Mirror Grinding Logbook

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1 Day 1: Setting Up the Grinding Station

The project began by unboxing the materials and planning the layout for our mirror grinding station.

1.1 Wooden Base Construction

We collected wooden pieces from a busy area inside the city to build the base.

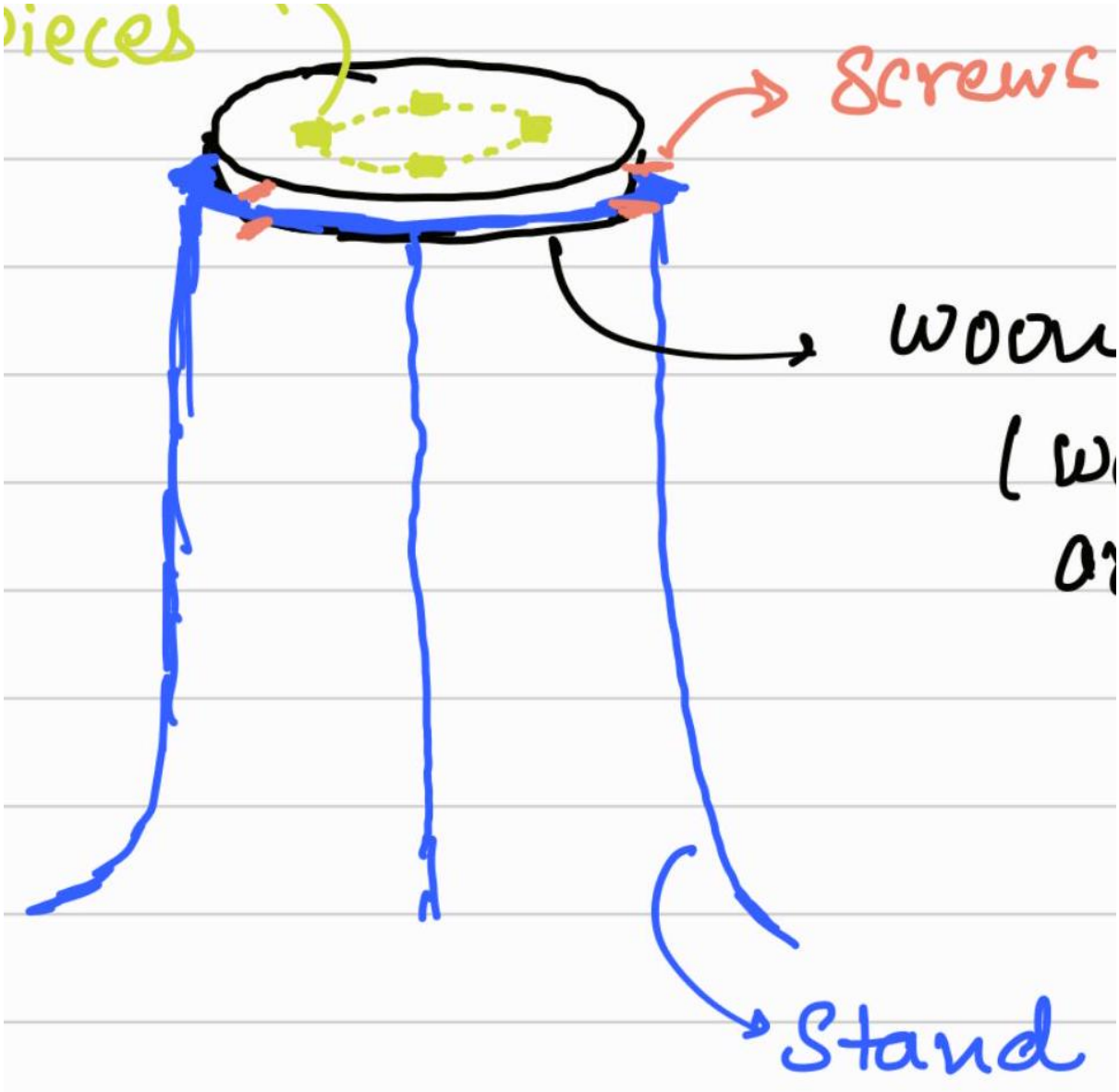

Figure 1: Wooden pieces for the base structure.

