Hong Kong Olympiad in Informatics 2014

Heat Event (Senior Group)

Official Solution

Statistics (N = 172)

Full mark = 40. Maximum = 40. Median = 14.25. Advance to Final = 16.5 marks or above.

Section A

Q	A	Explanation
1	D	The ASCII code of "A", "a", " ", "0" are 65, 97, 32, 48 respectively.
2	/	Cancelled due to different choices in English and Chinese versions. The correct answer is i only. There are N colors of socks, to guarantee that we take K socks of the same color, we need to take $N(K-1)+1$ socks.
3	B	Draw a flowchart to understand what instructions are actually executed. In the first program, each loop contains 1 comparison and 2 assignments. In the second program, each loop contains 2 comparisons and 4 assignments (but i is increased by 2 instead of 1). The execution time should be doubled.
4	/	Cancelled. Correct answer would be B if the graph is planar which we did not specify.
5	C	The 1st to 56th letters form a 4-wonderful sentence, so the 55th letter is 'B'. The 57th to 63rd letters form a 5-wonderlul word, next comes 'ABAABBA' so the 70th letter is 'A'
6	C	Simplifying a bit, we have 12 water = 49 pork, 26 pork = 36 rice = 17 cabbage. Now, let's convert everything to pork. A: 101 rice = 101 / 36 * 26 = 72.9 pork. B: 48 cabbage = 48 / 27 * 26 = 73.4 pork. C: 74 pork. D: 18 water = 18 / 12 * 49 = 73.5 pork
7	C	f(2, 2) = f(1, 2) + f(2, 1) = 1 + 1 = 2. f(3, 2) = f(2, 2) + f(3, 1) = 2 + 1 = 3. f(2, 3) = f(1, 3) + f(2, 2) = 1 + 2 = 3. f(3, 3) = f(2, 3) + f(3, 2) = 3 + 3 = 6. So, c = f(2, 3) + f(3, 3) = 3 + 6 = 9
8	A	Binary search can only be applied to a sorted array.
9	A	Candidate prime numbers are {5, 7, 11, 13, 17, 19}, 6 elements. Number of ways = 6C3 = 20
10	D	The symbol represents the logical operator "OR". OR is associative, meaning that the expression can become ((NOT U OR U) OR V) AND V, which is (TRUE OR V) AND V, which is TRUE AND V, which is V.

Q	A	Explanation
11	D	We can draw a graph like this: Tryndamere ↔ Taric ↔ Xin Zhao ↔ Jarvan IV Master Yi ↔ Wukong Lee Sin ↔ Garen Number of pairs of friends = 4C2 + 1 + 1 = 6 + 2 = 8
12	C	The `a[k+1] = j` at the end of the loop body inserts the new number in the correct position, which shows that the program implements insertion sort.
13	D	Due to precision error, the loop would not stop.
14	D	A and B are false: The condition $(x < 100)$ and $(x \geq 100)$ covers all values of x, including both integers and real numbers. So the program will never output -1. C is false: If x is negative, the program output '0'. A floating point variable can store small integers without losing information.
15	B	12 = 1100(2), 4 = 0100(2), 12 & 4 = 0100(2). 10 = 01010(2), 21 = 10101(2), 10 | 21 = 11111(2) Hint: If the operands are positive, the result of & would not be larger than the smaller operand. The result of | would not be smaller than the larger operand.
16	B	Only ordinal data types such as `int`, `char`, `bool` can be used. Hint: floating point operations are not performed in the ALU.
17	A	(i) is wrong because David didn't guarantee that his students will pass the test. Assume A, B class each has 2 students respectively, and all students got same amount of cookies. This example disproves statement (ii), (iii) and (iv).
18	/	Cancelled. None of the answers are correct. The correct answer is 96. Let $f(x)$ = number of ways to form \$$x$. We have $f(0) = 1$ and $(x) = 0$ for $x < 0$. $f(x) = f(x - 0.5) + f(x - 1) + f(x - 2)$ for $x > 0$. Our answer is $f(4.5)$

