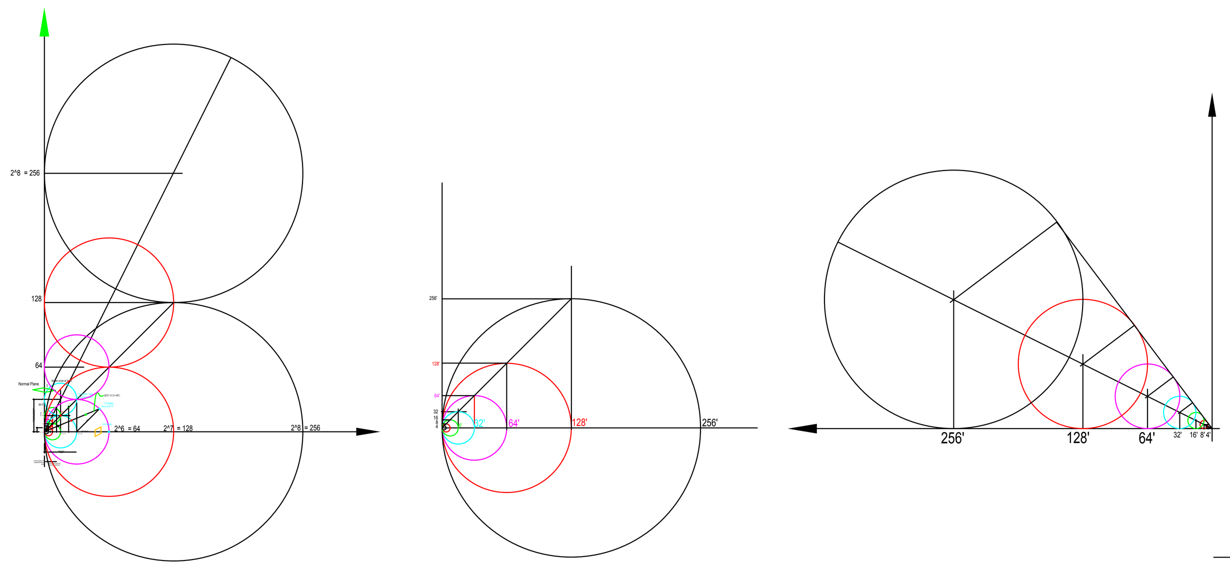
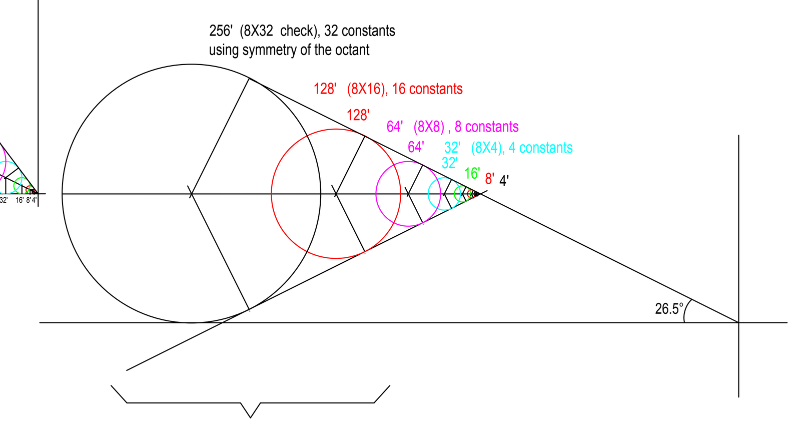
Elastic constants with Power series 2^n



