GeoGebra Workshop 24th May 2010
Paul Robinson, IT Tallaght

Websites
Geogebra Homepage: http://www.geogebra.org/cms/
Use the Webstart Version of Geogebra or download a stand alone version.

Geogebra Forum: http://www.geogebra.org/forum/
Community of Geogebra users, bug reports and feature requests.

Geogebra Wiki: http://www.geogebra.org/en/wiki/index.php/English
Collection of re-usable teaching resources.

University of Limerick: http://www.ul.ie/cemtl/resources.htm
Excellent GeoGebra step by step demos.

Math 247:   http://math247.pbworks.com/Learn-and-Use-GeoGebra
Fantastic Step-by-Step Help on How to Use GeoGebra by Dr Linda Fahlberg-Stojanovska. Includes accessing Geogebra properties and methods using Javascript – very cool.

LaTeX online equation editor:
http://www.numberempire.com/texequationeditor/equationeditor.php
Indispensible if you want to put mathematics into a Geogebra text box or within Moodle and don't know any LaTeX!

This workshop builds on Workshops 1 (where we developed a simple interactive problem sheet for trigonometry in right angled triangles) and Workshop 2 (where we looked at exporting a Geogebra file as an applet and using the Spreadsheet view to graphically solve a first order differential equation using the first order Euler method). See other handout! In this workshop we will create an animation of a tank of water emptying according to an exponential law. The user will be able to set initial and final volumes together with the rate constant. A checkbox will be used to start an animation and also to display the solution for how long the tank takes to drain.

Animating an emptying tank of water
Before we start, go to *Options*, *Labeling* and choose *No New Objects*.

Make the tank
1. Put in the corners

Click on the *Point Tool*. Click on the point (-1,0) on the x-axis. Click on the points (-3, 0), (-1, 5) and (-3, 5).

2. Put on the sides

Click on the *Segment Tool*. Click on the 2 points of the tank base. Repeat for the two sides.
Hold the mouse over one of the sides until its name comes up then right click it and choose Properties…On the left side of the Properties window you will see the three segments listed. With **Ctrl** pressed select the three segment names. Choose a colour for the 3 sides and in Style set the thickness to 5.

3. Set the water level
The water level at time t is given by $V = V_o\exp(-kt)$ where V_o is the initial volume and k is the rate constant. The purpose of our construction is to create a worksheet where students can set V_o, k and V then work out t themselves.
Put on a slider for V_o:

Click on the *slider tool* then on the drawing pad (near the top right). Call it V_0 and set its values from 0.5 to 5 in steps of 0.1. Slide the initial value to 5 (don't forget to click the selection tool first!).
Repeat for a slider called V with values from 0.5 to 5. Slide the initial value to 2.
Repeat for a slider called k with values from 0.1 to 2. Slide the initial value to 0.2.
Repeat for a slider called t with values from 0 to 10. Slide the initial value to 0.

Right click the sliders if you want to change their colour, thickness etc.

In the Input line at the bottom type W = V_0*exp(-k*t) and press return. Now type (-1, W) followed by return and (-3, W) folled by return. Move the sliders V_0 and t to see what happens.

Click on the *Polygon Tool*. Click on your two new points, the two corners of the tank base in turn and then back to the first point you clicked.
You should get a coloured in rectangle. Right click in the rectangle and change its colour and style (the Fill property).
Move the sliders to check that everything looks OK. Right click the t slider and click Animate On. Do the same to switch it off!
If you want to remove the corner construction points at this stage right click one of them and in the left hand side of the pane click the circles next to each name (which hides the object).
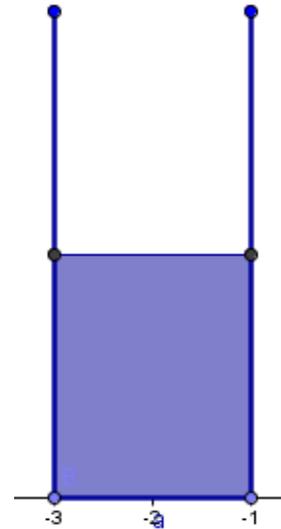
Plot a graph of the water level
In the Input line at the bottom of the screen type
        Function[V_0*exp(-k*x), 0, 10]

In the Input line type (t, W). Move the slider t a little so that you see this new point on the graph.
In the Input line type
        Segment[(0, W), (t, W)]
In the Input line type
        Vector[(t, W), (t, 0)]

You could also plot (0, W) and (t, 0) then create the segment/vector using the *Segment Tool* and *Vector Tool* on the toolbar.
Note: You can double click an object to see how it was defined and copy its definition.

