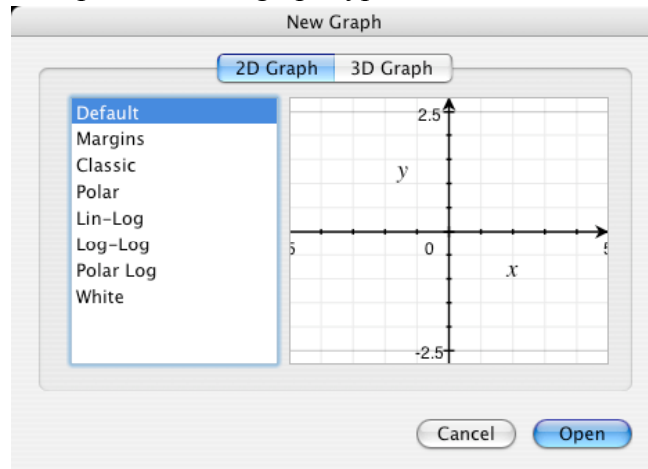# Using Grapher to enhance curve sketching skills
By David Emery, Catholic Education Office, Wollongong

1. Grapher is a Mathematical Graphing program which is bundled with Mac OS X and is found in the Utilities folder inside the Applications folder. Firstly, drag its icon onto your Dock.

2. Launch Grapher and accept the default graph type; Default.

3. At some stage you will want to change the axes units or the displayed domain and range. To do this, you can either change the size of the graph window or more specifically, double-click an axis, say the x-axis, then set the Variable Range and Tick Marks. Do the same for the y-axis.
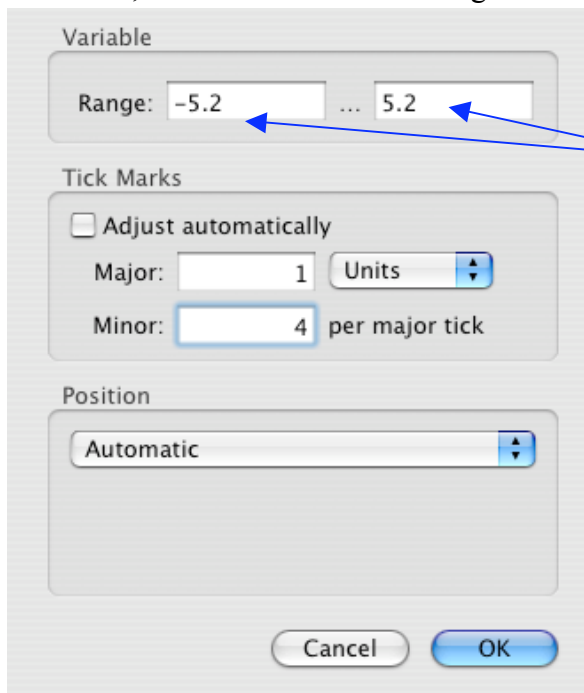
I always like to add a few decimals extra to each axis so that the integer labels won't cut off as seen on the *x*-axis above.

4. To move the *x* and *y* axes labels, first ensure the Inspector palette is showing (Window → Show Inspector). This is a contextual menu palette — it displays information relative to what you click-on. Click on the *x* label, then adjust the Position slider on the Inspector. Repeat for the *y* label.
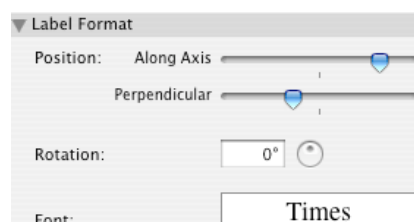
5. The Properties palette allows for different coloured lines, axes tick, curve thicknesses, etc. Use it to customise any look you require.
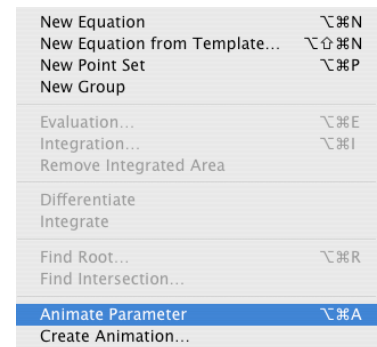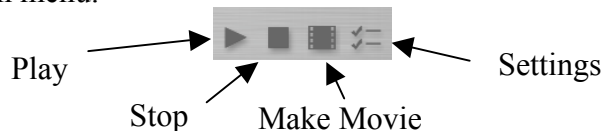
Curve Sketching

