

OK Geometry Easy

Reference for OK Geometry Easy (v.23)

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1 Introduction

OK Geometry is a tool for the analysis of dynamic geometric constructions. In a dynamic geometric construction, OK Geometry detects patterns and certain properties of the construction. OK Geometry (Easy mode) can be also used to present geometric properties or to comment on them.

You can think of OK Geometry as a pair of geometric spectacles that allow very precise observation of dynamic geometric constructions. OK Geometry helps students to notice properties that they may not be aware of. With OK Geometry (Easy mode) students can also develop the sense of proof. This is achieved with prepared tasks in which they are asked to organise properties of a construction into a deductive structure. **Students should be aware that it is one thing to see (observe) a property, another thing to know that a property is true, and yet another thing to have an explanation why something is true.** OK Geometry (Easy mode) can be also used to present geometric properties or proofs of facts in planar geometry.

With OK Geometry (Easy mode) you can:

- import geometric constructions from some dynamic geometry systems (DGS), currently from Cabri, Cabri II, Cabri Express, GeoGebra, C.a.R., Cinderella, Geometry Expressions, Sketchometry, JGEX, OK Geometry;
- spot patterns and properties in geometric constructions;
- organise properties, given in prepared exercises, into a proof and write a report;
- present the found properties.

Note: OK Geometry (Basic mode) offers much more: it is possible to create dynamic constructions, including implicit constructions and constructions based on optimisation, and to study them. It is also possible to devise proof problems to be solved in the Easy mode. OK Geometry (Plus mode) offers additional advanced observational methods.

2 Accessing the Easy mode

To access the Easy mode of OK Geometry, click in the menu line the command **Configure|Working mode|Easy** (Figure 1).

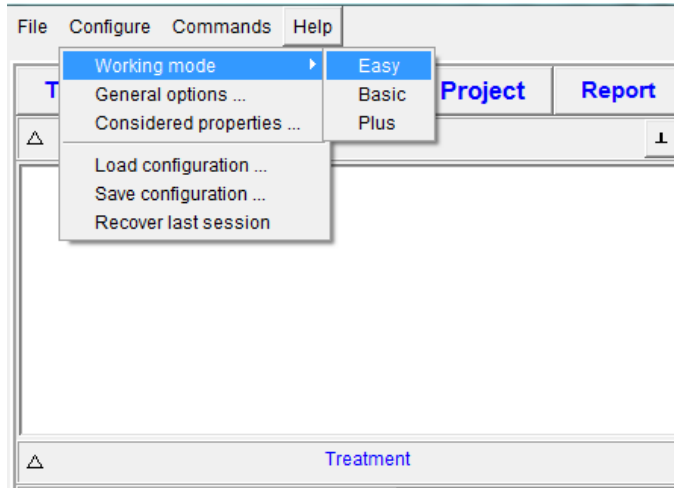


Figure 1

3 Spotting the properties of dynamic constructions

With OK Geometry Easy you can analyse geometric constructions made by dynamic geometry software. Here is what you need to do:

1. **Obtain a construction.** Create a construction using a dynamic geometry software (Cabri, Cabri Express, Cinderella, Geometry Expressions, GeoGebra, C.a.R., Sketchometry, JGEX). Save the construction to a file. Note that C.a.R. constructions should be saved in non-compressed native format (.zir), Sketchometry files should be exported as .jc files, and JGEX constructions need to be written in text format (.txt). Try to label all relevant vertices in the construction! (See Section 4 for additional information.) For convenience, some files created with different dynamic geometry software are already included in the *OKExamples\OKG_Import* directory (*Incircle.fig*, *Incircle.clmx*, *Incircle.ggb*, *Incircle.cdy*, *Incircle.p*, *Incircle.jc*, *incircle.zir*, *Incircle.txt*).
2. **Import the construction into OK Geometry.** Press the button **Task** in the main menu bar (see Figure 2) to select a file with a construction and import it into OK Geometry. The drawing of the construction should appear on the right pane.
3. **Detect geometric properties.** Press the button **Observe** (see Figure 2) to detect the geometric properties of the imported construction. The found properties are listed in the Observed properties section in the left pane (see Figure 2).
4. **Visualise instances of properties.** To access to instances of a property click the + sign in front of the property (see Figure 3). Click on an instance of the property to visualise the instance (see Figure 3). Note that above the visualised property appears a symbolic representation of it.
5. **Visualise selected objects involved in a property.** Click on any symbol in the symbolic description to emphasize the object represented by the symbol. (See Figure 3). You may find

useful the arrow keys on the keyboard and the Shift arrow keys to navigate between the shown objects.