Slide the t value to check that everything is behaving as it should.
This is our construction finished. We now need text to appear as required and make our tank drain automatically. This will require us accessing some Boolean (true/false) variables so that we can show/hide or start/stop.

Making things look attractive

You can move the axes location and change their scale with this tool. Click on an axis and drag to change its scale. Click on the drawing pad itself to move the picture.

Right click any object on the screen and go to Properties.. You can change colours and line thicknesses by selecting each object in the left hand pane and setting each property.

Hide any points you don't want to see by clicking in the circle in Algebra View.

Creating interactivity using Boolean Values
All being well you should now have something like this
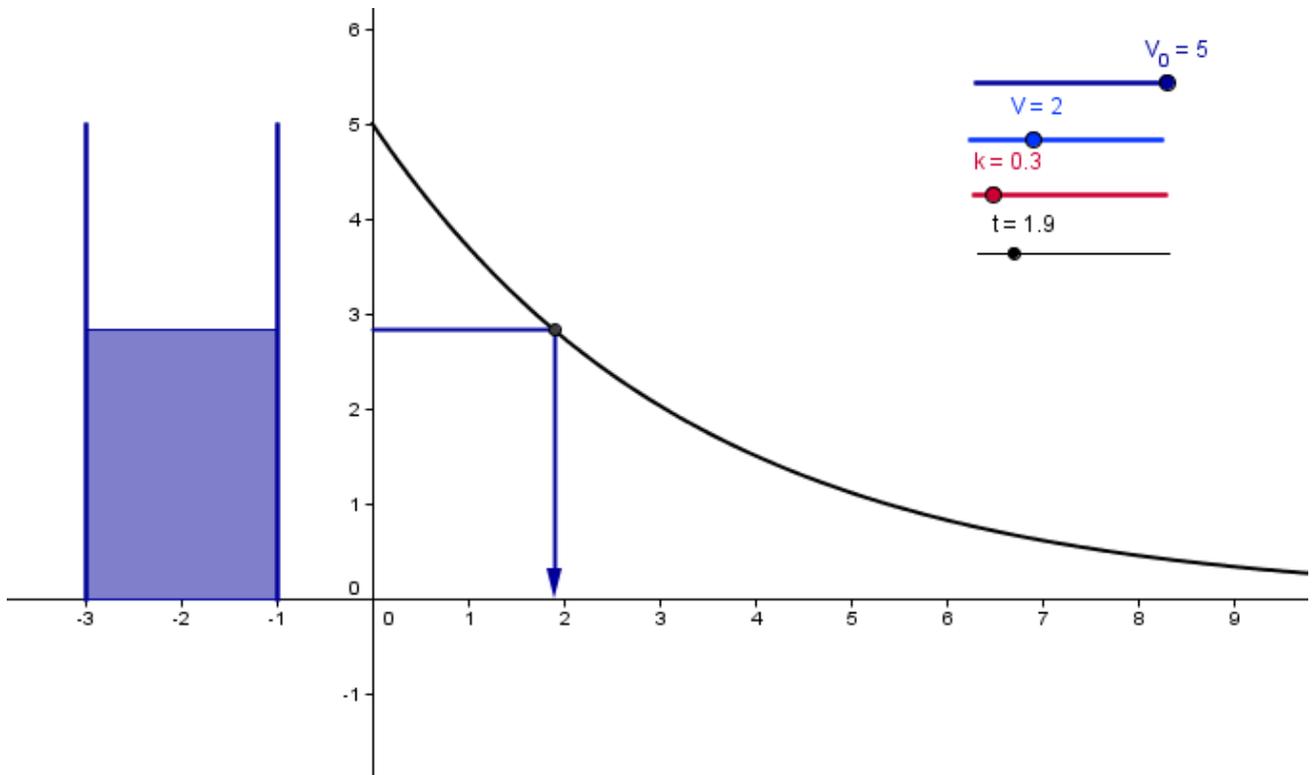
At this point you can hide the algebra view (*View, Algebra view*) as we will not be creating new points.
1. State the problem

[ABC] Click the *Insert Text* Tool, then the screen. Type
                Use pen and paper to solve the equation

Click the *Insert Text* Tool again, then the screen. Type

V_0 + "exp(-" + k + "t) = " + V

and click on LaTeX formula. With LaTeX formula on, anything inside quotes is taken as text and anything added to this will have its variable value used. Place the second text below the first and both somewhere above the graph. Try moving the sliders.

