Final Exam

Thermodynamics

$T_F = \frac{9}{5}T_C + 32^\circ$

$T_K = T_C + 273.15$

$\Delta L = \alpha L_0 \Delta T$

$\Delta V = \beta V_0 \Delta T$

$F/A = -Y\alpha\Delta T$

$Q = \pm mL$

$H = dQ/dt$

$H = kA(T_H - T_C)/L$

$Q = mc\Delta T$

$H = Ae\sigma T^4$

$\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4

$Q = nC_V\Delta T$ (isochoric)

$Q = nC_p\Delta T$(isobaric)

$W = nRT\ln(V_2/V_1)$ (isothermal)

$W = \frac{p_0V_0 - p_fV_f}{\gamma - 1}$ (adiabatic)

$C_V = \begin{cases} 3R/2 & \text{monatomic} \\ 5R/2 & \text{diatomic} \end{cases}$

$R = 8.31$ J/(mol K)

$\gamma = C_p/C_V$

$C_p = C_V + R$

$\frac{1}{2}m(v^2)_{av} = \frac{3}{2}k_BT$

$v_{rms} = \sqrt{(v^2)_{av}} = \sqrt{3RT/M}$

$k_B = 1.38 \times 10^{-23}$ J/(molecule K)

$\lambda = \frac{V}{4\pi\sqrt{2}r^2N}$

$K_{\text{tr}} = \frac{3}{2}nRT$

$\Delta U = Q - W$

$pV = nRT$

$\Delta U = nC_V\Delta T$

$W = p\Delta V$

$dW = pdV$

$W = \int_{V_o}^{V_f} pdV$

$p_0V_0^\gamma = p_fV_f^\gamma$ (adiabatic)

$T_0V_0^{\gamma-1} = T_fV_f^{\gamma-1}$ (adiabatic)

$|Q_H| = |W| + |Q_C|$

$e = \frac{W}{Q_H} = 1 - \frac{|Q_C|}{Q_H}$

$Q_C/Q_H = -T_C/T_H$(Carnot)

$e = 1 - \frac{T_C}{T_H}$ (Carnot)

$K = \frac{|Q_C|}{|W|}$

$K = T_C/(T_H - T_C)$ (Carnot)

$\Delta S = \int_1^2 \frac{dQ}{T}$

$\Delta S = \Delta Q/T$

Electrostatics

$|\mathbf{F}| = \frac{k|q_1||q_2|}{r^2}$

$k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9$ Nm^2/C^2

$|\mathbf{E}| = \frac{k|q|}{r^2}$

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

$\Phi_E = \int \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{encl}}{\varepsilon_0}$

$\epsilon_0 = 8.854 \times 10^{-12}$ C^2/(Nm^2)

$U_a - U_b = -W_{a\to b}$

$V = U/q_0$

$U = \frac{kqq_0}{r}$

$V = \frac{kq}{r}$

$V_a - V_b = \int_a^b \mathbf{E} \cdot d\mathbf{l}$

$\mathbf{E} = -\nabla V$

$C = Q/V$

$C_0 = \varepsilon_0 A/d$

$\frac{1}{C_{\text{eq}}} = \sum_i \frac{1}{C_i}$ (series)

$C_{\text{eq}} = \sum_i C_i$ (parallel)

$U = Q^2/2C = CV^2/2 = QV/2$

$u = \varepsilon_0 E^2/2$

$C = KC_0$

$\varepsilon = K\varepsilon_0$

Electrodynamics

$I = \frac{dQ}{dt}$ $J = I/A$

$I = nAv_d|q|$ $\mathbf{J} = nq\mathbf{v}_d$

$\rho = |\mathbf{E}|/|\mathbf{J}|$ $R = \rho L/A$

$V = IR$ $P = IV = I^2R = V^2/R$

$R_{\text{eq}} = \sum_i R_i$ (series) $\frac{1}{R_{\text{eq}}} = \sum_i \frac{1}{R_i}$ (parallel)

