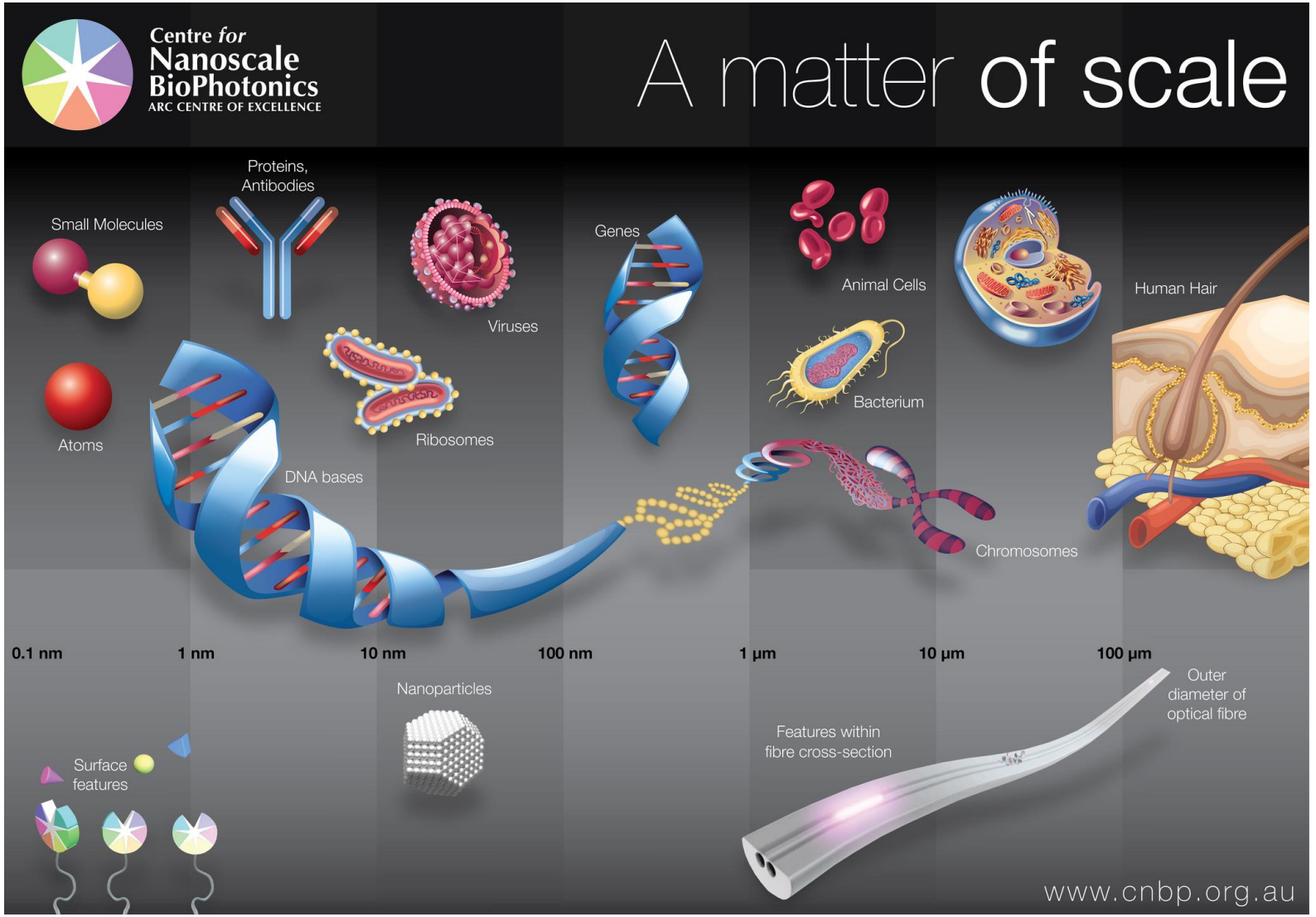
Engineering Self-Cleaning Hydrophobic Surfaces

Nanoscale: nanomaterials that typically measure between 1 nm and 1000 nm

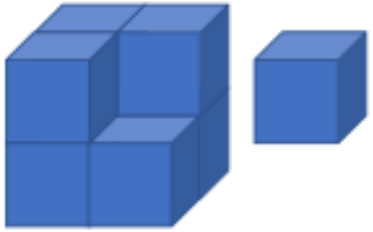


Nanoscale

If a large particle is broken down into smaller particles, the total surface area increases. Increasing the surface area can increase the rate of a reaction as more surface area is available for the reaction. Surface Area (SA) of a cube = $6s^2$, where s = the length of one side.

