Apparatus Guide for the IJSO

Apparatus Guide

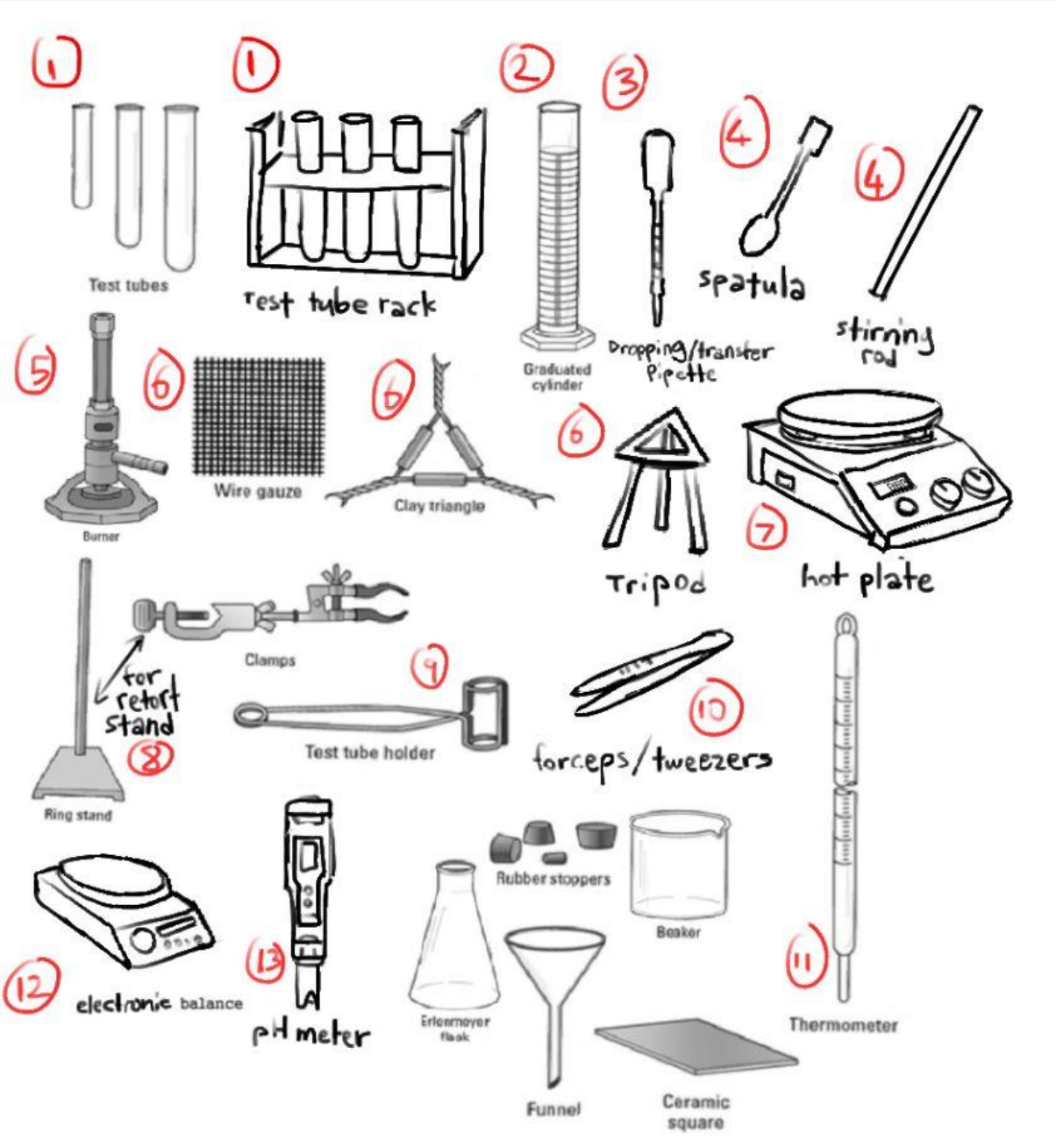
Experiments are a big part of the IJSO. Whether it's chemistry, physics, or biology, you'll need to know how to use common lab equipment correctly and safely. This guide brings together the essential apparatus you might see during the competition, with clear explanations of their purpose, how they're used, and important safety tips.

