UNIVERSITY OF WATERLOO

The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

2020
Beaver
Computing
Challenge
(Grade 9 & 10)
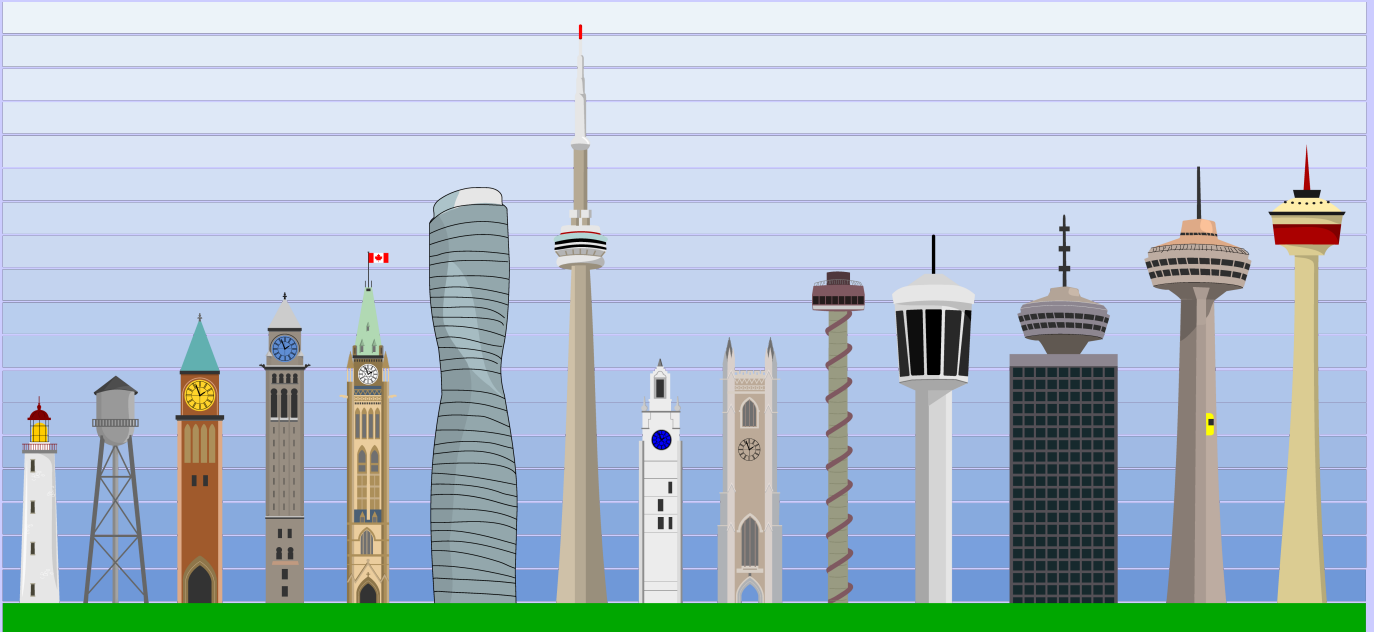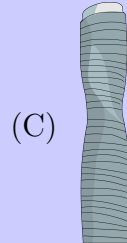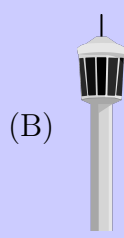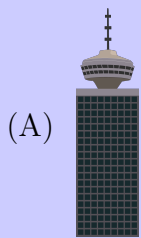
Questions

Part A

Skyline

A skyline consists of 14 towers as shown.

The height of a tower is measured from the bottom of its base to its highest point, including any flagpoles or antennas.

Question

If the towers are listed from shortest to tallest, which tower would be 10th in the list?

(A)   (B)   (C)   (D)

Library Books

Story

Beavertown Library has only a small pile of books. When a beaver wishes to borrow a book, they take the book that is on the top of the pile and record their name. When a beaver returns a book, they place their book on the top of the pile and record their name again.

