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

**Statistics (N = 256)**

Full mark = 45. Maximum = 41. Median = 16.75. Advance to Final = 20 marks or above.

**Section A**

| Q | A | Explanation |
|---|---|---|
| 1 | F | Random-Access Memory(RAM) is a hardware which cannot be downloaded from the Internet. |
| 2 | F | Both USB 2.0 and USB 3.0 data signals are digital. One of the reason why USB 3.0 has higher data transfer rate is because it supports full duplex data transfer. |
| 3 | T | A char requires 1 byte (8 bits) to represent 0 ~ 255 (or -128 ~ 127 depend on compiler). |
| 4 | T | No matter when x is true or false, (x and (not x) ) is always false. |
| 5 | F | Here is the proof. |
| 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]<br>B = [0, 4]<br>B – A = [0, 4] – [0, 6] = [-6, 4] = 11 possible outputs. |
| 9 | B | Assume B is the correct answer.<br>Let the correct answer be T and the wrong answer be F. Since there is only one correct answer:<br>A = F, B = T, C = F, D = F<br>When A is F, (B != T and C != T) need to be false<br>When B is T, (C != T and D != T) need to be true<br>When C is F, (C = T) need to be false<br>When D is F, (A != T and B != T) need to be false.<br>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.<br>Deep blue is designed for playing chess. Pokémon Go is a mobile phone game.<br>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.<br>Program B and C can't sort the number correctly.<br>Program B is bubble sort as in each i for loop, it move the smallest number in a[i..n – 1] into a[i] |
| 12 | B | There is only two cases to pick two numbers which their product is not a multiple for four.<br>1. odd x odd<br>2. {2, 6} x odd<br>So the number of ways is 4C2 + 2 * 4 = 14. |
| 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.<br><br>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.<br><br>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.<br>When x * 2 >= 2^31, x will overflow and become negative number.<br>E.g f(2^30) = 2^31 = 2147483648 = -2147483648. So (i) is true and (ii) is false. |
| 15 | B | Notice that we only need to consider the last character since y can always be express in 16k + (s[n – 1] – 'A') where 16k is a even number. So we only care about (s[n – 1] – 'A') is even or not. Only (ii) satisfy it. ('E' – 'A' = 4 = even number) |
| 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 | A | Let's rephrase the question in to the following.<br>Which of the expression is same as (x >= y)<br>b) (-x <= -y)<br>c) (y < x)<br>d) !(x -y <= y – x)<br><br>b = (-x <= -y) = (x >= y)<br>c) (y < x) = (x > y)<br>d = !(x – y <= y – x) = !(x <= y) = x > y<br><br>So only b is same as (x >= y) |

| | | |
|---|---|---|
| 18 | D | Since x and y is unsigned integer. (x \|\|\| y) performs logical OR on x's and y's bit patterns. So no 1's bit will lost and the result is always >= x and >= y.<br>(x \|\|\| y) performs logical AND on x's and y's bit patterns. So no 1's bit will gain and the result is always <= x and <= y.<br><br>So both (i), (ii) and (iii) are true. |
| 19 | B | Trace the program carefully and will get the following result.<br>A = 20<br>B = 40<br>C = 30<br>D = 30 |
| 20 | A | The program will output a * max(0, (8 – b)) number of *s.<br>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 | C | There is 3 if part in this program.<br><br>1) if (score >= 90) cout << "A"; else if (score >= 80) cout << "B";<br>2) if (score >= 70) cout << "C";<br>3) if (score >= 60) cout << "D"; else cout << "F";<br><br>70 satisfy (2) and the first if statement of (3).<br>So the output is CD. |
| 23 | A | Notice that 7! = 5040 > 2017.<br>So ai is < 7 for any i from 1 to n.<br><br>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.<br><br>We can get 2 * 6! + 4 * 5! + 4 * 4! + 1! = 1440 + 480 + 96 + 1 = 2017.<br><br>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.<br>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)<br>(Accept reverse order) | s[st] == s[ed] && f(st + 1, ed – 1)<br>(Accept reverse order) |
| | A palindrome is made by two equal character including another palindrome | |
| J | i * a + j – a (may replace a by 4) | |
| K | (i + j – 2) mod a + 1<br>(May replace a by 5) | (i + j – 2) % a + 1<br>(May replace a by 5) |
| L | x mod 10 + x div 10 mod 10 (or x mod 100 div 10) + x div 100 = 8 | |
| | x % 10 + x / 10 % 10 (or x % 100 / 10) + x / 100 == 8 | |
| | x % 10 is the units digit. x div 10 mod 10 is the tens digit.<br>x div 100 is the hundreds digit. | |
| M | 16 | |
| | Count the number of pairs such that a[j] > a[i] and j < i | |