Assignment #1

ASE 366L

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1) $\vec{R}_c = \frac{m_1\vec{R}_1 + m_2\vec{R}_2}{m_1+m_2}$ $\quad \vec{r} = R_1 - R_c$

$$a = \frac{d^2 r}{dt^2}$$

$$\vec{r} = \vec{R}_1 - \frac{m_1\vec{R}_1 + m_2\vec{R}_2}{m_1+m_2} = \vec{R}_1 - \frac{m_1\vec{R}_1}{m_1+m_2} - \frac{m_2\vec{R}_2}{m_1+m_2}$$

$$= \left(1 - \frac{m_1}{m_1+m_2}\right)\vec{R}_1 - \frac{m_2\vec{R}_2}{m_1+m_2}$$

$$= \left(\frac{\cancel{m_1}+m_2}{m_1+m_2} - \frac{\cancel{m_1}}{m_1+m_2}\right)\vec{R}_1 - \frac{m_2\vec{R}_2}{m_1+m_2}$$

$$= \frac{m_2}{m_1+m_2}\left(\vec{R}_1 - \vec{R}_2\right) \qquad \vec{\rho} = \vec{R}_2 - \vec{R}_1$$

$$\Rightarrow \vec{r} = -\frac{m_2}{m_1+m_2}\vec{\rho} \Rightarrow \vec{\rho} = -\frac{m_1+m_2}{m_2}\vec{r}$$

$$\rho = \frac{m_1+m_2}{m_2} r$$

$$\frac{d^2\vec{r}}{dt^2} = \frac{d^2}{dt^2}\left(\vec{R}_1 - \vec{R}_c\right) = \frac{d^2}{dt^2}\vec{R}_1 = \frac{-Gm_2}{\rho^2}\hat{r}$$

$$\Rightarrow \frac{d^2\vec{r}}{dt^2} = \frac{-Gm_2^3}{(m_1+m_2)^2 r^2}\frac{\vec{r}}{r} = \frac{-Gm_2^3}{(m_1+m_2)^2 r^3}\vec{r}$$

$$\vec{a} = \frac{d^2\vec{r}}{dt^2} = \frac{-Gm_2^3}{(m_1+m_2)^2 r^3}\vec{r}$$

2) $U = -m_s \frac{\mu}{r} \rightarrow a = -\frac{\mu}{r^3} r \qquad \mu = Gm_1$

$$r = r_i \hat{i} + r_j \hat{j} + r_k \hat{k}$$

$$U = -m_s \frac{\mu}{r} = -m_s \frac{Gm_1}{r} \qquad a = -\frac{Gm_1}{r^3} r$$

$$\frac{mv^2}{r} = \frac{Gm_1 m_2}{r^2} \Rightarrow v^2 = \frac{Gm_1}{r}$$

$$U = -m_s v^2$$

$$v = \sqrt{\frac{U}{-m_s}} = U^{1/2}(-m_s)^{-1/2}$$

$$\frac{dv}{dt} = \frac{1}{2} U^{-1/2} \cdot -\frac{1}{2}(-m_s)^{-3/2}$$

3.1) Q_{ijk}^{NTW} $\quad \hat{T} = \frac{V}{v} \quad \hat{W} = \hat{h} = \frac{r \times v}{\|r \times v\|}$

$\hat{N} = \hat{T} \times \hat{W}$

$$Q_{ijk}^{NTW} = [\hat{N}\ \hat{T}\ \hat{W}] = \left[\hat{T} \times \hat{W},\ \frac{V}{v},\ \frac{r \times v}{|r \times v|}\right]$$

3.2) $r = -2\hat{i} + \hat{j} + 0.5\hat{k}$ DU

$v = -0.4\hat{i} - 0.2\hat{j} + 0.5\hat{k}$ DU/TU

$$Q_{ijk}^{NTW} = \begin{bmatrix} -0.652 & -0.596 & 0.469 \\ 0.722 & -0.298 & 0.624 \\ -0.233 & 0.744 & 0.624 \end{bmatrix}$$

4) r_1 same as above $\quad v_1$ same as above

$r_2 = -2\hat{i} + 0.9\hat{j} + 0.51\hat{k}$ DU $\quad V_2 = -0.39\hat{i} - 0.21\hat{j} + 0.4\hat{k}$ DU/TU

$r_{21} = r_2 - r_1 \quad r_{21,RSW} = Q_{RSW}^{ijk} \cdot r_{21,ijk}$

$$r_2 - r_1 = \begin{bmatrix} 0 \\ -0.1 \\ 0.01 \end{bmatrix} DU$$

$$Q_{RSW}^{ijk} = \left[\frac{r}{r}\ \ \hat{W} \times \hat{R}\ \ \frac{r \times v}{|r \times v|}\right]^T = \begin{bmatrix} -0.873 & 0.436 & 0.218 \\ -0.136 & -0.647 & 0.750 \\ 0.469 & 0.625 & 0.624 \end{bmatrix}$$

$$r_{21,RSW} = \begin{bmatrix} -0.0415 \\ 0.0723 \\ -0.0562 \end{bmatrix} DU$$

5)

Date	Brightness (mag)	Start			Highest point			End			Pass type
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.	
02 Feb	-1.1	19:56:00	10°	NNW	19:56:29	13°	NNW	19:56:29	13°	NNW	visible
03 Feb	-2.3	19:08:17	10°	NNW	19:10:50	20°	NE	19:10:59	20°	NE	visible
04 Feb	-2.6	19:56:13	10°	NW	19:58:42	42°	W	19:58:42	42°	W	visible
05 Feb	-3.9	19:08:01	10°	NW	19:11:19	68°	NE	19:13:45	17°	SE	visible

Date	Brightness (mag)	Start			Highest point			End			Pass type
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.	
06 Feb	-0.7	19:57:40	10°	W	19:59:34	14°	SW	20:01:29	10°	SSW	visible
07 Feb	-1.6	19:08:35	10°	WNW	19:11:30	28°	SW	19:14:24	10°	S	visible

I believe the visible pass on **February 5 is the "best" pass** for casual viewing. The biggest reason is because it has the greatest magnitude (-3.9) which will make it the easiest pass to see, especially with light pollution. It also has the highest altitude for its highest point, giving us the best chance to see it over the local horizon. The pass on February 4 is a good alternative as well.