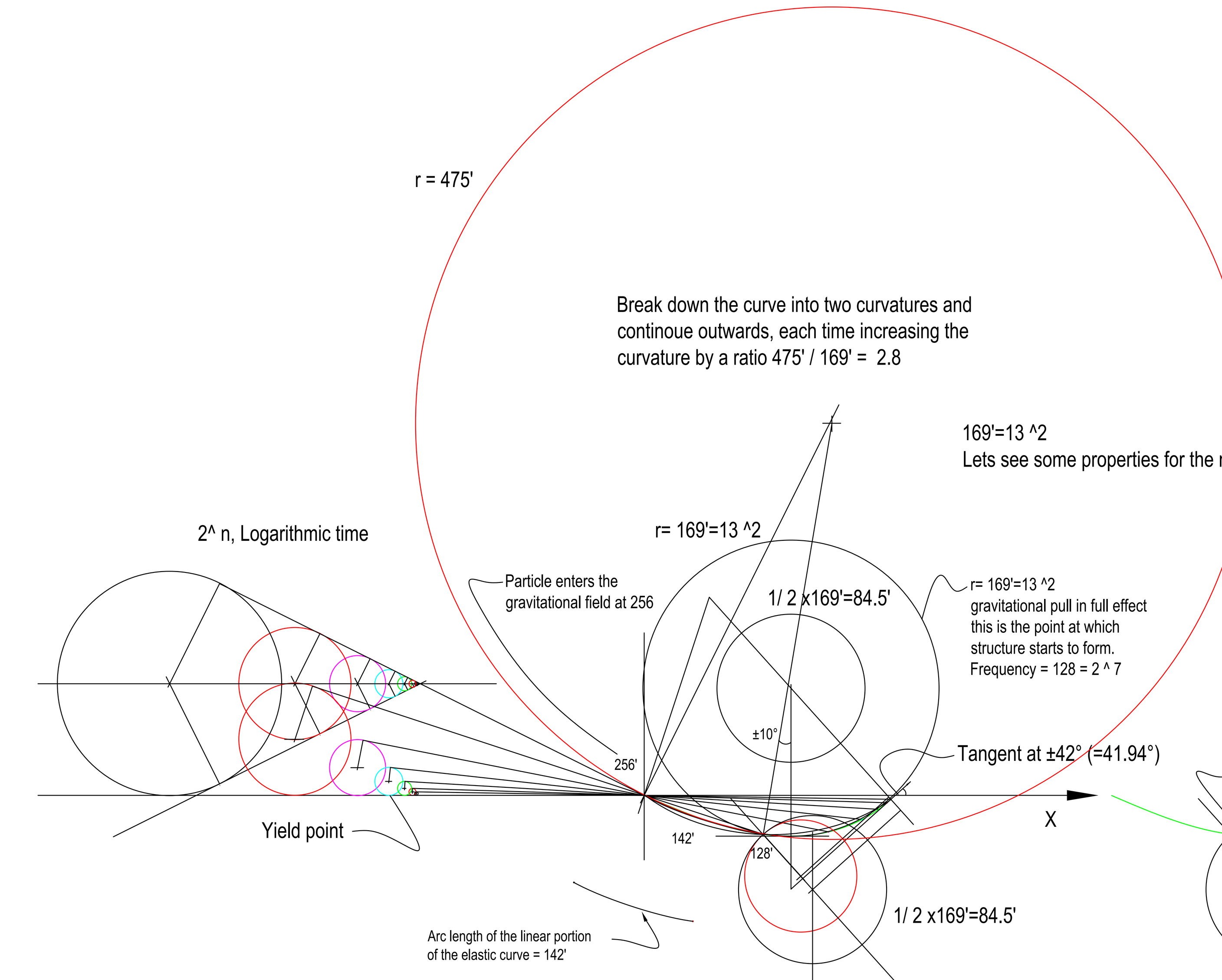
2^ 7th power = 128, we develop a new sphere with 2.8 times the curvature

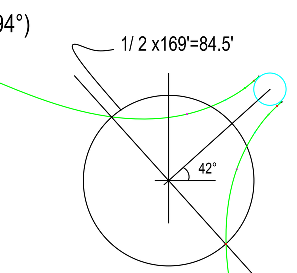
Number of elastic constants in reverse (inverse force field) going from linear to non linear range of the elastic curve. The particle enters the orbit at 256. If we consider the material as a solid being pulled in tension, then on the velocity pole curve, when the material when approaches the core can be assumed to have passsed the plastic point and failed at the point where its frequency is equal to 8. If we are dealing with a gaseous material, the curve would be traced in reverse. The number of constants would equal to 1 to 2 , corresponding to 8, and 16 in the diagram below. If we take the load up to the yield point that would require 4 constants.

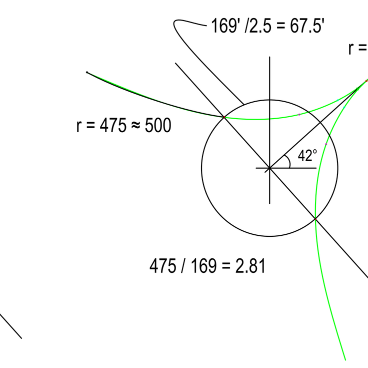
Series : 2 ^n with 8 terms / 7 segments



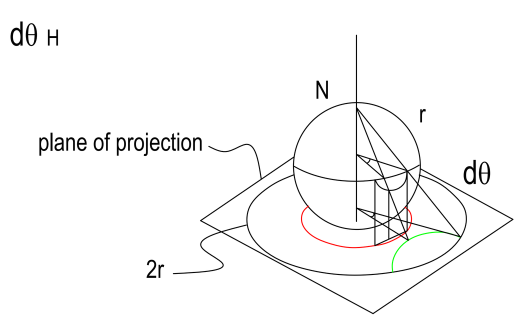
Linear range







The separation of the two pole curves will depend on the amount of available energy.



If the projected sphere radius is larger than 2r, say 2.8 r, then the sphere must be at a height above the plane of projection. Hence its potential energy has increased. The converse is also true.

