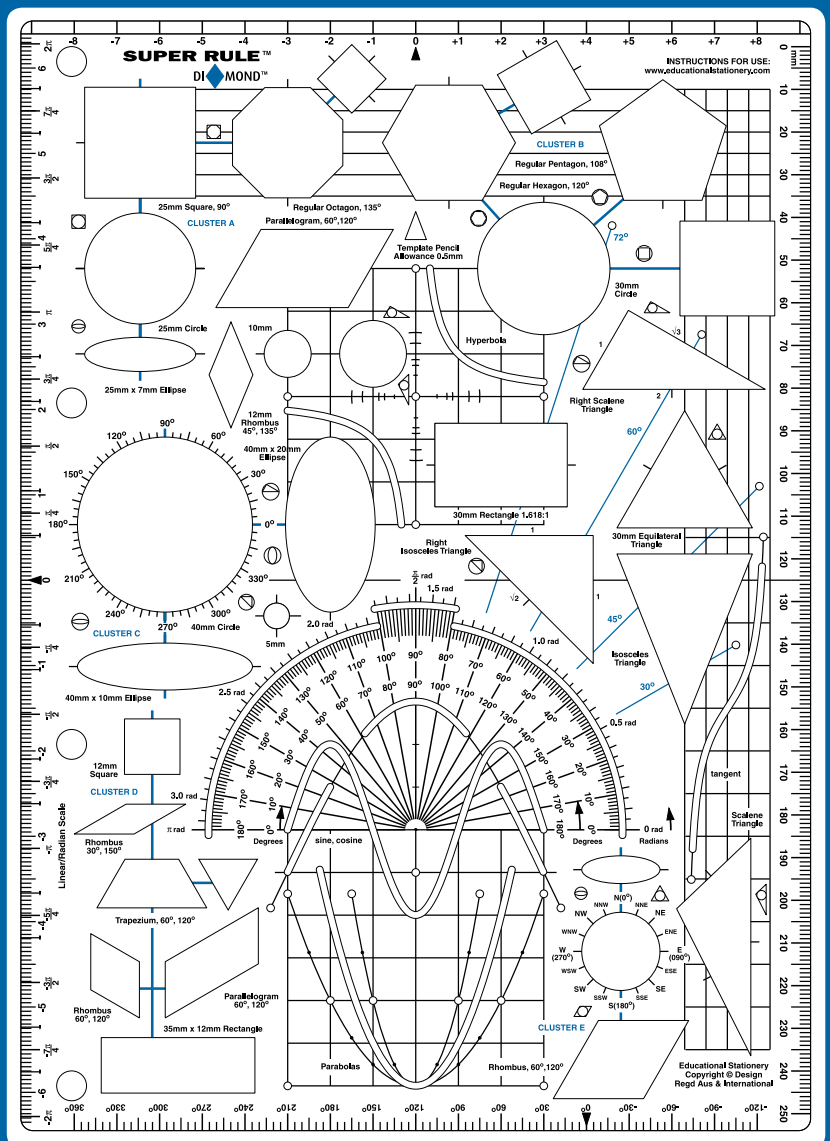
Designed for Secondary School Mathematics
(Suitable for year 8 to year 12 students.)

SUPER RULE™

DI◆MOND™ MODEL INCLUDING INSTRUCTIONS FOR USE

- All the common classroom shapes
- Easy to use, genuine cluster design
- Template Assistance Graphics (TAGs™)
- Extensive circumscription and inscription of shapes
- Tessellations
- Continuous parabola
- Linear/radian scale



- Measurement to 250mm
- Giant regular polyhedra net guides
- Classroom size sine and cosine curves with 20mm & 40mm amplitudes
- Tangent curve
- Hyperbola
- Trigonometric degree axis, compatible with sine/cosine curves of template

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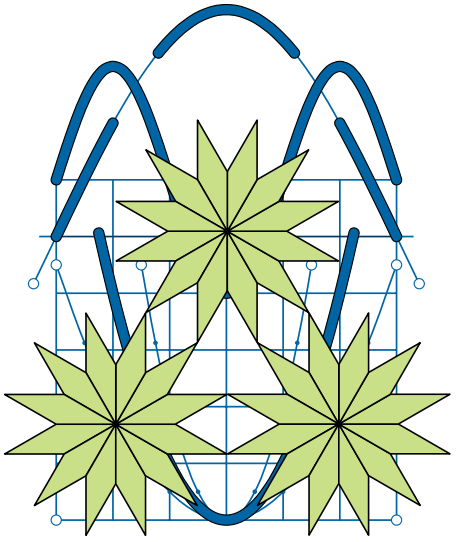
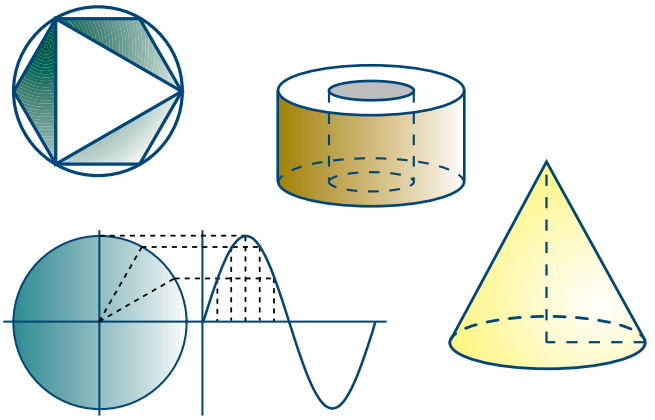




NOTE: All images in this booklet are scale drawings of template shapes and scales.

Preparation:

Your Diamond model **SUPER RULE**™ is a valuable acquisition for classroom and home use. Mark it with your name in permanent ink and store in a ring-binder file. (Note the small holes on the left side.) Alternatively, keep it in the plastic sleeve which also has holes for ring-binder storage.

It is made of a quality, flexible material, which ensures it will be extremely strong and long-lasting.

The shapes are designed for accurate drawing with a **1mm diameter** pencil lead or biro point. That is, if you draw around the inside of a shape such as a circle, the final drawn line will be **0.5mm** inside the template shape (all the way around). This means that the shape for a 40mm square (say) is actually 41mm, so that when the shape is drawn it will finish at the required 40mm. You will find that most "medium" point pens or pencils will do the job.

You should experiment with your pens and pencils to find those that "best fit".

To test your pen/pencil for suitability, try superimposing some related shapes (such as the square and the circle in Cluster B, below). If the shapes fit each other exactly, once drawn, then you have a suitable pen.

About the Template:

The functions of the **SUPER RULE**™ can be described as either:

- **primary functions** – straight forward measuring with the linear or circular scales, or simple drawing with one of the template shapes provided.
- **secondary functions** – where two or more shapes are combined to draw a more complex shape.

The **SUPER RULE**™ has been especially designed to enable a large number of primary and secondary functions to be achieved. Your template is a world leader in this regard.

About the Shapes:

All the common shapes are there for your use – circles, ellipses, squares, rectangles, triangles (equilateral, isosceles, scalene; right, right isosceles), parallelograms, rhombuses, a trapezium, a regular hexagon, a regular pentagon and a regular octagon.

Different rectangles, squares, triangles and trapeziums can also be drawn by connecting suitable vertices of the regular octagon, hexagon and pentagon. (Have a go – there are many possible.)

