10.8: Formulae, Constants, and Conversion Factors for Chapter 10

Formulae	Relationship
$g = \frac{GM}{R^2}$	Surface The universal force of attraction between all matter. gravity:
$d = v_0 t + \frac{1}{2} a t^2$	The length of space between two objects. " id="term-2350855" tabindex="0">Distance and acceleration:
$v = at$	How fast an object moves in a given direction, i.e., the **speed** of an object in a given direction. Velocity differs from **speed** because **speed** is how fast something moves without regard to direction. " id="term-2350855" tabindex="0">Velocity and acceleration:
$t = \frac{t_0}{\left(1 - \frac{gH}{c^2}\right)}$	the distortion of time between **inertial frames**. Observers in different inertial frames will measure time to pass more quickly in their own frame than in any inertial frame moving relative to their own. The slowing of clocks that are in motion relative to an observer when compared to clocks at rest with respect to the observer. Predicted by Einstein's **Special Theory of Relativity.** " id="term-2350855" tabindex="0">Time dilation (weak field approximation):
$f = f_0 \left(1 - \frac{gH}{c^2}\right)$	Gravitational This is the name given to the apparent change in the wavelength of light due to the **Doppler effect**. Scientists know what the regular spectrum of a galaxy should look like (based on the spectrum of light emitted from known elements). If the light waves from a galaxy appear to have shifted towards higher frequency (blue), it is moving towards us, and if they have shifted toward a lower frequency (red), it means the object is moving away. " id="term-2350855" tabindex="0">redshift (weak field approximation, A property of a wave that describes how many wave patterns, or cycles, pass by a point in a given time. Frequency is often measured in hertz (Hz), where one hertz is one cycle per second. " id="term-2350855" tabindex="0">frequency, A quantum (particle) of light or electromagnetic energy. Photons are have zero rest-mass and no electric charge. " id="term-2350855" tabindex="0">photon traveling upward):
$\lambda = \frac{\lambda_0}{\left(1 - \frac{gH}{c^2}\right)}$	Gravitational redshift (weak field approximation, The distance between adjacent peaks in a series of periodic waves. Also see **electromagnetic spectrum**. " id="term-2350855" tabindex="0">wavelength):
$f = f_0 \sqrt{1 - \frac{2GM}{Rc^2}}$	Gravitational redshift (full expression, frequency):
$\lambda = \frac{\lambda_0}{\sqrt{1 - \frac{2GM}{Rc^2}}}$	Gravitational redshift (full expression, wavelength):
$d^2 = (\Delta x)^2 + (\Delta y)^2$	in any right triangle with sides a and b and hypotenuse c, $a^2+b^2=c^2$ " id="term-2350855" tabindex="0">Pythagorean theorem:
$d^2 = (R\Delta\theta)^2 + \cos^2\theta (R\Delta\alpha)^2$	Distance on a sphere:
$d^2 = (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2$	Pythagorean Theorem in 3-D:

Formulae	Relationship
$s^2 = (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 - (c\Delta t)^2$	the four-dimensional system employed in special relativity that merges three spatial dimensions with one dimension of time and describes all events as points in that system: *(t, x, y, z)*. Three coordinates, *x, y,* and *z* describe the position of an event in space, and one, *t*, describes its position in time. " id="term-2350855" tabindex="0">Spacetime interval in space in which the **Pythagorean Theorem** holds. " id="term-2350855" tabindex="0">flat space:
$s^2 = \left(1 - \frac{2GM}{rc^2}\right)^{-1} \left[(\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2\right] - \left(1 - \frac{2GM}{rc^2}\right)(c\Delta t)^2$	the four-dimensional system employed in special relativity that merges three spatial dimensions with one dimension of time and describes all events as points in that system: *(t, x, y, z)*. Three coordinates, *x, y,* and *z* describe the position of an event in space, and one, *t*, describes its position in time. " id="term-2350855" tabindex="0">Spacetime interval in spherically curved space:
$\theta = \frac{2GM}{bc^2}$	Angle of deflection of light:
$P_{gw} = \frac{2}{5}\left(\frac{GM}{Rc^2}\right)^5 \left(\frac{m}{M}\right)^2 \left(\frac{c^5}{G}\right)$	Power emitted by ripples in spacetime caused by the changing of mass distributions. " id="term-2350855" tabindex="0">gravitational waves:
$\mathbf{G} = 8\pi G\, \mathbf{T}/c^4$	Einstein equation: