Exercise 1: Answer Key

1. This question is rather subjective, so answers will vary. A good answer will address each question (2 pts each) in a thoughtful manner; i.e., given an opinion and JUSTIFY it! Some points I expect to raised: natural systems may be sensitive to perturbations, but they have the ability to *adapt* to accommodate them; factors leading to oscillations: seasonality or other aspects of climate, migration, immigration, disease, competition with other species, extinction events, human impact. 10 pts total

2. Deterministic Unpredictability is almost an oxymoron because if something is deterministic, it should be fully predictable because the future is fully determined by the past. Unpredictability is more a global property of a deterministic system in that at the local scale (time-step to time-step) the system is fully predictable, but the long-run behavior may not be, even if the initial conditions are known. Non-deterministic Unpredictability occurs when the rules that govern the transitions from one state to another are probabilistic (i.e., they have an element of uncertainty). Thus, even if we know the present state or starting conditions, we cannot predict the behavior of the system and the local scale. Interestingly, even though local interactions may not be predictable, non-deterministic systems often have very predictable global characteristics. 4 pts total

3. Answers will vary; if you did not have any new insight…well, you might want to think the exercise over again. Hint: If the instructor asks if you learned anything, chances are you should have learned something. 2 pts total

4. Answers will vary:
    a. Random: non-deterministic; governed by probability rules or uncertainty
    b. Ordered: having an arrangement; i.e., a recognizable pattern or regime (not the same as being "organized")
    c. Chaotic: sensitivity to initial conditions produce a behavior or state that appears to be random; simple/small changes produce complex outcomes
    d. Disordered: lacking an arrangement, but not necessarily lacking a relationship

    + 2 extra credit if you realized that random and chaotic are dynamic terms indicating that a process is occurring, while disorder and ordered are static, reflecting a state of a system. 4 pts total

5. Answers will vary (because parts b/c are opinion questions). A good answer addresses each question and JUSTIFIES opinions. You should also, for part a) at least touch upon the following:

    The system is chaotic because it is sensitive to initial conditions and this sensitivity makes the long-run behavior difficult to predict despite the fact that it is deterministic.

    The questions were meant to be for both of the systems for which you generated printouts. Each print out is worth 1 pt. Because most of you only answered the questions for the 3-body problem (my fault it was confusing) the question is worth 7 pts + 1-5 extra credit if you discussed your other print out as well (amount depends on nature of discussion). Part a is 1 pt, b and c 2 pts each.