6. You can change the level of analysis (see Figure 2) and repeat the Observation. The higher the level, the more sophisticated properties are checked.
7. You can also set which vertices to consider (see Figure 2). For example, if you want to consider only vertices ABCDP write in the entry ABCDP. If you want to list the vertices to be excluded from the consideration, write an exclamation point at the beginning, e.g. !ABP to exclude the vertices A,B,P from the analysis.
8. If necessary, new labels of points can be added, changed or removed by right-clicking on the right pane and choosing the appropriate command.
9. In order to list only properties that involve a given object, use appropriate **? button** on right side to select the type of object and then point to object on display (or its vertices) (Figure 4).
10. If the number of instances of a property exceeds a threshold (set in *Configure/General options/Observe*), a notice '**x properties not examined**' appears at the end of the list. Click on the notice to see the affected properties and respective number of instances. To observe the properties, increase the threshold for the number of considered instances or reduce the points considered in the configuration.

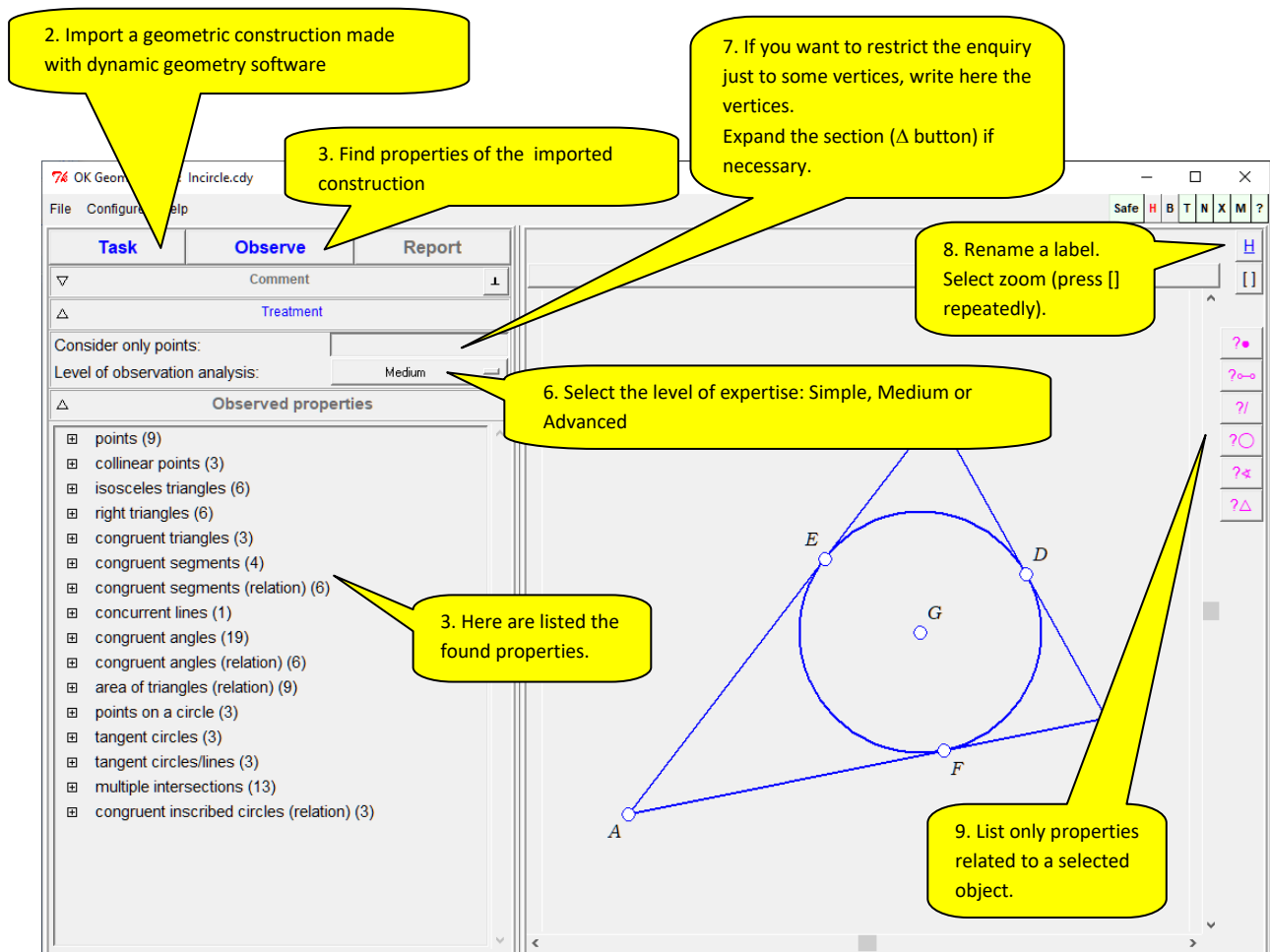


Figure 2

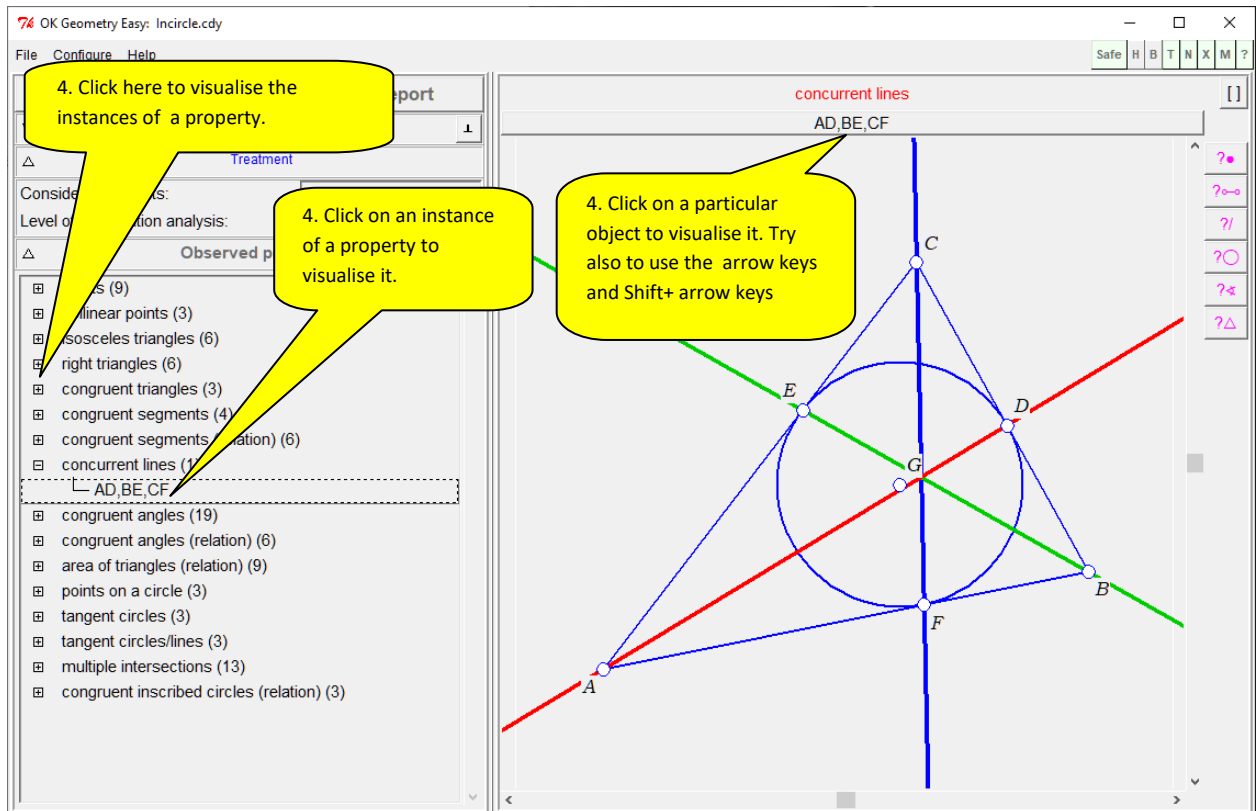


Figure 3

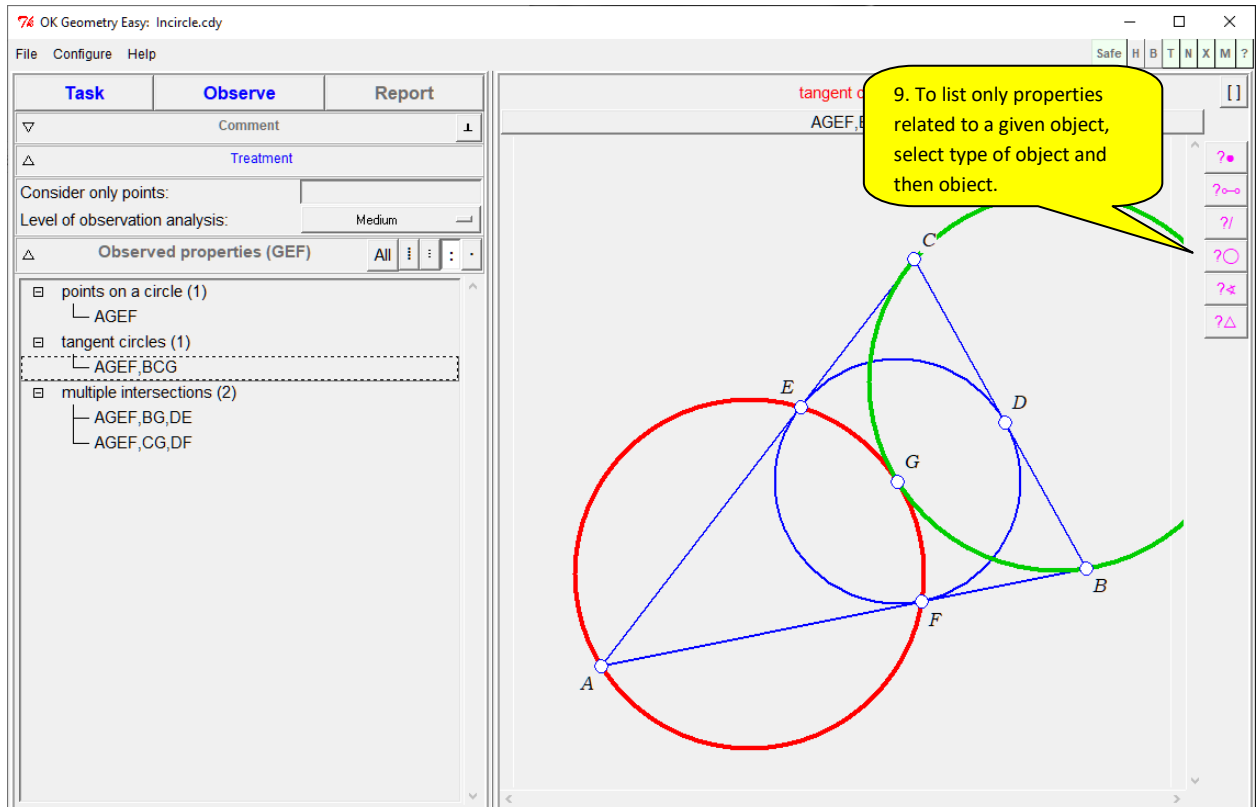


Figure 4

4 Understanding the properties

