Hong Kong Olympiad in Informatics 2013
Heat Event (Junior Group)
Official Solution

Statistics (N = 190)

Full mark = 46. Maximum = 37. Median = 18.5. Advance to Final = 21 marks or above.

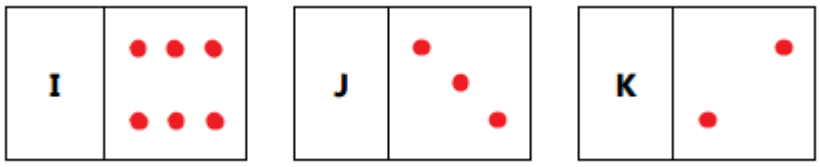
Section A

Q	A	Explanation
1	F	Cloud computing is, of course, unrelated to the real clouds on the sky.
2	T	Integers are 32-bit signed variables (**Pascal**: `longint`, **C**: `int`) as defined in the instructions. Let's say `int a = -2000000000, b = -2000000000`, `a + b` exceeds the range of `int`, and therefore would result in overflow.
3	F	If `n = -1`, `n / 2` gives `0` while `n / 2.0` gives `-0.5`.
4	F	In Fibonacci sequence the pattern is as follows: 2 odd numbers followed by 1 even number and so on. Therefore no such N exists.
5	T	They can be used in this way.
6	A	In situation ii, there exists a winning strategy for the first player if the first player place an 'O' at the center for the next move.
7	C	Let the positions of A, B, C and D be *a*, *b*, *c* and *d* respectively. We have $c - a \leq 5$, $d - b \leq 9$ and $c - b \geq 3$, which means $b - c \leq -3$. Distance between D and A: $$d - a = d - b + b - c + c - a = (d - b) + (b - c) + (c - a)$$ To maximize $d - a$, we maximize $d - b$, $b - c$ and $c - a$. $$d - a \leq 5 + 9 + (-3) = 11$$
8	C	Among positive integers, only 1, 2, 4, 5, 8, 11 are unobtainable. If $n \equiv 0 \pmod 3$, it is obviously obtainable ($x = n/3$). If $n \equiv 1 \pmod 3$, one solution is $x = (n - 7)/3$ and $y = 1$. If $n \equiv 2 \pmod 3$, one solution is $x = (n - 14)/3$ and $y = 2$.
9	A	Program code in the same line after the inline comment symbol `//` are ignored
10	B	Here, `k = k * 2;` would be executed if and only if `i == k` k = 2→4→8→16→32→64→128→256→512→1024→2048 (as 1024<2013)
11	C	The program implements bubble sort. Array `a` after the fourth iteration of `i`: 4,7,1,6,2,8,3,5→4,1,6,2,7,3,5,8→1,4,2,6,3,5,7,8→1,2,4,3,5,6,7,8→1,2,3,4,5,6,7,8 Question is asking for `ans = a[j] = a[7-i] = a[7-3] = a[4] = 5`

