Astronomy 2 Winter 2017 Midterm
Useful formulae, unit conversion, and constants

Relevant Formulae

speed = \frac{\text{distance}}{\text{time}}

\text{angular size} = \frac{\text{physical size}}{360^\circ} = \frac{2\pi \times \text{distance}}{2\pi \times \text{distance}}

Kepler’s third law for our Solar System, orbit period P in years and radius (semi-major axis, average distance from the sun) of the orbit

\[ A^3 = P^2 \]

A in years

C = 2\pi d Circumference C of a circle with radius d

F = ma Newton’s law relating force F, mass m and acceleration a

\[ F_g = \frac{GMm}{r^2} \]

gravitational force \( F_g \) between masses \( M, m \) at distance \( r \) from each other

\[ a = \frac{GM}{R^2} \]

surface gravity; acceleration \( a \) due to the gravitational force from mass \( M \) at distance \( R \) from the center

\[ P^2 = \frac{4\pi^2}{GM} A^3 \]

A in meters for the units of G given on the formula sheet. You can ignore the mass of the small object.

momentum = mv

\[ v_{\text{escape}} = \sqrt{\frac{2GM}{R}} \]

Escape velocity at distance \( d \) from object of mass \( M \)

\[ v_{\text{circ}} = \sqrt{\frac{GM}{R}} \]

velocity of an object in a circular orbit around an object of mass \( M \) at distance distance \( d \)

\[ \lambda_{\text{peak}} = 2.9 \times 10^6 \text{ nm K} \]

thermal radiation: Wien’s law, relationship between peak wavelength \( \lambda_{\text{peak}} \) in nm and temperature \( T \) in Kelvin

\[ E = hf \]

photon energy \( E \) for frequency \( f \)

\[ E = \frac{hc}{\lambda} \]

photon energy \( E \) for for wavelenth \( \lambda \)

\[ \frac{v}{c} = \frac{\lambda_{\text{shift}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}} \]

Doppler shift
Units and Constants

1 km = 1000 m
1 AU = 1.5 \times 10^{11} m
\begin{align*}
c &= 3 \times 10^5 \frac{\text{km}}{\text{s}} \\
M_{\text{Sun}} &= 2 \times 10^{30} \text{ kg} \\
M_{\text{Earth}} &= 6 \times 10^{24} \text{ kg} \\
R_{\text{Earth}} &= 6,400 \text{ km} \\
M_{\text{Moon}} &= 7 \times 10^{22} \text{ kg}
\end{align*}

Distance from the moon to the Earth: 384,000 km
\begin{align*}
g &= 9.8 \frac{\text{m}}{\text{s}^2} \text{ (acceleration due to gravity on Earth)} \\
G &= 6.67 \times 10^{-11} \frac{\text{m}^3}{\text{kg} \cdot \text{s}^2} \text{ (Gravitational constant)}
\end{align*}

3.14 \times 10^7 \text{ seconds per year}

1 \text{ light year} = 9.46 \times 10^{12} \text{ km}

h = 6.626 \times 10^{-34} \text{ Js}