1 particle
5mm/side

$SA = 6 \cdot 5^2 = 150mm^2$

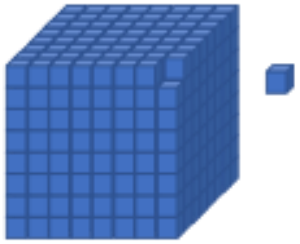


8 particles
2.5mm/side

$SA = 6 \cdot 2.5^2 \cdot 8 = 300mm^2$

64 particles
1.25mm/side

$SA = 6 \cdot 1.25^2 \cdot 64 = 600mm^2$



512 particles
0.625mm/side

$SA = 6 \cdot 0.625^2 \cdot 512 = 1200mm^2$

At this size, materials begin to exhibit unique properties that affect physical, chemical, and biological behavior

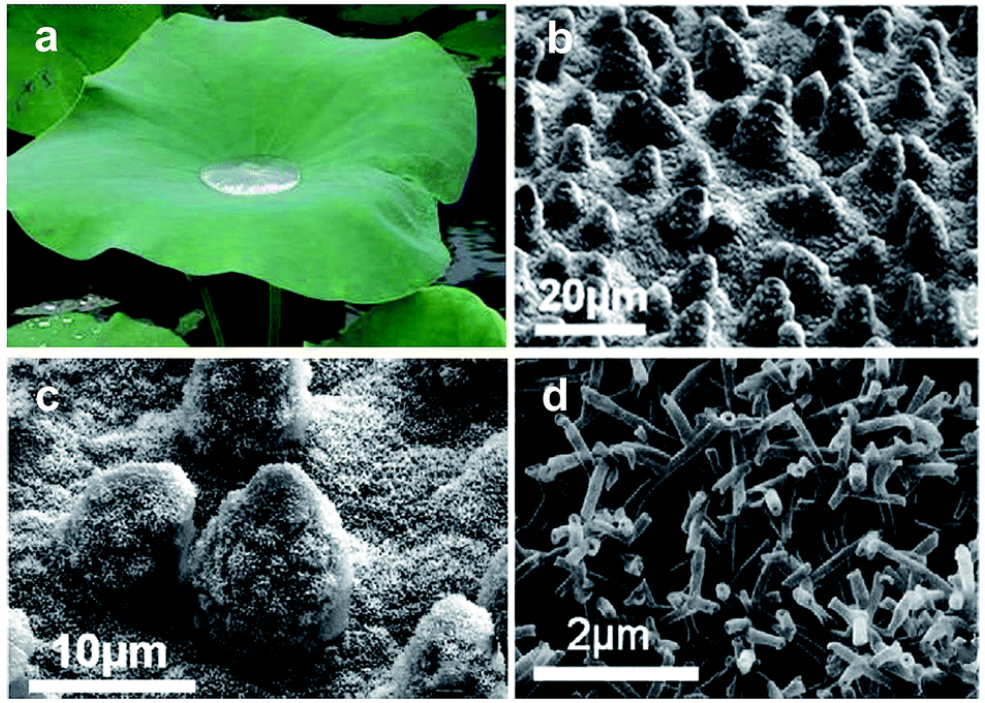
When a particle is broken down into smaller pieces, the surface area increases.

