1. State the Buckingham Pi Theorem.

2. Consider the force $K$ experienced by an object with cross-sectional area $A$ in a fluid with density $\rho$ and speed $u$.
   (a) Use dimensional analysis to express $K$ as a function of $A$, $\rho$ and $u$.
   (b) What assumption did you use in (a) ?

3. In class we considered a cellular automaton where the state is on/off with the following rule: “(i) If on and any neighbor is on, then go off; (ii) if off and all neighbors are off, then go on.” Suppose we now change as follows. Every node has a distinct (numerical) ID. The rule becomes: “(i) If on and any neighbor with smaller ID is on, then go off; (ii) if off and all neighbors are off, then go on.”
   Prove that the system will always converge to a stable configuration.

4. In class we discussed SnakeSort. Wayne comes along and changes the sort so that every row is always sorted left to right. Give an example to show that this process does not sort.

5. Suppose with the original Game of Life we start with exactly five cells in a row alive. What happens?

6. (a) Explain the present value of an annuity and give its formula.
   (b) Do the same for a perpetuity.

7. A paper looking at generalizations of the Lotka–Volterra model had the following example system:
   \[
   \begin{align*}
   \dot{N} &= aN(1 - \frac{N}{K}) - bNP - cNQ \\
   \dot{P} &= dNP - eP - fPQ \\
   \dot{Q} &= gNQ + hPQ - jQ
   \end{align*}
   
   Explain what situation this is modeling, as compared to the original model.

8. Describe and compare the two SIR models given in class: the system of differential equations and the cellular automaton.