Rules

- Please write your answers directly on the pages.
- You may use your notes, your book, a calculator.
- You may **not** discuss the test with anyone else, including online sources (via cell phone, computer).
- You may ask clarification questions during the exam.
1. Pictures

A. A 4MP digital camera has an image size of 2289 x 1712 pixels. How many bits is a picture from this camera?

B. The Octopus Song is 3 minutes and 1 second long. If the audio is stored at “CD quality” (192 Kbps), how many bits does it take to store the audio portion of the song?

2. Binary Numbers

(A) What is the decimal number 157 in binary?

(B) What is 11100111 in decimal?

(C) What is the two’s complement of 11100111?
3. Logical Construction

A. Fill in the truth table, then write a logical expression (C = something that can include As, Bs, nots, ands, and ors) to match.

A = Has sail on back. B = Walks on four legs.

Which prehistorical creatures do I like?

C =

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>False</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
</tbody>
</table>

3. continued

B. Fill in the truth table, then write a logical expression (C = something that can include As, Bs, nots, ands, and ors) to match.


Which combinations do they make?

C =

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>False</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
</tbody>
</table>
4. Binary Arithmetic

Solve these problems, show carries and borrows.

\[
\begin{array}{c}
00100111 \\
+ 11001010 \\
11000011 \\
\end{array}
\quad
\begin{array}{c}
11000011 \\
- 10010111 \\
10010111 \\
\end{array}
\]

5. Relay Circuit

What logical formula does this circuit compute?

C =
6. If-Then-Else-32

An “if-then-else” gate takes three bits as input, A, B, and C. It produces one bit of output, which is equal to B’s value if A is True and C’s if A is False. It can be constructed out of 1 not, 2 ands, and an or.

If we generalize to an “if-then-else-k” gate, A is still one bit, but B and C are now k bits each. It produces k bits of output, which are equal to B if A is True and C if A is False. It can be constructed out of k separate “if-then-else” gates.

How many nots, ands, and ors does it take to make an “if-then-else-32” gate?

7. How Many Pops?

A. When the flag is clicked, how many times will the pop sound happen before everything stops?

B. What value will A have at the end?
8. Halloween Lights

- **A**: not A and B
- **B**: A
- **C**: not C

(a) What sequence of values do the state variables take starting from A=T, B=T, C=T?

(b) What is the period of this pattern?


What will $E$ be after each of these short machine-language programs are executed?

(A) 
\[
\begin{align*}
\text{acc} &= \text{not } A \\
E &= \text{acc} \\
\text{acc} &= B \\
\text{acc} &= \text{acc or } C \\
E &= \text{acc and } E
\end{align*}
\]

(B) 
\[
\begin{align*}
\text{acc} &= C \\
\text{acc} &= \text{acc or } D \\
\text{acc} &= \text{acc and } A \\
\text{acc} &= \text{acc and } B \\
E &= \text{acc}
\end{align*}
\]
10. Halt or Not?

For what values of “?” does each of these Scratch scripts halt? (“*” means multiplication.)

(A) 
```
set count to ???
repeat until count < 1
play sound and wait
change count by 2
```

(B) 
```
set count to ???
repeat until count < count - 1
play sound and wait
change count by 2
```

(C) 
```
set count to ???
repeat until count < 64
play sound and wait
set count to count * 2
```

(D) 
```
set count to ???
repeat until count > 1024
play sound and wait
change count by 2
```