CS 105: Final Exam
Final Exam from Fall 2014
Consider a popular mobile and Facebook game where you swap adjacent squares of candy pieces in order to match three-in-a-row.

As an example, swapping the two cells highlighted in bold in the image to the right results in three lollypops lining up in the second column.

For processing this grid in JavaScript, we will assign each image a specific letter. Specifically:
- Let 🍭 be represented by the letter “A” possibly for Green Apple Jolly Rancher?
- Let 🍬 be represented by the letter “B” possibly for Bubblegum-Pop?
- Let 🍯 be represented by the letter “C” possibly for Candy Corn?

Based on this translation, we can generate an array that represents the original state of the board. The original board shown above is represented in JavaScript as the following:

```
var board = [ ["A", "B", "C", "B"],
             ["B", "C", "A", "B"],
             ["C", "B", "A", "C"] ];
```

Each element of `board` is a single row within our grid and each element within that row is a letter that represents a candy. The two cells highlighted in bold in the original image, the lollypop (“B”) and candy corn (“C”) are at `board[1][0]` and `board[1][1]` in our array.

1. What type of variable is `board`?
   A. An array of strings
   B. An array of array of strings
   C. An array of objects
   D. An array of array of objects
   E. An array of objects with arrays

For the next three questions, consider the following answers:
   A. 0
   B. 1
   C. 2
   D. 3
   E. 4

2. From the above answers, what is the value of `board.length`?
   3

3. From the above answers, what is the value of `board[0].length`?
   4

4. From the above answers, what is the value of `board[0][0].length`?
   1
Continuing from the previous page, we are still working with a board array with the following general layout (reprinted for reference):

```javascript
var board = [ ["A", "B", "C", "B"],
              ["B", "C", "A", "B"],
              ["C", "B", "A", "C" ] ];
```

Consider a function designed to check for a three-in-a-row match on a board:

```javascript
function foundMatch(board)
{
  for (var i = 0; i < board.length - 2; i++)
  {
    for (var j = 0; j < board[i].length - 2; j++)
    {
      // Check vertically
      if ( ________________________ )
        return true;
      // Check horizontally
      if ( ________________________ )
        return true;
    }
  }
  return false;
}
```

5. What Boolean expression can be placed inside of Line 8 to complete the conditional in order to check if there are three candies in-a-row vertically?

   A. `board[i] == board[i + 1] && board[i + 1] == board[i + 2]`
   C. `board[i][j] == board[i][j + 1] && board[i][j + 1] == board[i][j + 2]`
   D. `board[i][j] == board[i + 1][j] && board[i + 1][j] == board[i + 2][j]`

6. Suppose we want to increase a score variable by 20 points when a three-in-a-row match is made. Using the function defined above, which snippet of code correctly increases the score when a match was made?

   A. `if (foundMatch(board) = true) score++;`
   B. `if (foundMatch(board) == true) score++;`
   C. `if (foundMatch(board) = true) score += 20;`
   D. `if (foundMatch(board) == true) score += 20;`
   E. `if (foundMatch(board) != true) {
        score += 20;
    }`
Consider the following spreadsheet for the next four questions:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Date</td>
<td>Merchant</td>
<td>Type</td>
<td>Amount</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Dec. 10, 2014</td>
<td>App Multiverse</td>
<td>Department Store</td>
<td>$ 1.99</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Dec. 11, 2014</td>
<td>Caffeine Comrade</td>
<td>Restaurant</td>
<td>$ 4.57</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dec. 12, 2014</td>
<td>Pizza Portal</td>
<td>Restaurant</td>
<td>$ 17.57</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dec. 13, 2014</td>
<td>Akihabara Aces</td>
<td>Department Store</td>
<td>$ 56.20</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dec. 14, 2014</td>
<td>Grub2Go</td>
<td>Restaurant</td>
<td>$ 3.56</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Dec. 15, 2014</td>
<td>Produce Peddler</td>
<td>Grocery</td>
<td>$ 30.15</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Dec. 16, 2014</td>
<td>Pizza Portal</td>
<td>Restaurant</td>
<td>$ 18.08</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Average Expenditure:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Expenditure of Restaurants:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Number of Department Store Expenditures:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Which of the following formulas will indicate the day of the week (eg: return some value that could be translated to Saturday, Sunday, Monday, etc) about Dec. 10, 2014?
   A. =DAY(A2)
   B. =WEEK(A2)
   C. =WEEKDAY(A2)
   D. =MONTH(A2)
   E. =YEAR(A2)

