Co-funded by the Erasmus+ Programme of the European Union

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Workshop on Problem Solving Methods

Project Nr: 2019-1-DE03-KA201- 059604

This project has been funded with support from the European Commission. This PowerPoint reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained herein.

Examples

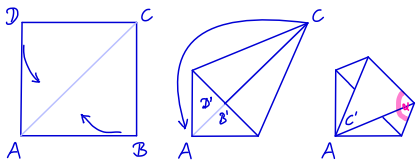
Find possible solutions that students might give. Work in small groups. The problems with (∗) are additional.

(∗) Paper folding

A square paper is folded into a pentagon as shown in the figure:

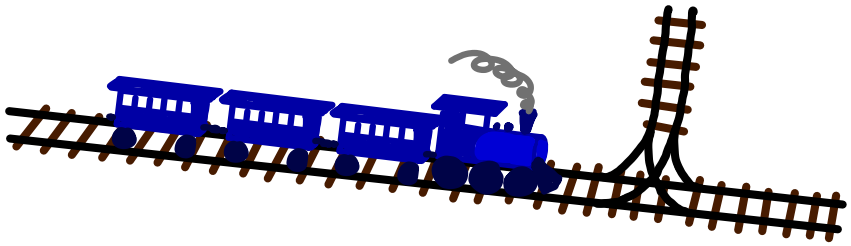
(a) The sides BC and CD are folded on the diagonal AC.

(b) C is folded onto A.



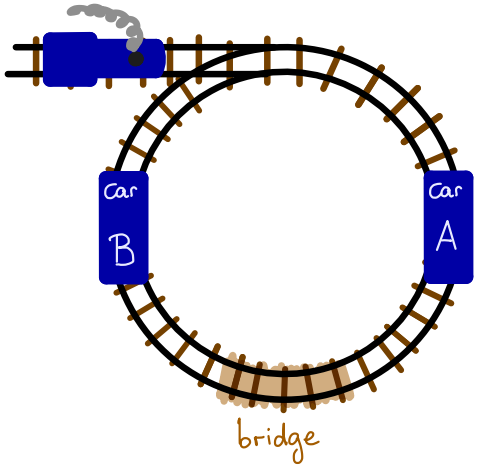
Find the angle a without the help of a protractor. Can you find as many other angles as possible without measuring?

1. A train is to turn around on a single track line. There is only one very short siding that can accommodate at most the locomotive or one car. Give a method that can be used to turn the entire train around.



2. In a marshalling yard, a locomotive is approaching a circular piece of track on which two empty wagons are standing. Between them is a bridge strong enough to support a car, but not the locomotive. The locomotive driver is supposed to switch the two wagons. Give a sequence of shunting steps that solves this task.

   Thereby each car and the locomotive can be coupled and uncoupled at both sides. However, all coupling maneuvers are performed only when the train is stationary, shunting approaches are not allowed. The bridge is just as long as a wagon, and the locomotive must leave the circular track at the end.



3. Three red candies and three green candies are distributed in three boxes, where each box contains candies. The boxes are marked with "GG", "GR" and "RR". However, in no case does the inscription correspond to the contents of the box.

   One candy may be taken from one box with the eyes closed. The color of the candy can be determined only after closing the box. From which box do you have to take a piece of candy from to be able to tell the exact contents of all the other boxes?

4. A couple had less than 10 children. They are boys and girls. Each girl has as many sisters as brothers. However, each of the boys has only half as many brothers as sisters. How many are there exactly?

(∗) Klaus tells about his family. "I am more than 10 years old, but not yet 20 years old. My mother is one year older than my father and 12 times as old as my sister. My father is 21 years older than me." How old are each of the family members?

5. Mike, Thomas, Reiko and Alfons were playing soccer in the yard and broke a window. When the incident was investigated, the boys made the following statements:

   - Mike: "The window was broken by Thomas or Reiko."
   - Alfons: "Reiko did it."
   - Thomas: "I didn't break the window."
   - Reiko: "Neither did I."

   Their teacher, who knew the boys well, said, "Three of them speak always speak the truth."

   Who broke the window?

6. Anna, Barbara, Cecilie, Doris and Erika have a race on the sports field. There are 5 lanes next to each other.

   a) How many ways are there to distribute the 5 girls on the running tracks?

   b) Barbara and Erika are friends and want to run next to each other. How many possibilities are there, if the wish of both of them is considered?

(∗) From the set of letters `{p,r,o,d,u,c,t}` should be formed words (also meaningless) with 4 letters. What is the number of possible word formations, if

   a) No letter may be repeated?

   b) Repetitions are allowed?

   c) A word should consist of 2 consonants and 2 vowels of the given set of letters and repetitions are not allowed?

7. In the four-digit secret number on Mr. Muller's check card the first and fourth digits match. The two middle digits are also the same. The number that is formed from the last two digits is by 2 larger than the sum of the digits of the secret number. Justify that there can be only one secret number with these properties and determine it.

8. A gambler counted through a sum of ducats won, which was less than than 400. If he counts them in twos, threes, fives, and sevens, there will be one left over. If he counts them by twelves, he has seven ducats left over. How many ducats has he won?

9. Determine all numbers with the following properties:

   (a) The number has three digits and contains three different digits, which are all prime numbers,

   (b) The number is additionally divisible by each of the numbers denoted by its digits.

10. Which letter stands for which digit?

$$\begin{array}{cccccc} & & S & E & N & D \\ + & & M & O & R & E \\ \hline & M & O & N & E & Y \end{array}$$

11. Given a tetrahedron whose faces are congruent triangles and a point P inside. Prove, that the sum of the distances of P to all faces of the tetrahedron is constant.