



The question book



Creative problem solving

Acknowledgements

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The question book

Every species on this earth faces problem, big or small and finds probable solution(s) for it through various ways as per their capabilities and limitations. Problem solving is a daily activity for most of us, whether we realize it or not. Whenever there is a gap between where you are now and where you want to be and you don't know how to cross that gap, you have a problem¹. For example, if you want to go to your friends place and there are three paths to take and you don't know how to find the best path to take, that is a problem and when you figure out the best path after looking into various aspects that's problem solving.

Learning and understanding the process of problem solving and recognizing patterns in problems is a lifelong activity and a skill that can be applied both in personal and professional lives. This is one of the most essential 21 st century skills for anyone to learn.

The question book in your hand will take you through a journey where you will find various kinds of problems and discussions on them to find the probable solutions after looking into pros and cons of various aspects of it. It will also give you an opportunity to identify the problems in your daily life for which you will find best solutions yourself.

- Ankit and Ankita

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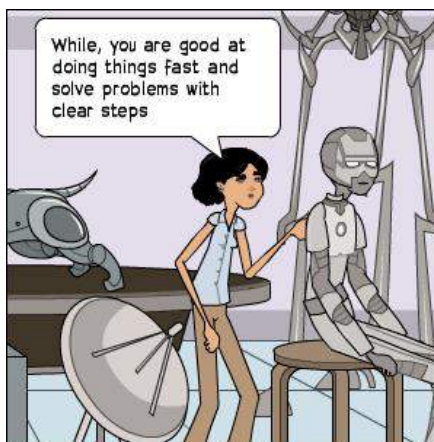
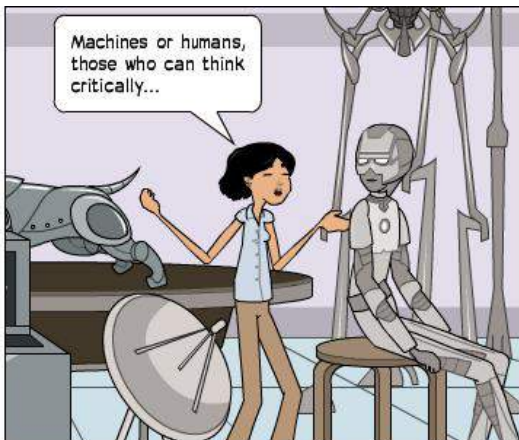
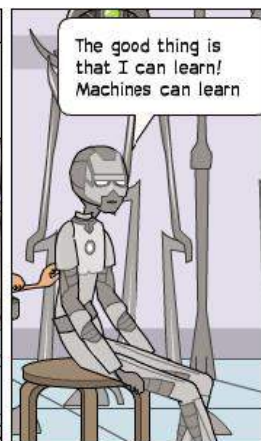
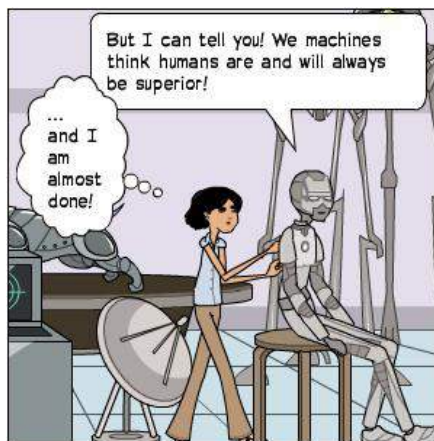
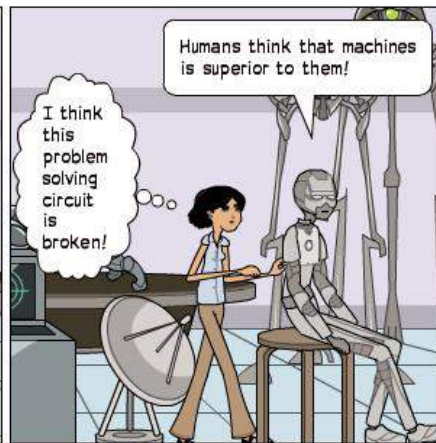
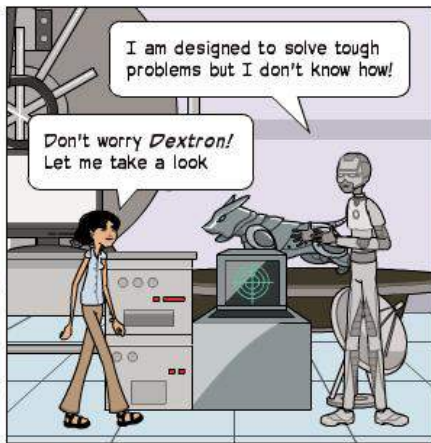
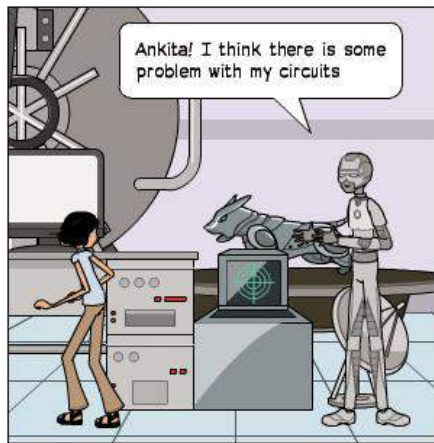
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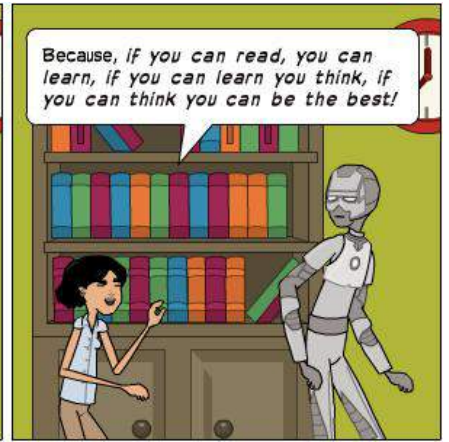
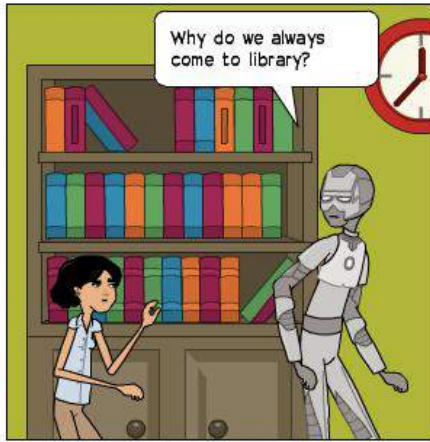
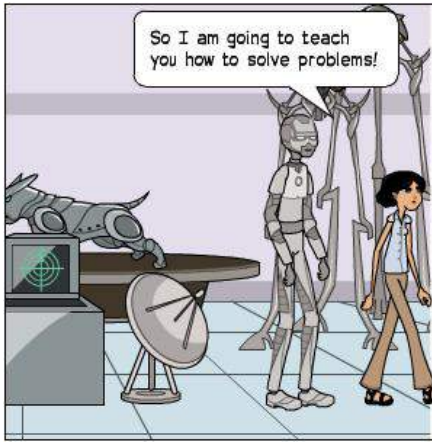
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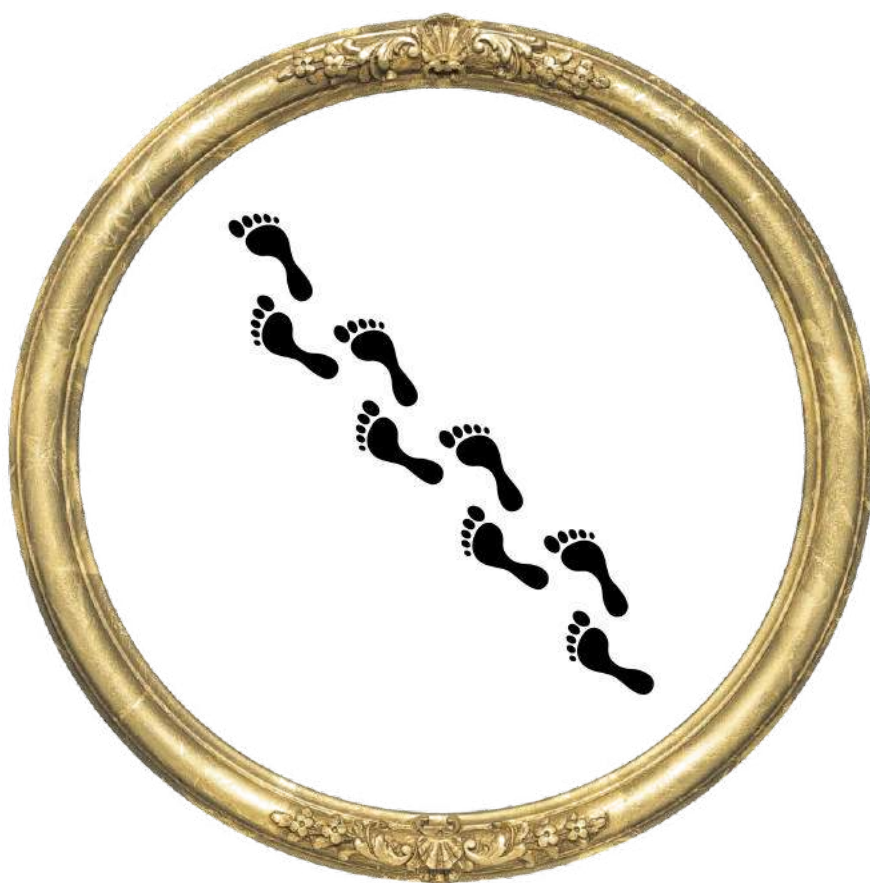
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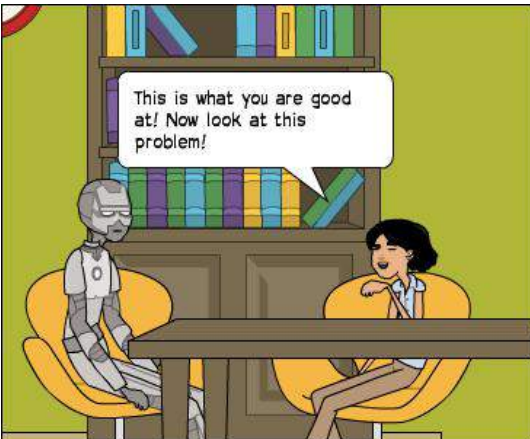
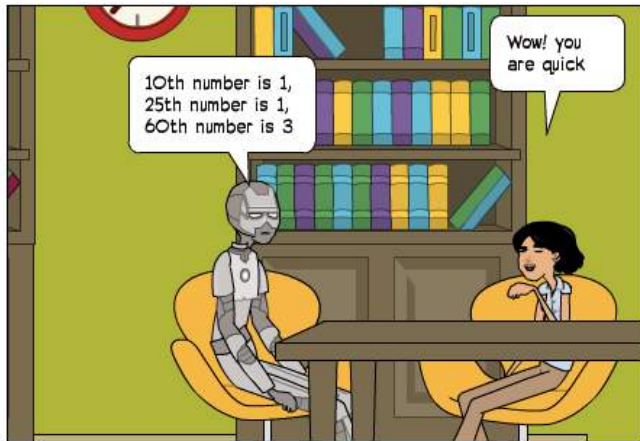
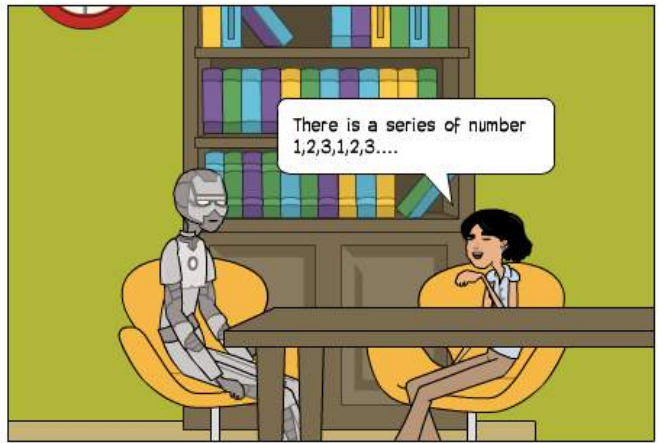






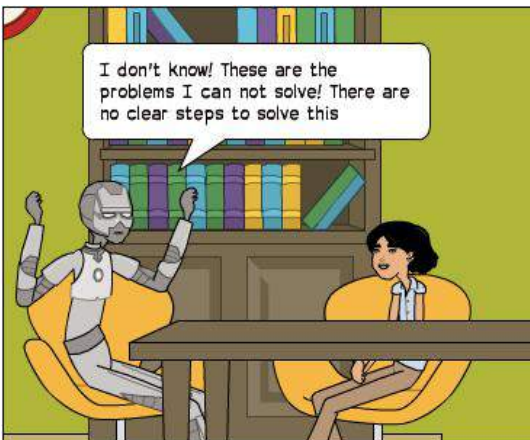
Step by Step





In a competition to make snowmen, the children made 60 snowmen. The heads of the snowmen followed a particular pattern shown on the diagram below. How do the heads of the 10th, the 25th and the 60th snowman look like?