Before fixing them with screws, we checked the bubble level to ensure the surface was horizontal. As the bubble stayed near the center, we concluded that our table was level.

1.2 Preparing the Mirror Blank

We used a kitchen *kadai* as a container and added graded sand to bevel the mirror's edge.

- We gently placed our mirror blank inside the sand bed.

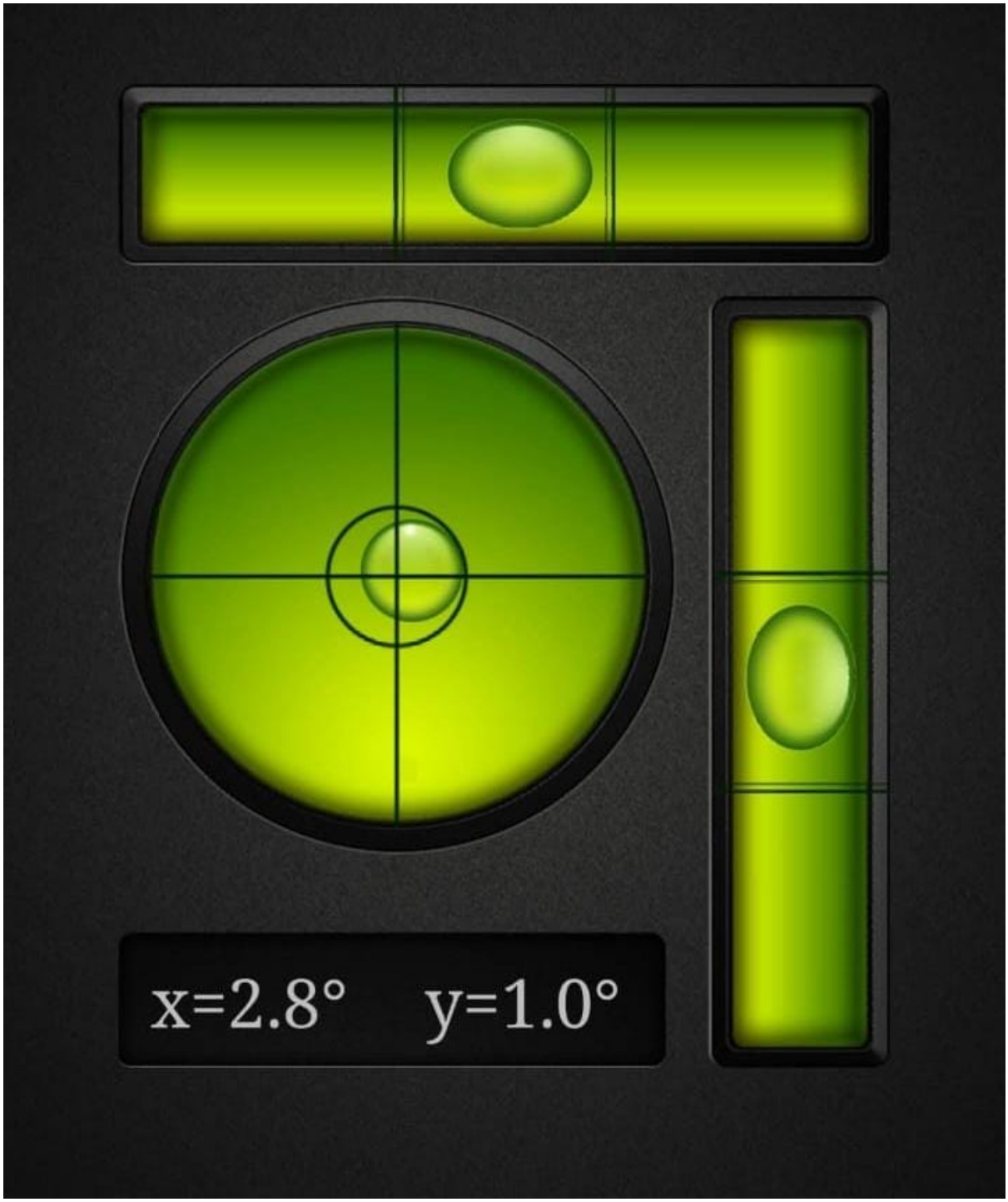

Figure 2: Checking the level of the grinding table.