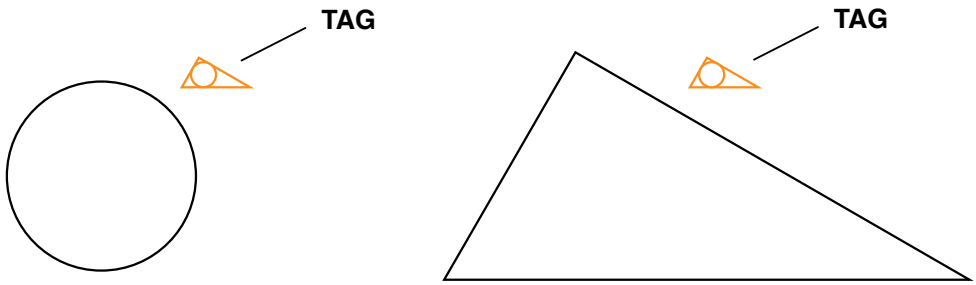
If you wish to locate the centre of a circle once it has been drawn, use the grid lines or the special arc graduations located about or on the vertical and horizontal axes of the hyperbola.

The protractor can be used to accurately measure and draw angles, both in degrees and radians (1 radian is approximately 57.3^{o}; π radians is exactly equal to 180^{o}.)

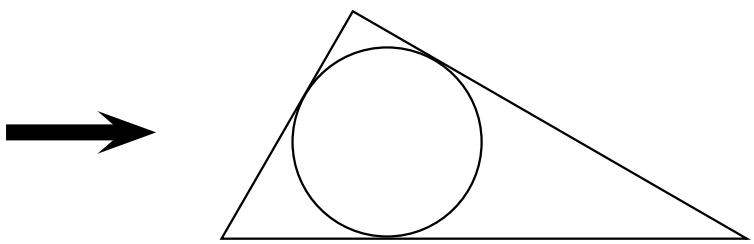
About TAGs™:

The Template Assistance Graphics (TAGs) are world unique to the **SUPER RULE**™ and are provided to make some of the secondary drawing easier. When certain template shapes are related so that one fits inside (or outside) of the other (this is called inscribing or circumscribing respectively), TAGs are shown alongside the shapes so that you can see at a glance which shape goes with which.

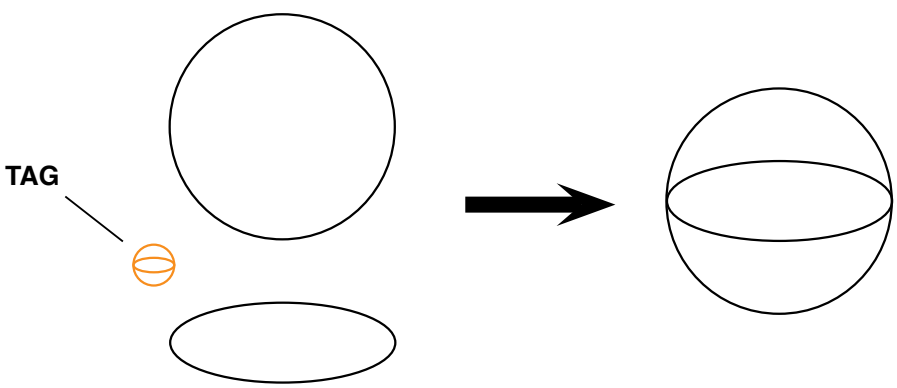
As an example, note the twin TAGs alongside these two shapes:



By using the hint provided by the TAGs this drawing results, combining both shapes, of a circle inscribed within a right triangle:



When there is only a single TAG (no twin), the TAG is telling you that the two shapes either side of it are related. For example, this pair of shapes and the TAG can be used to inscribe the ellipse inside the circle:



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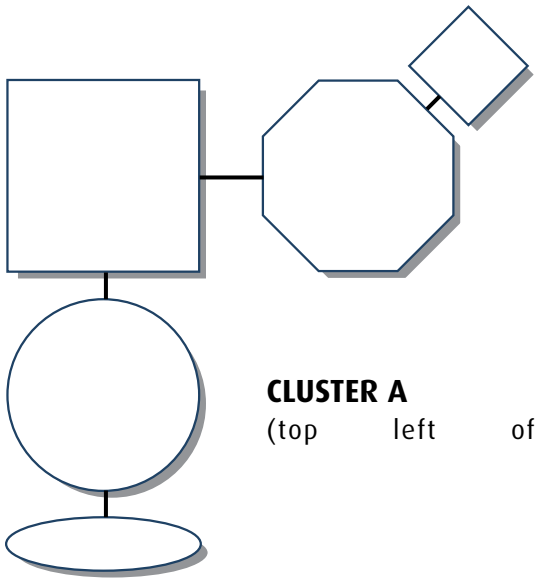
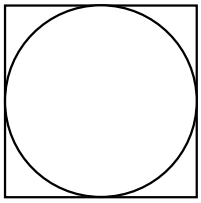
About Clusters:

Examine your **SUPER RULE**™ carefully and you will see that many of the shapes are connected by thick blue lines. Such related shapes are arranged in **clusters** (named A, B, C, D or E, top left of the template, top right of the template, etc.) and can be drawn together to create lots of important diagrams. Some shapes have both lines connecting them and TAGs. This is just telling you in two ways that the shapes are related and that secondary drawing is possible.

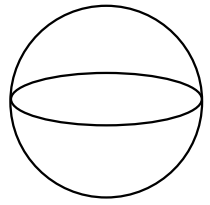
The following shapes are examples of what can be done with the clustered shapes. They serve only as examples – there are many other possibilities.



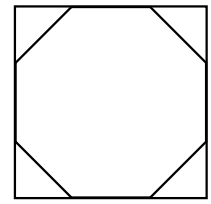
CLUSTER A
(top left of



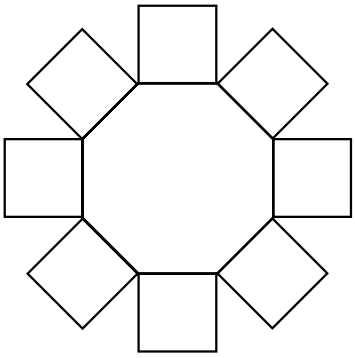
Circle inscribed within a square.



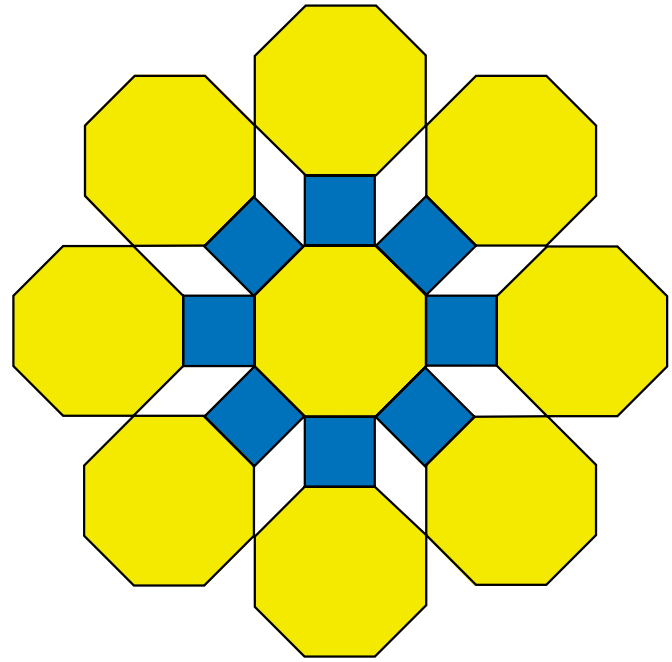
Ellipse inscribed within a circle to create a 3-D spherical effect.



Octagon inscribed within a square.