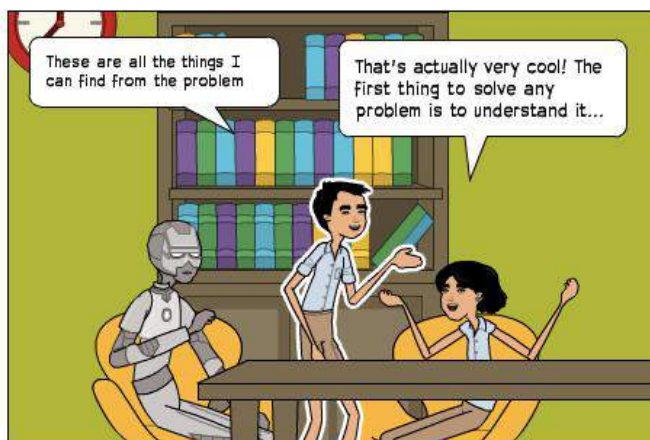
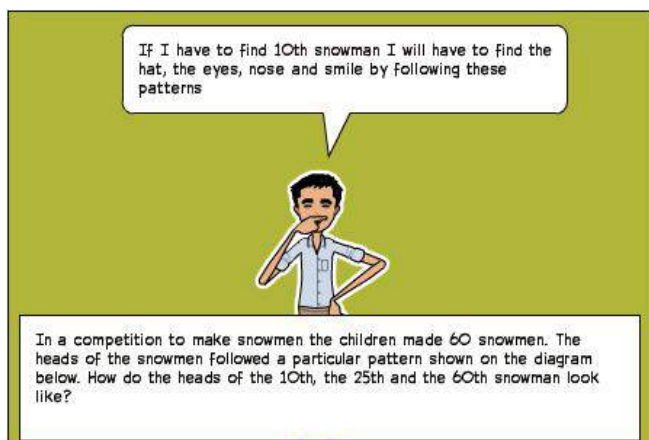
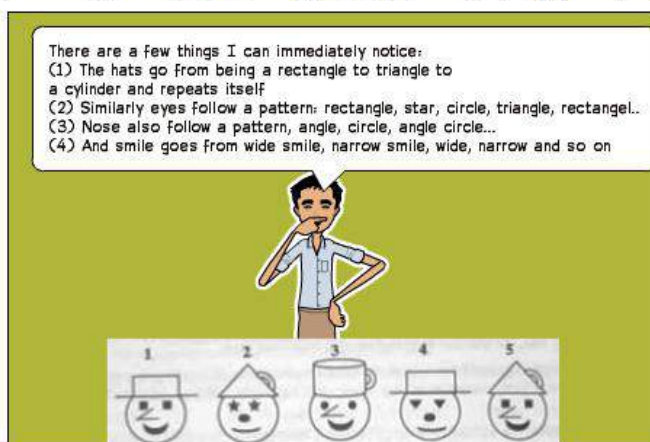
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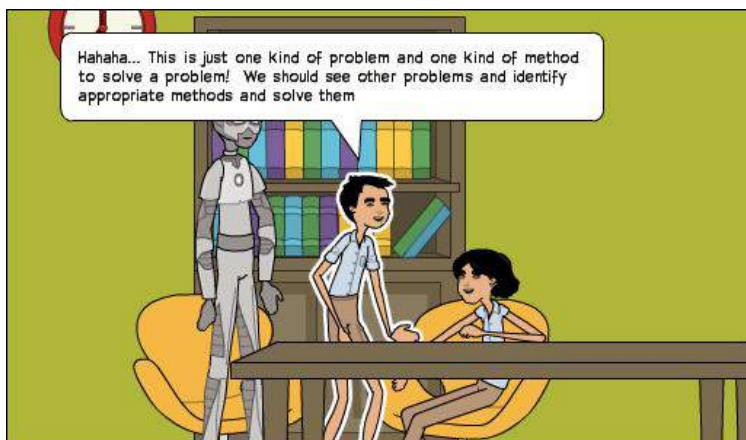
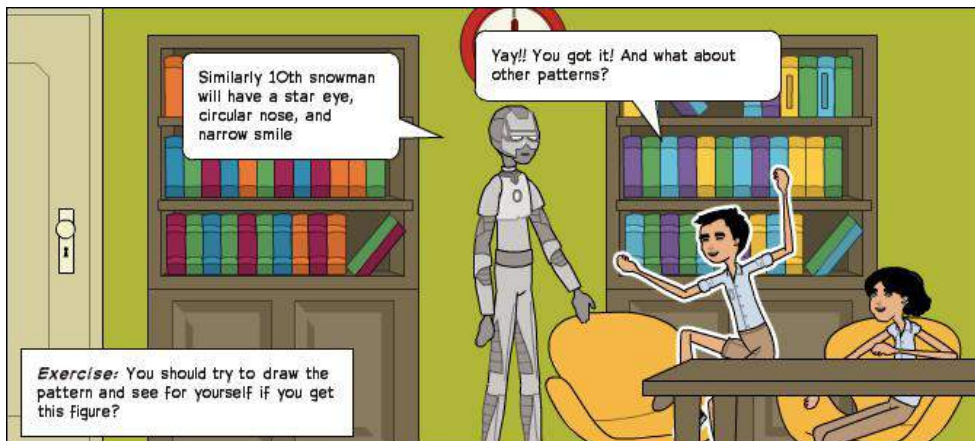
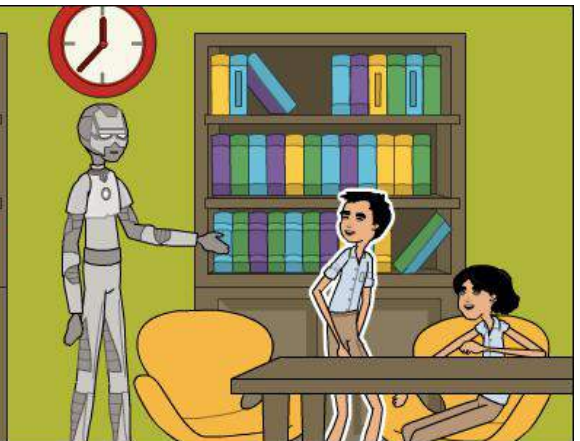
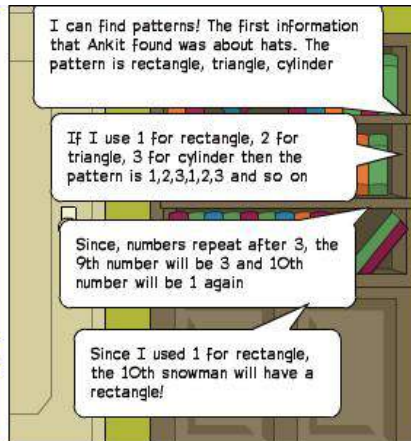
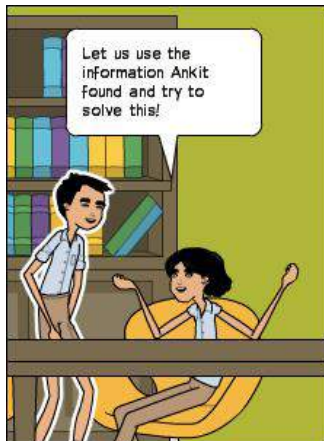
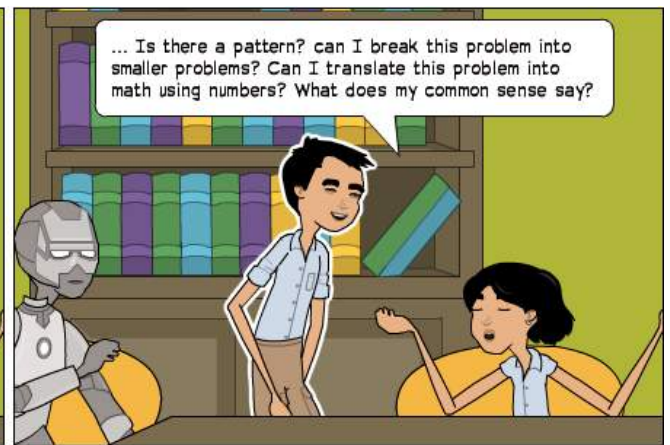


Step 1: identifying which pieces of data are relevant when faced with a mass of data, most of which is irrelevant

Step 2: combining pieces of information that may not appear to be related to give new information

Step 3: relating one set of information to another in a different form - this involves using experience: relating new problems to ones we have previously solved.





Polya's Problem Solving framework



George Pólya was a Hungarian mathematician. He made fundamental contributions to combinatorics, number theory, numerical analysis and probability theory. He is also noted for his work in heuristics and mathematics education.

(December 13, 1887 - July 9th, 1985)

First step

You have to understand the problem

Questions you should ask to yourself

What is the problem? What is the unknown in the problem? What is the data and facts that we already know? What is the condition?

Second step

Find the connection between data and the unknown

Have you seen it before or in a slightly different form? Do you know a related problem? Look at the unknown and try to think of a familiar problem having the same or similar unknown.

Third step

Carry out your plan

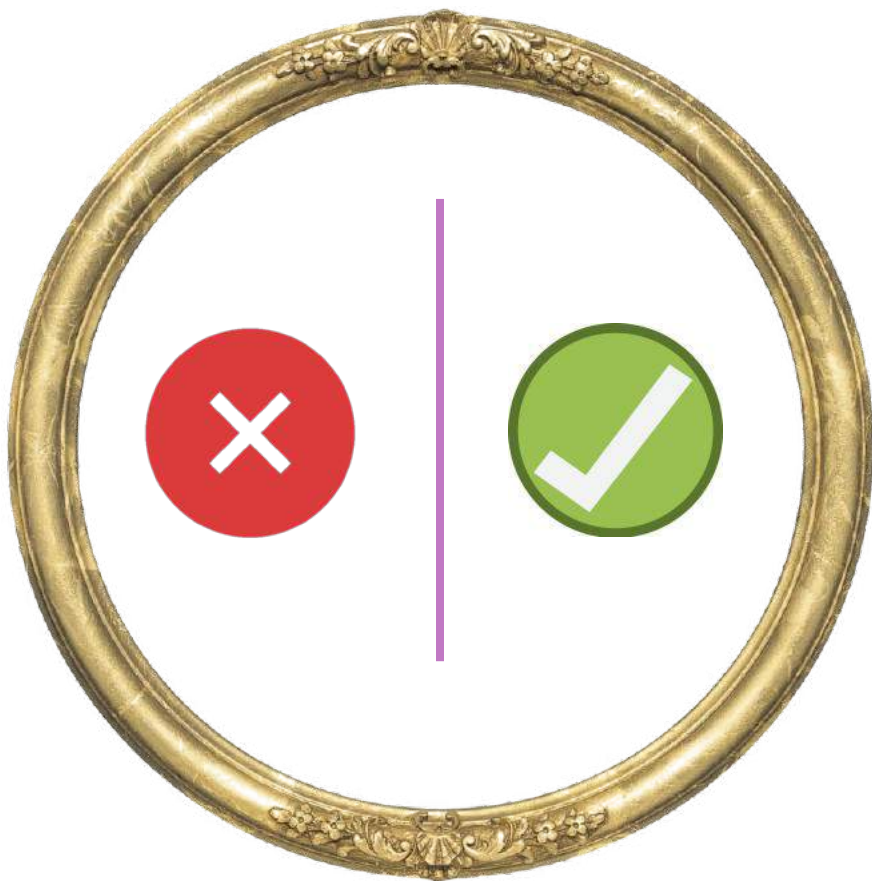
Carrying out a plan of the solution, check each step. Can you see clearly that the step is correct? Can you prove that it is correct?

