Source: [[KBPHYS360MasterIndex]]

1 | **Problem 1**

1.1 | $(1a)$

$$PE = -W$$

Work is force over distance. We will have distance be equal to r.

$$W = \vec{F} * r$$

In our case, force is not constant (and can be treated as a scalar as it is in only 1 direction):

$$W = \int_0^r F(x)\,dx$$

We know that the force applied to a point mass m by the gravitational field of the earth (with mass M_e) with distance x is modeled by

$$F(x) = \frac{GmM_e}{x^2}$$

. Therefore, our work integral can be modified to be

$$\begin{aligned} W &= \int_0^r \frac{GmM_e}{x^2}\,dx \\ &= GmM_e \int_0^r \frac{1}{x^2}\,dx \\ &= GmM_e[-\frac{1}{x}]_0^r \\ &= -\frac{GmM_e}{r} \\ PE &= \frac{GmM_e}{r} \end{aligned}$$

1.2 | $(1b)$

$$\begin{aligned} KE &= \frac{1}{2}mv^2 \\ KE &= PE \\ frac12mv^2 &= \frac{GmM_e}{r} \\ v &= \sqrt{\frac{2GM_e}{r}} \end{aligned}$$

1.3 | $(1c)$

2 | **Problem 2**

$$
\begin{aligned}
\sum_{i=1}^{n} \vec{F}_{net,i} &= (\sum_{i=1}^{n} m_i)\ddot{\vec{r}}_{CM} \\
\ddot{\vec{r}}_{CM} &= \frac{\sum_{i=1}^{n} \vec{F}_{net,i}}{\sum_{i=1}^{n} m_i} \\
&= \sum_{i=1}^{n} \frac{\vec{F}_{net,i}}{m_i} \\
&= \sum_{i=1}^{n} \frac{m_i \vec{a}_i}{m_i} \\
&= \sum_{i=1}^{n} \vec{a}_i \\
\vec{r}_{CM} &= \int\int \ddot{\vec{r}}_{CM}\, dt\, dt \quad = \int\int \sum_{i=1}^{n} \vec{a}_i\, dt\, dt \\
&=
\end{aligned}
$$