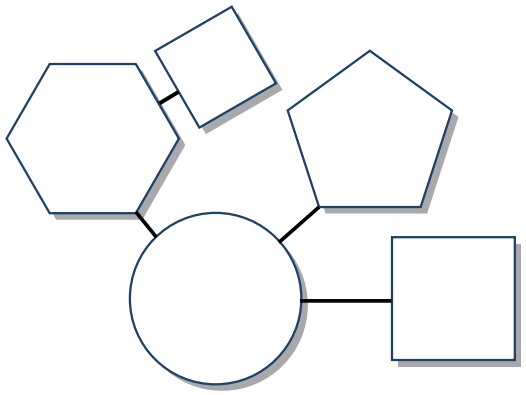


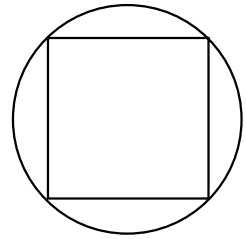
Squares drawn to the sides of the regular octagon.



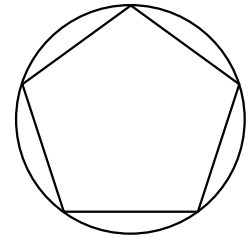
And if the drawing is continued, a **tessellation** like that to the right results. Are there any others?

CLUSTER B (top right of template)

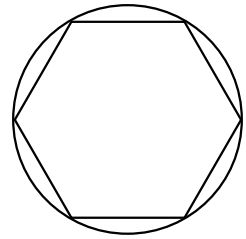




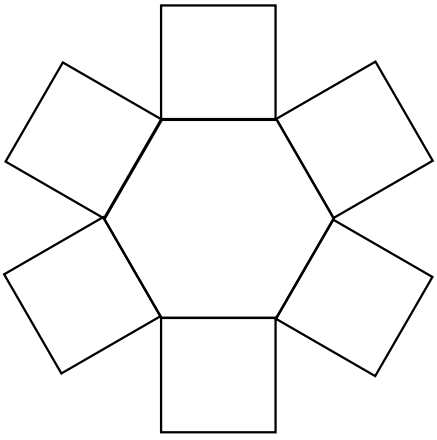
Circle circumscribing a square.



Circle circumscribing a regular pentagon.
This circle can also be used to circumscribe isosceles triangles and a trapezium. (Just connect suitable vertices of the regular pentagon.)

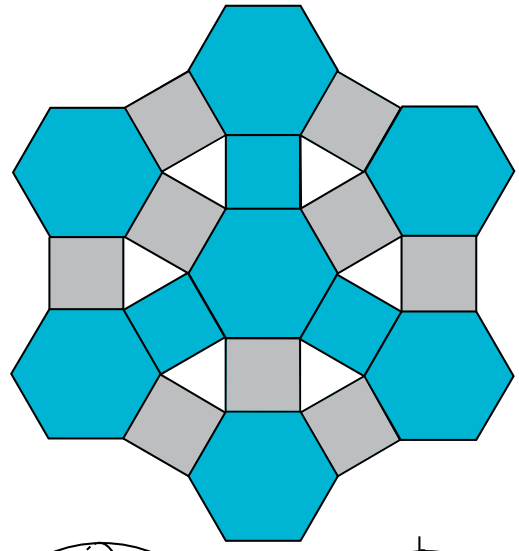


Circle circumscribing a regular hexagon.
This circle can also be used to circumscribe an equilateral triangle, a right triangle, a rectangle and others. (Just connect suitable vertices of the regular hexagon.)

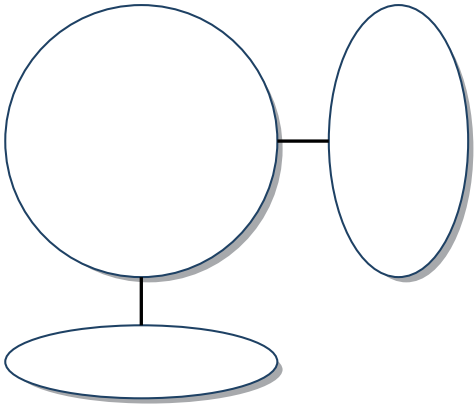


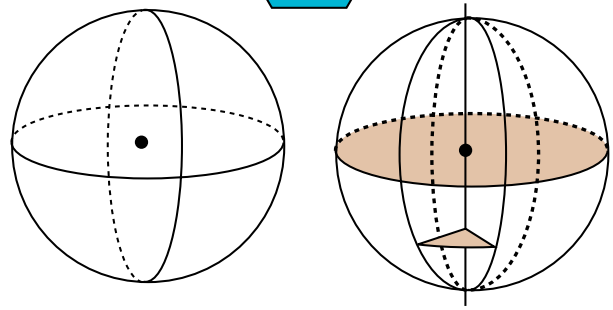
Squares drawn to the sides of the regular hexagon.

And if the drawing is continued, a tessellation like that to the right results. Are there any others?



CLUSTER C (middle left of template)





Ellipse drawn twice within a circle (above left). When both the wider and narrow ellipses are used (above right), more detailed diagrams are possible. These are very useful when drawing **lines of longitude and latitude** around a globe.

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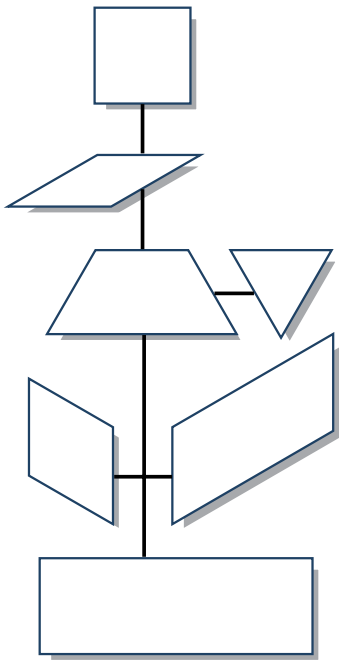
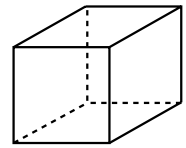
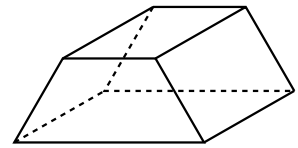
CLUSTER D (bottom left of template)

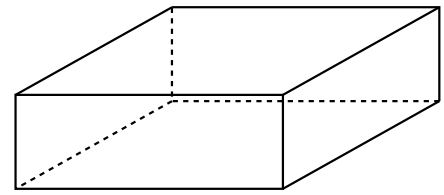




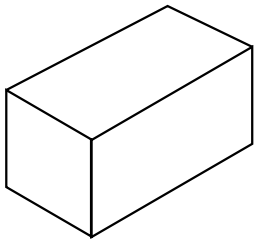
Cube
Just draw the square twice (translate the first shape) and join corresponding vertices.



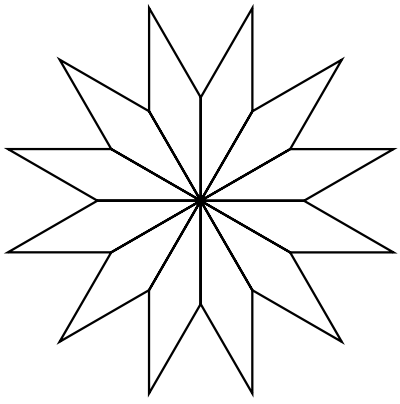
Trapezial Prism
Draw the trapezium twice (translation) and join corresponding vertices.



