Formula Sheet, Physics 24 Final Exam

(note that you are responsible for ALL material, not just that covered by these formulas. Some formulas you may need are NOT given here.)

Force on a charged particle: $\vec{F} = q\left(\vec{E} + \vec{v} \times \vec{B}\right)$.

Force on a wire of differential length $d\vec{l}$, carrying a current I in a magnetic field $\vec{B}$: $d\vec{F} = Id\vec{l} \times \vec{B}$.

Magnetic moment of a single current loop with current I and area A: $\mu = IA$
Moment points normal to A, with direction of current satisfying right-hand rule.

Torque on a magnetic moment: $\vec{\tau} = \vec{\mu} \times \vec{B}$.

Magnetic field from a wire carrying current (Biot-Savart law): $\vec{B} = \dfrac{\mu_0}{4\pi} \int \dfrac{Id\vec{l} \times \vec{r}}{r^2}$.

Maxwell's equations, in integral form:

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0} \tag{1}$$

$$\oint \vec{B} \cdot d\vec{A} = 0 \tag{2}$$

$$\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{A} = -\frac{d\Phi_B}{dt} \tag{3}$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{encl} + \mu_0 \epsilon_0 \frac{d}{dt} \int \vec{E} \cdot d\vec{A}. \tag{4}$$

Energy density in an electric field: $u_E = \dfrac{1}{2}\epsilon_0 E^2$.

Energy density in a magnetic field: $u_B = \dfrac{1}{2}\dfrac{B^2}{\mu_0}$.

Poynting vector (energy flux per unit area) $\vec{S} = \dfrac{1}{\mu_0}\vec{E} \times \vec{B}$.

Average intensity of an electromagnetic wave with amplitude E_0: $I = \dfrac{1}{2}c\epsilon_0 E_0^2$.

Superposition of two electric fields differing in phase by ϕ gives amplitude $E_p = 2E_0 \left|\cos\dfrac{\phi}{2}\right|$.

Constructive interference, two slits: $d\sin\theta = m\lambda$. Destructive interference, $d\sin\theta = (m + 1/2)\lambda$.

Useful trigonometric formulas:

$$\int_0^{2\pi} \cos^2 x dx = \int_0^{2\pi} \sin^2 x dx = \frac{1}{2}. \tag{5}$$

$$\int_0^{2\pi} \cos x \sin x dx = 0. \tag{6}$$

$$\cos(A + B) = \cos A \cos B - \sin A \sin B. \tag{7}$$

$$\sin(A + B) = \sin A \cos B + \sin B \cos A. \tag{8}$$