- We swirled the kadai for about 15–20 minutes.

The purpose of this step was to chip off sharp glass edges and make them smooth, which prevents fracturing during grinding.

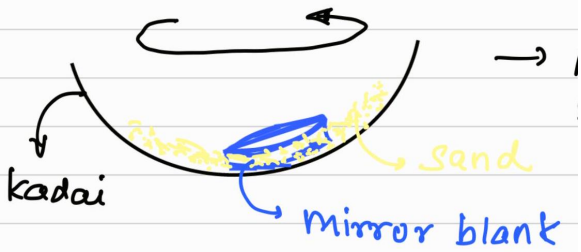

Figure 3: Smoothing the mirror edges in a sand bed.

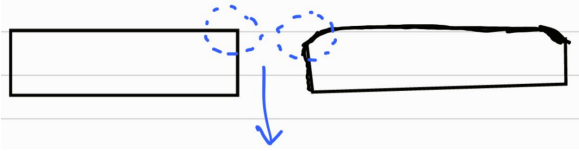

Figure 4: The final smoothed edge of the mirror.

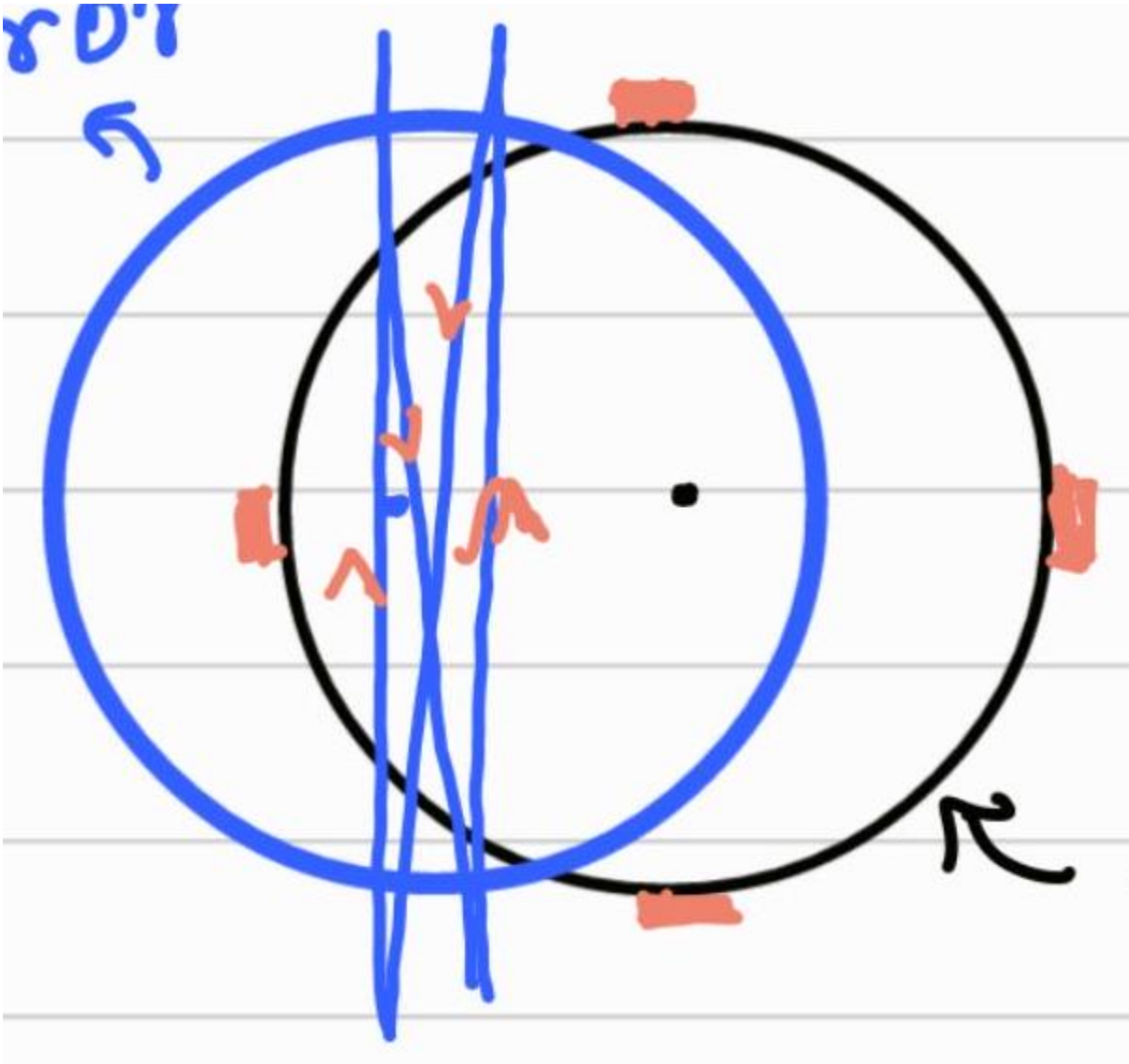

Figure 5: Mirror and tool setup for rough grinding.

2 Day 2: Rough Grinding

2.1 Grinding Technique with 80 Grit

- Keep about three-fourths of the mirror's diameter on the tool during strokes.
- After every 25–30 chordal strokes, rotate the mirror by about 25°–30° and the tool by 45°

in opposite directions.

Over time, this grinding motion gives the mirror surface a concave shape suitable for focusing light.