At the beginning of the week the pile of books was arranged as shown:

The library's records at the end of the week show the following information:

Charlotte's Web
Curious George
Go, Dog, Go!
The Hobbit
Fox in Socks

Alba – Borrow
Felix – Borrow
Alba – Return
Marta – Borrow
Felix – Return
Cato – Borrow

Question

Which book did Cato borrow?

(A) Charlotte's Web

(B) Curious George
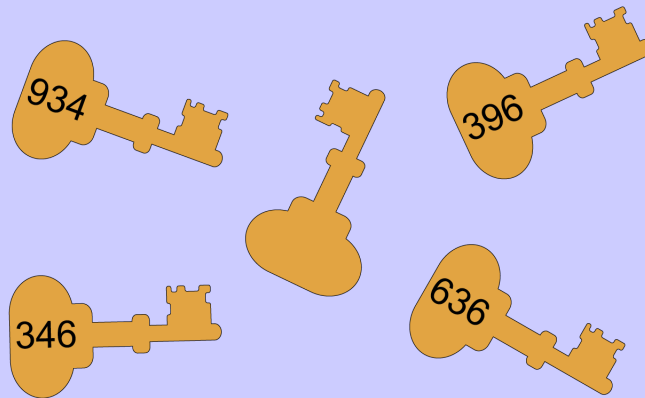
(C) Go, Dog, Go!

(D) The Hobbit

Locked Chests

Story

Five different chests are engraved with letters as shown:

BEB   RAB   ERB   EAB   AER

Each chest has a key labelled with digits corresponding to the chest's engraved letters. Each digit always corresponds to the same letter.

The keys fell on the floor and one label was lost:

934   396   346   636

Question

What is the lost label?

(A) 496

(B) 639

(C) 436

(D) 649

Water Bottles

Dani is required to entirely fill as many empty water bottles as possible using a 50 litre tank.

Suppose she is given the following 10 empty bottles where each bottle is labelled with the number of litres it can hold.

Question

What is the maximum number of bottles that Dani can fill entirely?

(A) 4

(B) 7

(C) 8

(D) 10

Ancient Texts

Story

Symbols form the titles of ancient texts. Each type of symbol is associated with a digit as shown below. Some different symbols are associated with the same digit.

symbol	□	△	☆	○	◉	◇	♡	☁	✚	⚙	☾	∝	⛰	≈	◌	☺
digit	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6

The *special number* of a text is the sequence of digits associated with the symbols in the title of the text (in order). For example, 56432 is the special number of the text with the title ◉ ◇ ○ ☆ △ .

