Hong Kong Olympiad in Informatics 2015/16
Heat Event (Junior Group)
Official Solution

Statistics (N = 271)
Full mark = 43. Maximum = 36. Median = 15. Advance to Final = 19 marks or above.

Section A

Q	A	Explanation
1	T	Different kinds of coins will cause different changes in magnetic flux.
2	T	The precedence of && (and) is higher than || (or), so the computer will evaluate the expression as Pascal: true or (false and false), C++: 1 || (0 && 0)
3	F	The maximum integer stored in char is 127 but the minimum integer is -128 instead of 0, so there are 256 possibilities
4	F	If the variable is not properly initialized or the program is doing something like accessing a random memory, the program may fail even there are no error on the first run
5	F	According to Pythagoras theorem, $a^2 + b^2 = c^2$ where a, b and c are the length of the side of a right-angled triangle. All primes are odd except for 2, by checking the parity, it is easy to prove that a, b and c cannot be all primes.
6	D	The possible outputs are -2, -1, 0, 1 and 2
7	C	Let the original value of a, b and c be A, B and C respectively. After the first line, a = B, b = B, c = C; After the second line, a = B, b = C, c = C After the third line, a = B, b = C, c = B. Therefore, (iii) must be correct
8	C	Let's consider the value of b – a. Initially, b – a = 2015. And the value of b – a will be decreased by 11 every loop. After 183 loops, b – a becomes 2015 – 11×183 = 2, so the program will run for one more loop, so it runs for a total of 184 loops. c is added by one in every loop, so the answer is 184
9	A	The program can be improved by checking only i = 2 .. sqrt(n)

10	B	In order to minimize the no. of ways, the obstacle should be placed at these places: S.... .*... ....E or S.... ....*. ....E * stand for an obstacle And by simply counting, the no. of ways is 15.
11	B	Let F_n be the n^{th} Fibonacci number, tri[i][j] is actually equal to F_{i-j+1} when $j \neq 0$ and equal to 1 when $j = 0$. So tri[7][1] = F_7 = 13
12	B	Similar to Q.11 tri[13][7] = F_7 = 13
13	C	If all 42 numbers are the same, the no. of permutation is 1, so (i) is possible. If there are 41 numbers which are the same and 1 is different from them, the no. of permutation is 42, so (iii) is possible. If all 42 numbers are distinct, the no. of permutation is 1×2×3×…×42, so (iv) is possible.
14	A	If we store the temporary max as we iterating through the array, only 41 comparisons are needed
15	D	One way to think is that the computer's memory is a very large array.
16	C	Due to the last in first out property of a stack, the array will be reversed if it is pushed into and then popped from a stack. And if the array is pushed into and popped from a queue, it will have no effects on the array. So, if only one of P and Q is a stack, then the array will be reversed.
17	C	A bishop can visit any cell on the board wherever the sum of the coordinates are of the same parity. 24 + 12 = 36 (even) so it can visit (77, 53) since 77 + 53 = 130 (even), and (58, 12) since 58 + 12 = 70 (even). The answer is (i) and (iii) only
18	A	Let $\triangle x$ be the difference in x-coordinate of the destination and the current position and $\triangle y$ be that in y-coordinate. If both $\triangle x$ and $\triangle y$ are not zero, then one step can decrease both of them by 1, so the overall step will be max($\triangle x$, $\triangle y$). In this case, the answer is max(2552 – 37, 3736 - 121) = max(2515, 3615) = 3615
19	B	x[j] is the no. of prime factors of j, the prime factors of 30 is 2, 3 and 5, the prime factor of 37 is 37, the prime factors of 60 is 2, 3 and 5, the prime factor of 999 is 3 and 37. Therefore x[30] + x[37] + x[60] + x[999] = 3 + 1 + 3 + 2 = 9

20	D	If the input is larger than 20, then the output will be greater than 12, so A is not correct. If the input is larger than or equal to 10, then the output will be smaller, so B is not correct either. C is incorrect, in fact, there are 6 positive integers 2, 5, 6, 7, 8, and 9 which will produce the same output. Therefore, the answer is D.
21	D	This program's output is the index of the first maximum element. For A, the output is 4, for B, the output is 3, for C, the output is 2, for D, the output is 6.

22	D	If (7, 7) is removed, one of the solutions looks like this:
		`AABCCDD`
		`ABBECFD`
		`GGHEEFF`
		`IGHHJJK`
		`IILLJKK`
		`MMNLOPP`
		`MNNOOP*`
		If (3, 6) is removed, one of the solutions looks like this:
		`AABCCDD`
		`ABBECFD`
		`GGHEEFF`
		`GHHIJJK`
		`LLIIJKK`
		`LM*NOPP`
		`MMNNOOP`
		If (2, 5) is removed, one of the solutions looks like this:
		`AABBCDD`
		`EABCCDF`
		`EEGGHFF`
		`IIGJHHK`
		`I*LJJKK`
		`MLLNOOP`
		`MMNNOPP`

23 B

24 A Skylake is the codename used by Intel for a processor microarchitecture which was launched in August 2015.

25 B The best solution is to produce a number of villagers continuously until such amount and wait for 500 units of food. The best solution is explained below.