OK Geometry imports and displays many elements from constructions created with different dynamic geometry software (GeoGebra, Cinderella, Geometry Expressions, Cabri, Cabri Express, Sketchometry, C.a.R., JGEX). When analysing geometric constructions OK Geometry considers:

- all **displayed labelled points**;
- all displayed lines, circles, and other objects;
- all lines (displayed or not) passing through any two **displayed labelled points**;
- all circles (displayed or not) passing through any three **displayed labelled points**;
- all conics (displayed or not) passing through any five **displayed labelled points**;
- specific objects (displayed or not) .

Special care should be taken to properly label the points in a construction. Remember:

1. **Point labels usually consist of a letter, optionally followed by apostrophes, numerals or other letters. The same label cannot be used for different points.** Thus the labels of points should be like: A, B, A', B'', A1, B12, AB . There is no need to label all displayed points in a geometric construction, label just the relevant ones, each with a different label.
2. **A reasonable number of points to consider in a construction is 4-12.** The number of detected patterns generally increases rapidly with the number of considered labelled points in a construction. An excessive number of considered points can lead to an unmanageable collection of properties and unclear visual representations. During the analysis it is possible to exclude some labelled points from consideration (either by specifying the labels to be considered or the labels to be excluded, see 3.7).
3. **At any time you can within OK Geometry change, delete or add labels for points.** Right click on the right pane and follow the menu commands.
4. **OK Geometry considers only acute and right angles between lines.** Properties are thus often stated in the form that something holds for *an angle or its supplementary angle*. The user has to find out where to take into consideration the angle and where the supplementary angle. In the Figure 5 (right) OK Geometry, for example, notes the ratio 1:2 between the two displayed angles ($\angle BCA$ and $\angle BDA$) or their supplementary angles. In fact, the ratio 1:2 is between the angle $\angle BCA$ (green colour) and supplement of $\angle BDA$ (supplement of the angle indicated by red colour).
5. **OK Geometry does not warn of trivial cases of congruency of angles (angles related to pairs of parallel lines, angles formed by two crossing lines).** In fact, a pair of parallel lines often gives rise to an immense number of congruent angles. Thus, when considering the spotted properties one should check if there are parallel lines and be aware of the congruency of angles defined by parallel lines and lines that cross them. In the trapezium (Figure 5 left), for example, OK Geometry does not list the fact that the angles $\angle DEA$ and $\angle BEC$ are congruent or that $\angle DCA$ and $\angle CAB$ are congruent.