Lets Bounce Some Balls!!!
in the figure we have the radius of the circle of the linear portion of the curve equal to 475 and the radius of the nonlinear portion as 169.
Now 475/ 169 = 2.8
We know that when we project on the plane from the north pole of the sphere our sphere size doubles. Here we have an increase in the size of sphere of 2.8 times. Hence our sphere has risen above the plane of projection by a specific height.
Hence our potential energy has risen by the height the sphere is above the projection plane.

In the figure to the right we have C6 = 2 C2

This is the point of stationary equilibrium. At this time we can show our spheres on the xy plane as resting on top of one another forming the figure 8. This is the state of stationary equilibrium.

The ball can be higher or lower than the projection plane or the hyperplane. If C2 is larger than 1 /2 C6, then our potential energy has increased and we are higher than the projection plane. If C2 is smaller than 1/ 2 C6 then the hyperplane/projectiomn plane will cross our sphere have some kinetic energy.

Now depending on the factor by which spheres C2 and C6 differ in size, we will have less or more energy rotating the wheels towards one another. The factor 2 is the stationary equilibrium. If we are higher than that, then the two spheres C2 and C3 will roll towards one another and if our factor is less than 2 they will roll away from one another.

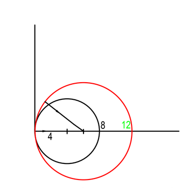
Lets us look at the complicated diagram of state of stationary equilibrium. At this time we can show our spheres on the xy plane as resting on top of one another forming the figure 8.

The figure is complicated or simple (depending on how you look at it) since we have chosen to line up the horizontal spheres in order of increasing (elastic) strain

We upper spheres, the centers of which are an an angle of 63.5 from the horizontal, can then be called the stress state (similar to stress path diagrams also refered to as the strain energy) since we obtained the velocity pole curve from them. Each consecutive sphere, say for example of radius 8, and 12 will have its elasic curve and modulous.

If the spheres are to cross one another or to separate from one another we will have a decrease or increase of energy respectively.

In the figure to the right going from r = 8 to r = 12 we have some kinetic energy left (note: the terms kinetic or potential are interchangeable and depend on wether we are talking about a solid or gas). We should have our next sphere be of diameter equal to 16. Hence the hyperplane has crossed our sphere by 12 /16 or 3 /4 of the way up the diameter. If we had two balls, they would penetrate one another by 1 /4 each.

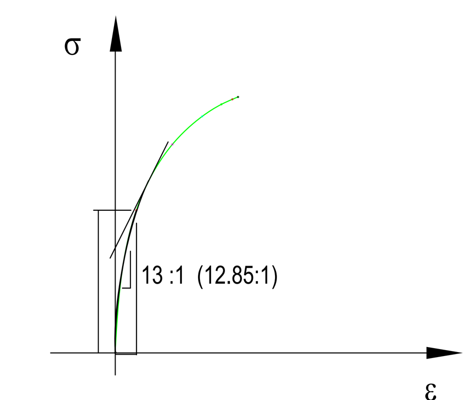


center of curvature and center of force for an inelastic material

30 /13= 2.3

Remember we had calculated the factor of safety of bending as the ratio: 26.5/11.5 = 2.3 . Adding these two together will result for a total of 5+2.3 = 7.3 as a factor of safety. We increase this to 8 to be on the safe side. 7.5 would have been ok as well.

Also we note that maximum size of the four sphere = 2 C1 / cos 30 = 2.3 .



Radius of arc for the linear portion of the elastic curve is equal to 425 to 475.
If the frequency is taken higher than 256 2^ 8, we would approach the x axis, but 2^ 8 is enough.

Take the radius r = 500 for linear portion of the elastic curve.

Remember this is a cantilever member, so for a member which is supported at both ends we take double the span. To put it another way, there are two wheels if you will or two portions to the curve.

Hence for a member which is supported at both ends this limit would be 1/ 1000

density of steel = 0.284 lb/in³
Modulus of elasticity of steel E = 30 x 10^ 6 lb/in²

Recall that in a central force field the radius sweeps out area at a constant rate A called the areal speed. If the mass of p is m, then the angular momentum L (= r x m v , I . ω) of p is = 2 m A . The factor 2 comes from the fact that we reduce the area of the parallelogram from the addition of vectors to that of the triangle almost equal to the arc of the circle, and also that there are actually two arcs, or wheels.

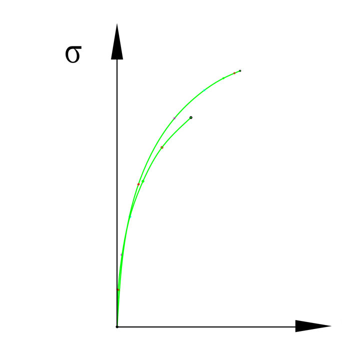
Area Segment of arc :
(142' x 12) x 475x 12 (1 /2)= 9,712,800 in² / 2

If we take twice the arc length 142 x 2 = 284

then area = (142' x 12) x 475x 12 = 9,712,800 in²
Break down the curve into two curvatures corresponding to the linear and nonlinear range and continoue outwards, each time increasing the curvature by a ratio 475' / 169' = 2.8 .
multiply the area 9,712,800 by 2.8 (475 / 169 = 2.81 , or 3) to account for the increase in area in going from linear to nonlinear range, or entering or being pulled into the orbit A = 9,712,800 in² x 2.8 = 27195840 in²
The factor 2.8 ≈ 3 accounts for the rigidity of the curve or material.

