You may use one sheet of notes. You may not use books or additional notes.

Name	
PID	
1	/ 9
2	/ 4
3	/ 5
4	/ 6
Total	/ 24

Planet	**Period (yr)**	**Semi-major axis (AU)**	**Eccentricity**
Mercury	0.241	0.387	0.206
Venus	0.615	0.723	0.007
Earth	1.000	1.000	0.017
Mars	1.881	1.523	0.093
Jupiter	11.86	5.202	0.049
Saturn	29.46	9.539	0.056

1. Write brief answers using a few complete sentences.
    a. (3 pts.) On Venus, you are a year old before you are a day old. Explain how that is possible.
    b. (3 pts.) What did Newton learn about Kepler's 3rd law that Kepler did not know?
    c. Pretend that Galileo saw three stars near Jupiter on 7 January, 1610 rather than three moons. Galileo's description from *Siderius Nunciaus* is below. Redraw what he saw on 7 Jan. (1 pt.) On the same picture, draw what he would have seen on 8 January. (2 pts.) In one or two sentences, point out and explain the differences and similarities between the real drawing and our hypothetical one.

On the seventh day of January in this present year 1610, at the first hour of night, when I was viewing the heavenly bodies with a telescope, Jupiter presented itself to me; and because I had prepared a very excellent instrument for myself, I perceived (as I had not before, on account of the weakness of my previous instrument) that beside the planet there were three starlets, small indeed, but very bright. Though I believed them to be among the host of fixed stars, they aroused my curiosity somewhat by appearing to lie in an exact straight line parallel to the ecliptic, and by their being more splendid than others of their size. Their arrangement with respect to Jupiter and each other was the following:

East ✳ ✳ ○ ✳ *West*

that is, there were two stars on the eastern side and one to the west. The most easterly star and the western one appeared larger than the other. I paid no attention to the distances between them and Jupiter, for at the outset I thought them to be fixed stars, as I have said.[18] But returning to the same investigation on January eighth—led by what, I do not know—I found a very different arrangement. The three starlets were now all to the west of Jupiter, closer together, and at equal intervals from one another as shown in the following sketch:

East ○ ✳ ✳ ✳ *West*

At this time, though I did not yet turn my attention to the way the stars had come together, I began to concern myself with the question how Jupiter could be east of all these stars when on the previous day it had been west of two of them. I commenced to wonder whether Jupiter was not moving eastward at that time, contrary to the computations of the astronomers, and had got in front of them by that motion.[19] Hence it was with great interest that I awaited the next night. But I was disappointed in my hopes, for the sky was then covered with clouds everywhere.

2. The right ascension of the star 51 Pegasi is 23^{hr}, and its declination is 21°. (1 pt.) On what date is it on the meridian at midnight? (3 pts.) Draw a model to show how you found the date.
3. (5 pts.) The Galilean moons Io, Europa, Ganymede, and Callisto orbit Jupiter. Draw an idea map to show what observations and equation(s) are needed to measure the mass of Jupiter.
4. The earth was closest to the sun on Jan 2 this year.
    a. (3 pts.) Find the distance between the earth and sun on Jan 2, when the distance is the closest. You may express your answer in AU.
    b. On average, the sun moves 360°/(365.24day)=0.98565°/day with respect to the stars. (3 pts.) Explain why the sun moves faster and slower at different times of the year.
    c. (3 pts. extra credit) How much does the sun move with respect to the stars on Jan 2nd compared with that on July 2nd?

Ast 207 Test 1

26 Sept 05

1) a) Unlike earth, which rotates on its axis 365 times a year, the rotation of Venus around its axis is much slower, slower in fact than one of its rotations around the sun. ✓

b.) Kepler's 3rd Law discusses a planets ~~size~~ orbital radius and period to be related, it is the equation $P^2 = R^3$. Kepler did not know however that the mass of the star was also involved in this equation, which is something Newton learned about Kepler's 3rd law. The equation Newton derived from Kepler's 3rd law was $P^2 = \frac{R^3}{M_{star}}$ ✓

Fig 1

c. 7th: A * B * Jupiter O C * stars: A, B, C

Fig 2 What he would have seen

8th: A * B * C * Jupiter O ✓

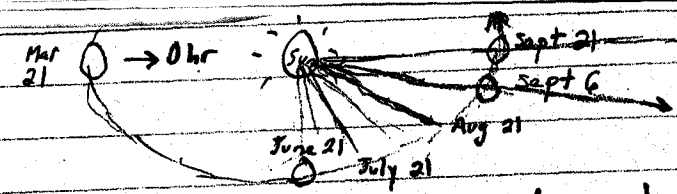
Fig 3 What he did see

6th: Jupiter O * * *

There is an obvious discrepancy here because the glowing objects are in fact not stars. If they were stars, retrograde motion would be observed and the pattern would be similar to what is drawn in Fig 2. Of course, no retrograde motion is observed and stars A, B, and C are not stars. 2e

Similarities: All "stars" are on the same side of Jupiter for either Fig.

Differences: The side the stars are on are different from Fig 2 to 3. The spacing among the stars is also different from one figure to the other.

2. 

On Sept 6, it is on the meridan at midnight (opposite the su

3. If Jupiter is considered as the "star", then $P^2 = \frac{a^3}{M_J}$

Need period and distance from Jupiter of any one its moons. → Convert → need to know in yrs & AU

$$M_J = \frac{a^3}{P^2}$$

in Sun Masses

3

4. a. Eccentricity = $\frac{\text{distance between foci}}{\text{major axis}}$ → Foci dis = (e)(a)

Foci dis = (.017)(2) = .034 AU

Distance b/t Earth & Sun = (semi-major axis) − $\left(\frac{\text{foci dis}}{2}\right)$

Earth-Sun dis = (1 AU) − $\left(\frac{.034\ AU}{2}\right)$ = .983 AU

.983 AU ✓ 3

b. Kepler's 2nd ✓ law states that the earth sweeps out equal areas of its orbit during each time period. Therefore, since the Earth is at different distances away from the sun at different times, the speed of revolution must change accordingly. If the Earth is closer to the sun, it will ✓ revolve faster and when it is further ✓ from the sun, it will revolve slower, in order to maintain equal areas. 3

c. $\frac{1.017\ AU}{.983\ AU}$ = 1.035

The sun moves 1.035 ✓ times faster with respect to the stars on Jan 2nd than July 2nd. 3