

EVACUATION



Preliminary round assignment 20th Mathematics A-lympiad

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getal en ruimte



Instructions for the preliminary round assignment for the Mathematics A-lympiad 2008/2009

This Mathematics A-lympiad assignment consists of three introductory assignments, two follow-up assignments and a final assignment.

General advice for working on this assignment

- First read the entire text of the assignment so that you'll know everything you have to do.
- **Keep an eye on the time you spend on the introductory and follow-up assignments, make sure you have enough time left for the final assignment.** Divide tasks where possible and confer with each other when needed.
- If you have divided your tasks, discuss the results of the introductory assignments with each other before you start on the final assignment.
- For the final assignment it is important that you formulate a real advice with a substantiated plan of evacuation, if necessary complemented by an alternative plan.
- The answers to the introductory and follow-up assignments should not be included in the elaboration of the final assignment. Add the results of the introductory and follow-up assignments as an appendix.

Hand in:

- A clear and elaborate advice for a plan of evacuation, supported by calculations and arguments.
- As appendices: the results of the introductory and follow-up assignments.

The jury will be given copies of your work. Of course these copies must be legible.

Therefore write and draw with a black pen, only print on A4 paper, and do not use pencil for any drawings. If in doubt, make a test copy yourself!

Among other things, the jury will pay attention to:

- legibility and clarity of the final assignment,
- whether the work is complete,
- the use of mathematics,
- the arguments used and justification of choices (realism may play a part here),
- the level to which the assignment has been done,
- presentation: form, legibility, structure, use and function of appendices, etc.

Have fun and good luck!

The TransEuro building



In every public building you will find signs to mark the escape route in case of disaster. In this Olympiad assignment you will look at the TransEuro building, an office tower that is part of Amherst University. The building dates from 1969, is 62 m high and has 22 floors. On every floor there are 60 people working, divided over fairly small offices. Of course there are several lifts in the building, but only one stairwell.

In case of an evacuation resulting from a disaster, all workers will have to be evacuated using this stairwell. The lifts may not be used.



Fire alarm drills have provided the following data:

- On each floor only one person at a time can go through the door into the stairwell.
- On each floor there will be a steady stream of people: every second someone will go through the door into the stairwell.
- Each person needs 15 seconds to walk down from one floor to the next.
- The stair is so narrow that a maximum of two people can walk next to each other.
- Once you're on the stair, you'll keep on walking until you reach the ground floor.
- Once you've reached the ground floor, there is a clear way out; it will take an additional 5 seconds to reach the outside.

In this assignment you will make a plan of evacuation for the TransEuro building. The plan of evacuation is based on the assumption that the lifts in the building may not be used.

Introductory assignments

To orient yourself, you will only look at the bottom five floors of the TransEuro building in the following assignments.

Assignment 1

Assume the only people in the building are 60 people working on the fifth floor. The rest of the building is empty. Calculate how long it will take at least for these 60 people to have left the building.

When there are many people present, a limiting condition will be added to the capacity of the stairwell (datum d). In the following assignment you will *not* yet take that into account.

Assignment 2

First, you will need a way to visualise the evacuation. Design this for a case where there are 60 people on *each* of the five floors and there are no limitations for the stairwell.

Of course, when you *do* take the limiting condition for the stairwell into account, there will be bottlenecks (datum d).

Assignment 3

Use the way of visualisation you made in assignment 2 to describe a possible evacuation of the five floors through the stairwell. Remember that only two people can walk alongside each other on the stairs. Write a clear explanation.

Follow-up assignments

Of course you will want to set up as efficient a plan of evacuation as possible. But what is as efficient as possible. To determine this, you need criteria, for instance: the total evacuation time; the total, average and maximum waiting times; the number of people waiting. Of course other criteria can be used, both for the whole building and for each floor.

Assignment 4

For the evacuation you designed in assignment 3, calculate the results for the criteria mentioned above.

Assignment 5

Can you draw conclusions now about those criteria for the whole TransEuro building (all 22 floors)? For instance, can you determine the total time needed for

the evacuation, the average waiting time per person and the maximum time that someone will have to wait? Explain your answer.

Final assignment

It is of course possible, based on criteria like the ones mentioned above, and the value you place on each of these criteria, to set up less or more efficient plans of evacuation for the whole TransEuro building.

Assignment 6

Write an advice for the Amberhavn University Board in which you put forward at least one proposition for an efficient plan of evacuation for the TransEuro building. Support your advice with calculations and arguments and justify the assumptions made.