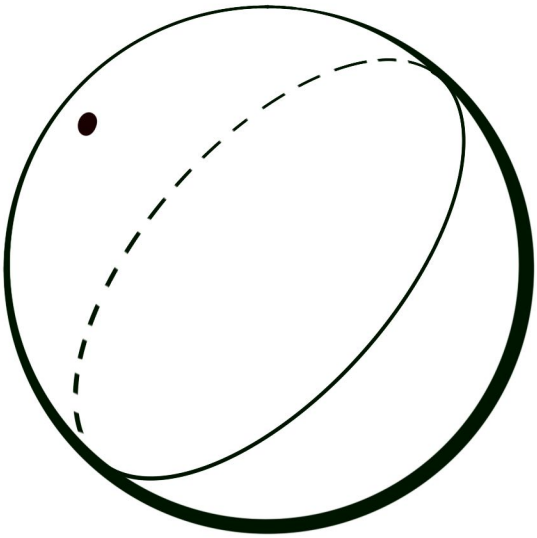
How To Draw a Sphere

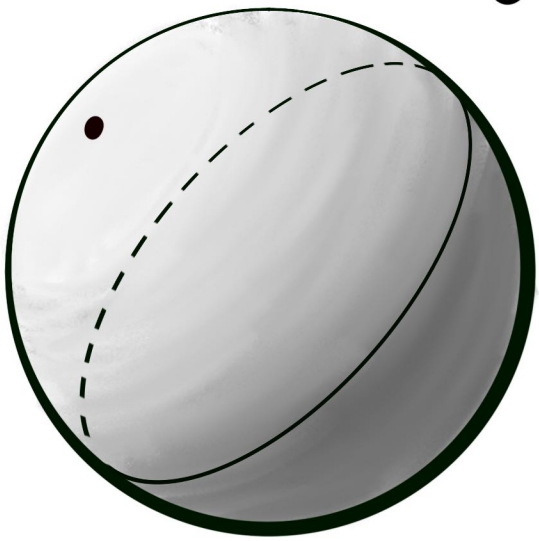
~a Synthetic, Pencil & eyeball construction~

