Physics 231 **Exam 2 Equations** **2006**

Things you must know:

(1) Definition of and approximation for average velocity (and the position update formula)

(2) Definition of momentum $$g = \frac{1}{\sqrt{1-\left(|\vec{v}|/c\right)^2}}$$

(3) The Momentum Principle (also, the momentum update formula and derivative form)

(4) Definitions of total energy, rest energy, and kinetic energy of a particle

(5) The Energy Principle – *be able to apply to "point particle" systems and real systems*

EVALUATING SPECIFIC PHYSICAL QUANTITIES

Projectile Motion: $x_f = x_i + v_{xi}\Delta t$ $\quad y_f = y_i + v_{yi}\Delta t - \frac{1}{2}g(\Delta t)^2$ $\quad v_{xf} = v_{xi}$ $\quad v_{yf} = v_{yi} - g\Delta t$

$F_x = -\frac{dU}{dx}$ $\quad \vec{F}_{\text{grav on 2 by 1}} = -G\frac{m_1 m_2}{|\vec{r}|^2}\hat{r}$ $\quad U_{\text{elec}} = \frac{1}{4pe_0}\frac{q_1 q_2}{|\vec{r}|}$

Near the Earth's surface $|\vec{F}_{grav}| \approx mg$, and $\Delta U_{grav} = \Delta(mgy)$

$\vec{F}_{\text{elec on 2 by 1}} = \frac{1}{4pe_0}\frac{q_1 q_2}{|\vec{r}|^2}\hat{r}$ $\quad U_{grav} = \frac{-Gm_1 m_2}{|\vec{r}|}$ $\quad |\vec{F}_{spring}| = k_s|s|$, opposite the stretch

$U_{spring} = \frac{1}{2}k_s s^2 + U_o$ $\quad w = \sqrt{\frac{k_s}{m}}$ $\quad Y = \frac{F/A}{\Delta L/L} = \frac{k_{s,atomic}}{d_{atomic}}$ $\quad v_{sound} = d_{atomic}\sqrt{\frac{k_{s,atomic}}{m}}$

$\Delta E_{\text{thermal}} = c_v m\Delta T$ Power = energy/time (watts = joules/second)

$\vec{F}_{air} \approx -\frac{1}{2}CrAv^2\hat{v}$ $\quad |\vec{F}_{buoyancy}| =$ weight of displaced fluid

$K \approx \frac{1}{2}mv^2 = \frac{p^2}{2m}$ for $v << c$ $\quad E^2 - (pc)^2 = (mc^2)^2$ $\quad W = \vec{F}\cdot\Delta\vec{r}$ (for constant force)

Circular motion at constant speed: $\frac{d\vec{p}}{dt} = -\frac{mw^2}{\sqrt{1-|\vec{v}|^2/c^2}}\hat{r}$, or $\frac{d\vec{p}}{dt} \approx -mw^2\hat{r}$ for $|\vec{v}| << c$ Where $w = \frac{dq}{dt} = \frac{2p}{T}$

$|\vec{v}| = \frac{2p|\vec{r}|}{T} = w|\vec{r}|$ $\quad \vec{F}_{\parallel} = \frac{d|\vec{p}|}{dt}\hat{p}$ $\quad \vec{F}_{\perp} = |\vec{p}|\frac{d\hat{p}}{dt} = |\vec{p}|\frac{|\vec{v}|}{R}\hat{n}$

Multiparticle Systems: $\vec{r}_{cm} = \frac{m_1\vec{r}_1 + m_1\vec{r}_1 + \ldots}{m_1 + m_2 + \ldots}$ $\quad \vec{P}_{cm} \approx M\vec{v}_{cm}$ (v<<c)

$K_{tot} = K_{trans} + K_{rel}$ $\quad K_{trans} \approx \frac{1}{2}Mv_{cm}^2$ (v<<c) $\quad K_{rel} = K_{rot} + K_{vib}$

CONSTANTS

$G = 6.7\times10^{-11}$ N·m²/kg² $\quad g = 9.8$ N/kg $\quad c = 3\times10^8\, m/s$ $\quad \frac{1}{4pe_o} = 9\times10^9\, N\cdot m^2/C^2$

Avogadro's number = 6×10^{23} molecules/mole $\quad m_{\text{electron}} = 9\times10^{-31} kg$ $\quad m_{\text{proton}} \approx m_{\text{neutron}} \approx m_{\text{hydrogen atom}} = 1.7\times10^{-27} kg$

Typical atomic radius $r \approx 10^{-10} m$ $\quad$ Proton radius $r \approx 10^{-15} m$ $\quad$ Specific Heat of water $c_v = 4.2\times10^3$ J/(Kg K)

$M_{Xena} = 2.86\times10^{22}\, kg$ $\quad M_{Gabrielle} = 5.63\times10^{19}\, kg$

Radius of Xena = $1.5\times10^6\, m$ $\quad$ Radius of Gabrielle = 1.9×10^5 m $\quad$ Distance from Sun to Xena = 1.0×10^{13} m

Distance from Xena to Gabrielle = 3.8×10^7 m