To account for increase in force in an inverse square force field we would square the constant 2.81 the increase in radius to equal 7.899 ≈ 8.

with 500 as the radius Area in in² = (284 ' x 12) x 500 x 12 x 1/ 2 x 2.8 = 28,627,200 in²
If we take the factor as 3 as opposed to 2.8 the area becomes:
A = (284 ' x 12) x 500 x 12 x 1/ 2 x 3 = 30672000 in² = 30.6 x 10^ 6 in²

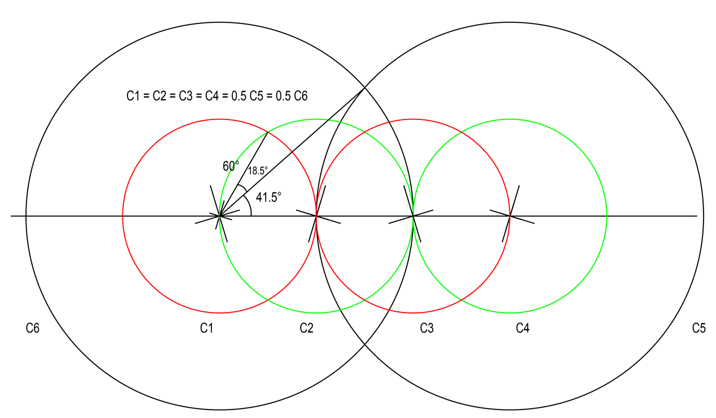


Loads increased as a series 2^ n and S . n (linear) for the same mass 256.

Translation /rotation as loss or gain of energy.

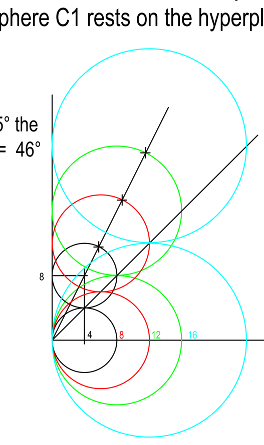
We note that C1 and C2 are crossed. If the center of circles C1 and C2 get any closer, C2 will have to increase in size. Next we consider spheres C2 which has increased in size and C6 which will also have to increase in size. If the spheres are kept at a constant size, then they will have to elevate from the projection plane.

Hence C1 can be considered to have rolled and translated to the center of sphere C6.



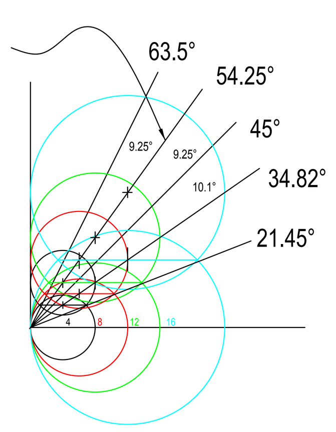
Sphere C6 = 2C2 constitutes stationary equilibrium where our sphere C1 rests on the hyperplane

As we rotate the horizontal axis by 63.5° the spheres separate with dθ H = 2 x 23° = 46°



For a linearly elastic material the center of stress (inclined) circles remain in a straight line

Rotational component is not included in the diagram to the right.



Kinetic or potential energy loss

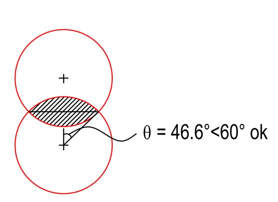
State of stationary equilibrium. Spheres rest on top of one another without crossing. In an elastic / perfectly plastic material the spheres will not cross one another. They will cross upon loading but will remain uncrossed upon unloading. The material is hence termed resilient.

If the circles cross one another proportionally by the same amount, then the process is considered linear.

The center of circles remain on a line at an angle of 54.25°.

The energy loss is proportional to the area of the union of the circles on the horizontal and the sloped line.

if the angle θ is less than 60° the material has yielded bu has not reached the plastic point. If θ is greater than 60 degrees the material will be considered to have yielded passed its plastic point, where it will no longer return to its original form upon loading. At this point the particle will have left the orbit, the sphere C2 will become larger and will be considered to have lifted from the projection plane.

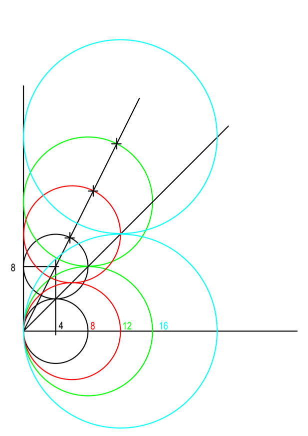


Another intrerpretation of the figure to the right is as follows:

Let the vertical axis be a barrier and on the horizontal axis have standing waves at point 4 be originated. The waves will bounce off the barrier as shown on the horizontal axis.

