Physics 201 • Exam Information Sheet

$\hat{c} = \mathbf{c}/c$ or $\mathbf{c} = \vec{c} = c\,\hat{c}$

$\mathbf{a} = \Delta\mathbf{v}/\Delta t \rightarrow \mathbf{a}$ is the slope of velocity

$\mathbf{A}\cdot\mathbf{B} = |\mathbf{A}||\mathbf{B}|\cos\theta$

$\mathbf{v} = \Delta\mathbf{x}/\Delta t \rightarrow \mathbf{v}$ is the slope of position

$\Sigma\mathbf{F} = m\,\mathbf{a}$

$g = 9.8\ \mathrm{m/s^2}$

$R_{\mathrm{E}} = 6.4\times10^{6}\ \ \mathrm{m}$

$G = 6.67\times10^{-11}\ \mathrm{N{\cdot}m^2/kg^2}$

$\mathbf{v}(t) = \mathbf{v_o} + \mathbf{a}\,t$

$\mathbf{x}(t) = \mathbf{x_o} + \mathbf{v_o}\,t + \frac{1}{2}\mathbf{a}\,t^2$

$\mathbf{v_f}^2 = \mathbf{v_o}^2 + 2\,\mathbf{a}\,(\mathbf{x_f} - \mathbf{x_o})$

$\mathbf{v}_{\mathrm{ave}} = \frac{1}{2}(\mathbf{v_f} + \mathbf{v_o})$

$\mathbf{N}$ force is perpendicular to surfaces

$\mathbf{W} = m\,\mathbf{g}$

$\tan\theta = \mathrm{opp}\ /\ \mathrm{adj}$

$\sin\theta = \mathrm{opp}\ /\ \mathrm{hyp}$

$\cos\theta = \mathrm{adj}\ /\ \mathrm{hyp}$

$F_r = -m\,v^2\,\hat{r}/R$

$\mathbf{a} = -r\,\omega^2\,\hat{r} + r\,\alpha\,\hat{\theta}$

$a_{\mathrm{rad}} = -\,v^2\,\hat{r}/R$

$a_{\mathrm{tan}} = \Delta|\mathbf{v}|/\Delta t$

$\mathbf{v}_{C/A} = \mathbf{v}_{C/B} + \mathbf{v}_{B/A}$

$F_{\mathrm{fric}} \le \mu\,N, \quad N = \mathrm{normal}$

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

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

$A_{\mathrm{circle}} = \pi R^2$

$C_{\mathrm{circle}} = 2\pi R$

$$a\,x^2 + b\,x + c = 0 \quad \text{then} \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$W = \mathbf{F}\cdot\mathbf{x} = |\mathbf{F}||\mathbf{x}|\cos\theta \quad \text{(work)}$