It is important to choose well, which points to mark and label in a geometric construction. In general, try to mark all points that you find to be potentially relevant to your investigation. In common tasks it is quite straightforward which points to mark and label. However, especially when

solving harder problems, a good choice of points to label is also a matter of good intuition (more precisely: of an extensive and well organised knowledge base).

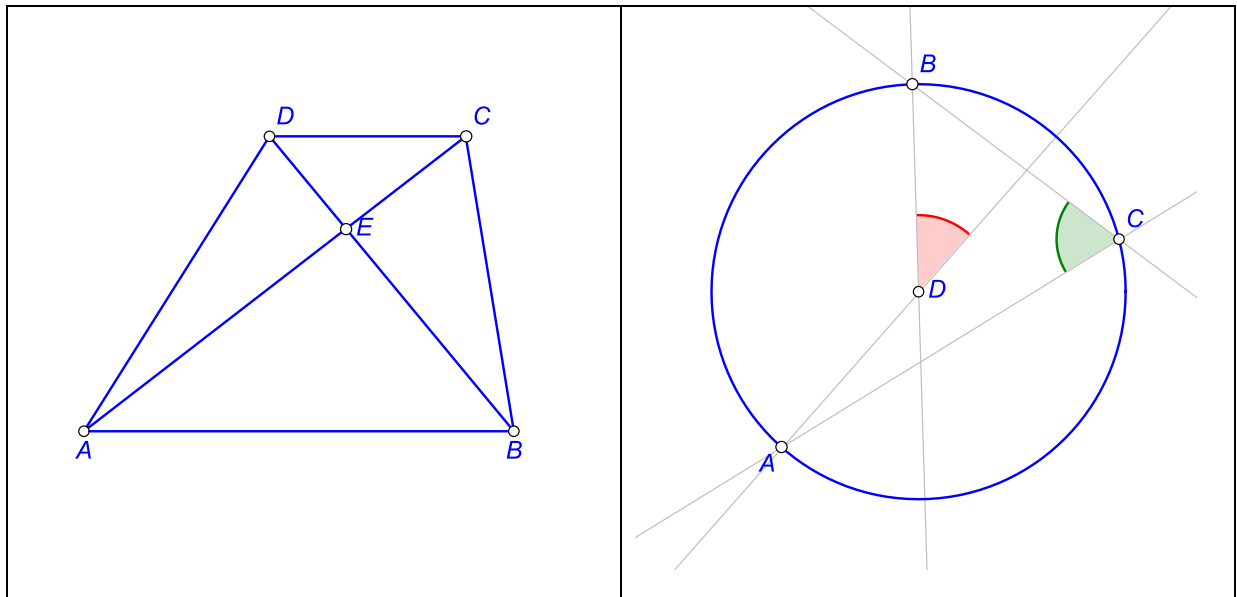


Figure 5

5 Solving simple proof-tasks

Students who are still learning the concept of a proof and students who have difficulty proving geometry facts will benefit if someone (e.g., their teacher using OK Geometry in basic mode) has previously selected the facts to be used in a proof. In this way, the student can focus on building up the proof by arranging the properties correctly and providing deductive arguments. In the *OKExamples\OKG_Easy* directory you will find some simple exercises of this kind, e.g. *Trapezium1.pro*. Note that the exercises are prepared with OK Geometry (not in Easy mode) and are saved in files with the .pro extension.

