

Part A: Questions 1–6

Each question should be answered by a single choice from A to E.
Questions are worth 3 points each.

1. Maze Shortcut

The way through the maze below passes through all 49 cells.

1	2	9	10	11	12	13
4	3	8	23	22	15	14
5	6	7	24	21	16	17
28	27	26	25	20	19	18
29	34	35	40	41	46	47
30	33	36	39	42	45	48
31	32	37	38	43	44	49

How long is the shortest path made possible by removing one wall of one cell?

- (A) 15 (B) 17 (C) 19 (D) 21 (E) 23

2. Up and Down

Given the list of numbers 1 3 4 2, you can extract three 'up-down' lists 1 3 2, 1 4 2, and 3 4 2, where the second digit is greater than the first and the third is smaller than the second.

How many 'up-down' lists can you make from 1 3 2 5 9 7 6 8 4?

- (A) 30 (B) 32 (C) 34 (D) 36 (E) 38

3. Don't like climbing

You wish to walk from the top-left cell to the bottom-right cell. You don't want to walk any further than you need to, so you will only walk right or down. But you don't like climbing so want to climb as little as possible. The number in a cell gives its height in metres. For instance, going from a cell at height 3 to one of height 5 means you climb 2 metres. Note that going downhill, such as from 5 to 3, counts as 0.

What is the least amount of climbing that you must do to walk from the top-left (shaded) cell to the bottom-right (shaded) cell?

0	4	2	4	1
3	2	4	2	4
1	3	2	3	2
3	1	2	0	3

(A) 5

(B) 6

(C) 7

(D) 8

(E) 9

4. Move 1 or 2

A game between two people is based on a line of numbers. Each number is either 1 or 2. Players take turns moving a token along the line. If the token is on a 1, it must be moved one place to the left. If it is on a 2, it can be moved either one or two places to the left. The aim of the game is to make your opponent make the last move, which will take the token off the line of numbers.

You are to start the game below.

P Q R S

1 2 2 2 1 2 2 2 1 2 1 1 1 2 1 2 1 1 2 2

Which of the starting positions P Q R S would guarantee you a win?

(A) P and Q

(B) P and R

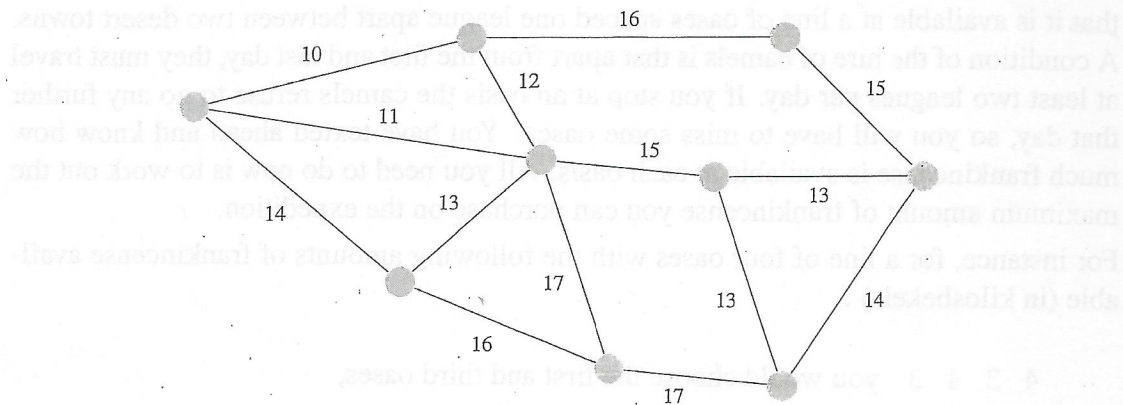
(C) Q and R

(D) Q and S

(E) R and S

5. The New Truck

A mining community consists of 9 towns that are already connected by an extensive road system. However a new truck has been ordered that requires some of the existing roads to be widened. A survey has revealed the cost of widening each section of road and the results are given on the diagram below. The costs are given in the local currency of rads. The council is not concerned whether the truck travels by the shortest route. It only requires that there is a way the truck will be able to travel from any one town to any other town in the community.

