Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 1 – IPSP

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Exercise Sheet 6 (WS 2013/14)

Date of Issue: Nov. 22nd 2013

Date of Submission: Nov. 29th 2013

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper. Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the seminar.

Exercises:

1. Mars orbits the Sun at a mean orbital radius of 228 Gm (1 Gm = 10^9 m) and has an orbital period of 687 d. Earth orbits the Sun at a mean orbital radius of 149.6 Gm. (a) The Earth-Sun line sweeps out an angle of 360° during one Earth year. Approximately what angle is swept out by the Mars-Sun line during one Earth-year? (b) How frequently are Mars and the Sun in opposition (on diametrically opposite sides of Earth)? Note: One earth year is 365.24 d. (7 Points)

2. A curve of radius 30 m is banked so that a 950-kg car traveling at 40.0 km/h can round it even if the road is so icy that the coefficient of static friction is approximately zero. You are commissioned to tell the local police the range of speeds at which a car can travel around this curve without skidding. Neglect the effects of air drag and rolling friction. If the coefficient of static friction between the road and the tires is 0.300, what is the range of speeds you tell them? (8 Points)

3. Earth rotates on its axis once every 24 hours, so that objects on its surface that are stationary with respect to the surface execute uniform circular motion about the axis with a period of 24 hours. Consider only the effect of this rotation on the person on the surface. (Ignore Earth's orbital motion about the Sun.) (a) What is the speed and what is the magnitude of the acceleration of a person standing on the equator? (Express the magnitude of this acceleration as a percentage of g.) (b) What is the direction of the acceleration vector? (c) What is the speed and what is the magnitude of the centripetal acceleration of a person standing on the surface at 35°N latitude? (6 Points)

4. In 1976, Gerard O'Neill proposed that large space stations be built for human habitation in orbit around Earth and the moon. Because prolonged free-fall has adverse medical effects, he proposed making the stations in the form of long cylinders and spinning them around the cylinder axis to provide the inhabitants with the sensation of gravity. One such O'Neill colony is to be built 5.0 miles long, with a diameter of 0.60 mi. A worker on the inside of the colony would experience a sense of "gravity", because he would be in an accelerated frame of reference due to the rotation. (a) Show that the acceletation of gravity experienced by the worker in the O'Neill colony is equal to his centripetal acceleration. (Hint: Consider someone "looking in" from the colony). (b) If we assume that the space

station is composed of several decks that are at varying distances (radii) from the axis of rotation, show that the "acceleration of gravity" becomes weaker the closer the worker gets to the axis. (c) How many revolutions per minute would this space station have to make to give an "acceleration of gravity" of 9.8 m/s^2 at the outermost edge of the station?