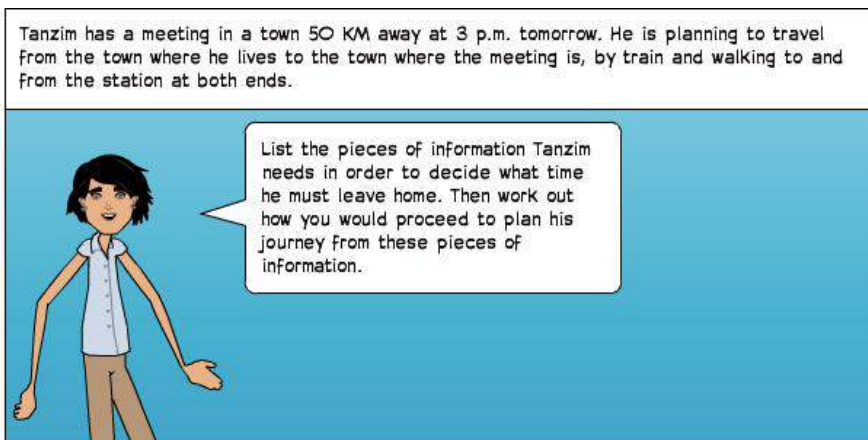
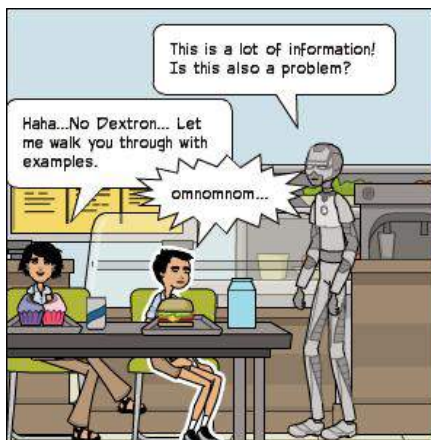
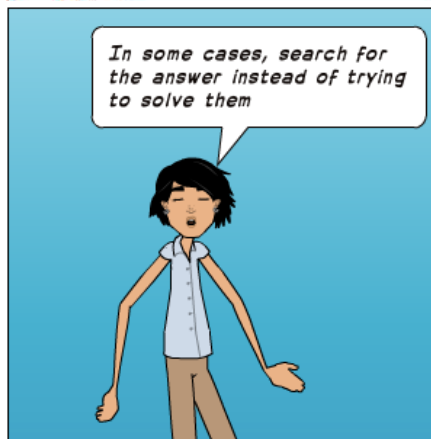
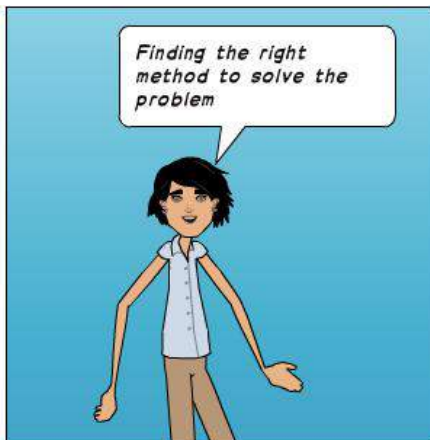
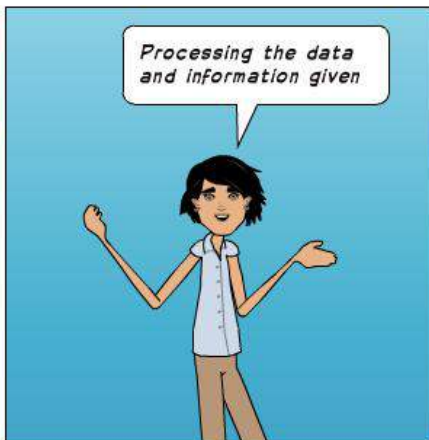
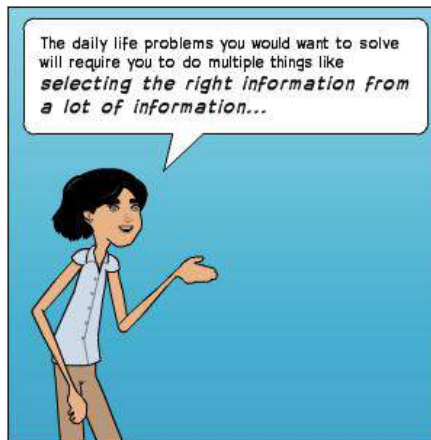
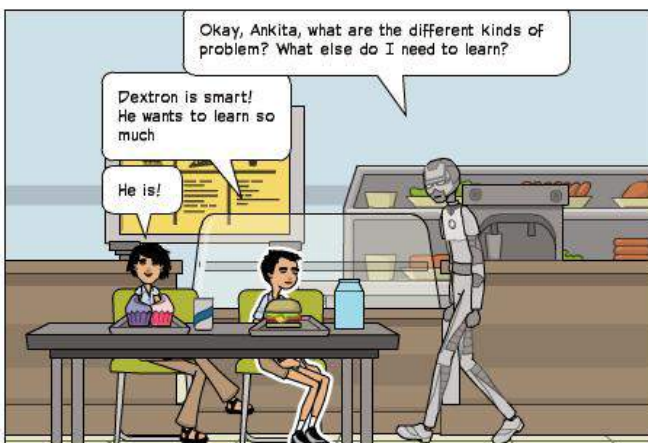
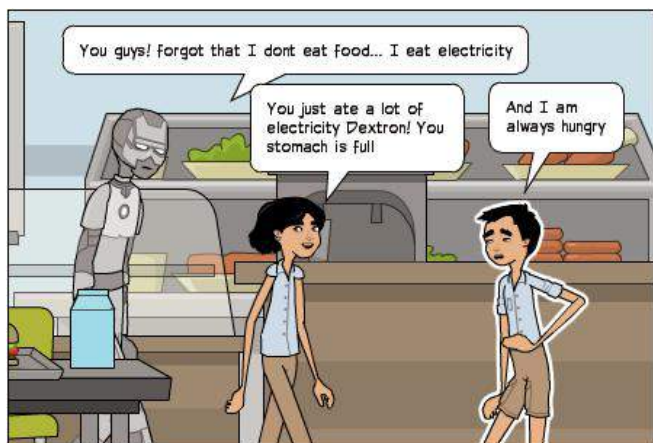
Fourth step

Examine the solution obtained

Can you check the result? Can you check the argument? Can you derive the results differently? Can you see the result, or method for some other problem?

I need this, I need this not



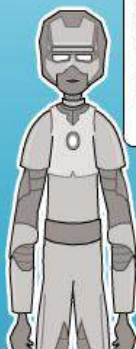


Tanzim needs to leave his house, walk to the station, buy train ticket, go to platform, wait for train and get in, sit inside till he reaches and then walk back



The pieces of information Tanzim needs are:

1. Time taken to walk till station
2. Time needed to get the ticket
3. Time needed to walk to the platform.
4. The train timetable
5. The time taken to walk from the station to where the meeting is being held.



Exactly! This is the most critical thing to do..

Always find all the information you need to solve the problem and only then proceed

Now let's go one step ahead. Find the information and check the data

RHEA HAS BEEN STAYING IN A HOTEL ON A BUSINESS TRIP. WHEN SHE CHECKS OUT, THE HOTEL'S COMPUTER ISN'T WORKING, SO THE RECEPTIONIST MAKES A BILL BY HAND FROM THE RECEIPTS, TOTALING **RS. 3635**. RHEA THINKS SHE HAS BEEN OVERCHARGED, SO SHE CHECKS THE ITEMIZED BILL CAREFULLY.

ROOM: 4 NIGHTS AT RS. 532.00 PER NIGHT
BREAKFAST: 4 AT RS. 70.00 EACH
DINNERS: 3 AT RS. 126.00 EACH
TELEPHONE: 10 UNITS AT RS 1 PER UNIT
RESTAURANT: VARIOUS DRINKS TOTALING RS. 161.00
LAUNDRY: 3 DRESSES AT RS. 100.00 EACH

IT APPEARS THAT THE RECEPTIONIST MISCOUNTED ONE OF THE ITEMS WHEN ADDING UP THE TOTAL. WHICH ITEM HAS RHEA BEEN CHARGED TOO MUCH FOR?

Hmmm... Let's see the total according to the itemized bill is..

Rs 3257

- (1) $4 \times 532 = \text{RS } 2128$
- (2) $4 \times 70 = \text{RS } 280$
- (3) $3 \times 126 = \text{RS } 378$
- (4) $10 \times 1 = \text{RS } 10$
- (5) $\text{RS } 161$
- (6) $3 \times 100 = \text{RS } 300$

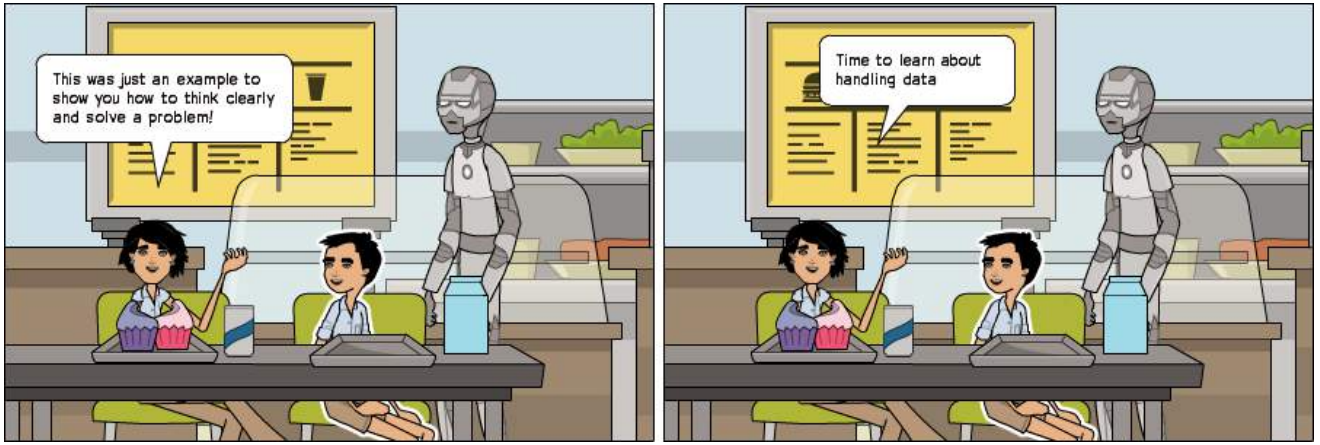
You are very quick!

Anyways! This means that $\text{Rs } 3635 - \text{Rs } 3257 = \text{Rs } 378$

This means, that she has been charged for an extra dinner

Because nothing else could come exactly to Rs 18

Yes! It seems you are right



Practice Problem

Problem 1

Rajesh is cooking a meal for some friends.

This will involve roasting corns (makka), which will take 2 hours' cooking time plus 15 minutes resting on removal from the oven. The oven takes 15 minutes to warm up. He will also cook some rice (30 minutes' soaking plus 15 minutes' cooking), cabbage (5 minutes to prepare and 5 minutes to cook) and a tomato sauce (10 minutes to prepare and 15 minutes to cook).

What should be the timing of each step of cooking the meal if the friends are to eat at 7 p.m.?