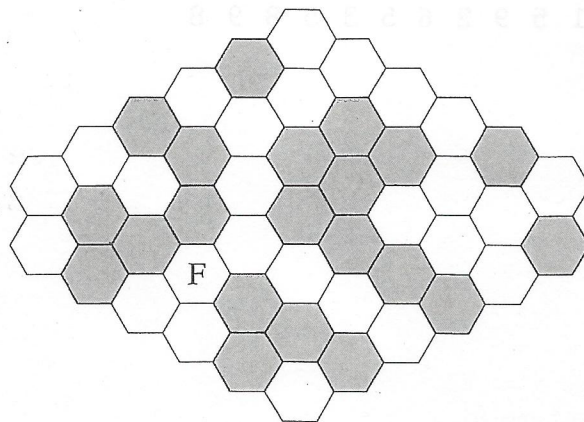
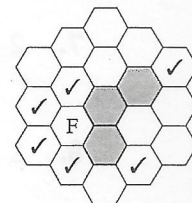


What is the smallest total cost in rads that the council would have to pay?

- (A) 100 (B) 102 (C) 104 (D) 106 (E) 108

6. Hex Frog

A frog is sitting on a lily pad in a large pond. The frog may jump from one lily pad to another. However, the frog may only jump straight up or down, or diagonally at 60° from the vertical. It can jump over large spans of water, but it may not jump over another lily pad or land in the water. (White squares represent lily pads and grey squares represent water.)



In the diagram above, the frog is on the lily pad marked F. The number of pads that are more than 3 jumps away from the frog is

- (A) 2 (B) 3 (C) 4 (D) 5 (E) 6

Part B: Questions 7–15

Each question should be answered by a number in the range 0–999.
Questions are worth 2 points each.

7–9. Camels

You are mounting an expedition to collect Hojari frankincense. You have determined that it is available at a line of oases spaced one league apart between two desert towns. A condition of the hire of camels is that apart from the first and last day, they must travel at least two leagues per day. If you stop at an oasis the camels refuse to go any further that day, so you will have to miss some oases. You have texted ahead and know how much frankincense is available at each oasis. All you need to do now is to work out the maximum amount of frankincense you can purchase on the expedition.

For instance, for a line of four oases with the following amounts of frankincense available (in kiloshekels) :

- 4 3 4 3 you would choose the first and third oases,
2 4 5 4 you would choose the second and fourth oases,
5 4 2 3 you would choose the first and fourth oases.

In each case you would buy 8 kiloshekels.

From each line of oases with availabilities of frankincense, determine the maximum total amount you could buy without stopping at adjacent oases.

7. 2 5 2 4 7 4 5 5

8. 1 2 4 3 2 1 2 3 1 2 1

9. 3 1 4 1 5 9 2 6 5 3 5 8 9 8

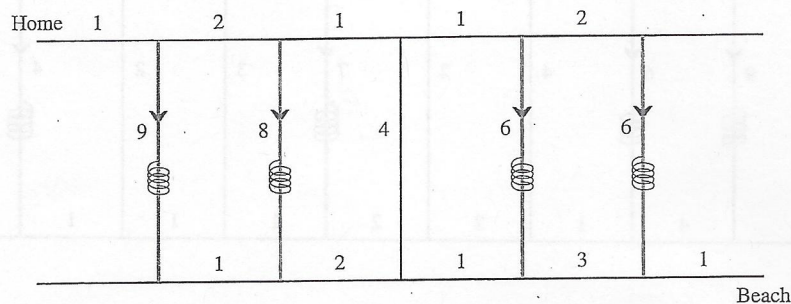


10–12. Electric Car

You intend driving from home to the beach in your new all-electric car. Your battery is only partly charged with 20kWh, and there is no recharge station at the beach, so you want to arrive with as much charge in your battery as possible. Some of the roads on the way are equipped with remote induction technology that charges the battery while you drive. You don't mind driving extra distance provided it increases your battery charge, but the induction roads are one way, and you are not permitted to circle round and keep recharging the battery.