To work out a prepared task of this kind (e.g. *Trapezium1.pro*) follow these steps:

1. Press the button **Task** in the main menu bar (Figure 6) to select and read a task, in our example the file *Trapezium1.pro*. (Such tasks can be previously prepared by the teacher with OK Geometry, but not in the Easy mode.) On the left pane you can see the task and the numbered observed facts. On the right pane you can see their respective iconic representations. (Note. Students can work as well with printed icons. OK Geometry Basic is in this case just a tool to make the learning aids.)
2. Try to find relations among the shown facts, i.e. which fact follows from which facts. When the arrangement of icons is set to *Free*, this is done by moving around (dragging) the icons (drag by pointing the icon and pressing the left button of the mouse). You can change the size of icons and elements of icons (e.g. size of labels) with the sliders on the lower left of the window. (see Figure 5).
3. To change the number order of icons:
 - right click on the icon and use the command *Set icon number*, or

- click on the icon and use the - or + keyboard key to decrease or increase the number of the icon.
- 4. Double click a description on the left pane or on an icon on the right pane. In the form that appears (Figure 7) write an explanation, e.g., why does the represented property follow from the previous facts in the list. In the text you can mark paragraphs as Claims, Arguments, Definitions (right click on the paragraph). Use the # symbol to refer to another property: e.g. #3 refers to the property and icon number 3. Note that it is possible to comment the relation directly on the left pane.
- 5. Additional commands are available with a right click on an icon. You can also use the command bar on the left to move among icons, to maximise an icon, to use special characters, etc.
- 6. When all properties are commented and the proof is worked out, you can obtain a report. Press the Report button (Figure 8) and follow the instructions.

