Question 1. *Consider the mystery code below:*

```
int N = 6;
int result = 1;
while (N > 1) {
  result = result * N;
  N = N - 1;
}
textbox.append(``'' + result + ``\n'');
```

(a) What is appended to the textbox?

    720

(b) How many times is the $(N > 1)$ *condition evaluated?*

    6

(c) If the first line was N = 0, then what would be written to the text box?

    1

(d) If the first line was N = 0, then how many times would the $(N > 1)$ *condition evaluated?*

    1

(e) What is the mathematical name for the function of N that is computed?

    The loop computes the factorial of N.

Question 2. *Using a loop, write code that sends the following sequence of strings to a server: "0", "01", "012", "0123", "01234", "012345", "0123456", "01234567". Assume that* `toServer` *is already declared and is assigned to a valid NetConnection.*

```
There are many "right" answers to this question including...


String message = "0";
while ( message.length() < 9 ) {
       toServer.out.println( message );
       message = message + message.length();
}

or

int nextVal = 0;
String message = "";
while ( nextVal < 8 ) {
       message = message + nextVal;
       toServer.out.println( message );
       nextVal = nextVal + 1;
}
```

Question 3. *Several fragments of a program are shown below:?*

```
1 public class DoesntWork extends GUIManager {
2    private NetConnection toServer;
.
. . . .
.
58    public void buttonClicked() {
59      String currentLine;
.
.      . . .
.
98      currentLine = toServer.in.nextLine();
99       while ( ! currentLine.equals( ``.'' ) ) {
.
.           . . .
.
107         while ( currentLine.contains( `` '' ) ) {
108            int endOfWord = currentLine.indexOf(`` '');
109            String firstWord = currentLine.subString(0, endOfWord );
.
.
115         }
.
.           . . .
.
123        messDisplay.append( currentLine );
124    }
.
.     . . .
.
257 }
```

Suppose that when the program containing the fragments shown is run and a button in its interface is clicked, the computer locks up suggesting the program is caught in an infinite loop. Furthermore, assume that when you use the debugger to stop the program, the debugger window indicates that execution was interrupted on line 109. In such a situation, it is tempting to assume that the infinite loop consists of the the code between lines 107 and 115. This loop, however, is nested inside of a larger, outer loop that extends from line 99 to 124. Explain how you could use the debugger to determine which of these two loops is actually the infinite one. Be specific. That is, indicate where you would place breakpoints (if any), what variable values you would examine (if any) and which control buttons (Step, Stop, or Continue) you would press and in what sequence you would perform these actions. In considering this problem, remember that even if it is not an infinite loop, a loop may execute many, many times before it terminates. Therefore, simply pressing the Step button over and over again is not a reasonable answer.

> The simplest approach would be to place a breakpoint (i.e. stop sign) on one of the lines that follow the inner loop (any line from 116 to 123 would do). Then, press the Continue button. If the inner loop is not infinite, the program will reach the breakpoint fairly soon and you will know that the outer loop must be infinite. If the program does not reach the breakpoint quickly, you can press Stop and begin looking at variable values to figure out why the inner loop is infinite.

Question 4. *Consider two computers, A and B that are connected by a wire that transmits at a rate of 1 Mbps (1 million bits/second). Suppose that A sends 2000 bits to B and the distance between A and B is 50km.*

(a) How long is it from when A transmits the first bit until B receives it, assuming that data travels at the speed of light (3×10^8 meters/second)?

> The propagation time required for the first bit to travel from A to B is just the length of the cable divided by the speed at which the signal propagates or $\frac{50\text{km}}{3\times10^5\text{km/sec}} = 1.6 \times 10^{-4}$sec.

(b) How long does it take A to put all 2000 bits onto the wire?

`The transmission time is just the number of bits sent divided by the rate at which bits are transmitted or` $\frac{2000\texttt{bits}}{10^6\texttt{bits/sec}} = 2 \times 10^{-3}\texttt{sec}$.

(c) *How long is it from when A starts sending the bits until B has completely received it?*

`The total time to deliver the message is just the sum of the transmission time and the propagation time or` $1.6 \times 10^{-4} + 2 \times 10^{-3}\texttt{sec} = 2.16 \times 10 - 3\texttt{sec}$.

