूहको राजपत्राङ्कित तृतीय श्रेणीका पदहरूको खुला र आन्तरिक  
प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

पाठ्यक्रमको रूपरेखा :- यस पाठ्यक्रमको आधारमा निम्नानुसार दुई चरणमा परीक्षा लिइने छ :

प्रथम चरण :- लिखित परीक्षा पूर्णाङ्क :- २००  
द्वितीय चरण :- अन्तर्वार्ता पूर्णाङ्क :- ३०

**प्रथम चरण – लिखित परीक्षा योजना (Examination Scheme)**

पत्र	विषय	पूर्णाङ्क	उत्तीर्णाङ्क	परीक्षा प्रणाली	प्रश्न संख्या X अङ्कभार	समय
प्रथम	केमिष्ट्री	१००	४०	वस्तुगत बहुउत्तर (Multiple Choice)	१००X१ = १००	१ घण्टा १५ मिनेट
द्वितीय		१००	४०	विषयगत (Subjective)	१०X१० = १००	३ घण्टा

**द्वितीय चरण**

विषय	पूर्णाङ्क	परीक्षा प्रणाली
व्यक्तिगत अन्तर्वार्ता	३०	मौखिक

- लिखित परीक्षाको माध्यम भाषा अंग्रेजी वा नेपाली, अथवा अंग्रेजी र नेपाली दुवै हुन सक्नेछ ।
- माथि उल्लिखित समूहको पाठ्यक्रमको प्रथम तथा द्वितीय पत्रको विषयवस्तु एउटै हुनेछ ।
- प्रथम र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- प्रथम तथा द्वितीय पत्रहरूका एकाईहरूको प्रश्नसंख्या निम्नानुसार हुनेछ :

प्रथम पत्रका एकाई	1	2	3	4	5
प्रश्न संख्या	20	20	20	20	20
द्वितीय पत्रका एकाई	1	2	3	4	5
प्रश्न संख्या	2	2	2	2	2

- द्वितीय पत्रको विषयगत प्रश्नहरूको स्वरूप निम्नानुसार हुन सक्नेछ :
  - ५.१ लामो उत्तर दिने १० अंकका पूरा प्रश्नहरू सोध्न सकिनेछ ।
  - ५.२ एउटै प्रश्नलाई दुई वा दुई भन्दा बढी भागमा (Two or more parts of a single question) विभाजन गरी सोध्न सकिनेछ ।
  - ५.३ एउटा प्रश्न अन्तर्गत दुई वा बढी टिप्पणीहरू (Short notes) सोध्न सकिने छ ।
- प्रथम पत्रमा वस्तुगत बहुउत्तर (Multiple Choice) प्रश्नहरूको उत्तर सही दिएमा प्रत्येक सही उत्तर बापत १ (एक) अङ्क प्रदान गरिनेछ भने गलत उत्तर दिएमा प्रत्येक गलत उत्तर बापत २० प्रतिशत अर्थात् ०.२ अङ्क कट्टा गरिनेछ । तर उत्तर नदिएमा त्यस बापत अङ्क दिइने छैन र अङ्क कट्टा पनि गरिने छैन ।
- यस पाठ्यक्रममा जेसुकै लेखिएको भएता पनि पाठ्यक्रममा परेका ऐन, नियमहरू परीक्षाको मिति भन्दा ३ (तीन) महिना अगाडि (संशोधन भएका वा संशोधन भई हटाइएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा रहेको सम्झनु पर्दछ ।
- प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र द्वितीय चरणको अन्तर्वार्तामा सम्मिलित गराइनेछ ।
- यस भन्दा अगाडि लागू भएका माथि उल्लिखित उपसमूहहरूका पाठ्यक्रमहरू खारेज गरिएका छन् ।
- पाठ्यक्रम लागू मिति :- २०६२/२/२३ देखि

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प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