Question

Which of the following texts has the same special number as the red text below?
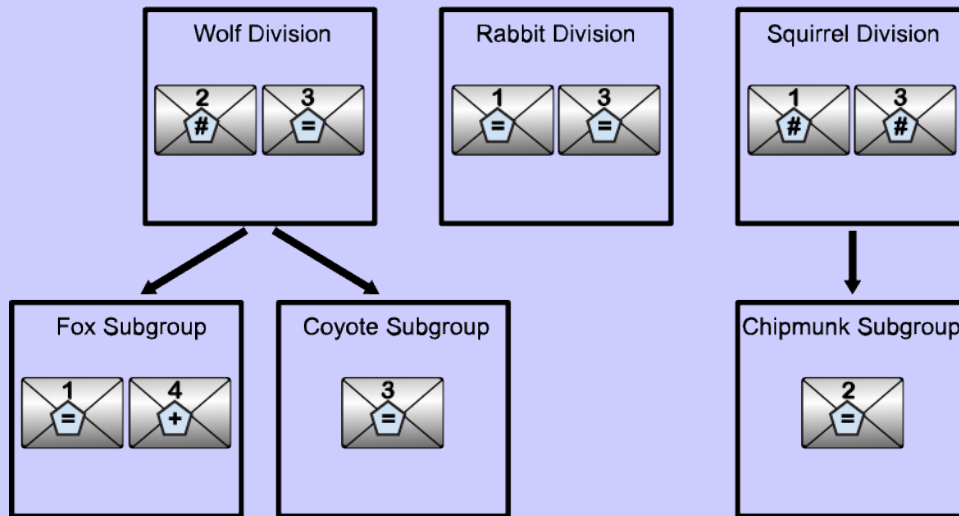
(A) (B) (C) (D)
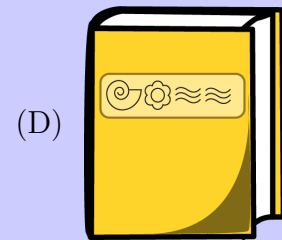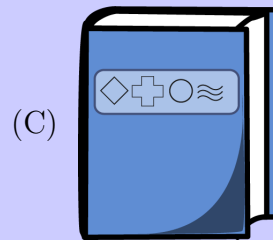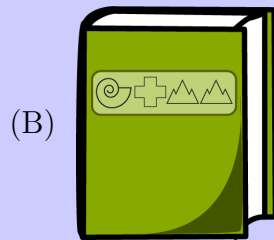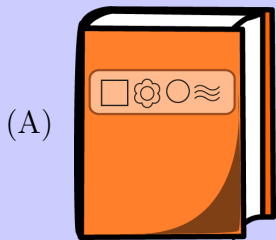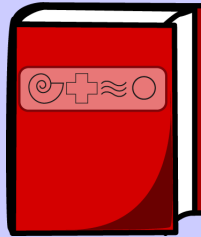
Part B

Beaver Intelligence Agency

Story

For security reasons, a secret message was broken into four parts (1, 2, 3, and 4). Copies of these parts were then sent to the divisions and subgroups of the Beaver Intelligence Agency (BIA) as shown:

Labels on the copies of the message parts indicate who has access to it:

- "+" means everyone in the BIA has access to this copy.

- "#" means the division that receives it and the division's subgroups (indicated by arrows) have access.

- "=" means only the division or subgroup that receives it has access to this copy.

Question

Which one of the following has access to all four parts of the message?

(A) Fox Subgroup

(B) Wolf Division

(C) Rabbit Division

(D) Chipmunk Subgroup

Mountain Climber

Binsa is climbing in the mountain range shown which has 11 peaks each of a different height.

Binsa climbs by starting at the top of a random peak, then looking left and right. If she sees a peak immediately beside her that is higher than the one she is currently on, she climbs to the top of this higher peak. If two neighbouring peaks are both higher, she climbs to the top of the higher one. She continues to do this until there is no higher peak immediately beside her.
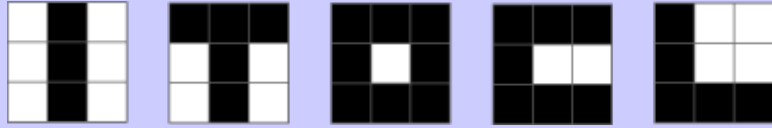
Question

From how many of the peaks (including the highest peak) will Binsa reach the highest peak?
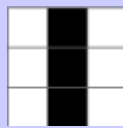
  (A) 3

  (B) 4

  (C) 6

  (D) 7

Image Scanner

Story

The following five images represent the letters I, T, O, C and L, respectively. Each image is a 3-by-3 grid made up of nine pixels that are each black or white.

When a machine scans an image, instead of recording black or white at a pixel, it records how many of the other four images have the same shade (black or white) at that pixel.

For example, when scanning the image , the machine records
0	3	1
1	1	3
1	4	1
.

Question

If the machine records
3	3	2
2	2	0
2	4	2
, what image did it scan?

