16

From Circles to Ellipses ...

www.magicmathworks.org/geomlab16

A) Ask a colleague to hold one opposite pair of bulldog clips while you pull the other pair apart, thus submitting the piece of rubber to an approximate one-way stretch.

B) Start with the paper stack upright. Draw the circle on the front face of the apparatus in blue. Use the handle to shear the stack. Draw the result in red.

If you can achieve a big enough shear angle, you will notice that, though a diameter (the red line) stays parallel to the line of shear, the ellipse's major axis swings ahead of it. A tracing of the 2D model shown would allow you to make measurements and perform constructions.

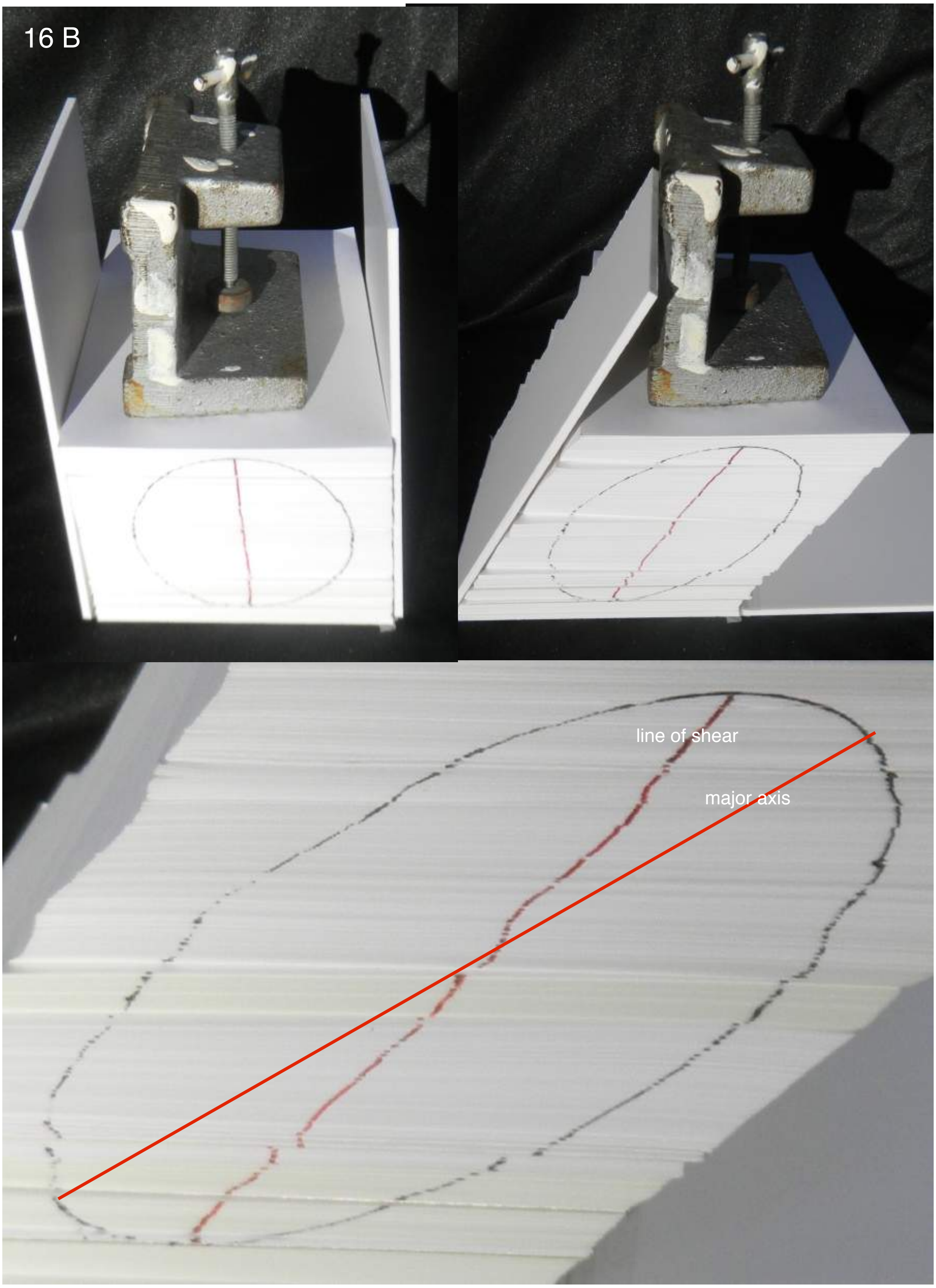
C) Experiment **8A**.

