FUNDAMENTAL PHYSICAL LAWS AND RELATIONSHIPS

Things you must know:

1. Definition of an approximation for average velocity (and the position update formula)

\[ v = \frac{1}{\sqrt{1 - (\frac{v}{c})^2}} \]

2. Definition of momentum

3. The Momentum Principle (also, the momentum update formula and derivative form)

Specific Results

Projectile Motion:

\[ x_f = x_i + v_{xi} \Delta t \]
\[ y_f = y_i + v_{yi} \Delta t - \frac{1}{2} g (\Delta t)^2 \]
\[ v_{sf} = v_{xi} \]
\[ v_{sf} = v_{xi} - g \Delta t \]

\[ \vec{F}_{grav} = -G \frac{m_1 m_2}{r_{2e-1}^2} \hat{r}_{2e-1} \]
\[ |\vec{F}_{grav}| \approx mg \text{ near the Earth’s surface} \]

\[ \vec{F}_{elec} = \frac{1}{4\pi \epsilon_o} \frac{q_1 q_2}{r_{2e-1}^2} \hat{r}_{2e-1} \]
\[ |\vec{F}_{elec}| = mg_{fluid.displaced} \]

\[ |\vec{F}_{spring}| = k_s' |s|, \text{ opposite the stretch} \]
\[ Y = \frac{F/A}{\Delta L/L} = \frac{k_{s,atomic}}{d_{atomic}} \]
\[ v = \sqrt{\frac{k_{s,atomic}}{m_{atomic}}} \]
\[ T = \frac{2\pi}{\omega} \]

\[ x(t) = A \cos(\omega t) + x_{eq} \]
\[ \omega = \sqrt{\frac{k_s}{m}} \]

\[ k_s = \frac{F}{A} \]

CONSTANTS

\[ G = 6.7 \times 10^{-11} \text{N} \cdot \text{m}^2/\text{kg}^2 \]
\[ g = 9.8 \text{ N/kg} \]
\[ c = 3 \times 10^8 \text{ m/s} \]

\[ M_{Earth} = 6 \times 10^{24} \text{ kg} \]
\[ M_{moon} = 7 \times 10^{22} \text{ kg} \]

\[ \text{Radius of the Earth} = 6.4 \times 10^6 \text{ m} \]
\[ \text{Radius of the Moon} = 1.75 \times 10^6 \text{ m} \]

\[ \text{Distance from Sun to Earth} = 1.5 \times 10^{11} \text{ m} \]
\[ \text{Distance from Earth to Moon} = 4 \times 10^8 \text{ m} \]

\[ \text{Typical atomic radius} \; r \approx 10^{-10} \text{ m} \]
\[ \text{Avogadro’s number} = 6 \times 10^{23} \text{ molecules/mole} \]

\[ m_{electron} = 9 \times 10^{-31} \text{ kg} \]
\[ m_{proton} \approx m_{neutron} \approx m_{hydrogen \; atom} = 1.7 \times 10^{-27} \text{ kg} \]