CS 105 Final Exam

Thursday, December 17, 2015
1:30pm – 4:30pm
Exam Form: A

EXAM INSTRUCTIONS

1. **We will not answer any questions during this exam.** All multiple choice questions only have one BEST ANSWER. Any errors in the exam will be reviewed after the exam.
2. Completely and carefully fill out all test material, which includes:
    a. Your name and NetID at the bottom of **this page**,
    b. Your name, NetID, UIN, and form number on the **bubble sheet**, and
    c. All information on both the **front and back of the free response** sheet
3. **This is a closed book exam**. You may not consult any materials during the exam other than the exam itself: no textbooks, no crib sheets, no calculators, etc.
4. Cheating or apparent cheating in any form will be taken very seriously. Cheating or leaving the exam constitutes a violation of academic integrity and will result in, at least, a zero on the exam.
5. When instructed to do so, stop writing, put your pencils down, and hand in your bubble answer sheet and exam to an exam proctor.

EXAM DETAILS

1. This is a timed, **180 minute exam**. A clock will be provided or the exam proctors will announce when there are 10 minutes left.
2. Answer all multiple choice questions on the bubble sheet and all free response questions (labeled as FR) on the free response sheet. Ensure you carefully shade in your bubble sheet.

FREE RESPONSE INSTRUCTIONS

1. **If you do not know the answer to a free response question**, we will give **20% credit if you write "I don't know" and nothing more for the answer**. A blank answer, or any attempt at an answer will be graded and you will not receive the 20% "I don't know" points.
2. Only answers appearing on the back of the free response sheets will be graded. Ensure that your **one and only answer** is clearly marked. We will not give credit if a right answer appears among many answers.
3. Write your answers, **extremely legibly, only in the box provided for each answer**. If we are unable to read your response, it will be graded as a 0. **It is okay to break up a single formula or line of code onto multiple lines.** It is okay to go outside of the box.

```
When instructed to do so you may turn this page over,
begin the exam, and answer the questions.
```

Name: _____ NetID: _____
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The game of chess is thought to have originated over 1400 years ago, but is still one of the most universally known games around the world. Chess is played on a square board of eight rows (called *ranks* and denoted with the numbers **1** to **8**) and eight columns (called *files* and denoted with the letters **a** to **h**) of squares. The colors of the 64 squares alternate and are referred to as "light" and "dark" squares. A chess board is shown below:

	a	b	c	d	e	f	g	h
8								
7								
6								
5								
4								
3								
2								
1								

An empty chess board

A typical game of chess consists sixteen different pieces, but we are only going to be focusing on the queen. The queen in the most powerful single piece in chess and she can move any number of squares along a rank, file, or diagonal. It is said that she controls the square if she is able to move to that square. A queen on **e5** controls nearly half the board, as she is able to control the entire 5th rank, the entire **e**-file, and two long diagonals (**b8/h2** and **a1/h8**).

	a	b	c	d	e	f	g	h
8		•			•			•
7			•		•		•	
6				•	•	•		
5	•	•	•	•	♛	•	•	•
4				•	•	•		
3			•		•		•	
2		•			•			•
1	•				•			

A chess board with a queen on e5, with dots showing all the square the queen currently controls.

In the next twelve questions, you will consider the classic n-queens puzzle. This puzzle asks: *how many queens could be placed on a chess board so that no queen is under the control of another queen?* Starting from the sample board above:
- A second queen <u>cannot</u> be placed on **c3** as the **c5** queen controls **c3**.
- A second queen <u>can</u> be placed on **c6** as the **c6** queen does not control **e5** and the **e5** queen does not control **c6**.
- With both a **c6** queen and an **e5** queen, a third queen <u>cannot</u> be placed on **g6** but <u>can</u> be placed on **a4**.