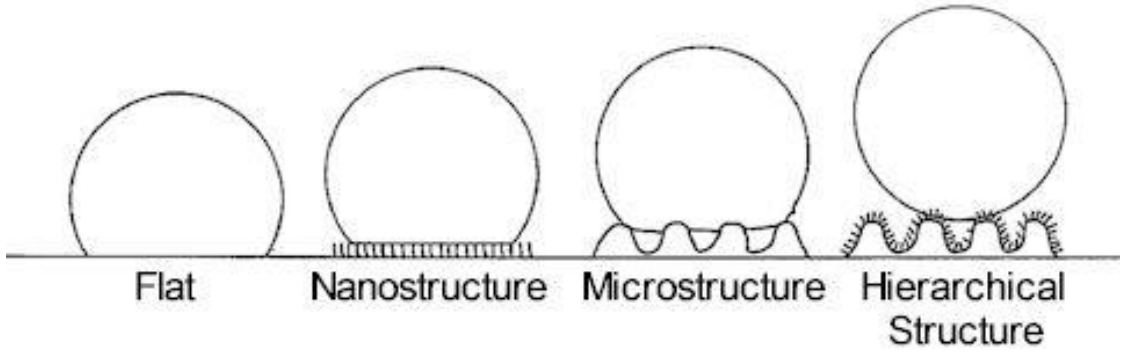
Biomimicry

Have you ever noticed how water rolls off a leaf, or how a lily pad floats on water? These plants parts are said to be “superhydrophobic” and their leaves never get dirty. Why is this?

What is the hydrophobic effect?

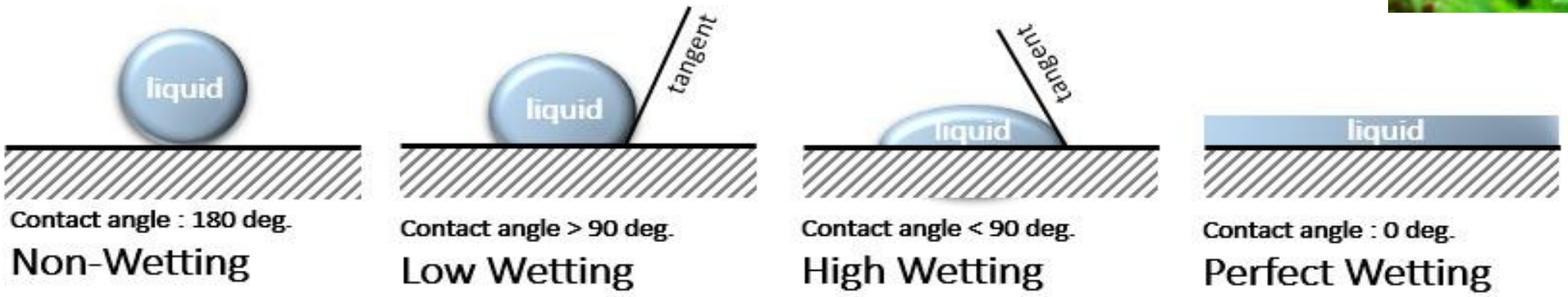
- Hydrophobic comes from the word hydro (water) and phobos (fear). It can be demonstrated by trying to mix oil and water.





