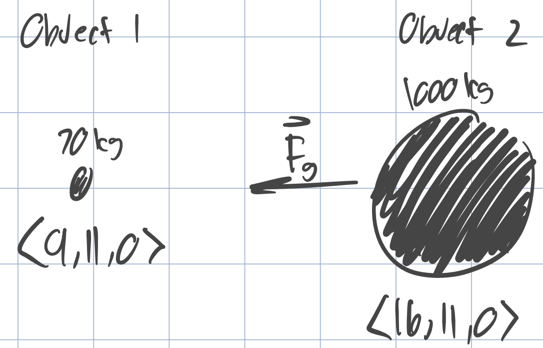
In outter space, far from other objects, block 1 of mass 70 kg is at position $\langle 9,11,0\rangle$ m, and block 2 of mass 1000 kg is at position $\langle 16,11,0\rangle$ m. What is the gravitational force acting on block 2 due to block 1?



$$\vec{F}_{\text{on 2 by 1}} = -G\frac{m_1 m_2}{|\vec{r}|^2}\hat{r}$$

$$\hookrightarrow \vec{r}_{\text{from 1 to 2}} = \vec{r}_2 - \vec{r}_1$$

$$= \langle 16,11,0\rangle - \langle 9,11,0\rangle$$

$$= \langle 7,0,0\rangle \text{ m}$$

$$\hookrightarrow |\vec{r}_{\text{from 2 to 1}}| = \sqrt{\vec{r}^{\,2}}$$

$$= 7 \text{ m}$$

$$\hookrightarrow \hat{r} = \frac{\vec{r}}{|\vec{r}|}$$

$$= \langle 1,0,0\rangle \text{ m}$$

$$\vec{F}_{\text{on 2 by 1}} = \langle -9.5714e{-8}, 0, 0\rangle \text{ N}$$

At 4.2 seconds after noon both blocks were at rest at the positions given in the last part. At 4.5 seconds after noon, what is the momentum of block 2.

$F_{net} = \langle -9.5714e-8, 0, 0 \rangle N$

$\Delta t = 0.3s$

$\vec{p}_f = \vec{p}_i + \vec{F}_{net} \cdot \Delta t$

$= \langle -2.8714e-8, 0, 0 \rangle kg\frac{m}{s}$

At 4.5 seconds after noon, what is the momentum of block 1.

Simply the opposite of block 2.

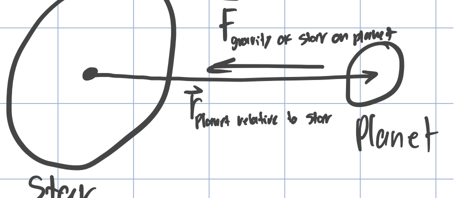
$\vec{p}_f = \langle 2.8714e-8, 0, 0 \rangle kg\frac{m}{s}$

A star of mass 5e30 kg is located at ⟨8e12, 5e12, 0⟩ m. A planet of mass 6e24 kg is located at ⟨6e12, 9e12, 0⟩ m and is moving with a velocity of ⟨0.5e4, 1.4e4, 0⟩ m/s.

During a time interval of 1e6 seconds, what is the change in the planets momentum?

$m_s = 5e30$ kg $\quad r_{si} = \langle 8e12, 5e12, 0 \rangle m$

$m_p = 6e24$ kg $\quad r_{pi} = \langle 6e12, 9e12, 0 \rangle m$



$\Delta t = 1e6 s \quad V_{pi} = \langle 0.5e4, 1.4e4, 0 \rangle m/s$

$$\vec{p}_{pf} = \vec{p}_{pi} + \vec{F}_{net}\Delta t$$

$\hookrightarrow \vec{F}_{net} = \vec{F}_{\text{gravity of star on planet}}$

$\hookrightarrow \vec{F}_{\text{gravity of star on planet}} = -G\dfrac{m_s m_p}{|\vec{r}_{s\to p}|^2}\hat{r}$

$\hookrightarrow \vec{r}_{s\to p} = \vec{r}_{pi} - \vec{r}_{si}$

$= \langle 6e12, 9e12, 0\rangle - \langle 8e12, 5e12, 0\rangle$

$= \langle -2e12, 4e12, 0\rangle\ m$

$\hookrightarrow |\vec{r}_{s\to p}| = 4.4721e12$

$\hookrightarrow \hat{r}_{s\to p} = \dfrac{\vec{r}}{|\vec{r}|}$

$= \langle -0.4472, 0.8944, 0\rangle\ m$

$\vec{F}_{\text{gravity of star on planet}} = \langle 4.4946e19, -8.9891e19, 0\rangle\ N$

$\vec{F}_{net} = \langle 4.4946e19, -8.9891e19, 0\rangle\ N$

$\Delta\vec{p} = \vec{p}_{pf} - \vec{p}_{pi}$

$= \cancel{\vec{p}_{pi}} + \vec{F}_{net}\Delta t - \cancel{\vec{p}_{pi}}$

$= \langle 4.4946e25, -8.9891e25, 0\rangle$

What is the change in the planets position?

$$\vec{P}_{pf} = \vec{P}_{pi} + \Delta \vec{P}_p$$

$$= \vec{V}_{pf} m_p + \Delta \vec{P}_p$$

$$= \langle 3e28, 8.4e28, 0 \rangle + \langle 4.4946e25, -8.9891e25, 0 \rangle$$

$$= \langle 3.0045e28, 8.3910e28, 0 \rangle$$

$$\Delta \vec{r} = \vec{r}_{pf} - \vec{r}_{pi}$$

$$= \cancel{\vec{r}_{pi}} + \frac{\vec{P}_{pf}}{m_p} \Delta t - \cancel{\vec{r}_{pi}}$$

$$= \frac{\vec{P}_{pf}}{m_p} \Delta t$$

$$= \langle 5007.49, 13985.01848, 0 \rangle \Delta t$$

$$= \langle 5.007e9, 1.3985e10, 0 \rangle \text{ m}$$