

Syllabus for NTRCA written Examination

Post: Demonstrator

Subject: Chemistry

Subject Code: 460

Exam duration: 3 hours

Full Marks: 100

Instructions: There will be five sections (A, B, C, D, E) and two (02) questions from each section. Every question will contain 10 marks, and may have more than one parts like a, b, c. The marks distribution of a question may be 2+3+5/ 2+2+6/ 3+3+4/ 2+4+4/ 1+4+5/ 4+6 etc. Candidate have to answer all questions. Question setter will have to set two questions from each section. Question setter may consider the distribution of lower marks (1 or 2) for basic level of questioning (such as- define, classify, explain etc.) and higher marks (3 or 4 or 5) for advanced level of questioning (such as- apply, calculate, analyze, evaluate etc.).

Marks distribution

Sections	No. of question \times Marks = Total Marks
A. Physical Chemistry	$2 \times 10 = 20$
B. Inorganic Chemistry	$2 \times 10 = 20$
C. Organic Chemistry	$2 \times 10 = 20$
D. Analytical Chemistry	$2 \times 10 = 20$
E. Industrial and Environmental Chemistry	$2 \times 10 = 20$
	Full marks = 100

Section A: Physical Chemistry

Assessment Targets: The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Explain the gas laws • Derive different equation using gas laws • Solve mathematical problem using gas laws 	<p>1. Gaseous state The gas laws, Ideal gas equation, Deviation from ideal behaviour, Vender Waals equation, Dalton's law of partial pressure; Measurement of volume of a gaseous product of a reaction.</p>	20
<ul style="list-style-type: none"> • Define different terms related to solution. • Explain different laws of solution. • Solve mathematical problem using different laws of solution and solubility concepts. • Explain different colloids and its uses. • Compare between solution and colloid system. 	<p>2. Solutions Degree of dissociation, Equilibrium constant. Ostwald dilution law. Le-chatelier principle, Solubility, Ionic product, Solubility product, Common ion effect, pH and buffer solution, buffer action, Henderson equation. Determination of pH, Importance of pH and buffer in Agriculture, Medicine, Industry. Solution, Mixture and Colloids</p>	
<ul style="list-style-type: none"> • Define acids and bases from different viewpoints • Determine pH of a solution • Explain the acid base neutralization titration. 	<p>3. Acid-Base Various concepts of Acid and Base (Arrhenius concept, Bronsted-Lowry concept, Lewis concept), conjugate acid and base, strength of Acid and base. Self ionization of water and pH. Experimental uses of acid-base neutralization titration.</p>	
<ul style="list-style-type: none"> • Define different terms related to Electrochemistry. • Explain the terms related to conductance. • Explain the construction different electrodes and cells. • Derive the mathematical equation of emf of different electrodes and cells. • Solve mathematical problem of emf of different electrodes and cells. • Explain different laws of Thermochemistry. • Solve mathematical problem 	<p>4. Thermochemistry and Electrochemistry Enthalpy, enthalpy changes in various chemical and physical processes, entropy, Lavoisier and Hess's law and its application. Determination of reaction enthalpy, heat of solution and heat of neutralization. Reactivity series of metals, Electrochemical cells, pH and Electrode potentials-e.m.f. of cells, Electrolytic and galvanic cells, Half cells, Different types of electrodes, Standard Hydrogen electrode, Construction of electrochemical cells, Measurements of electrolytic conductance. Standard <i>e.m.f</i> of cell, Measurement of emf of cell, Nernst equation.</p>	

Assessment Targets: The candidate will be able to.....	Contents	Marks
using different laws of Thermochemistry.		

Section B: Inorganic Chemistry

Assessment Targets The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Explain an atom and its orbit and orbital • Distribute electrons in different shells following some rules • Explain the concept of various chemical bonding • Relate the function of electron with bonding types 	<p>1. Atomic Structure and chemical Bonding Nuclear model of the atom, Quantum number and atomic orbital, Electronic configuration, Pauli exclusion principle, Hund's rule; Aufbau principle. Ionic bonds, covalent bonds, co-ordinate covalent bonds, Octet rule, Multiple bonds, Polar covalent bonds, delocalized bonding, resonance, Metallic bond, Hydrogen bond, Vander Waals forces, MOT</p>	20
<ul style="list-style-type: none"> • Make various charts/tables for elements • Categorize elements into different groups and assign them in periodic table • Link up the physical and chemical properties of elements with periodicity 	<p>2. Periodic Table and Classification of Elements The modern periodic tables, Usefulness and, limitations of the periodic tables, Periodic properties, Atomic radius, Ionization energy, Electron affinity and electronegativity.</p>	
<ul style="list-style-type: none"> • Differentiate clearly between oxidation and reduction reactions • Complete redox reaction • Explain the oxidation reduction titration. 	<p>3. Oxidation and Reduction Oxidation, reduction, oxidation half reaction, reduction half reaction, redox reaction, oxidant, deducing agent, oxidation number, Redox reaction completion. Experimental uses of oxidation reduction titration.</p>	
<ul style="list-style-type: none"> • Explain the test of different radicals. • Explain the group reagents in salt analysis. 	<p>4. Analysis of Inorganic salts Dry test, Wet test, Group analysis of basic radicals, Group reagents, Role of common ion effect and solubility product in group analysis, Conformation test of acid and basic radicals.</p>	