Suppose we represent the chess board as an array of array of numbers in JavaScript, where each element has the value of 0 if it is currently not controlled by a queen and a value of 1 if it is currently controlled by a queen (or is the queen herself). This is represented visually below:

This chess board Is represented by this array.

```
var board = [
    [0, 1, 0, 0, 1, 0, 0, 1],
    [0, 0, 1, 0, 1, 0, 1, 0],
    [0, 0, 0, 1, 1, 1, 0, 0],
    [1, 1, 1, 1, 1, 1, 1, 1],
    [0, 0, 0, 1, 1, 1, 0, 0],
    [0, 0, 1, 0, 1, 0, 1, 0],
    [0, 1, 0, 0, 1, 0, 0, 1],
    [1, 0, 0, 0, 1, 0, 0, 0]
];
```

1. What is the value of `board.length`?
    A. 0
    B. 1
    C. 8
    D. 64

2. In terms of chess, what is the meaning of `board[0]`?
    (See the previous page for an explanation of the terms "rank" and "file".)
    A. `board[0]` is the 1st rank on the chess board
    B. `board[0]` is the 8th rank on the chess board
    C. `board[0]` is the **a**-file on the chess board
    D. `board[0]` is the **h**-file on the chess board

3. What index in `board` is **e5** (the location of the queen in the figure at the top of the page)?
    A. `board[3][4]`
    B. `board[3][5]`
    C. `board[4][4]`
    D. `board[4][5]`

Consider a `findRankIndex` function, a function that takes in the `rank` (a number in the range 1…8, representing the rank on the chess board) and returns the index for the `board` array for the given `rank`. This function is written below:

```
1  var findRankIndex = function(rank) {
2      ___Line 2___ ;
3  };
```

4. Which statement can be placed in <u>Line 2</u> to create a correct `findRankIndex` function?
    A. `return rank;`
    B. `return rank - 7;`
    C. `return rank - 8;`
    D. `return 7 - rank;`
    E. `return 8 - rank;`

Consider a `findFileIndex` function, a function that takes in the `file` (a string of one letter in the range **a**…**h**, representing the file on the chess board) and returns the index for the `board` array for the given `file`. One way to write the function is outlined in the code below:

```
1   var findFileIndex = function(file) {
2     if (file == "a") { return ___Line 2___; }
3     if (file == "b") { return ___..._____; }
..    ...
9     if (file == "h") { return ___Line 9___; }
10
11    return -1;
12  };
```

5. In order to return the correct index for `file` "a", what value should be returned in <u>Line 2</u>?
   (See the previous page for an explanation of the translation between the chess board and the array.)
   A. 0
   B. 1
   C. 7
   D. 8

6. In order to return the correct index for `file` "h", what value should be returned in <u>Line 9</u>?
   A. 0
   B. 1
   C. 7
   D. 8

Finally, consider the `find` function that takes a chess position (for example: `"e5"` or `"c7"`) and returns the value of that position in the `board` array:

```
1   var find = function(position) {
2     var rankIndex = getRankIndex( Number( ___Line 2___ ) );
3     var fileIndex = getFileIndex( ___Line 3___ );
4
5        ___Line 5___ ;
6   };
```

7. In order to pass the `getRankIndex` and `getFileIndex` functions the correct values, we must find the rank and file components of the `position` string. When placed in <u>Line 2</u> and <u>Line 3</u>, which values return the rank and file components of positon correctly?
   A. Line 2: `position[0]`   Line 3: `position[0]`
   B. Line 2: `position[0]`   Line 3: `position[1]`
   C. Line 2: `position[1]`   Line 3: `position[0]`
   D. Line 2: `position[1]`   Line 3: `position[1]`

8. Which line returns the correct value when placed in <u>Line 5</u>?
   A. `return board[rankIndex][fileIndex];`
   B. `return board[fileIndex][rankIndex];`
   C. `return board["rankIndex"]["fileIndex"];`
   D. `return board["fileIndex"]["rankIndex"];`

In order to check if you can place eight queens on a chess board at one time without any queen controlling the square of another queen *(thereby solving the n-queens puzzle, where n=8)*, we will call a new function `checkQueens` with all the possible locations for the eight queens. Each set of possible positions will come in the form of an array of chess positions:

```
["a2", "b4", "c6", "d8", "e3", "f1", "g7", "h5"]
```

The following outlines the `checkQueens` function. In this code, you should assume that `addPositionToBoard` will add a queen to `board` at the specified position and mark all the squares she's controlling to the value of `1` (in the `board` array).

```
1   var checkQueens = function(positions) {
2     board = createBlankBoard();   /* Creates a board of 0s. */
3
4     for (___Line 4___) {
5        var p = ____Line 5____ ;
6
7        if ( ____Line 7____ ) {
8           addPositionToBoard( board, p );
9        } else {
10           return false;
11        }
12     }
13
14     return true;
15  };
```

9. Which line of code can be placed in <u>Line 4</u> in order to loop through the `positions` array?
   - A. `i < positions`
   - B. `i < positions.length`
   - <mark>C. `var i = 0; i < positions.length; i++`</mark>
   - D. `var positions = 0; positions < i; positions++`

