1. What planet has the hottest surface?
   Venus

2. What percentage of the solar system’s mass is made up from planets? Show your work.
   We will express masses in terms of Earth’s mass (consult the Appendix to the text). We can ignore the mass of comets, asteroids, minor planets and moons. Sun = 333,000, Mercury = 0.055, Venus = 0.815, Mars = 0.107, Jupiter = 317.9, Saturn = 95.2, Uranus = 14.54, Neptune = 17.13. Adding these and the Earth up we get 333,446 in round numbers. The percentage made from planets is then 446/333446=0.0013 = 0.13%.

3. Where were synthesized most of the elements of which the Earth is made?
   Inside stars, ejected in supernovae.

4. During a transit of Venus, approximately what angle would exist between a line connecting the north pole of Earth, Venus’ center and the Sun and another line connecting the south pole of Earth, Venus’ center and the Sun? Is this angle larger than the angular size of the Sun? Show your work.
   We make use of the fact that the distance of Venus from the Sun is 0.723 AU, so the distance of Earth from Venus would be 1 AU - 0.723 AU = 0.277 AU. The diameter of the Earth is 12,750 miles which is 12750/93 million = 0.000137 AU. Therefore, the sin or the tangent of the angle between two lines connecting Venus’ center with the North and South poles, respectively, of the Earth is 0.000137/0.277 = 0.000495. The angle is therefore 0.000495 radians = 0.000495 × 57.3 degrees = 0.028 degrees. This angle is much less than the angular size of the Sun which is approximately 0.5 degrees.

5. What are the major objections to the theory that planets originate from close encounters of stars with each other?
   A chance encounter would almost certainly have spread out solar material in a direction uncorrelated to the Sun’s equator, and planets formed from the debris would not be orbiting in a plane nearly coincident with the Sun’s equator. Also, close encounters with another star are very rare, too rare to account for the multitude of solar systems we have observed. Also, there are many observations of debris disks around young stars.

6. What is the major reason that the terrestrial planets have higher proportions of heavier elements than the jovian planets?
   The majority of solid stuff forming where the jovian planets originated would have been composed of ice, not rock, and therefore composed of lighter elements.
7. What slowed the rotation of the Sun, which was probably spinning much faster initially than it does today?
   Interactions (friction) between the solar field and the solar nebula.

8. After 3 halflives, what fraction of a radioactive isotope remains in a sample? What fraction remains after 30 halflives? Show your work.
   After n halflives, the fraction \((1/2)^n\) remains. After 3 halflives, \(1/8\) remains. After 30 halflives, \((1/2)^{30} = 1/1,073,741,824 \approx 10^{-9}\) remains.

9. \(^{14}C\) has a halflife of 5730 years. If all carbon on the Earth had been \(^{14}C\) when the Earth formed, what would be the fraction of it left now? How can you explain the fact that the ratio of \(^{14}C/^{12}C\) in the atmosphere and in your body is about 1 trillionth \((10^{-12})\)? Show your work.
   The age of the Earth is about 4.5 billion years. The number of halflives of \(^{14}C\) this corresponds to is \(4.5 \cdot 10^9/5730 = 7.9 \cdot 10^5\). The fraction of \(^{14}C\) remaining today would be \((1/2)^{790,000}\) which is about \(10^{-238000}\). In other words, the amount left would be insignificant. However, the fraction around today in the atmosphere (and your body) is \(10^{-12}\), much larger. There must be a source of fresh \(^{14}C\) continuously active today. This source is provided by cosmic rays bombarding atoms in the atmosphere, releasing a small number of neutrons. A neutron colliding with a \(^{14}N\) nucleus can produce a \(^{14}C\) nucleus.