D) Find the drum lined with velcro. Take the wheel with half its diameter. Rest a pen in the hole between the centre and circumference. Roll the wheel round inside the drum. You would need to try other holes in this and other wheels to find in what way(s) **16D** is a special case.

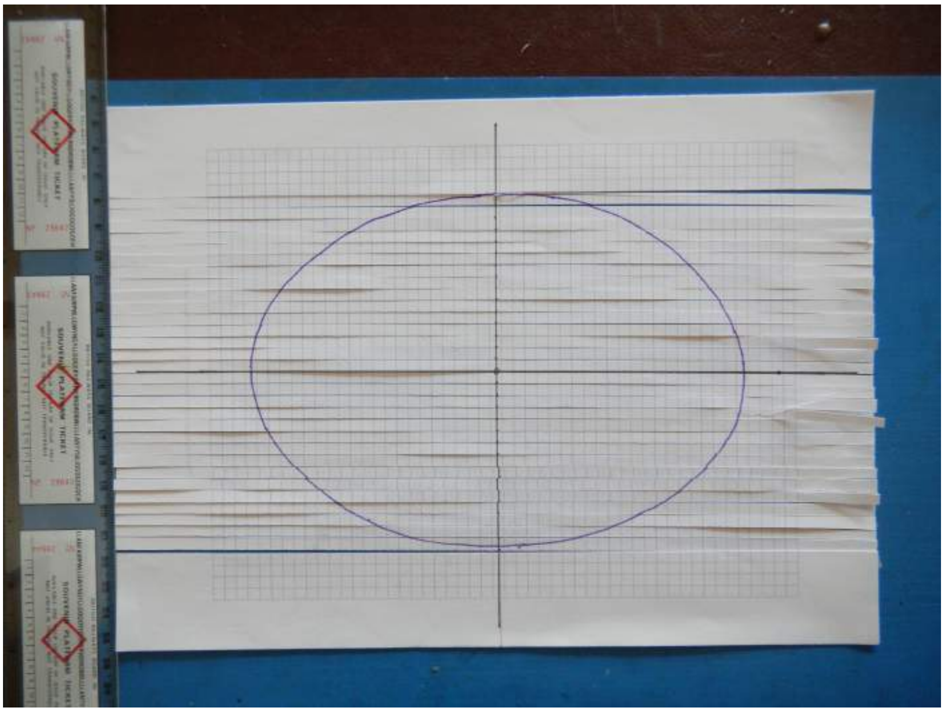
In **17** we get back to circles (but not simply by performing the inverse operations to **16A** and **B**).

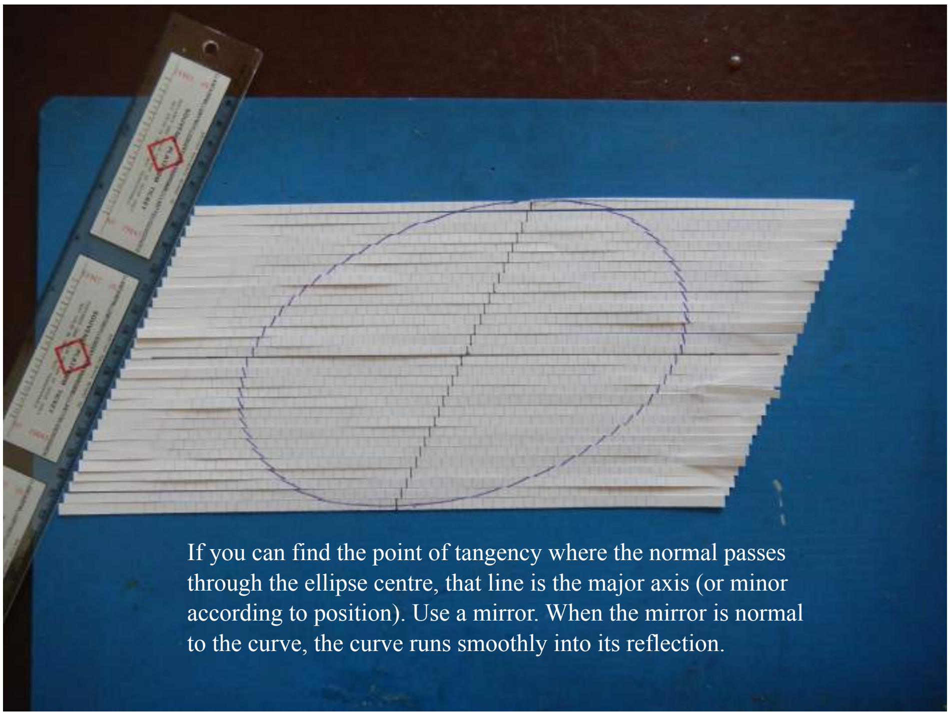
Paraboloid
Hyperbola
Hyperboloid
Hyperbolic paraboloid
Line pair
Sine curve
Tractrix
Exponential curve
Catenary
Catenoid
Helix
Helicoid
Plane
Polygon
Polyhedron
Tiling
Archimedean spiral
Equiangular spiral
Loxodrome
Line family
Circle
Cylinder
Cone
Sphere
Ellipse
Line
Parabola

