#2. The orbital period of Mercury is 88 days, while that of Venus is 224.7 days and Earth’s is 365 days. Using the formula given on page 197 \(\frac{1}{P_{\text{Inner}}} - \frac{1}{P_{\text{Outer}}} = \frac{1}{P_{\text{Synodic}}}\), we get, for Mercury and Venus, \(P_{\text{Synodic}} = 145\) days, while for Venus and Earth it’s \(P_{\text{Synodic}} = 584\) days. The synodic period of Venus as seen from Earth has to be the same as the synodic period of Earth as seen from Venus. An observer on either planet would measure the same time interval between successive alignments.

#3. The mass of Mars is 0.107 times the mass of the Earth, or about \(0.107 \times 6 \times 10^{24}\) kg = \(6 \times 10^{23}\) kg. The energy of such an object striking the Earth at a speed of 20 km/s can be calculated from \(E = \frac{1}{2} m v^2 = \frac{1}{2} (6 \times 10^{23}\) kg) \((20,000 \text{ m/s})^2 = 1.2 \times 10^{32}\) J. The gravitational binding energy of the Earth can be calculated from \(E = GM^2/R\) (where \(G = 6.67 \times 10^{-11}\) m \(^3\) kg\(^{-1}\) s\(^{-2}\) and the radius of the Earth \(R = 6.378 \times 10^6\) m): \(E = 3.8 \times 10^{32}\) J. So the energy of such an impact would only be about 30% of the Earth’s gravitational binding energy, i.e., not enough to break it apart.