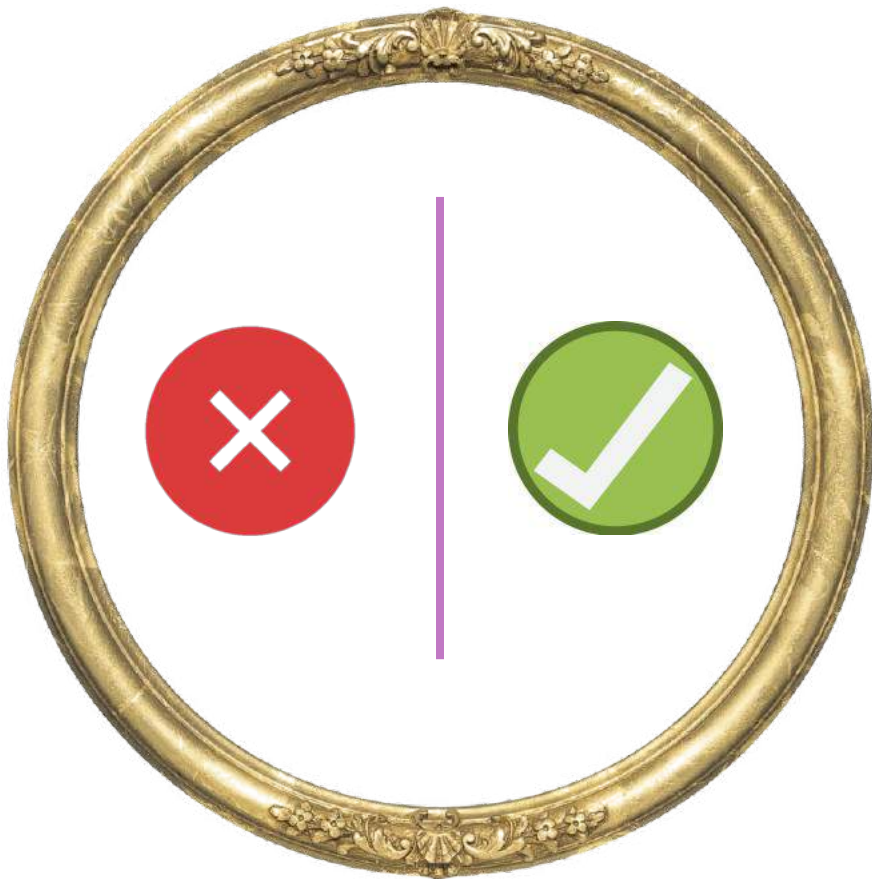
Problem 2

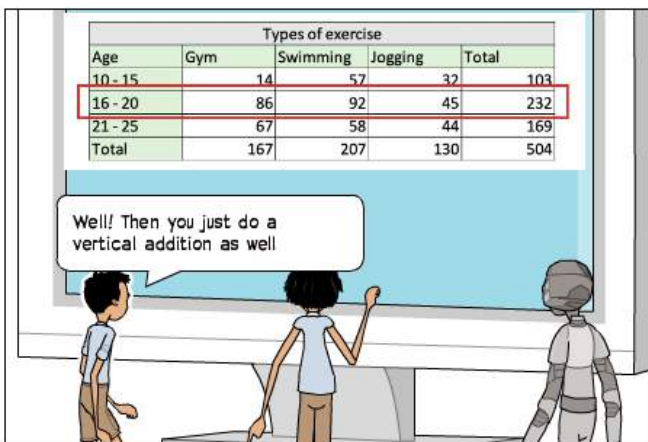
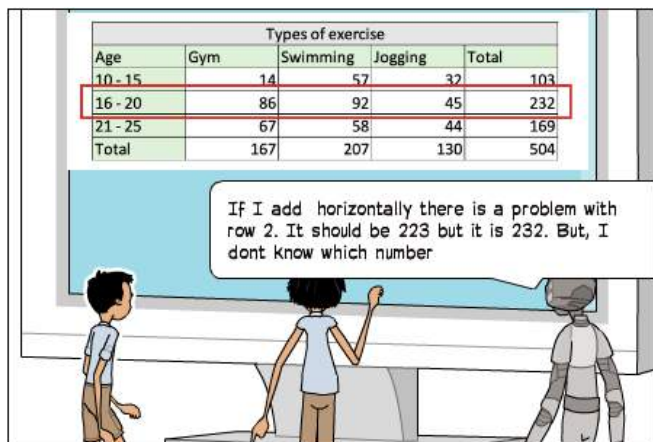
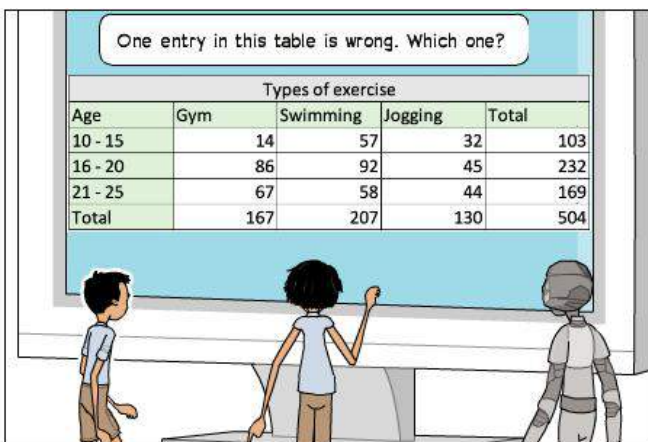
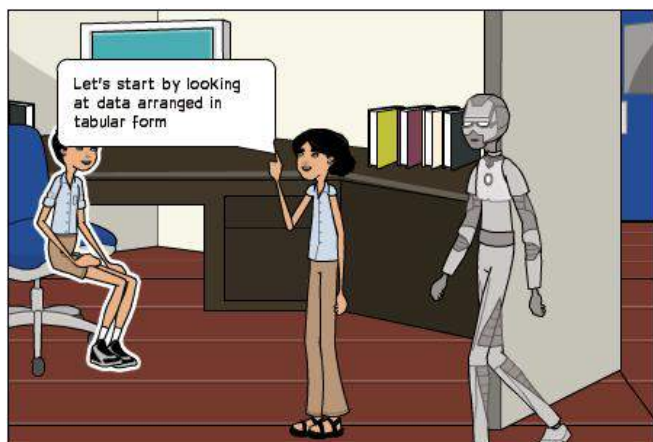
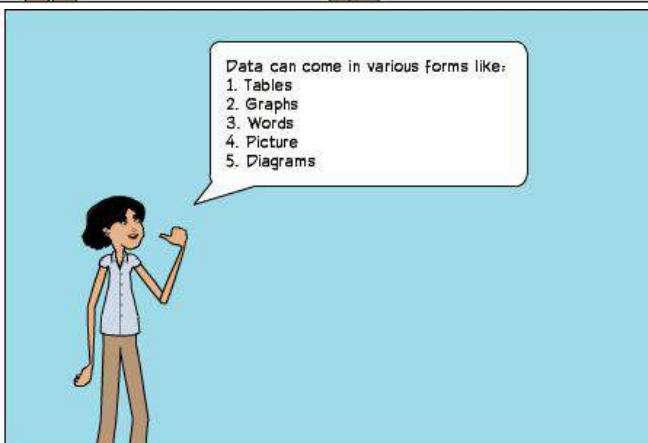
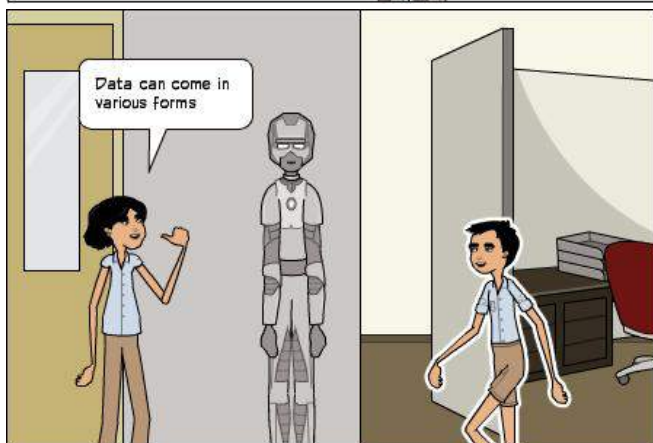
The SuperSave supermarket sells Birma washing powder for Rs 1.20 a bottle. At this price they are charging 50% more than the price at which they buy the item from the manufacturers. Next week SuperSave is having a 'Buy two get a third free' offer on this item. The supermarket does not want to lose money on this offer, so it expects the manufacturers to reduce their prices so SuperSave will make the same actual profit on every three bottles sold.

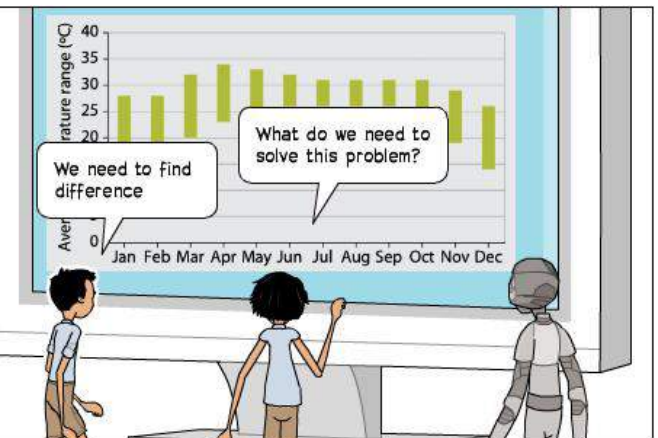
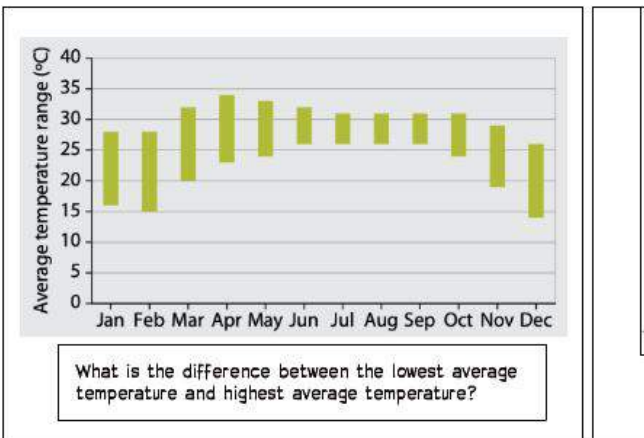
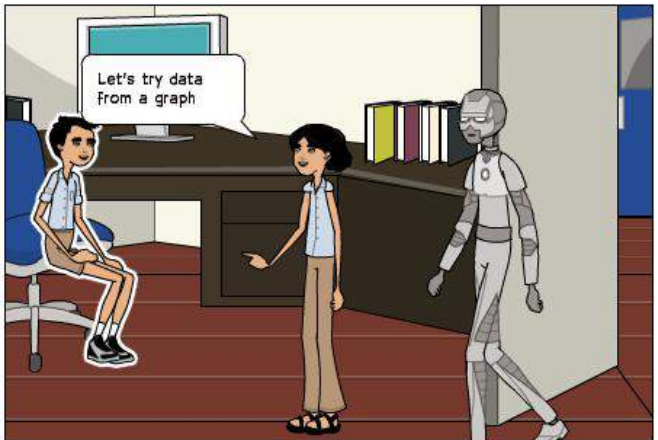
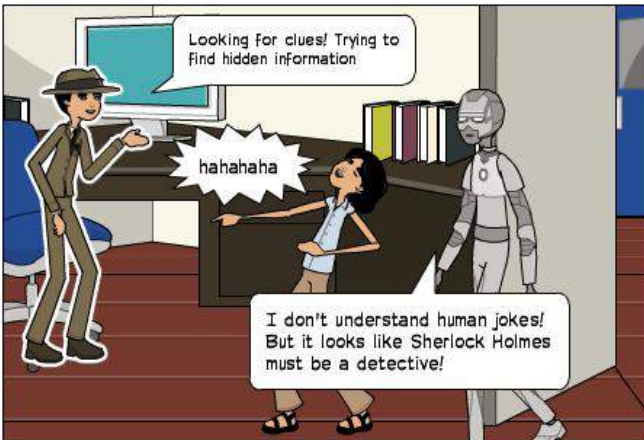
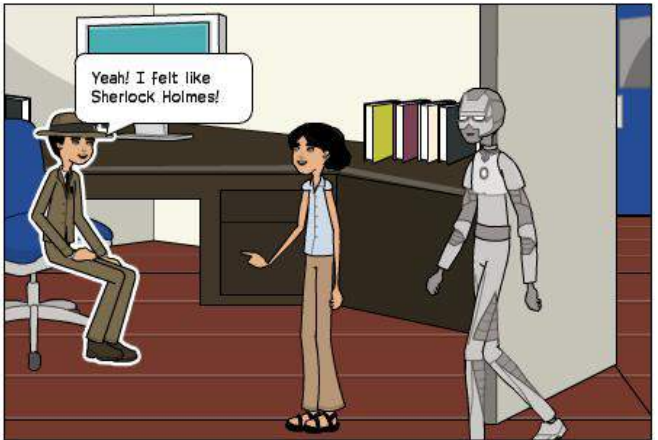
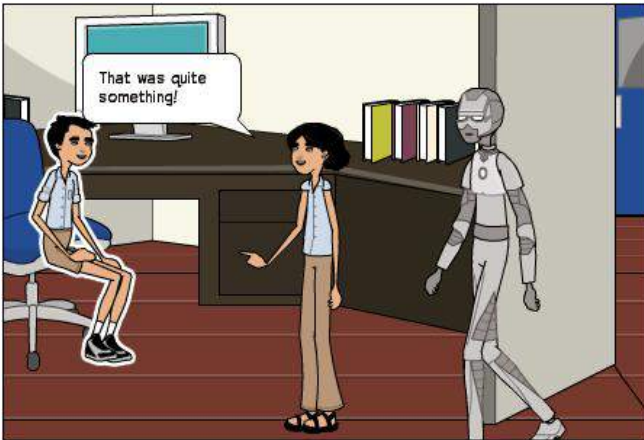
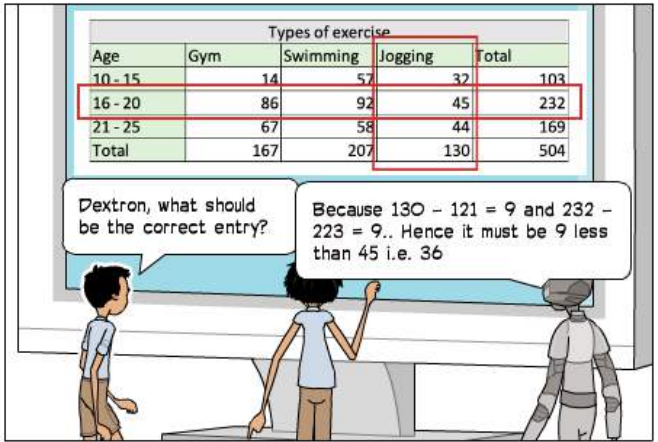
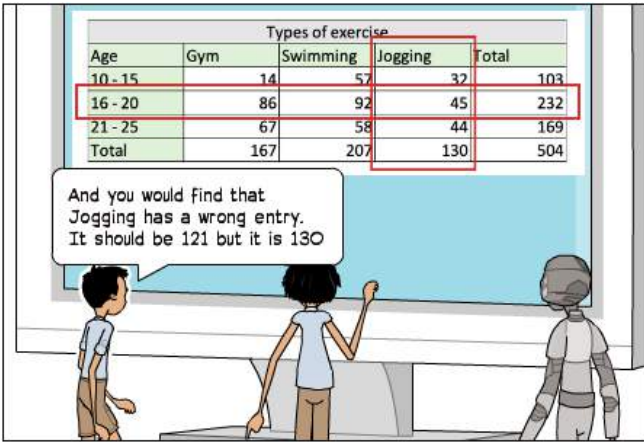
By how much will the manufacturers have to reduce their prices?

