Mathematics Department
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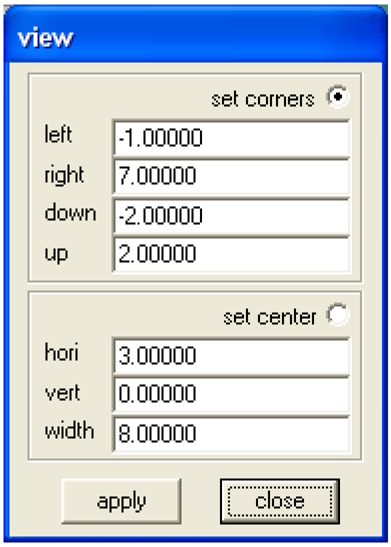
Trigonometric graphs using WinPlot.

1. Open Winplot and select **Window** then **2-dim**.
   Select **View** from the menu bar and **View**.
   Set the values as shown opposite.
   Check **set corners** then **apply**.
   Close the dialogue box using the **X** in the top right corner.

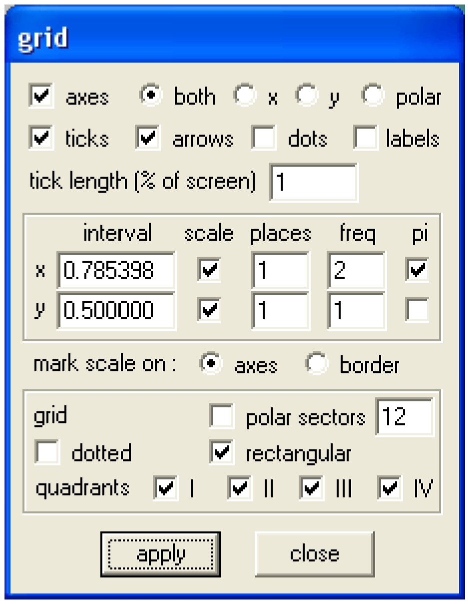


2. Select **view** from the menu bar and **Grid**.

   Carefully make all the selections as shown opposite.

   Now **apply** the changes.

   Close the dialogue box using the **X** in the top right corner.

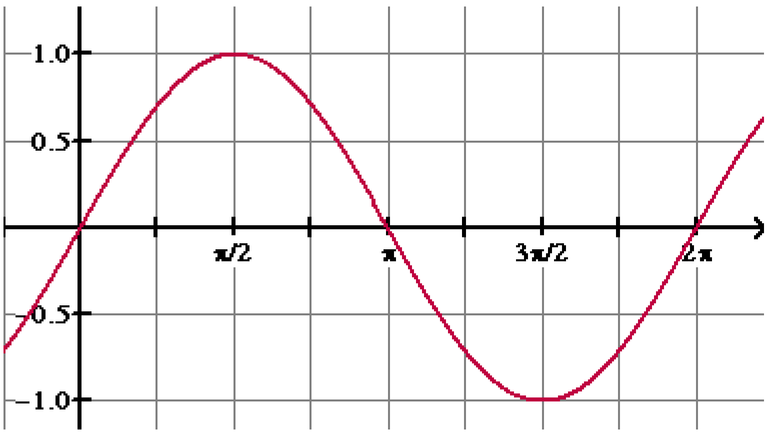


3. Select **Misc** from the menu bar then **Fonts** then **scale on axis**. Change the font to Symbol and select Bold as the style (this will allow Winplot to display the π symbol). This may already be selected by defalt. Close the dialogue box using the **OK** button.

4. Select **Equa** from the menu bar and **explicit.** Change the default function xsin(x) to f(x) = **sin(x)** and change the pen width to 2.
   Press OK.

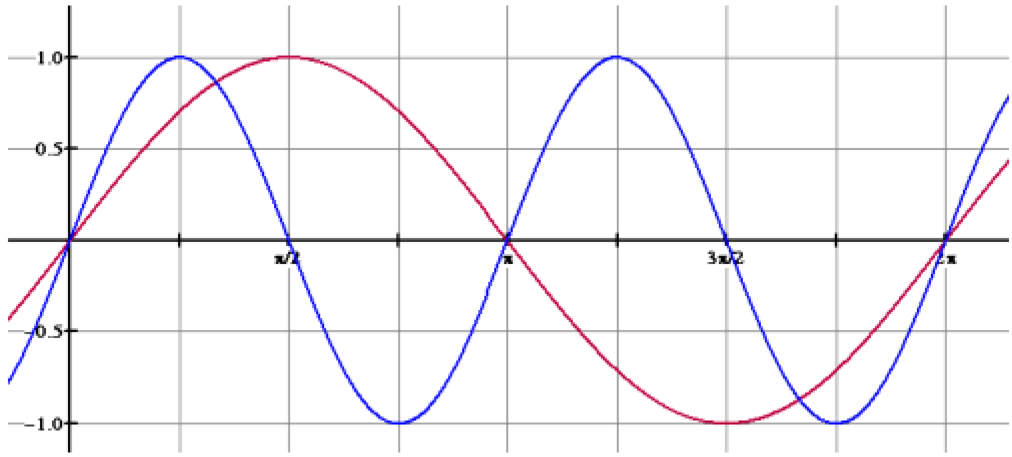
   You should now see the f(x) = **sin(x)** graph as shown here.