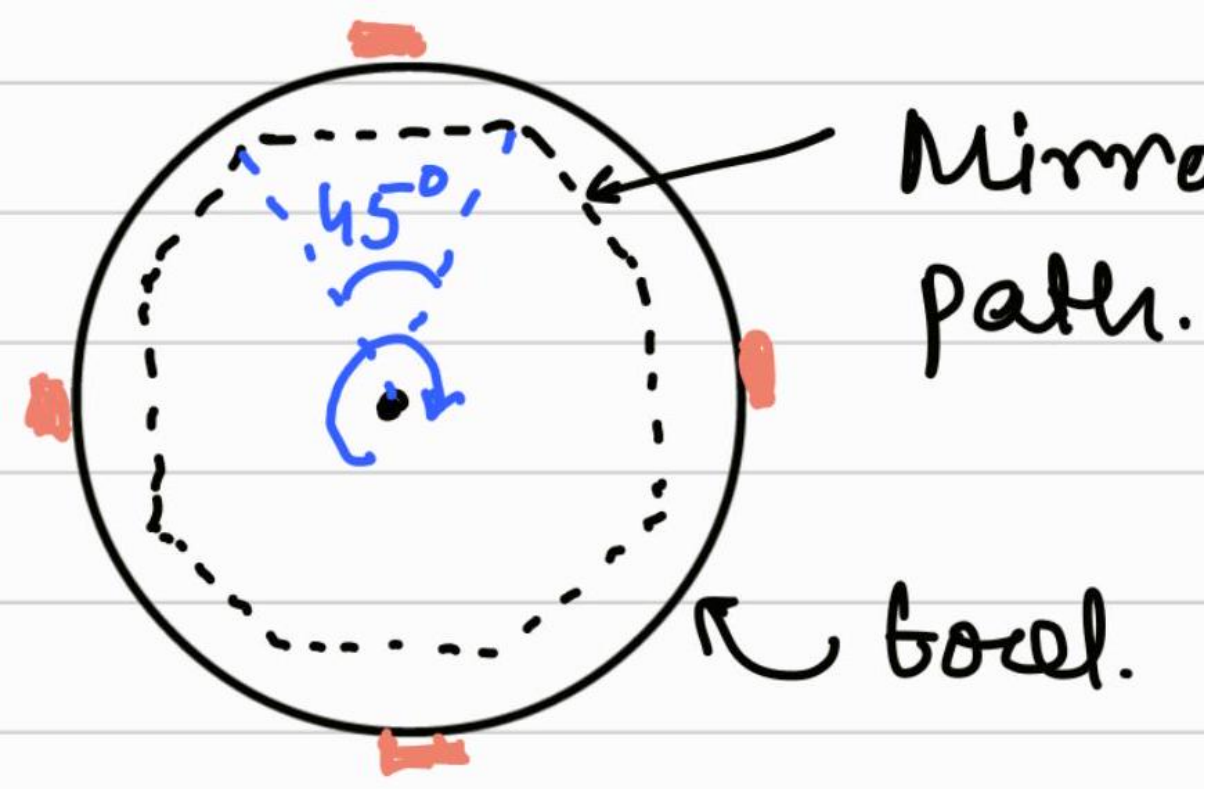

Figure 6: Typical grinding motion pattern.

Calculating Focal Length: The focal length (f) of the mirror is determined by its diameter (D) and the depth of its central curve, known as the sagitta (s). The approximate formula is:

$$f = \frac{D^2}{16s}$$

The focal ratio is then calculated as $F = f/D$. We periodically measure the sagitta to track our progress.

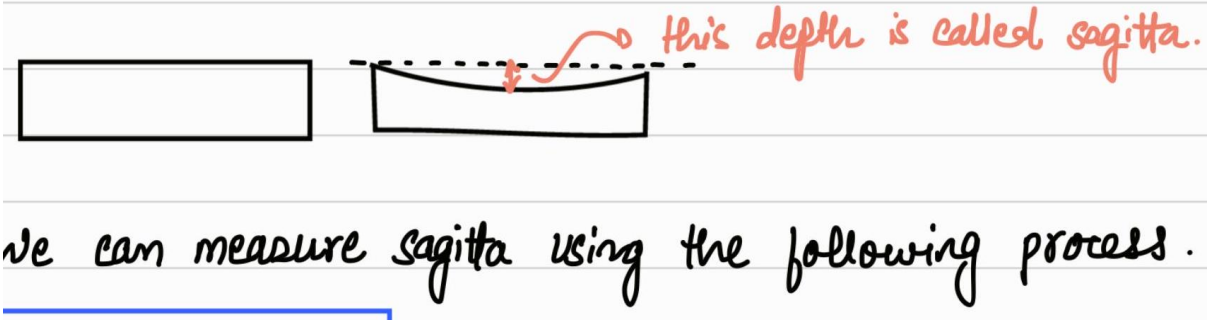

Figure 7: Formation of the concave curvature on the mirror.

2.2 Using 120 Grit Carborundum

The 120-grit powder fills in the deeper pits left by the 80-grit abrasive and removes larger scratches.

- Spread the powder evenly, sprinkle some water to make a slurry, and begin grinding.
- Measure the focal length every hour to ensure it doesn't get too short (overshoot).