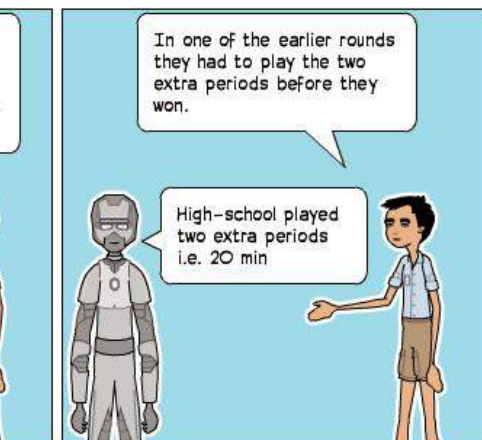
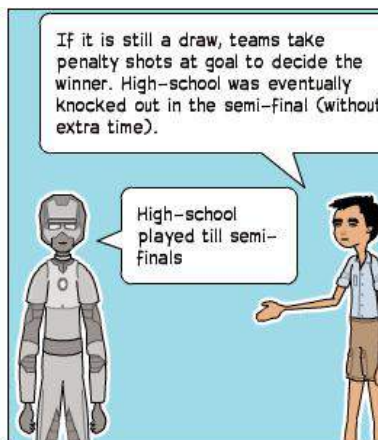
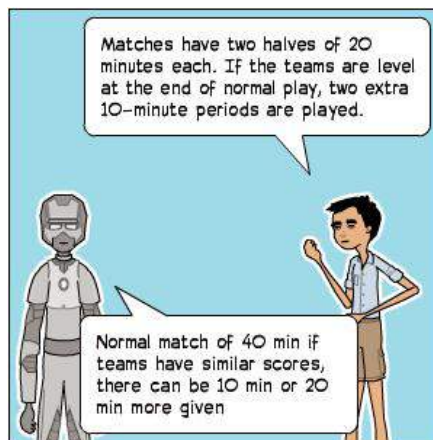
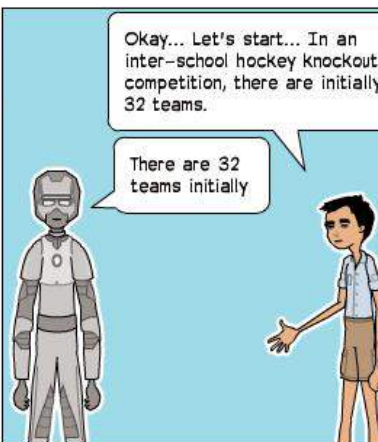
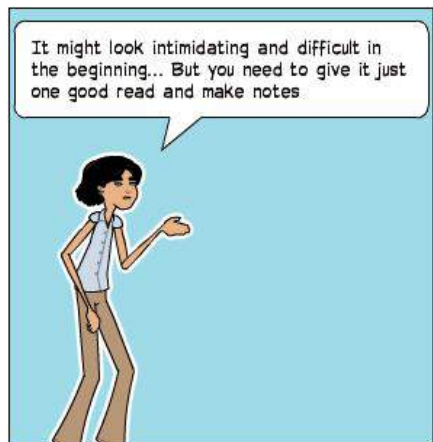
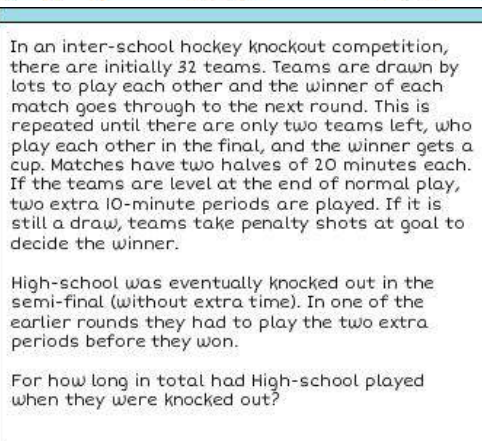
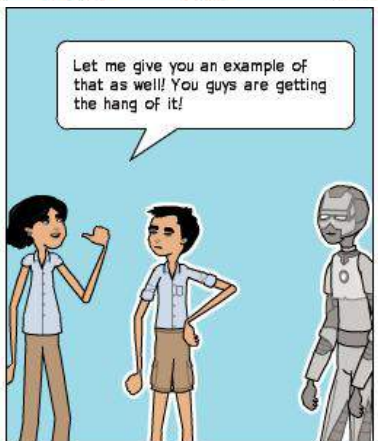
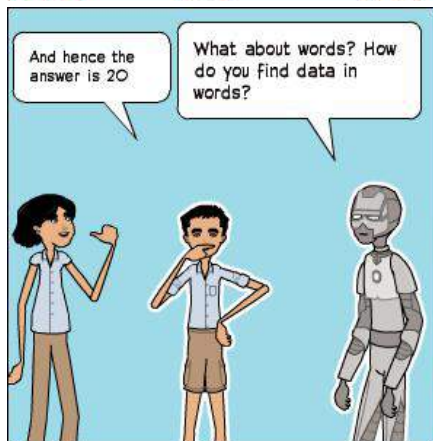
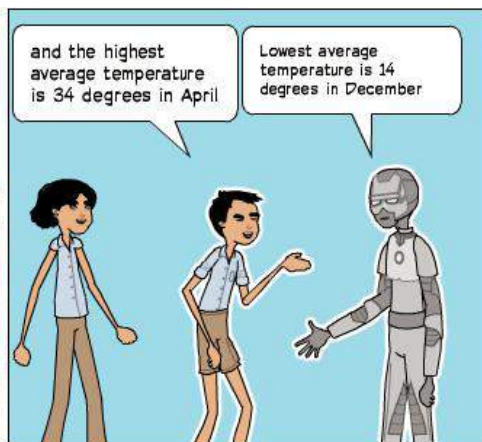
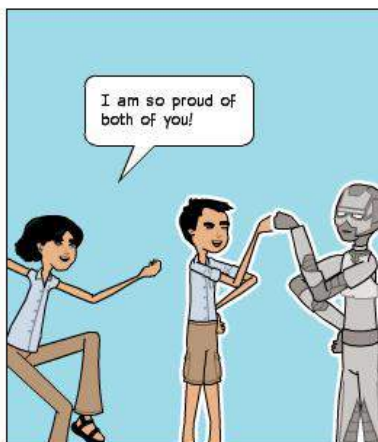
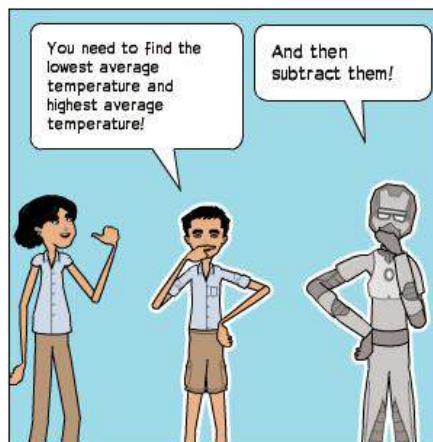
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- (b) $1/4$
- (c) $1/3$
- (d) $1/2$
- (e) $2/3$

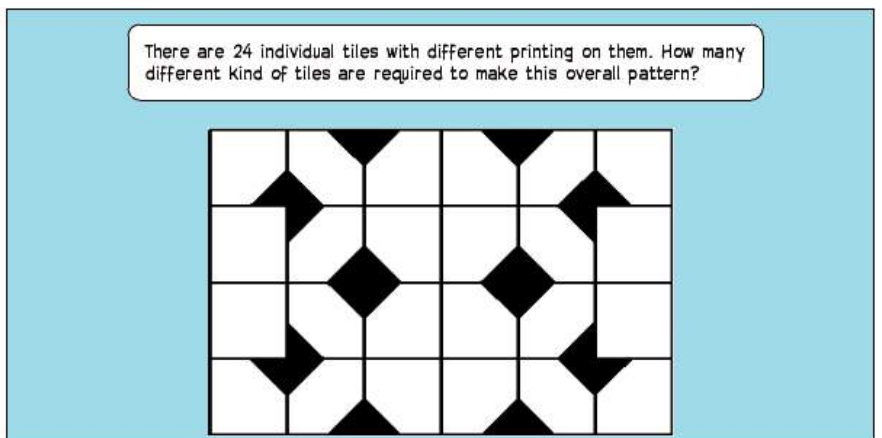
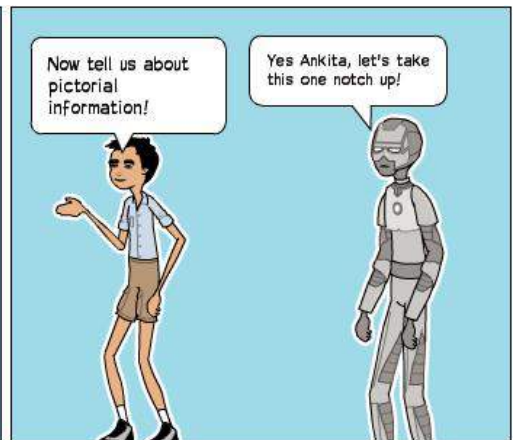
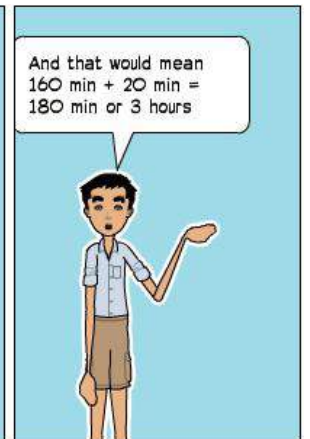
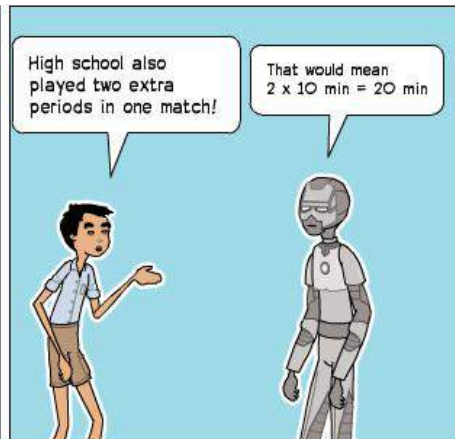
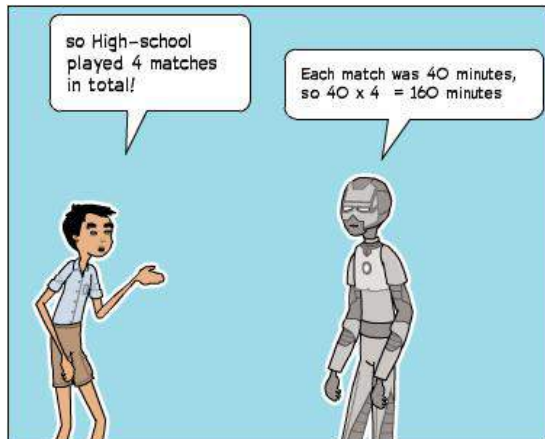
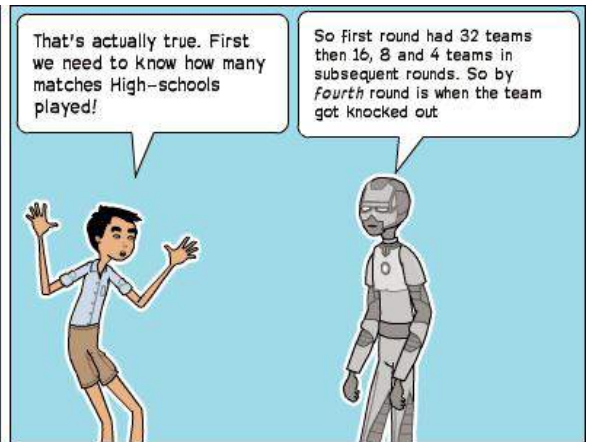
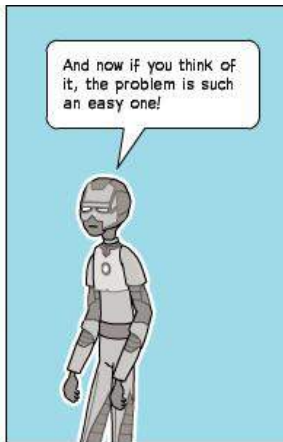
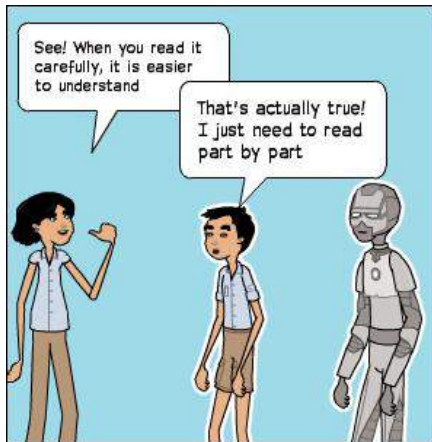
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You will have to think in steps. There are tiles that probably can be rotated and used.

Yes! The procedure is to eliminate tiles one by one, noting each time if a new tile can be used or a new tile is needed!

Let's start with the first tile. This will be unique!

The second tile is different from the first one. We would need this tile so let's keep it!

We can use the pattern in second tile to make third tile! So we will cross it!

Tile 2 can be used to get this

Tile 1 can be rotated to get this

And if you continue to do this you will get

You will get three unique patterns which can be used to make the 24 tiled pattern

This was so much fun! What else do you have in your hat?

