Physics 121 Midterm 1 Equation Sheet Autumn 2023

Constants		**Momentum**	
Accel. Due to gravity	$g = 9.8\, m/s^2$	Momentum vector	$\vec{p} = m\vec{v}$
		Impulse	$\vec{J} = \Delta\vec{p}$
Mathematics		Momentum of isolated system	$\vec{p}_f = \vec{p}_i$ $\Delta\vec{p} = 0$
Quadratic Equation	$ax^2 + bx + c = 0$	Inertia	$\frac{m_u}{m_s} = -\frac{\Delta v_{x,s}}{\Delta v_{x,u}}$
Solution to quad eq'n.	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$		
Difference in variable y:	$\Delta y = y_f - y_i$ $y_{12} = y_2 - y_1$	**Energy**	
		Kinetic Energy	$K = \frac{1}{2}mv^2$
1D Motion		Energy of closed system	$E_f = E_i$ $\Delta E = \Delta(K + E_{int}) = 0$
Position vector	$\vec{r} = x\hat{\imath}$	Relative velocity	$\vec{v}_{12} = \vec{v}_2 - \vec{v}_1$
Distance between points	$d = \lvert x_2 - x_1 \rvert$	Relative speed	$v_{12} = \lvert \vec{v}_{12} \rvert = \lvert \vec{v}_2 - \vec{v}_1 \rvert$
x −displacement	$\Delta x = x_f - x_i$ $\Delta x = \int_{t_i}^{t_f} v_x dt$	Coefficient of Restitution	$e = \frac{v_{12,f}}{v_{12,i}}$
Displacement vector	$\Delta\vec{r} = \vec{r}_f - \vec{r}_i$ $\Delta\vec{r} = (x_f - x_i)\hat{\imath} = \Delta x\hat{\imath}$	1-D Coefficient of Restitution	$e = \frac{\lvert v_{2x,f} - v_{1x,f} \rvert}{\lvert v_{2x,i} - v_{1x,i} \rvert}$
Average velocity vector	$\vec{v}_{av} = \frac{\Delta\vec{r}}{\Delta t}$	Non-convertible Kinetic Energy	$K_{CM} = \frac{1}{2}m_{tot}v_{CM}^2 = \frac{p_{tot}^2}{2m_{tot}}$
Average velocity x −component	$v_{x,av} = \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$	Convertible Kinetic Energy	$K_{conv} = K - K_{CM}$ $K_{conv} = \frac{1}{2}\mu v_{12}^2$
Instantaneous velocity	$\vec{v} = \frac{d\vec{r}}{dt}$	Energy Units	$Joule = kg\,\frac{m^2}{s^2}$
Instantaneous velocity x −component	$v_x = \frac{dx}{dt}$	Reduced Mass	$\mu = \frac{m_1 m_2}{m_1 + m_2}$
Average acceleration vector	$\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t}$		
Average acceleration x −component	$a_{x,av} = \frac{v_f - v_i}{t_f - t_i} = \frac{\Delta v_x}{\Delta t}$	**Reference Frames**	
Instantaneous acceleration	$\vec{a} = \frac{d\vec{v}}{dt}$	Velocity of object *o* in Frame *A*	$\vec{v}_{Ao}$
Instantaneous accel. x −component	$a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$	Velocity of object *o* in Frame *B*	$\vec{v}_{Bo} = \vec{v}_{BA} + \vec{v}_{Ao}$
Change in velocity x − component	$\Delta v_x = \int_{t_i}^{t_f} a_x dt$	Position of object *o* in Frame *B*	$\vec{r}_{Bo} = \vec{r}_{Ao} + \vec{v}_{BA}t_e$
Constant acceleration	$x(t) = x_i + v_i t + \frac{1}{2}at^2$	Acceleration of object *o* in Frame *B*	$\vec{a}_{Bo} = \vec{a}_{Ao}$
	$v_x(t) = v_{x,i} + a_x t$	Center of Mass Position	$\vec{r}_{CM} = \frac{m_1\vec{r}_i + m_1\vec{r}_i + \cdots}{m_1 + m_2 + \cdots}$
	$v_{x,f}^2 = v_{x,i}^2 + 2a_x\Delta x$	Center of Mass Velocity	$\vec{v}_{CM} = \frac{m_1\vec{v}_i + m_1\vec{v}_i + \cdots}{m_1 + m_2 + \cdots}$
	$\Delta x = \frac{v_{x,f} - v_{x,i}}{2}\,\Delta t$		$\vec{v}_{CM} = \frac{\vec{p}_{system}}{m_{system}}$
Accel. on inclined plane	$a_x = g\sin\theta$		