Now if the waves are reflected at an angle 26.5 degrees from the vertical the energy loss will will be transferred in the form of translation, hence the separation of the spheres.

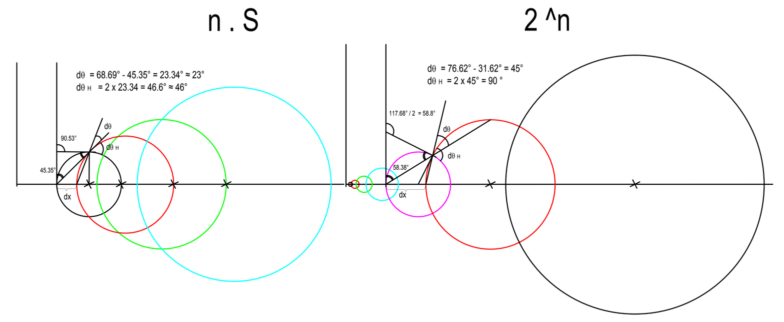
The spheres will not be perfect spheres but will be in the form of ellipses unless we are speaking of a perfect "Newtonian" fluid.



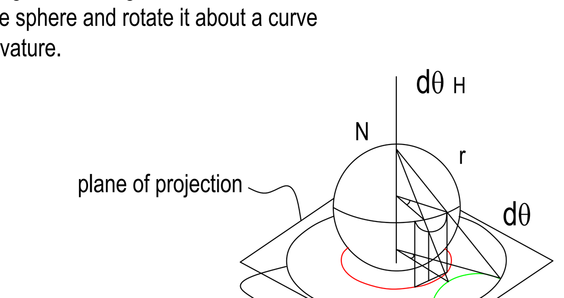
The non Euclidean (Hyperbolic) angle dθ H is twice the Euclidean angle dθ
dθ H = 2 dθ

n . S

2 ^n

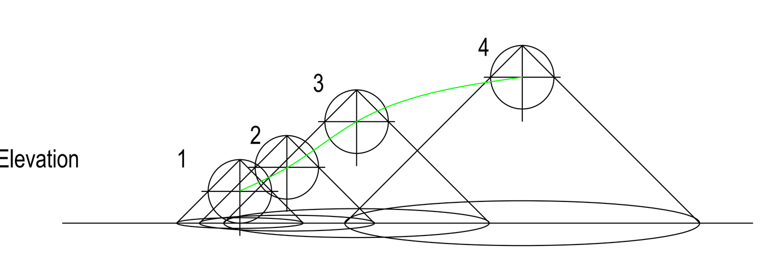


Using the figure to the right we can both elevate the sphere and rotate it about a curve of any curvature.