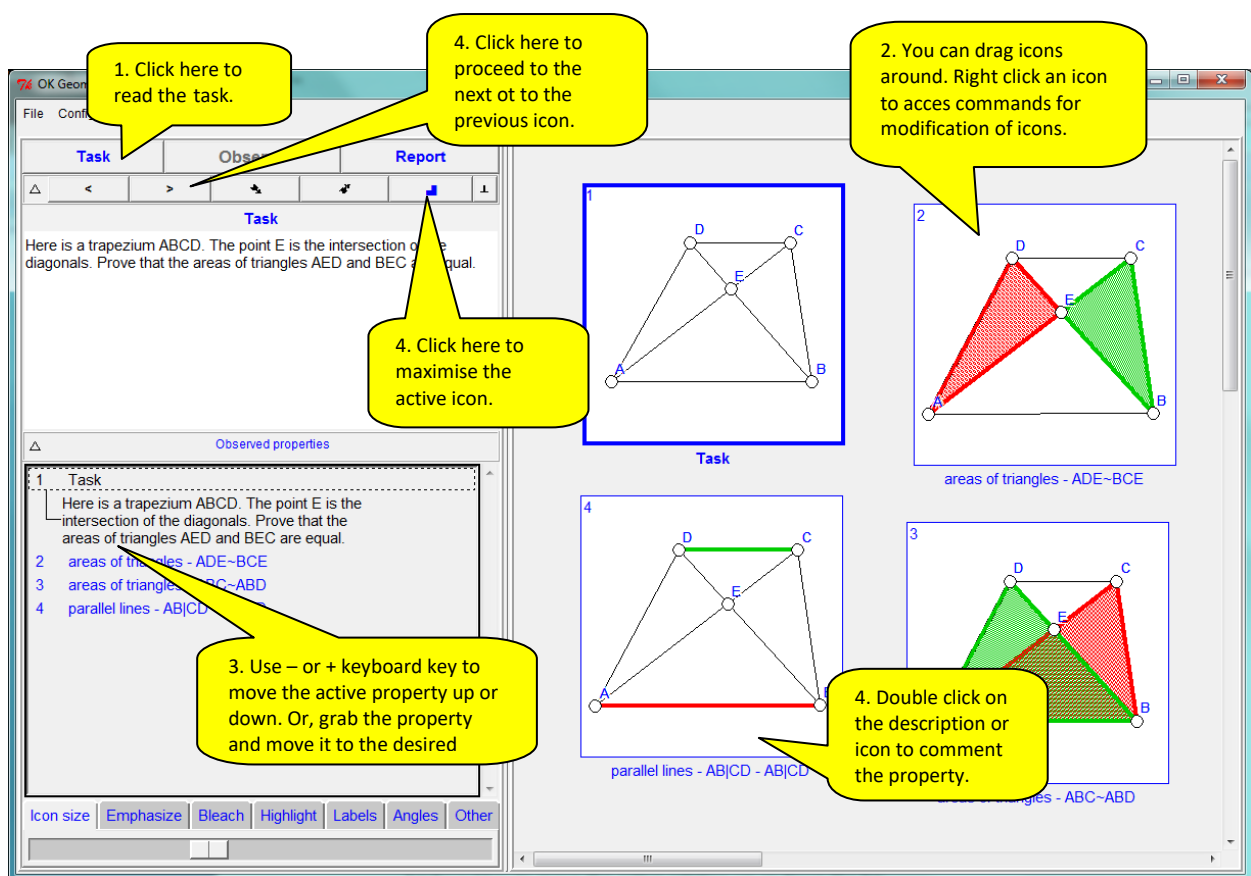


Figure 6

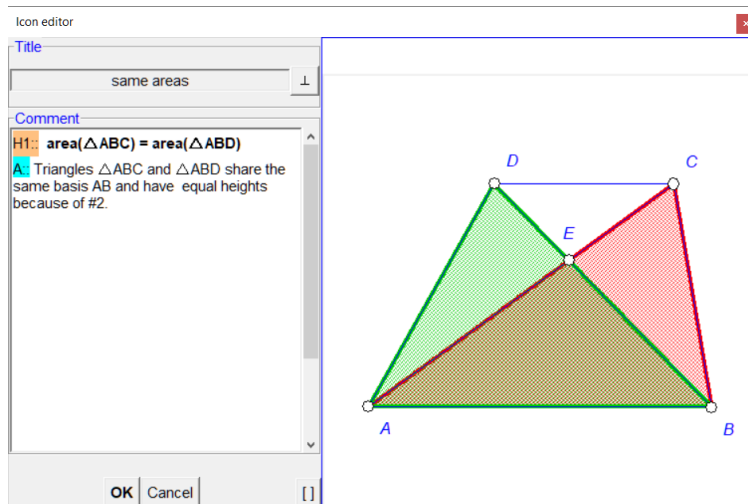


Figure 7

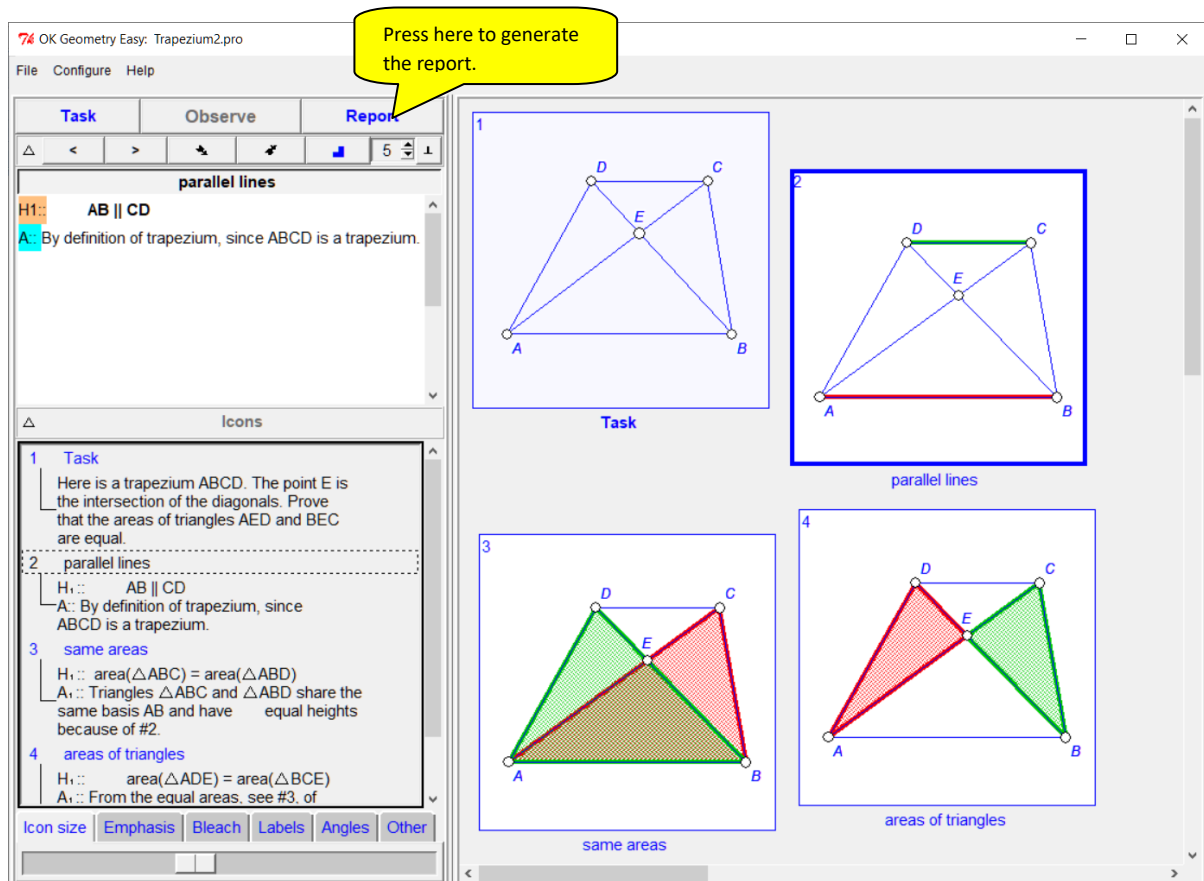


Figure 8

Note:

- OK Geometry Easy **does not** check the correctness of the proof.
- Steps 2-4 can be repeated in any order.
- You can save your work using the *File/Save project* command in the main menu.
- This section describes only the basics of writing up simplified proofs. More details are in the documentation of OK Geometry Basic.
- You can find more examples in the directory *OKExamples\OKG_Easy*.

6 Making a report

OK Geometry can create reports in different styles (paragraph form with images in or above the text, two-column form, etc.) in different file formats (htm, doc, tex, odt). We present here how to create a two-column proof in HTM format.

To obtain the report, press the Report button in the main menu bar (Figure 8). First you will be asked for the name of the file to be created - in our case, choose a file name with the file extension htm. In the form that appears, specify the desired modalities of the report to be created - in our case, select Two column with icons structure of the report.

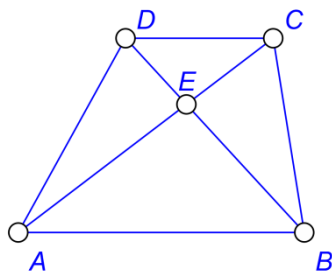
Once the HTML report has been generated, you can edit it using an HTML editor or a suitable word processing program. Here is how a final report might look like:

Author: Zlatan Magajna (Fri May 6 22:08:02 2022)

Source: C:\OKExamples\ Trapezium2.pro

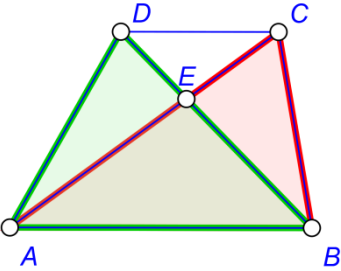
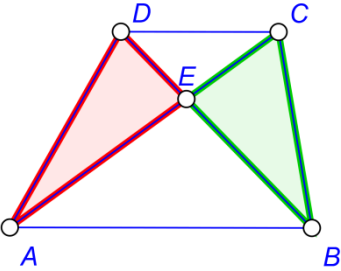
Task

1 Task