we will break up the process into 4 easy steps

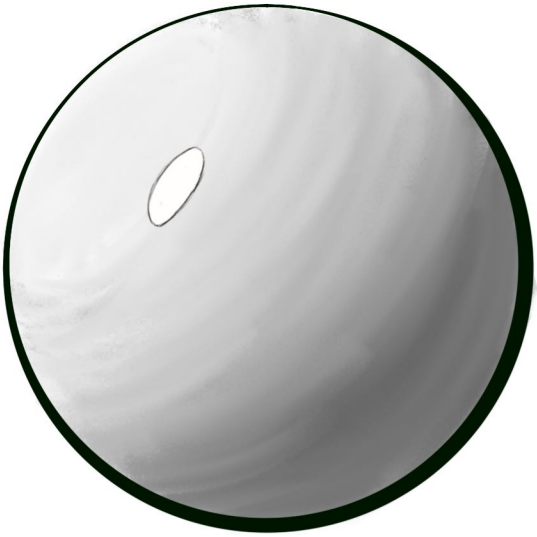
step 1: Scaffolding



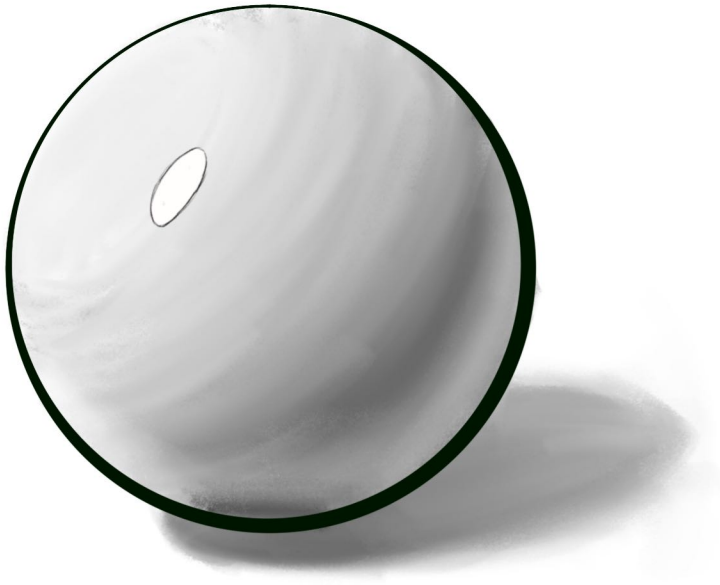
Step 2: shading



Step 3: highlights



Step 4: Ambiance

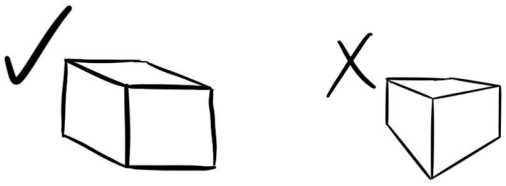


Goal:

draw an unadorned sphere, sitting on a table, in orthographic projection, lit from a sun beam.

Orthographic:

Parral lines appear parralel



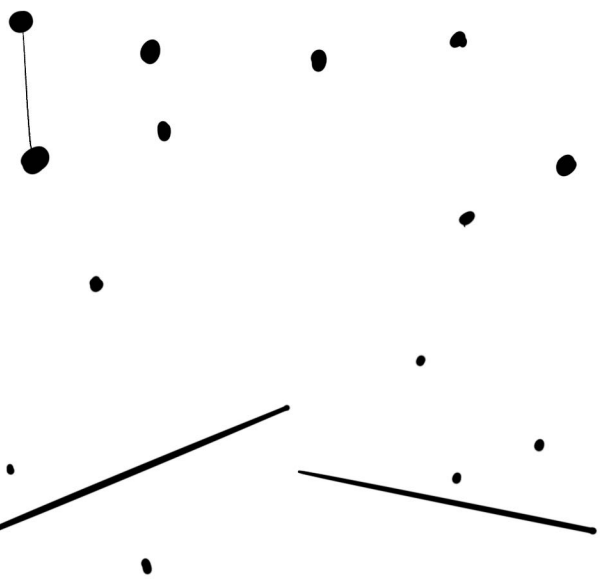
Sunbeam:

All light rays are parralel

We want to draw this as accuratly as possible with no tools except a pencil and our eye. Fortunatly, the sphere with all its shadings is exactly constructable. We need to design this construction so that it may be accuratly eyeballed. This gives an interesting model of geometry.

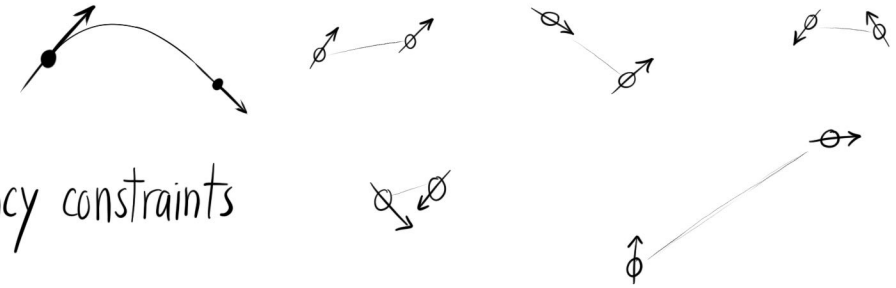
Constructions w/ pencil & eyeball:

- line between 2 points.
  (can only extend a short distance)