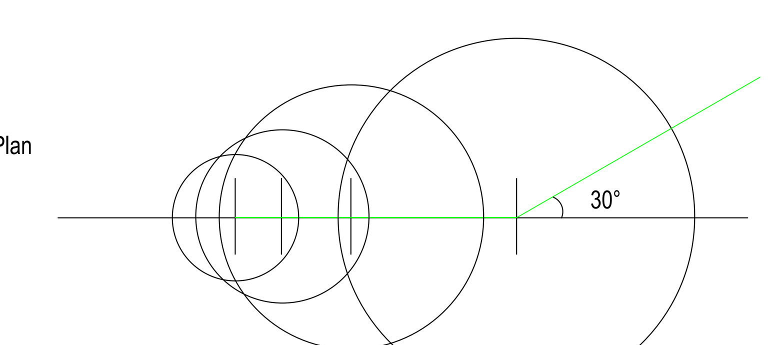


Two dimensional curve
Translation in a straight line plus elevation

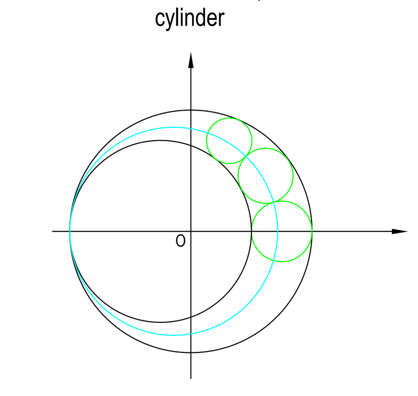
Elevation



Plan

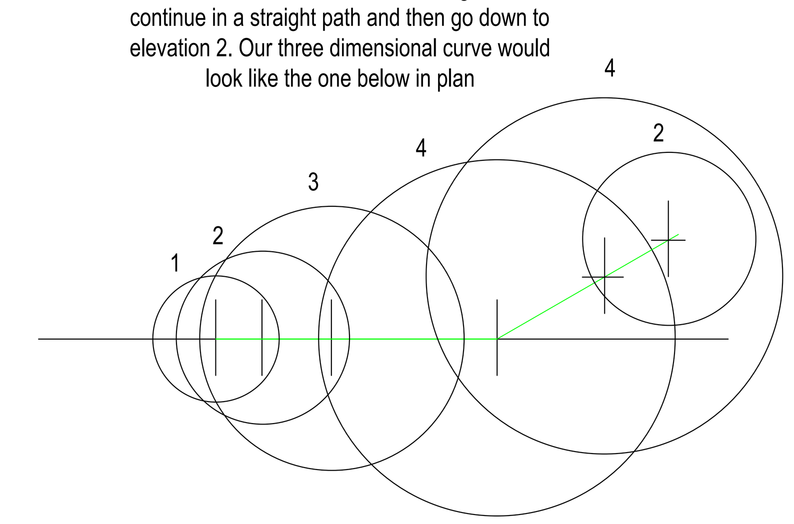


Draw the two dimensional spiral about a cylinder



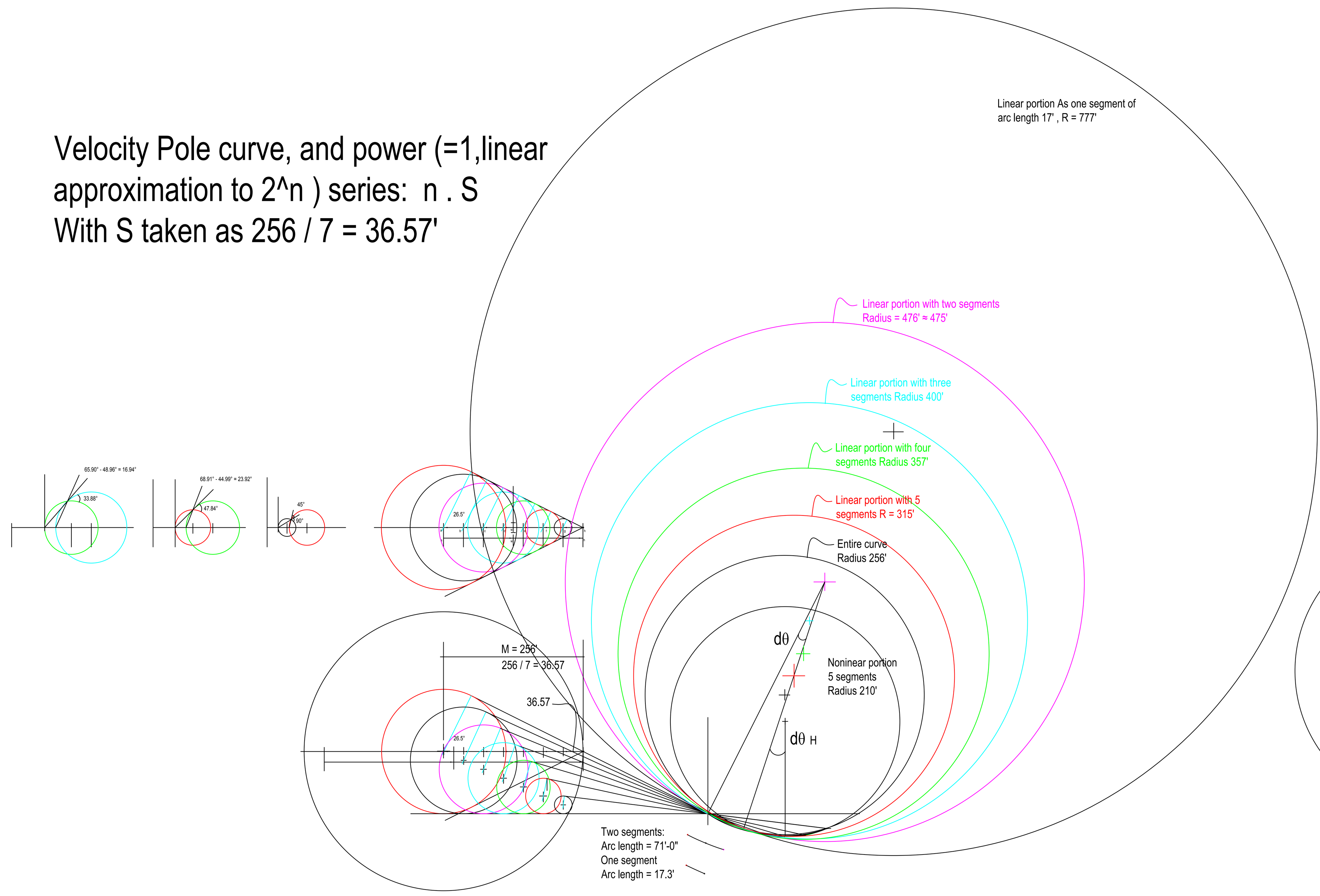
How about the Doughnut !