Q	A	Explanation
12	C	Let *x* and *y* be the values of wine X and wine Y (in thousands). $\begin{cases} \frac{1}{2}x = \frac{1}{3}y + (\frac{1}{2})(3) \\ \frac{2}{3}y = \frac{1}{4}x + (\frac{1}{4})(3) \\ (\frac{3}{4})(3) = \frac{1}{4}x + \frac{1}{3}x \end{cases}$ $\begin{cases} 3x = 2y + 9 \\ 8y = 3x + 9 \\ 27 = 3x + 4y \end{cases}$ By solving the equations we get $x = 5$ and $y = 3$.
13	D	We have: `A=E, A=!B, D=!B, C=D, D=!G, F=!D, F=G` From the first four clauses we can deduce `D=!B=A=E`, so `D=E`. This question can also be solved by arbitrarily assigning values to the variables, such as A = true. Then the values of other variables can be easily obtained.
14	A	'0'<'1'<'2'<'3'<'h'<'i'<'k'<'o' in character comparison. `h` > `a`, so `h` is printed. `k` > `h`, so `k` is printed. `o` > `k`, so `o` is printed. The remaining characters are all smaller than `o`.
15	D	It is always possible that today is cloudy. Then, Ken feels sad and eats a lot of dinner. Thus, all three conditions are possible.
16	C	Precision error occurs in code segment iii. In code segment ii, `b = b - 0.5` would not result in precision error as both 2013.0 and 0.5 can be accurately stored using floating point data types.
17	B	P1 prints $N(N-1)(N-2)/6$ '*'s. For $N = 4$, P1 prints 4 '*' s P2 prints N^2'*'s. For $N = 4$, P2 prints 16 '*'s P3 prints fewer than $N(1 + \lfloor \log_2 N \rfloor)$ '*'s. For $N = 4$, P3 prints 12 '*' s P4 prints $2^{N-4} - 1$ '*'s. For $N = 4$, P1 prints 0 '*' s
18	A	P1 prints $N(N-1)(N-2)/6$ '*'s. For $N = 9$, P1 prints 84 '*' s P2 prints N^2'*'s. For $N = 9$, P2 prints 81 '*'s P3 prints fewer than $N(1 + \lfloor \log_2 N \rfloor)$ '*'s. For $N = 9$, P3 prints 33 '*' s P4 prints $2^{N-4} - 1$ '*'s. For $N = 9$, P1 prints 31 '*' s
19	C	We only need to compare P1 and P4 as P1 has the highest degree of *N*. For $N = 11$, P1 prints 165 '*'s, P4 prints 127 '*'s. For $N = 12$, P1 prints 220 '*'s, P4 prints 255 '*'s. (P2: 144, P3; 44)
20	D	The program copies the value of `s[9-i]` to `s[i]` but not the reverse. `hkoi` is overwritten.
21	D	The expression did not check `a+b>c`. (The first two conditions are equivalent)
22	B	Answer = $3C2 \times 3^2 = 27$
23	B	`f(n)` returns the number of '1's in the binary representation of `n`. From 0 to 15, '1' appears 8 times for each bits 0 - 3. Answer = 8*4 = 32

Q	A	Explanation
24	Cancelled	
25	A	For each distinct prime factor *p* of *n*, `ans = ans / p * (p-1)` So f(53) = 53/53*52 = 52, f(54) = 54/2*1/3*2 = 18, f(55)=55/5*4/11*10 = 40, f(56)=56/2*1/7*6 = 24

Section B

<table>
<tr><th colspan="3">Answer and Explanation</th></tr>
<tr><td>A</td><td colspan="2">16
Try 1, 11, 111, 1111, etc. Using long division you will get you the answer.
Note that there are only 17 possible remainders (0-16) when a number is divided by 17 so the maximum number of tries required is 17.</td></tr>
<tr><td>B</td><td colspan="2">108
Initial village = 4 choices, after first step each time we have 3 choices.
Therefore number of paths with length 3 is $4 \times 3 \times 3 \times 3 = 108$.</td></tr>
<tr><td>C</td><td colspan="2"><code>hkoi2013hkoi201</code> or <code>koi2013hkoi2013</code>
We just need to repeat the string once. We also need to remove the first or the last character (repeated substring) due to character limitation.</td></tr>
<tr><td>D</td><td>14</td><td>54</td></tr>
<tr><td>E</td><td colspan="2"><code>abs(x1-x2)+abs(x1-x2)</code> or
<code>(x1-x2)*(x1-x2)+(y1-y2)*(y1-y2)</code>
The function <code>dist</code> returns an <code>int</code>.
The program fails to distinguish 1 (exactly 1) and $\sqrt{1+1} \approx 1.41$.</td></tr>
<tr><td>F</td><td colspan="2"><code>a[i]=maximum</code> or <code>max(a[i], maximum)</code></td></tr>
<tr><td>G</td><td colspan="2"><code>break</code></td></tr>
<tr><td>J</td><td colspan="2"><code>max(0,n-1)</code>
The basic principle of the function is to find out the position of maximum element (using linear search), and set that element to negative so that the second maximum element become the maximum element.</td></tr>
<tr><td></td><td colspan="2"> 

The fastest way to solve this problem is to tear out the question paper and fold a dice yourself!</td></tr>
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