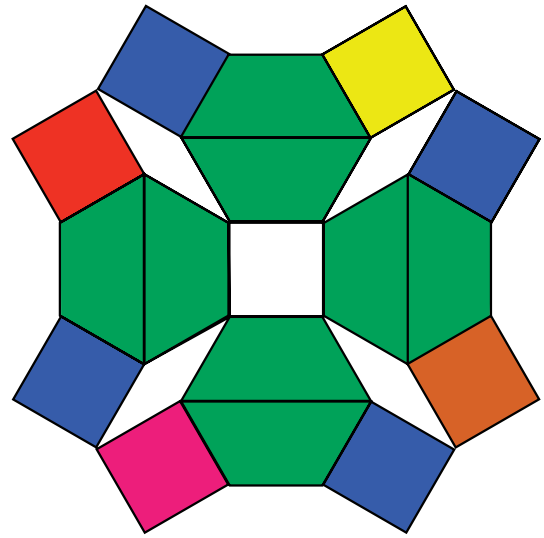
Cuboid or Rectangular Prism
Can be drawn by either translating the parallelogram or by translating the rectangle.



Square Prism
This version is drawn as a solid without the "transparent" appearance of those previous. It can be drawn by translating the small rhombus or drawing both the small rhombus and the adjacent parallelogram.



Patterns like these can be created by rotating a suitable rhombus. Not all rhombuses will tessellate like this.
Why not?



There are lots of tessellations possible using the shapes of Cluster D. This is just one example.

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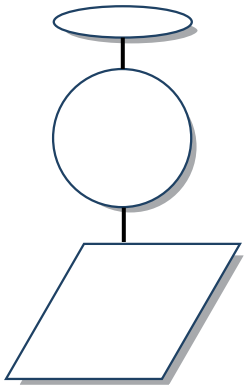
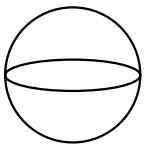
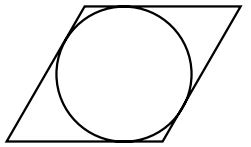
CLUSTER E
(bottom right of template)

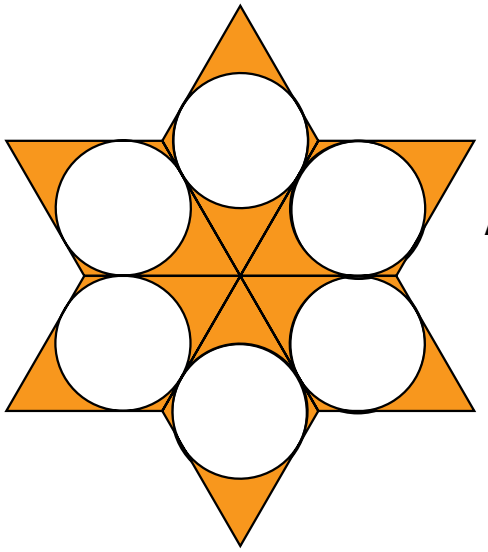




Ellipse inside the small circle.

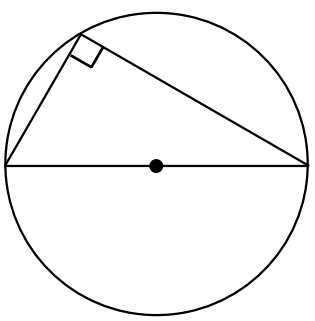


Circle inscribed within the rhombus.

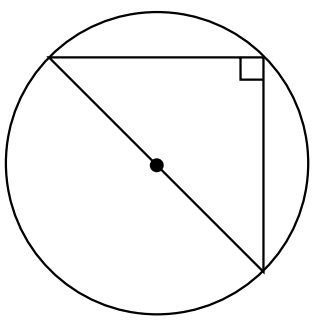


Another tessellating pattern.
Others are possible.

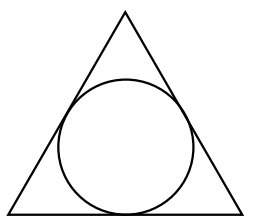
MISCELLANEOUS RELATED SHAPES:



The 1 : 2 : $\sqrt{3}$ (30^0, 60^0, 90^0) **right triangle** is circumscribed by the large circle. Note its hypotenuse becomes a diameter. Note also that the relationship between the circle and the right triangle is indicated on the **SUPER RULE**™ with twin TAGs.



The 1 : 1 : $\sqrt{2}$ (45^0, 45^0, 90^0) **right triangle** is circumscribed by the large circle. Note its hypotenuse is also a diameter. Note also that the relationship is described with twin TAGs.



The circle near the bottom right (with cardinal points) can be inscribed within the equilateral triangle (see twin TAGs).

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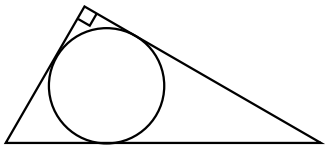
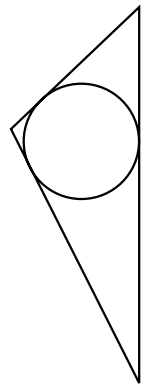
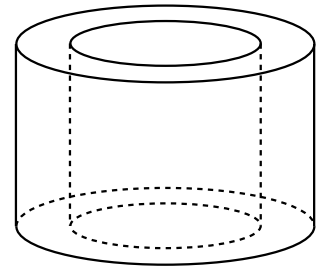


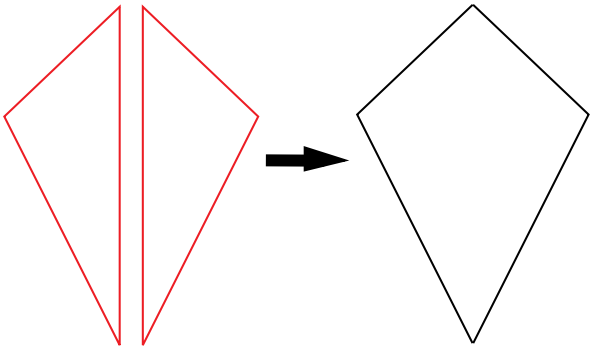
The circle near the origin of the hyperbola axes can be inscribed within the $1 : 2 : \sqrt{3}$ (30^0, 60^0, 90^0) right triangle (see twin TAGs).



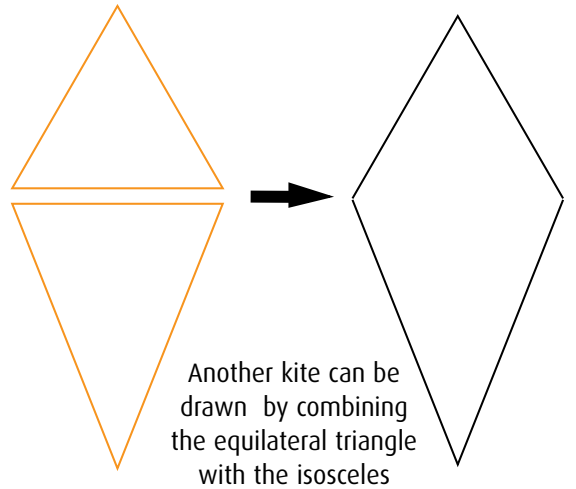
The circle near the origin of the hyperbola axes can also be inscribed within the **scalene triangle** (lower right of template), see twin TAGs.



Cylinders or hollow cylinders can be drawn with selected ellipses. This diagram uses the bottom ellipses of clusters A and C.



A **kite** can be drawn by reflecting the scalene triangle (above).

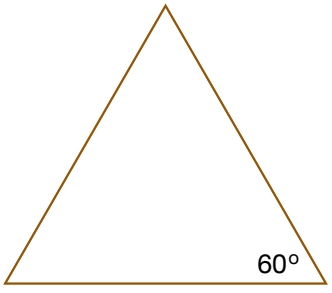


Another kite can be drawn by combining the equilateral triangle with the isosceles triangle below it.

