جَامِعَة الحريري الكندِيَّة

Hariri Canadian University

PHYSICS ENTRANCE EXAM TOPICS

College of Engineering and College of Science & Information Systems:

- **Mechanics**

  a- Work and Energy (potential (gravitational and elastic), kinetic and mechanical)
  b- Newton's Second Law
  c- Linear Momentum
  d- Mechanical Oscillations (elastic spring only)

- **Electricity and Magnetism**

  a- Capacitor (2nd and 3rd year secondary)
  b- Magnetic Field of a Long Wire, circular loop and solenoid
  c- Electromagnetic induction (2nd and 3rd year secondary)
  d- Self-Induction
  e- Alternating Sinusoidal Current
  f- Transformer

- **Light**

  a- Diffraction of Light
  b- Interference of Light

PHYSICS

COURSE OF STUDY

FOR HCU ENTRANCE EXAM

Motion in One Dimension

Objectives

The student should be able to:

a. describe and calculate the displacement, average and instantaneous velocity and instantaneous and average acceleration of objects in motion.
b. draw and interpret motion diagrams.
c. calculate the initial velocity, final velocity, displacement, acceleration and time of moving objects undergoing constant acceleration.
d. apply the concepts of uniform acceleration to free falling objects.

Subject Headings

a) Displacement
b) Average Velocity
c) Instantaneous Velocity
d) Acceleration
e) Motion Diagrams
f) One-Dimensional Motion with Constant Acceleration
g) Freely Falling Objects

The Laws of Motion

Objectives

The student should be able to:

a. relate, calculate and apply the concept of force to Newton's Laws of Motion.
b. describe and relate the normal force, coefficient of friction and friction force.
c. calculate and apply friction force to Newton's Laws of Motion.

Subject Headings

a) The Concept of Force
b) Newton's First Law
c) Newton's Second Law
d) Newton's Third Law
e) Some Applications of Newton's Laws
f) Force of Friction

Work and Energy

Objectives

The student should be able to:

a. calculate work and relate it to the conservation of mechanical energy.
b. relate work and kinetic energy with the Work-Kinetic Energy Theorem.
c. describe and relate conservative and nonconservative force.
d. relate work from conservative forces to the Work-Kinetic Energy Theorem a and the conservation of mechanical energy.
e. calculate power and relate it to force and work.

Subject Headings

a) Work
b) Kinetic Energy and the Work-Kinetic Energy Theorem
c) Potential Energy
d) Conservative and Nonconservative Forces
e) Conservation of Mechanical Energy
f) Nonconservative Forces and the Work-Kinetic Energy Theorem
g) Conservation of Energy in General
h) Power

Momentum and Collisions

Objectives

The student should be able to:

a. describe, calculate and relate momentum and impulse.
b. relate elastic and inelastic collisions.
c. calculate and apply the conservation of momentum in linear and glancing collisions.

Subject Headings

a) Momentum and Impulse (variation of momentum)
b) Conservation of Momentum
c) linear Collisions elastic and non elastic
d) two dimensional collision (graphyical solution)

- Rotational Dynamics

Objectives

The student should be able to:

a. relate moment with linear force.
b. determine the center of gravity.
c. calculate and relate moment (torque), angular acceleration and static equilibrium.
d. describe the conservation of mechanical energy involving gravitational potential energy, translational kinetic energy and rotational kinetic energy.

Subject Headings

a) Torque (moment)
b) Torque and the Second Condition for Equilibrium
c) The Center of Gravity
d) Examples of Objects in Equilibrium
e) Relationship Between Torque and Angular Acceleration
f) Rotational Kinetic Energy

Vibrations (mechanical oscillation)

Objectives

The student should be able to:

a. state and apply Hooke's Law with objects in Simple Harmonic Motion.
b. relate Simple Harmonic Motion with the conservation of gravitational potential energy, spring potential energy and kinetic energy.
c. describe the Simple Harmonic Motion of an elastic pendulum and calculate period and frequency of the pendulum.

Subject Headings

a) Hooke's Law
b) Elastic Potential Energy and kinetic energy
c) conservation of energy and 2^{nd} order differential equation
d) Velocity as a Function of Position
e) Position, Velocity, and Acceleration as a Function of Time
f) Damped Oscillations
g) Frequency, Amplitude, and Wavelength

Magnetism

Objectives

The student should be able to:

a. use the defining equation for a magnetic field B and the right-hand rule to determine the magnitude and direction of the magnetic force exerted on an electric charge moving in a region where there is a magnetic field.
b. relate the differences between the forces exerted on electric charges by electric fields and those forces exerted on moving charges by magnetic fields.
c. calculate the magnitude and direction of the magnetic force on a current-carrying conductor when placed in an external magnetic field.
d. determine the magnitude and direction of the torque exerted on a closed current loop in an external magnetic field.
e. calculate the magnitude and determine the direction of the magnetic field for the following cases: a point in the vicinity of a long, straight current-carrying conductor at the center of a loop, and at interior points of a solenoid.