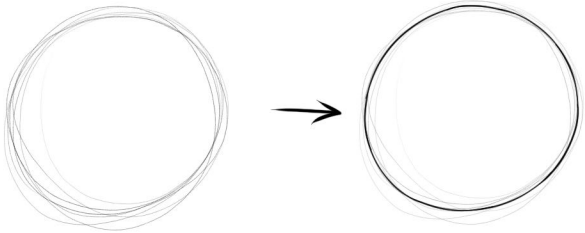
- Perpindicular thru line

- Bezier curves

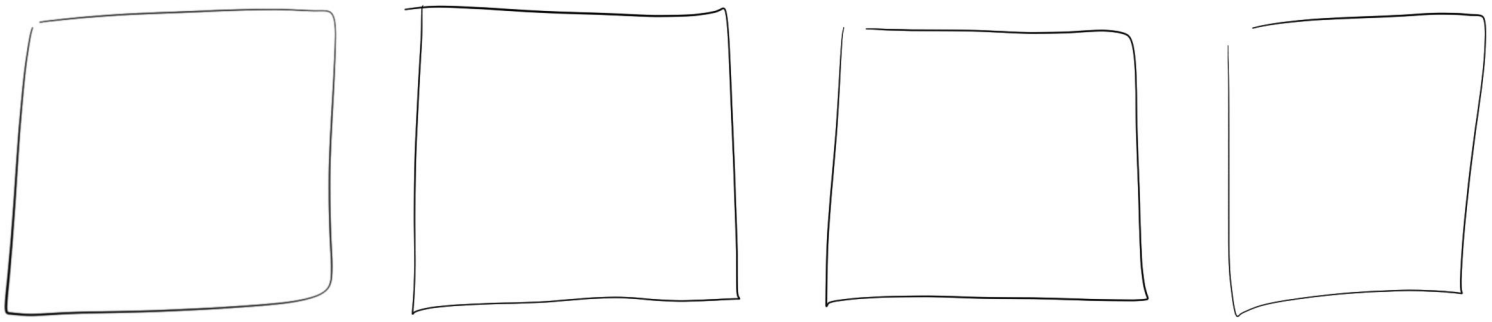


curves w/ point & tangency constraints

- Circles



try it!



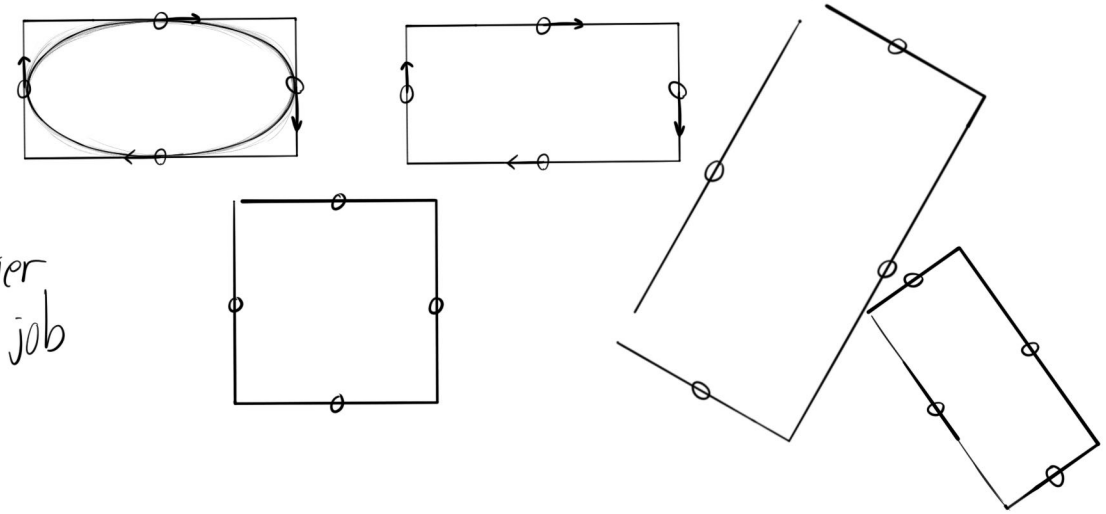
or, trace something circular.

Tip: How to find lines

- Make many light attempts & see where they concentrate

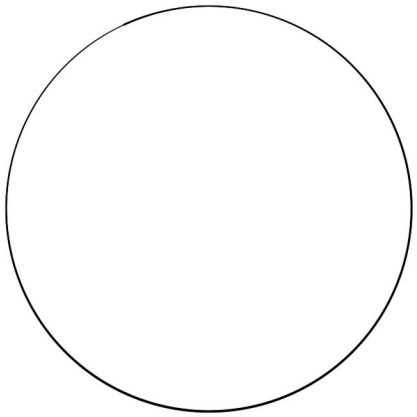
- erase sketch, & make single dark line

- Ellipses:
a bunch of Bezier curves does the job



Step 1: Build the scaffolding

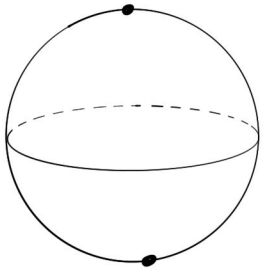
Try to draw a simple diagram of a sphere, showing the equator & north pole:



