NUMS MDCAT CURRICULUM

PHYSICS

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FORCE AND MOTION

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- Law of conservation of momentum
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- Elastic collision
- Elastic collision in one dimension
- Elastic collision in one dimension under different cases
- Projectile motion
- Characteristics of projectile motion
- Time of flight
- Maximum height
- Horizontal range

Learning Outcomes

- Describe displacement.
- Describe average velocity of objects.
- Interpret displacement-time graph of objects moving along the same straight line.
- Define uniform acceleration
- Distinguish between, uniform and variable acceleration.
- Explain that projectile motion is two-dimensional motion in a vertical plane.
- Communicate the ideas of a projectile in the absence of air resistance.

- Horizontal component (VH) of velocity is constant.
- Acceleration is in the vertical direction and is the same as that of a vertically free-falling object.
- The horizontal motion and vertical motion are independent of each other.
- Evaluate using equations of uniformly accelerated motion that for a given initial velocity of frictionless
- Projectile.
- How higher does it go?
- How far would it go along the level land?
- Where would it be after a given time?
- How long will it remain in air?
- Determine for a projectile launched from ground height.
- Launch angle that results in the maximum range.
- Relation between the launch angles that result in the same range.
- Describe how air resistance affects both the horizontal component and vertical component of velocity and hence the range of the projectile.
- Apply Newton's laws to explain the motion of objects in a variety of context.
- Describe the Newton's second law of motion as rate of change of momentum.
- Correlate Newton's third law of motion and conservation of momentum.
- Solve different problems of elastic and inelastic collisions between two bodies in one dimension by using law of conservation of momentum.
- Describe that momentum is conserved in all situations.
- Identify that for a perfectly elastic collision, the relative speed of approach is equal to the relative speed of separation.

WORK AND ENERGY

- Work
- Energy
- Kinetic energy
- Potential energy
- Gravitational potential energy
- Power

Learning Outcomes

- Describe the concept of work in terms of the product of force F and displacement d in the direction of force (Work as scalar product of F and d).
- Define Energy
- Explain Kinetic Energy
- Explain the Difference between Potential energy and gravitational Potential energy.
- Describe that the gravitational PE is measured from a reference level and can be positive or negative, to denote the orientation from the reference level
- Express power as scalar product of force and velocity
- Explain that work done against friction is dissipated as heat in the environment
- State the implications of energy losses in practical devices

ROTATIONAL AND CIRCULAR MOTION

- Angular displacement
- Revolution
- Degree
- Radian
- Angular velocity
- Relation between linear and angular variables
- Relation between linear and angular displacements
- Relation between linear and angular velocities
- Relation between linear and angular accelerations
- Centripetal force
- Forces causing centripetal acceleration

Learning Outcomes

- Define angular displacement, express angular displacement in radians
- Define Revolution, degree and Radian
- Define and Explain the term Angular Velocity
- Find out the relationship between the following:
- Relation between linear and angular variables
- Relation between linear and angular displacements
- Relation between linear and angular velocities
- Relation between linear and angular accelerations
- Solve problems using centripetal force $F = mr\omega^2$, $F = mv^2/r$.

WAVES

- Progressive waves
- Crest
- Trough
- Amplitude
- Wavelength
- Time period and frequency
- Types of progressive waves
- Transverse waves
- Longitudinal waves
- Periodic waves
- Transverse periodic waves
- Longitudinal periodic waves
- Speed of sound in air
- Principle of superposition/ superposition of sound waves
- Stationary waves/ standing waves
- Stationary waves in a stretched string/ fundamental frequency and harmonics
- Doppler effect
- Observer is moving towards a stationary source
- Observer is moving away from a stationary source
- When the source is moving towards the stationary observer
- When the source is moving away from the stationary observer
- Simple harmonic motion (SHM)
- Characteristics of simple harmonic motion
- Instantaneous displacement
- Amplitude
- Vibration
- Time period
- Frequency
- Angular frequency

Learning Outcomes

- Describe what is meant by wave motion as illustrated by vibrations in ropes, springs and ripple tank.
- Demonstrate that mechanical waves require a medium for their propagation while electromagnetic waves do not.
- Define and apply the following terms to the wave model; medium, displacement, amplitude, period, compression, rarefaction, crest, trough, wavelength, velocity.
- Solve problems using the equation: v = fl.
- Describe that energy is transferred due to a progressive wave.
- Identify that sound waves are vibrations of particles in a medium.
- Compare transverse and longitudinal waves.
- Explain that speed of sound depends on the properties of medium in which it propagates and describe Newton's formula of speed of waves.
- Describe the Laplace correction in Newton's formula for speed of sound in air.
- Identify the factors on which speed of sound in air depends.
- Describe the principle of superposition of two waves from coherent sources.
- Describe the phenomenon of interference of sound waves.
- Describe the phenomenon of formation of beats due to interference of non-coherent sources.
- Explain the formation of stationary waves using graphical method
- Define the terms, node and antinodes.
- Describe modes of vibration of strings.
- Describe formation of stationary waves in vibrating air columns.
- Explain the principle of Super position
- Explain S.H.M and explain the Characteristics of S.H.M.

