Q1) Recall that Scribbler has sensors that detect "Obstacle on Left", and "Obstacle on Right." Is it possible, at least in principle, to program the Scribbler to recognize the *shapes* of obstacles? For example, could we program the Scribbler to make a sound only if the obstacle in front of it is a cube, and not a sphere? If you think the answer is "yes", describe at a conceptual level how (you don't have to use pseudocode). If not, argue cogently why you don't think so.

Q2) Recall from lecture that the Scribbler can be programmed to act as a burglar alarm. The idea is to shine a beam of light across and just in front of the door we're protecting, and onto the Scribbler. If the door is opened, the beam of light will be broken, which the Scribbler can detect with its light sensor. At that point, the Scribbler can sound an alarm. Write Scribbler pseudocode that implements this behavior. You may find it helpful to refer to the sample programs from Lab 2.

Q3) Recall the *findmin* algorithm, which determines the location of the smallest number in an array *A* of *n* numbers:

```
best ← 1;
Do for i=2 to n
{
    If (A[i] < A[best]) then
    {
        best ← i;
    }
}
```

Modify this algorithm so that it computes the *average* of the numbers in *A* (you'll probably want to introduce some new variables). Your answer should be in pseudocode.

Q4) In this problem, we'll study population growth. To make things clearer, let's just consider the growth in the human *female* population. Suppose that, throughout history, each woman has had *d* daughters, and that *d* has remained constant over time. What is the size of a woman's *n*th generation of female descendants? For example, the size of a woman's 1st generation of female descendants (i.e. her female children) is *d*. Express your answer as a simple formula in terms of *d* and *n*.

The number of women in the world in the 2001 was about 3 billion. Consider a woman living in the year 1. Assuming a new generation is born every 25 years, what is the largest possible value for *d*? Does this value seem right to you? If it seems too low,

explain why the current population doesn't match the prediction. (Note: Perhaps the first person to study population this way was Thomas Malthus.)

Q5) Estimate the total number of arithmetic operations you have done in your entire life. It doesn't have to be a precise estimate; just come up with a loose upper bound. Explain you reasoning, and list all your assumptions. When in doubt, round up. Now determine how long it would take the Scribbler to perform the same number of operations, assuming it can perform 5 million operations per second.

Q6) Write pseudocode that computes the formula you found in Question 4. In other words, given two variables d and n, the pseudocode should calculate the size of a woman's nth generation of female descendants, assuming that every woman has d daughters.