Question 5. *Imagine two computers, A and B that are attached to the original Ethernet described in the paper by Metcalfe and Boggs. Assume that A and B are attached to opposite ends of a maximum length Ethernet cable. Suppose that A sends a minimum sized packet (i.e., a packet containing just one byte of data) to B.*

(a) *How long is it from when A transmits the first bit (the SYNC bit) until B receives it, assuming that data travels at the speed of light* (3×10^8 *meters/second)?*

The maximum length of the cable in the original Ethernet was 1km. Therefore, the time required for the first bit sent to reach the destination would be $\frac{1km}{3\times 10^5 km/sec} = 0.33 \times 10^{-5}$*sec.*

(b) *How long does it take A to put the entire packet onto the wire? In addition to the byte = 8 bits of data, a packet on the experimental Ethernet would contain one sync bit, two 8 bit addresses, and a 16 bit error check at the end of the packet. The total size of the packet would therefore be 41 bits. The time to transmit such a packet would just be the packet size divided by the transmission rate of the network which was* 3 *megabits/sec on the original Ethernet. Therefore, the transmission time would be* $\frac{41 bits}{3\times 10^6 bits/sec} = 1.366 \times 10^{-5}$*seconds.*

(c) *How long is it from when A starts sending the packet until B has completely received it?*

`This will be just the sum of the values given for parts (a) and (b) or` $0.33 \times 10^{-5} + 1.366 \times 10^{-5}\texttt{seconds} = 1.7 \times 10^{-5}\texttt{seconds}$

(d) *Suppose now that the distance between A and B is halved. How does this change your answer to part c?*

`If the distance was halved, the answer to part (a) would also be halved so the total delivery time would become:` $0.166\times 10^{-5}+1.366\times 10^{-5}\texttt{seconds} = 1.533 \times 10^{-5}\texttt{seconds}$

(e) *Suppose that the distance remains the same but the transmission speed doubles. How does this change your answer to part c?*

`If the transmission rate were doubled, the answer to part (b) would be halved so the total delivery time would become:` $0.33\times 10^{-5}+0.683\times 10^{-5}\texttt{seconds} = 1.0163 \times 10^{-5}\texttt{seconds}$

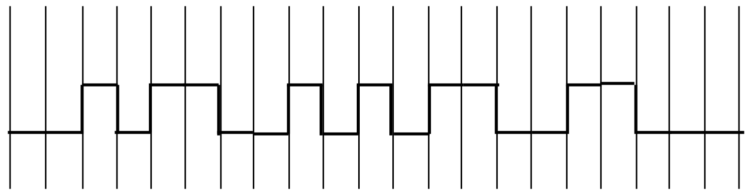
(f) *How long would the network cable have to be so that the receiver would receive the first bit of a minimum sized packet at the same time that the sender is sending the last bit?*

`If we refer to the network length as L, then we want it to be the case that` $\frac{L}{3\times 10^5\texttt{km/sec}} = \frac{41\texttt{bits}}{3\times 10^6\texttt{bits/sec}}$.
`That is,` $L = \frac{41\texttt{bits}\times 3\times 10^5\texttt{km/sec}}{3\times 10^6\texttt{bits/sec}} = 4.1km$

Question 6. *Consider the signal represented by the following diagram:*

(a) *Assuming that signal is intended to transmit data encoded using on-off keying and that each of the intervals between the thin vertical lines represents the transmission of one bit, what sequence of binary digits does this signal represent? (Hint: Yes, the answer should be 21 bits long.)*

`001011001010110011000`



(b) *Now, continue to assume that on-off keying is being used and that the vertical lines represent bit times, suppose that the data has been grouped into 8-bit frames with one start bit preceding each frame. Under these assumptions, what data does the signal represent?*

```
01100101 10011000
```

(c) *Finally, suppose we drop the assumptions about on-off keying and the vertical lines representing bit times. Instead, assume that the Manchester encoding scheme is being used. In addition, continue to assume that the data is grouped into 8-bit frames and that each frame is preceded by a start bit. Under these assumptions, what data does the signal represent?*

```
10111010
```