The first issue we must deal with is that V cannot exceed V_o or the emptying tank problem makes no sense.

[ABC] Click the *Insert Text* Tool, then the screen. Type
                Sorry, the value of V must be less than the value of V_0.

Move the textbox below the first two. Right click this textbox and click Properties… In the Advanced Tab type put in this condition to show the object
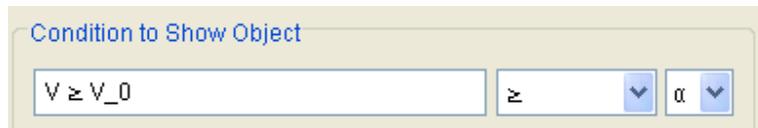
The ≥ symbol must be chosen from the dropdown as shown. Click close and move the V and V_0 sliders to see the effect.

Now you can create a problem and solve for t. We now want to see the solution illustrated in the tank, on the graph and numerically.

2. Create a checkbox

Click on the *Checkbox* Tool, then on the screen. Change the Name to SolveIt and the Caption to
<center>*Show the solution for t*</center>

Cautionary Note: If we already had some text boxes to Show, we could select them in the Select objects dropdown at this point. The text boxes (and any other objects we wanted) would then Show when the checkbox is clicked on and disappear when it is clicked off. The problem with this is that we cannot access that selection list again once the checkbox is created (try it!). If we then wanted to add another object to Show/hide we would have to start all over again with the checkbox. Things get worse if you use the value of the checkbox (SolveIt is true or false) to start animation. Then, deleting the checkbox to start again deletes any object or variable that depends on it.
As a rule, just use a checkbox to get a True/False value and use that value to Show/hide objects or start animations. We will do this now.
End Cautionary Note

3. Create our problem solution
Put a textbox on the screen with text
<center>*The solution for t is t =*</center>
Put a textbox on the screen with text
<center>*“”+ln(V / V_0) / (-k)*</center>
and click the LaTeX option.
Line up the two textboxes as required.
Note that the “”+ forces the following expression to evaluate. Try *ln(V / V_0) / (-k)* on its own with the LaTeX option on to see!
Note that
<center>*“The solution for t is t = “+ln(V / V_0) / (-k)*</center>

In one textbox won't work as you might expect. You can have text these combinations
    1. Text on its own, LaTeX off
    2. Equations on their own, LaTeX on, produces equations
    3. “”+ followed by equations, LaTeX on, evaluates equations

4. Symbols in parenthesis mixed with +, LaTeX on, can mix equations with evaluations
e.g.

"-" + k + "t = ln(" + (V / V_0) + ") = " + (ln(V / V_0))

Gives

-0.3t = ln(0.4) = -0.9136

When k = 0.3 and V/V_0 = 0.4.

These are our fourth and fifth textboxes respectively. Right click one of them and click on *Properties*. In the left hand window select text4 and text5 together (use Ctrl when selecting) and go to *Advanced*. In the *Condition to show object* box type SolveIt, the name of your checkbox. Click the *Close* button. Both texts will now show when close is true (ticked) and vanish when it is not ticked – try it!
If you want to put more detail into the solution with further textboxes you can simply repeat the process of adding SolveIt to each textbox within *Advanced*.

It remains to animate our model.
4. Animate the model
In the input line type

Speed = If[SolveIt, If[t ≤ -1 / k ln(V / V_0), 1, 0]]

This says that if SolveIt is clicked then if the time value is less than the solution of the problem set Speed to be 1, otherwise set it to be 0.
Finally, right click the t slider and click on *Properties*. On the Slider Tab, in the speed box, type Speed then *Close*. Now when the checkbox is ticked not only does the text solution show but time t is animated, which in turn animates our tank and our graph. Try it!

Resetting the worksheet and Export as .html
After completing a problem it would be nice to be able to reset the slider values to their original values. If we could do this, then we could hide the t slider. Unfortunately, slider reset is not possible within GeoGebra itself. It happens automatically, however, if the worksheet is *Exported as an Applet*. See GeoGebra Worksheet 2 for another example of this.
To Export:
1. Put t to 0 and hide the slider
2. Hide the Algebra View
3. Click on the *Selection Tool* so that users can use the sliders after Export
4. Go to File, Export, Dynamical Worksheet as Webpage.. and put in a title and some text.
5. In Advanced, have only "Show icon to reset construction" and "Show Toolbar" clicked on. Make sure "ggb files and jar files" is not checked and Export!

After Export, the Reset button is in the top right hand corner of the applet window.