- If the focal length decreases too much, flip the mirror and grind with the tool on top to flatten the curve slightly.

2.3 The Bubble Test

This test checks if the surfaces of the mirror and tool are matching evenly.

1. Clean both surfaces thoroughly, ensuring there is no leftover abrasive.
2. Spray some water on the tool, place the mirror on top, and perform 2–3 gentle strokes.
3. If a large bubble appears at the center, the surfaces are not making good contact. Continue grinding to fix this.
4. When no bubbles are seen, the surfaces are well-matched and you can proceed.

Figure 8: A bubble indicates uneven surfaces.

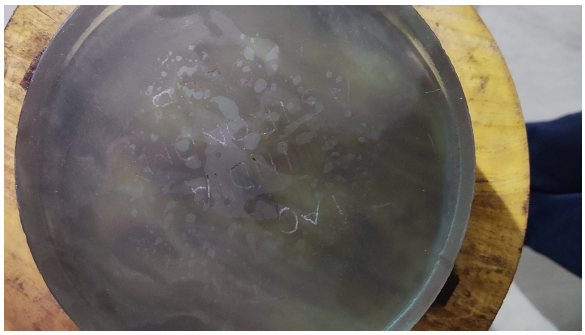

Figure 9: No bubble indicates even surfaces.

Once the surfaces are even (which can take ∼4–5 hours with 120 grit), we move to 220 grit.