We've organized the equipment into general, chemistry, physics, and biology sections so you can quickly find what you need. Not every tool here will appear in every experiment, but being familiar with all of them will help you feel confident and prepared.

Think of this as a quick-reference manual: something you can skim before practice sessions, revise from before the exam, or use whenever you're unsure about a piece of equipment.

GENERAL

Diagram of general common apparatus. Not all are explained. The numbers show the bullet point where the apparatus in this section is explained.



1. Test tube & test-tube rack
    - Test tubes hold small amounts of liquids or solids. Test tubes are held by a test tube rack
    - **Do not heat a test tube. It may crack or explode**

2. Graduated/Measuring cylinder
    - Measures volume of liquid
    - **To reduce parallax error, read from bottom meniscus, perpendicular to eye level**

3. Dropping/transfer pipette
    - Transfers liquid. Press the top to draw/dispense liquid

4. Spatula & stirring rod
    - Spatula is used to scoop and transfer solids.
    - Stirring rod is used to stir solutions/mix liquids.

5. Bunsen burner
    - Heats reactants (using open flame). When heating, the oxygen hole should be opened, and the bunsen burner should be on a heat-resistant mat.
    - **Do not put glassware in water/ice immediately after heating.**

6. Tripod with wire gauze, and clay triangle
    - These are used to support items carrying reactants to be heated (like an evaporating dish or crucible).

7. Hot plate
    - Heats reactants without open flame. A knob controls the heat
    - **Glassware on the hot plate must contain water, otherwise they'll crack. Do not put glassware in water/ice immediately after heating.**

8. Retort stand
    - Holds glassware or apparatus during experiments. The clamp can be adjusted for different heights

9. Test tube holder
    - Used to hold boiling tubes over a bunsen burner

10. Forceps/tweezers
    - Used to pick up solid substances

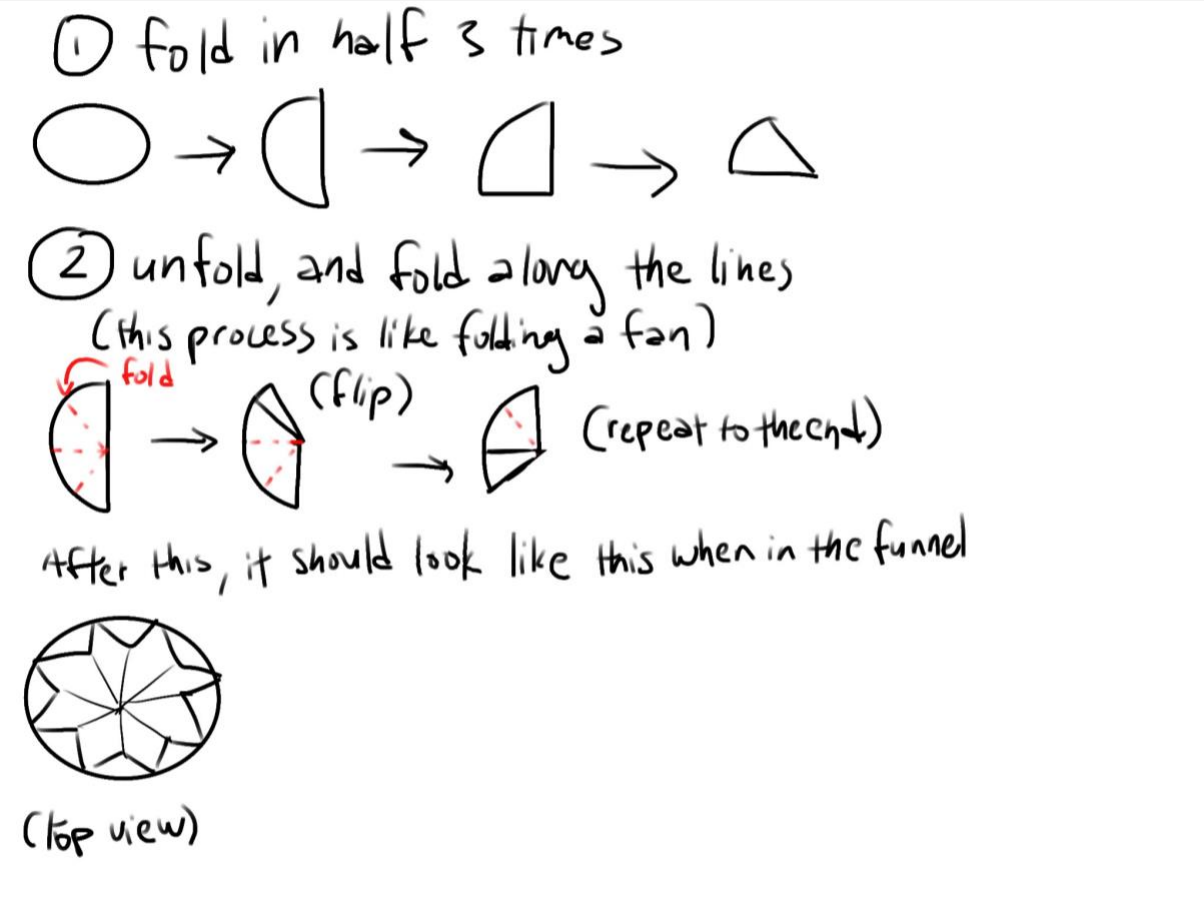
11. Thermometer
    - To measure temperature
    - **To reduce parallax error, read from bottom meniscus, perpendicular to eye level. The thermometer should not touch the walls of the glassware**