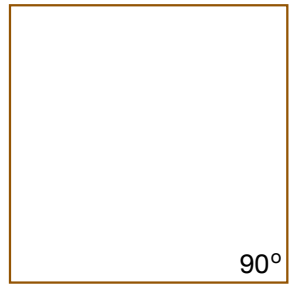
POLYGONS and POLYHEDRA:

A polygon is a multi-sided (closed) planar figure. If all of the sides are of equal length and all angles are equal, then it is called a **regular polygon**.

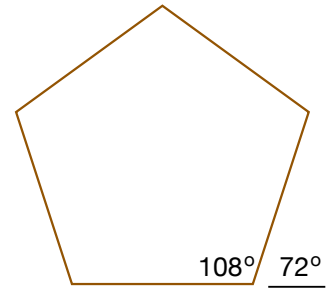
Some of the common regular polygons are:



Regular Triangle (Equilateral)
3 sides



Regular Quadrilateral – Square
4 sides



Regular Pentagon
5 sides

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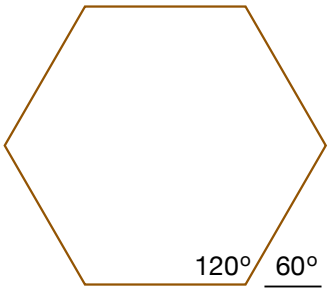
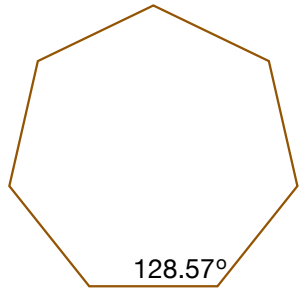
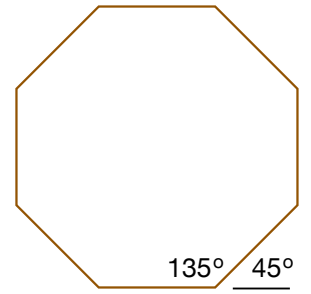


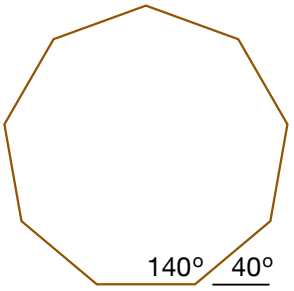
Regular Hexagon
6 sides



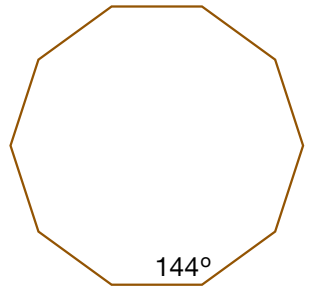
Regular Heptagon
7 sides



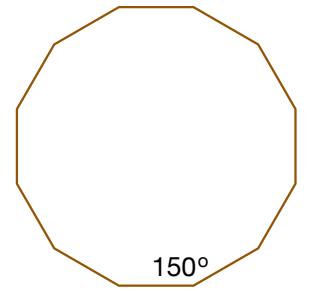
Regular Octagon
8 sides



Regular Nonagon
9 sides



Regular Decagon
10 sides



Regular Dodecagon
12 sides

The more common of the above shapes are available on the **SUPER RULE**™. If not, you can use the protractor to accurately draw them.

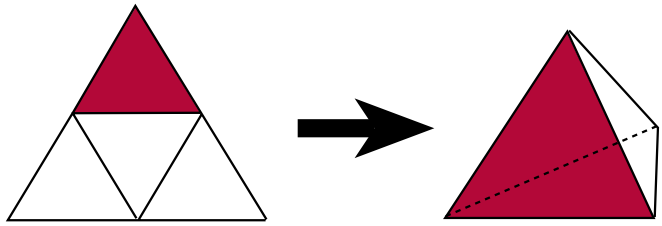
Polyhedra:

A **polyhedron** is a three-dimensional solid bounded by four or more plane faces, where each plane face is a polygon. (The plural of polyhedron is *polyhedra*.)

A **regular polyhedron** has all faces which are equal sized regular polygons, and has the same number of edges intersecting at each vertex (corner point).

There are five regular polyhedra.

These can be constructed by drawing and then cutting out and folding appropriate **nets** of the polyhedra. In the illustrations below, the net is on the left, the regular polyhedron on the right.



Tetrahedron

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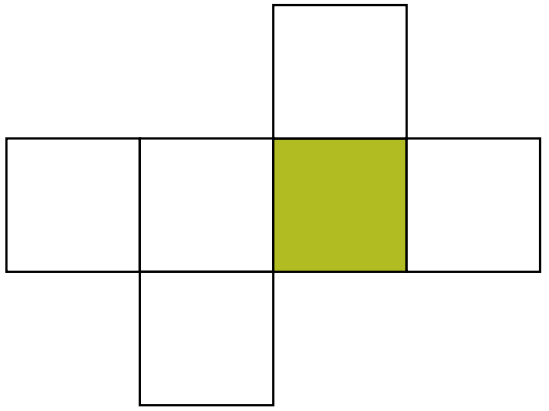
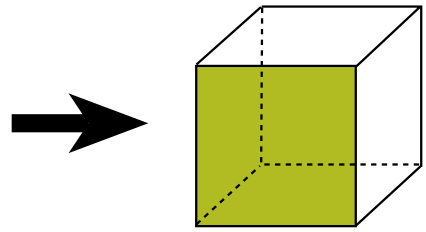
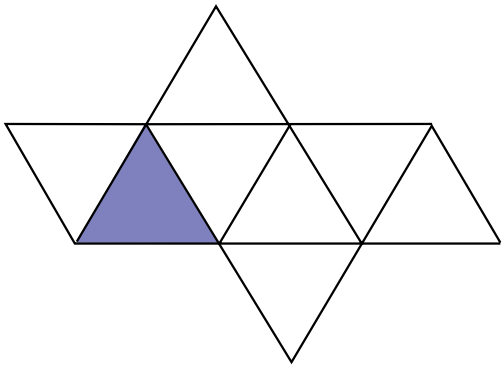
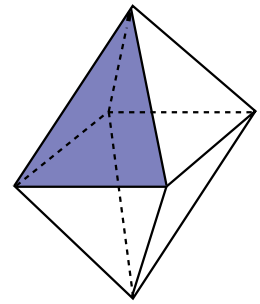


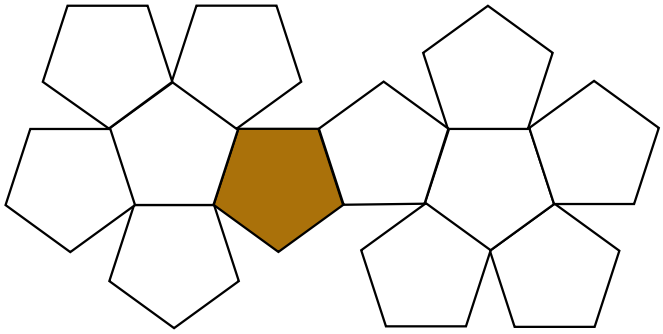


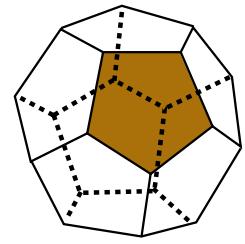
Hexahedron (cube)



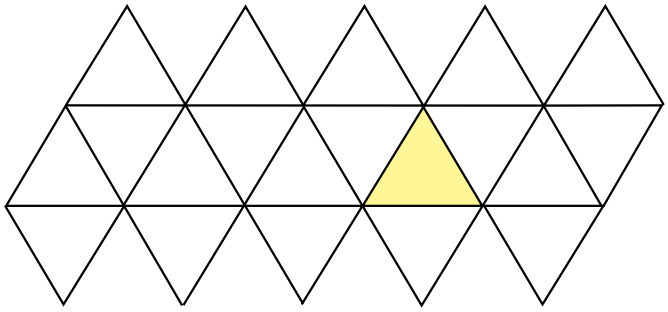


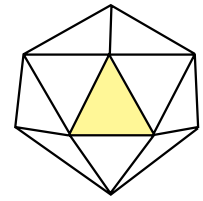
Octahedron





Dodecahedron





Icosahedron

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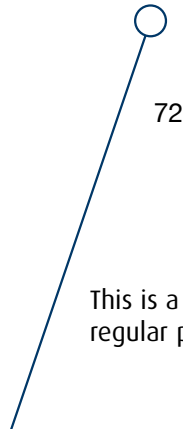
The **SUPER RULE**™ has guide lines for accurately drawing giant nets and other large shapes. These guide lines can be found coming up from and above the protractor.