8. If the average expenditure per transaction is to be calculated in D10, which one of the following formulas should be used?
   A. =AVG(E4 : E10)
   B. =AVERAGE(D2 : D8)
   C. =SUM(D2:D8) / (A8 - A2)
   D. =(E4 : E10) / COUNTA(E4 : E10)
   E. =E2:E8 / COUNT(E2:E8)

9. If the expenditure on restaurants is to be calculated in D11, which one of the following formulas should be used?
   A. =VLOOKUP("Restaurant ", SUM(D2:D8), 2, TRUE)
   B. =VLOOKUP("Restaurant ", SUM(D2:D8), 2, FALSE)
   C. =SUM(D2 : D8) IF (D = "Restaurant ")
   D. =SUMIF(C2:C8, "Restaurant ", D2:D8)
   E. =SUMIF(C2:C8, ="Restaurant ", D2:D8)

10. If the Number of Department Store Expenses is to be calculated in D12, which one of the following formulas should be used?
    A. =COUNT(C:C, "Department Store")
    B. =COUNT(D2:D8, "Department Store")
    C. =COUNTIF(C2:C8, "Department Store")
    D. =SUM(C2:C8, "Department Store")
    E. =SUMIF(C2:C8, "=Department Store")
When you graduate from the University of Illinois, you can graduate with an honors distinction by fulfilling some college-specific requirements and earning a certain GPA. The following spreadsheet shows these GPA requirements:

<table>
<thead>
<tr>
<th>GPA (Min)</th>
<th>GPA (Max)</th>
<th>Honors Type (Latin)</th>
<th>English Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>Cum Laude</td>
<td>With Honors</td>
</tr>
<tr>
<td>3</td>
<td>3.749</td>
<td>Magma Cum Laude</td>
<td>With High Honors</td>
</tr>
<tr>
<td>3.75</td>
<td>4.0</td>
<td>Summa Cum Laude</td>
<td>With Highest Honors</td>
</tr>
</tbody>
</table>

11. When entered into cell E2, which formula displays “Summa Cum Laude”?
   A. =VLOOKUP(3.7, A2:C4, 2, TRUE)
   B. =VLOOKUP(3.8, A2:C4, 2, TRUE)
   C. =VLOOKUP(3.7, A2:C4, 3, TRUE)
   D. =VLOOKUP(3.8, A2:C4, 3, TRUE)

12. When entered into cell E3, which formula displays “Cum Laude”?
   A. =INDEX(2.9, MATCH(C:C, A:A, 1), 1)
   B. =INDEX(3.1, MATCH(C:C, A:A, 1), 3)
   C. =INDEX(3.1, MATCH(A:C, A:A, 1), 3)
   D. =INDEX(C:C, MATCH(3.1, A:A, 1), 1)
   E. =INDEX(A:C, MATCH(2.9, A:A, 1), 3)

13. What is the result of the formula: 
   =INDEX(A:E, COUNTIFS(A:E, “>3.7”), MATCH(D:D, “With Honors”, 0))
   A. 3
   B. 3.499
   C. 3.5
   D. 3.749
   E. 3.75

Now, consider a new sheet, Students, of students and GPAs within the same file:

<table>
<thead>
<tr>
<th>Student</th>
<th>GPA</th>
<th>Honor Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Bob</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Charlie</td>
<td>3.74</td>
<td></td>
</tr>
</tbody>
</table>

**FR1. (10pts)** Write a formula that can be placed in Students!C2 that can be copied and pasted down in c3 and c4 that displays the Honors Type (Latin) for which the student qualifies if they qualify for one. If the student does not qualify for any honors, the cell should display “Does not qualify”. Your formula must reference the data on the Requirements sheet in order to determine the correct qualifications (as they may change at a later data).