10. Which line of code can be placed in <u>Line 5</u> to get position for the current index out of the `positions` array and into the `p` variable?
    - A. `positions`
    - B. `positions.i`
    - C. `positions@i`
    - <mark>D. `positions[i]`</mark>

11. Which line of code can be placed in <u>Line 7</u> to check if a queen is currently **not** covering the position?
    - <mark>A. `find( p ) == 0`</mark>
    - B. `find( positions ) == 0`
    - C. `p.find() == 0`
    - D. `positions.find() == 0`
    - E. `positions[0].find() == 0`

12. What is the return value of `checkQueens` if all eight queens can be placed on the board?
    - <mark>A. `true`</mark>
    - B. `false`

Consider the following spreadsheet. It should look very familiar to you as a slightly modified version of a grocery store receipt that we used in class.

	A	B	C	D	E
1		**Item**	**Category**	**Price**	
2		OF Milk 64oz	Grocery	4.39	
3		Scope 32oz	Health & Beauty	7.45	
4		Stonyfield Yogurt Pl	Grocery	5.25	
5		Tide 120oz Spring	Household	14.97	
6		Vermont Bread	Grocery	2.55	
7					
8			**Subtotal:**		
9		Tax Rate:			
10		10%	**Tax:**		
11					
12			**Grand Total:**		
13					

13. Which formula calculates the total spending before tax (which will go into `D8`)?
   A. `SUM(D2:D6)`
   B. `SUMIFS(D2:D6)`
   C. `ADD(D2:D6)`
   D. `ADDALL(D2:D6)`

14. Now that `D8` has the total before tax, calculate the sales tax (which will go into `D10`)! Assume that `B10` is in PERCENTAGE format, meaning that 10% is stored as 0.1!
   A. `D8 * 10`
   B. `D8 / B10`
   C. `D8 * B10`
   D. `SUM(D8, B10)`

15. Now that you have the total before tax in `D8` and the sales tax amount in `D10`, calculate the grand total for `D12`!
   A. `SUM(D2:D8)`
   B. `SUM(D8:D10)`
   C. `SUMIFS(D2:D8, B10, D2:D8)`
   D. `SUMIFS(D8:D10, B10, D8:D10)`

16. How much was spent on groceries? (Before tax)
   A. `SUM(D2:D6)`
   B. `SUM(C2,C4, C6)`
   C. `SUMIFS(C2:C6, C2:C6, "Grocery")`
   D. `SUMIFS(D2:D6, C2.C6, "Grocery")`

For the next five questions, consider the following spreadsheet:

	A	B	C
1	**Company**	**Revenue ($ bn)**	**Benchmark Comparison**
2	Sinopec	461	
3	Toyota	326	
4	Samsung	305	
5	PetroChina	439	
6	Walmart	185	
7	Saudi Aramco	378	
8	Exxon Mobil	394	
9	BP	359	
10	State Grid	333	
11	Royal Dutch Shell	421	
12			
13			
14	Benchmark Company:		
15			

17. Which formula correctly returns the company name with the lowest revenue value?
    A. `MATCH(A2:A11, INDEX(MIN(B2:B11), B2:B11), 0)`
    B. `INDEX(B2:B11, MATCH(MIN(A2:A11), A2:A11), 0)`
    C. `INDEX(A2:A11, MATCH(MIN(B2:B11), B2:B11), 0)`
    D. `MATCH(A2:A11, INDEX(MIN(A2:A11), B2:B11), 0)`

18. Which of these VLOOKUP functions will return 359?
    A. `VLOOKUP("BP", A1:B11, 2, FALSE)`
    B. `VLOOKUP(359, A1:B11, 2, FALSE)`
    C. `VLOOKUP("BP", A1:B11, 2, TRUE)`
    D. `VLOOKUP(359, A1:B11, 2)`

19. Which formula correctly returns the difference between the highest and lowest revenue?
    A. `B2 - B11`
    B. `MAX(B2:B11) - MIN(B2:B11)`
    C. `INDEX(A2:A11, MATCH( MAX(A2:A11), A2:A11), 0) -`
       `INDEX(B2:B11, MATCH( MIN(B2:B11), B2:B11), 0)`
    D. `MATCH( MAX(B2:B11), B2:B11 ) - MATCH( MIN(B2:B11), B2:B11 )`