12. Electronic balance
    - Measures the mass of an object/substance
    - **Make sure to tare the scale before use to reduce zero error**

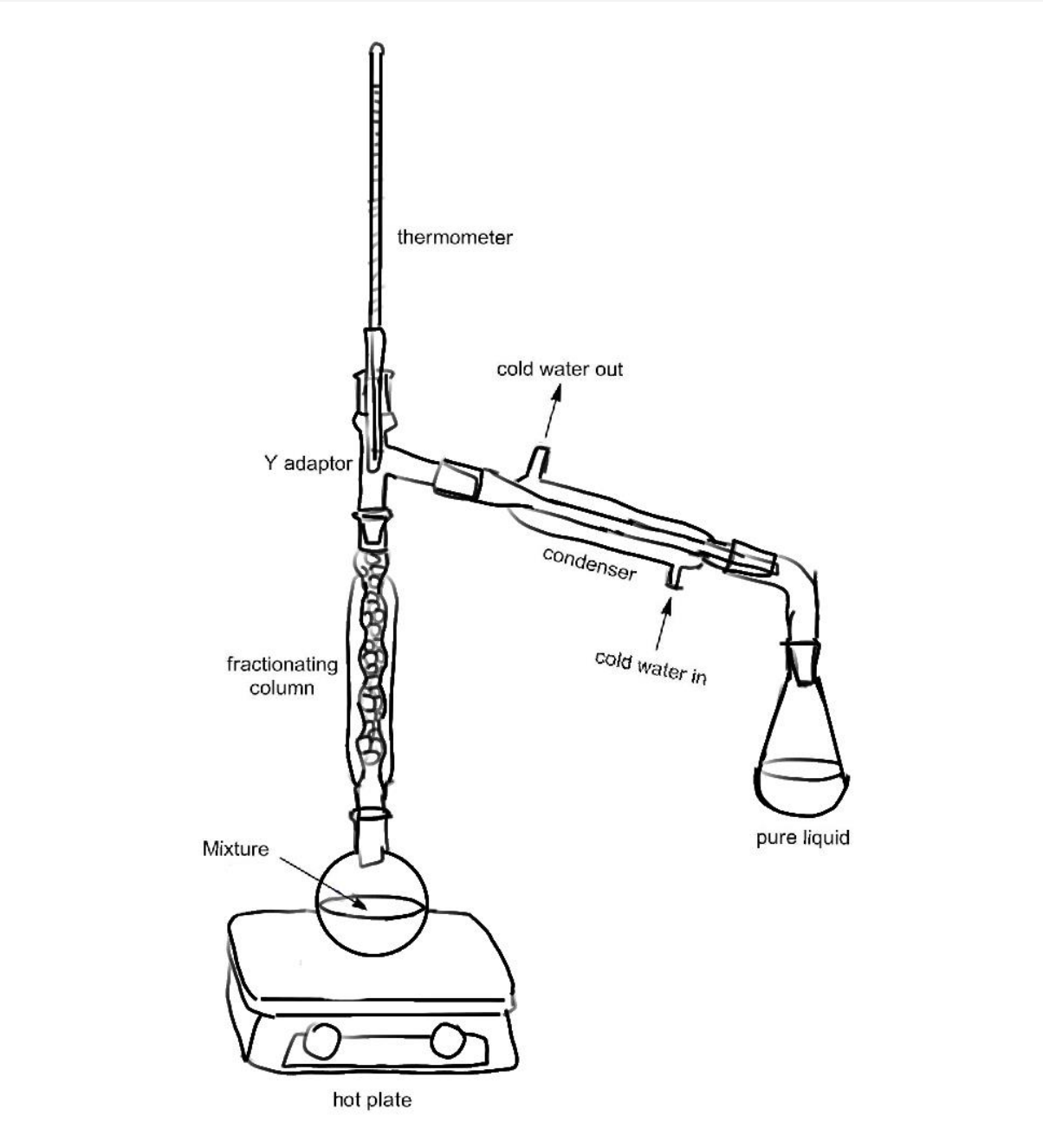
13. pH meter
    - Measures the pH of a solution
    - Rinse the electrode (bottom of the pH meter) in distilled water. Gently shake off extra water droplets, and pat dry using tissue paper. **Do not wipe or rub it as it could generate static electricity, affecting measurement.**
    - Immerse the pH meter into the desired solution (making sure the electrode does not knock the walls of the container) and record the reading.
    - **Ensure that it's properly calibrated before use to reduce error**