=IF(B2>=Requirements!A$2, VLOOKUP(B2, Requirements!A:C,3,TRUE),"Does not qualify)
Consider the following spreadsheet of historical weather data in Champaign-Urbana:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Month</td>
<td>Avg. High</td>
<td>Avg. Low</td>
<td>Precipitation</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Nov. 2014</td>
<td>43.9</td>
<td>24.9</td>
<td>2.42</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Oct. 2014</td>
<td>63.3</td>
<td>44.0</td>
<td>4.96</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sept. 2014</td>
<td>75.9</td>
<td>53.2</td>
<td>3.44</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Aug. 2014</td>
<td>82.5</td>
<td>64.3</td>
<td>1.52</td>
<td></td>
</tr>
</tbody>
</table>

14. Which formula returns the month with the most precipitation occurring in the dataset?
   A. =VLOOKUP(MAX(D:D), A:D, 1, FALSE)  
   B. =VLOOKUP(MAX(D:D), A:D, 2, FALSE)  
   C. =VLOOKUP(MAX(D:D), A:D, 3, FALSE)  
   D. =VLOOKUP(MAX(D:D), A:D, 4, FALSE)  
   E. None of the above

VLOOKUP does not work for this problem.  
ONLY can search from left to right

15. Which formula returns the total number of months in the dataset?
   A. =COUNT(B:B)  
   B. =SUM(B:B)  
   C. =AVERAGE(B:B)  
   D. =TOTAL(B:B)  
   E. =ISNUMERIC(B:B)

COUNT() only works for numbers!  
COUNTA() counts the num. of cells that is not empty

Consider the following spreadsheet for the next two questions:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Day</td>
<td>Weather</td>
<td>Temp.</td>
<td>Play Tennis?</td>
<td>Go Running?</td>
</tr>
<tr>
<td>2</td>
<td>Monday</td>
<td>Sunny</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Tuesday</td>
<td>Windy</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Wednesday</td>
<td>Raining</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Thursday</td>
<td>Sunny</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Friday</td>
<td>Sunny</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the next two questions, consider the following answers:
   A. Monday  
   B. Monday and Friday  
   C. Monday and Tuesday  
   D. Thursday and Friday  
   E. Monday, Thursday, and Friday

16. Suppose the formula =IF(B2 = "Sunny", IF(C2<>"Low", "Yes", "No"), "No") is entered into D2 and then the cell is copied and pasted to D3:D6. On what days does Column D report “Yes”?  
   A. Monday  
   B. Monday and Friday  
   C. Monday and Tuesday  
   D. Thursday and Friday  
   E. Monday, Thursday, and Friday

If B column is “Sunny” and C column is not “Low” ——> “Yes”

17. Suppose the formula =IF(B2 <> "Raining", IF(C2="High", "No", "Yes"), "No") is entered into E2 and then the cell is copied and pasted to E3:E6. On what days does Column E report “Yes”?  
   A. Monday  
   B. Monday and Friday  
   C. Monday and Tuesday  
   D. Thursday and Friday  
   E. Monday, Thursday, and Friday

If B column is not “Raining” and C column is not “High”—”Yes”
18. What is the result of 1001 XOR 0101?
   A. 0000
   B. 0101
   C. 1001
   D. 1001
   E. 1100

Check lecture notes on Mon, Apr. 20 for these two problems.

19. In CS 105, an implementation of TLS was described using Diffie-Hellman key exchange by imagining very large numbers (keys) as colors of paint. Which of the following was an assumption that must be true in order for the algorithm to be secure?
   A. The public, shared certificate (“yellow paint”) must be different for each person visiting a website
   B. The act of combining two keys (“colors of paint”) to make a new key is irreversible (eg: you cannot subtract paint colors)
   C. The inner-workings of the operation (XOR) that is applied to the message being translated must not be known to the attacker
   D. An attacker must not be able to read the Internet communications made when connecting via TLS; you are only secure if your weren’t spied on when you connect

20. Which of the following best summarizes d3.js?
   A. d3.js helps the computer to execute JavaScript code faster
   B. d3.js provides increased security to web-based applications
   C. d3.js allows the programmer to write complex matrix multiplication
   D. d3.js simplifies drawing visualizations in web-based applications
   E. d3.js adds styling to an HTML document in place of a CSS file

21. What is ASCII code?
   A. A special version of JavaScript that we are using in CS 105
   B. A universally recognized translation between letters and numbers
   C. An encryption technique that makes text hard to read
   D. A programming language used to make Android and iPhone apps
   E. The five primary colors of light used on a computer screen

It is based on the English alphabet, it encodes 128 specified characters into 7-bit binary integers

22. What is the decimal (base 10) value of the following binary number: 1001
   A. 3
   B. 5
   C. 6
   D. 7
   E. 9

Start from unit digit:

\[1\cdot2^0+0\cdot2^1+0\cdot2^2+1\cdot2^3 = 1+0+0+8 = 9\]