   Thicken the axes by choosing **View**, **Axes**, **Screen thickness** and changing to 2.



5. Select **Misc**, **colors** then **Background** and choose white.
Select **Equa** from the menu bar then **Inventory**. From the inventory dialogue box click on **edit**. Another dialogue box opens, now select **color** and click on a colour of your choice and then **close**.
Close the inventory dialogue box using the **X** at top right.
Finally expand the graph to fit full screen by clicking on this symbol at the top right of the graph.

6. You should now be looking at the graph of $f(x) = \sin x$. We will now superimpose the graph of $f(x) = \sin 2x$ on the same graph.
From the menu bar select **Equa** then **Explicit.** Delete the default function, xsin(x), and type **sin(2x).** Notice how brackets must be used. Change the **pen width** to **2** and select a suitable colour for a contrast as before. Close the dialogue boxes and view the graphs as shown below.



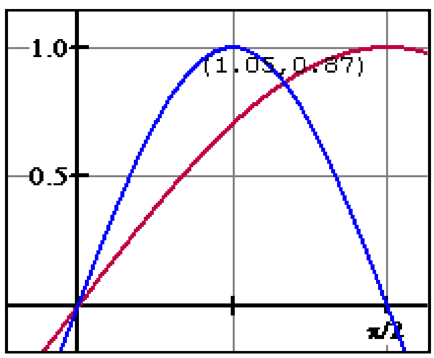
7. As an exercise you should solve the equation sinx=sin2x for $0 \le x \le 2\pi$ to find the intersection points before continuing.

To check your answers using your graphs in WinPlot select **Misc** from the menu bar then **Decimal places**. Change the **5** to a **2** and press **OK**.

The first solution is obviously x=0.

The next solution is x=60°. To convert to radians, calculate $\frac{\pi}{180} \times 60 = 1.05$
When using WinPlot you may wish to have your calulator set to radian measure to save converting.

Position the arrow cursor at the intersection and left click.



The solution for x appears along with the function value at that point. Check this on your calculator by finding f(60°) or f(1.05 rads).

8. The next obvious solution is at 180° or π. Use the same method as before to find the solution in the 4th quadrant. You should get 300° or $\frac{5\pi}{3} = 5.24$ in radian measure.

9. We are about to change the graph of f(x)=sin2x to f(x)=2sinx. Select **Equa** from the menu bar then **Inventory**. In the inventory dialogue box make sure **y=sin(2x)** is highlighted and select **edit**. Change the function to f(x)=**2sin(x).** Close all dialogue boxes and examine the new graph.

10. Clear y=2sinx from the graph by selecting **Equa** from the menu bar then **Inventory** and click on **delete** (make sure the correct function is highlighted). Close the dialogue box and all you should see is just the graph of y=sinx.

    We can ask WinPlot to show the graph of the derivative.
    Select **Equa** from the menu bar then **Inventory**. From the inventory dialouge box click **derive**. The graph of the derivative is now drawn. Also another function has appeared in the dialogue box. It should already be highlighted. Click on **edit**. Although we are not allowed to edit this function we can change its colour. Click **color** and choose a colour. Close all dialogue boxes and view the two graphs. You should recognise the derivative as being the graph of y=cosx.
    No surprise here I hope, as you should already know that the derivative of sinx is cosx!

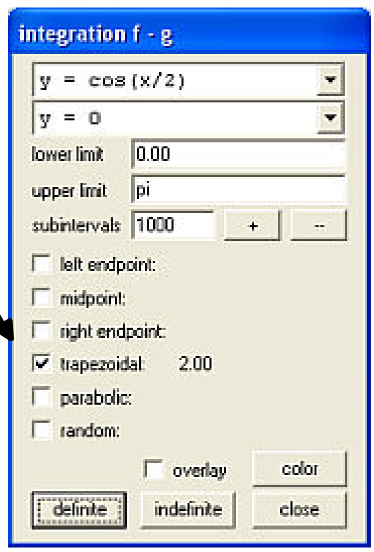
11. Clear both functions from the graph by selecting **Equa** from the menu bar then **Inventory** and click on **delete** twice. Close the dialogue box and from the menu bar select **Equa** then **Explicit.** This time enter the equation **cos(x/2)** and choose a **pen width** of **2** and a suitable colour as before.
    We are about to find the area under the curve for $0 \le x \le \pi$.
    Do this by hand now by evaluating;-

$$\int_0^\pi \cos(\tfrac{\theta}{2})d\theta$$

    Winplot needs to know that you are calculating the area between the curve and the x-axis. So we have to draw the line y=0 (the x-axis). To do this, select **Equa** and **Explicit** and enter 0 where you would normally type the function.

