This Review Set asks you to prepare written answers to questions on code improvement. Each of the questions has a short answer. You may discuss this Review Set with other students and work on the problems together.

1. Consider the following fragment of intermediate code:

```plaintext
START
  if a = 2 goto L3
L0:  b := 2
L1:  d := a / 2
     c := a % b
     if c = 0 goto L2
     if b >= d goto L3
     b := b + 1
     goto L1
L2:  a := a + 1
     goto L0
L3:  END
```

(a) Divide this code into basic blocks; there should be at least 6. Assume that START and END are placeholder instructions (i.e. they don’t do anything).

(b) Draw a control-flow graph for this program, using your answer to (a). Place each basic block in a single node.

(c) Describe concisely what this program does if the value of a is the only output.
2. Consider the following section of a flow-graph for a bubble-sort algorithm in three-address code:

\[
\begin{align*}
t_8 & \leftarrow j - 1 \\
t_9 & \leftarrow 4 \times t_8 \\
temp & \leftarrow A[t_9] \\
t_{10} & \leftarrow j + 1 \\
t_{11} & \leftarrow t_{10} - 1 \\
t_{12} & \leftarrow 4 \times t_{11} \\
t_{13} & \leftarrow A[t_{12}] \\
t_{14} & \leftarrow j - 1 \\
t_{15} & \leftarrow 4 \times t_{14} \\
A[t_{15}] & \leftarrow t_{13} \\
t_{16} & \leftarrow j + 1 \\
t_{17} & \leftarrow t_{16} - 1 \\
t_{18} & \leftarrow 4 \times t_{17} \\
A[t_{18}] & \leftarrow temp
\end{align*}
\]

Use the following local optimizations we discussed in class to improve the code (show all steps):

(a) Algebraic simplification
(b) Constant folding
(c) Common subexpression elimination
(d) Copy propagation
(e) Dead code elimination