Information for the Final

Fundamental Concepts

Things you must know:

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

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

(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*

(6) The Angular Momentum Principle

Definitions and Specific Results

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

$\vec{F}_{\text{elec on 2 by 1}} = \dfrac{1}{4pe_0}\dfrac{q_1 q_2}{|\vec{r}|^2}\hat{r}$ $\qquad \vec{F}_{\text{grav on 2 by 1}} = -G\dfrac{m_1 m_2}{|\vec{r}|^2}\hat{r}$ $\qquad |\vec{F}_{\text{grav}}| \approx mg$ near Earth's surface

$U_{\text{elec}} = \dfrac{1}{4pe_0}\dfrac{q_1 q_2}{|\vec{r}|}$ $\qquad U_{\text{grav}} = -G\dfrac{m_1 m_2}{|\vec{r}|}$ $\qquad U_{\text{grav}} \approx mgy$ near Earth's surface

$|\vec{F}_{\text{spring}}| = k_s|s|$ $\qquad U_{spring} = \frac{1}{2}k_s s^2$ $\qquad \Delta E_{thermal} = mC\Delta T$

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

$K \approx \frac{1}{2}mv^2 = \dfrac{p^2}{2m}$ for $v << c$ $\qquad E^2 - (pc)^2 = (mc^2)^2$ $\qquad W = \vec{F}\cdot\Delta\vec{r}_{\text{point.}of.application}$

$Y = \dfrac{F_T/A}{\Delta L/L}$ (macro) $\qquad Y = \dfrac{k_{s,i}}{d}$ (micro) $\qquad v = d\sqrt{\dfrac{k_{s,i}}{m_a}}$

$\vec{F}_{||} = \dfrac{d|\vec{p}|}{dt}\hat{p}$ $\qquad \vec{F}_{\perp} = |p|\dfrac{d\hat{p}}{dt} = -|p|\dfrac{m|v|}{r}\hat{r}$

$x(t) = A\cos(wt)$ $\qquad w = \sqrt{\dfrac{k_s}{m}}$ $\qquad T = \dfrac{2p}{w}$

$\vec{L}_A = \vec{r}_A \times \vec{p}$ $\qquad \vec{t}_A = \vec{r}_A \times \vec{F}$ $\qquad |\vec{A}\times\vec{B}| = AB\sin q_{AB} = A_{\perp}B$

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

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

$\vec{L}_{tot.A} = \vec{L}_{trans.A} + \vec{L}_{rot.cm}$ $\qquad \vec{L}_{trans.A} = \vec{r}_{cm\leftarrow A}\times\vec{P}_{tot}$ $\qquad \vec{L}_{rot.cm} = I\vec{w}$ $\qquad I = m_1 r_{1\perp cm}^2 + m_2 r_{2\perp cm}^2 + \ldots$

Physical Constants

$c = 3\times10^8$ m/s $\qquad e = 1.6\times10^{-19}$C $\qquad N_A = 6.02\times10^{23}$ atoms/mole

$g = 9.8$ m/s^2 $\qquad G = 6.7\times10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2$ $\qquad 1/4pe_0 = 9\times10^9\,\text{N}\cdot\text{m}^2/\text{C}^2$

$m_{\text{proton}} = 1.7\times10^{-27}$ kg $\qquad m_{\text{electron}} = 9\times10^{-31}$ kg $\qquad 1\text{ eV} = 1.6\times10^{-19}$ J