SYLLABUS FOR NTRCA (WRITTEN) EXAMINATION

Post: Demonstrator

Subject: Physics

Code: 459

Time: 03 (Three) Hour   **Full Marks:100**

Instructions: There will be 10 questions of equal value and candidates have to answer all of the ten questions in stipulated time. Each question will design from each individual unit. Each question may have multiple sub items like a, b, c, etc. The distribution of marks for each question can be 2+2+3+3 or 2+3+5 or 2+2+6 or 1+4+5 or 1+2+3+4 or 5+5.

Assessment Targets. The candidates will be able to ….	Contents	Marks
• Explain concept and terms regarding vector, motion, work, energy& power. • Relate the concept with the real-life phenomenon regarding vector, motion, work, energy & power. • Formulate mathematical expression related to the context of vector, motion, work, energy & power. • Demonstrate the problem-solving ability in relation to vector, motion, work, energy & power.	**Unit: One (Mechanics)** **Vector Algebra:** Vectors and their components, vector addition and subtraction. Dot and Cross product. Scalar and Vector triple products. **Laws of Motion:** Uniform Circular Motion, Projectile Motion, Newton's laws of Motion and their applications, Galileo's Law of falling body, Frictional forces, Impulse and Momentum, Conservation of liner momentum. Elastic collision. **Work, Energy and Power:** Work and Kinetic Energy, Conservative and Non conservative Forces, Work done by constant force, variable force and Spring force, Work and potential energy, Gravitational potential energy, Work-energy theorem, Conservation of energy, Efficiency. **Rotational Motion:** Rotational Variables, Torque, Moment of inertia & Radius of gyration and their calculations, Kinetic energy of rotation, Angular Momentum and its conservation.	10

• Explain concept and terms regarding gravitation and properties of matter. • Analyze real world phenomena with the concept of gravitation and properties of matter. • Formulate mathematical expression related to context of gravitation and properties of matter. • Demonstrate the problem-solving ability regarding the concept of gravitation and properties of matter.	**Unit: Two (Properties of Matter)** **Gravitation:** Newton's law of universal gravitation, Acceleration due to Gravity and its variations, Measurement of acceleration due to Gravity by Compound pendulum and Kater's pendulum, Gravitational potential and field in simple cases, Escape velocity, Planets and satellites. **Elasticity:** Hooke's law, Elastic Moduli and their interrelation, Determination of Young's and Rigidity modulus, Torsion of a cylinder, Bending of beams and cantilevers. **Fluid Mechanics:** Surface tension and surface energy, Molecular origin of Surface Tension, Angle of contact and its measurements, Determination of surface tension of water and mercury drop, Streamline and Turbulent flow, Bernoulli's equation and application, co-efficient of viscosity Poiseuille's formula and its correction, Determination co-efficient of viscosity using capillary flow method.	10
• Interpret the concept and terms of heat and thermodynamics. • Relate the concept with the real life phenomenon in relation to heat and thermodynamics. • Formulate mathematical expression in relation to heat, thermodynamics, and radiation. • Demonstrate the problem-solving ability in relation to heat, thermodynamics and radiation.	**Unit: Three (Thermal Physics & Radiation)** **Heat and Kinetic Theory Gases:** Heat and Temperature, Platinum resistance thermometer, Equation of state of an ideal gas, Kinetic Theory of Gases, Mean Free Path, Van der Waals equation of State, Degrees of freedom and Molar Specific Heats, Specific Heat and its determination for solid, liquid and gas. **Thermodynamics:** Zero-th Law of Thermodynamics, First law of thermodynamics and its applications, Reversible & Irreversible Processes, Entropy, Change in Entropy, Second Law of Thermodynamics, Heat Engine, Newton's Law of cooling. **Radiation:** Concept of Black Body and Black Body Radiation, Stefan-Boltzmann's Law, Wien's displacement law, Rayleigh-Jean's law, Planck's Radiation law.	10
• Explain concept and terms regarding electromagnetism. • Analyze real world	**Unit: Four (Electricity and Magnetism)** **Electric Field:** Scalar and vector fields, Gradient, Divergence and curl, Coulomb's law from Gauss's law. Electric field and Potential due to Point charge &	10

phenomena with the concept of electricity and magnetism • Formulate mathematical expression in relation to electromagnetism. • Demonstrate the problem-solving ability related to the concept of Electromagnetism.	electric Dipole. Parallel-plate capacitor, Energy stored in a capacitor, Capacitors in parallel and in series, Gauss's law with dielectrics. **Current and Magnetic field:** Current density, drift velocity, Ohm's law, resistance and resistivity, addition of resistances, Kirchhoff's law, Problems involving multi-loop circuits, Ammeter, Voltmeter and their uses, Wheatstone bridge principle , Biot - Savart law, Amperes law and their applications, Magnetic properties of matter , Paramagnet, Diamagnet and Ferromagnet, Magnetization vectors, Hysteriesis . **Time Varying Phenomena:** Faraday's law & Lenz's Law of Induction and their applications, Transformers, RC and LC circuit , Energy transformation in LC circuit.	
• Explain concept and terms regarding waves, oscillation and optics. • Relate the concept with the real-life phenomenon to the concept of waves, oscillation and optics. • Formulate mathematical expression in relation to waves, oscillation and optics. • Demonstrate the problem-solving ability regarding waves, oscillation and optics.	**Unit: Five (Sound and Optics)** **Waves:** Transverse and Longitudinal Wave, Progressive Wave Equation, The Principle of superposition for waves , Standing Waves and Resonance, Beats, The Doppler Effect, Applications of waves in real life. **Oscillation:** Simple Harmonic Motion (SHM), Relation between SHM and uniform circular motion. Energy in SHM, combinations of two SHM"S, Lissajous figures, Damped SHM, Vibrations of string and air-column, Sonometer, Melde"s experiment. **Optics:** Light and the electromagnetic spectrum, wave front and Huygens principle, Coherent source , Interference of light, Young's experiment, Fresnel and Fraunhofer class diffraction, Diffraction from single slit and double slits, Diffraction grating, Polarised and unpolarised light, polarization by polarizer, Brewsters law, Dispersion of light , Optical phenomena in real life, Optical fiber in communication.	10