Lines: *y = mx + b*

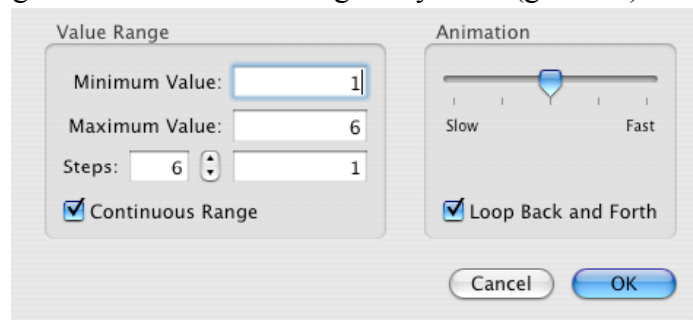1. On a new set of axes, have the students graph;

$y = x$	$y = -x$	$y = x + 1$	$y = x - 1$
$y = 2x$	$y = -2x$	$y = x + 2$	$y = 2x - 2$
$y = 3x$	$y = -3x$	$y = x + 3$	$y = 3x - 3$
$y = 4x$	$y = -4x$	$y = x + 4$	$y = 4x - 4$

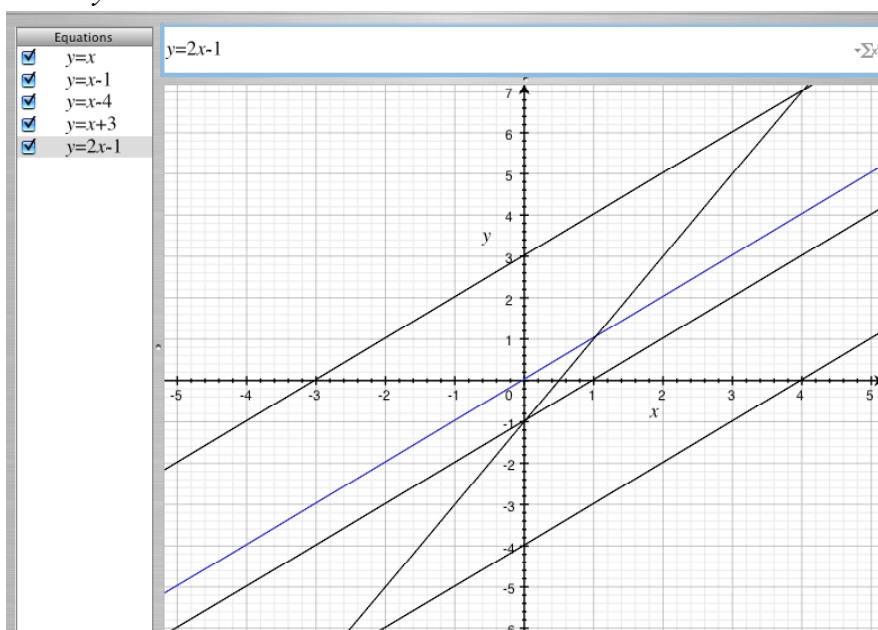Comment on each of the graphs.

2. Graph the variable graph by creating a new sheet and entering;

   $m=1$ followed by

   $y = mx$

3. Click on the $m=1$ equation and choose Animate Parameter from the Equation menu.

New Equation	⌥⌘N
New Equation from Template...	⌥⇧⌘N
New Point Set	⌥⌘P
New Group	
Evaluation...	⌥⌘E
Integration...	⌥⌘I
Remove Integrated Area	
Differentiate	
Integrate	
Find Root...	⌥⌘R
Find Intersection...	
Animate Parameter	⌥⌘A
Create Animation...	

Play   Stop   Make Movie   Settings

4. Click on the Settings button and enter settings for your m (gradient) variable (in this case).

   Value Range
   Minimum Value: 1
   Maximum Value: 6
   Steps: 6   1
   ☑ Continuous Range

   Animation
   Slow ———————— Fast
   ☑ Loop Back and Forth

   Cancel   OK

5. Play the animation and observe the changes to the line as m changes. A movie can be made from this by clicking on the Make Movie button.

6. On a new Graph Sheet, start with the variable $b=1$ and draw graphs of $y = x + b$ include the range for b that you think illustrates its effect.

