

PHYS 1010 6.0: CLASS TEST 6

Time: 50 minutes; Calculators & formulae provided at the end = only aid; Total = 20 points.

Problem solving out of chapters 21, 22, and 12.

FORMULA SHEET

$$v(t_f) = v(t_i) + \int_{t_i}^{t_f} a(t) dt \quad s(t_f) = s(t_i) + \int_{t_i}^{t_f} v(t) dt$$

$$v_f = v_i + a\Delta t \quad s_f = s_i + v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad v_f^2 = v_i^2 + 2a\Delta s \quad g = 9.8 \text{ m/s}^2$$

$$f(t) = t \quad \frac{df}{dt} = 1 \quad F(t) = \int f(t) dt = \frac{t^2}{2} + C$$

$$f(t) = a \quad \frac{df}{dt} = 0 \quad F(t) = \int f(t) dt = at + C \quad F(t) = \text{anti-derivative} = \text{indefinite integral}$$

area under the curve $f(t)$ between limits t_1 and t_2 : $F(t_2) - F(t_1)$

$$x^2 + px + q = 0 \text{ factored by: } x_{1,2} = -\frac{p}{2} \pm \sqrt{\frac{p^2}{4} - q}$$

$$\text{uniform circular m. } \vec{r}(t) = R(\cos \omega t \hat{i} + \sin \omega t \hat{j}); \quad \vec{v}(t) = \frac{d\vec{r}}{dt} = \dots; \quad \vec{a}(t) = \frac{d\vec{v}}{dt} = \dots$$

$$\exp' = \exp; \quad \sin' = \cos; \quad \cos' = -\sin. \quad \frac{d}{dx}[f(g(x))] = \frac{df}{dg} \frac{dg}{dx}; \quad (fg)' = f'g + fg'$$

$$m\vec{a} = \vec{F}_{\text{net}}; \quad F_G = \frac{Gm_1m_2}{r^2}; \quad g = \frac{GM_E}{R_E^2}; \quad R_E = 6370 \text{ km}; \quad G = 6.67 \times 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}; \quad M_E = 6.0 \times 10^{24} \text{ kg}$$

$$f_s \leq \mu_s n; \quad f_k = \mu_k n; \quad f_r = \mu_r n; \quad \mu_r \ll \mu_k < \mu_s. \quad F_H = -k\Delta x = -k(x - x_0).$$

$$\vec{F}_d \sim -\vec{v}; \text{ linear: } F_d = dv; \text{ quadratic: } F_d = 0.5\rho A v^2; \quad A = \text{cross sectional area}$$

$$W = F\Delta x = F(\Delta r) \cos \theta. \quad W = \text{area under } F_x(x). \quad \text{PE}_H = \frac{k}{2}(\Delta x)^2; \quad \text{PE}_g = mg\Delta y.$$

$$\Delta \vec{p} = \vec{J} = \int \vec{F}(t) dt; \quad \Delta p_x = J_x = \text{area under } F_x(t) = F_x^{\text{avg}} \Delta t; \quad \vec{p} = m\vec{v}; \quad K = \frac{m}{2}v^2$$

$$\Delta \vec{p}_1 + \Delta \vec{p}_2 = 0; \quad K_1^{\text{in}} + K_2^{\text{in}} = K_1^{\text{fn}} + K_2^{\text{fn}} \text{ for elastic collisions.} \quad \vec{a}_{\text{CM}} = \frac{m_1 \vec{a}_1 + m_2 \vec{a}_2}{m_1 + m_2}$$

$$\vec{\tau} = \vec{r} \times \vec{F}; \quad \tau_z = rF \sin(\alpha) \text{ for } \vec{r}, \vec{F} \text{ in } xy \text{ plane.} \quad I = \sum_i m_i r_i^2; \quad I\alpha_z = \tau_z; \quad (\hat{k} = \text{rot. axis})$$

$$K_{\text{rot}} = \frac{1}{2}I\omega^2; \quad L_z = I\omega_z; \quad \frac{d}{dt}L_z = \tau_z; \quad \vec{L} = \vec{r} \times \vec{p}; \quad \frac{d}{dt}\vec{L} = \vec{\tau}$$

$$x(t) = A \cos(\omega t + \phi); \quad \omega = \frac{2\pi}{T} = 2\pi f; \quad v_x(t) = \dots; \quad v_{\text{max}} = \dots$$

$$m_e = 9.11 \times 10^{-31} \text{ kg} \quad m_p = 1.67 \times 10^{-27} \text{ kg} \quad e = 1.60 \times 10^{-19} \text{ C} \quad K = \frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}$$

$$\vec{F}_C = \frac{Kq_1q_2}{r^2} \hat{r} \quad \vec{F}_E = q\vec{E} \quad E_{\text{line}} = \frac{2K|\lambda|}{r} = \frac{2K|Q|}{Lr} \quad E_{\text{plane}} = \frac{|\eta|}{2\epsilon_0} = \frac{|Q|}{2A\epsilon_0} \quad \vec{E}_{\text{cap}} = \left(\frac{Q}{\epsilon_0 A}, \text{pos} \rightarrow \text{neg} \right)$$

