Rubric for Reading Primary Literature
(a) Cite paper: Authors, "Title," Journal (year) vol:pages.

Katherine A. Mirica, Scott T. Phillips, Sergey S. Shevkoplyas, and George M. Whitesides. "Using Magnetic Levitation to Distinguish Atomic-Level Differences in Chemical Composition of Polymers, and to Monitor Chemical Reactions on Solid Supports"
Journal of the American Chemical Society, 2008, vol. 130, pp 17678-17680

(b) What did I learn by reading the title?

The title states that the paper will cover how magnetic levitation can be used to chemically detect differences on polymers and to monitor reactions.

(c) What did I learn by reading the abstract?

This particular paper was a communication, so there is no abstract.

(d) What did I learn from the rest of the paper: See below.

In a brief written analysis of the paper you should:
1. Identify the context of the paper: Summarize the *Big Picture* aspect of the work.

This big picture of this work is the development of an inexpensive technique which provides a rapid visual output of the progress in a chemical reaction.

2. Indicate what work by others was critical to the current paper: Identify 2-3 critical background references.

The most critical references were those which laid the foundation for the concept of magnetic levitation, and then one which applied that concept to diamagnetic materials in paramagnetic solutions. The five references in (7) laid the foundation of magnetic levitation. Then reference (8) (also from the Whitesides group) demonstrated the use of magnetic levitation with a reaction over polymeric beads.

3. Identify the central hypothesis that is to be tested.

Can magnetic levitation be used to determine atomic/molecular scale differences between polymeric materials?

4. Indicate preparative experiments: What did they have to do before they could do the critical experiments?

The main preparative experiment is shown visually in Figure 1 and Figure 2. Basically, the authors levitated solid polymer beads of different density, and were able to demonstrate that the density of the bead affects the position of the bead in a cuvette placed between two strong magnets with like poles lined up in a repelling fashion (anti-Helmholtz configuration). In Figure 2, the polymer beads had different densities because they had different chemical terminating groups as shown in 2B.

5. Indicate the critical experiments that test the hypothesis: Which is the most important figure or table in the paper?

Figure 4 was the most important figure of the paper. It summarized the results of monitoring the reaction. (The data was obtained by "stopping" the reaction at various time points by withdrawing an aliquot of the polymer beads and rinsing off any acid to quench the reaction before suspending in the paramagnetic solution in the levitation device.) The reaction was tracked from start to completion, and the height was used to determine %completion, multiplied by the starting leucine concentration to get the concentration of reactant (leucine) at time t. Figure 4A shows a photograph of the different time points is given. In Figure 4B, the correlation of the curve of this plot to density is shown (as measured using an independent sink-float technique). This standard kinetic data was then used to show the pseudo-first order behavior of the reaction (with the 2,5-diiodobenzoic acid in excess) by plotting the natural log of the concentration of leucine versus time.

6. Outline the major conclusions reached.

Major conclusions were that a density-based approach can be used to monitor chemical functionality and reaction progress on polymeric supports in a simple and cost-effective way.

7. Indicate what evidence the major conclusions are based upon.

These conclusions were based upon the data shown in Figure 4, i.e., the strong correlation between sample height and density.

8. Discuss the reproducibility of the experimental data and how might this affect the conclusions that are reached for each experiment.

Once a researcher has found the proper balance of concentration of the paramagnetic solution and magnet configuration for the system they are interested in such that the sample levitates both before and after the reaction (rather than sitting at the extreme top or bottom of the cuvette) the experiments should be reproducible. The reproducibility of the data will depend upon careful measurement of levitation height.

9. Identify the controls that are used.

The main control was the independent measurement of density and comparison to levitation height as shown in Figure 4. This involved preparing a set of standard salt solutions of varying density (a concentration gradient), and centrifuging the beads in each solution to determine the point at which they go from sinking or floating (density too high or too low) to being uniformly suspended in solution.

10. Discuss the potential pitfalls of the techniques used.

Potential pitfalls include the availability of strong magnets (as rare earth metals are currently relatively high priced), and the portability of these magnets (they are so strong that it is somewhat dangerous to walk around with the device unless you have it packed in a case). During the reaction, since some beads may have reacted more than others, the beads spread out in the cuvette and accurate determination of height can be challenging. There will also be limitations in sensitivity and the density ranges this technique can measure. Another limitation is the requirement of at least one of the reactants being immobilized on a diamagnetic polymeric support.