Material from mechanics (PHY2048) you should have learned

Units – Every answer must have the appropriate units to be correct.

Vectors – Find scalar (dot) product, vector (cross) product, arbitrary unit vector = $(x\hat{i} + y\hat{j} + z\hat{k})/r$.

Conservation of Momentum – $\vec{p} = m\vec{v}$ (relativistic $p = gmv$); $\sum \vec{p}_i = \sum \vec{p}_f$ if $\vec{F}_{net} = 0$.

Conservation of Energy – $K = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2$, $E = K + U$, $E_f - E_i = W_{\text{ext}}$.

Relativistic total energy $E = K + mc^2 = gmc^2$; $E^2 = (pc)^2 + (mc^2)^2$, $v/c = pc/E$.

Work, Potential Energy, and Power – $W = \int \vec{F} \cdot d\vec{s} \rightarrow \vec{F} \cdot \vec{s}$, $P = \frac{dW}{dt} \rightarrow \vec{F} \cdot \vec{v}$;

$U_f - U_i = -\int_i^f F_x dx$, also special cases: $U(x) = \frac{1}{2}kx^2$ and $U(y) = mgy$.

Statics – $\sum F_x = 0$ and $\sum F_y = 0$, plus $\sum t = 0$ about any axis.

Linear Motion – $\vec{F}_{\text{net}} = m\vec{a}$ $\left(\vec{F} = \frac{d\vec{p}}{dt}\right)$, where $\vec{a} = \frac{d\vec{v}}{dt}$ and $\vec{v} = \frac{d\vec{r}}{dt}$, plus constant a equations:

$\vec{v}_f(t) = \vec{v}_0 + \vec{a}t$, $\vec{r}_f(t) = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$, $v_f^2 - v_0^2 = 2\vec{a} \cdot \vec{s}$, $\vec{r}_f(t) = \vec{r}_0 + \vec{v}_{\text{avg}}t$.

Circular Motion – angular to linear (tangential) relations: $a_{\text{tang}} = ar$, $v_{\text{tang}} = wr$, $s = rq$.

<u>radial:</u> $a_{\text{radial}} = v^2/r$ due to a centripetal force = $m\vec{a}_{\text{radial}}$.

<u>tangential:</u> $t_{\text{net}} = Ia$ $\left(\vec{t} = \frac{d\vec{L}}{dt}\right)$, where $a = \frac{dw}{dt}$ and $w = \frac{dq}{dt}$, plus constant $\vec{a}$ equations

Torque – $\vec{t} = \vec{r} \times \vec{F} \rightarrow [\text{lever arm}]|\vec{F}|$ or $|\vec{r}|F_\perp$;

Conservation of Angular Momentum – $\vec{L} = \vec{r} \times \vec{p} = I\vec{w}$; $\sum \vec{L}_i = \sum \vec{L}_f$ if $\vec{t}_{net} = 0$.

Waves – $A\sin(kx - wt)$, $k = \frac{2p}{l}$, $w = \frac{2p}{T} = 2pf$; $v = fl = \frac{w}{k}$.

Thermodynamics – Thermal expansion: $\Delta L/L = a\Delta T$.

Gravity – $\vec{F} = \frac{GMm}{r^2}(-\hat{r}) \rightarrow mg(-\hat{j})$; $U = -\frac{GMm}{r} \rightarrow \Delta U = mg(y_f - y_i)$.