

# 1 Cognitive reasoning in the chemical sciences 2.3

1. **An oak tree in Ithaca:** Make a rough plot of the total number of leaves on a growing oak tree in Ithaca over a two year period. Assume the tree starts at 6 feet tall and ends at 10 feet tall. Label approximate numerical values for the horizontal and vertical axes. Now make a plot of the number of leaves formed in a month or dropped in a month. For which month is your slope both positive and steepest? For which month is the slope negative and steepest?
2. **Cows and goats vs. effusion**
  - (a) Cows and goats share a fenced-in pasture with a single gate. Goats are smaller and move 10% faster than cows. If the pasture initially consists of 75% cows and 25% goats, initially what percentage of the animals leaving the pasture are goats? What percentage are cows?
  - (b) Same cows and goats as the previous problem. But now it is early morning and both the cows and goats are moving 50% faster than they were in the previous problem. If the pasture initially consists of 75% cows and 25% goats, initially what percentage of the animals leaving the pasture are goats? What percentage are cows?
  - (c) Write effusion problems which are as similar as possible to the previous two problems. Choose real molecules for the problem which you write.
  - (d) Same problem as the previous cow and goat problem but now the fenced-in pasture, which we will call pasture A is surrounded on all sides by a bigger fenced-in pasture with a single gate to the outside world, pasture B. While the gate was on the north side of pasture A, the second gate to the outside world is on the south side of pasture B. If pasture A initially consists of 75% cows and 25% goats, initially what percentage of the animals leaving pasture B for the outside world are goats? What percentage are cows?
  - (e) Fenced-in pasture A is inside fence-in pasture B, which is in fenced-in pasture C and so forth. Ten such pastures. If pasture A initially consists of 75% cows and 25% goats, initially what percentage of the animals leaving pasture J (J is the tenth letter) for the outside world are goats? What percentage are cows?
  - (f) *Flasks in flasks or how to make an atom bomb:*  $\text{UF}_6$  turns from a solid to a gas at  $56^\circ\text{C}$ . The initial sample of uranium is 10%  $^{235}\text{U}$  and 90%  $^{238}\text{U}$ . It is placed in the inner-most flasks. Assume nuclear weapons require uranium to be at least 50%  $^{235}\text{U}$ . How many flasks need to be placed inside flasks, which are placed inside flasks, etc... for the collected sample to be just over 50%  $^{235}\text{U}$ ?
  - (g) In what way are the last two problems the same? in what ways different?