$K = \frac{1}{2}\,m v_{\mathrm{cm}}^2$

$W = \Delta K$

$\Delta K = K_f - K_i = \frac{1}{2}m(v_f^2 - v_i^2)$

$U = -\,\mathbf{F}\cdot\mathbf{x} \quad \text{(potential energy)}$

$\mathbf{F}_x = -\Delta U/\Delta x$

$F = k\,x \quad \text{(linear spring)}$

$\mathbf{F}_m = -GMm\,\hat{r}/r^2$

$U_{\mathrm{surface}} = mgh$

$U = -GMm/r$

$\Delta U + \Delta K + \Delta Q = 0$

$m_1\mathbf{v}_1 + m_2\mathbf{v}_2 = (m_1 + m_2)\mathbf{v}_f$

$\mathbf{v}_{1_f} = \mathbf{v}_{1_i}\,(m_1 - m_2)/(m_1 + m_2)$

$\mathbf{v}_{2_f} = \mathbf{v}_{1_i}\,(2\,m_1)/(m_1 + m_2)$

$\mathbf{F} = \Delta\mathbf{p}/\Delta t$

$\Delta\mathbf{p} = \mathbf{p}_f - \mathbf{p}_i = m\mathbf{v}_f - m\mathbf{v}_i$

$\mathbf{J} \equiv \mathbf{F}\,\Delta t = \Delta\mathbf{p}$

$v_f = v_i + v_{\mathrm{exh}}\ln(m_i/m_f)$

$|\Delta Q| = F_{\mathrm{fric}}\,d$

$x_{\mathrm{cm}} = (\sum m_i\,x_i)/M, \quad M = \sum m_i$

$U = \frac{1}{2}k\,x^2 \quad \text{(linear spring)}$

$P = \mathbf{F}\cdot\mathbf{v} = \Delta E/\Delta t \quad \text{(power)}$

$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$

$\omega = \Delta\theta/\Delta t = \omega_o + \alpha t$

$\omega^2 = \omega_o^2 + 2\,\alpha\,(\theta - \theta_o)$

$\alpha = \Delta\omega/\Delta t$

$s = r\theta$

$v = r\omega$

$a = r\alpha$

$K_{\rm rot} = \frac{1}{2}I\omega^2$

$K_{\rm total} = \frac{1}{2}mv_{\rm cm}^2 + \frac{1}{2}I\omega^2$

$I = \sum r^2\,\Delta m$

$I_{\rm pt\,mass} = mr^2$

$I_{\rm solid\,sphr} = \frac{2}{5}mr^2$

$I_{\rm solid\,cyl} = \frac{1}{2}mr^2$

$I_{\rm sphr\,shel} = \frac{2}{3}mr^2$

$I_{\rm hoop} = mr^2$

$I_{\rm rod,\,center} = \frac{1}{12}m\ell^2$

$I_{\rm rod,\,end} = \frac{1}{3}m\ell^2$

$\Sigma\,\vec{\tau} = I\,\vec{\alpha}, \quad \tau = r_\perp\,F$

$I = I_{\rm cm} + m\,h^2$

$\mathbf{L} = m\,\mathbf{r}\times\mathbf{v} = \mathbf{r}\times\mathbf{p} = I\vec{\omega}$

$\vec{\tau} = \Delta\vec{L}/\Delta t$

$\vec{\tau}\,\Delta t = \Delta\vec{L}$

$\mathbf{L}_i = \mathbf{L}_f$

$\omega = 2\pi f = 2\pi/T$

$\omega = \sqrt{k/m}$ (spring-mass oscillator)

$T = 2\pi\sqrt{I/\kappa}$ (torsion pendulum)

$T = 2\pi\sqrt{I/(m\,g\,x_{\rm cm})}$ (simple pendulum)

$x(t) = x_{\rm max}\,\cos(\omega t + \phi)$

$v(t) = -x_{\rm max}\omega\,\sin(\omega t + \phi)$

$a(t) = -x_{\rm max}\omega^2\,\cos(\omega t + \phi)$

$a(t) + \omega^2\,x(t) = 0$

$x(t) = x_{\rm max}\,\cos(\omega' t + \phi)e^{-bt/(2m)}$

$\omega' = \sqrt{k/m - b^2/(4m^2)}$

$E_{\rm total}(t) = \frac{1}{2}kx_{\rm max}^2 e^{-bt/m}$

resonance: $\omega_{\rm driven} = \omega$

$x_{\rm CG} = (\sum g_i\,m_i\,x_i)/(\sum g_i\,m_i)$

$x_{\rm CG} = x_{\rm cm} = (\sum m_i\,x_i)/M \quad g_i =$constant

$F = YA\;\Delta L/L_o$

$p = F/A$

$v_{\rm esc} = \sqrt{2GM/R}$

$R_{\rm Schw} = 2GM/c^2$

$c = 3.0\times 10^8$ m/s

$E_{\rm total} = -GMm/(2r)$

$\Delta A/\Delta t =$ constant

$4\pi^2\,r^3 = GM\,T^2$

$\rho = m/V$

$p = p_o + \rho g h$

$F_{\rm buoy} = \rho_{\rm fld}\,g\,V_{\rm dsplcd}$

$W_{\rm app} = W - F_{\rm buoy}$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2 = dm/dt$

