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

Name	
PID	
1	/ 9
2	/ 5
3	/ 5
4	/ 5
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. Short answers

   a. (3 pts.) Below are two paragraphs from Galileo's *Siderius Nuncius*. On Jan 8, 1610, Galileo posed the question "how Jupiter could be east of all these stars when on the previous day it had been west of two of them." In one or two sentences, answer his question.

   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   *   *   O   *   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 re-

   turning 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   O   *   *   *   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.

   b. (3 pts.) What was a most important question in cosmology in 1473 when Copernicus was born?

   c. The moon was full about a week ago. (1 pt.) What was the approximate right ascension of the moon? (2 pt.) Briefly explain how you found the answer.

2. (5 pts.) Draw a model of the Sun, Earth, and stars according to Ptolemy. Draw another model to show the Sun, Earth, and stars 6 months and 6 hours later. For clarity, you may represent all of the stars with a single star.

3. A new planet is found around the star X. Its period is 3.6 days or 0.01 year. Assume the star is exactly like the sun and assume the orbit is circular.

   a. (2 pts.) Is its orbit smaller or larger than that of Mercury around the sun? Explain your reasoning.

   b. (2 pts.) Show how to compute the radius of the orbit.

   c. (1 pt.) Give a numerical answer for the radius of the orbit.

4. (5 pts.) The time from noon on one day to noon on the next day is slightly shorter in June than in December. For this question, the definition of noon is the instant when the sun is on the meridian. Explain why. A drawing may help to clarify your explanation.