Assume at elevation 4 we turn 30 degrees and continue in a straight path and then go down to elevation 2. Our three dimensional curve would look like the one below in plan

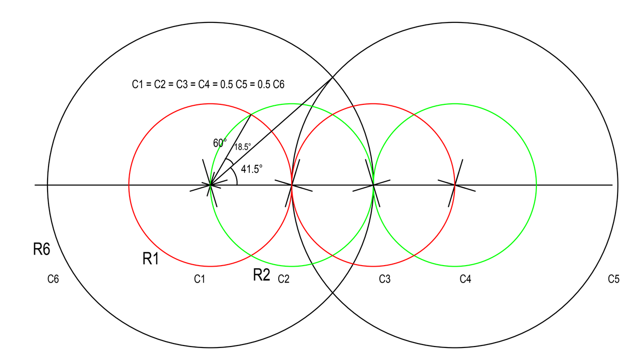


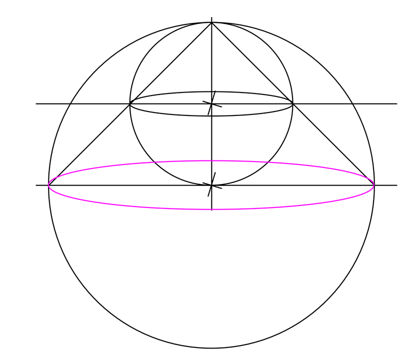
Elastic constants and Modulus of rigidity with linear approximation (S.n) to Power series 2^n

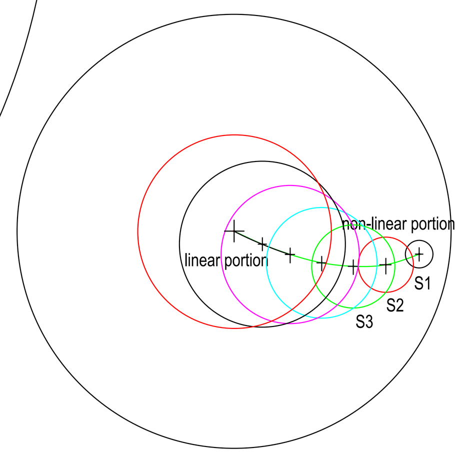
Velocity Pole curve, and power (=1,linear approximation to 2^n) series: n . S
With S taken as 256 / 7 = 36.57'



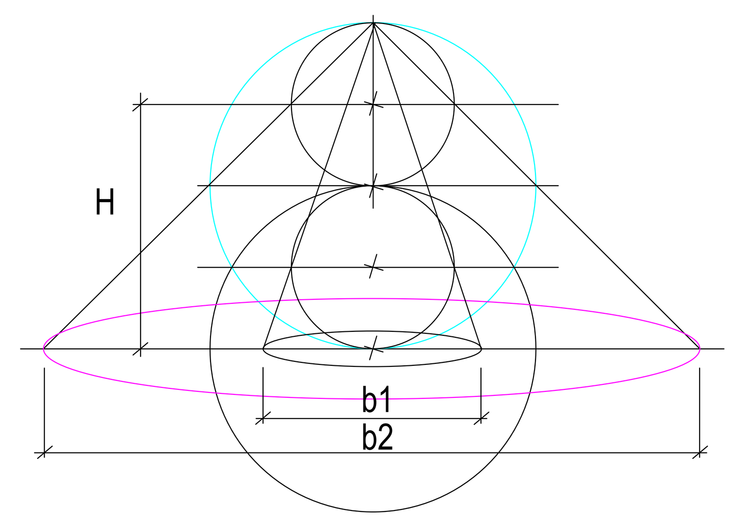
In the figure below set R6 = 475'
R2 should be 1/ 2 = 237, with R2 = 256 we are barely above the projection plane





