G1 Geometer’s Sketchpad Instructions for v4.06

This program is the mathematician’s toolbox.

**Tools:** The basic construction devices provided are

- **Selection arrow** (to select and translate items),
- **Point tool,**
- **Compass tool,**
- **Straightedge tools** (to create segments, rays, and lines),
- **Text tool** (creates labels and caption boxes),
- **Custom Tools menu.**

The point, line, and circle can be referred to as the Freehand Tools, since they allow you to **draw** objects freehand. (As opposed to **constructing** objects.)

The point tool has a sub menu (point at it and hold down the button) to translate, rotate or dilate objects you point at. First select the object to be moved, then the center of the transformation. The line tool also has a submenu to draw a segment (default), ray, or line.

You select objects by pointing at them and clicking. If you select something you don’t want, you can unselect it by clicking on it again. To unselect everything, simply point at a blank area of the screen and click or press the **esc** key. To select several objects, click on them in succession.

**GSP4:** You do **not** have to hold down the shift key to select multiple objects.

**Labeling:** The A tool labels objects. When the finger is pointing at something, it turns black. Click to toggle the label off and on. Points are labeled with capital letters, lines with lowercase letters, figures with vertex labels or with letters and numbers. If you point at the label with the tool, then hold down the mouse button and drag, you can shift the position of the label. If you point at the label with the text tool and double-click (click-click quickly), then a dialog box appears. You can then type in anything you want to modify the label, including subscripts.

**GSP4:** An object’s label is generated only when a label is needed. The first point you label with the text tool in a new sketch will be labeled A, even though that is not the first point constructed.

To unlabel something, just point at it with the text tool and click again.
The menu bar contains the following choices:

- **File** menu has the usual choices of Open, Save, Print, etc. It is recommended that you always use Print Preview before printing to avoid your construction being printed on two pages. Print Preview lets you scale your drawing to fit the vertical or horizontal page.

- **Edit** menu has the usual Cut, Copy, Paste and Clear options. The Undo allows you to undo continuously, back to your very first step — very useful. This menu also contains the Action Buttons, which are used to create buttons for movement, animation, hide/show, presentation, link, and scroll.

- **Edit** menu also allows you to select the Parents and Children of an object. When you select the necessary objects and then construct something, the construction is the child and the original objects are the parents. You can move a parent, or change its size, and thereby modify the child. You may not move a child in such a way that it changes the parent. (Moving a child will slide the entire figure on the page.) You can always identify an independent object because when you point at a parent (or free) object, the pointer turns sideways.

- **GSP4**: You can edit objects and definitions. For example, you can split a point from its parent, split a point into two points, merge two points, or merge a point to a path. You can also split and merge text. You can edit the definition of a calculation, function, parameter, or plotted point. You can change the properties of any object on the screen, label, value, plot, parameter, and button.

- **Display** menu contains several useful tools. The top section contains choices to change line thickness and color and text size and font. The next two sections deal with hiding and showing objects and labels. This allows you to hide constructions. The next choice allows you to trace the path of an object (locus).

- **Animate** choice lets you move an object.

  - **GSP4**: An independent point moves randomly, points on straight paths move bidirectionally, while points on circles or interiors move around their paths. Dependent objects move the object on which they depend. This differs from the animation under the Action Buttons on the Edit menu, which creates a button you can turn off and on. The next two choices increase/decrease or stop the animation. GSP4 also has a motion controller.

- **Construct** menu, you have the usual constructions from which to choose. Unlike other geometry programs, you must first select the required points, lines, etc. before you choose...
the construction. For example, if you select two points and then go to the **Construct** menu, you will see Segment, Ray, Line and Circle By Center+Point darkened. These are the four constructions possible with two points. (Since the circle choice lists center+point, the first point will be the center and the second a point on the circle. The ray will be constructed from the first point through the second.)

If you select an object, such as a circle or line, then you can choose Point On Object. This gives you a point that you can move along the path of the object by the point-click-and-drag method. This point cannot be moved off the original object (unless you split it from its parent), unlike a point created by the Freehand tool.