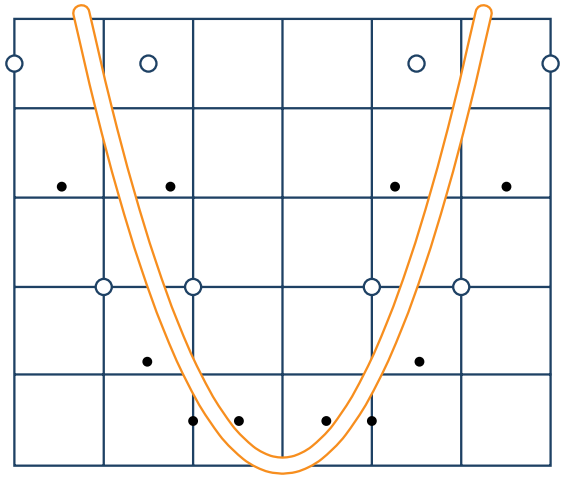


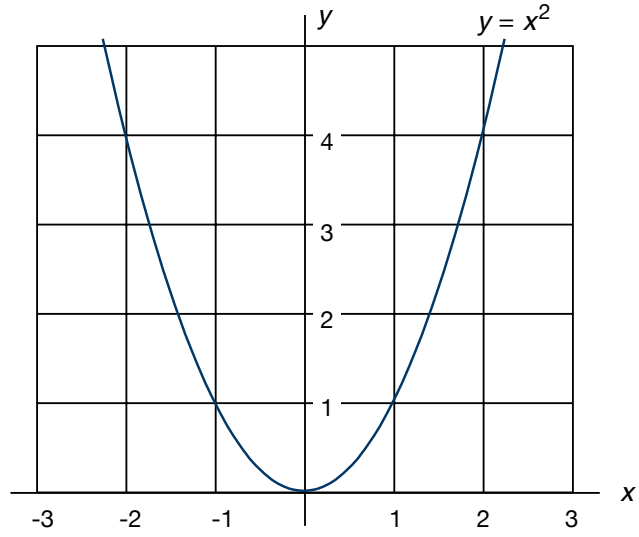
This is a guide suitable for a large regular pentagon.

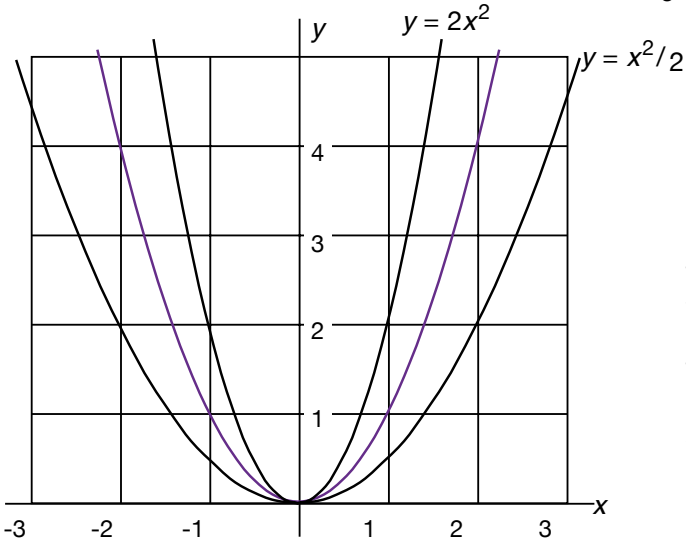
There are guides like that above available also for 30°, 45°, and 60°.

PARABOLAS and HYPERBOLAS:

For students of algebra and calculus, some common parabolas and hyperbolas can be easily drawn.







Use the small circular holes to plot the $y = x^2/2$ and $y = 2x^2$ curves. The small black dots are there for you to check your accuracy.

These and other parabolas can be drawn by re-scaling one or both axes.

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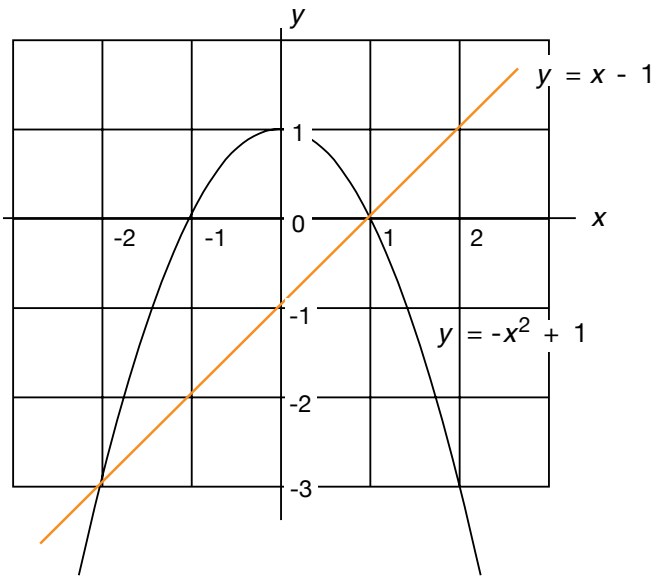
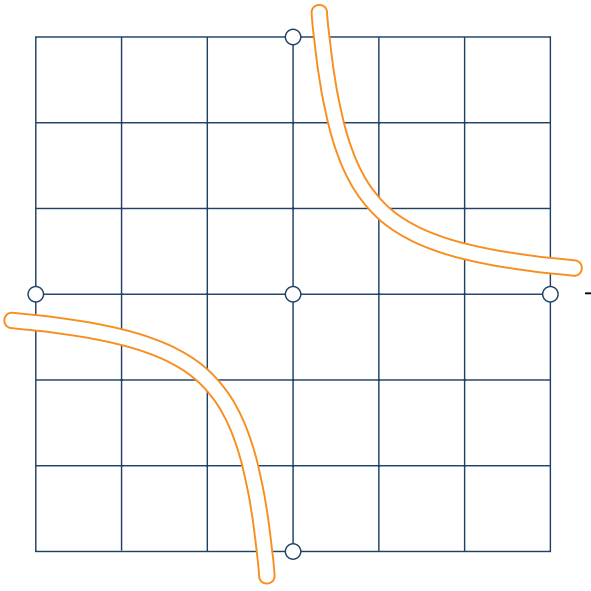
Solution of two equations, two unknowns.