SEPARATION

1. Filter funnel and filter paper
    - Separates insoluble substance from a solution
    - Filter paper is placed in the funnel, which rests on a beaker/conical flask.
    - To allow faster and more efficient filtration, the filter paper is folded as shown below



2. Distillation apparatus
    - Separates 2 substances with varying boiling points.
    - Simple distillation - for substances with a difference in boiling point of **at least 25°C**
    - Fractional distillation - for substances with a difference in boiling point of **less than 25°C**

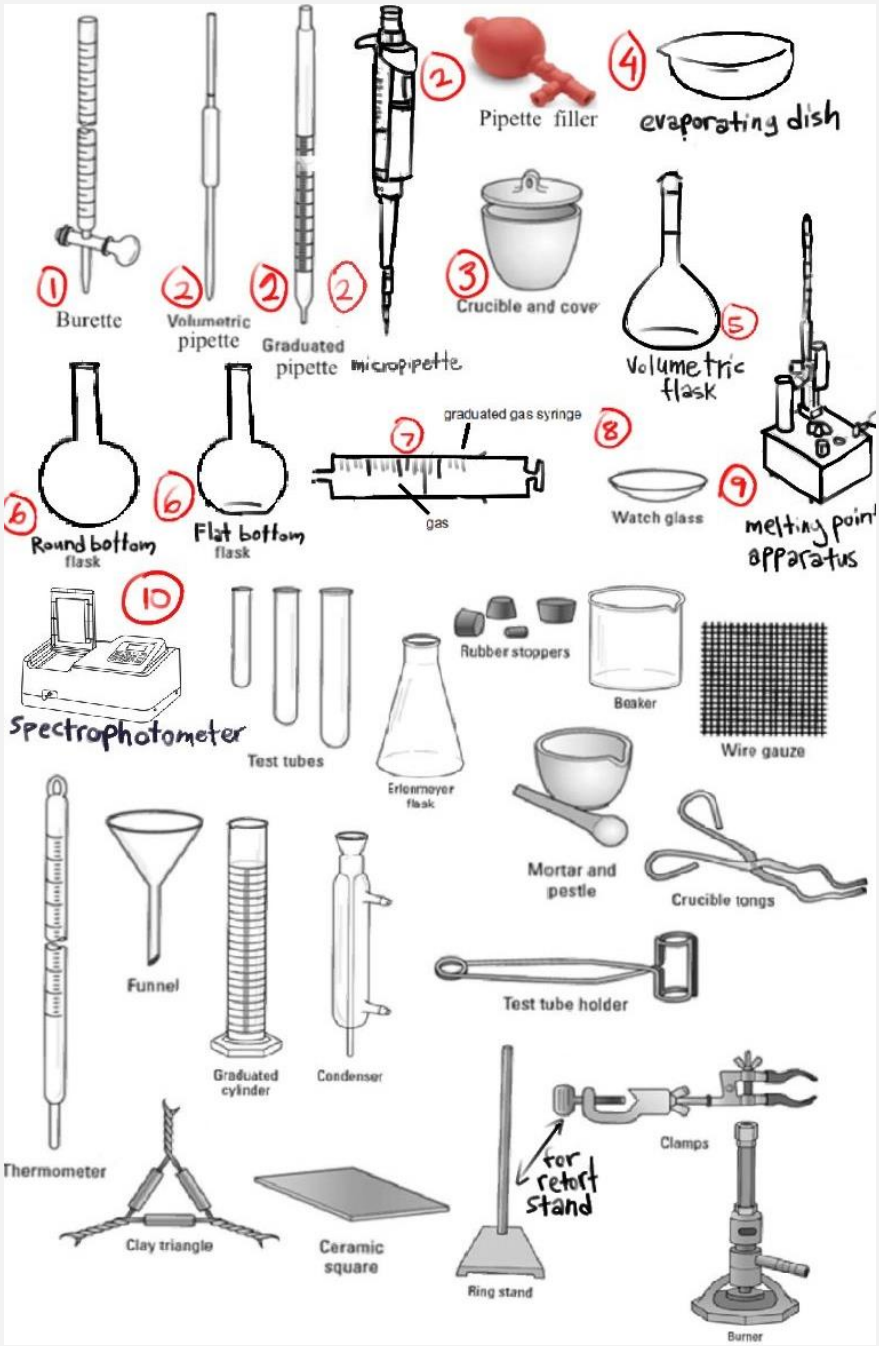


The image shows a setup for fractional distillation. Simple distillation is the same but **without** the fractionating column

Sections below this are more specific to the subject, but they may also use anything mentioned above.

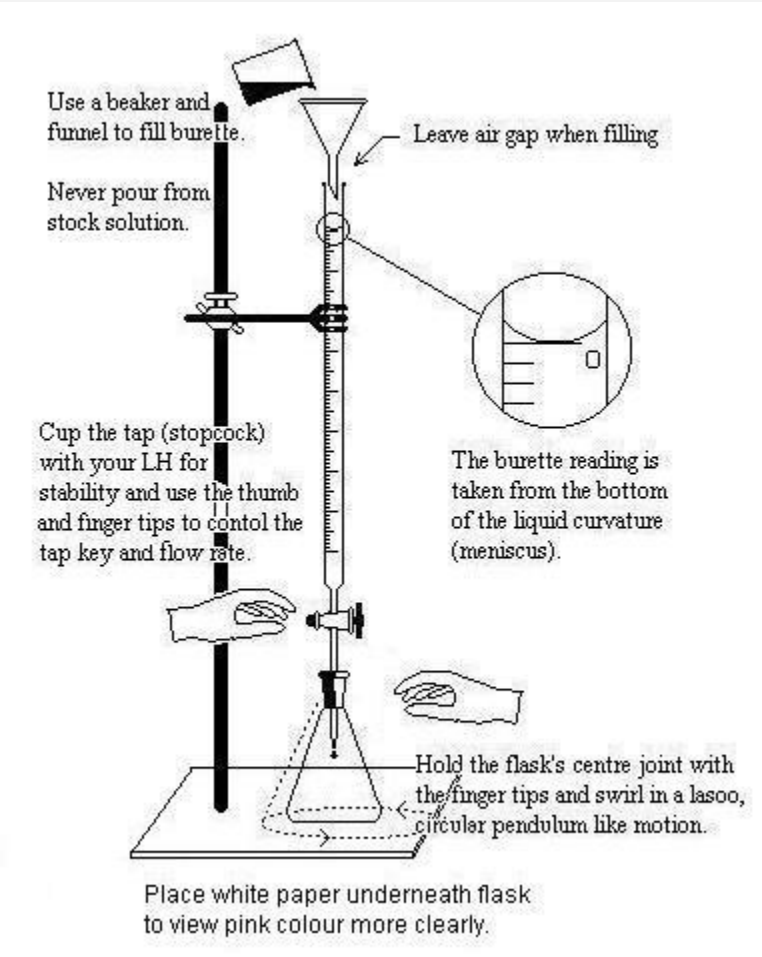
CHEMISTRY

Diagram of common apparatus for chemistry. Not all are explained; some are explained already above. The numbers show the bullet point where the apparatus in this section is explained.