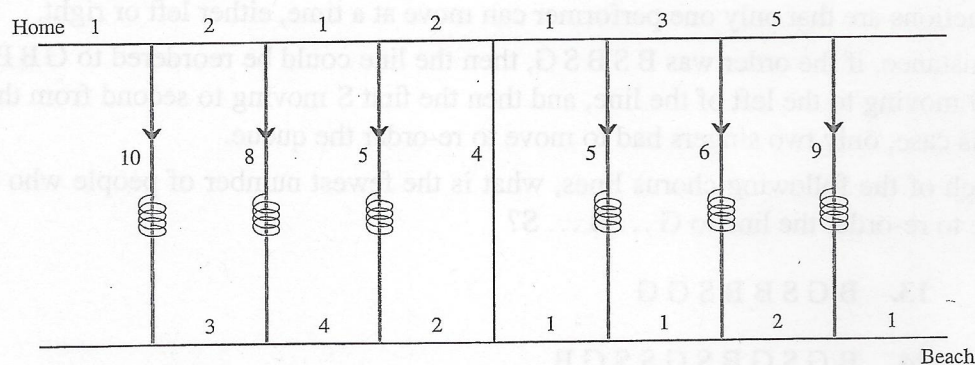
For example, on the roads below, the numbers indicate how many kWh you use on the normal roads, or the amount of charge you will get on the induction roads. Arrows indicate the direction you can travel. Your best route is to take the first road down, go back up the middle road, and then down the last road.

This leaves you with $20 - 1 + 9 - 1 - 2 - 4 - 1 - 2 + 6 - 1 = 23$ kWh.

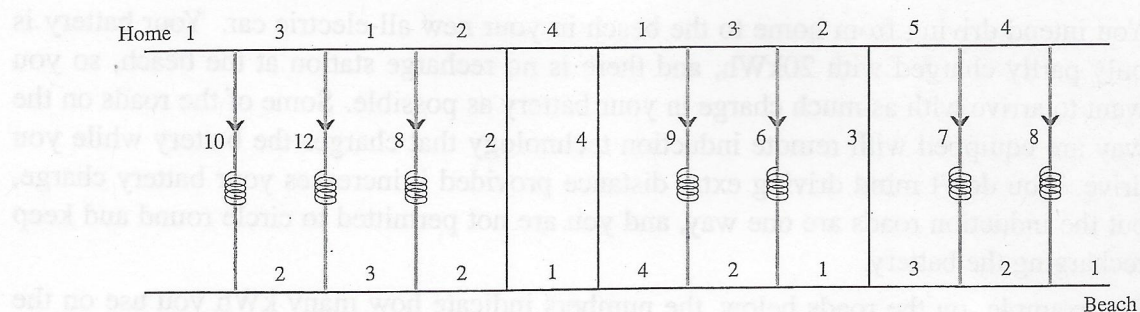


For each of the roads below, what is the greatest number of kWh you could have in your battery on arriving at the beach? In each case, your battery starts with 20kWh.

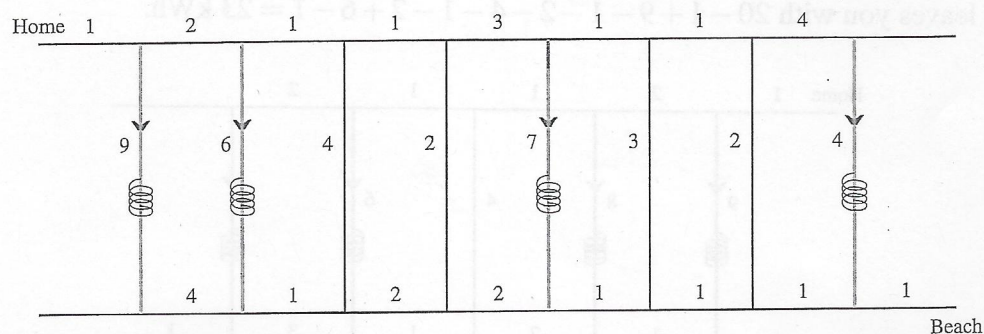
10.



11.



12.



13–15. Carmen

During a performance of the opera Carmen, a chorus line of gypsies (G), bullfighters (B) and soldiers (S) has to be re-ordered so that all of the gypsies are at the left end of the line, the bullfighters are in the middle, and the soldiers are on the right. The director's instructions are that only one performer can move at a time, either left or right.

For instance, if the order was B S B S G, then the line could be reordered to G B B S S by the G moving to the left of the line, and then the first S moving to second from the right. In this case, only two singers had to move to re-order the queue.

In each of the following chorus lines, what is the fewest number of people who have to move to re-order the line to G ... B ... S?

13. B G S B B S G G

14. B G S G B S G S S G B

15. B G S G B S G S S G B B G S G B S G S S G