Here is a trapezium ABCD. The point E is the intersection of the diagonals. Prove that the areas of triangles AED and BEC are equal.

	2 parallel lines Claim 1 $AB \parallel CD$	Argument 1 By definition of trapezium, since ABCD is a trapezium.
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	3 same areas Claim 1 $\text{area}(\triangle ABC) = \text{area}(\triangle ABD)$	Argument 1 Triangles $\triangle ABC$ and $\triangle ABD$ share the same basis AB and have equal heights because of #2.
	4 areas of triangles Claim 1 $\text{area}(\triangle ADE) = \text{area}(\triangle BCE)$	Argument 1 From the equal areas, see #3, of $\triangle ABC$ and $\triangle ABD$ we subtract the common area of $\triangle ABE$. The remaining parts, $\triangle AED$ and $\triangle BCE$, have the same area.

7 Other modes of OK Geometry (Basic and Plus mode)

The Basic mode of OK Geometry offers several additional possibilities for working out and analysing planar geometric constructions. In the Basic mode of OK Geometry one can:

- Make new dynamic constructions and edit imported constructions.
- Make advanced and implicit constructions, e.g. construct a circle that is tangent to three given circles or determine a point that satisfies a minimisation criterion.
- Select the properties to be taken into consideration in the analysis of constructions.
- Efficiently search among the detected observed facts.
- Collect the properties to be used for further elaboration (e.g. in a proof).

There is also a Plus mode of OK Geometry. This mode allows advanced methods of observation of geometric and algebraic properties and the observation of specific properties of triangles and the creation of deductive proofs.