20. Which formula correctly displays the average revenue of companies with revenue greater than $400 billion?
    A. `AVERAGEIFS(B2:B11, B2:B11, ">400")`
    B. `AVERAGEIFS(B2:B11, B2:B11, >400)`
    C. `AVERAGEIFS(A2:A11, A2:A11, ">400")`
    D. `AVERAGEIFS(A2:A11, A2:A11, >400)`

Continuing to use the same spreadsheet as the previous four questions:

	A	B	C
1	**Company**	**Revenue ($ bn)**	**Benchmark Comparison**
2	Sinopec	461	
3	Toyota	326	
4	Samsung	305	
5	PetroChina	439	
6	Walmart	185	
7	Saudi Aramco	378	
8	Exxon Mobil	394	
9	BP	359	
10	State Grid	333	
11	Royal Dutch Shell	421	
12			
13			
14	Benchmark Company:		
15			

21. When the user enters a company's name in **B14**, then the revenues of all companies should be compared to that benchmark company. The results will appear in the C column. For example, if the user enters "Walmart" in **B14**, then **C2** would display the difference in revenues of Sinopec and Walmart (Sinopec's revenue – Walmart's revenue). **C3** would compare Toyota and Walmart. **C4** would show Samsung's revenue – Walmart's revenue and so on.

    Which formula can be typed into **C2** and then copied down into **C3** through **C11** to make this happen?

    A. `B2 - INDEX(B$2:B$11, MATCH($B$18, A$2:A$11, 0) )`

    B. `B2 - INDEX(B$2:B$11, MATCH($B$18, A$2:A$11, 1) )`

    C. `B2 - INDEX(B$2:B$11, MATCH($B$18, A$2:A$11) )`

    D. `B2 - MATCH(B$2:B$11, INDEX($B$18, A$2:A$11, 0) )`

    E. `INDEX(B2 - MATCH(B$2:B$11,$B$18))`

Consider this list of four Computer Science students and their final grades for Fall 2015:

	A	B	C	D	E
5		**Student**	**Major**	**Course**	**Grade**
6		Sam	CS	Machine Learning	94
7		Sam	CS	Discrete Math	84
8		Sam	CS	Data Structures	91
9		John	Math	Discrete Math	89
10		John	Math	Algebra	78
11		John	Math	Calculus	83
13		Lily	English	Intro to Film	95
14		Lily	English	Intro to Computing	81
15		Tony	CS	Discrete Math	77
16		Tony	CS	Data Structures	63
17		Tony	CS	Algorithms	76
18		Tony	CS	Theory of Computation	82
19		Tony	CS	Operating Systems	69

22. Assuming there were no other students in "Discrete Math", what was the average grade in that class?
- A. `AVERAGE(E6:E19)`
- B. `AVERAGEIFS(E6:E19)`
- C. `AVERAGEIFS(E6:E19, D6:D19, D7)`
- D. `AVERAGEIFS(E6:E19, D7)`
- E. `AVERAGE(E6:E19, D7)`

23. Which student achieved the highest score in any of the courses?
- A. `INDEX(E6:E19, MATCH( MAX(E6:E19), B6:B19, 0 ))`
- B. `INDEX(B6:B19, MATCH( MAX(E6:E19), B6:B19, 0 ))`
- C. `INDEX(B6:B19, MATCH( MAX(E6:E19), E6:E19, 0 ))`
- D. `INDEX(E6:E19, MATCH( MAX(E6:E19), E6:E19, 0 ))`
- E. `INDEX(E6:E19, MATCH( MAX(B6:B19), E6:E19, 0 ))`

24. How many CS majors took "Discrete Math"?
- A. `COUNT(C6:C19, "CS", D6:D19, "Discrete Math")`
- B. `COUNTIFS(C6:C19, "CS", D6:D19, "Discrete Math")`
- C. `SUMIFS(C6:C19, "CS", D6:D19, "Discrete Math")`
- D. `VLOOKUP(C6:D19, "CS", "Discrete Math", FALSE)`

Consider this list of employees' phone extensions:

	A	B
1	**Name**	**Extension**
2	Brandon	9862
3	Joseph	2082
4	Graham	1731
5	Kaolin	2017
6	Nicholas	6964
7	Carley	4729
8	Mengxuan	1675
9	Jessica	2602