Subject Headings

a) Magnets
b) Magnetic Fields
c) Magnetic Force on a Current-Carrying Conductor
d) Torque on a Current Loop
e) Magnetic Field of a Long, Straight Wire and Ampere's Law
f) Magnetic Field of a Current Loop
g) Magnetic Field of a Solenoid

Induced Voltages and Inductance

Objectives

The student should be able to:

a. calculate the emf induced in a circuit when the magnetic flux is varying due to changes in (i)the area of the circuit, (ii) the magnitude of the magnetic field, (iii) the direction of the field or (iv) the orientation of the circuit in the magnetic field.
b. relate Lenz's law as a consequence of the law of conservation of energy.
c. apply Lenz's law to determine the direction of an induced emf.
d. calculate the emf induced between the ends of a conducting bar as it moves through a constant magnetic field.
e. describe self-inductance.
f. calculate the total magnetic energy stored in a magnetic field when device inductance and current are given.
g. describe the manner in which the instantaneous value of the current in an RL circuit changes while the current is increased or decreased with time.

Subject Headings

a) Induced emf and Magnetic Flux
b) Faraday's Law of Induction
c) Motional emf
d) Lenz's Law Revisited
e) Generators
f) Self-Inductance
g) RL Circuits
h) Energy Stored in a Magnetic Field

Electrical Energy and Capacitance

Objectives

The student should be able to:

a. understand the concept of electric potential and electrical potential difference.
b. calculate the electric potential difference in a uniform electric field and a group of point charges.
c. calculate and relate the electric potential energy and electron volts.
d. define capacitance and evaluate the capacitance of a parallel plate capacitor of given area and plate separation.
f. determine the equivalent capacitance of a network of capacitors in series-parallel combination and calculate the final charge on each capacitor and the potential difference across each when a known potential is applied across the combination.

Subject Headings

a) Potential Difference and Electric Potential
b) Potentials and Charged Conductors
c) Applications
d) The Definition of Capacitance
e) The Parallel-Plate Capacitor
f) Combinations of Capacitors
g) Energy Stored in a Charged Capacitor
h) Capacitors with Dielectrics

Alternating Current Circuits and Electromagnetic Waves

Objectives

The student should be able to:

a. calculate reactance in an ac circuit as a function (i) capacitance, (ii) inductance and (iii) frequency.
b. interpret the meaning of phase angle and power factor in an ac circuit.
c. calculate (i) the instantaneous and rms voltage drop across components, (ii) the instantaneous and effective current in the circuit, (iii) the phase angle by the current leads or lags the voltage, (iv) the power expended in the and the resonance frequency of circuit, give resistance, inductance, capacitance and the emf source in an RLC series circuit.
d. describe how step-up and step-down transformers in transmitting electrical power over long distances.
e. calculate the primary to secondary voltage andd current ratios for an ideal transformer.

Subject Headings

a) Resistors in an ac Circuit
b) Capacitors in an ac Circuit
c) Inductors in an ac Circuit
d) The RLC Series Circuit
e) Power in an ac Circuit
f) Resonance in a Series RLC Circuit
g) The Transformer
h) Properties of Electromagnetic Waves
i) The Spectrum of Electromagnetic Waves

Wave Optics

Objectives

The student should be able to:

a. describe the various experimental results which support the view of the dual nature of light including Young's experiment and the photoelectric effect.
b. describe Young's double-slit experiment to demonstrate the wave nature of light.
c. account for the phase difference between light waves from two sources as they arrive at a given point of the screen.
d. state the conditions for constructive and destructive interference in terms of each of the following: path difference, phase difference, distance from center of screen
e. account for the conditions of constructive and destructive interference in thin films considering both path difference and any expected phase changes due to reflection.
f. describe Fraunhofer diffraction produced by a single slit and determine the positions of the maxima and minima in a single-slit diffraction pattern.