प्रथम र द्वितीय पत्र :- केमिष्ट्री

- 1. Physical Chemistry** **20%**
- 1.1 Ionic Equilibrium and Electrochemistry: pH, Buffer solution, buffer capacity and buffer range, pH change in acid base titration, theory of acid base indicator, hydrolysis of salt, Debye Huckel limiting law, activity and activity coefficient, Ionic strength, Elementary idea on electrical double layer, Emf of a cell, Nernst equation, glass electrode, ion selective electrode and their applications, photo electrochemical and fuel cells
- 1.2 Chemical Kinetics: Effect of temperature and catalyst on reaction rate, concept of activation energy, collision theory and transition state theory of reaction rates, chain reaction, photochemical reaction, Fast reaction, techniques to study fast reaction, Enzyme catalyzed reaction, Diffusion controlled reaction in solution kinetic salt effect
- 1.3 Thermodynamics: Statistical treatment of entropy, Entropy change in physical and chemical change, free energy change for reaction, Gibbs Helmholtz equation, Thermodynamic criteria of equilibrium, chemical potential, partial molar quantities, Boltzman distribution law
- 1.4 Spectroscopy and Solid state chemistry: Electromagnetic radiation, origin of molecular spectra, types of molecular spectra: Rotational spectra, vibrational spectra, vibrational rotational spectra, Electronic spectra. Seven crystal system and fourteen Bravais lattice, Bragg's law, Crystal structure of sodium chloride, Lattice energy of ionic solid, success and limitation of classical free electron theory of metal, point defects: Frenkel and Schottky defects
- 2 Inorganic chemistry** **20%**
- 2.1 General concept of the followings: Electro negativity, choice of electro negativity system, group electronegativity, electron affinity, anomalous electron affinity, ionization energy, Intrinsic and mean bond energy. Metallic bonding, Buck minister fullerene, Noble gas compounds, Non aqueous solvents, Protic and non-protic solvents, Reactions of NH<sub>3</sub> and SO<sub>2</sub>
- 2.2 Molecular orbital theory, molecular orbital, LCAO approximation, valence bond theory for simple homonuclear diatomic
- 2.3 Bonding and applications of coordinate compounds: Valence bond theory, crystal field, characterization of coordinate compounds, Isomerism in coordination compounds, ligand substitution reactions and trans effect, spectrochemical series, Nephelausetic effect, Jahn Teller effect, Evidence for adjusted crystal field theory
- 2.4 Organometallic compounds: General survey of types, synthetic methods, metallocenes
- 2.5 Radioactivity and nuclear reactions, <sup>14</sup>C dating, tracer technique, radiochemical analysis
- 3. Analytical chemistry** **20%**
- 3.1 General concept of statistical methods in chemical analysis: Accuracy, precision, minimization of error, significant figures, mean and standard deviation, reliability of results, rejection of results, regression analysis, t-test, chi-test.
- 3.2 Principle and applications of: Atomic absorption spectroscopy, flame photometry, uv-vis spectrophotometry, NMR, IR, mass spectroscopy, emission spectroscopy.
- 3.3 Solvent extraction, ion exchange chromatography, gas chromatography, HPLC, exclusion chromatography (gel permeation chromatography), affinity; chromatography, partition,

column, and paper chromatography, thermo gravimetric analysis, differential thermal analysis,

3.4 Principle and applications of potentiometry, ion selective electrodes, pH measurement, polarography, amperometry, electrogravimetry and conductometry.

3.5 Gravimetric and volumetric analysis, principles of volumetric and gravimetric analysis, uses of adsorption indicators, use of Redox indicator, metal ion indicator, use of common organic reagents in gravimetric analysis.

