

Equation Sheet for Exam 3

MAGNETISM

Lorentz Force $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$

The direction of the cross product is determined from the right-hand rule.

Circular motion for a particle in a magnetic field

$$ma = F \quad \text{implies} \quad \frac{mv^2}{r} = qvB$$

Magnetic force on a segment of wire

$$\mathbf{F} = L\mathbf{I} \times \mathbf{B}$$

(L = length; \mathbf{I} = current)

ELECTROMAGNETISM

Ampère's Law. The magnetic field due to a long straight wire is

$$B(r) = \frac{\mu_0 I}{2\pi r} \hat{\phi} \quad \text{where } \mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$$

The direction (ϕ) is determined by the right-hand rule.

The **magnetic flux** through an open surface with area A is $\Phi = B A \cos \theta$. If the magnetic field is perpendicular to the surface then $\theta = 0$ and $\Phi = B A$.

Faraday's Law.

$$emf = -\frac{\Delta\Phi}{\Delta t}$$

Ideal transformer equations. Alternating current is supplied to the primary coil;

$$\frac{V_1}{N_1} = \frac{V_2}{N_2} \quad \text{and} \quad I_1 V_1 = I_2 V_2$$

(V = emf, I = current, N = the number of turns of wire I in the coil)

OTHER EQUATIONS

Newton's second law

$$F = ma \quad \text{where} \quad a = \frac{\Delta v}{\Delta t}$$

Constant acceleration

$$v = v_0 + at \quad \text{and} \quad x = x_0 + v_0 t + \frac{1}{2} at^2$$

Kinetic energy $K = \frac{1}{2} mv^2$

Gravitational potential energy $U = mgh$

Spring potential energy $U = \frac{1}{2} kx^2$

Universal Gravitation $F = Gm_1 m_2 / r^2$

Kepler's 3rd Law $T^2 = a^3$

Coulomb force $F = Kq_1 q_2 / r^2$

Electric field $\mathbf{E} = \mathbf{F} / q$

Electric current $I = \Delta Q / \Delta t$

Ohm's law $I = V / R$

Joule's law $P = IV = I^2 R$

CONSTANTS

$g = 9.81 \text{ m/s}^2$

$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$

$K = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$

$e = 1.602 \times 10^{-19} \text{ C}$

proton mass = $1.67 \times 10^{-27} \text{ kg}$