23. What is the binary (base 2) value of the following decimal number: 5
   A. 001
   B. 010
   C. 100
   D. 101
   E. 110
Consider the following Excel spreadsheet:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coffee House</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ERC: Union</td>
<td>4.9</td>
<td>3.1</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ERC: Library</td>
<td>4.1</td>
<td>4.2</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ERC: Daniel St.</td>
<td>4.0</td>
<td>4.7</td>
<td>3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>ERC: Goodwin St.</td>
<td>3.7</td>
<td>4.9</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>ERC: BIF</td>
<td>3.2</td>
<td>3.7</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Starbucks: Bookstore</td>
<td>2.9</td>
<td>3.9</td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Starbucks: Green St.</td>
<td>2.9</td>
<td>4.1</td>
<td>4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Bevande (Siebel)</td>
<td>1.7</td>
<td>1.0</td>
<td>4.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. What is the value of the formula: =INDEX(A2:A9, COUNTIF(A:A, "ERC*"))
   A. 0 
   B. 5  
   C. 6  
   D. A:A  
   E. ERC: BIF

   *Ambiguous matching: Start with “ERC" =INDEX(A2:A9, 5, 1)

25. To ensure that you get a correct result, which is the only column that can be used to find the lookup_value in VLOOKUP when the rangelookup is TRUE?
   A. Column A  
   B. Column B  
   C. Column C  
   D. Column D  
   E. Column E

   *Need to be sorted!!!

26. Suppose we want calculate an average rating in Column E that includes only the two lowest ratings for each coffee house. Which formula, typed into E2 and then copied and pasted into E3:E9, would calculate this average correctly?
   A. =AVERAGE(B2:D2)
   B. =AVERAGE(MAX(B2:D2), MIN(B2:D2))
   C. =AVERAGE( IF(B2<B2, B2, C2), IF(C2<D2, C2, D2) )
   D. =AVERAGE( IF(B2<C2, B2, C2), IF(B2<D2, B2, D2) )
   E. =(SUM(B2:D2) – MAX(B2:D2)) / 2

27. Which formula can be placed in cell F2, and be copied and pasted into F3:F9, displays "Highest Rated" in the cell if and only if the rating calculated in column E is the highest rating among all of the coffee houses listed.
   A. =MAX(E:E, "Highest Rated")
   B. =IF(E2=MAX(E:E), "Highest Rated", "")
   C. =VLOOKUP(MAX(D:D), D:E, 1, FALSE)
   D. =INDEX(D:D, MATCH(MAX(D:D), D:D, 1), 0)
   E. =IF(VLOOKUP(MAX(D:D), D:E, 1, FALSE)=MAX(D:D), "Highest Rated", ")
Suppose we now want to visualize data on our spreadsheet using d3.js. A portion of the spreadsheet is re-printed here for convenience:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee House</td>
<td>Rating 1</td>
<td>Rating 2</td>
<td>Rating 3</td>
<td>Average</td>
<td>Comment</td>
</tr>
<tr>
<td>ERC: Union</td>
<td>4.9</td>
<td>3.1</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERC: Library</td>
<td>4.1</td>
<td>4.2</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERC: Daniel St.</td>
<td>4.0</td>
<td>4.7</td>
<td>3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERC: Goodwin St.</td>
<td>3.7</td>
<td>4.9</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28. Suppose we want to organize a new sheet in a way that allows Excel to export a D2:D5 in a format that can be directly copied and pasted as a JavaScript array. When we copy D2:D5 and paste it onto a new sheet, what special operation is needed when the data is pasted?
   A. Add Operation
   B. Subtract Operation
   C. Transpose
   D. Values Only
   E. Formulas Only

29. Based on the previous question, what file format must be used when exporting the data from Excel?
   A. CSV
   B. JSON
   C. TSV
   D. XLSX
   E. XML

Consider the following function:

```javascript
function x(data) {
  var value = data[0];   // First value in data
  for (var i = 0; i < data.length; i++) {
    if (data[i] > value) {
      value = data[i];
    }
  }
  return value;
}
```

FR2. (10pts) If the input parameter to the function x() is an array of numbers, as would be exported by the process described in the previous two questions, what does this function return?

