

उत्तर-पूर्वी अंतरिक्ष उपयोगकेंद्र/**North-EasternSpaceApplicationsCentre**
उमियम/**Umiam** – 793103, मेघालय/**Meghalaya**

Name of the Post: Scientific Assistant

Advertisement No. NESAC/RMT-R/02/2019 dated 24.01.2020

Syllabus of the Written Test for the post Scientific Assistant

Date of written test: June 28th, 2020 (Tentative)

Question shall be from General knowledge, Reasoning, general Aptitude, English etc., Chemistry (10+2 level), Mathematics (10+2 level), Computer Science (10+2 level), Physics (10+2 level and B. Sc. in Physics (Hons./Major/Main) Level).

From the syllabus of B. Sc. Physics following topics will be more focused:

Waves and Optics

Simple Harmonic Motions (SHM), Simple Harmonic Oscillations. Differential equation of SHM and its solution. Damped oscillation, Forced oscillations, Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Kinetic energy, potential energy, total energy..

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two and more collinear oscillations, Beats. Superposition of two perpendicular Harmonic Oscillations.

Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive Waves, Wave Equation, Particle and Wave Velocities, Differential Equation, Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave, Ripple and Gravity Waves.

Velocity of Waves, Velocity of Transverse Vibrations of Stretched Strings, Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound, Laplace's Correction.

Standing (Stationary) Waves in a String, Energy of Vibrating String, Transfer of Energy, Normal Modes of Stretched Strings, Plucked and Struck Strings.

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection. Interference in Thin Films: parallel and wedge shaped films. Newton's Rings: Measurement of wavelength and refractive index. Michelson Interferometer, Idea of form of fringes, Fabry-Perot interferometer. Fraunhofer diffraction.

Working principle of Telescopes, Resolving Power of a telescope, Diffraction grating. Resolving power of grating. Fresnel Diffraction. Explanation of Rectilinear Propagation of Light. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a

wire. Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Electricity and Magnetism

Coulombs law, Definition of Electrostatic Field, Field lines, Divergence of the Electrostatic field, Flux, Gauss's theorem of electrostatics. Applications of Gauss theorem. Curl of the Electrostatic Field and its conservative nature. Electric potential. Laplace's and Poisson equations. Electric field and charge density. Conductors in an electrostatic field. Capacitance of a conductor. Electrostatic energy, Energy per unit volume in electrostatic field.

Electric potential and field due to an electric dipole. Electric dipole moment. Force and torque on a dipole. Electric Fields inside matter: Electric Polarization. Bound charges, Displacement vector. Relations. Linear Dielectric medium. Electric Susceptibility and Permittivity. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric.

Biot-Savart's law. Force on a moving point charge due to a magnetic field: Lorentz force law. Divergence of the magnetic field. Magnetic vector potential. Curl of the magnetic field. Ampere's circuital law.

Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field. The magnetic intensity - H. Relation between B, H and M. Magnetic Susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis.

Ohms law and definition of E.M.F. Faraday's laws of electromagnetic induction, Lenz's law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Charge conservation. Displacement current and resurrection of Equation of Continuity. Energy stored in magnetic field.

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and Quality Factor.

Ideal Constant-voltage and Constant-current Sources. Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem.

Thermodynamics

Zeroth and First Law of Thermodynamics, Thermodynamic Equilibrium, Concept of Work & Heat, Applications of First Law, Relation between C_P and C_V , Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Second Law of Thermodynamics: Reversible and Irreversible process. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, Kelvin-Planck and Clausius theorem and their Equivalence. Applications of Second Law of Thermodynamics. Concept of Entropy, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy.

Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Surface Films and Variation of Surface Tension with Temperature. First and second order Phase

Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations, Maxwell's Thermodynamic Relations. Change of Temperature during Adiabatic Process.

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas, Degrees of Freedom. Law of Equipartition of Energy, Specific heats of Gases. Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: Viscosity, Thermal Conductivity and Diffusion. Brownian motion and its Significance.

Behavior of Real Gases, Deviations from the Ideal Gas Equation. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Temperature of Inversion. Joule-Thomson Cooling.

Thermal conductivity, diffusivity. Fourier's equation for heat conduction of its solution.

Electromagnetic Theory

Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).

Description of Linear, Circular and Elliptical Polarization. Origin of Double-Refraction: Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Production & analysis of polarized light.

Electronics and Instrumentation

Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of LEDs, Photodiode, Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cut off & Saturation regions Current gains. Load Line analysis of Transistors. DC Load line & Q-point. Voltage Divider Bias Circuit for CE Amplifier. H-parameter, Equivalent Circuit. Analysis of single-stage CE amplifier using

hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers.

Characteristics of an Ideal and Practical Op-Amp, Open loop and closed loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector.

Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator.

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. AND, OR and NOT Gates. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra.

Binary Addition, Binary Subtraction, Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.
