29:61 General Astronomy
Exam 1 — Key

1 <u>Can tell latitude.</u>

Equation to use: $Al = \bar{l} + \delta$, Al = altitude angle at transit,

If Capella at zenith, $Al = 90°$, so

$90° = \bar{l} + \delta$, For Capella $\delta = 46°$

so $90° = \bar{l} + 46°$,

$\bar{l} = 44°$, so $l = \underline{46°}$

2. Circumpolar stars are those that never set. Their diurnal circles never go below the horizon.

Reason for dependence on latitude. A circumpolar star must be at an angle from the celestial pole that is less than or equal to the angle the celestial pole is above the horizon. This latter angle depends directly on latitude.

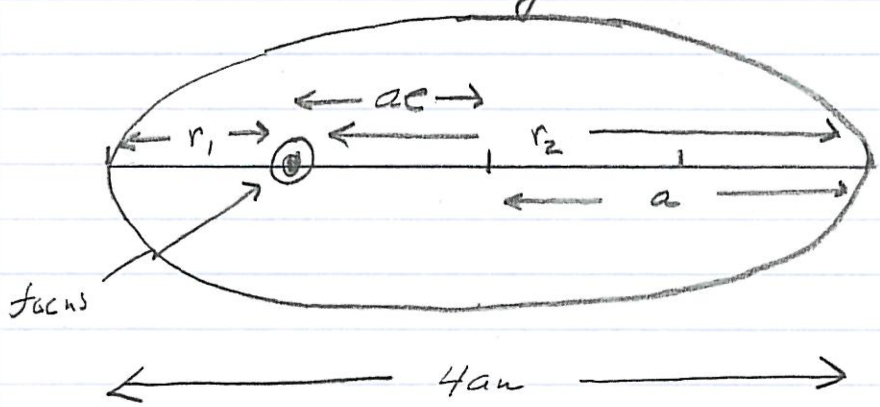
3. Ecliptic

4. Only superior planets are seen at opposition. They are further from the Sun than the Earth. Inferior planets are never seen beyond the Earth on a line Sun — Earth — planet.

The planets that come to opposition are Mars, Jupiter, Saturn, Uranus, and Neptune. Venus and Mercury never come to opposition.

5. In a few days after the exam was the Autumnal Equinox. The Sun is on the celestial equator so $\delta = 0°$. The RA $= 12^h$ because the origin of Equatorial Coordinates is taken to the the Vernal Equinox.

6. Make a drawing of the orbit.



$= 2au$

The ellipse is drawn so that its eccentricity is 0.50.

From Kepler's 2nd Law (Equal Area Law)

$dA = \frac{1}{2} r\, r\, \dot{\theta}\, dt \quad \frac{1}{2} r^2 \dot{\theta}\, dt$, where $\dot{\theta}$ is the angular speed.