25. Assume you wanted to give away a prize to a random employee. How could you use this list to display a random name?

    A. `RANDBETWEEN(A2:A9)`

    B. `INDEX(A2:A9, RANDBETWEEN(1, 8))`

    C. `MATCH(A2:A9, RAND()*8, 0)`

    D. `VLOOKUP(A2:B9, RAND(), FALSE)`

26. Which of these formulas returns a pseudo-random value between 5 and 10?

    A. `RANDBETWEEN(1, 10) - 5`

    B. `5 + RAND() * (10 - 5)`

    C. `RAND() / 5 + 10`

    D. `RANDBETWEEN(1, 10) / 2`

Look at this UIUC enrollment data and answer the following five questions:

	A	B	C	D	E	F
1	**Major Name**	**Freshman**	**Sophomore**	**Junior**	**Senior**	**Total Undergraduates**
2	Accountancy	10	130	343	462	
3	Advertising	90	97	215	190	
4	Aerospace	110	100	133	170	
	...	...	...	...	...	...
22	Computer Science	100	217	300	496	
	...	...	...	...	...	...
53	Supply Chain M.	0	0	35	57	
54	Systems Mgmt.	11	24	54	104	

27. What formula tells you which major has the most freshmen?

    A. `INDEX(MAX(B3:B54), B3:B54, 0)`

    B. `INDEX(B3:B54, MATCH(MAX(B3:B54), A3:A54, 0), 1)`

    C. `INDEX(B3:B54, MATCH(MAX(B3:B54), B3:B54, 0), 1)`

    D. `INDEX(A3:A54, MATCH(MAX(B3:B54), B3:B54, 0), 1)`

    E. `VLOOKUP(MAX(B3:B54), A3:B54, 1)`

Continuing to look at the same data, reprinted here for convenience:

	A	B	C	D	E	F
1	**Major Name**	**Freshman**	**Sophomore**	**Junior**	**Senior**	**Total Undergraduates**
2	Accountancy	10	130	343	462	
3	Advertising	90	97	215	190	
4	Aerospace	110	100	133	170	
	…	…	…	…	…	…
22	Computer Science	100	217	300	496	
	…	…	…	…	…	…
53	Supply Chain M.	0	0	35	57	
54	Systems Mgmt.	11	24	54	104	

28. What formula would you write in cell `F3` so that it can be pasted down to correctly fill the column with the total number of undergraduates in each major?
  A. `B$3 + C$3 + D$3 + E$3`
  B. `$B$3 + $C$3 + $D$3 + $E$3`
  C. `SUM(B:E)`
  D. `SUM($B:$E)`
  E. `SUM(B3:E3)`

29. After you complete column F is the previous question, what formula would you use to count the number of majors that have less than the average number of undergraduates?
  A. `COUNTIFS(A3:A54, "<" & AVERAGE(F3:F54))`
  B. `SUMIFS(A3:A54, "<" & AVERAGE(F3:F54))`
  C. `COUNTIFS(F3:F54, "<" & AVERAGE(F3:F54))`
  D. `SUMIFS(F3:F54, "<" & AVERAGE(F3:F54))`
  E. `AVERAGEIFS(F3:F54, "<" & AVERAGE(F3:F54))`

30. Which of these formulas will give you the number of sophomores in the Computer Science major?
  A. `VLOOKUP("Computer Science", A:E, 0)`
  B. `VLOOKUP("Computer Science", A:E, 1)`
  C. `VLOOKUP("Computer Science", A:E, 2)`
  D. `VLOOKUP("Computer Science", A:E, 3)`
  E. `VLOOKUP("Computer Science", A:E, 4)`

31. What will be the result of `VLOOKUP("Advertising", A:E, 1)`?
  A. Major Name
  B. Advertising
  C. Freshman
  D. 60
  E. #N/A

Take a look at this list of the first ten presidents of the United States:

	A	B	C
1			
2		George	Washington
3		John	Adams
4		Thomas	Jefferson
5		James	Madison
6		James	Monroe
7		John	Adams
8		Andrew	Jackson
9		Martin	Van Buren
10		William	Harrison
11		John	Tyler

32. Let's make up some presidents. Use a formula to make up a random fake president's name by scrambling their first and last names. For example, your formula could return "James Van Buren" or "William Adams". Which formula will do the trick?