Subject Headings

a) Conditions for Interference
b) Young's Double-Slit Interference
c) Diffraction
d) Single-Slit Diffraction
e) diffraction grating

Physics formulas

$\vec{p} = m\vec{v}$	$\vec{I} = \bar{\vec{F}}\,\Delta t = \Delta\vec{p}$	$\sum \vec{F}_{ext} = \frac{d\vec{p}_{tot}}{dt}$	$x_{CM} = \frac{\sum_i x_i m_i}{M}$

$\vec{F}_{net} = m\vec{a}$	$\vec{F}_{1,2} = -\vec{F}_{2,1}$	$F_G = G\frac{m_1 m_2}{r^2}$

$\theta = \frac{s}{r}$	$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$	$\alpha = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$

$\omega_f = \omega_i + \alpha t$	$\theta_f - \theta_i = \omega_i t + \frac{1}{2}\alpha t^2$	$\omega_f^{\,2} = \omega_i^{\,2} + 2\alpha(\theta_f - \theta_i)$

$a_c = \frac{v^2}{r}$	$F_c = \frac{mv^2}{r}$	$v = \frac{2\pi r}{T}$ $v = \sqrt{\frac{GM_E}{r}}$ escaping speed

$K_R = ½I\omega^2$	$K = ½I_{CM}\omega^2 + ½Mv_{CM}^2$

Moment = rF sin φ = Fd	Σ(moment) = Iα (N.2nd.LAW)

$\vec{L} = \vec{r} \times \vec{p}$	L = mvr sinφ	$\vec{L} = I\vec{\omega}$	$\sum \tau = \frac{d\vec{L}}{dt}$

W = Fd cos θ = $\int F_x\,dx$	W= $½kx_i^2 - ½kx_f^2$	P ≡ W/Δt

Spring formulas:

$F(x) = -kx$	$PE_{Elastic} = \frac{1}{2}kx^2$

$K \equiv \frac{1}{2}mv^2$	$W_{net} = K_f - K_i$

$U_g \equiv mgh$	$U_s \equiv \frac{1}{2}kx^2$	$W_c = -\Delta U = U_i - U_f$	$E = K + U$

Simple Harmonic Motion:

$\omega = \frac{2\pi}{T} = 2\pi f$	$f = \frac{1}{T}$ $T = \frac{2\pi}{\omega}$	$v_{max} = A\omega$	$a_{max} = A\omega^2$

$x(t) = A\cos(\omega t + \phi)$

$\omega = \sqrt{\frac{k}{m}}$ (spring)	$\omega = \sqrt{\frac{g}{L}}$ (pendulum)	$\omega = \sqrt{\frac{Mga}{I}}$ (compound)

$v(t) = -\omega A\sin(\omega t + \phi)$	$a(t) = -\omega^2 A\cos(\omega t + \phi)$	$E = \frac{1}{2}kA^2$

$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$	$a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt}$	$v_{xf} = v_{xi} + a_x t$

$x_f - x_i = v_{xi}t + \frac{1}{2}a_x t^2$	$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$

Fluid dynamics:

$P = \frac{F}{A}$	$\rho = \frac{m}{V}$	$P_2 = P_1 + \rho gh$

$\rho Av = const.$	$P + \frac{1}{2}\rho v^2 + \rho gy = conts.$

Optics:

Constructive interference: $|x_1 - x_2| = n\lambda$

Destructive interference: $|x_1 - x_2| = \frac{1}{2}(2n+1)\lambda$

Diffraction: $\sin\theta = \frac{\lambda}{D}$

or for a circular opening: $\sin\theta = 1.22\frac{\lambda}{D}$

Beat frequency: $f_{beat} = |f_1 - f_2|$

Standing waves on a string: $f_n = n\left(\frac{v}{2L}\right)$

Standing waves in a column of air open at both ends: $f_n = n\left(\frac{v}{2L}\right)$

Standing waves in a column of air closed at one end: $f_n = n\left(\frac{v}{4L}\right)$ (odd harmonics only)

Radioactive decay equations

$$\frac{dN}{dt} = -\lambda N$$

$$\Rightarrow \frac{dN}{N} = -\lambda dt$$

$$\Rightarrow \int_{N_0}^{N_t}\frac{dN}{N} = -\int_0^t \lambda dt$$

$$\Rightarrow ln\left(\frac{N_t}{N_0}\right) = -\lambda t$$

$$\Rightarrow N_t = N_0 e^{-\lambda t}$$

The energy of the hydrogen atom in the n^{th} state is expressed as

$$E_n = -\frac{13.6}{n^2}eV$$

Quantity	Symbol	Value
Avogadro's number	N_A	6.022×10^{23} /mol
Boltzmann's constant	k	1.381×10^{-23} J / K
Electron charge magnitude	e	1.602×10^{-19} C
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ T · m / A
Permittivity of free space	ε_o	8.854×10^{-12} $C^2 / (N \cdot m^2)$
Planck's constant	h	6.626×10^{-34} J · s
Electron mass	m_e	9.1094×10^{-31} kg
Neutron mass	m_n	1.6749×10^{-27} kg
Proton mass	m_p	1.6726×10^{-27} kg
Speed of light in vacuum	c	2.9979×10^{8} m / s
Universal gravitational constant	G	6.673×10^{-11} $N \cdot m^2 / kg^2$