UNIVERSITY OF WATERLOO

The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

2021 Beaver Computing Challenge (Grade 9 & 10)

Questions

Part A

Messages

Story

Beaver Xavier creates a code by representing letters using only the digits 1 and 0 as shown.

Letter	T	E	A	K	C	R
Code	1	00	0010	0110	1010	1110

Xavier uses the letters to write a message for Yvonne. Then he replaces each letter with the corresponding code and sends her the result.

Question

Which of the following messages does Xavier write if he sends Yvonne 100100110001010001011000 ?

(A) TEACRATE

(B) EATCAKE

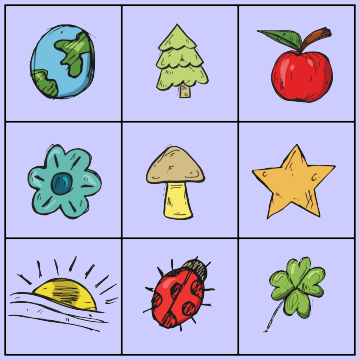
(C) TAKECARE

(D) RETAKE

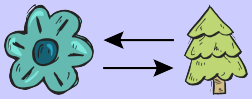
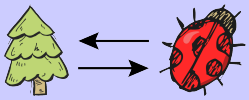
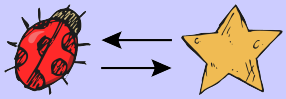
Arranging Objects

Story

A board is divided into squares and a different object is placed in each square as shown.

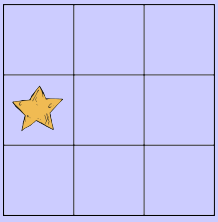


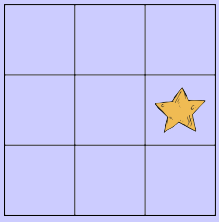
A *swap* exchanges the locations of two objects. Three swaps occur in this order:

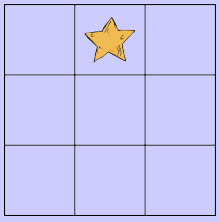
1. 
2. 
3. 

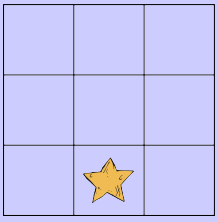
Question

What is the location of  after the last swap?

(A) 

(B) 

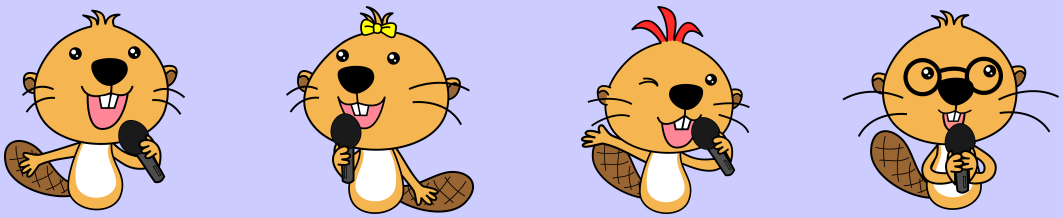
(C) 

(D) 

Singing Contest

Story

Three judges evaluate four singers in a singing contest.



Each judge uses their own scoring system, resulting in the following scores.

Singer	Judge 1	Judge 2	Judge 3
Ara	9	85	20
Benito	7	100	15
Chien	8	70	25
Dennis	10	60	45

The different scoring systems make it difficult to declare a winner, so the judges each rank the singers 1st, 2nd, 3rd, and 4th from highest to lowest score.

For example, Judge 1 ranks Benito 4th since Benito received the lowest score by Judge 1. Judge 2 ranks Benito 1st since Benito received the highest score by Judge 2.

Each singer's ranks are then added together to get their *rank sum*. The singer with the *lowest* rank sum is declared the winner.

Question

Who won the singing contest?