A. `INDEX(B2:B11, RANDBETWEEN(1,10)) & " " & INDEX(B2:B11, RANDBETWEEN(1,10))`

B. `RAND(B2:11) & " " & RAND(C2:C11)`

C. `INDEX(B2:B11, RANDBETWEEN(1,10)) & " " & INDEX(C2:C11, RANDBETWEEN(1,10))`

D. `RANDBETWEEN(B2:B11, 1, 2)`

33. Look up President Van Buren's first name!

A. `VLOOKUP("Van Buren", B:C, 1, FALSE)`

B. `INDEX(B:B, MATCH("Van Buren", C:C, 0))`

C. `VLOOKUP("Van Buren", B:C, 1)`

D. `INDEX(C:C, MATCH("Van Buren", C:C, -1)`

Consider the following spreadsheet for your next free response question:

	A	B	C
1	**Warmer Than:**	**Cooler Than:**	**Then Say:**
2	40	212	*Light jacket will do.*
3	20	40	*Bring a decent coat.*
4	0	20	*You will need a winter coat.*
5	-90	0	*Just stay at home!*
6			
7	**Current Temp:**		
8	**Fashion Message:**		

FR1.
(15pts)
Winter is finally here and it is getting colder outside. You want to teach your computer to be a "fashion advisor" that will suggest the appropriate piece of clothing depending on the temperature. Assume that the temperature is automatically populated in **B7** and that your formula will be placed in **B8** to generate a fashion recommendation based on the temperature ranges above.

...write the appropriate formula on your free response answer sheet as answer FR1.

Consider the following Excel spreadsheet:

	A	B	C	D	E	F
1	**Coffee House**	**Rating 1**	**Rating 2**	**Rating 3**	**Average**	**Comment**
2	ERC: Granger Library	4.9	3.1	1.5		
3	ERC: Undergrad Library	4.1	4.2	3.1		
4	ERC: Daniel St.	4.0	4.7	3.4		
5	ERC: Goodwin St.	3.7	4.9	3.5		
6	ERC: BIF	3.2	3.7	3.8		
7	Starbucks: Bookstore	2.9	3.9	3.9		
8	Starbucks: Green St.	2.9	4.1	4.1		
9	Einstein's Bagels (Siebel)	1.7	1.0	4.4		

34. 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

35. 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 `range_lookup` is `TRUE`?
   A. Column A
   B. Column B
   C. Column C
   D. Column D
   E. Column E

36. Suppose we want to 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`

37. Which formula, when typed in cell `F2` and copied and pasted into `F3:F9`, displays "Highest Rated" in the cell if and only if the average rating calculated in column `E` is the highest average 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", "")`

For the next four questions, consider the following spreadsheet listing Rafael Nadal's recent championship games.

	A	B	C	D
1	**Championship**	**Surface**	**Outcome**	**Opponent**
2	2008 French Open	Clay	Winner	Roger Federer
3	2008 Wimbledon	Grass	Winner	Roger Federer
4	2009 Australian Open	Hard	Winner	Roger Federer
5	2010 French Open	Clay	Winner	Robin Soderling
6	2010 Wimbledon	Grass	Winner	Thomas Berdych
7	2010 US Open	Hard	Winner	Novak Djokovic
8	2011 French Open	Clay	Winner	Roger Federer
9	2011 Wimbledon	Grass	Runner Up	Novak Djokovic
10	2011 US Open	Hard	Runner Up	Novak Djokovic
11	2012 Australian Open	Hard	Runner Up	Novak Djokovic
12	2012 French Open	Clay	Winner	Novak Djokovic
13	2013 French Open	Clay	Winner	David Ferrer
14	2013 US Open	Hard	Winner	Novak Djokovic

Write formulas that will answer the following questions even if the data changes. For example, the answer of =B8 to **(a)** will not be given any credit as it will be wrong when the data changes. In the context of this spreadsheet, "Runner Up" means that Rafael Nadal lost the match.

You must answer all three formulas inside of the box for the free response. Make sure it is very clear which answer is for (a), for (b), and for (c).

FR2.
(3 * 5pts)
a) On what surface was the 2011 French Open played on?

b) How many times did Rafael Nadal win against the opponent Novak Djokovic?

c) Who did Rafael Nadal lose against in the 2011 US Open?

...write the appropriate formula on your free response answer sheet as answer FR2.

Now imagine that you wanted to create this table (on the same sheet) that lists Rafael Nadal's wins and losses on the three different surfaces:

	E	F	G
20		**Winner**	**Runner-Up**
21	**Clay**		
22	**Grass**		
23	**Hard**		

FR3.
(15pts)
Write **one** formula for F21 that can be copied into F21:G23 to display the number of games he won or lost on each turf.