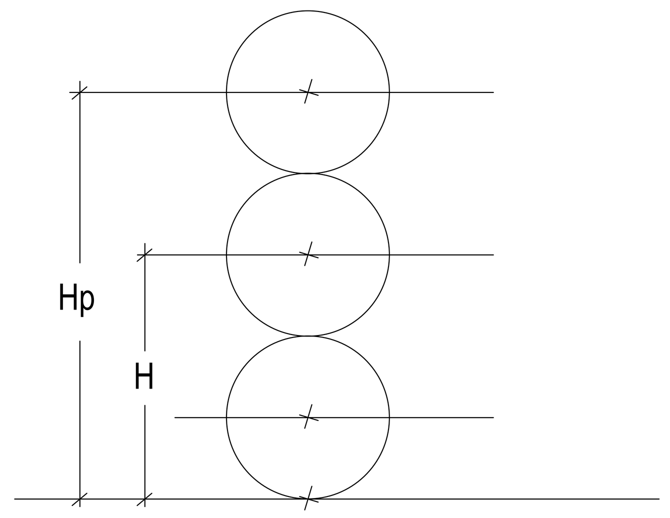


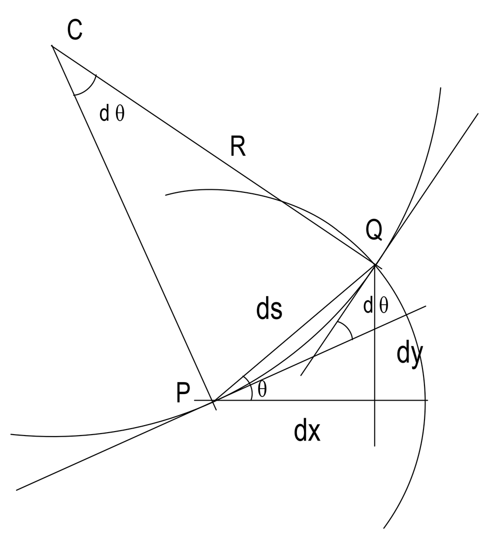
Note: linear and non-linear portion can be interchanged depending on whether we are dealing with a tensile or compressive force (leaving or entering orbit)



Quick approximation:
The circle for the entire curve or mass, with R=256' , gets enlarged eventually to the circle S3 approaching R= 475' , the sphere R=475' would then in turn enlarge, or we would rise to the height H multiplied by the ratio of the base of the two light cones shown in the figure below to the left. Let H = 3/ 2 R
Height above plane Hp = H x b2 / b1 = H x 773.6'/ 257 ≈ H x 777 / 256
Hp = 3 H
Hp = 3 x 3/ 2 R = 4.5 R
Note: as of yet , the rotation of the sphere has not been accounted for.
To calculate the effect of torsion or take the tangent vector which rotates an amount d θ . The radius is equal to the entire arc chord which equals 220 '. Our circle (or sphere) has increased to R = 475'. The ratio of the two circles equals 475'/220' = 2.15 ≈ 2. So that the torsional effect is 1/ 2 the tensile effect.

With simple ratios we can calculate Hp total = 4.5 R x 220'/475' (4.5 R) = 6.5 R
How do we account for the fluctuation?





Take two segments, with three of the last terms of the series, to equal the arc length of the linear portion of the curve where the particle has entered orbit. Then:
Arc length = 71' of linear portion consisting of two segments, or terms of the series.
475 /210 = 2.26 (Ratio of radius of convergence / radius of linear portion considered.
2 /2 = ratio of 1 /2 base times height for two triangles making up the parallelogram

Area = 71' x 2 /2 x 12 x 475' x 12 x 2.26 = 11 X 10^ 6

For the same mass equal to 256, if it is applied uniformly, the area is decreased by a third. This would be equivalent to the modulus of elasticity of Aluminum.

S3 - Three segments - Try with the linear portion arc length of 3 segments with the Arc length equal to 110'.
This would result in a radius of 400'.
The radius of convergence as 400' instead of 475' would give a ratio of 400' / 256' = 1.5625
Area = 110' x 2 /2 x 12 x 400' x 12 x 1.5625 = 9.9 X 10^ 6

S4 - Four Segments: R = 357 instead of 475', Arc length = 148'
Area = 148' x 12 x 357' x 12 x 357 / 256 = 10610129 = 10.6 ^ 6

S5 - Five Segments: R = 315.6' instead of 475' Arc length = 184'
Area = 184' x 12 x 315.6 x 12 x 315.6 / 256 = 10401189 = 10.4 ^6 Note with 5 segments we converge to 10.4

This is the modulus of rigidity. G = 10.4 ^6

With one segment 17.3', R = 777' , and 777' / 256' = 3.03
Area = 17.3' x 12 x 777' x 12 x 3.03 = 5,865,057 = 5.86 x 10 ^6

Taking one segment (the last two terms of the series) is interesting for fun and exercise as we have technically set our limit of the linear portion to R = 475'.

Keeping the radius of convergence 475' and mass 256' as constant, and then if we take one segment as the arc length of the linear portion the area would provide the modulus of elasticity of wood.

Modulus of elasticity of wood: (Note: we have assumed the series converges with R = 475' hence keep 475' as a constant)
Arc length = 17.3' , 475' /256 = 1.855
Area = 17.3' x 2 /2 x 12 x 475' x 12 x 1.859 = 2.19 X 10^ 6

Keep increasing the arc length and the smaller sphere to reach a material of higher strength such as steel, or even higher. The problem is the weight of the material will become larger as we take more segments.

3 Segments : Arc length = 110' (recall 475'/256' = 1.855)
110' x 12 x 2/ 2 x 475' x 12 x 1.855 = 13,957,020 = 13.9 x 10 ^6
4 segments: Arc length = 148' ,
148' x 12 x 475' x 12 x 1.855 = 18,778,536 = 18.7 x 10^ 6
Try 5 segments entire curve:
Arc length of six segments = 227'
Area = 227' x 12 x 475' x 12 x 1.855 = 28,802,214 = 28 x 10 ^6

Segments shown going backwards

R1 = 777' corresponding to the first segment or term of the series
Note: linear portion should be set to two segments as R = 475'