(A) Ara

(B) Benito

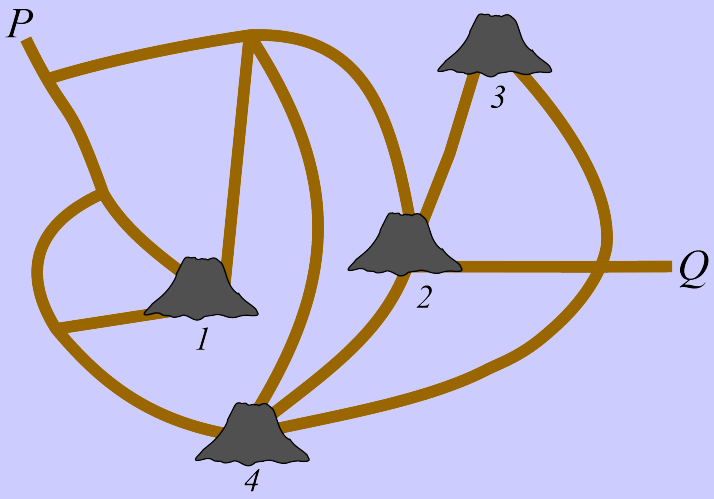
(C) Chien

(D) Dennis

Volcanoes

Story

In the map shown, Dino can follow roads and can climb up and over volcanoes unless they are erupting.



Because two volcanoes are erupting, Dino cannot get from point P to point Q.

Question

Which two volcanoes are erupting?

(A) Volcanoes 1 and 2

(B) Volcanoes 3 and 4

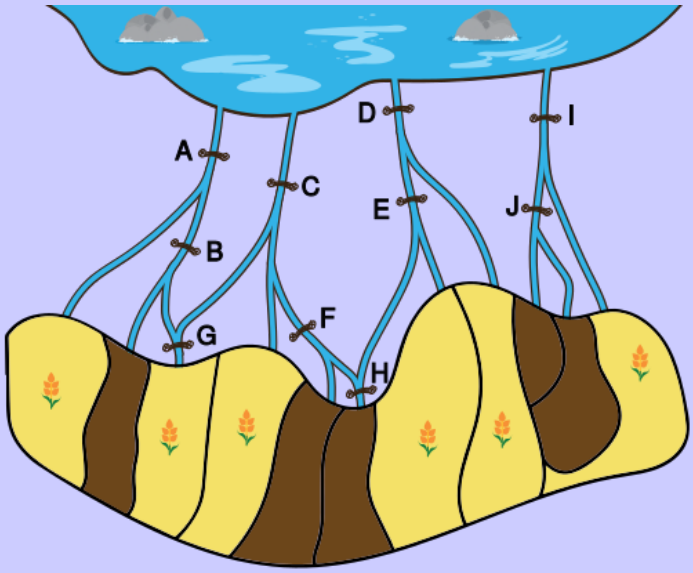
(C) Volcanoes 1 and 4

(D) Volcanoes 2 and 4

Wheat Field Irrigation

Story

Water flows from a lake along irrigation channels towards some fields. The water only flows downwards in the diagram. Valves at the spots marked A to J can each be open or closed. When a valve is closed, water stops flowing further towards the fields through that channel. Water can flow past an open valve.



A farmer configures the valves so that water is supplied to the six yellow wheat fields marked with , but no water is wasted on the other five fields of weeds shown in brown.

Question

How many valves are closed?

(A) 2

(B) 3

(C) 4

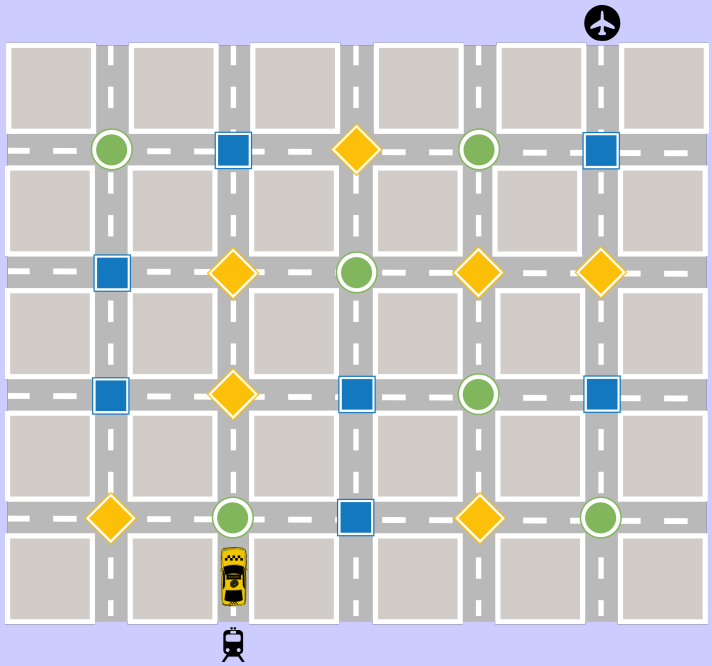
(D) 5

Part B

Taxi

Story

A taxi travels from the train station to the airport along the city streets shown in the map below. At each intersection, the taxi travels one block in the direction indicated by the symbol at that intersection.