Superhydrophobic Surfaces

High Contact Angle and Low Roll Off Angle Aids in Cleaning



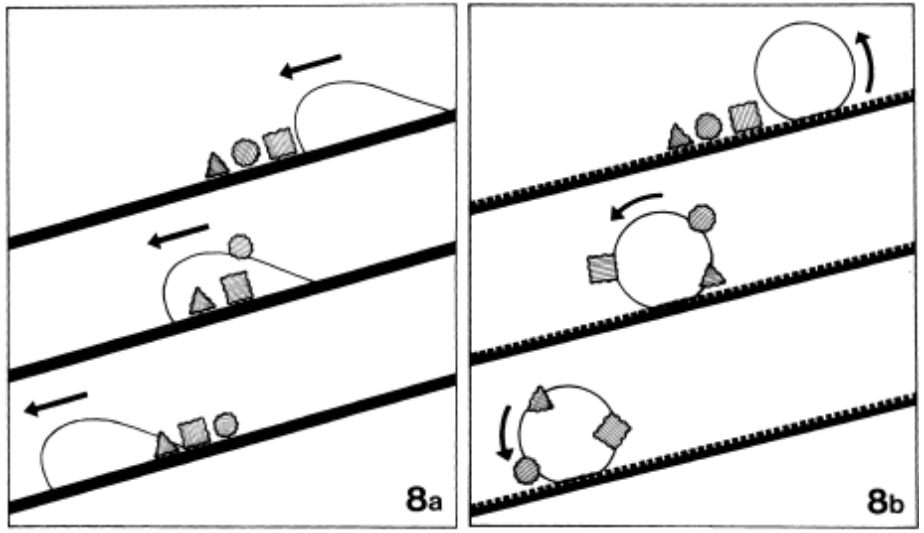
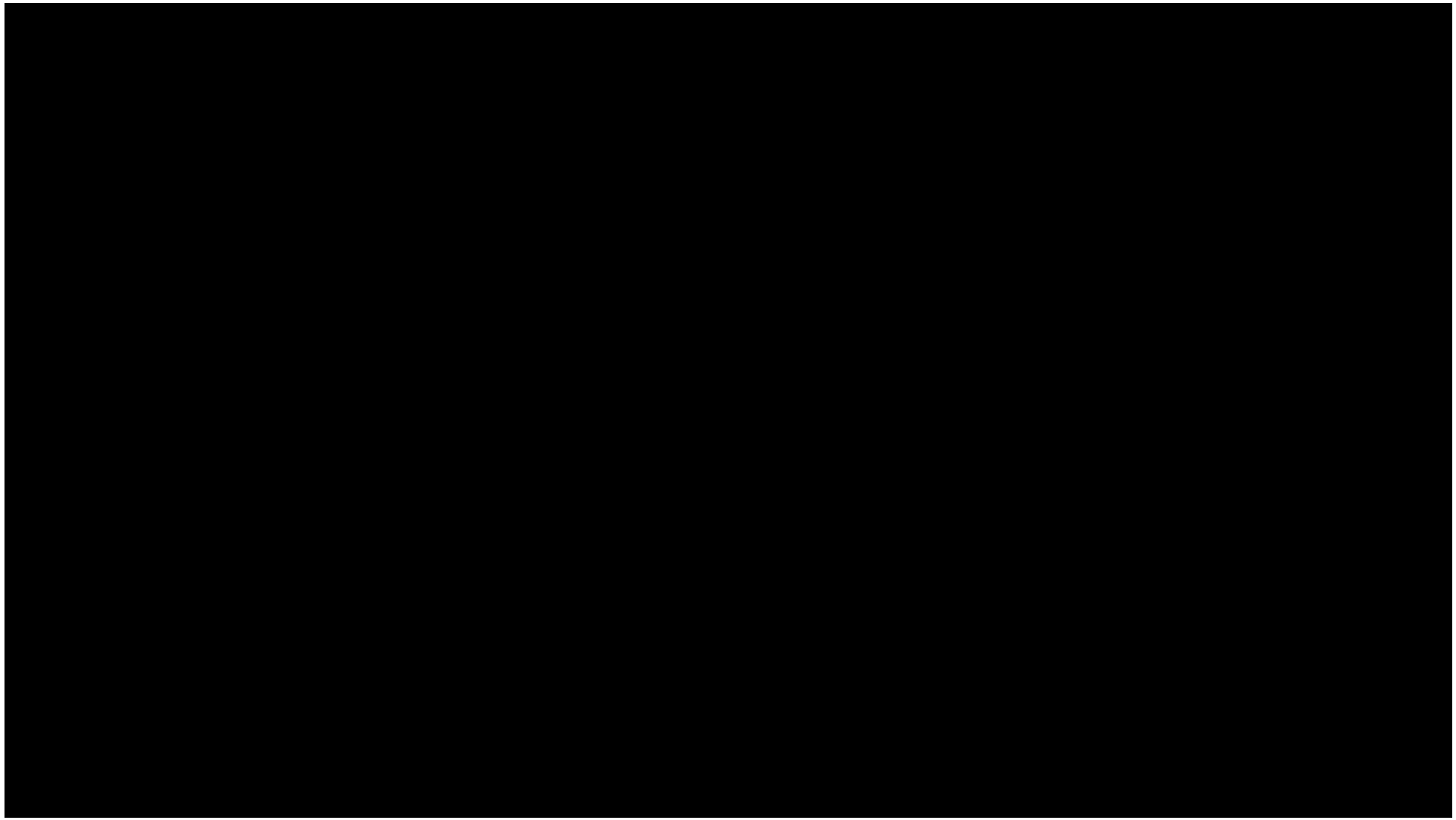


Diagram of water on tilted surface

Using self-cleaning products, you may be able to avoid stained clothing and dirty cars.