19	B	Let's walk inversely from destination to the origin!
		`A: 17/9  -> 8/9  -> 8/1  -> 7/1 -> 6/1 -> 5/1 -> 4/1 X`
		`B: 17/10 -> 7/10 -> 7/3  -> 4/3 -> 1/3 -> 1/2 -> 1/1 O`
		`C: 13/15 -> 13/2 -> 11/2 -> 9/2 -> 7/2 -> 5/2 -> 3/2 X`
		`D: 11/8  -> 3/8  -> 3/5  -> 3/2 -> 1/2 -> 1/1 -> ?/? X`

20	A	Let's track the value of j: 1 -> 0 -> 2 -> 3 -> 7 -> 4 -> 5 -> 8 Finally, the output is `a[8]`, which is 2
21	B	Let's track the value of j: 0 -> 1 -> 7 -> 8 -> 4 -> 0 -> … The cycle length is 5 and the loop is executed 10008 times. $10008 \equiv 3 \pmod 5$
22	A	Answer = $2 \times 3 \times 2 \times 1 \times 3 \times 1 \times 2 \times 3 \times 2 \times 1 \times 2 = 864$
23	A	Let's say Compiler is able to compile C programs, and Source A (written in C) is the source code of the C compiler, and Source B is the source code of the Pascal compiler (written in C). Neither Source A nor Source B (both in C) can be compiled by the Pascal compiler.

Q	A	Explanation
24	A	i. is obviously true.
		ii is not always true. Compiler C may take a lot of time trying to optimize the program.
		iii. is not always true. Compiler A produces programs which run slower, but it may take shorter time to compile. Compiler C2 produces programs which run faster, but it may take longer time to compile.
25	A	The output number is smallest when it has the fewest digits.
		Number of digits for
		A: 2 * 3 * (4 + 1) = 30
		B: 3 * 4 * (2 + 1) = 36
		C: 4 * 2 * (3 + 1) = 32
		D: 4 * 3 * (2 + 1) = 36

Section B

	Answer and Explanation	
A	A: 76545336 B: `A43D`	
B	There is a very easy way to convert a number between binary, octal and hexadecimal. For A, first convert the hexadecimal number to binary. 0 = 0000, F = 1111 and so on. The result is 1111,1010,1100,1010,1101,1110. Rearrange it into groups of 3 bits (from LSB), which gives 111,110,101,100,101,011,011,110 and convert each group to decimal.	
C	`x mod 200+200`	`x%200+200`
	Alternative answer: `200-(-x%200)` Notice that we are working with $x \leq 0$. Therefore `x % 100` would give -199 to 0. Adding 200 to that result would give 1 to 200 (which is the correct final value)	
D	324	
	The first circle we can put any of the four numbers. The other circles we can put any of the three numbers different from the previous one. Number of arrangements = 4×3^4	
E	84	
	First, assign an arbitrary color X to the top left circle. (4 choices) Then, assign a color Y different to the previous one to the bottom left circle. (3 choices) Now for the top left circle we put color Z. If $Z = Y$, the bottom right circle have 3 choices. If $Z \neq Y$, Z itself have 2 choices and the bottom right circle have 2 choices. Answer = $4 \times 3 \times (3 + 2 \times 2) = 84$	
F	Cancelled. The given number 2232 should be 2332 instead. Contestants who answered $2232 \times x\ 7 = 15624$ all ranked high enough that they are not affected by the cancellation.	
G	Logic	
H	21	59
I	`halt end`	`return 0;}`
	Originally, when n is a triangular number, both lines will be printed. We need to stop the program in the body of the if statement.	
J	`swap(p,p+1)`	
K1	`p>0`	
K2	`p:=p-1`	`p=p-1`
L	`p:=p+1`	`p=p+1`
	Alternative answer for J2: `p=0` The program implements insertion sort. A new element will be swapped into correct place before moving on to the next element.	
M	`...><...>.`	
N	`...<.....>`	
O	`..<......>`	
	The first > gets overwritten by the < due to the execution order.	