Question

Which of the following gives the correct instruction for each symbol?

(A)
- continue in the same direction
- turn the taxi to the driver's left
- turn the taxi to the driver's right

(B)
- continue in the same direction
- turn the taxi to the driver's right
- turn the taxi to the driver's left

(C)
- turn the taxi to the driver's right
- turn the taxi to the driver's left
- continue in the same direction

(D)
- turn the taxi to the driver's left
- turn the taxi to the driver's right
- continue in the same direction

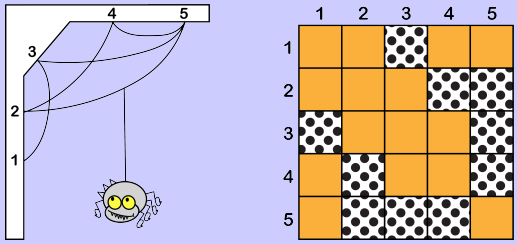
Spider Quilts

Story

When Wanda sees an interesting spider web, it inspires her to design a new quilt. She first numbers the places where the web is anchored to the wall from 1 to n. Then she arranges dotted  and solid  fabric squares into an n by n grid as follows:

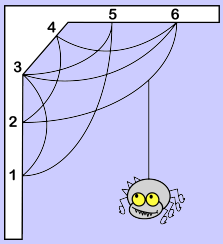
- For every piece of web silk, if its anchors are numbered x and y, she places:
  - one dotted fabric square where row x and column y meet, and
  - another dotted fabric square where row y and column x meet.
- Wanda fills the rest of the grid using solid fabric squares.

For example, the spider web on the left inspired Wanda to design the quilt on the right.

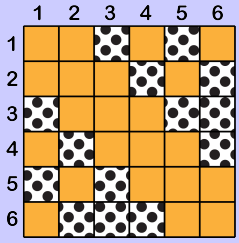


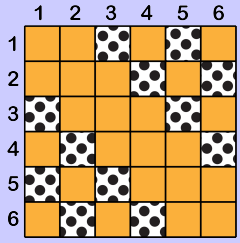
Question

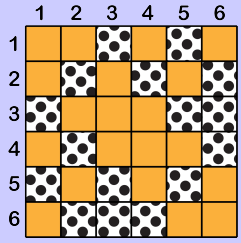
Wanda now sees the following spider web.

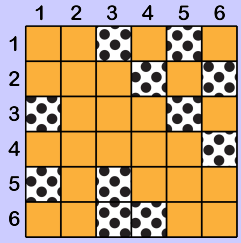


What new quilt will this inspire her to design?

(A) 

(B) 

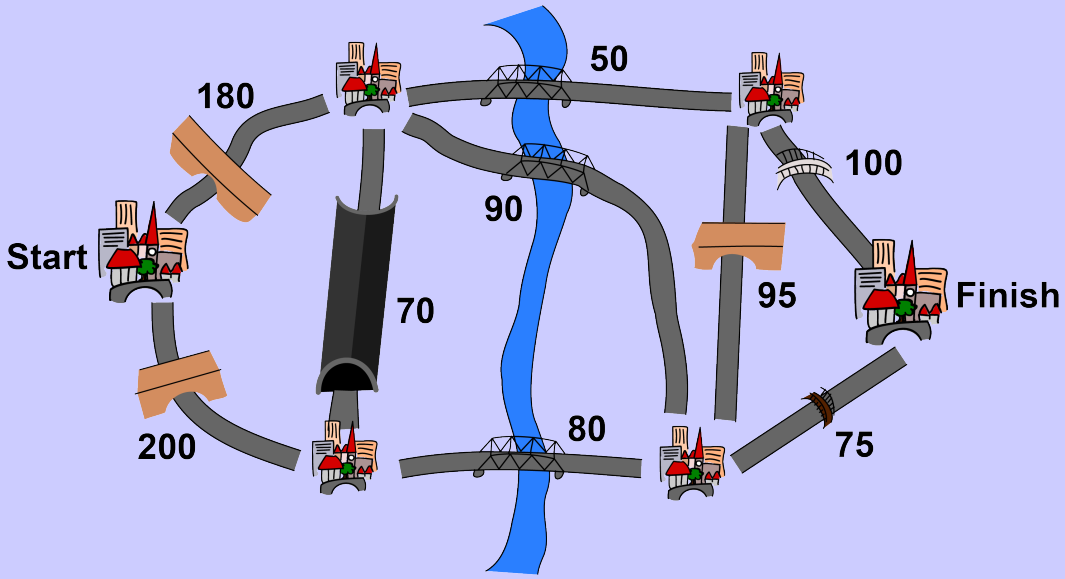
(C) 