$$\frac{mv^2}{2} + U_{\text{el}}(s) = \frac{mv_0^2}{2} + U_{\text{el}}(s_0), \quad (U \equiv PE_{\text{el}}) \quad U_{\text{el}} = qEx \text{ for } \vec{E} = -E \hat{i} \quad V_{\text{el}} = U_{\text{el}}/q \quad E_x = -\frac{dV_{\text{el}}}{dx}$$

$$Q = C\Delta V_C \quad \text{farad} = F = \frac{C}{V} \quad C = \frac{\epsilon_0 A}{d} \quad \epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2} \quad \text{PE}_C = \frac{C}{2}\Delta V_C^2$$

$$\text{parallel } C_1, C_2: C_{\text{eq}} = C_1 + C_2 \quad \text{series } C_1, C_2: C_{\text{eq}}^{-1} = C_1^{-1} + C_2^{-1}$$

$$\Delta V_{\text{loop}} = \sum_i \Delta V_i = 0 \quad \sum I_{\text{in}} = \sum I_{\text{out}}$$

$$P = \Delta VI \quad \text{watt} = W = VA \quad P_R = \Delta V_R I = I^2 R$$

$$\tau = RC \quad Q(t) = Q_0 e^{-t/\tau} \quad I(t) = -\frac{dQ}{dt} = \frac{\Delta V_0}{R} e^{-t/\tau}$$

$$\vec{B} = \frac{\mu_0 q \vec{v} \times \vec{r}}{4\pi r^3} = \frac{\mu_0 I \Delta \vec{s} \times \vec{r}}{4\pi r^3} \quad B_{\text{wire}} = \frac{\mu_0 I}{2\pi d} \text{ (use RH rule)} \quad \frac{\mu_0}{4\pi} = 10^{-7} \frac{\text{Tm}}{\text{A}} \quad \text{tesla} = \text{T} = \frac{\text{N}}{\text{Am}}$$

$$\text{short coil, } R \gg L \text{ (} N \text{ turns): } B_{\text{coil,centre}} = \frac{\mu_0 NI}{2R} \quad \text{solenoid, } L \gg R: B_{\text{sol,inside}} = \frac{\mu_0 NI}{L}$$

$$\text{mag dipole: } \vec{\mu} = (AI, \text{from south to north}) \quad \vec{B}_{\text{dip}} = \frac{\mu_0 2\vec{\mu}}{4\pi z^3} \text{ on axis, far away}$$

$$\vec{F}_{\text{onq}} = q\vec{v} \times \vec{B} \quad \text{force on current } \perp \text{ to } \vec{B}: F_{\text{wire}} = ILB$$

$$\text{force betw. parallel wires: } F_{2\text{wires}} = \frac{\mu_0 LI_1 I_2}{2\pi d} \quad \text{torque on mag dipole: } \vec{\mu} \text{ in } \vec{B}: \vec{\tau} = \vec{\mu} \times \vec{B}$$

bar (length L) moves w. $\vec{v} \perp \vec{B}$ gen. EMF: $\varepsilon = vLB$;

$$\Phi_m = \vec{A} \cdot \vec{B} \quad \Phi_m = AB \cos \theta \quad \varepsilon = \left| \frac{d\Phi_m}{dt} \right| = \left| \vec{B} \cdot \frac{d\vec{A}}{dt} + \vec{A} \cdot \frac{d\vec{B}}{dt} \right|$$

$$L = \frac{\Phi_m}{I} \quad \text{henry} = \text{H} = \frac{\text{Tm}^2}{\text{A}} \quad \varepsilon_{\text{coil}} = L \left| \frac{dI}{dt} \right| \quad \Delta V_L = -L \frac{dI}{dt} \quad \text{PE}_L = \frac{L}{2} I^2$$

series L and R: $\tau = \frac{L}{R}$ $I(t) = I_0 e^{-t/\tau}$; parallel L and C: $\omega = \sqrt{\frac{1}{LC}}$ $I(t) = \omega Q_0 \sin \omega t$

$\lambda f = v_w$ sinusoid travelling in pos dir'n: $D(x, t) = A \sin(2\pi(\frac{x}{\lambda} - \frac{t}{T}) + \phi_0) = A \sin(kx - \omega t + \phi_0)$

transverse wave on a string: $v_w = \sqrt{\frac{T}{\mu}}$ where T is tension, $\mu = M/L$

$\omega = v_w k$ $v_{\text{sound}} = 343\text{m/s}$ in air at $T = 20^\circ\text{C}$ in water: $v_{\text{sound}} = 1480\text{m/s}$

light in vac.: $v_w = c = 3.00 \times 10^8\text{m/s}$ visible: $\lambda = 400\text{nm}$ (blue/UV); $\lambda = 700\text{nm}$ (red/IR)

refraction: $n_{\text{glass}} = 1.5$; $n_{\text{water}} = 1.333$; light in medium: c/n ; wavelength: λ_{vac}/n

approaching source (speed v_s): $f_+ = \frac{f_0}{1 - v_s/v_w}$ receding: $f_- = \frac{f_0}{1 + v_s/v_w}$

$\sin(\alpha \pm \beta) = \sin \alpha \cos \beta \pm \cos \alpha \sin \beta$ $\sin \alpha + \sin \beta = 2 \cos \frac{\alpha - \beta}{2} \sin \frac{\alpha + \beta}{2}$

transverse standing wave, string length L : $\lambda_n = \frac{2L}{n}$ $n = 1, 2, \dots$ f_n from $\lambda_n f_n = c_w$