• Explain concept and terms regarding atomic and molecular physics and Lasers. • Analyze real world phenomena with the concept of atomic and molecular physics and Lasers. • Formulate mathematical expression in relation to theory of atomic and molecular physics and Lasers. • Demonstrate the problem-solving ability regarding atomic and molecular physics and Lasers.	**Unit: Six (Atomic and Molecular physics)** **Quantum Theory:** Quantum character of radiation, photoelectric effect, Einstein's photon theory, photoelectric equation, Compton effect, **Rutherford Nucleus:** Rutherford alpha scattering experiment, Nucleus, Bohr quantization rules, Hydrogen atom spectra, Pauli's exclusion principle. Vector & shell atom model. **X-ray & Laser:** Production and properties of X-rays, Characteristics of X-rays, X-rays spectra, Basic principles of laser; Stimulated absorption, spontaneous and stimulated emission; population inversion, laser idea, three and four level lasers, properties of a laser beam, optical pumping; Helium-Neon laser; Application of laser.	10
• Explain concept and terms regarding physical basis, special theory of relativity and quantum mechanics. Relate the concept with the real-life phenomenon in relation to physical basis, special theory of relativity and quantum mechanics. • Formulate mathematical expression in relation to physical basis, special theory of relativity and quantum mechanics. • Demonstrate the problem-solving ability regarding physical basis, special theory of relativity and quantum mechanics.	**Unit: Seven (Modern Physics)** **Physical basis**: Failure of classical mechanics and emergence of Quantum Mechanics. Black body radiation, Wave particle duality, De Broglie wavelength, Phase and group velocities, The Uncertainty principle. Blackbody radiation; Photoelectric effect; Einstein photon theory; The Compton effect. **Special Theory of Relativity:** Postulates of special theory of relativity, Lorentz transformation, The Michelson–Morley experiment ;Time dilation; Length contraction; Relativity of mass, Mass-energy equivalence. **Quantum Mechanics:** Schrödinger's equation, Time dependent form and Steady-state form; Application of Schrödinger's equation: particle in a box, harmonic oscillator and hydrogen atom.	10
• Explain concept and terms regarding nuclear physics, elementary particles and medical physics.	**Unit: Eight (Nuclear Physics and Application of Modern Physics)** **Nuclear Physics**: Nuclear composition; Binding energy and separation energy; Radioactive decay; Half life, Mean life, Nuclear reaction; Nuclear fission and fusion;	10

• Analyze real world phenomena with the concept of nuclear physics, elementary particles and medical physics. • Formulate mathematical expression in relation to nuclear physics, elementary particles and medical physics. • Demonstrate the problem-solving ability regarding nuclear physics, elementary particles and medical physics.	GM counter, Nuclear reactor and Nuclear power plant in Bangladesh. **Elementary Particles:** General properties and classification of elementary particles, Elementary particle quantum numbers, different types of interaction and conservation laws, Quarks Models, Field Boson; Unification of forces; Origin of the universe and The Big Bang; Ultimate fate of the universe, Dark matter. **Physics in Medical science**: Uses physics concepts and procedures in the prevention, diagnosis and treatment of disease: X-rays, Ultrasonography, MRI, CT Scan, ECG, ETT, Endoscopy, Radiography, Chemotherapy, Angiography, Precaution and care in using instruments in diagnosis.	
• Explain concept and terms regarding semiconductor, superconductor, diode and transistor. • Relate the concept with the real-life phenomenon with the concept of semiconductor, superconductor, diode and transistor. • Design and analyze circuit with the concept of diode, transistor and integrated circuit. • Demonstrate the problem-solving ability and evaluate related to the concept of semiconductor, superconductor, diode and transistor.	**Unit: Nine (Solid State Physics)** **Semiconductor:** Band theory, Types of Semiconductors, P-N Junction, Biasing, Diode Characteristics, Diode rectification, LED, Photo-diode & Solar Cell. **Transistor and its Applications:** Types of Transistors, Transistor Configurations: CB, CE and CC configuration, Input and Output characteristics, Transistor as an amplifier and a switch, Integrated Circuit. **Superconductivity:** Basic properties of superconductors, Meissen effect, BCS theory of superconductivity.	10
• Explain concept and terms regarding logic gates, computer and laboratory work. • Relate the concept with the	**Unit: Ten (Computer fundamentals and Experimental physics)** **Fundamental concepts:** Boolean Algebra, De Morgan's theorem, Truth Tables, Basic logic operations and gates: OR, AND, and NOT, Universal gates: NAND and NOR, Complex gates: X-OR & X-NOR,	10

real-life phenomenon with the concept of logic gates, computer and laboratory work. • Draw diagram logic circuit with the concept of logic gates, computer and laboratory work. • Demonstrate the problem-solving ability with the concept of logic gates, computer and laboratory work.	Universality of NAND and NOR Gates. Design of a Half and Full Adder. Computer CPU, Keyboard, Mouse, Monitor, Printer, E-mail. **Laboratory :** Fair note book, Errors in Measurement (Theoretical & Experimental), Determination of Significant Figure, Analysis of the experiment (Mathematical & Graphical).	