Your answer should either be:
(a): The name of the Excel function that this function replicates OR
(b): A two or three word description of the return value of the function

...answer this question on your free response answer sheet as question FR2.
After completing the operations on the previous page, our data is now inside of a data variable within JavaScript:

```
var scores = [1.5, 3.1, 3.4, 3.5];
```

Suppose we use d3.js to begin to process the data with the following code:

```
// Create the SVG element
var svg = d3.select("body")
  .append("svg")
  .attr("width", 5)
  .attr("height", 5);

// Draw on the SVG
svg.selectAll("rect")
  .data(scores)
  .enter()
  .append("rect")
      .attr("x", function(d, i) { return 0; })
      .attr("y", function(d, i) { return i; })
      .attr("width", function(d, i) { return d; })
      .attr("height", function(d, i) { return 1; })
      .attr("fill", "black");
```

30. Given that the two code segments shown above are in the same file, how many times does each attribute in Lines 14-18 get executed?
   A. 0 times  
   B. 1 time    
   C. 2 times  
   D. 3 times  
   E. 4 times

Depends on how many number in the array

On your free response sheet, you have a grid marked as FR (d3) where each box is a pixel. As an example, we have drawn a rectangle at pixel (1,1) with a width of 1 and a height of 1 on the grid to the right (➡).

Using the code and data shown above, draw the result of the d3 code in the grid.

<table>
<thead>
<tr>
<th>Sample Grid</th>
<th>x: 0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In various athletics events that contain a subjective assessment of performance (such as diving, gymnastics, and others), a multi-judge panel is used and the lowest and highest scores are dropped. For example, consider an event where five judges judged a performance:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Performer</td>
<td>#1</td>
<td>#2</td>
<td>#3</td>
<td>#4</td>
<td>#5</td>
<td>High</td>
<td>Low</td>
<td>Average</td>
<td>DD</td>
</tr>
<tr>
<td>2</td>
<td>Alice</td>
<td>8.4</td>
<td>8.2</td>
<td>8.5</td>
<td>8.1</td>
<td>8.3</td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bob</td>
<td>7.9</td>
<td>8.4</td>
<td>6.1</td>
<td>8.1</td>
<td>9.2</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Charlie</td>
<td>6.2</td>
<td>6.4</td>
<td>6.3</td>
<td>6.9</td>
<td>6.8</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Eve</td>
<td>6.6</td>
<td>7.9</td>
<td>5.4</td>
<td>6.8</td>
<td>7.3</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

31. Which formula can be used to in G3 to calculate the highest judge score for the performer?
   A. =SUM(B3:F3)
   B. =COUNT(B3:F3)
   C. =AVERAGE(B3:F3)
   D. =MAX(B3:F3)
   E. =MIN(B3:F3)

32. Which formula can be used to in H3 to calculate the lowest judge score for the performer?
   A. =SUM(B3:F3)
   B. =COUNT(B3:F3)
   C. =AVERAGE(B3:F3)
   D. =MAX(B3:F3)
   E. =MIN(B3:F3)

33. Which formula can be used in I3 to calculate the “Adjusted Average”, the average of all scores after the highest and lowest scores are dropped?
   A. =AVERAGE(B3:F3)
   B. =AVERAGE(B3:F3) - G3 - H3
   C. =AVERAGE(B3:F3) - (G3 + H3) / 2
   D. =AVERAGE(B3:H3) - AVERAGE(G3 + H3)
   E. = (SUM(B3:F3) - SUM(G3 + H3)) / 3

34. The “Final Score” (Column K) is calculated by taking the “Adjusted Average” and multiplying that score by the Degree of Difficulty (DD, shown in Column J). Which formula(s) can be used in K3, and can be copied and pasted into K4:K6, to calculate the “Final Score”?
   A. =I3 * J3
   B. =$I3 * $J3
   C. =$I$3 * $J$3
   D. (A) and (B) are both correct
   E. (A), (B), and (C) are all correct

35. With the setup of the spreadsheet above, is it possible to use VLOOKUP to find the name of the performer with the highest final score?
   A. Yes, VLOOKUP can be used
   B. No, it is not possible to use VLOOKUP
Suppose you design your own turn-based card game similar to many popular card games (Pokémon, Hearthstone, and others). In this game, each card has a name that identifies the card and two attributes:

- Attack Power, the amount of damage the card does when used
- Health, the initial amount of health of the card

As an example, consider several cards:

<table>
<thead>
<tr>
<th>Card Name</th>
<th>Attack</th>
<th>Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bloodfren Raptor</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Chillwind Yeti</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Boulderfist Ogre</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Each card can be represented as a JavaScript object. For example, the JavaScript objects for the cards shown above are each defined in their own variable:

```javascript
var yeti = { name: "Chillwind Yeti", attack: 4, health: 5 };
var raptor = { name: "Bloodfren Raptor", attack: 3, health: 2 };
var ogre = { name: "Boulderfist Ogre", attack: 6, health: 7 };
```

36. Suppose you wrote the following line of code:

```javascript
var deck = [ yeti, raptor, ogre ];
```

What type of variable is `deck`?

A. An array of strings  
B. An array of arrays  
C. An array of objects  
D. A string of arrays  
E. An object of arrays

37. Consider the following function:

```javascript
function f(deck)
{
    var card = deck[0];
    for (var i = 0; i < deck.length; i++)
    {
        if (deck[i].health > card.health)
            card = deck[i];
    }
    return card.health;
}
```

If the `deck` variable from the previous question was passed into this function as `deck`, what is the return value of this function?

A. 0  
B. 1  
C. 3  
D. 5  
E. 7
Continuing with the card game from the previous page, suppose our game has only one interaction: two cards may attack each other. When this occurs, we define one card as the attacker and the other as the defender. The rules are:

- The attacker subtracts from its health the attack value of the defender AND
- The defender subtracts from its health the attack value of the attacker.

Simply stated, both the attacker and defender lose health equal to the attack value of the other card involved. As an example, if a Boulderfest Ogre (6 attack, 7 health) attacks a Chillwind Yeti (4 attack, 5 health):

- The Ogre loses 4 health (attack value of the Yeti), bringing the health of the Ogre down from 7 health to 3 remaining health.
- The Yeti loses 6 health (attack value of the Ogre), bringing the health of the Yeti down from 5 health to -1.

When the health of a card is at or below zero, we consider that card to be destroyed. In the previous example, the Yeti is destroyed since its health ended at -1.

38. If the cards involved in the attack are stored in the variables attacker and defender, which conditional will be true when both the attacker and the defender are not destroyed?

A. if (attacker.health > defender.attack ||
   defender.health > attacker.attack)
B. if (attacker.health >= defender.attack ||
   defender.health >= attacker.attack)
C. if (attacker.health == defender.attack ||
   defender.health == attacker.attack)
D. if (attacker.health > defender.attack &&
   defender.health > attacker.attack)
E. if (attacker.health >= defender.attack &&
   defender.health >= attacker.attack)

39. Which line of JavaScript correctly updates the health of the attacker after the attack?

A. attacker.health = attacker.health - defender.attack;
B. attacker.health = defender.attack - attacker.health;
C. attacker.health = attacker.health - attacker.attack;
D. attacker.attack = attacker.attack - attacker.health;

40. After the health is updated (from the code in the previous question), which line of JavaScript checks if the attacker has been destroyed?

A. if (attacker.health > 0)
B. if (attacker.health >= 0)
C. if (attacker.health == 0)
D. if (attacker.health <= 0)
E. if (attacker.health < 0)

41. Suppose we replace attacker with defender and defender with attacker in the previous two questions. Would making only this change correctly update the defender after the attack?

A. Yes
B. No
One recent trend in social networking is location-aware or location-based social networking. In these apps, a post can only be made and/or seen if the user is within a certain distance from a set point. For example, in order to post as part of the University of Illinois, you must be within 10 miles of the University of Illinois within a location-aware app.

In order to check the distance, we have a `findDistance()` function has already been defined for you. This function takes in two JavaScript objects that define a location and returns the approximate distance between the two locations in miles:

```javascript
function findDistance( location1, location2 )
{
    /* Find the distance in the x-direction */
    var dx = location2.x - location1.x;

    /* Find the distance in the y-direction */
    var dy = location2.y - location1.y;

    /* Use the Pythagorean Theorem to find the distance */
    var dist = Math.sqrt( dx * dx + dy * dy );

    return (dist * 65);
}
```

42. In mathematics, the Pythagorean Theorem, \( d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = \sqrt{x^2 + y^2} \), tells us the distance between two points in 2D-space. If `Math.sqrt()` is a JavaScript function to find the square root of an input parameter, what line of code should be placed in Line 10 to find the distance between the two locations passed into the function `findDistance()` above?