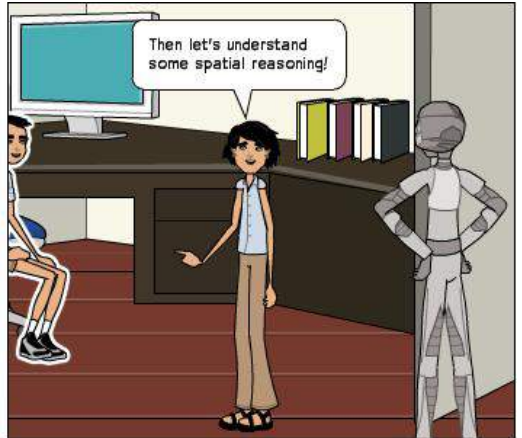
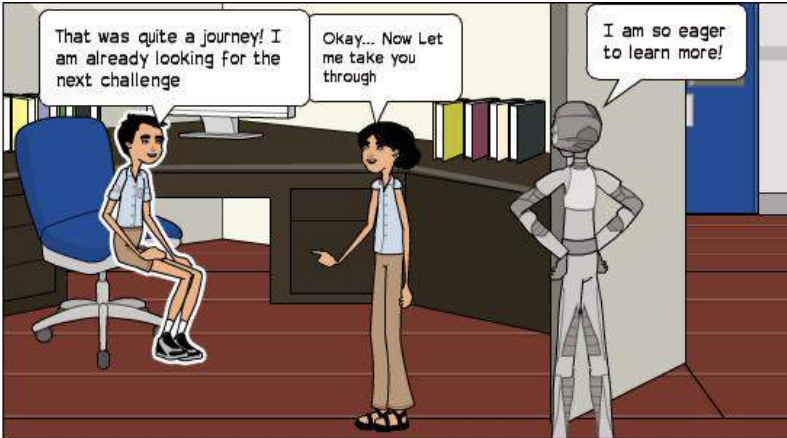
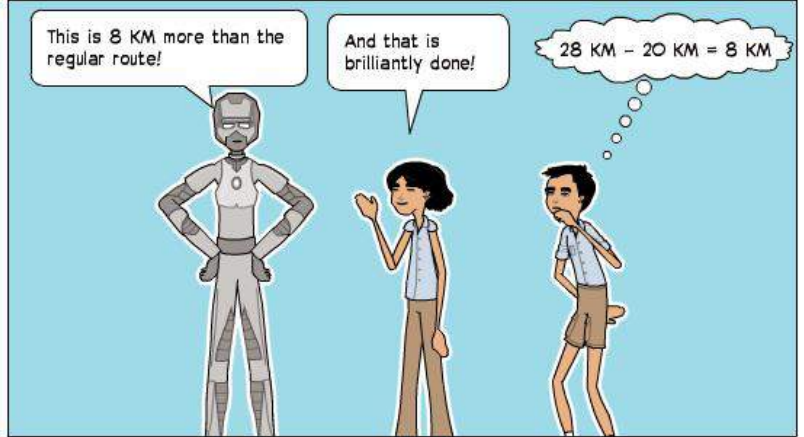
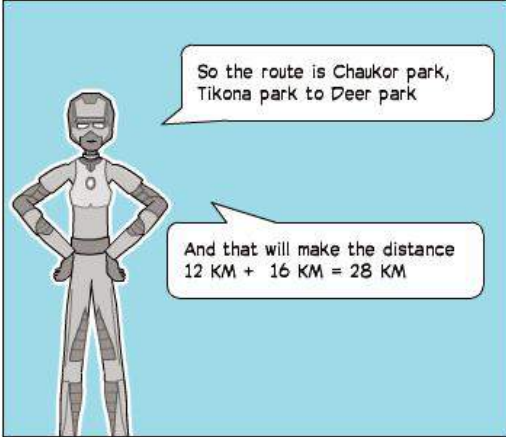
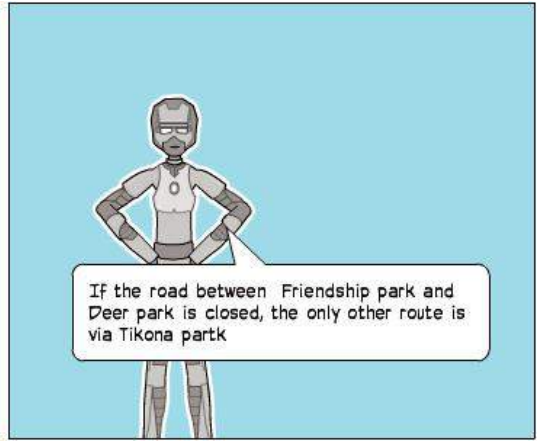
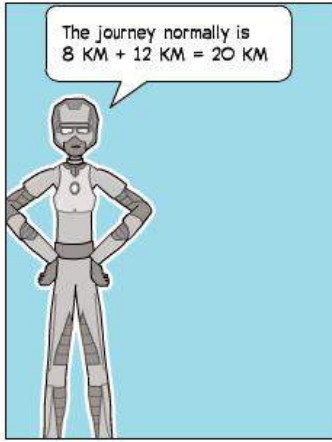
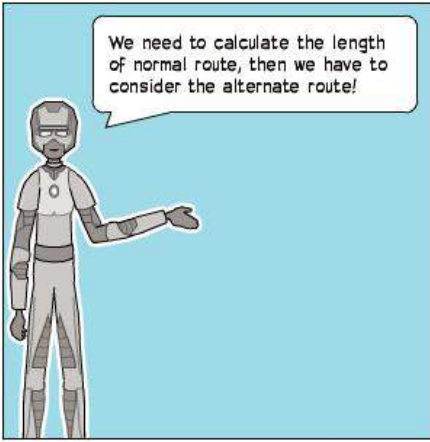
Hahahah... Well the next thing you both should try is extracting information from a diagram!

Let's do it!

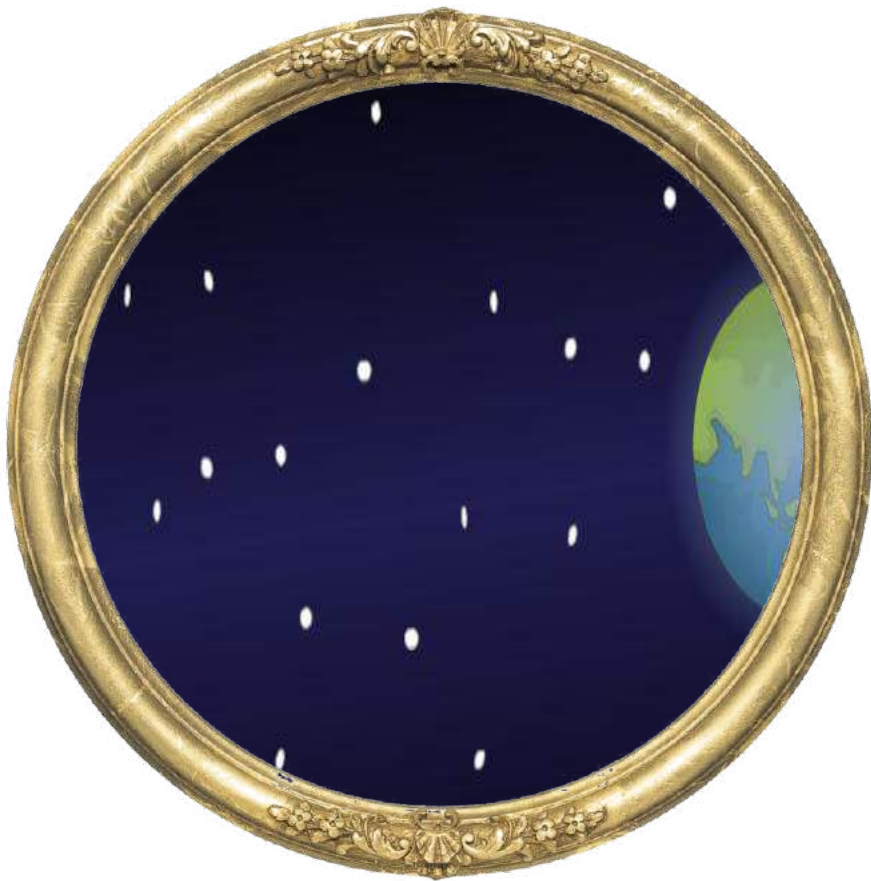
What else do you have in your hat is a phrase used to say what is the next thing you will bring up

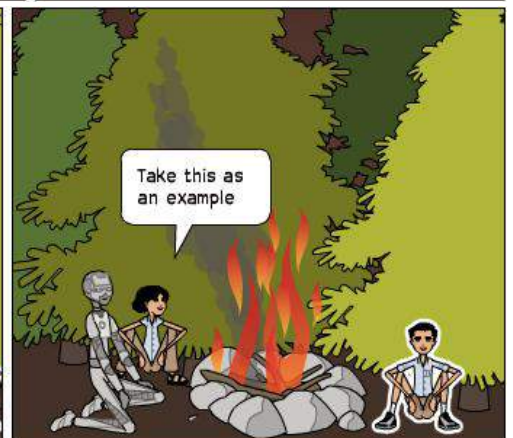
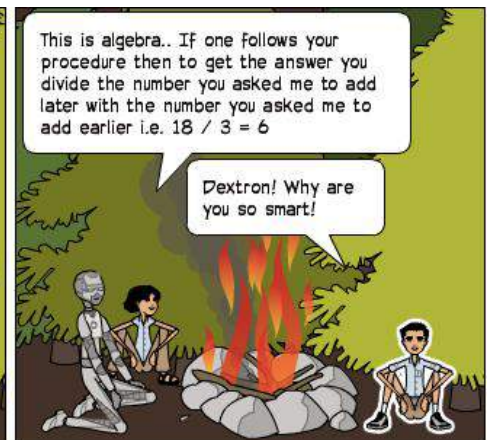
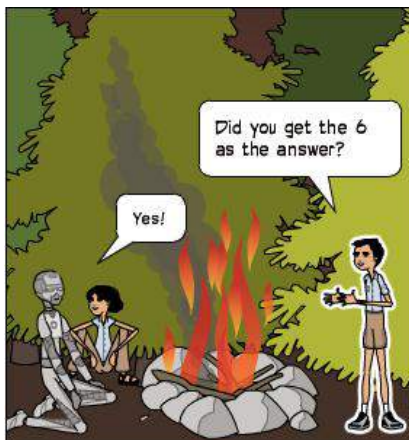
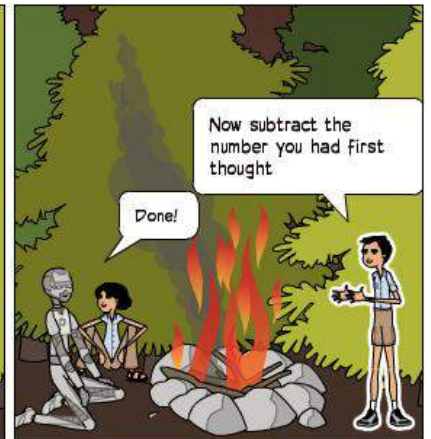
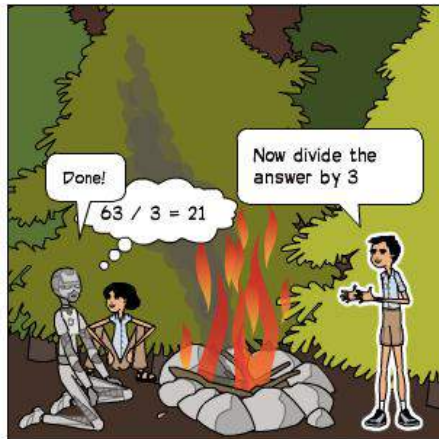
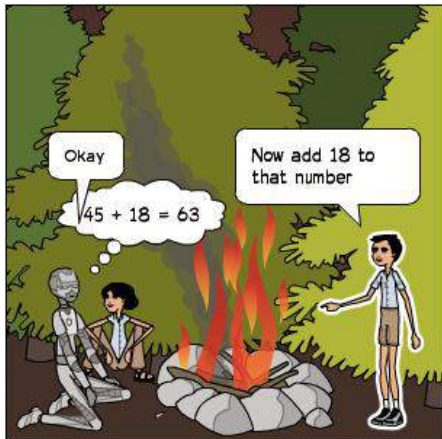
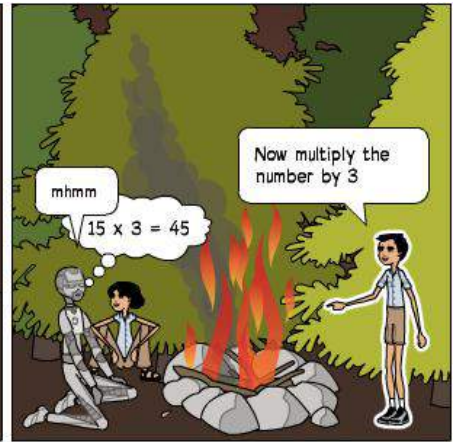
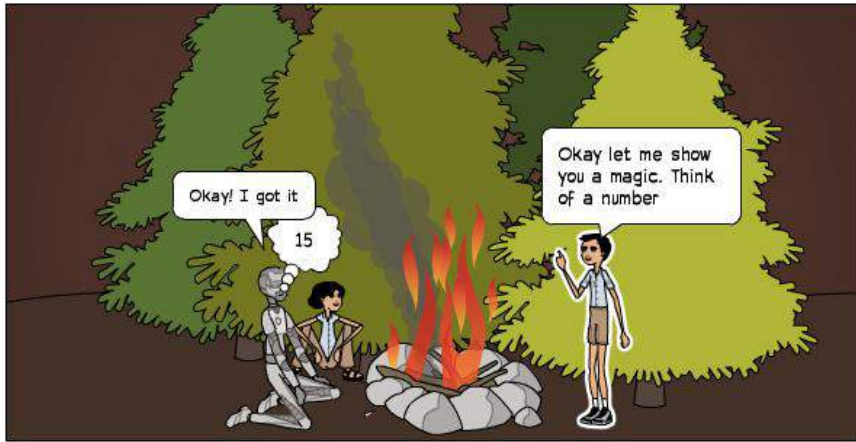
I live in Chaukor park and wish to visit a friend in Deer park. I normally go via Friendship park but have discovered (before setting off) that the road between Friendship park and Deer park is blocked by an accident. How much will this add to my journey?

This one is easy!

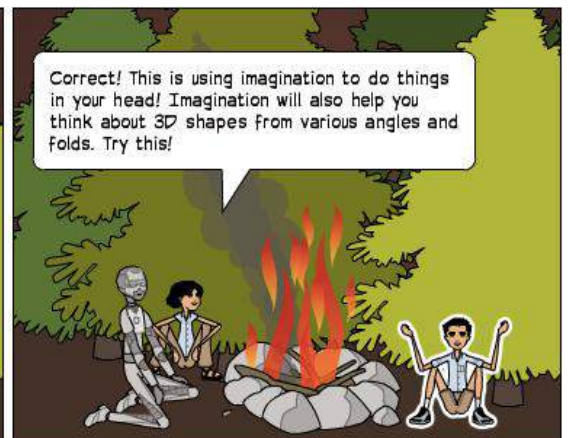
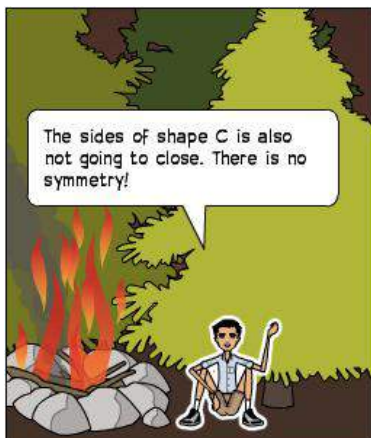
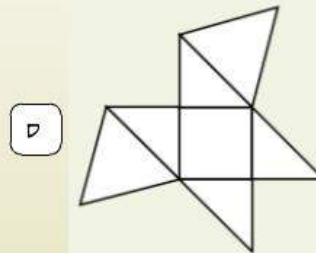
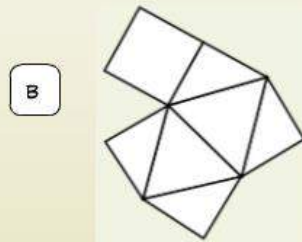
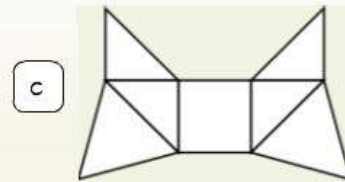
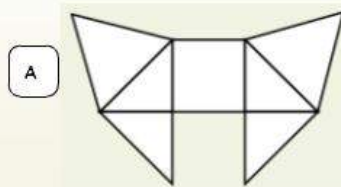
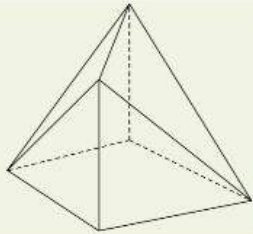


Give me some space!