THERMODYNAMICS

- Thermodynamics system
- First law of thermodynamics
- Specific heat and Molar specific heat / specific heat capacity
- Second law of thermodynamics
- Lord Kelvin statement

Learning Outcomes

- Describe that thermal energy is transferred from a region of higher temperature to a region of lower temperature.
- Describe that regions of equal temperatures are in thermal equilibrium.
- Define the Lord Kelvin Statement
- Define thermodynamics and various terms associated with it.
- Differentiate between Specific heat and Molar Specific Heat.
- Calculate work done by a thermodynamic system during a volume change.
- Describe the first law of thermodynamics expressed in terms of the change in internal energy, the heating of the system and work done on the system.
- Explain that first law of thermodynamics expresses the conservation of energy.
- Define the terms, specific heat and molar specific heats of a gas.
- Apply first law of thermodynamics to derive $C_p - C_v = R$.
- State and explain second law of thermodynamics.

ELECTROSTATICS

- Coulomb's Law
- Coulomb's law in material media
- Electric field and its intensity
- Electric field intensity due to an infinite sheet of charge
- Electric field intensity between two oppositely charged parallel plates
- Electric potential
- Capacitor
- Capacitance of a capacitor and its unit
- Capacitance of a parallel plate capacitor
- Combinations of capacitors
- Parallel combination of capacitors
- Energy Stored in a Capacitor
- Charging and Discharging a Capacitor

Learning Outcomes

- State Coulomb's law and explain that force between two-point charges is reduced in a medium other than free space using Coulomb's law.
- Describe the concept of an electric field as an example of a field of force.
- Calculate the magnitude and direction of the electric field at a point due to two charges with the same or opposite signs.
- Sketch the electric field lines for two-point charges of equal magnitude with same or opposite signs.
- Describe and draw the electric field due to an infinite size conducting plate of positive or negative charge.
- Define electric potential at a point in terms of the work done in bringing unit positive charge from infinity to that point.
- Define the unit of potential.
- Derive an expression for electric potential at a point due to a point charge.
- Describe the functions of capacitors in simple circuits.
- Solve problems using formula for capacitors in series and in parallel.

- Explain polarization of dielectric of a capacitor.
- Demonstrate charging and discharging of a capacitor through a resistance.

CURRENT ELECTRICITY

- OHM's Law
- Electrical resistance
- Specific resistance or resistivity
- Effect of temperature on resistance
- Temperature co-efficient of resistance
- Variation f resistivity with temperature
- Internal resistance of a supply
- Electric power
- Unit of electric power
- Kilowatt-hours
- Kirchhoff's Rule
- Kirchhoff's current law
- Kirchhoff's voltage law
- Procedure of Kirchhoff's law for Problem solution
- Potentiometer

Learning Outcomes

- Describe the concept of steady current.
- State Ohm's law.
- Define resistivity and explain its dependence upon temperature.
- Explain the internal resistance of sources and its consequences for external circuits.
- Describe the conditions for maximum power transfer.
- Apply Kirchhoff's first law as conservation of charge to solve problem.
- Apply Kirchhoff's second law as conservation of energy to solve problem.

ELECTROMAGNETISM

- Magnetic field
- Magnetic Flux
- Magnetic Flux Density

Learning outcome

- Define magnetic flux density and its units.
- Describe the concept of magnetic flux (Ø) as scalar product of magnetic field (B) and area (A) using the relation $\text{Ø}B = B^{\perp} A = B.A$.
- Describe quantitatively the path followed by a charged particle shot into a magnetic field in a direction perpendicular to the field.
- Explain that a force may act on a charged particle in a uniform magnetic field.

ELECTROMAGNETIC INDUCTION

- Electromagnetic induction
- Activity
- Faraday's Law: application in seismometer
- Lenz's Law
- Lenz's Law and conservation of energy
- Generating electricity
- Alternating Current Generator
- Transformers

Learning Outcomes

- State Faraday's law of electromagnetic induction.
- Account for Lenz's law to predict the direction of an induced current and relate to the principle of conservation of energy.
- Apply Faraday's law of electromagnetic induction and Lenz's law to solve problems.
- Given a rod or wire moving through a magnetic field in a simple way, compute the potential difference across its ends.
- Define mutual inductance (M) and self-inductance (L), and their unit henry.
- Describe the construction of a transformer and explain how it works.
- Describe how set-up and step-down transformers can be used to ensure efficient transfer of electricity along cables.

ELECTRONICS

- Rectification

Learning Outcomes

- Define rectification and describe the use of diodes for half and full wave rectifications.

DAWN OF MODERN PHYSICS

- The wave nature of particles
- The wave-particle duality

Learning Outcomes

- Explain the particle model of light in terms of photons with particular energy and frequency.
- Explain how the very short wavelength of electrons, and the ability to use electrons and magnetic fields to focus them, allows electron microscope to achieve very high resolution.
- Describe uncertainty principle.

ATOMIC SPECTRA

- Atomic Spectra/ Line Spectrum
- Production of X-rays

Learning Outcomes

- Describe and explain Atomic Spectra/ Line Spectrum.
- Show an understanding of the existence of discrete electron energy levels in isolated atoms (e.g. atomic hydrogen) and deduce how this leads to spectral lines.
- Understand that inner shell transitions in heavy elements result into emission of characteristic X-rays.

NUCLEAR PHYSICS

- Spontaneous and random nuclear decay/ the Law of Radioactive Decay
- Half Life and rate of decay
- Biological effects of Radiation
- Biological and Medical Uses of Radiation

Learning Outcomes

- Describe a simple model for the atom to include protons, neutrons and electrons.
- Identify the spontaneous and random nature of nuclear decay.
- Describe the term half-life and solve problems using the equation.
- Describe Biological effects of radiation state and explain the different medical uses of Radiation.