Some common pitfalls:

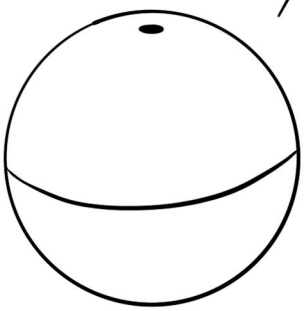
Seeing both poles at once

X



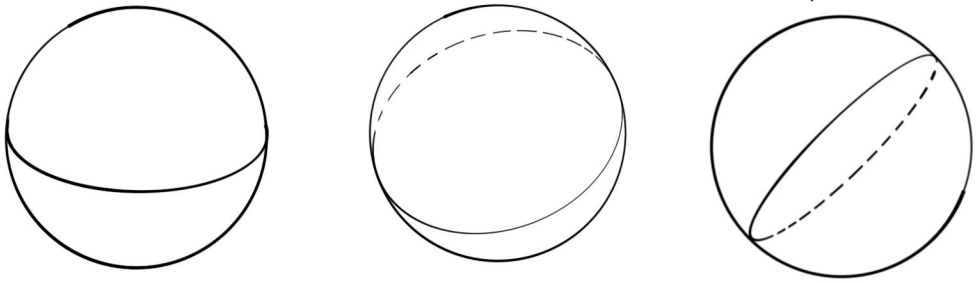
Equator not tangent to boundary

X

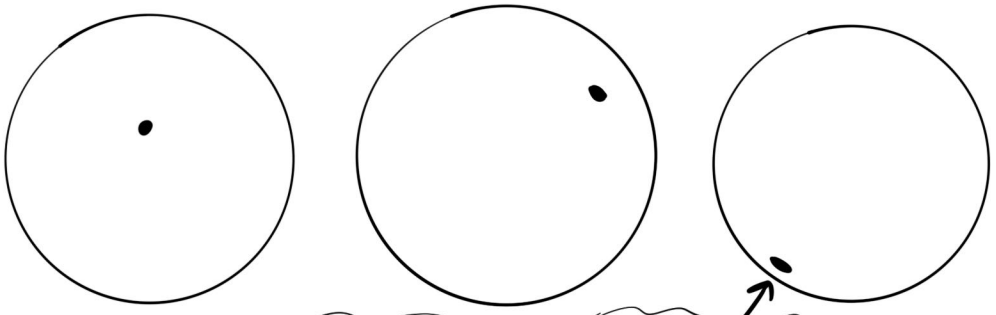


The trickiest part is matching the perspective. The curvature of the equator determines the rotation of the sphere, which determines the pole's position.

Place the poles w/ these equators:

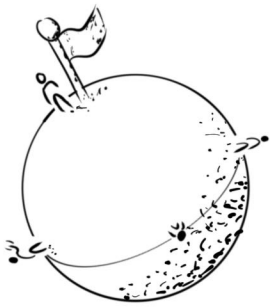


Place the equators w/ these poles:

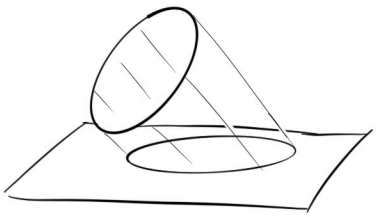


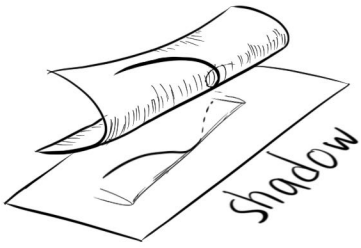
{ Tip: Draw pole as flat disc to show angle

A theory of equators:



- An equator forms a circle in 3D space, so its projection to the page is an ellipse