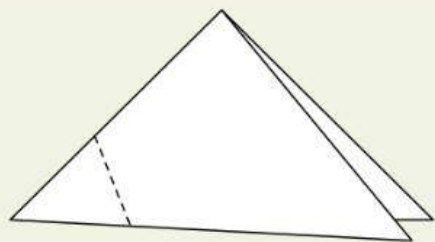




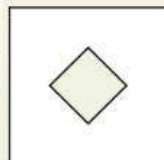
This is a 3 dimensional shape! Which of the following pieces of cardboard shape will fold to make the shape?



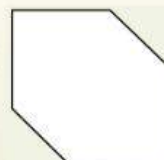
Some children are making decorations. A square sheet of paper is folded along a diagonal and then again so the two sharp points meet, as shown. A cut is made through all the layers of paper along the dotted line shown and the small pieces removed. The paper is then opened. What does it look like?



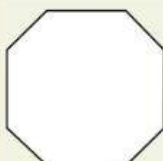
A



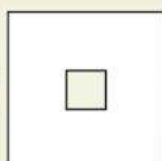
B



C



D



E



I think you will have to cut the top to get side A. So that can not be the answer

It would also not look like shape B

However, if you made a side cut, it would look like shape C. That must be the answer!

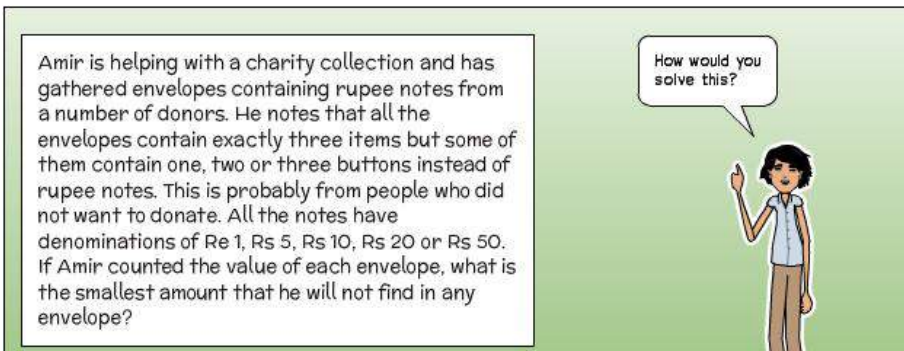
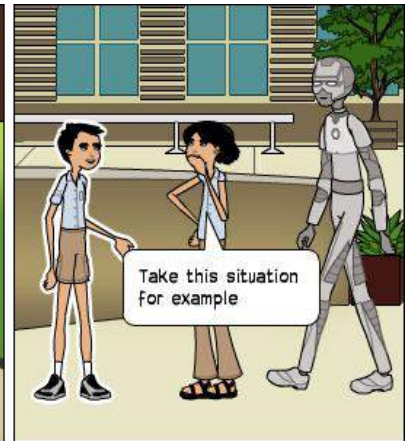
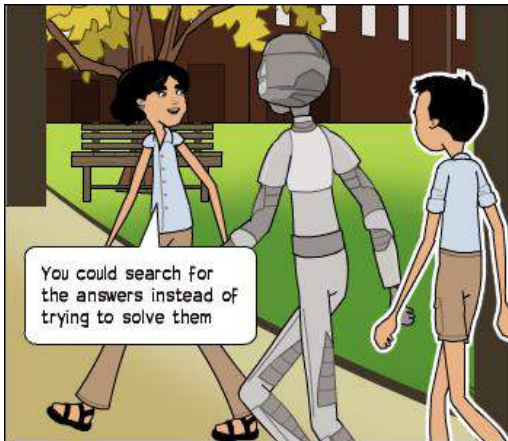
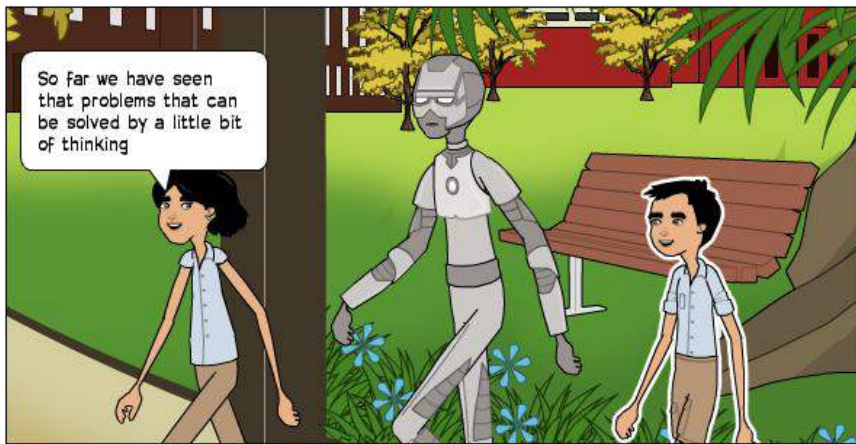
Well yes! You can try thinking about shape D and E as well just to verify it!

Thinking about shapes can be pretty fun and useful. This thinking will help in various fields such as engineering, architecture and even high levels of Physics!

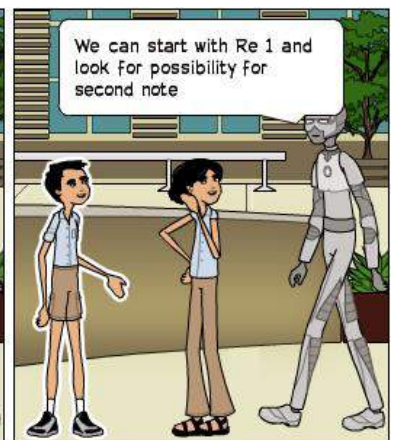
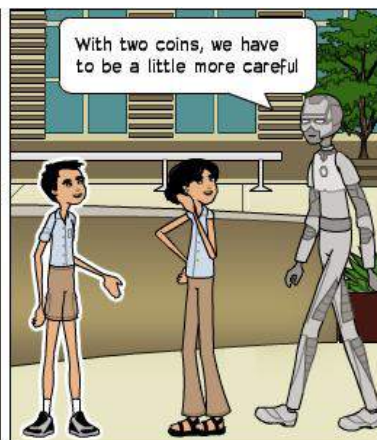
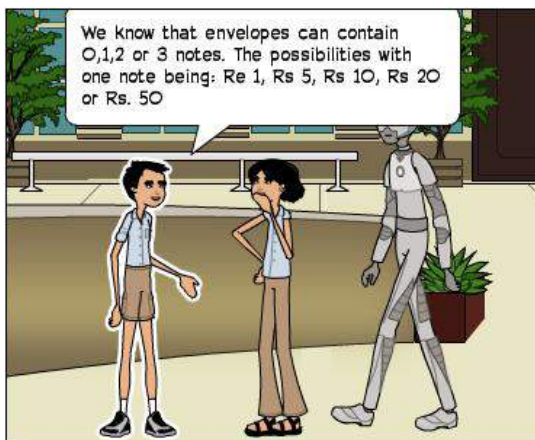
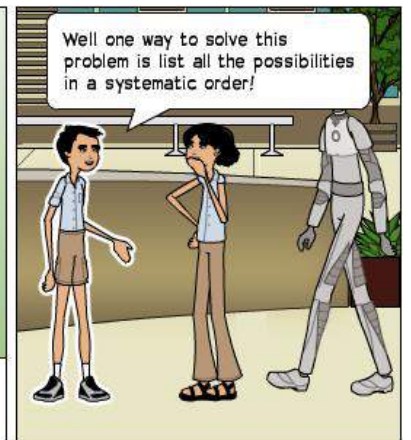
Now is the time when I taught you about solving problems by searching the answer

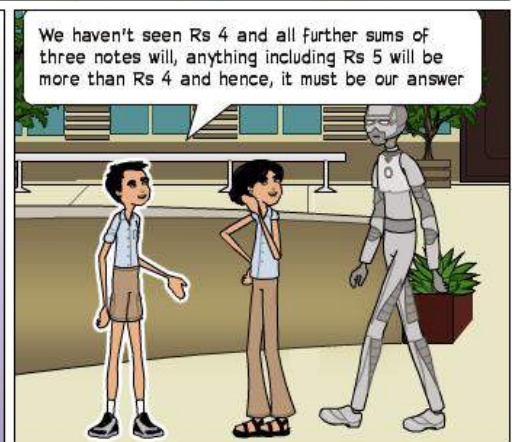
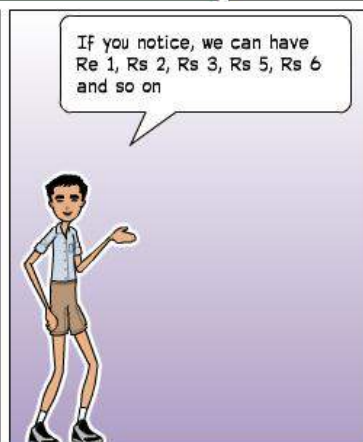
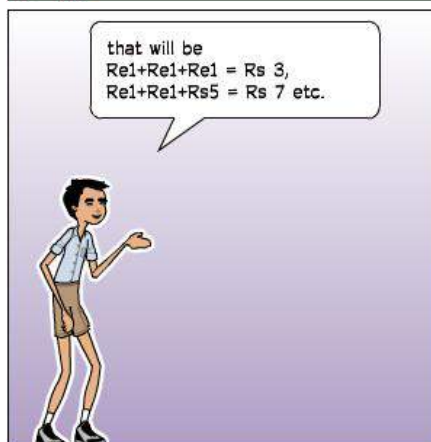
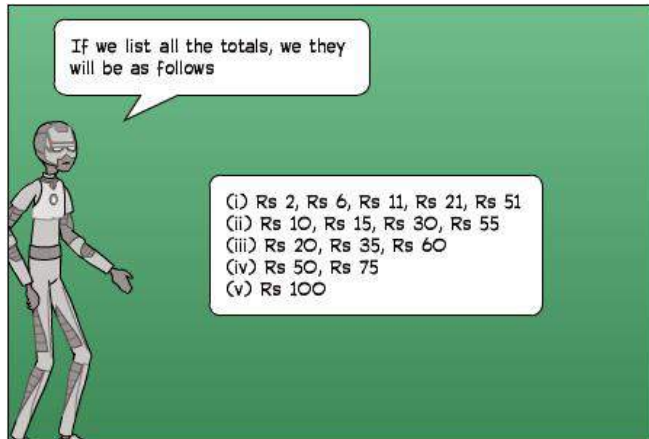
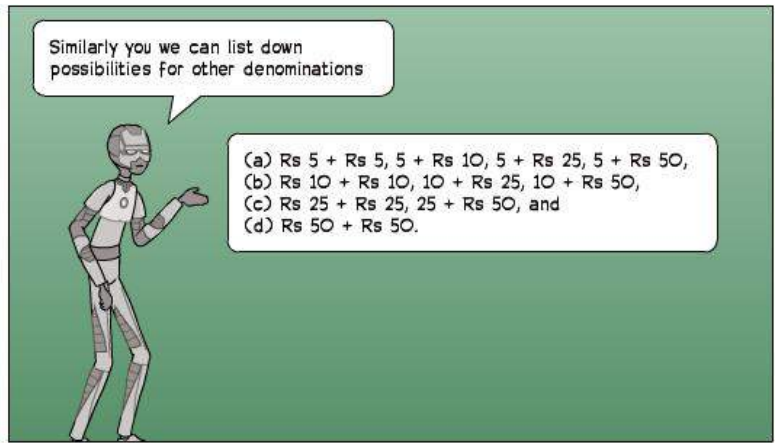
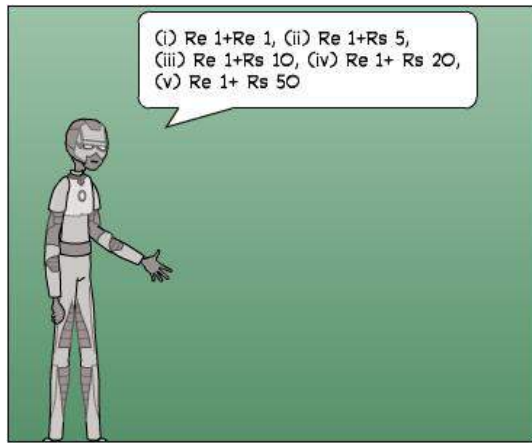
**If you can't solve it,
search for it !**





Explanation: Each envelope can have a different value starting from as low as Re 1 to as high as Rs 150. But there are value that Amir can not find in the envelope. For example, Amir can not find Rs 14 in any note as he would need Rs 10 and four Re 1 note and each envelope has three notes maximum.