3 Fine Grinding

The process continues with progressively finer abrasives. Each new grit size removes the pits and scratches left by the previous one.

- Measure the focal length and sagitta periodically to monitor progress.
- For beginners, an f-ratio between f/6 and f/8 is ideal. For a 6-inch mirror, this is a focal length (f) of 914–1219 mm.

Table 1: Typical Time Estimates for Fine Grinding Stages

Abrasive Grit Size	Typical Time (hours)
220	4–5
340	2–3
600	5
800	3
1000	3

4 Cleaning of Abrasives (Levigation)

For fine grits, it is important to remove any oversized particles that could cause scratches.

1. Mix 2 teaspoons of powder with water in a tub and stir well.
2. Allow it to settle for 5 seconds, then carefully pour (decant) the top half of the cloudy water into a bottle.
3. Refill the tub with water, stir, settle for 5 seconds, and decant again into the same bottle. Repeat once more.
4. Allow the contents of the bottle to settle, pour off the excess clear water, and the remaining slurry is ready for use.

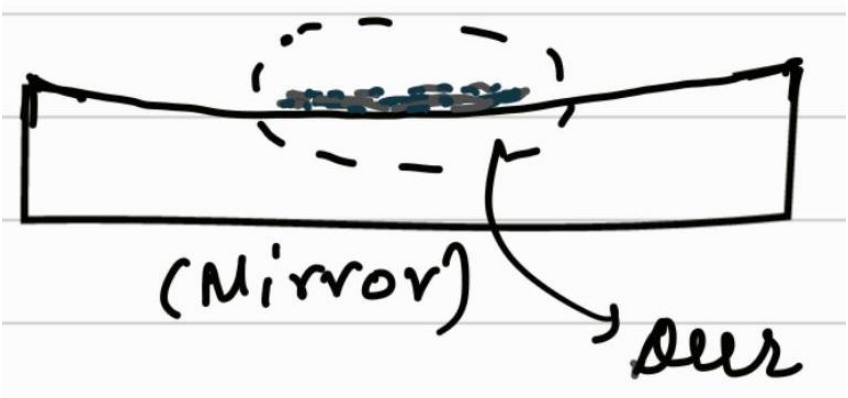

Figure 10: Prepared abrasive mixture with a consistency like wet mud.

Grind for 2–3 hours with the prepared slurry, checking for any remaining pits or scratches with a magnifier. Once the surface appears uniformly smooth, you can proceed to the next finer grit.

5 Polishing with a Pitch Lap: Theory

After the final stage of fine grinding, the mirror's surface has the correct spherical curve, but it is opaque and frosted. The next major step is to polish this surface to an optical finish, making it transparent and highly reflective. This is not done with abrasives, but with a special tool called a pitch lap.

5.1 The Purpose of Polishing

Polishing removes the microscopic pits left by the finest abrasive, creating a surface that is smooth to a fraction of the wavelength of light. This is accomplished using a polishing agent, such as Cerium Oxide, which is much finer than any grinding grit. The polishing action is a combination of microscopic mechanical abrasion and chemical smoothing of the glass surface.

5.2 The Pitch Lap

Unlike the hard grinding tool, polishing uses a tool with a surface made of optical pitch. Pitch is a unique viscoelastic material—it feels solid to the touch but will slowly flow under sustained pressure.

- **Creation:** A pitch lap is made by melting optical pitch and pouring it onto the surface of the grinding tool. While the pitch is still warm and soft, the mirror (protected by a thin layer of soapy water) is pressed onto it. This molds the pitch into a perfect convex counterpart to the mirror's concave curve.
- **Function:** The viscoelastic nature of pitch ensures that the lap maintains extremely close contact with the entire surface of the mirror during polishing. This is essential for achieving a uniform, high-quality polish. Channels are typically cut into the pitch surface to allow the polishing slurry to circulate and to prevent suction.

The goal of this stage is to achieve a perfect "polish-out," where the entire mirror surface is flawlessly transparent, with no remaining haze or pits from the grinding process. Only after a good polish is achieved can the final, most precise stage—figuring the mirror into a parabola—begin.