    On the menu bar select **Two** then **integration**.
    Change the second function to y=0 using the drop down menu.

    In the dialogue box (shown opposite) insert the **limits** and **check** the trapezoidal box (this is a method that WinPlot uses to integrate).

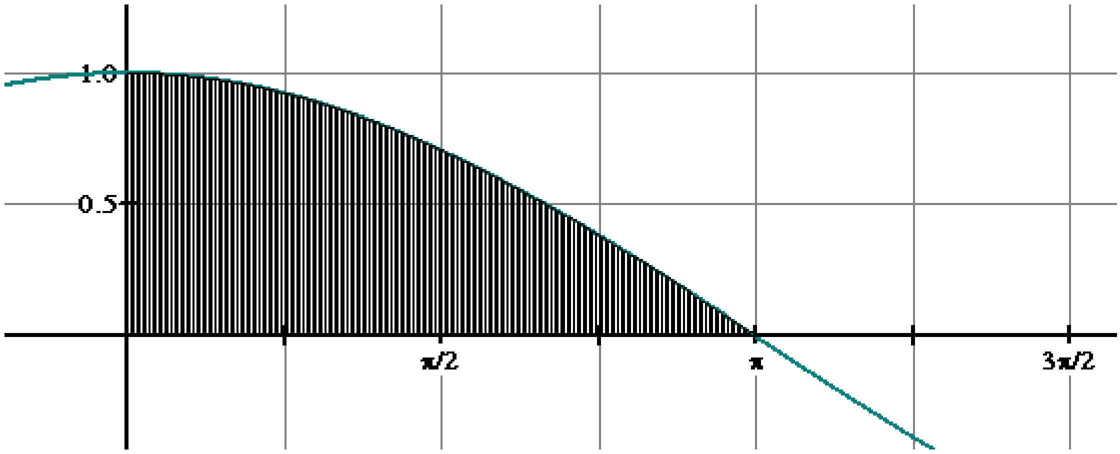


    Click on the **definite** button and the answer should appear beside the integration method.

    Hope it agreed with your calculated answer!

11 (continued)

Keep the integration dialogue box open. To see this area on your graph, **check** the box beside **overlay** and click **definite** again.

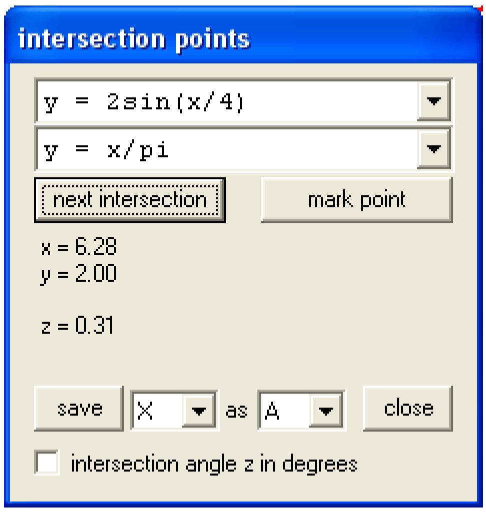


12. Finally we are going to find the area between two functions.

Close the dialogue box and select **equa** then **inventory** and **delete** the current functions. Select **Equa** from the menu bar then **Eplicit** and enter **2sin(x/4).**

Repeat this for the function **x/pi**. As before, WinPlot will recognise **pi** as π. Use a **pen width** of **2** and choose colours for yourself. You should now see the region whose area we are about to calculate.

Let's just check the intersection points.
Select **two** from the menu bar and **intersections**.
The intersections dialogue box is now shown.
Click the next **intersection button** a few times and you will see the x and y values toggle between the two visible intersections.



This tells us the limits of integration which is 0 and 6.28 (or 2π).

This calculation can be written as
$\int_0^{2\pi}(2\sin\frac{\theta}{4}-\frac{\theta}{\pi})d\theta$ (using θ instead of x).

You should try evaluate this integration before continuing.

Select two and integration as before. Make sure the correct two functions are displayed then calculate the area as before.

You should obtain 1.72