Astro HW 1

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1.1

- A) Collaboration and working with fellow students is encouraged, however, work still must be that of the individual, and copying answers is not allowed.
- B) Copying from others, cheating, enabling others to cheat, all are violations of academic honesty.
- C) Because they are the words/work of someone other than myself, meaning that I am not truly learning the material.

1.2

$$tan^{-1}(\frac{61}{384}) \approx 9.0\,\text{deg}$$

$$9.0 * \frac{\pi}{180} \approx .16rad$$

1.3

$$G = 6.67430 * 10^{-11} m^3 kg^{-1} s^{-2} = 39.5 AU^3 M_\odot^{-1} yr^{-2}$$

$$6.67430 * 10^{-11} m^3 kg^{-1} s^{-2} * 1.989 * 10^{30} kg M_\odot$$

$$6.67430 * 10^{-11} m^3 \cancel{kg^{-1}} s^{-2} * 1.989 * 10^{30} \cancel{kg} M_\odot$$

$$6.67430 * 10^{-11} m^3 s^{-2} * 1.989 * 10^{30} M_\odot * (1.496 * 10^{11})^3 AU^3 m^{-3}$$

$$6.67430 * 10^{-11} \cancel{m^3} s^{-2} * 1.989 * 10^{30} M_\odot * (1.496 * 10^{11})^3 AU^3 \cancel{m^{-3}}$$

$$6.67430 * 10^{-11} s^{-2} * 1.989 * 10^{30} M_\odot * (1.496 * 10^{11})^3 AU^3 * (3.154 * 10^7)^2 s^2 y^{-2}$$

$$6.67430 * 10^{-11} \cancel{s^{-2}} * 1.989 * 10^{30} M_\odot * (1.496 * 10^{11})^3 AU^3 * (3.154 * 10^7)^2 \cancel{s^2} y^{-2}$$

$$6.67430 * 10^{-11} * 1.989 * 10^{30} M_\odot * (1.496 * 10^{11})^3 AU^3 * (3.154 * 10^7)^2 y^{-2}$$

$$= 39.5 AU^3 M_\odot^{-1} yr^{-2}$$

1.4

1.4.1 a

$$\frac{x}{\hat{s}} = \cos(\delta)$$
$$x = \cos(\delta)$$
$$x = \hat{x}\cos(\delta)$$

$$\frac{z}{\hat{s}} = \sin(\delta)$$
$$z = \sin(\delta)$$
$$z = \hat{z}\sin(\delta)$$

$$\hat{s} = \hat{x}\cos(\delta) + \hat{z}\sin(\delta)$$

1.4.2 b

$$\frac{z'}{\hat{x}} = \cos(\ell)$$
$$z' = \cos(\ell)$$
$$z' = \hat{z'}\cos(\ell)$$

$$\frac{x}{\hat{x}} = \sin(\ell)$$
$$x' = \sin(\ell)$$
$$x' = \hat{x'}\sin(\ell)$$

$$\hat{x} = \hat{z'}\cos(\ell) + \hat{x'}\sin(\ell)$$

1.4.3 c

$$\frac{z'}{\hat{z}} = \cos(90 - \ell)$$

$$z' = \cos(90 - \ell)$$

$$z' = \hat{z'} \cos(90 - \ell)$$

$$\frac{-x'}{\hat{z}} = \sin(90 - \ell)$$

$$-x' = \sin(90 - \ell)$$

$$-x' = \hat{x'} \sin(90 - \ell)$$

$$\hat{z} = \hat{z'} \cos(90 - \ell) - \hat{x'} \sin(90 - \ell)$$

$$\hat{z} = \hat{z'} \cos(90 - \ell) - \hat{x'} \sin(90 - \ell)$$

$$\hat{z} = \hat{z'} \sin(\ell) - \hat{x'} \cos(\ell)$$

1.4.4 d

$$\hat{s} = \hat{x} \cos(\delta) + \hat{z} \sin(\delta)$$

$$\hat{s} = \cos(\delta)(\hat{z'} \cos(\ell) + \hat{x'} \sin(\ell)) + \sin(\delta)(\hat{z'} \sin(\ell) - \hat{x'} \cos(\ell))$$

$$\hat{s} = \hat{z'} \cos(\ell) \cos(\delta) + \hat{x'} \sin(\ell) \cos(\delta) + \hat{z'} \sin(\ell) \sin(\delta) - \hat{x'} \cos(\ell) \sin(\delta)$$

$$\hat{s} = \hat{z'}(\cos(\ell) \cos(\delta) + \sin(\ell) \sin(\delta)) + \hat{x'}(\sin(\ell) \cos(\delta) - \cos(\ell) \sin(\delta))$$

$$\hat{s} = \hat{z'} \cos(\ell + \delta) + \hat{x'} \sin(\ell - \delta)$$

1.4.5 e

$$\theta = \frac{\pi}{2} - (\ell + \delta), \ell < \delta$$

$$\theta = \frac{\pi}{2} - (\ell - \delta), \ell > \delta$$

1.4.6 f

$$\theta_{NCP} = \ell$$

1.4.7 g

$$\delta_{lim} = 40.11\overline{6}^{\circ} - 90^{\circ}$$

$$\delta_{lim} \approx -49.884^{\circ}$$

$$\delta_{lim} \approx -49^{\circ}53'$$

Yes, you can see NGC 1316 from Champaign-Urbana. This is because $\delta_{NGC1316} > \delta_{lim}$, or $37^{\circ}12.5' > 49^{\circ}53'$, meaning that is it above the horizon at some point.

1.4.8 h

$$\delta = \ell$$

1.5

$$d\Omega = \sin\theta d\theta d\phi$$

$$\int d\Omega = \int_0^{2\pi} \int_0^{\theta_r} \sin\theta d\theta d\phi$$

$$\Omega = \int_0^{2\pi} (-\cos\theta_r + 1) d\phi$$

$$\Omega = (-\cos\theta_r + 1)$$

$$\approx 2\pi(-\cancel{1} - \frac{\theta_r^2}{2} + \cancel{1})$$

$$\Omega = -\pi\theta_r^2$$