7. Discus aspects of $y = mx + b$ for different values of m and b.

Equations
☑ $y=x$
☑ $y=x-1$
☑ $y=x-4$
☑ $y=x+3$
☑ $y=2x-1$

$y=2x-1$

Parabola: $y = ax^2 + bx + c$ (Tip: press Shift-6 to type the power ^)

1. On a new set of axes, have the students graph;

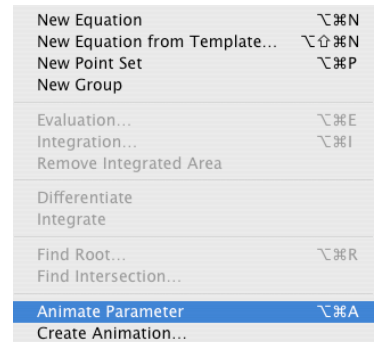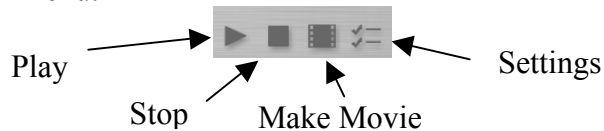|			
$y = x^2$	$y = -x^2$	$y = x^2 + 1$	$y = (x - 1)^2$
$y = 2x^2$	$y = -2x^2$	$y = x^2 + 2$	$y = (x - 2)^2$
$y = 3x^2$	$y = -3x^2$	$y = x^2 - 1$	$y = (x + 3)^2$
$y = 4x^2$	$y = -4x^2$	$y = x^2 - 4$	$y = (x + 4)^2$

Comment on each of the graphs.

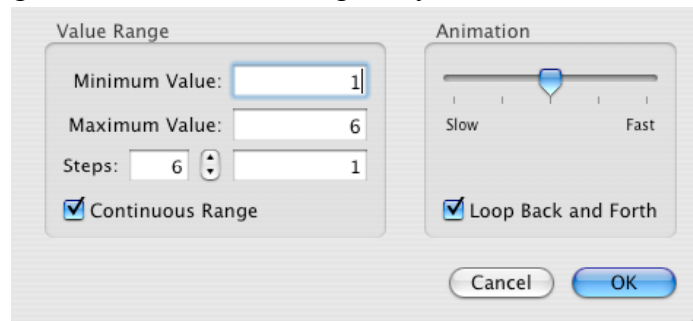|	
New Equation	⌥⌘N
New Equation from Template...	⌥⇧⌘N
New Point Set	⌥⌘P
New Group	
Evaluation...	⌥⌘E
Integration...	⌥⌘I
Remove Integrated Area	
Differentiate	
Integrate	
Find Root...	⌥⌘R
Find Intersection...	
Animate Parameter	⌥⌘A
Create Animation...	

2. Graph the variable graph by creating a new sheet and entering;
   $a=1$ followed by
   $y = ax^2$
3. Click on the $a=1$ equation and choose Animate Parameter from the Equation menu.

   Play → ▶ ■ 🎞 ☰ ← Settings
   Stop ↗   Make Movie ↑

4. Click on the Settings button and enter settings for your a variable.

   Value Range
   Minimum Value: 1
   Maximum Value: 6
   Steps: 6   1
   ☑ Continuous Range

   Animation
   Slow ——————○—————— Fast
   ☑ Loop Back and Forth

   (Cancel) (OK)

5. Play the animation and observe the changes to the parabola as a changes. A movie can be made from this by clicking on the Make Movie button.
6. On a new Graph Sheet, start with the variable $c=1$ and draw graphs of $y = x^2 + c$ include the range for c that you think illustrates its effect.
7. Discus aspects of $y = ax^2 + c$ for different values of a and c.
8. Repeat the exercise for $y = (x + d)^2$. Compare and contrast results relating to $y = ax^2 + bx + c$.