A. `var dist = Math.sqrt( location1 + location2 );`
B. `var dist = Math.sqrt( location1.x + location2.y );`
C. `var dist = Math.sqrt( (location1.x)^2 + (location2.y)^2 );`
D. `var dist = Math.sqrt( dx + dy );`
E. `var dist = Math.sqrt( (dx * dx) + (dy * dy) );`

43. Given the location of The University of Illinois is at 40.1105° N, 88.2284° W, which of the following lines of code correctly defines a JavaScript object that can be passed into `findDistance()` as one of its two input parameters?

A. `var location = 40.1105, -88.2284;`
B. `var location = [40.1105, -88.2284];`
C. `var location = [x: 40.1105, y: -88.2284];`
D. `var location = <x>40.1105</x><y>-88.2284</y>;`
E. `var location = { x: 40.1105, y: -88.2284 };`

44. Suppose we have a program where we are searching through data in an array millions of times. If we want our program to run as fast as possible while getting the correct result, how should we search our data?

A. Set up our data in any order and use a linear search
B. Set up our data in any order and use a binary search
C. Set up our data in any order and use a selection search
D. Set up our data in sorted order and use a linear search
E. Set up our data in sorted order and use a binary search
Consider the following representation of a hand of standard playing cards:

```javascript
var hand = [
    { suit: "Diamond", rank: "K" },
    { suit: "Club", rank: "10" }
];
```

45. What type of variable is `hand`?
A. A string
B. A number
C. A function
D. An array
E. An object

46. Consider the following code snippet:

```javascript
var s = "";
for (var i = 0; i < hand.length; i++)
{
    s += hand[i].rank;
}
```

What is the value of `s` after the code has completed?
A. "", (An empty string)
B. "K10"
C. "10K"
D. "DiamondClub"
E. "ClubDiamond"

47. Consider the following code snippet that calculates the score of a hand based on the rank of a card. If the card’s rank is a “K”, “Q”, or “J”, it is scored as 10; if the card’s rank is “A”, it is scored as 1; otherwise, the card is scored the value of its rank.

```javascript
var score = 0;
for (var i = 0; i < hand.length; i++)
{
    var c = hand[i].rank[0];
    if (c == "J" || c == "Q" || c == "K") { score += 10; }
    else if (c == "A") { score += 1; }
    else { score += parseInt(c); }
}
```

Which of the following is true for a standard deck of playing cards?
A. The score is always calculated correctly for hands of at least one card
B. The score is sometimes calculated correctly for certain hands of at least one card
C. The score is never calculated correctly for any hand with at least one card
D. The score is sometimes calculated correctly for hands with zero cards
E. The score is never calculated correctly for hands with zero cards

When rank = 10, rank[0] = 1
For the next three questions, consider the sales of iPhones by Apple. The data for each quarter of sales is reported to you in a table to the right, and also represented as an array:

```javascript
var sales = [ 0.27, 1.12, 2.32, 1.70, 0.72, 6.89, 4.36, 3.79, 5.21, 7.37, 8.74, 8.75, 8.40, 14.10, 16.24, 18.65, 20.34, 17.07, 37.04, 35.06, 26.03, 26.91, 47.79, 37.43, 31.24, 33.80, 51.03, 43.72 ];
```

48. Which of the following lines of JavaScript correctly accesses the total number of iPhone sales during the second quarter of 2008 (“Q2 ’08”)?
   A. sales[0]
   B. sales[1]
   C. sales[2]
   D. sales[3]
   E. sales[4]

49. Which line of JavaScript correctly accesses the total number of data entries (quarters of years) available as part of our data?
   A. sales.totalQuarters()
   B. total(sales)
   C. sizeof(sales)
   D. sales.size
   E. sales.length

50. If we wanted to search the array sales for a specific sales number, which search options are available to us?
   A. Only binary search would get the correct result
   B. Only linear search would get the correct result
   C. Both binary search and linear search would get the correct result

FR-JS. (20pts) Assuming that the data always starts at Q3 ’07, write a JavaScript function that returns the quarter and the year for the period with the largest number of iPhone sales within the array sales.

In writing this answer, you should not simply provide 20+ if-statements. (This would be marked as incorrect.) Additionally, your answer must use the sales array specified as part of this problem.

...answer this question on your free response answer sheet as question FR-JS.
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