(A)   (B)   (C)   (D)

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Story

As a practical joke, someone has connected appliances to buttons P, Q, R, S, and T in a very strange way. Pressing a button toggles the on/off state of each appliance it is connected to. For example, pressing button T will turn the vacuum cleaner on if it is off and off if it is on. Pressing button T will also turn the television on if it is off and off if it is on.
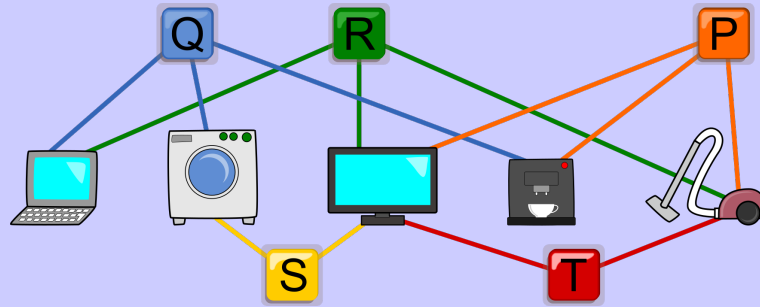
All of the appliances are off.

You want only the television and coffee machine on (the third and fourth appliances from the left in the picture).
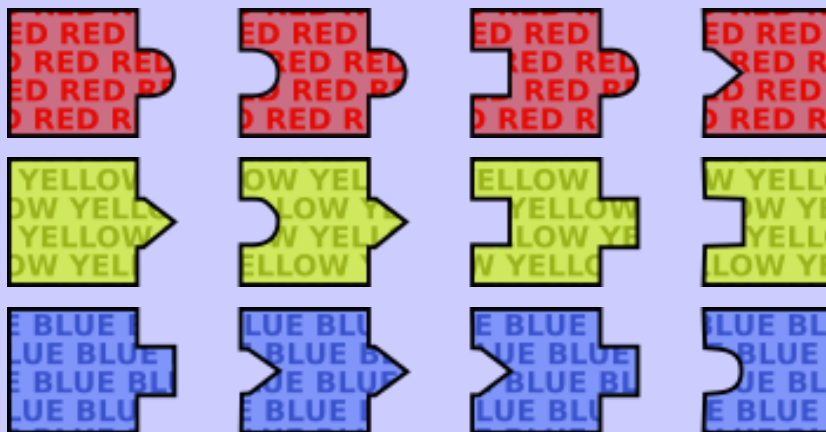
Question

Which of the following sequences of buttons should you press?

(A) T, R, Q, P

(B) R, Q, P, S

(C) S, P, T, R

(D) Q, S, R, T

Puzzle Pieces

Story

A beaver has a puzzle with 12 different types of pieces, 4 of which are red, 4 of which are yellow, and 4 of which are blue, as shown below. There is an unlimited number of each type of piece.

Using these pieces, the beaver can create various colour sequences. The first piece in a sequence must have a flat left side and the last piece must have a flat right side. Pieces join in the usual way but two pieces can't be joined on their flat sides and pieces can't be rotated. One possible sequence is shown below.

Question

Which of the following colour sequences **cannot** be constructed?