...write the appropriate formula on your free response answer sheet as answer FR3.

Suppose you are creating a website to store your family recipes. Each recipe contains a series of ingredients and quantities, which you store as an array of objects:

```
1  var recipe = [
2    { ingredient: "flour", quantity: 1.5, unit: "c" },
3    { ingredient: "baking powder", quantity: 3.5, unit: "tsp" },
4    { ingredient: "salt", quantity: 1, unit: "tsp" },
5    { ingredient: "sugar", quantity: 1, unit: "T" },
6    { ingredient: "milk", quantity: 1.25, unit: "c" },
7    { ingredient: "egg", quantity: 1, unit: "egg" },
8    { ingredient: "butter, melted", quantity: 3, unit: "T" }
9  ];
```

38. What is the data type of `recipe[0]`?
- A. A string
- B. A number
- C. An array
- D. An object
- E. An array of objects

For the next three problems, consider the following loop:

```
1  for (var i = 0; i < recipe.length; i++) {
2    alert(___Line 2_____);
3  }
```

39. Based on the data for this question, how many times does the loop run?
- A. 0 times
- B. 5 times
- C. 6 times
- D. 7 times

40. Suppose we want to write out the ingredients in human-readable form to an alert box such that the output looks like the following:

```
1.5 c. flour
3.5 tsp. baking powder
...
```

Which of the following lines of code could be placed in <u>Line 2</u> to generate the output?
- A. `recipe.quantity + " " + recipe.unit + ". " + recipe.ingredient`
- B. `recipe[quantity] + " " + recipe[unit] + ". " + recipe[ingredient]`
- C. `recipe.i.quantity + " " + recipe.i.unit + ". " + recipe.i.ingredient`
- D. `recipe[i].quantity + " " + recipe[i].unit + ". " + recipe[i].ingredient`

41. Based on the data for this question and the output format described in the previous question, which ingredient would result in a typographical error being displayed?
- A. Baking powder
- B. Egg
- C. Milk
- D. Salt
- E. Sugar

```
1   var recipe = [
2     { ingredient: "flour", quantity: 1.5, unit: "c" },
3     { ingredient: "baking powder", quantity: 3.5, unit: "tsp" },
..      ...
9   ];
```

*As a reference, the data from the previous page is re-printed above.*

Consider the following table that shows the volume (in ounces) of each unit:

Quantity	Unit	Abbreviation	Volume (oz.)
1	cup	c	8
1	tablespoon	T	0.5
1	teaspoon	tsp	0.1667
1	egg	egg	1

FR4.
(20pts)
Write a JavaScript function that takes the `recipe` array as an argument and returns the total volume, in ounces.

...answer this question on your free response answer sheet as question FR4.

Now that we have the total volume, suppose we want to visualize the relative difference between each unit by using a series of rectangles in d3.js, similar to the following:
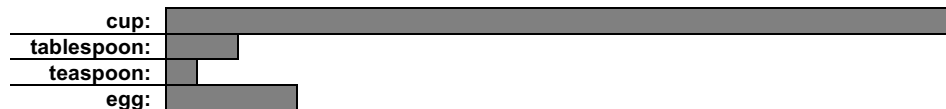
42. After converting the table into a format appropriate for d3.js, which of the following shows the representation of the cup measurement?

A. `"1 cup c 8"`
B. `"1 cup (c.) is 8 oz."`
C. `[1, "cup", "c", 8]`
D. `{quantity: 1, unit: "cup", abbreviation: "C", volume: 8}`
E. `{cup.quantity: 1, cup.unit: "cup", cup.abbreviation: "C", cup.volume: 8}`

43. After setting up the data and boilerplate code, what line of JavaScript must be used to begin rendering each shape in our visualization?

A. `.append("rect")`
B. `.attr("rect", "rectangle")`
C. `.attr("shape", "rect")`
D. `.attr("shape", "rectangle")`

44. Suppose we want the width of the rectangle to be equal to 20 times the number of ounces in the unit. Which line of JavaScript correctly sets this width when using d3.js?

A. `.attr("width", 20)`
B. `.attr("width", 20 * d)`
C. `.attr("width", 20 * d.volume)`
D. `.attr("width", function (d, i) { return 20 * d; })`
E. `.attr("width", function (d, i) { return 20 * d.volume; })`

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