Let dt be same at perihelion & aphelion, so

$$dA_{peri} = \frac{1}{2} r_1^2 \dot{\theta}_{peri}\, dt$$

$$dA_{ap} = \frac{1}{2} r_2^2 \dot{\theta}_{ap}\, dt$$

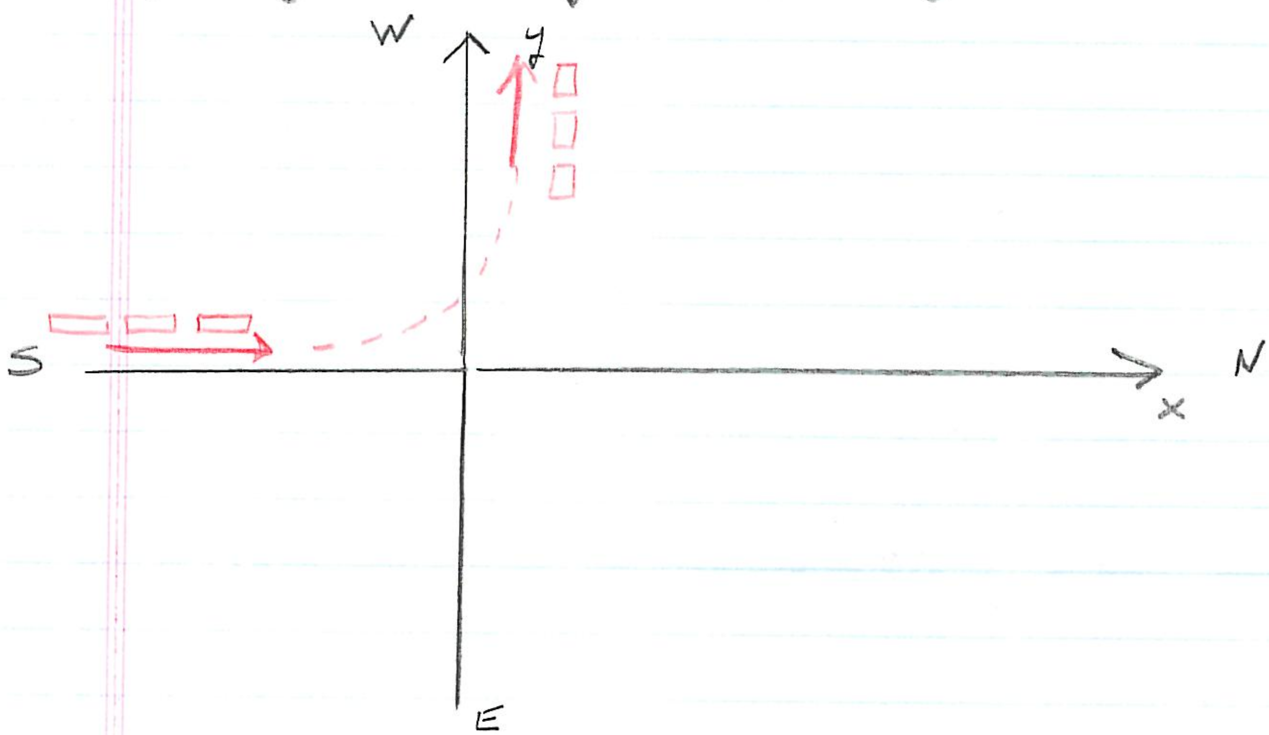
Since $dA_{peri} = dA_{ap}$ (for dt the same)

$$\frac{1}{2} r_1^2 \dot{\theta}_{peri} = \frac{1}{2} r_2^2 \dot{\theta}_{ap}$$

so $$\dot{\theta}_{peri} = \left(\frac{r_2^2}{r_1^2}\right) \dot{\theta}_{ap}$$

Since $r_2 = 3r_1$, $\dot{\theta}_{peri} = 9\,\dot{\theta}_{ap} = 9^\circ/\text{month}$

7. Choose a coordinate system with X axis pointing north, y axis pointing to west



Initial velocity is $\vec{v} = 65\hat{i} + 0\hat{j}$ (miles/hr)

Final velocity is $\vec{v} = 0\hat{i} + 65\hat{j}$ (miles/hr)

Even though the magnitude of the vector is constant, its direction has changed, so the vector has changed over time. There is acceleration

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{\Delta\vec{v}}{\Delta t}$$

$\Delta t = 5$ minutes, $\Delta\vec{v} = \vec{v}_2 - \vec{v}_1$

$\Delta\vec{v} = (0-65)\hat{i} + (65-0)\hat{j}$ (miles/hr)

so $\vec{a} = -13\hat{i} + 13\hat{j}$ miles/hr/min

This is the average acceleration. It is pointed toward the southwest.

8. Equation for orbital speed in a circular orbit

$$v = \sqrt{\frac{GM}{R}}$$

Make sure SI units used consistently throughout.

M = mass of Sun $= 1.989 \times 10^{30}$ kg
G = gravitational constant $= 6.672 \times 10^{-11}$
R = semimajor axis of Saturn's orbit,

$R = 9.54\,(1.496 \times 10^{11})$ meters, so,

$$v = \sqrt{\frac{6.672\times10^{-11}\,(1.989\times10^{30})}{9.54\,(1.496\times10^{11})}}$$

$$= \sqrt{9.30\times10^{7}} = 9643 \text{ m/sec}$$

$$= 9.64 \text{ km/sec}$$