Answers and Hints to Exercise Questions in "Solar System Dynamics"
(Last Updated: 1 September 2006)

Chapter 1

Q1.1 Let O=octahedron, I=icosahedron, D=dodecahedron, T=tetrahedron, C=cube. (b) The largest rms is 3.139 AU for O/C, T, I/D, D/I, C/O; the smallest rms is 0.248 AU for I/D, D/I, O/C, T, C/O. By using the semi-major axes in Table A.2 the rms in (a) increases to 1.367 AU; in (b) the largest rms is 3.156 AU and the smallest is 0.258 AU but the orderings are unchanged.

Q1.2 Use the same notation as in Q1.1. (c) The largest rms is 2.484 AU for O/C, T, I/D, D/I, C/O. By using the semi-major axes in Table A.2 the rms in (b) increases to 0.159 AU; in (c) the largest rms is 2.502 AU but the ordering is unchanged. Kepler produced astrological reasons why his ordering of the solids had to be correct but he also managed to find the best possible ordering to fit his model.

Q1.4 Note that there is only one additional pair with $|c| < 0.15$. See error listings.

Q1.5 Planets 3 and 4 are close to a 7:6 (i.e. $p = 6$) commensurability and satisfy the condition.

Q1.6 (a) There is no *simple* relationship between $N_{\rm r}$ and $i_{\rm max}$. Although there are at most $i_{\rm max} - q$ rationals of the form $p/(p+q)$ for a given q with $p + q < i_{\rm max}$, some of these can be reduced to rationals of lower order (e.g. $\frac{2}{6} = \frac{1}{3}$). For $i_{\rm max} = 2, 3, 4, 5, 6, 7, 8, 9, 10$ we have $N_{\rm r} = 1, 3, 5, 9, 11, 17, 21, 27, 31$ respectively. (b) $\epsilon_{\rm max} = \frac{1}{2}\left(\frac{i_{\rm max}-1}{i_{\rm max}} - \frac{i_{\rm max}-2}{i_{\rm max}-1}\right)$. (c) You need to make some assumptions to get this expression for p. (d) Think binomial distribution. (e) Note that the satellites of Neptune should be included and the upper limit of the satellite eccentricity should be 0.15 and not 0.1. See error listings. Using the J2000 values for the planets from Table A.2 as well as the satellite data gives $N_{\rm p} = 44$ and $N_{\rm obs} = 30$. With $p = 17/31$ the formula gives $P = 0.025$.