(D) 

Travelling Trucks

Story

Trucks travel between six cities using the roads shown in the diagram. Each road has a bridge or tunnel that limits the height of a truck that can travel along it. The maximum truck height for each road is indicated in the diagram.



Question

What is the maximum height of a truck that can travel from Start to Finish?

(A) 70

(B) 80

(C) 90

(D) 95

Picket Painting

Story

A beaver wants to paint as many pickets of a fence as possible using the following cans of paint.

		
4 cans of red paint	3 cans of blue paint	2 cans of yellow paint

The amount of paint in one can is exactly the amount needed to paint one picket.

Two half cans of different colours can be mixed to paint one picket but the paint cannot be mixed in any other way. Mixing yellow and blue makes green. Mixing red and yellow makes orange. Mixing red and blue makes violet. This means that there are six possible colours for the pickets.

The fence must be as colourful as possible. Specifically:

- One colour cannot be used to paint two pickets unless there is at least one picket of every other colour.
- One colour cannot be used to paint three pickets unless there are at least two pickets of every other colour.

Question

How many pickets can be painted in total?

(A) 7

(B) 8

(C) 9

(D) 10

Acorns and Mushrooms

Story

A squirrel enjoys acorns and mushrooms as a treat. It creates four piles of treats with seven treats in each pile. Then it adds an eighth treat to each pile as follows:

- If there is an even number of acorns, then it adds a mushroom.
- If there is an odd number of acorns, then it adds another acorn.

Later, a rival squirrel changes two piles by swapping a random from one pile with a random from another pile. Now the piles of treats look like this:

Pile 1 Pile 2 Pile 3 Pile 4

Question

Which two piles did the rival squirrel change?

(A) Piles 1 and 3

(B) Piles 2 and 3

(C) Piles 1 and 4

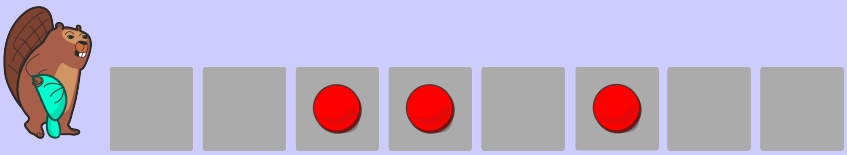
(D) Piles 2 and 4

Part C

Hat Game

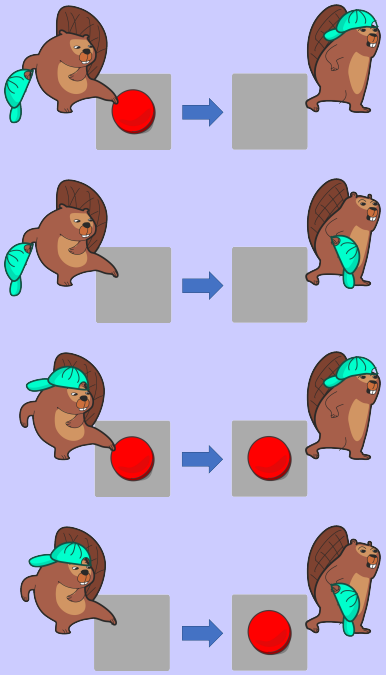
Story

A beaver plays a game with chips, a hat, and the gameboard shown.