Ultra Ever Dry (Video)



Your Challenge

You are a part of a team of materials engineers at a company that specializes in waterproofing materials.

Your team has been asked to create a product that can make any surface dirt and stain resistant.

Make Observations – Define your Problem
Choose Materials

Surfaces to Modify

- 10 cm x 10 cm wood
- 10 cm x 10 cm cotton fabric

Water Proofing Materials

- wax
- crayons
- flax seed oil
- lanolin
- clay
- glue

Tools to Modify

- sandpaper
- wax paper
- sand

Plan & Design

- Must have a written plan for chosen surface.
  - What material will you modify.
  - What industry is this for?
- How will you modify?
  - What tools and materials will you use to modify your surface?
  - Explain how and why you are using each material.
- Sketch your design.

Create/Modify

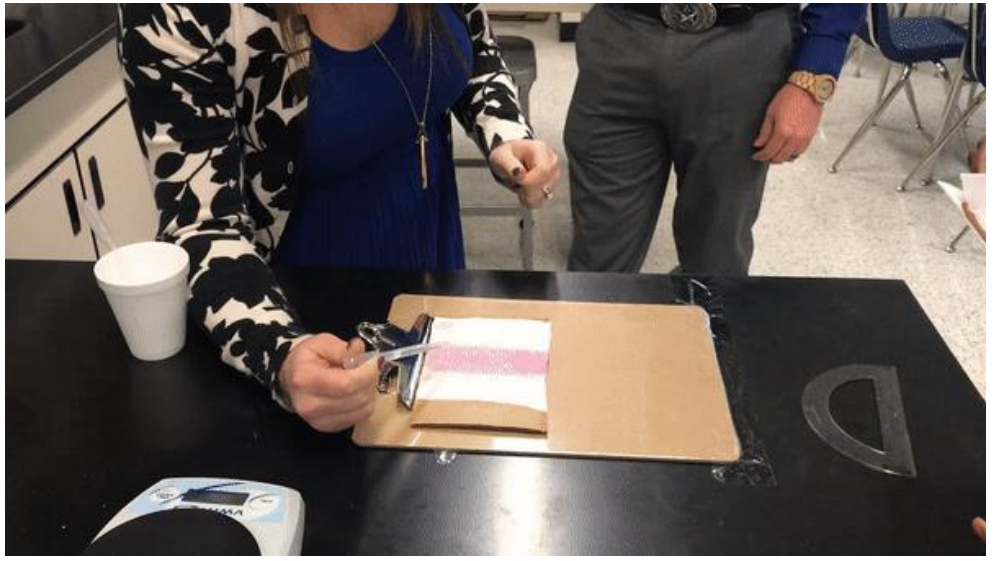
- Modify your surfaces.
- Make sure to adjust and make note of any changes to your original plan as you create.

Investigate and Test

Step 1: Observe surface and record.

