3.4 Particle motion

Dynamics definitions[a]

Newtonian force	$\boldsymbol{F}=m\ddot{\boldsymbol{r}}=\dot{\boldsymbol{p}}$	(3.63)	$\boldsymbol{F}$ force m mass of particle $\boldsymbol{r}$ particle position vector
Momentum	$\boldsymbol{p}=m\dot{\boldsymbol{r}}$	(3.64)	$\boldsymbol{p}$ momentum
Kinetic energy	$T=\frac{1}{2}mv^2$	(3.65)	T kinetic energy v particle velocity
Angular momentum	$\boldsymbol{J}=\boldsymbol{r}\times\boldsymbol{p}$	(3.66)	$\boldsymbol{J}$ angular momentum
Couple (or torque)	$\boldsymbol{G}=\boldsymbol{r}\times\boldsymbol{F}$	(3.67)	$\boldsymbol{G}$ couple
Centre of mass (ensemble of N particles)	$\boldsymbol{R}_0=\frac{\sum_{i=1}^{N}m_i\boldsymbol{r}_i}{\sum_{i=1}^{N}m_i}$	(3.68)	$\boldsymbol{R}_0$ position vector of centre of mass m_i mass of ith particle $\boldsymbol{r}_i$ position vector of ith particle

[a]In the Newtonian limit, $v \ll c$, assuming m is constant.

Relativistic dynamics[a]

Lorentz factor	$\gamma=\left(1-\frac{v^2}{c^2}\right)^{-1/2}$	(3.69)	γ Lorentz factor $\boldsymbol{v}$ particle velocity c speed of light
Momentum	$\boldsymbol{p}=\gamma m_0\boldsymbol{v}$	(3.70)	$\boldsymbol{p}$ relativistic momentum m_0 particle (rest) mass
Force	$\boldsymbol{F}=\frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t}$	(3.71)	$\boldsymbol{F}$ force on particle t time
Rest energy	$E_\mathrm{r}=m_0c^2$	(3.72)	E_r particle rest energy
Kinetic energy	$T=m_0c^2(\gamma-1)$	(3.73)	T relativistic kinetic energy
Total energy	$E=\gamma m_0c^2$ $=(p^2c^2+m_0^2c^4)^{1/2}$	(3.74) (3.75)	E total energy $(=E_\mathrm{r}+T)$

[a]It is now common to regard mass as a Lorentz invariant property and to drop the term "rest mass." The symbol m_0 is used here to avoid confusion with the idea of "relativistic mass" $(=\gamma m_0)$ used by some authors.

Constant acceleration

$v=u+at$	(3.76)	u initial velocity v final velocity t time s distance travelled a acceleration
$v^2=u^2+2as$	(3.77)	
$s=ut+\frac{1}{2}at^2$	(3.78)	
$s=\frac{u+v}{2}t$	(3.79)	