16 A

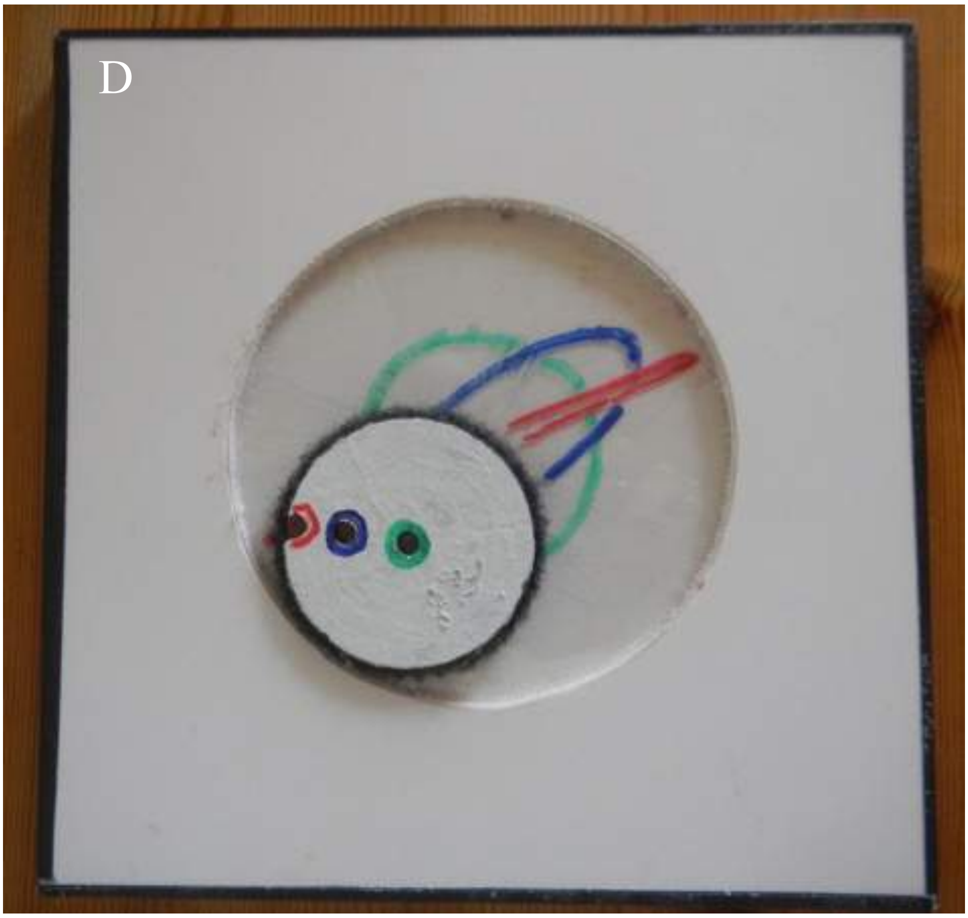

16 B
line of shear
major axis

16 B





If you can find the point of tangency where the normal passes through the ellipse centre, that line is the major axis (or minor according to position). Use a mirror. When the mirror is normal to the curve, the curve runs smoothly into its reflection.


D

A note on 16B:

In mountain-building movements (*orogenies*) deformations of the rock on the smallest scale consist only of stretches and shears. A body which begins as a sphere, for example one formed by an isotropic chemical diffusion process, ends as an *ellipsoid*, having half-axes *a, b, c* distinct in the general case. A single direction of shear or stretching produces a *spheroid*, in which two half-axes are equal. But to resolve the component shears or stretches requires evidence from other locations in the rock stratum.