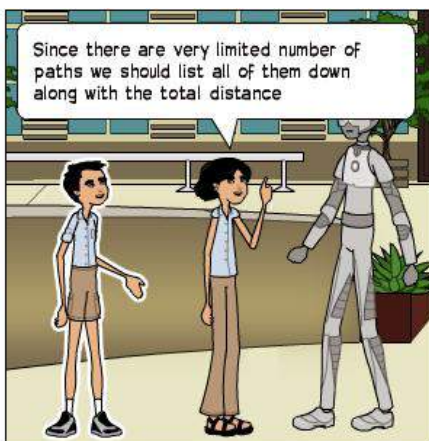
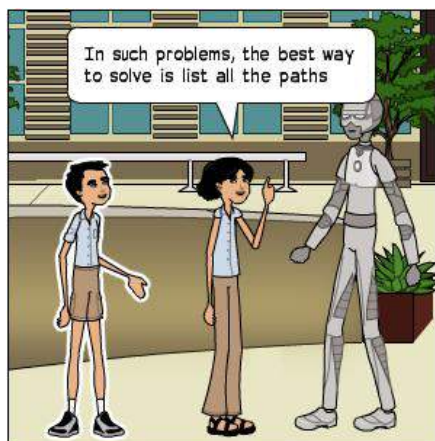
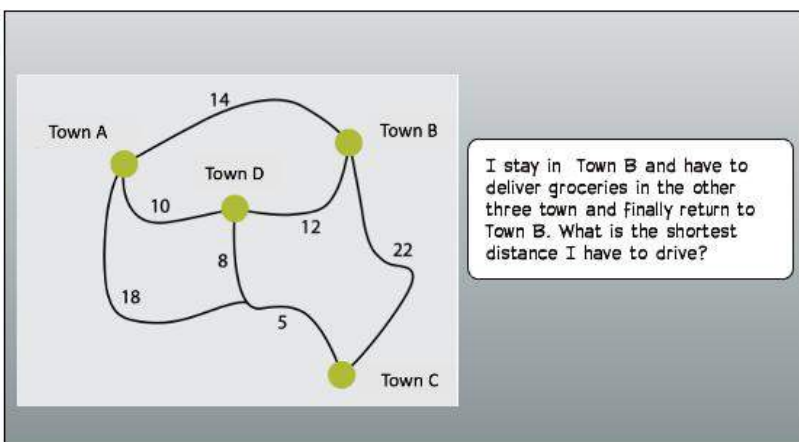
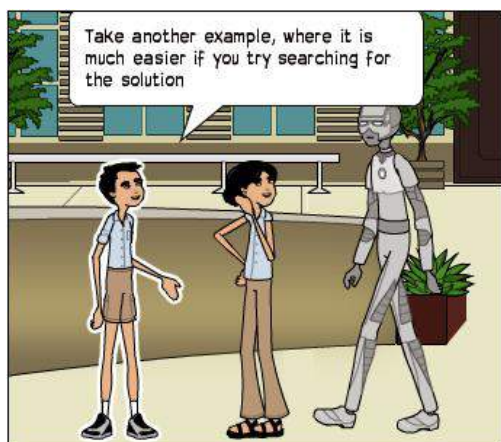


If you list down all the values that envelop can have:

Re 1, Rs 2, Rs 3, Rs 4, Rs 5, Rs 6, Rs 7, Rs 8, Rs 9 and so on

Then you can start striking off the numbers that you have found as the problem asks you to find the number that is not possible to get in the envelope. In this case:

~~Re 1, Rs 2, Rs 3, Rs 4, Rs 5, Rs 6, Rs 7, Rs 8, Rs 9~~ and so on



These are all the possible paths

$$BADCB = 14+10+8+5+22 = 59$$

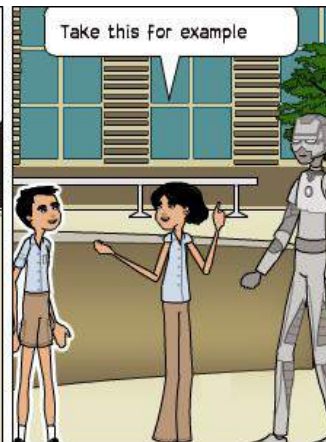
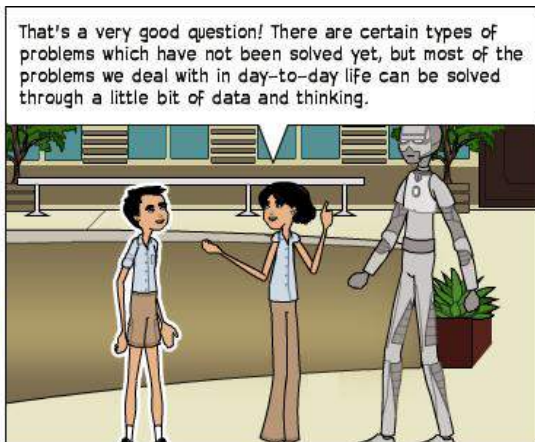
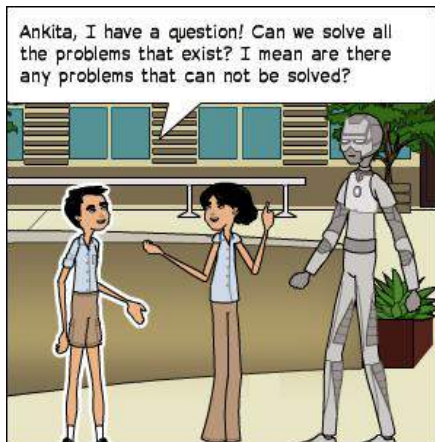
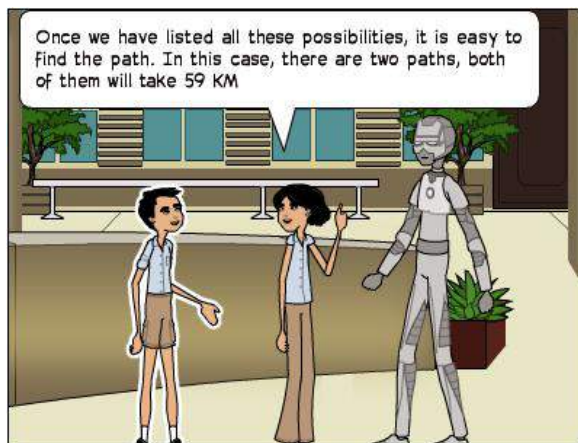
$$BACDB = 14+18+5+5+8+12 = 62$$

$$BDACB = 12+10+18+5+22 = 67$$

$$BDCAB = 12+8+5+5+18+14 = 62$$

$$BCDAB = 22+5+8+10+14 = 59$$

$$BCADB = 22+5+18+10+12 = 67$$



I use the trip meter on my car to measure the distance driven since I last had the car serviced, so that I know when the next service is due. The trip meter can be set to zero by the press of a button and records the kilometres driven since it was last reset.

I set the trip meter to zero after my last service. The next service is due after 20,000 km have been driven. Some time later, I lent the car to my brother. I forgot to tell him about the trip meter; he pressed the button to zero it and drove 575 km. I then started driving again without realising what he had done.

What should the trip meter read when the next service is due?

The above problem cannot be solved with the information given. What additional piece of information is needed to solve it?

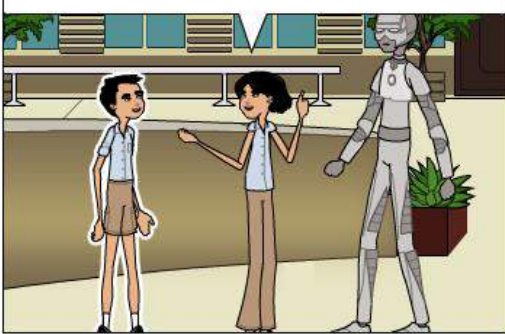
hmmm....The distance driven from the last service when your brother returned the car was the distance you had driven plus the distance he had driven.



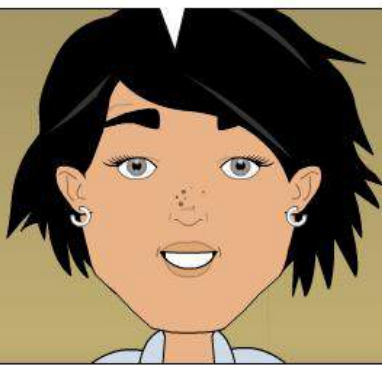
I know how far he had driven, so what I need to know was the distance on the trip meter when you gave the car to your brother.



In this example, the data was not sufficient to solve the problem. If you read the problem carefully, you will be able to find if the data is sufficient or not to solve the problem!



Why don't you try this problem by yourself and see if you can find the answer?



I have a small collection of three different types of old coin (1 paisa coins, 2 paisa coins and 5 paisa coins). The collection contains 15 coins in total. There are more 1 Paisa coin than 2 Paisa coins and more 2 Paisa coins than 5 Paisa coins. Which one of the following single pieces of information would enable you to know exactly how many of each type of coin there was?

(a) There are four more 2 Paisa coin than 5 Paisa coins

(b) There are five more 1 paisa coin than 5 paisa coins

(c) There are three more 1 paisa coin than 2 paisa coins.

(d) There is one less 1 paisa coin than 5 paisa coins and 2 paisa coins together.

You can apply the same strategy we used earlier. Search for the solution



1 paisa coin	2 paisa coin	5 paisa coin
12	2	1

Acknowledgement

We acknowledge the work done by Mr. John Butterworth and Mr. Geoff Thwaites on critical thinking through their book - Thinking Skills (Critical Thinking and Problem Solving)
This book has been a big source of inspiration for this book

Additional resources

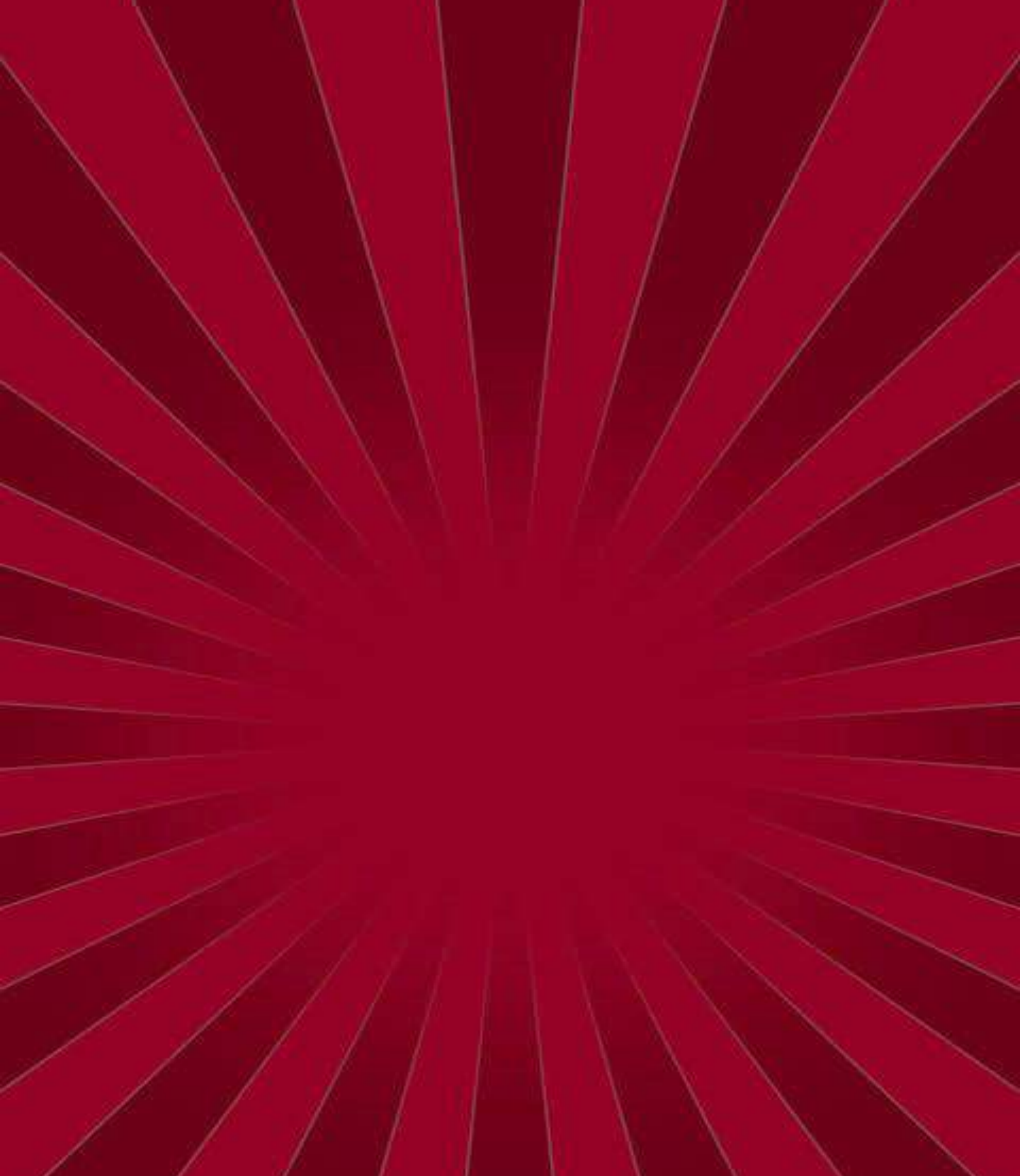
Readings

1. Hands on Maths
2. Mathematics Can Be Fun
3. Great Ideas of Modern Mathematics
4. Polya's Problem Solving strategy

Videos

1. [TED-Ed - Riddles](#)
2. [TED-Ed - Think like a coder](#)

We thank all the contributors for making the above resources available on the internet. We specially thank **Padma Shree Arvind Gupta** for making excellent learning resources available for free on the internet.



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