(A) YELLOW → BLUE → BLUE → RED → BLUE

(B) BLUE → YELLOW → RED → YELLOW → RED

(C) RED → RED → YELLOW → BLUE → BLUE

(D) BLUE → RED → YELLOW → BLUE → RED

Part C

Craft

The following shapes are available to make a craft. There is no limit on how many times each shape can be used, but you have to pay every time you use a shape. The number on a shape is the shape's cost (in dollars). The shapes can be rotated.
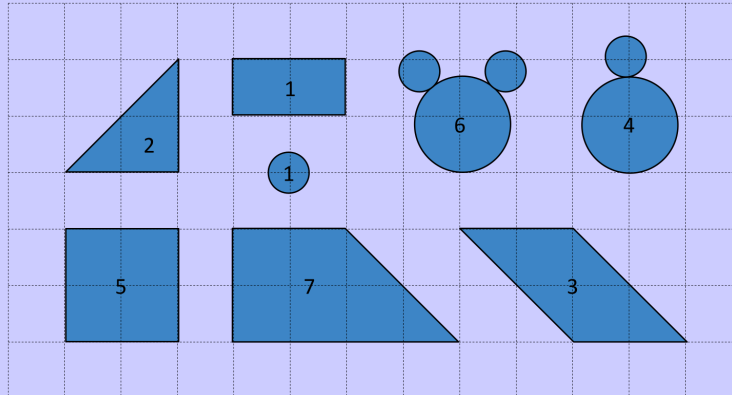
One way to make the craft shown on the left is by arranging shapes as shown on the right. The total cost of this construction is 18 dollars.
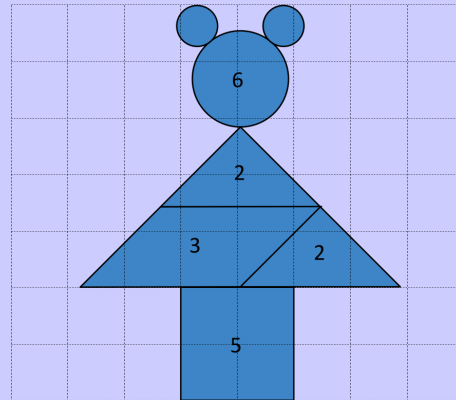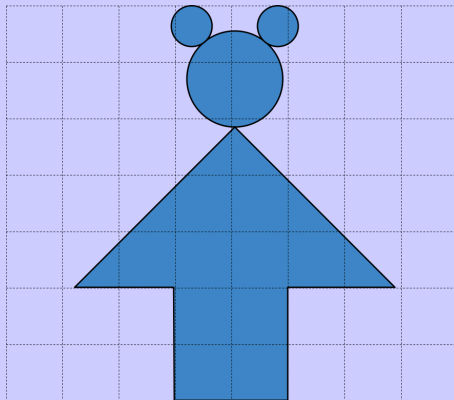

Question

What is the minimum possible total cost to make the same craft?

(A) 13 dollars

(B) 14 dollars

(C) 15 dollars

(D) 16 dollars

Vegetable Shipment

Story

A nation consists of six islands called Alpha, Beta, Gamma, Delta, Eta, and Kappa. All vegetables are grown on Alpha and shipped to the other islands. Vegetables are shipped only on the transportation routes indicated by the dotted arrows in the diagram. The number on each arrow represents the maximum amount of vegetables (in tonnes) that can be shipped along that route in a single day.
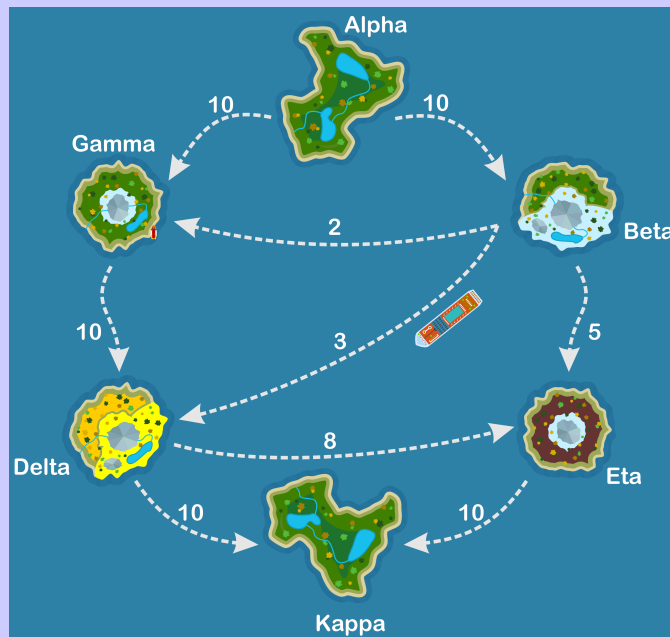
For example, up to 2 tonnes can be sent from Beta to Gamma in a single day, and up to 8 tonnes can be sent from Delta to Eta in a single day. Alpha always has enough vegetables to ship 20 tonnes per day.