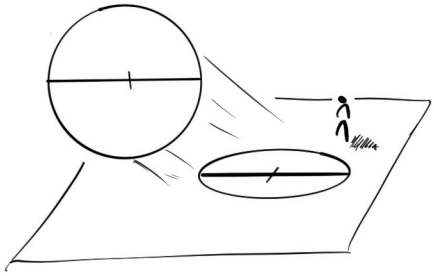




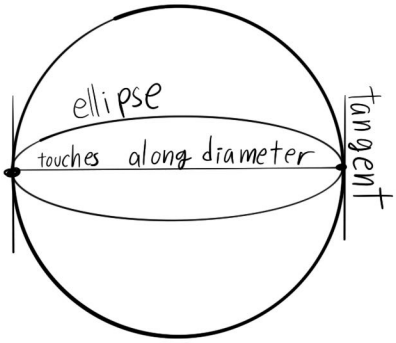
- Any differentible curve on a surface must project tangent to the folds of the surface

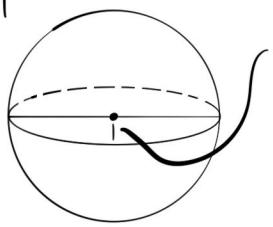
in particular, the equatorial ellipse must be tangent to the outline circle of the sphere

- The major axis of the projection of a circle equals the diameter of the circle. in particular, the equatorial ellipse has major axis equal to the diameter of the outline circle



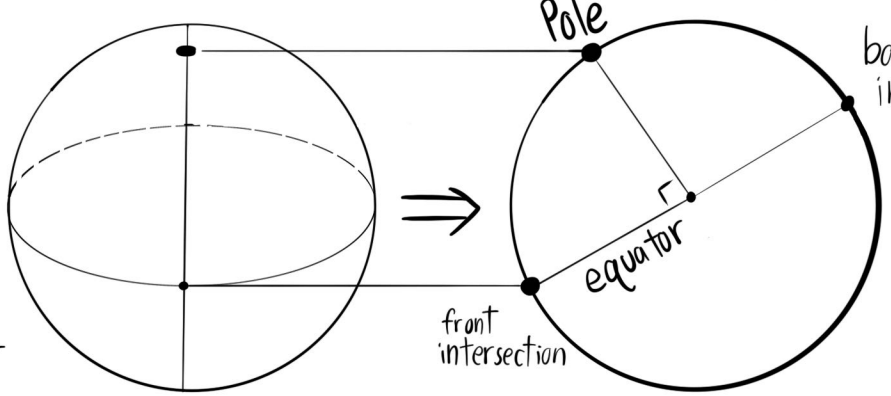
All together, the equator must be drawn as up to rotation of the drawing.





The minor axis controls the perspective

So how does minor axis control pole position?



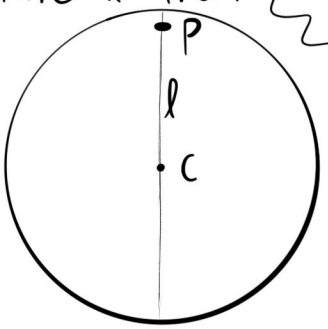
Take a vertical crossection, & see intersections with pole & equator

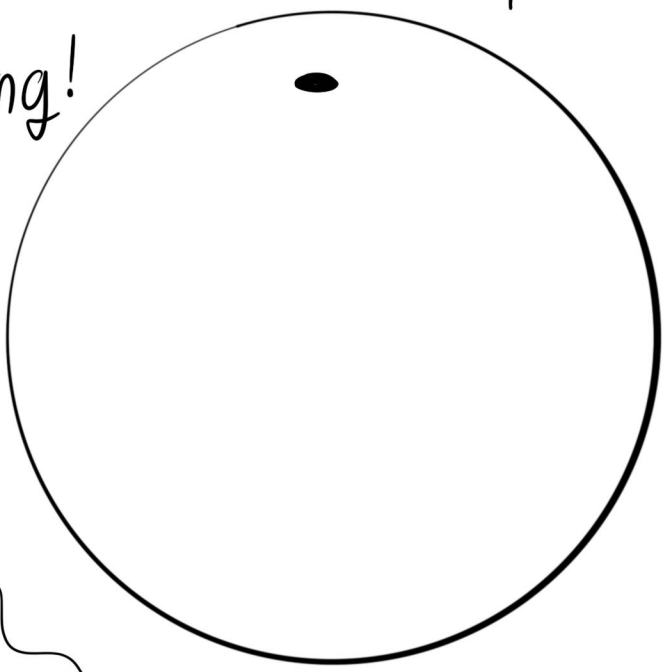
This gives a drawing guide !!