#### **4. Organic Chemistry**

**20%**

4.1 General idea on types, mechanism and scope of the followings:

4.1.1 Nucleophilic reaction

4.1.2 Elimination reaction

4.1.3 Addition reaction

4.1.4 Free radical reaction

4.2 Study and application of the followings:

4.2.1 Oxidation and reduction reactions

4.2.2 Halogenations

4.2.3 Acetylation

4.2.4 Alkylation

4.2.5 Acylation

4.2.6 Aldol condensation and related reactions.

4.3 Photochemistry:

4.3.1 Basic concept of Photochemical energy

4.3.2 Electronic excitation

4.3.3 Energy transfer

4.3.4 Photochemistry of carbonyl compounds

4.4 Heterocyclic Chemistry: Structure and reactivity of the following heterocyclic compounds:-

4.4.1 Pyrrole

4.4.2 Thiazole

4.4.3 Furan

4.4.4 Imidazole

4.4.5 Pyridine

4.4.6 Indole

4.5 Stereochemistry:

4.5.1 Symmetry and symmetry elements

4.5.2 Enantiomers

4.5.3 Diastereomers

4.5.4 Meso-isomers

4.5.5 Racemic mixture

4.5.6 Enantioselective reaction

4.5.7 Diastereoselective reaction

4.5.8 Regioselective reaction

4.6 Carbohydrate: Chemistry of Glucose, fructose, sucrose and cellulose

#### **5. Biochemistry and applied chemistry**

**20%**

5.1 Biochemistry

5.1.1 Natural products and drug analysis:

5.1.1.1 Phytochemical screening

- 5.1.1.2 Isolation, purification and identification of natural molecules (essential oil, alkaloids, terpenoids, flavonoids)
- 5.1.1.3 Biosynthesis of lipids and terpenes with taking typical examples of stearic acid and citral
- 5.1.1.4 Vitamins and hormone
- 5.1.1.5 Chemotherapy
- 5.1.1.6 Drugs
- 5.1.1.7 Synthetic drugs: types and typical examples
- 5.1.1.8 Identification, qualitative and quantitative analysis of various antibiotics
- 5.1.1.9 Quantitative analysis of dextrose, ascorbic acid, vitamin A in various products
- 5.1.2 Lipids:
  - 5.1.2.1 Composition of fats
  - 5.1.2.2 Hydrolyses
  - 5.1.2.3 Phosphoglycerides
  - 5.1.2.4 Rancidity types
  - 5.2.1.5 Prevention
- 5.1.3 Enzymes, Proteins and Nucleic Acids:
  - 5.1.3.1 Enzymes and co-enzymes, Co-factors
  - 5.1.3.2 Application of enzymes in food industries
  - 5.1.3.3 Structure and reactions of amino acids, peptides
  - 5.1.3.4 Protein
  - 5.1.3.5 Nucleic acids, Biological functions of DNA and RNA
  - 5.2.1.3 Regulation of gene expressions and Genetic code
- 5.2 Applied chemistry
  - 5.2.1 Soil, sediments and rock analysis:
    - 5.2.1.1 Soil texture and organic matter in soil
    - 5.2.1.2 Cu, Pb, Zn & Ag in soil, sediments and rock
    - 5.2.1.3 Acid insoluble matter, loss on ignition, CaO, MgO, total oxide((Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>) and SiO<sub>2</sub> in limestone, dolomite and magnesite.
  - 5.2.2 Water, wastewater and air analysis:
    - 5.2.2.1 BOD, COD, dissolved oxygen, alkalinity, ammonia, nitrite, nitrate, chloride, phosphate, sulfate, iron, manganese, arsenic and other toxic metals in water and wastewater.
    - 5.2.2.2 PM<sub>10</sub>, TSS, SO<sub>2</sub>, CO, CO<sub>2</sub>, NO<sub>x</sub> in air
  - 5.2.3 Food, food products and feed analysis:
    - 5.2.3.1 Proximate analysis (moisture, protein, fat and carbohydrate) of food, food products and feed
    - 5.2.3.2 Color detection in food and food products.
    - 5.2.3.3 Simple chemical methods (quick test) for detection of food adulteration.
    - 5.2.3.4 General concept of Pesticide and pesticide residue analysis in water, soil and foodstuff.
  - 5.2.4 Analysis of industrial products:

