

1 Cognitive reasoning in the chemical sciences 2.1

1. Below are some puzzles for you to work out.

- (a) You are in an elevator going down at 50 miles/hour. The elevator is inside a rocket, which has just taken off from the surface of the Earth, travelling at 200 miles an hour. How fast are you travelling?
- (b) You are in a train moving at 20 miles an hour. The train is going through a highway crossing. How fast would you have to run to the back of the train in order for your position relative to the highway crossing not to change?
- (c) Two people are sitting at complete opposite ends of this same train. The train is one mile long. The train crosses a highway. How many minutes would have to elapse after the first person crosses the highway crossing before the second person crosses the highway crossing?
- (d) A train goes 500 miles along a straight track without stopping, completing the trip with an average speed of exactly 50 miles per hour. It travels, however, at different speeds along the way. It seems plausible that nowhere along the 500 miles of track is there a segment of 50 miles that the train traverses in precisely one hour.

Prove that this is not the case.

- (e) A law is passed. US senators, governors and presidents are allowed only to serve for one single term. There are 100 US senators, 50 governors, and one president. Senators serve for six years, governors for four years and presidents for four years. Only senators or governors ever become presidents. Senators never become governors and governors never become senators. One-half a percent of all senators become president. What fraction of governors become president?
- (f) Joe enjoys counting. He videotapes a recent convention of biochemists. He determines that the number of biochemists who shook hands an odd number of times is odd. Is it possible that Joe counted correctly? Please explain.
- (g) You have three book covers for three different books. You can put the book covers on with the correct or the backwards orientation. If you put the book covers on at random, what is the chance that you place the book covers on correctly?
- (h) A five-pointed star has a side of length two. Another identically shaped five-pointed star has sides of length six. How many times greater is the area of the larger star than the smaller star?
- (i) How many edges are there in a cube?
- (j) A tree starts off with a single trunk. The following year the trunk splits into three branches. The following year each of the branches splits into three new branches and so forth. After five years how many tips are there on the tree?

- (k) The Little Princess walks along the surface of a spherical planet. She only walks along paths which are arcs of great circles. She first walks along a great circle for one quarter of the circumference of the planet. She then turns right ninety degrees and again walks quarter of the circumference of the planet. Again she turns right ninety degrees and walks one-quarter the circumference of the planet. And so forth. Altogether she turns 90 degrees 1096 times. She starts her walk and ends her walk without turning. How far is she from the point at which she started?
- (l) Place three cities, A, B, and C, at any point you wish on the surface of the Earth. You are required to go the shortest possible way visiting each city at least once, You wish to place the cities so that the trip as long as possible. Demonstrate that in order to make the trip as long as possible, no two cities can lie at the opposite ends of the Earth to another of the cities.
- (m) There are four beads strung on a circle of string: two red, one blue and one black. What is the probability that the two red beads are neighbors?