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PH2201 – Intermediate Mechanics I
Study Guide 6

Readings

Topic	**Book/section**	**Comments**
Planetary motion and	Kleppner 10.5	Study examples 10.5, 10.6, 10.7
	Kleppner 10.6	Study Note 10.2 pp. 4-5-407 (skip Note 10.1)
Kepler's laws	Morin 7.4	For central forces like gravity, which vary
	Taylor 8.6-8.8	inversely as the distance squared, the allowed orbits have the shape of conic sections: a circle, an ellipse, a parabola, or a hyperbola.

Note: Kleppner uses a definition of θ for planetary orbits in which the orbits open up to the right (so the closest approach occurs to the left of the gravitational center). This is different from the usual convention (in Taylor, Morin, and this course). To convert the formulae in Kleppner, make the replacement $\theta \rightarrow \theta + \pi$ in the ch. 10 equations. The orbits then open to the left, not to the right.

Practice Problems
(not for turning in)

Kleppner: probs 10.9, 10.11

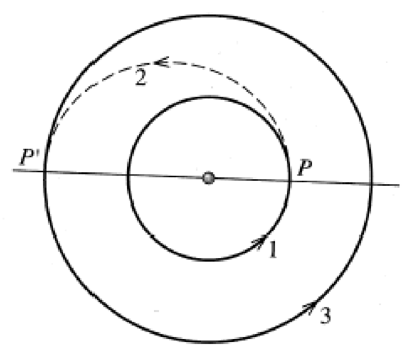
Morin: prob. 7.11

Taylor: probs 8.28, 8.29

Homework Problems

Homework set 6 is **due Monday Oct. 12:**

1. Kleppner 10.10
2. Imagine that the earth is suddenly (and tragically) stopped in its orbit, and then allowed to fall radially into the sun. How long will this take? Assume the earth's motion is approximately circular, and take 1.5 x 10^{11} m as the earth-sun distance, and 2 x 10^{30} kg as the mass of the sun. Hint: Consider the earth's new path to be part of a very thin ellipse.
3. A rock travels in a parabolic orbit in a planet's gravitational field and skims the surface at its closest approach. The planet has mass density ρ. Relative to the center of the planet, what is the angular velocity of the rock as it skims the surface? (we are neglecting air resistance, so this would be a small planet with no atmosphere). Your answer will contain only fundamental constants and ρ.
4. An earth satellite is observed at perigee to be 250 km above the earth's surface and traveling at about 8500 m/s. Find the eccentricity of its orbit and its height above the earth at apogee. [Hint: the earth's radius is $R_e \approx 6.4\times10^6$ m, and you can use $GM_e/R_e^2 = g = 9.8$ m/s^2.]
5. Suppose that we decide to send a spacecraft to Neptune, using the simple orbital transfer illustrated in the diagram (see the example on p. 318 of Taylor). The craft starts in circular orbit #1 close to the earth at point P (radius 1 AU from sun), and fires its thrusters to enter the elliptical transfer orbit #2. After arriving at point P′ near Neptune (radius from sun about 30 AU) it fires its thrusters again to end up in a circular orbit. Use Kepler's third law to determine how long this transfer will take. [Note: in practice this time can be considerably shortened if the craft gets a gravitational boost as it passes Jupiter]



6. If the eccentricity of a planet's orbit about the sun is 0.4, find (a) the ratio of the lengths of the major to minor axes of the planet's orbit, and (b) the ratio of the speeds of the planet when it is at the ends of the major axis of its elliptical orbit.