To construct an Arc On Circle, you first select the center, the first point on the arc, then the second point going counter-clockwise. This enables you to construct both major and minor arcs. You can also select 3 points and construct an arc through those points. Once an arc is selected, you can construct the sector or segment interior.

The Interior choice will change depending on what is selected. To construct the interior of a circle, first select the circle. To construct a polygon, select the vertices in order, then choose segment under the **Construct** menu. To construct the interior of a polygon, select the vertices in order and then choose Polygon Interior. If you choose an arc, the choices are Arc Sector or Arc Segment Interior.

The last choice is Locus. For this you need a driver and an object that is driven. The driver determines the position of the object and should be constructed on a path.

The **Transform** menu has choices to Translate, Rotate, Dilate, and Reflect. You can translate by a vector in polar notation (distance & angle), rectangular notation ($\Delta x, \Delta y$), or a marked vector (from one point to another). In order to rotate, you must first designate a center point, then you can rotate by a fixed angle (enter measure) or marked angle (designated by 3 points). To dilate, you must designate a center point, then enter a fixed ratio or a marked ratio (designate 2 segments). To reflect, you must first select a straight object for the mirror.

**GSP4:** You can also iterate a sequence of steps and do multiple iterations.

You can select objects, then go to the **Measure** menu to get the measurement. You can select two points to get Distance or a segment to get Length. You need three points for the measure of an Angle. Angles are measured counter-clockwise. To measure the Perimeter or Area of an object, you must first construct the interior (see Construction tools).

If you select the circle and 2 or 3 points on it, or if you select an arc, you can measure the ArcAngle or ArcLength of the arc with those end points. You can also determine the radius of a circle by selecting the circle, the circle interior, an arc of the circle, or an arc interior. By selecting 2 segments or 3 collinear points, you can measure the ratio between the distances.

You can measure the Slope of a line, line segment, or ray. If you select a point, you can obtain the Coordinates of the point, its Abscissa (x-coordinate) or its Ordinate (y-coordinate). Selecting 2 points will give you the distance between those points. By selecting a line or circle you can get
the Equation of that object. Equation does not work for a line segment, so a line must be constructed collinear with the segment. The selections listed in this paragraph will automatically put coordinate axes on the screen using the unit set under preferences.

If you change things that have been measured, the measurements will also change. This is a dynamic part of this program.

Notice that the measurements are right on the graphics screen. You can select them and move them by the point-click-and-drag maneuver. You can do calculations with several measurements by selecting them (multiple selections), then choose Calculate under the Measure menu. You will see a calculator with rectangle labeled Value. This rectangle is a pull-down menu containing the measurements you selected, plus π and e. You calculate by selecting values and operations. You can also enter numbers by clicking on them, just like buttons on a calculator. There is also a Functions menu for trig functions, logs, etc. Okay completes the calculation and returns to the graphics screen.

The first choice under the Graph menu is Define Coordinate System. This can be done by first selecting one point (the origin), a circle (unit circle), a defining distance(s) (one unit), or nothing (uses defaults). The next choice, Mark Coordinate System, is useful if you are using more than one coordinate system. The grid forms available are polar, square, or rectangular (x- and y-axes different size units). You can choose to show the grid (or just the axes) and you can choose to have the points snap to the lattice points. You can plot points as (x, y) or (r, theta).

**GSP4:** A new feature is New Parameter, which allows you to define a parameter for a sketch that can easily be modified using the + and – keys. You can then define a New Function using these parameters or using constant coefficients. The next step is to plot the function. If no function is selected, then the choice appears as Plot New Function, which firsts asks for the equation. If a function is first selected, then the choice appears as Plot Function. The next command creates a new function that is the derivative of a selected function. You can calculate, evaluate, and plot derivative functions, but you cannot edit them because they are children of the parent functions. To change a derivative function, you have to edit the parent function. Differentiation of complicated functions may take a long time — if you cancel the differentiation process, GSP will calculate an approximate derivative.

The last section allows you to make a table. You can select several measurements and put them in a table by choosing Tabulate under the Graph menu. To add successive values, either double-click on the table or choose Add Table Data. To remove entries choose Remove Table Data.