

# Statistical Mechanics Assignment 1

**Due:** January 16, 11:00 a.m.

**Marks:** 21

1. Baseball fans are crazy about statistics. Each team gets a turn at bat in each inning, the basic unit of play in baseball. The players on the team at bat take turns trying to hit the ball. If a player fails, and there are various ways this can happen, he is called out. When three players have been called out, the team's turn at bat, called a half-inning, is over. A normal game has nine innings, although extra innings can be added if the score is tied at the end of the ninth inning. One statistic used by baseball fans (and team managers) is the on-base percentage (OBP), which is actually usually expressed as a decimal fraction rather than a percentage. The OBP is, in essence, the fraction of the time that a player is not called out, leaving out occasions where this occurs because of an error or foul by the opposing team. The average OBP is about 0.340. Of course, this varies greatly from player to player, but to keep things simple we will assume a team made up entirely of average players with this OBP. An OBP of 0.340 means that a player reaches the bases safely 34.0% of the time, and is called out the remaining 66.0% of the time, again neglecting errors and fouls by the opposing team. A baseball team consists of nine players.
  - (a) What is the probability that the entire team gets at least one turn at bat in a half-inning? This is called "batting around". [5 marks]
  - (b) What is the probability that a team will bat around at least once in a nine-inning game? [1 mark]
2. Suppose that I have three urns and balls of three different sizes, small, medium and large. The first urn has a small opening, so only the small balls can be put in this urn. The second urn has a medium opening, so either the small or medium balls can be put in this urn. The third urn has a large opening, and any of the balls can be put in it. A small child is given two balls of each size. She puts the balls in the urns, selecting balls and urns randomly, give or take the physical constraints of what balls fit in what urns.
  - (a) What is the probability that the urn with the large opening will contain at least one ball of each size? [4 marks]
  - (b) What is the probability that the urn with the small opening won't contain any balls at all? [1 mark]
  - (c) Verify your result using a simulation. In your report, describe how you carried out the simulation, and give any formulas you used. [10 marks]

You can use any software you want to carry out this simulation. If you use Excel, you may find the following functions useful, in addition to those we have already seen in class: `AND()`, `OR()`. Use the built-in help system for more information.

Note that similar problems come up when discussing the partitioning of energy among molecules with different energy level spacings.