Time	No. of villagers	No. of food before	No. of food after
0	3 + 4 = 7	200	200 – 200 = 0
0 + 8 = 8	7 + 1 = 8	0 + 7 × 8 = 56	56 – 50 = 6
8 + 6 = 14	8 + 1 = 9	6 + 8 × 6 = 54	54 – 50 = 4
14 + 6 = 20	9 + 1 = 10	4 + 9 × 6 = 58	58 – 50 = 8
20 + 5 = 25	10 + 1 = 11	8 + 10 × 5 = 58	58 – 50 = 8
25 + 45 = 70	11	8 + 11 × 45 = 503	503 – 0 = 503

70 seconds is the fastest time.

Section B

<table>
<tr><th colspan="4">Answer and Explanation</th></tr>
<tr><td>A</td><td colspan="2"><code>write(sqrt(x):0:3)</code></td><td><code>printf("%.3f", sqrt(x))</code></td></tr>
<tr><td>B</td><td colspan="2"><code>x>1</code></td><td><code>x>1</code></td></tr>
<tr><td rowspan="2">C</td><td colspan="2"><code>x mod 2=1</code></td><td><code>x%2==1</code></td></tr>
<tr><td colspan="3">We need to multiply x by 3 and then plus one when x is an odd number</td></tr>
<tr><td rowspan="2">D</td><td colspan="2"><code>x:=x div 2</code></td><td><code>x=x/2</code></td></tr>
<tr><td colspan="3">We need to divide x by 2 when x is an even number.</td></tr>
<tr><td>E</td><td colspan="3">7
These 7 people are 1, 2, 3, 7, 8, 9, 10</td></tr>
<tr><td>F</td><td colspan="3">4
These 4 people are 1 (or 2), 4, 5, 8 (or 9).</td></tr>
<tr><td>G</td><td colspan="2"><code>21</code></td><td><code>61</code></td></tr>
<tr><td rowspan="2">H</td><td colspan="2"><code>if (a[l] = x) then</code></td><td><code>if (a[l] == x)</code></td></tr>
<tr><td colspan="3">After finishing the binary search, <code>r</code> will be the index of the last number less than <code>x</code>, and <code>l</code> is equal to <code>r + 1</code>, <code>a[l]</code> must not be less than <code>x</code> and all the element after <code>a[l]</code> will be greater than <code>a[l]</code>, so <code>a[l] = x</code> if and only if <code>x</code> is an element of <code>a</code>.</td></tr>
<tr><td>I1</td><td colspan="3">Primes and their powers (eg. 31, 32)
Suppose x = a * b (a <= b), the program will output a then a * b which is incorrect. If x is a prime or a prime power, then</td></tr>
<tr><td>I2</td><td colspan="3">All other numbers (eg. 33, 34)
See I1.</td></tr>
<tr><td rowspan="2">J</td><td colspan="2"><code>abs(a-x)+abs(y-b)=3</code></td><td><code>abs(a-x)+abs(y-b)==3</code></td></tr>
<tr><td colspan="3"><code>abs(a-x)+abs(y-b)</code> is the Manhattan distance of the center of two crosses. If two crosses are connected, the distance of the center is 3. Since the two crosses do not overlap, so the difference in x and y coordinates of two crosses will not be 1, therefore if their distance is 3, their center will be in either the same row or the same column.</td></tr>
<tr><td rowspan="2">K</td><td><code>(abs(a-x)+abs(y-b)=4)and(a<>x)and(y<>b)</code></td><td colspan="2"><code>abs(a-x)+abs(y-b)==4 && a!=x && y!=b</code></td></tr>
<tr><td colspan="3">If two crosses touch each other, the distance of the center is 4. Since the two crosses do not overlap, so the difference in x and y coordinates of two crosses will not be 1 but may be zero. So we need to check if it is the case.</td></tr>
<tr><td>L</td><td colspan="2"><code>length(s)</code></td><td><code>strlen(s)</code></td></tr>
<tr><td rowspan="2">M</td><td colspan="2"><code>(s[i-1]=' ')and(s[i]<='Z')</code></td><td><code>s[i-1]==' '&&s[i]<='Z'</code></td></tr>
<tr><td colspan="3">We first check whether the previous character is a space and then check whether the current character is a capital letter.</td></tr>
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