Shipments take very little time to complete. For example, it is possible for vegetables to be shipped from Alpha to Gamma to Delta in a single day, as long as the individual daily route limits are not exceeded.

Question

What is the largest amount of vegetables that can be shipped from Alpha to Kappa in a single day?

  (A) 19 tonnes

  (B) 18 tonnes

  (C) 15 tonnes

  (D) 12 tonnes

DNA Sequence

Story

Genes in cells contain DNA which can tell us a lot about a living thing. A DNA sequence is formed from nitrogen bases. Each nitrogen base is one of four types: Adenine (A), Guanine (G), Cytosine (C), or Thymine (T). DNA can mutate to form a new sequence that is different from the original sequence.

Vormi is a creature for which each mutation is one of three kinds:

1. Substitution: Change one occurrence of a base to another base type.
   Example: AGGTC becomes AGATC (change second G to A).

2. Deletion: Remove one occurrence of a base.
   Example: AGGTC becomes AGTC (delete one G).

3. Duplication: Replace one occurrence of a base with two occurrences of the same base.
   Example: AGGTC becomes AGGTTC (duplicate T).

Question

If Vormi's DNA sequence is initially GTATCG, what sequence **cannot** be the result after exactly three mutations?

(A) GCAATG

(B) ATTATCCG

(C) GAATGC

(D) GGTAAAC

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Story

A doctor has 16 patients numbered $0, 1, 2, \ldots 15$ and 8 test tubes labelled A, B, C, D, E, F, G, and H.

Exactly one patient is ill. The doctor takes a blood sample from each patient and divides it into four test tubes mixing it with samples from other patients.

The Test Tube Distribution shown indicates which test tubes the blood samples for each beaver are mixed into. For example, the blood of patient 0 was divided amongst test tubes A, C, E and G.

Sending a test tube to a lab will produce an *infected* result if it contains the blood from the ill patient. Otherwise, a test tube will produce a *healthy* result. The first three lab results are shown below.

Test Tube Distribution:

0 ACEG	8 BCEG
1 ACEH	9 BCEH
2 ACFG	10 BCFG
3 ACFH	11 BCFH
4 ADEG	12 BDEG
5 ADEH	13 BDEH
6 ADFG	14 BDFG
7 ADFH	15 BDFH

Test results so far:

- Test tube C - healthy
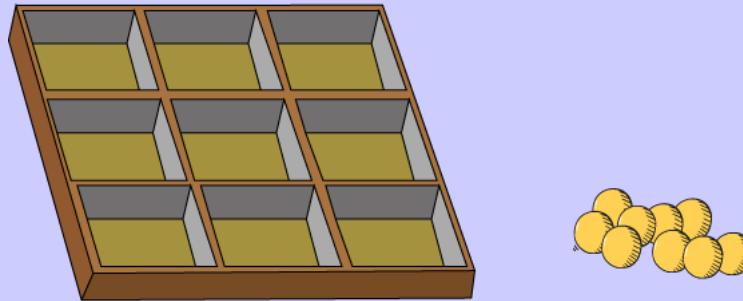- Test tube A - infected
- Test tube E - healthy

Question

In order to identify the ill beaver on the fourth lab test, which of the following test tubes could be sent to the lab?

(A) Test tube B

(B) Test tube D

(C) Test tube F

(D) Test tube G

Nine Marbles

Story

Hira has a box with nine compartments:

Hira chooses 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9 marbles and places them in the box according to the following rules:

- Each marble is in a different compartment.

- The total number of marbles in each row is even.

- The total number of marbles in each column is even.

Question

In how many different ways can Hira place the marbles in the box?

(A) 12

(B) 16

(C) 64

(D) 512