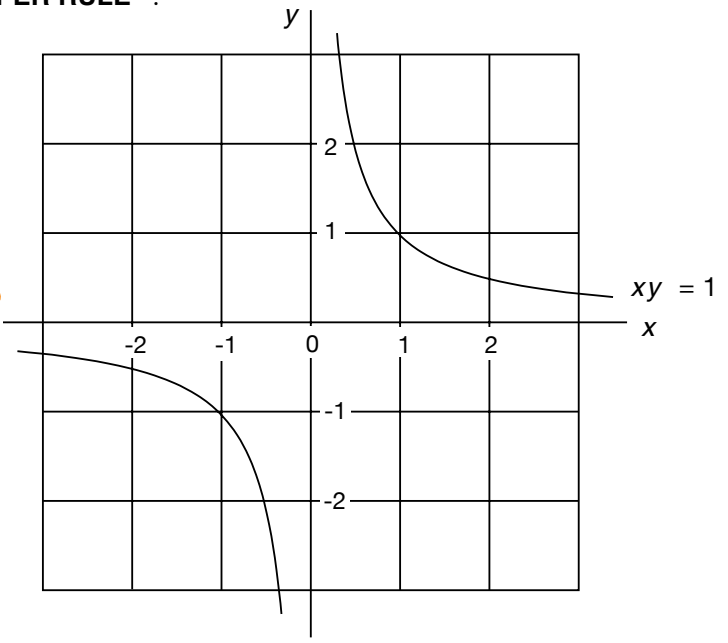
For example, to solve simultaneously $y = -x^2 + 1$ and $y = x - 1$, look for their graphical intersection.

Here the simultaneous solution is (1,0) or (-2,-3).



Simple **hyperbolas** can be drawn with the **SUPER RULE**™.

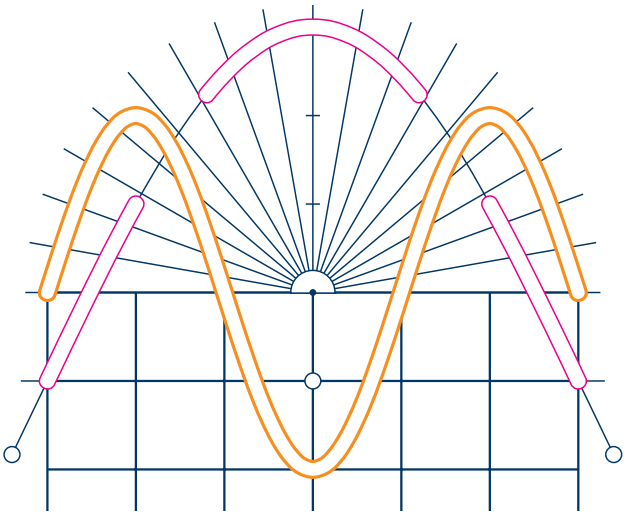




TRIGONOMETRIC FUNCTIONS:

The shapes within the protractor can be used to draw a variety of sine and cosine curves.

These allow you to draw sine and cosine curves with actual physical half-heights of 20mm and 40mm. Both curves can be extended by rotating 180^0 about an end point (and then translating, as appropriate).



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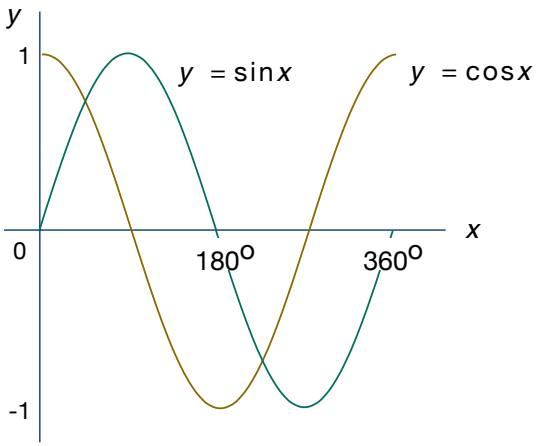
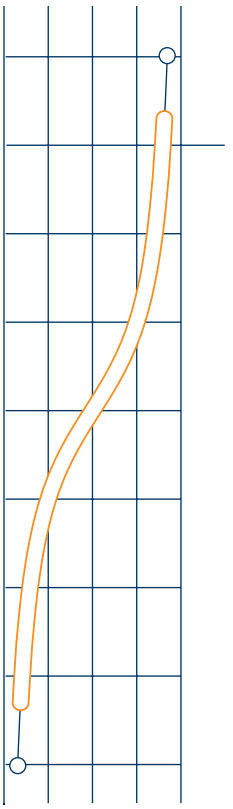
Here are two standard curves, $y = \sin x$ and $y = \cos x$, both sketched for x between 0^o and 360^o.

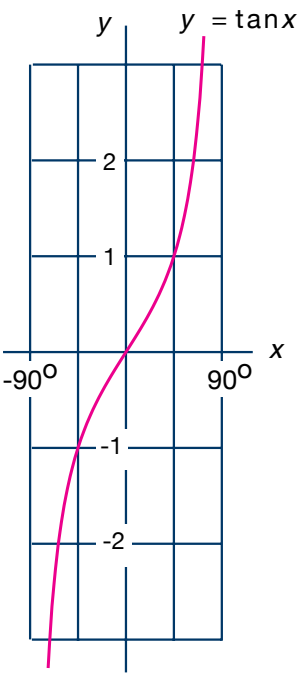


More advanced students of trigonometry can sketch curves like $y = \sin 2x$ and $y = 2\cos x$ by adjusting the scales on the axes. In fact you can use either of the sine/cosine template shapes to draw any sine/cosine curve but you will, in most cases, need to adjust the scales to suit.

There is also a tangent curve (right).



This allows for accurate sketches of tangent curves like $y = \tan x$, drawn here for x between -90^o and 90^o. The curve reaches infinite heights at -90^o and 90^o (and every 180^o thereafter) and the vertical grid lines which will never be crossed are called *asymptotes*.