$\sum I = 0$ $\sum V = 0$

$q = C\mathcal{E}(1 - e^{-t/(RC)})$ (charging) $q = Q_0 e^{-t/(RC)}$ (discharging)

$e = 1.6 \times 10^{-19}$ C $\tau = RC$

$\mathcal{E} = V_{\text{bat}} + Ir = IR + Ir$ (batteries)

Magnetism and Induction

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

$\mathbf{B} = \frac{\mu_0}{4\pi} \frac{q\mathbf{v}\times\hat{\mathbf{r}}}{r^2}$ $d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{Id\mathbf{l}\times\hat{\mathbf{r}}}{r^2}$

$R = \frac{mv}{|q|B}$ $F = \frac{\mu_0 I_1 I_2 L}{2\pi r}$

$\boldsymbol{\mu} = I\mathbf{A}$ $\boldsymbol{\tau} = \boldsymbol{\mu} \times \mathbf{B}$

$B = \frac{\mu_0 I}{2\pi r}$(long straight wire) $B = \frac{\mu_0 NI}{2a}$ (center of N circular loops)

$B = \mu_0 nI$ (solenoid) $B = \frac{\mu_0 NI}{2\pi R}$ (toroidal solenoid)

$\Phi_B = \int \mathbf{B} \cdot d\mathbf{A}$ $\oint \mathbf{B} \cdot d\mathbf{A} = 0$

$\oint \mathbf{E} \cdot d\mathbf{l} = -\frac{d\Phi_B}{dt}$ $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_{encl} + \mu_0\varepsilon_0 \frac{d\Phi_E}{dt}$

$\varepsilon = -Nd\Phi_B/dt$ $\varepsilon = NBA\omega \sin(\omega t)$

$M_{21} = N_2\Phi_{B,2}/i_1 = \frac{\mu_0 N_1 N_2 A}{l}$ $\varepsilon_2 = -M_{21} di_1/dt$

L=NΦ_B/i $\varepsilon = -Ldi/dt$

$\varepsilon = BLv$ $U = \frac{1}{2}LI^2$

$u_E = \frac{1}{2}\varepsilon_0 E^2$ $u_B = \frac{1}{2\mu_0}B^2$

$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$ $\tau = L/R$ (RL circuit)

$\omega = \sqrt{\frac{1}{LC}}$ (LC circuit) $P = IV = V^2/R = I^2R$

$\mu_0 = 4\pi \times 10^{-7}$ Tm/A

EM waves and Optics

$c = f\lambda$

$k = 2\pi/\lambda;\ \omega = 2\pi f$

$E = cB$

$c^2 = \frac{1}{\mu_0\epsilon_0}$

$\mathbf{S} = \frac{1}{\mu_0}\mathbf{E}\times\mathbf{B}$

$I = S_{\mathrm{av}} = \frac{1}{2}\epsilon_0 c E_{\mathrm{max}}^2$

$v_n = c/n$

$\lambda_n = \lambda/n$

$\theta_r = \theta_i$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\sin\theta_c = n_2/n_1$

$\tan\theta_p = n_2/n_1$

$I = I_0 \cos^2\theta$

$I = I_0/2$

$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'} = \frac{1}{d_O} + \frac{1}{d_I}$

$m = y'/y = -s'/s$

$f = R/2$

$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$c = 3.00 \times 10^8$ m/s

2325 reminders

$\mathbf{a}\cdot\mathbf{b} = ab\cos(\theta)$

$|\mathbf{a}\times\mathbf{b}| = ab\sin(\theta)$

$V_{\mathrm{sphere}} = \frac{4}{3}\pi R^3$

$V_{\mathrm{cylinder}} = \pi R^2 h$

$A_{\mathrm{sphere}} = 4\pi R^2$

$A_{\mathrm{cylinder}} = 2\pi Rh + 2\pi R^2$

$K_i + U_i = K_f + U_f$

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

$F_{cent} = \frac{mv^2}{r}$