Equations
☑ $y=x^2$
☑ $y=x^2-4$
☑ $y=x^2+2$

No Equation Selected
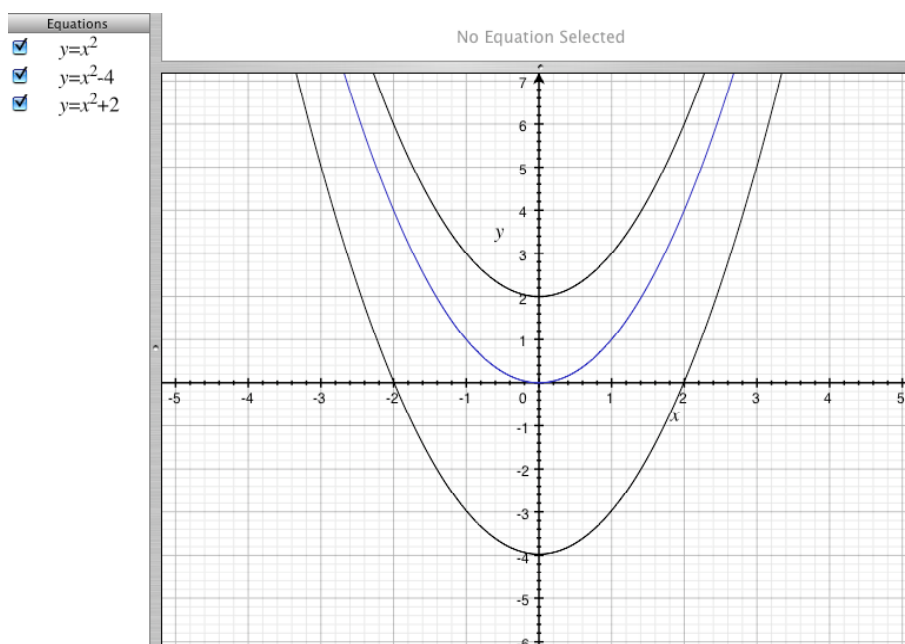
Hyperbola: $y = \dfrac{x+a}{x+b}$ (Tip: Choose Show Equation Palette from the Window menu and click on the fraction button to insert the fraction. Press the tab key to go from numerator to denominator.)
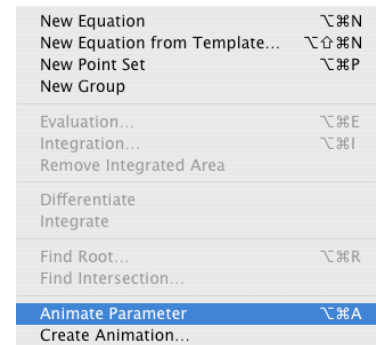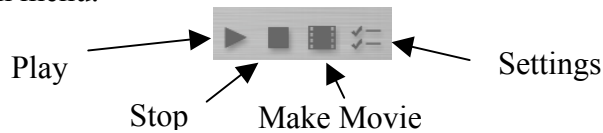
1. On a new set of axes, have the students graph;

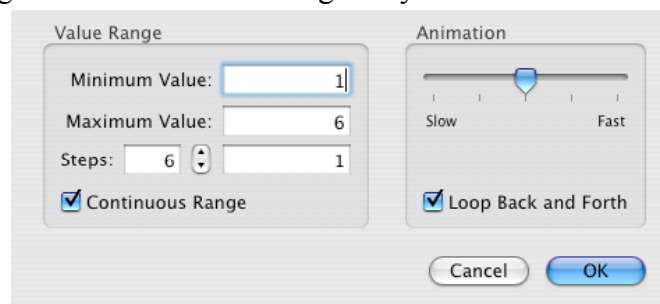|			
$y = \dfrac{1}{x}$	$y = \dfrac{1}{2x-1}$	$y = \dfrac{x-1}{x+1}$	$y = \dfrac{2x-1}{x+1}$
$y = \dfrac{1}{x-1}$	$y = \dfrac{1}{3x-1}$	$y = \dfrac{x-2}{x+1}$	$y = \dfrac{3x-1}{x+1}$
$y = \dfrac{1}{x-2}$	$y = \dfrac{1}{2x+1}$	$y = \dfrac{x-3}{x-1}$	$y = \dfrac{x+1}{2x-1}$
$y = \dfrac{1}{x+3}$	$y = \dfrac{1}{2x+4}$	$y = \dfrac{x-4}{x-1}$	$y = \dfrac{4x+1}{2x-1}$

Comment on each of the graphs.

2. Graph the variable graph by creating a new sheet and entering;

   $a=1$ followed by

   $y = \dfrac{1}{x-a}$

3. Click on the $a=1$ equation and choose Animate Parameter from the Equation menu.

New Equation	⌥⌘N
New Equation from Template...	⌥⇧⌘N
New Point Set	⌥⌘P
New Group	
Evaluation...	⌥⌘E
Integration...	⌥⌘I
Remove Integrated Area	
Differentiate	
Integrate	
Find Root...	⌥⌘R
Find Intersection...	
Animate Parameter	**⌥⌘A**
Create Animation...	

Play ——► ■ ▦ ⧉ ◄—— Settings

Stop Make Movie

4. Click on the Settings button and enter settings for your a variable.

Value Range

Minimum Value: 1

Maximum Value: 6

Steps: 6 ⇕ 1

☑ Continuous Range

Animation

Slow ———●——— Fast

☑ Loop Back and Forth

Cancel   OK

5. Play the animation and observe the changes to the parabola as a changes. A movie can be made from this by clicking on the Make Movie button.

6. On new Graph Sheets, construct variable formulae for;

   $y = \dfrac{1}{ax-1},\; y = \dfrac{a}{x-1},\; y = \dfrac{x-a}{x+1},\; y = \dfrac{ax-1}{x+1},\;$ etc