	5.2.4.1	Urea
	5.2.4.2	Fertilizer
	5.2.4.3	Bleaching powder
	5.2.4.4	Alcohol
5.2.5	Miscellaneous:	
	5.2.5.1	Application of chemical methods in preservation of archaeological property.
	5.2.5.2	Application of good laboratory practice and ISO 17025 concepts in the quality management.
	5.2.5.3	Role of Chemists in Environmental Impact Assessment

**वस्तुगत बहुउत्तर नमूना प्रश्नहरू (Sample questions)**

- Crystal splitting depends upon
  - size of the ligand
  - charge on the ligand
  - acceptor properties of the ligand
  - none of the above

**Correct Ans. (C)**
- Which of the following nuclides is likely to be stable
  - $^{40}_{20}\text{Ca}$
  - $^{30}_{13}\text{Al}$
  - $^{32}_{16}\text{S}$
  - $^{55}_{25}\text{Mn}$

**Correct Ans. (B)**
- In liquid ammonia  $\text{KNH}_2$  would act as
  - strong base
  - strong acid
  - neutral compound
  - none of the above

**Correct Ans. (A)**
- A reaction is not feasible if
  - $\Delta H$  is positive and  $\Delta S$  is also positive
  - $\Delta S$  is positive and  $\Delta H$  is negative
  - $\Delta H$  is negative and  $\Delta S$  is also negative
  - $\Delta H$  is negative and  $\Delta S$  is positive

**Correct Ans. (B)**
- Glass electrode for pH measurement is an example of
  - membrane electrode
  - hydrogen ion selective electrode
  - ion selective electrode
  - all of the above.

**Correct Ans. (D)**
- Formylation of phenol with chloroform in presence of a base is an example of
  - Reimer-Tiemann reaction
  - Friedel Craft reaction
  - Cannizzaro reaction
  - Perkins reaction

**Correct Ans. (A)**
- Pyrrrole is less basic than pyridine, because
  - the nitrogen lone pair electrons is not involved in aromatic sextet.
  - the nitrogen lone pair electrons is involved in aromatic sextet.

- C. pyrrole is five-member heterocyclic compound.  
 D. pyrrole is not aromatic compound

**Correct Ans. (B)**

8. Deficiency of which of the following causes beriberi?  
 A. biotin                      B. ascorbic acid                      C. pyridoxine                      D. thiamine

**Correct Ans. (C)**

9. The essential conditions in determination of BOD in water analysis are:  
 A. incubation at fixed temperature    B. presence of bacteria  
 C. absence of toxic matter in water    D. all of above.

**Correct Ans. (D)**

10. ISO 17025 is more related to:  
 A. quality production                      B. cleaner chemistry  
 C. laboratory accreditation                      D. none of above

**Correct Ans. (B)**

### विषयगत नमूना प्रश्नहरू (Sample questions)

1. What are coordination compounds? Use any theory of your choice to account for the nature of bonding in co-ordination compounds. 2+8
2. What is an acid base indicator? What determines its sensitiveness? Explain why methyl orange is used in the titration of total alkalinity and phenolphthalein is used in for the estimation of alkali carbonates in the presence of bicarbonates. 2+3+5
3. Discuss the Michaelis and Menten mechanism of enzyme-catalyzed reaction. How the orders of reaction vary with the substrate concentration? 5+5
4. Explain why meso tartaric acid containing two symmetric carbons is optically inactive. 10
5. Write notes on the uses of the following reagents: 2.5x4
  - a. Lithium aluminum hydride
  - b. Jone's reagent
  - c. Wittig's reagent
  - d.  $\text{KMnO}_4$
6. Write steps leading to biosynthesis of citral. 10
7. Explain the following terms: 5x2
  - a. Vitamins and hormones
  - b. Antipyretic and analgesic drugs
8. List the different parameters that are used to check the suitability of limestone for cement production. Describe in brief how these parameters are determined. 4+6
9. What is the basic principle of GC and describe in detail the major steps that are involved in the analysis of chlorinated pesticide residue in food. 5+5
10. Write short note on: 5x2
  - a. Detection of color adulteration in food.
  - b. Analytical methods for determination of dextrose.