Section C: Organic Chemistry

Assessment Targets: The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Define different terms related to basic organic chemistry. • Explain different phenomena in organic compounds. • Explain the stabilities of carbocation's, carbanions- free radicals • Explain nomenclature of organic compounds • Analyze the isomerization (structural, geometrical and conformational) in organic compounds 	<p>1. Bonding of Organic Compounds Atomic orbitals, covalent bonds, hybridization of orbitals and shapes of molecules, functional groups, homologous series, nomenclature of organic compounds, polarity of molecules, fission/cleavage of covalent bond, carbocation's, carboanions-free radicals and their stabilities, Isomerisations.</p>	20
<ul style="list-style-type: none"> • Explain structure, source, preparation, physical and chemical properties of aliphatic and aromatic hydrocarbons. • Explain the characteristic reactions in aliphatic and aromatic hydrocarbons. • Identify the saturated and unsaturated hydrocarbon through chemical reactions. • Explain the mechanism of reactions in aliphatic and aromatic hydrocarbons • Explain the markowikov's and anti-markowikov's rule & application. • Explain the Concept of aromaticity and Huckel's rule 	<p>2. Aliphatic and Aromatic Hydrocarbons Alkanes, cycloalkanes, alkenes, dienes, alkynes, classification of hydrocarbons, (structure, source, preparation, physical and chemical properties) of aliphatic and aromatic hydrocarbons, mechanism of reactions, CFC, cis-trans & E-Z systems, markowikov's and anti-markowikov's rule & application, conjugated dienes, acidity of alkynes etc. Addition reaction in unsaturated hydrocarbons. Concept of aromaticity, Huckel's rule, substitution and orientation, activation and deactivation in aromatic substitutions, electrophilic substitutions in aromatic system: (halogenations, nitration. sulphonation, alkylation and acylation).</p>	

Assessment Targets: The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Explain nomenclature of aliphatic compounds. • Explain structure, source, preparation, physical and chemical properties of aliphatic compounds. 	3. Aliphatic Organic Compounds of different functional groups Structure, nomenclature, classification, preparations and properties and reactions of Alkyl Halides, Hydroxy Compounds, Carbonyl Compounds & Carboxylic Acids, Amine, Determine the melting and boiling point of organic compounds. Elemental test of organic compounds, Test of functional groups.	
<ul style="list-style-type: none"> • Explain nomenclature of aromatic compounds. • Explain structure, source, preparation, physical and chemical properties of aromatic compounds. 	4. Aromatic Organic Compounds of different functional groups Structure, nomenclature, classification, preparations, properties and reactions of Aryl Halides, Hydroxy aromatic Compounds, Aromatic carbonyl Compounds & Carboxylic Acids, Aromatic Amine, Determine the melting and boiling point of organic compounds. Elemental test of organic compounds, Test of functional groups.	

Section D: Analytical Chemistry

Assessment Targets: The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Explain about the basic concept of analytical terms • Consider the necessary parameters for correct analytical calculations 	1. Basic Concepts in Analytical Chemistry Classical and modern concepts of analytical detection and quantification, sensitivity, selectivity, specificity, concentration limit, dilution limit etc. of chemical reactions, sample containers, sample preservation, sampling, sample dissolution, reagents and reactions, precision and accuracy, mean and median, types of errors, significant figure convention.	20
<ul style="list-style-type: none"> • Evaluate the role of buffer in analytical chemistry • Select suitable indicator for acid-base titrations • Explain the role of solvent choice in titration • Use redox technique in analysis • Choose indicator for redox titration 	2. Volumetric Methods of Analysis Preparation of solutions and dilution of solutions: Primary and secondary standard substance, molar solution, molal solution, ppm, ppb, % solution. Acid-Base Reactions: Acid-base equilibrium and buffers in analytical chemistry, indicators, titrations of acid-base, titration in non-aqueous solvents - solvent choice and advantages. Redox Reactions: Oxidation-reduction	