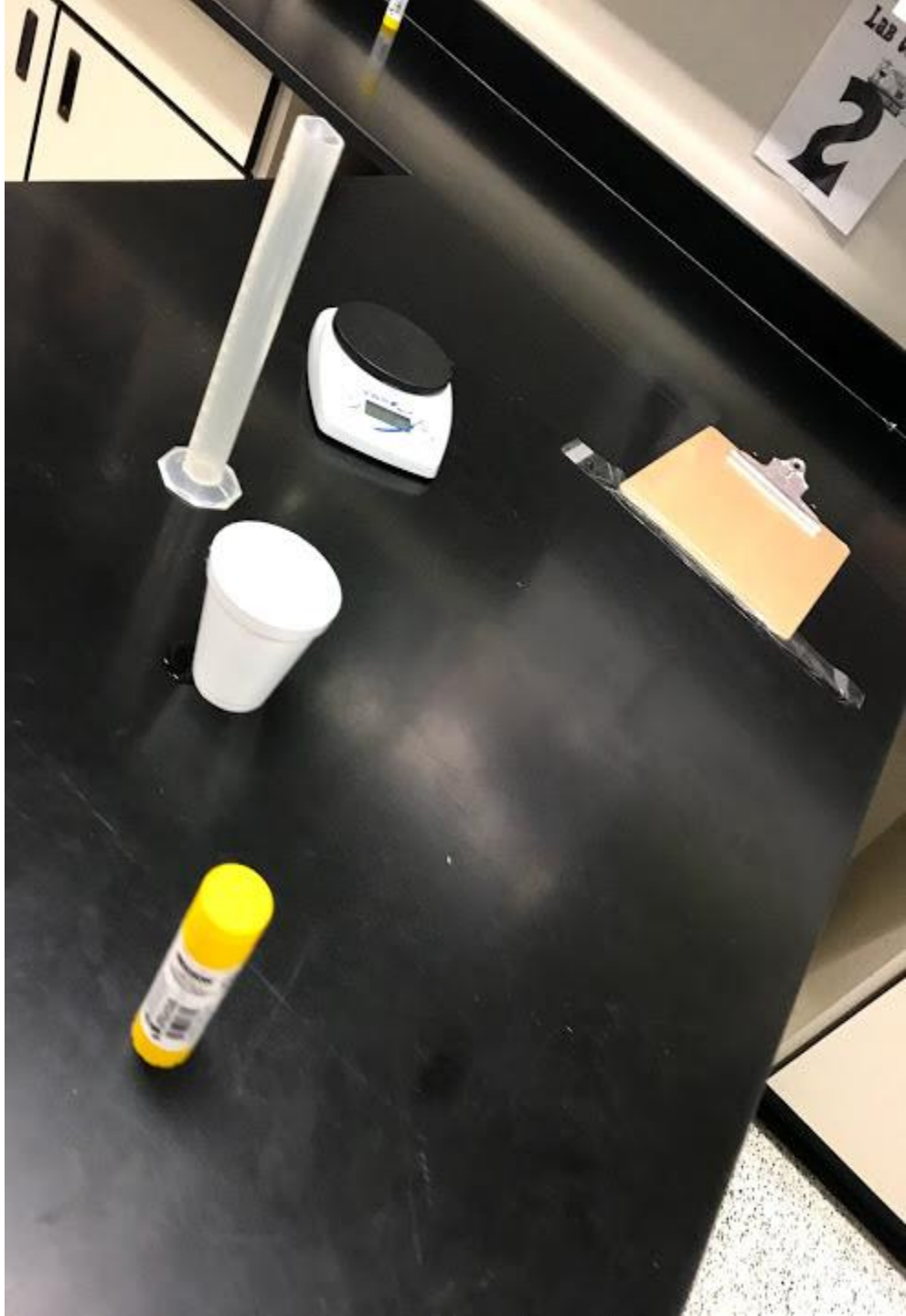
Step 2: Drop profile / Contact angle

Step 3: Tilt / Roll off angle



Testing Self Cleaning Ability

1. You will be provided with “dirt” to make your surfaces dirty.
2. Sprinkle the “dirt” on your surface.
3. Measure the initial mass. Record in data table below.
4. Over a sink pour water over your material until all water is gone.
5. Measure final mass of material after cleaning. Record in data table below.
6. Repeat steps 2-5 for material 2.



Reflections/Improvements

- Discuss and answer reflections questions the with group.
  - Remember properties of a superhydrophobic surface!
    - Water contact angle above 150^{o}
    - Water roll off below 10^{o}
- Create a poster with following information:
  - Your groups specific problem, chosen material, proposed solutions, results (surface observations, tilt angle, and drop profile), and conclusion that includes future work.
- Choose a spokesperson to communicate results.