$p_1 + \rho g y_1 + \frac{1}{2}\rho\,v_1^2 = p_2 + \rho g y_2 + \frac{1}{2}\rho\,v_2^2$

$y(x,t) = y_{\rm max}\sin(kx - \omega t)$

$k = 2\pi/\lambda$

$v = \omega/k = \lambda/T = \lambda f$

$\sin x + \sin y = 2\sin[(x+y)/2]\cos[(x-y)/2]$

$v = \sqrt{F/\mu}, \quad \mu = m/\ell$

$f_n = nv/(2L), \quad n = 1, 2, \ldots$

$P_{\text{ave}} = \frac{1}{2}\mu v\,\omega^2\,y_{\text{max}}^2$

nodes: $x = n\lambda/2 \quad n = 1, 2, \ldots$

solids: $v = \sqrt{Y/\rho}$

fluids: $v = \sqrt{B/\rho}$

$v_{\text{sound/air}} = 343$ m/s

$I = P_{\text{source}}/(4\pi r^2)$

$\beta = 10\,\log_{10}(I/I_o)$ dB

$I_o = 1 \times 10^{-12}$ W/m^2

$f' = f(v \pm v_{\text{listener}})/(v \pm v_{\text{source}})$, numerator: + listener moving TOWARD source
numerator: − listener moving AWAY from source
denominator: + source moving AWAY from listener
denominator: − source moving TOWARD listener

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

$T_K = T_C + 273.15$

$\Delta L = \alpha L_o \Delta T$

$\Delta V = 3\,\alpha V_o \Delta T$

$Q = cm\Delta T$

$Q_{\text{cond}} = kAt\Delta T/L$

$Q_{\text{rad}} = \epsilon\sigma t A T^4$

$P_{\text{rad}} = Q_{\text{rad}}/t$

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

Blackbody: $\epsilon = 1$

$PV = kNT$

$k = 1.38 \times 10^{-23}$ J/K

$N = nN_A$

$N_A = 6.022 \times 10^{23}$ particles/mol

$R = N_A k = 8.31$ J/(mol·K)

$PV = RnT$

$Nk = nR$

$Q_{\text{lat}} = mL$

$M = mN_A$

$\overline{K} = \frac{1}{2}m\overline{v}^2 = \frac{3}{2}kT$

$v_{\text{rms}} = \sqrt{\overline{v}^2} = \sqrt{3kT/m} = \sqrt{3RT/M}$

$U = N\overline{K} = \frac{3}{2}NkT = \frac{3}{2}nRT$

$\Delta W = P\Delta V$, $\quad P =$ pressure

$\Delta Q - \Delta W = \Delta U$

$W_{\text{iso thrm}} = nRT\,\ell n(V_f/V_i)$

adiabatic: $\Delta Q = 0$

$Q_{\text{v}} = nC_{\text{v}}\Delta T$

$Q_{\text{p}} = nC_{\text{p}}\Delta T$

monatomic: $C_{\text{v}} = \frac{3}{2}R$

monatomic: $C_{\text{p}} = \frac{5}{2}R$

all ideal gases: $C_{\text{p}} - C_{\text{v}} = R$

$\gamma = C_{\text{p}}/C_{\text{v}}$

adiabatic: $P_1 V_1^\gamma = P_2 V_2^\gamma$

$\epsilon = W/Q_{\text{h}} = (Q_{\text{h}} - Q_{\text{c}})/Q_{\text{h}}$

$\epsilon_{\text{carnot}} = 1 - (T_{\text{c}}/T_{\text{h}})$

$\text{COP} = Q_{\text{c}}/W$

$\Delta S = Q/T$

$\Delta S_{\text{universe}} \geq 0$