How to draw an Equator, from the pole

Follow along!

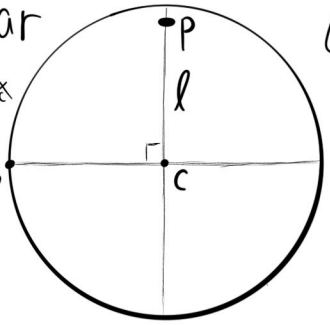
1: Draw line ℓ from pole to center





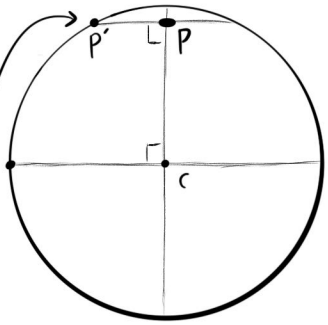
2: Draw perpindicular to ℓ, from center

this is where equator will intersect boundary



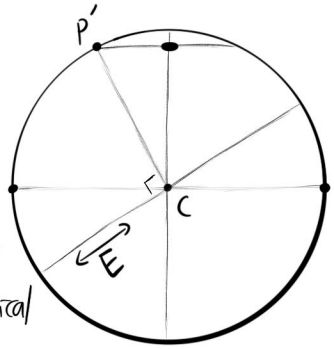
3: Draw perpindicular to ℓ from pole. intersect w/ outer circle @ P′

(we are using the outline circle as our vertical cross-section. This is the pole location)



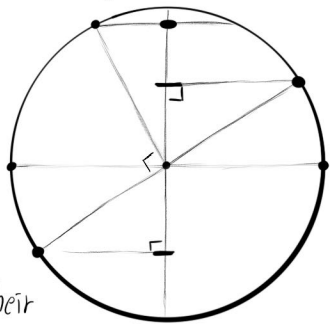
4. Draw line from P′ to center. Construct ⊥ through center. Call new line E.

(E represents equator in the vertical crossection)

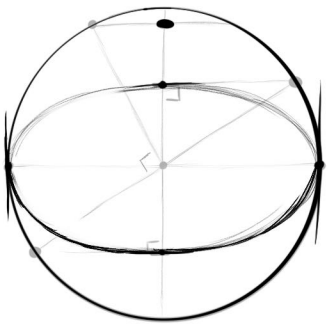


5. Intersect E with circle, then drop ⊥ to ℓ.

these lines are the vertical extent of the equatorial ellipse. We know the ellipse is tangent to these lines & (by symmetry) the tangency points are their intersection with ℓ.