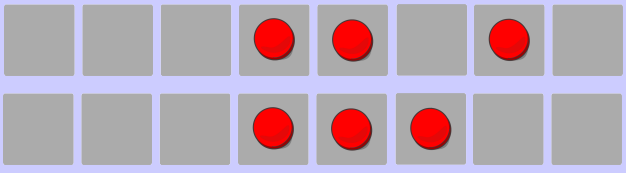
Each square on the gameboard either contains one chip or no chip. The beaver starts with a hat in its hand. It then steps on the squares one at a time from left to right, and acts according to the following rules until it moves off the gameboard:

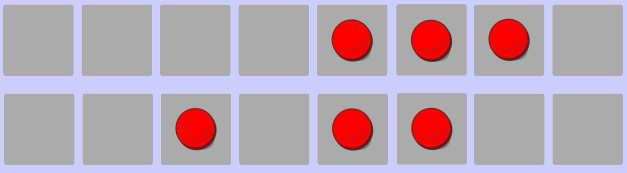
- If the beaver has the **hat in its hand** and steps on a square that **contains a chip**, then the beaver removes the chip from the square, puts the hat on its head, and then moves to the next square.
- If the beaver has the **hat in its hand** and steps on a square that **does not contain a chip**, then the beaver simply moves to the next square.
- If the beaver has the **hat on its head** and steps on a square that **contains a chip**, then the beaver simply moves to the next square.
- If the beaver has the **hat on its head** and steps on a square that **does not contain a chip**, then the beaver puts a chip on the square, puts the hat in its hand, and then moves to the next square.



Question

What does the final gameboard look like once the beaver has moved through all eight squares?

(A) 

(B) 

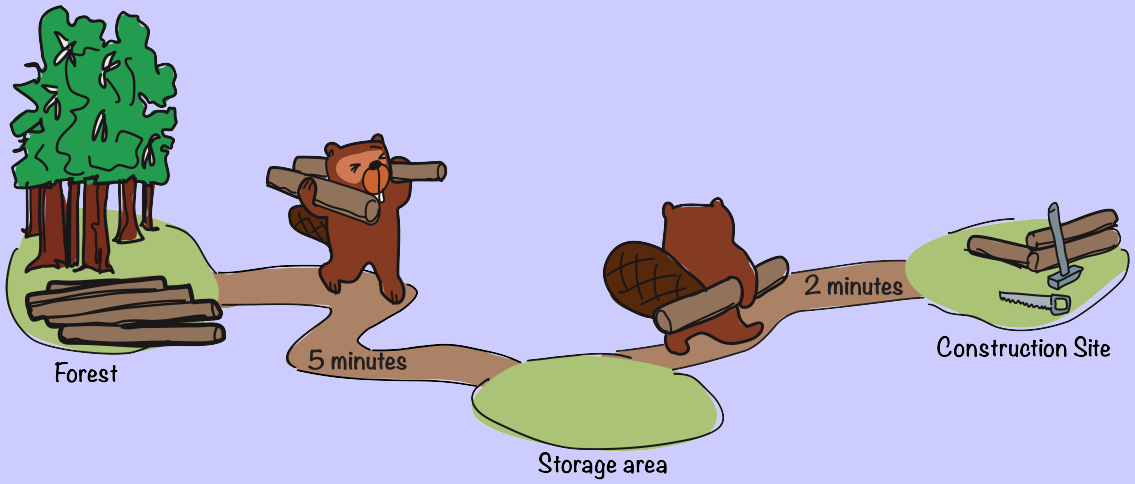
(C)

(D)

Logs

Story

Nila and Sam are building a log house. Nila delivers logs from the forest to the storage area. She carries 2 logs per trip and it takes her 5 minutes to make the trip in either direction. Sam delivers logs from the storage area to the construction site. She carries 1 log per trip and it takes her 2 minutes to make the trip in either direction.



When Nila arrives at the storage area, she immediately returns to the forest and vice versa.

As soon as there is 1 log at the storage area and she is no longer carrying logs, Sam immediately heads to the storage area, and then immediately back to the construction site. Otherwise, she remains at the construction site.

When work begins, Nila is at the forest, Sam is at the construction site, and all logs are in the forest.

Question

How many logs will be at the construction site 30 minutes after work begins?

(A) 3

(B) 4

(C) 5

(D) 6

Unlock the Crown

Story

A crown is locked in one of 15 drawers as shown.

