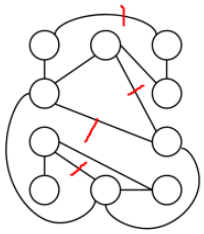
Hong Kong Olympiad in Informatics 2016/17
Heat Event (Senior Group)
Official Solution

Statistics (N = 238)

Full mark = 45. Maximum = 36. Median = 14.5. Advance to Final = 17 marks or above.

Section A

Q	A	Explanation
1	B	We can compare 1st and 2nd element, 3rd and 4th element, and compare the larger one of them to get the maximum element. Then compare the smaller one of them to get the minimum element. Total comparisons is 4.
2	C	In the worst case, (i) is O(N), (ii) is O(NlogN), (iii) is O(logN)
3	C	Since 2017 = 11111100001 (binary), all the bits from 0 to 10 from leftmost has appeared. So the OR sum of 1 to 2017 is 2^11 – 1 = 2047
4	C	We can turn the graph into a tree. A tree is a graph with N node and N – 1 edge which all the node is connected. So, the maximum edge we can delete is 13 – (10 – 1) = 4. The following is one of the solution. 
5	A	We can observe that a is made by repeating {1, 5, 8, 2, 3} 20 times. So the sum is (1 + 5 + 8 + 2 + 3) x 20 = 380
6	D	Ransomware is a type of malicious software which encrypts the victim's files, making them inaccessible and demands a ransom payment to decrypt them.
7	A	The nature of nested function calling and returning is the same as that of a stack.
8	B	A = [0, 6] B = [0, 4] B – A = [0, 4] – [0, 6] = [-6, 4] = 11 possible outputs.

9	B	Assume B is the correct answer. Let the correct answer be T and the wrong answer be F. Since there is only one correct answer: A = F, B = T, C = F, D = F When A is F, (B != T and C != T) need to be false When B is T, (C != T and D != T) need to be true When C is F, (C = T) need to be false When D is F, (A != T and B != T) need to be false. The situation in above satisfy all the restrictions. So B is the answer, other cases will result in contradiction.
10	C	AlphaGo is a Ai computer program developed by Google that plays the board game Go. Deep blue is designed for playing chess. Pokémon Go is a mobile phone game. DuckDuckgo is a search engine.
11	D	Program A is insertion sort as in each for loop, a[0..i – 1] is already sorted and it moves a[i] to the suitable position.
12	A	There is only two cases to pick two numbers which their product is not a multiple for four. 1. odd x odd 2. 2k x odd, where k is an odd number So the number of ways is 50C2 + 50 x 25 = 2475
13	A	If we place a rook on (x, y), we cannot place any rook on row x and column y any more. So, we can view place a rook on (x, y) as delete row x and column y. If the player cannot delete any row or column (all row or column is deleted), he loses. So we only care about min(N, M) as after min(N, M) moves, row or column are all deleted and the game is ended. If min(N, M) is odd, then the first player win, else the first player lose. Only min(3, 5) is odd, so only when N = 3 and M = 5, Alice will win.
14	B	No matter f(x) will overflow, f(x) is always even number. When x * 2 >= 2^31, x will overflow and become negative number. E.g f(2^30) = 2^31 = 2147483648 = -2147483648. So (i) is true and (ii) is false.
15	A	An undirected graph has an Eulerian path if and only if exactly zero or two vertices have odd degree, and all of its vertices with nonzero degree belong to a single connected component.
16	C	(ii) is not possible because when Alice go, Bob will also go. So there don't exist situation that when Alice go, Bob doesn't go.
17	C	One way to do this question is to trace carefully. Other way is to observe that the output is the sum of a[2..3][3..4] where a[i][j] = i * 4 + j.

18	A	If one of x or y is negative integer, (i), (ii) and (iii) may wrong because of two's complement.
19	B	Trace the program carefully and will get the following result. A = 20 B = 40 C = 30 D = 30
20	A	The program will output a * max(0, (8 – b)) number of *s. So A will output 12 *s. B will output 10 *s. C will output 0 *s. D will output 11 *s.
21	D	Notice in the j for loop, it compare a[i] and a[i + 1] but not a[j] and not a[j + 1]. So it is not bubble sort. Trace the program carefully and you will get the answer.
22	D	Because 0.2 cannot precisely represented by floating point data type but 2.0 can, so 'B' is not outputted and 'C' is outputted.
23	A	Notice that 7! = 5040 > 2017. So ai is < 7 for any i from 1 to n. We can use greedy algorithm, which pick the number k from 6 to 0 whenever the current sum + k! <= 2017, to find out the solution which n is minimized. We can get 2 * 6! + 4 * 5! + 4 * 4! + 1! = 1440 + 480 + 96 + 1 = 2017. However, since 0! = 1! =1, we can replace 1! with 0!. So the sum of ai = 2 * 6 + 4 * 5 + 4 * 4 + 0 = 48
24	C	The 3rd line only restrict that data has to be an array and the first element of data is a number. So it CAN store an array of 10 numbers.
25	D	a.slice(x, y) extracts a section of array from a[x] to a[y]. If y is omitted, the a.slice(x) extracts a section of array from a[x] to end of array. So a.slice(0) extract array a from a[0] to its end, which means make a copy of array.

Section B

Answer and Explanation		
A1	`22`	`62`
A2	`a[j + 1] := t;`	`a[j + 1] = t;`
	`j` is the last index where `a[j] <= t`, so we should insert `t` in `a[j + 1]`	
B	`7`	
C	`7 5 3 x + 8 4 / -` OR `7 5 3 x 8 4 / - +`	
D	`1, 7, 10` (allow permutation)	
E	`3`	
F	`st + ed - i`	
	`st + ed – i` means the last i^{th} element	
G	`true`	`true` or `1`
	A character is always a palindrome	
H	`s[st] = s[ed]`	`s[st] == s[ed]`
	A string of two character is palindrome if both characters are equal	
I	`(s[st] = s[ed]) and f(st + 1, ed – 1)` (Accept reverse order)	`s[st] == s[ed] && f(st + 1, ed – 1)` (Accept reverse order)
	A palindrome is made by two equal character including another palindrome	
J	`(x * x * x * x mod y = 0) and (y * y * y * y mod x = 0)`	
	`X * x * x * x % y == 0 && y * y * y * y % x == 0`	
	Because 2^5 = 32 > 30, so in prime factorization, the power of prime must <= 4. If we take the number to the power of 4, one can always be divided by other number if they have common prime set.	
K	`min(a * a * 9 + 4 + a, b * b * 9 + 4 + b) mod 9 - 4`	
	`min(a * a * 9 + 4 + a, b * b * 9 + 4 + b) % 9 - 4`	
	Square the number to compare abs(a) and abs(b). Then we have to compare a and b, because [-4, 4] have 9 number, we first multiply 9 to the square, so that the number is now = 0 (mod 9). After that we add 4 plus that number (we treat -4 as 0 and 4 as 9). Finally, mod the number by 9 and minus 4 to get the original number. In this way, we can compare the absolute value first, then the original value.	
L	`16`	
	Count the number of pairs such that `a[j] > a[i] and j < i`	
M	`17`	
	Count the number of tuples such that `a[k] > a[j] > a[i] and k < j < i`	