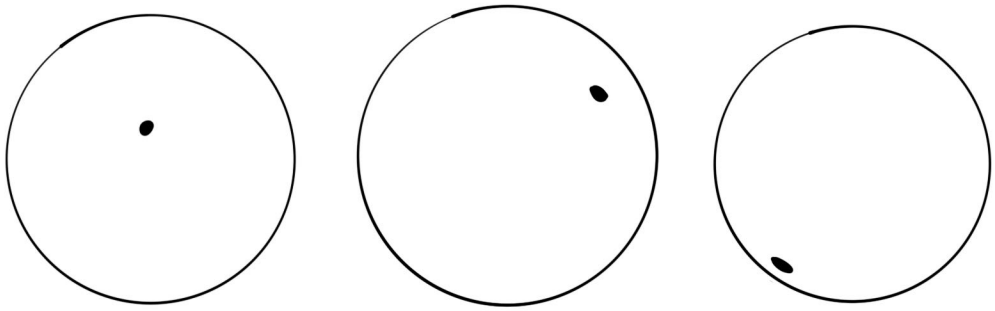


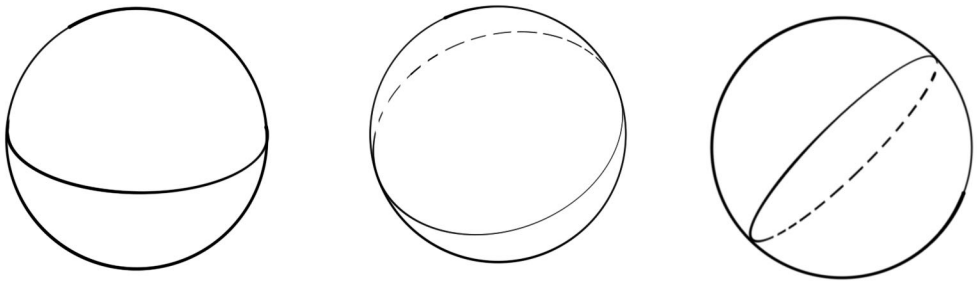
6. construct the equatorial ellipse



Practice!

Draw equators





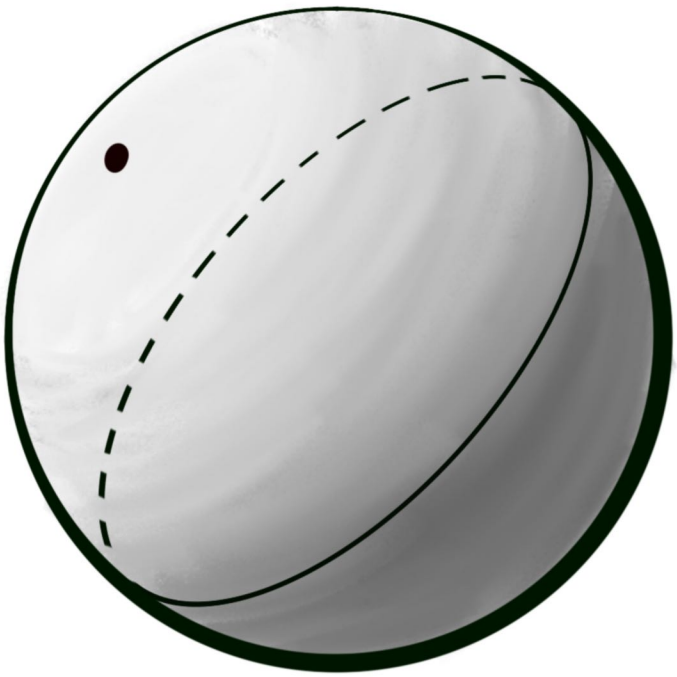
Draw poles

Shading:

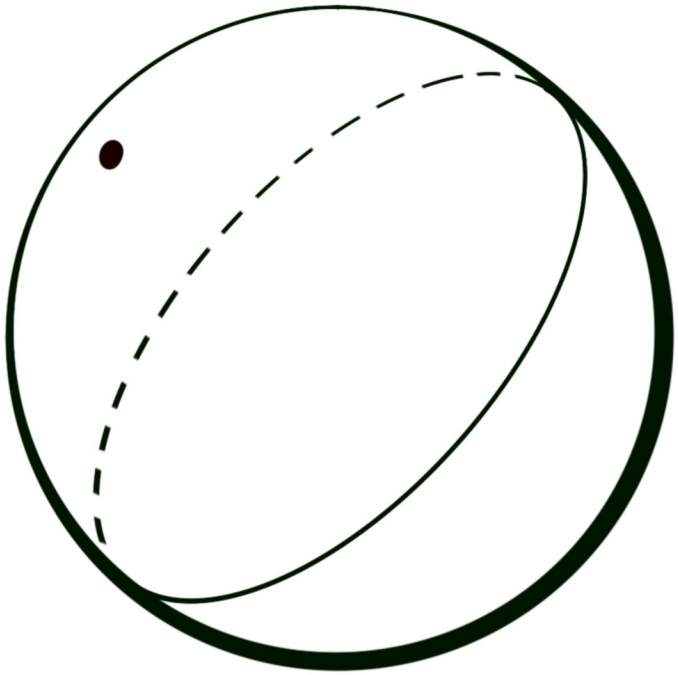
imagine light shining on a sphere, w/ north pole facing towards the light. Everything below equator is facing away, so is in shadow.

Try to shade:
- Uniform dark color below equator
- soft gradient above equator, w/ brightest pt @ pole.

Example:



Your turn:



try shading your equators above! on some, put the light behind the sphere.