There is a keyhole at the top of each drawer. To open the drawer, you must insert an object with the same shape as the keyhole. For example, for the keyhole on the top left drawer, you must insert an object shaped like a diamond.

Each drawer contains one object as indicated on the front of the drawer below the keyhole. For example, the top left drawer contains an object shaped like a heart.

Question

Bella has an object shaped like a circle. What is the minimum number of drawers that Bella needs to open in order to retrieve the crown?

(A) 3

(B) 4

(C) 5

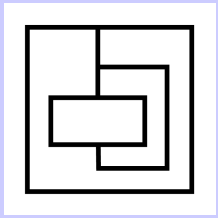
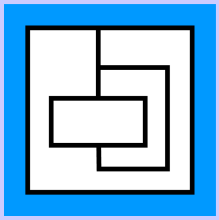
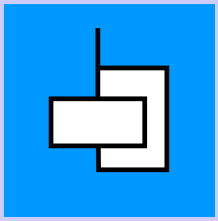
(D) 6

Flooding

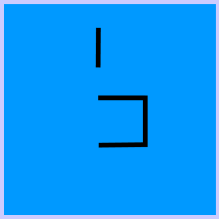
Story

A large flood in the land of Bevaria destroys many of its castles' walls.

First, water floods the exterior of a castle. Then after 1 hour, every wall that has water on one side but not the other breaks under the pressure of the water, and is destroyed. Walls with water on both sides, or water on neither side, remain intact. The water then floods any new exterior walls. For example:

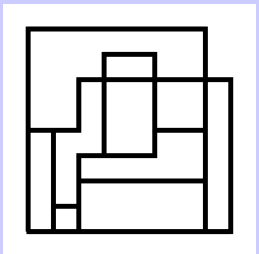
Castle before a flood	**Castle with exterior walls flooded**	**Remaining walls after 1 hour**
		

This process repeats until water has flooded the entire area of the castle. In our example, it takes a total of 2 hours to flood the entire area after the water floods the exterior walls. Notice that some walls remain after all the flooding.

Remaining walls after 2 hours


Question

After water floods the exterior of the castle shown, how many hours will it take to flood the entire area?



(A) 2

(B) 3

(C) 4

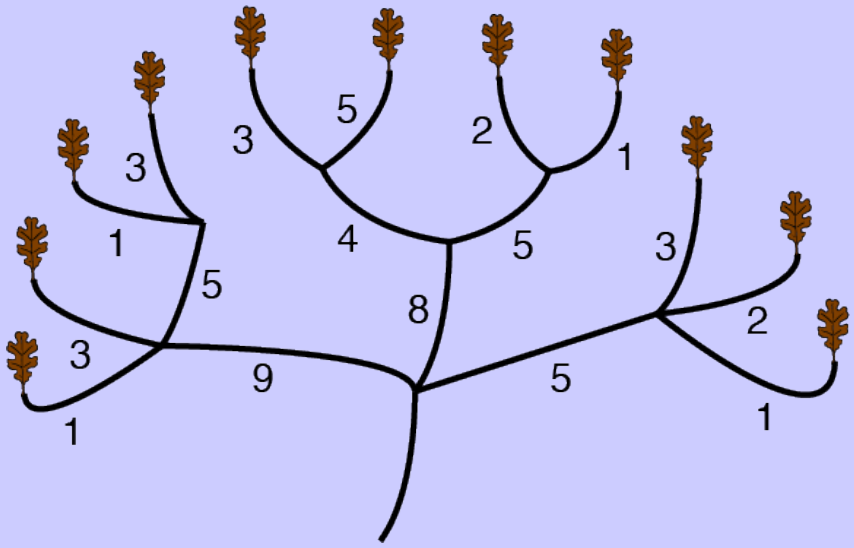
(D) 5

Cutting Branches

Story

Removing dead leaves from a tree can encourage new growth. Dead leaves are removed by cutting branches.

The following tree has 11 dead leaves. The time needed (in minutes) to cut each branch is shown.



When a branch is cut, all branches and leaves attached to it are removed from the tree. For example, if you cut the branch that takes 9 minutes, the four leftmost leaves are removed.

Question

What is the shortest amount of time needed to remove all 11 dead leaves from this tree?

(A) 19 minutes

(B) 20 minutes

(C) 22 minutes

(D) 25 minutes