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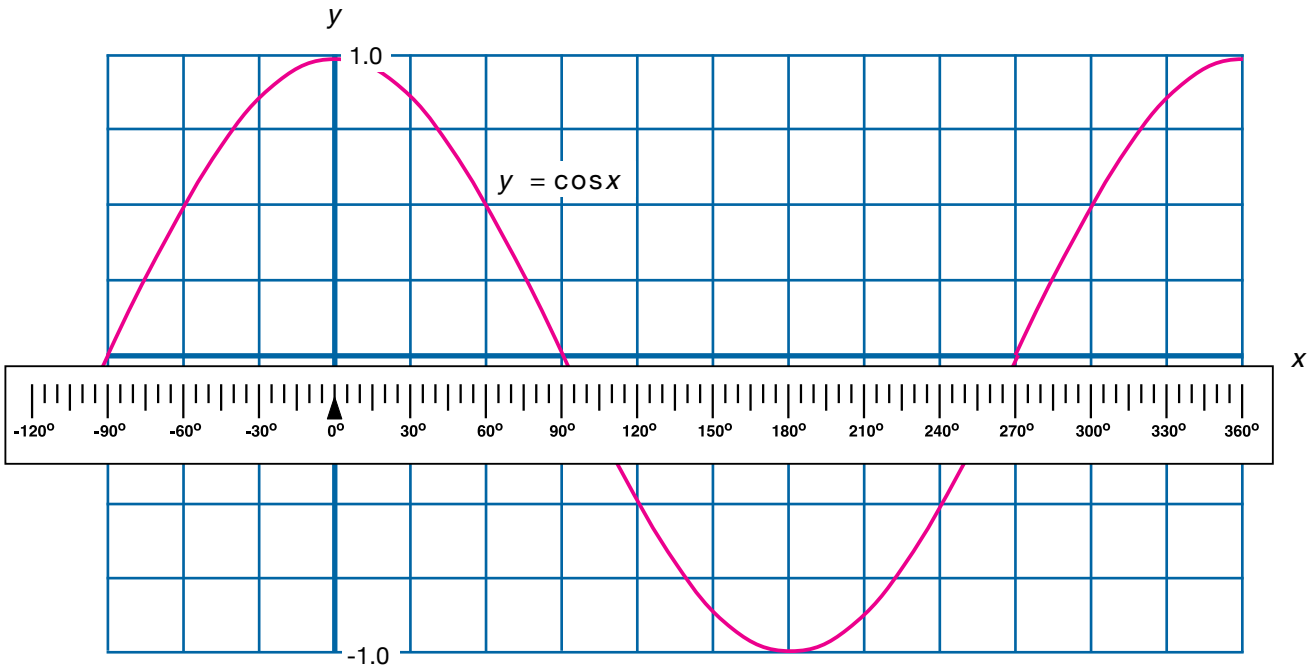
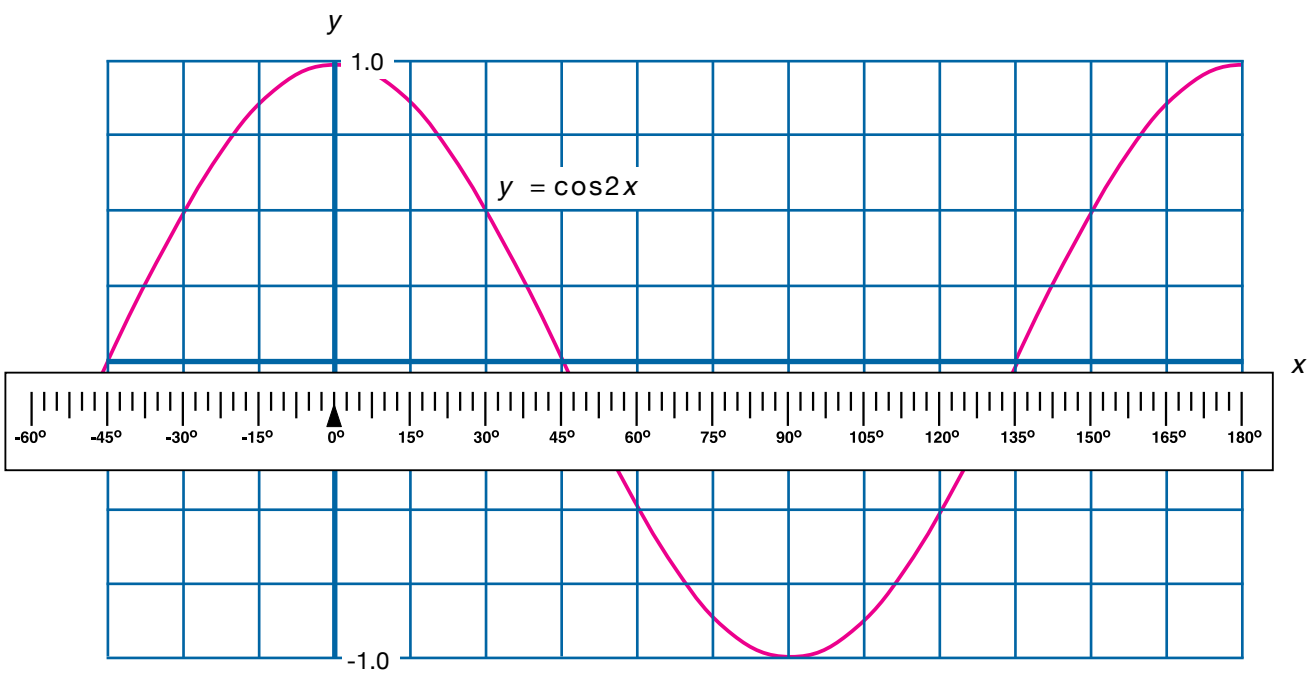
DEGREE AND LINEAR/RADIAN SCALES and GRAPHING TRIGONOMETRIC FUNCTIONS:

The **degree axis** (located at the base of the **SUPER RULE**™):

The axis can be used to graph trigonometric functions with a degree domain. Notice that it is graduated into 5^0 intervals (six graduations per major 30^0 interval) which makes it particularly suitable for freehand sketches and is sometimes exactly compatible with the template shapes.



By changing the degree measurements on the degree scale, different curves result. In the following case, for example, if the measurements are halved then the curve $y = \cos 2x$ results (using the same template shape as above).



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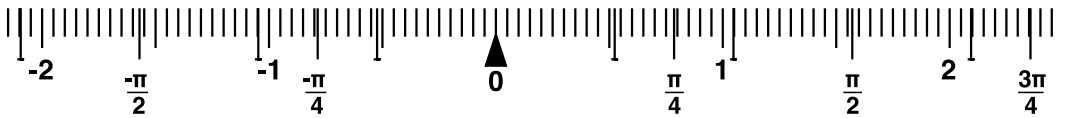
The **linear/radian axis** (located on the left of the **SUPER RULE**™):

Note that the longer graduations represent fractions of π (as marked). The inverted "T" graduations represent π/6, π/3, etc., that is incrementing in π/6 amounts.



This scale can assist you to graph trigonometric functions with a real number/radian domain, although the curve will need to be drawn freehand if you use this exact scale.

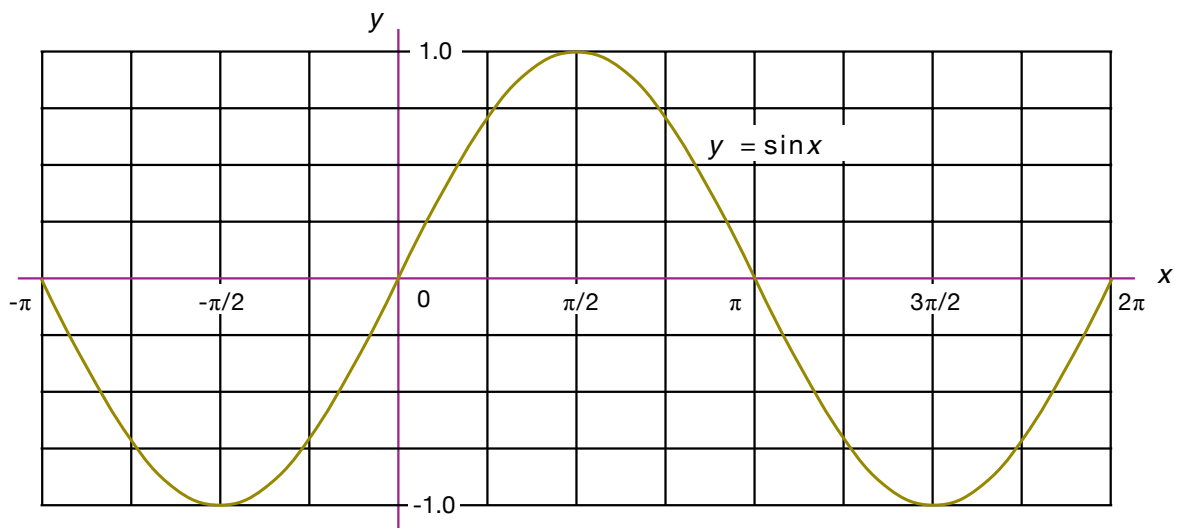
Keep in mind that **π radians equals 180°**.

Hence:

$$\sin \pi = \sin 180^{o} = 0$$

$$\sin \pi/6 = \sin 30^{o} = 0.5$$

$$\cos 2\pi/3 = \cos 120^{o} = -0.5 \text{ , etc.}$$



*Have fun in mathematics with your **SUPER RULE**™ !*

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