Assessment Targets: The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Utilize some oxidant for standard titration methods • Explain terms related to EDTA titration. • Calculate the step-wise formation constant • Apply masking and demasking technics for selective complex formation 	<p>equilibrium in chemical analysis, redox titration curve, indicators for oxidation-reduction titrations, KMnO_4 as a standard oxidants, titrations with $\text{K}_2\text{Cr}_2\text{O}_7$ and cerium (IV), redox titrations involving iodine, iodometric and iodi-metric methods.</p> <p>Complex metric Methods of Analysis Complexes, formation constants, chelates, EDTA equilibrium, effect of pH on EDTA equilibrium, EDTA titration curves, types of EDTA titrations, selectivity, masking and demasking agents, metal ion indicators, applications.</p>	
<ul style="list-style-type: none"> • Describe the Limit the wavelength range of Ultraviolet and visible radiation • Describe the advantage and limitations of the Beer-Lambert's law • Apply the Beer-Lambert's law for determination of metal-ligand complexes 	<p>3. Spectrophotometric Analysis Ultraviolet and visible radiation, absorbance, transmittance, absorptivity, the Beer-Lambert's law, limitations of Beer-Lambert's law, wavelength selection, basic components of a spectrophotometer, qualitative and quantitative analysis, stoichiometric determination of metal-ligand complexes.</p>	
<ul style="list-style-type: none"> • Define chromatographic terms • Know various chromatographic techniques • Separate solvents/ compounds using chromatographic techniques 	<p>4. Chromatography Chromatographic behavior of solute, retention behavior, partition coefficient, column efficiency, resolution, quantitative and qualitative analysis.</p> <p>(i) Plane chromatography Principle of paper chromatography (PC) and thin layer chromatography (TLC), nature of mobile phase, stationary phases, development, location of spot, quantitative methods, applications.</p> <p>(ii) Liquid column chromatography Principles, stationary phases, mobile phases and applications.</p> <p>(iii) Ion-exchange method Principles, types of resin, structure, swelling, effect of pH, separation of metal ions, action of ion exchange resins, applications.</p>	

Section E: Industrial Chemistry and Environmental Chemistry

Assessment Targets: The candidate will be able to.....	Contents	Marks
<ul style="list-style-type: none"> • Explain the source, causes of pollutants of water, air and soil pollution. • Explain the types of water, air and soil pollutants. • Explain the various techniques of treatment of water, air and soil pollution. • Explain the source, causes of pollutants of heavy metal pollution. • Explain the impact of heavy metal pollution in human body. 	<p>1. Environmental pollution Water: Causes of water pollution, different types of water pollutants, industrial waste water and municipal water treatment, control and treatment of water pollution, measurement parameter pH, DO, BOD, COD. Air: Composition of atmosphere Causes of air pollution, primary and secondary pollutants; toxic effects of various pollutants; acid rain photochemical smog; greenhouse gases & greenhouse effects; ozone layer depletion. Control and treatment of air pollution. Soil: Composition of soil, different types of soil pollutants and their effects, Causes of soil pollution, sustainable practices and techniques for control of soil pollution. Heavy Metal Pollution: Mercury, chromium, arsenic lead pollution, source, biochemical effects, toxicity, control and treatment, Industrial waste ETP.</p>	20
<ul style="list-style-type: none"> • Explain the principals of caning of foods. 	<p>2. Processing of Local Food: Caning of foods: Process of caning of tomato, mango, Guava, pea, pineapple and meat.</p>	
<ul style="list-style-type: none"> • Explain the preparations of toiletries, • Explain the preparation of vinegar and molt vinegar, • Explain the extraction of ghee and butter from milk, 	<p>3. Commercial Preparations: Process of preparation of rose water, after shave lotion, cold cream, talcum powder. Process of preparation of toiletries. Preparation of toilet cleaner and glass cleaner. Preparation of Vinegar from acetic acid, Preparation of molt vinegar from sugar cane juice, extraction of ghee and butter from milk.</p>	
<ul style="list-style-type: none"> • Explain the safety laboratory uses. • Explain the safety uses of laboratory apparatus and instruments. • Explain the safety storage and disposal of chemical and reagents. • Explain the health hazards of chemicals and perform the first aid. 	<p>4. Laboratory safety: Laboratory safety uses, glass apparatus, burner, volumetric analysis, titration, laboratory wastes, chemical balance, uses of Bunsen burner, heating technique, safety storage and disposal of chemicals and reagents, techniques of uses of reagent bottles, hazards symbol, semi micro and micro analysis, first aid.</p>	