1. Burette
    - Measures volume of liquid. It is more often used in chemistry than other subjects

- **Common use: Titration (measuring the titrant, known concentration)**

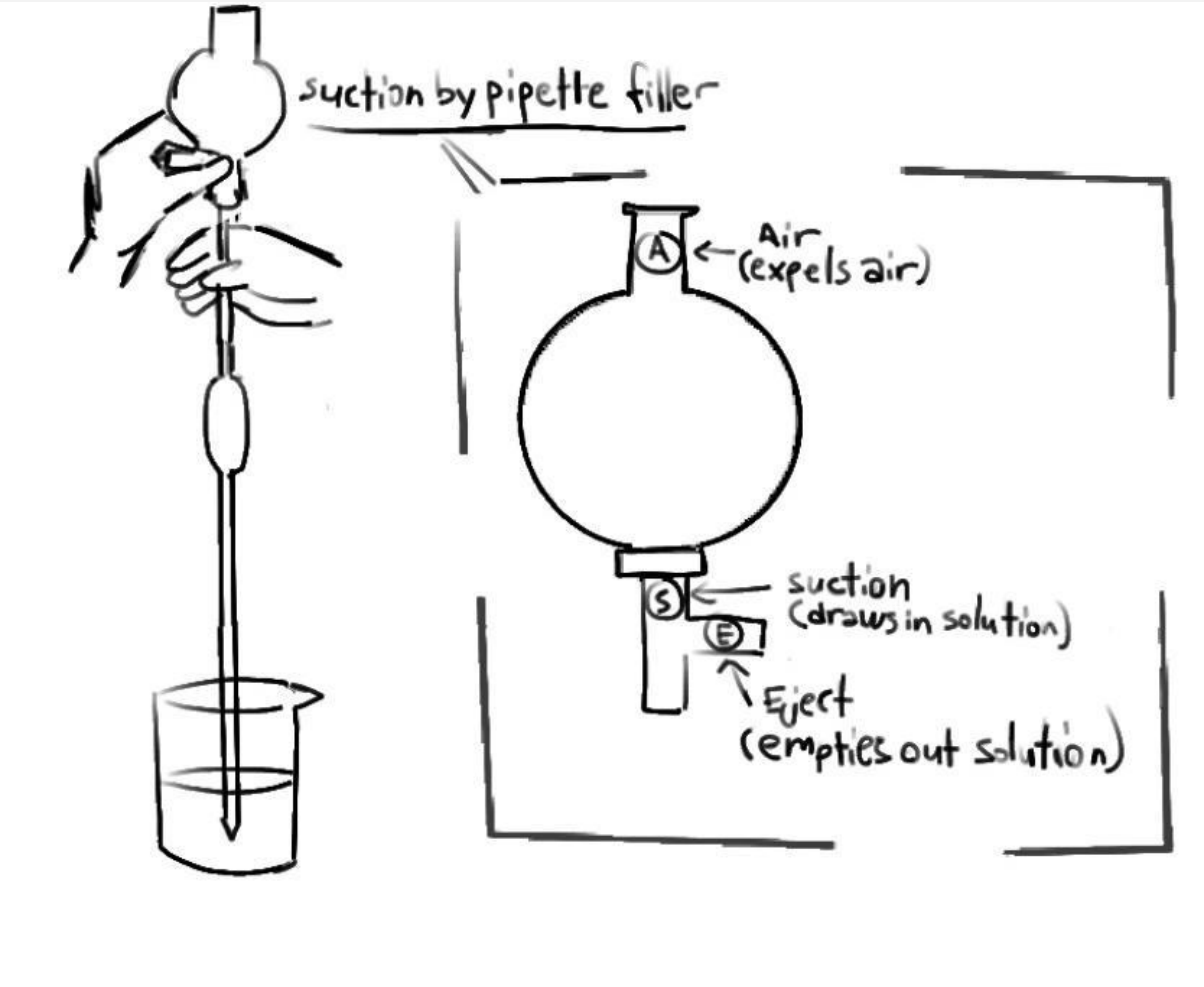


Source : [1]

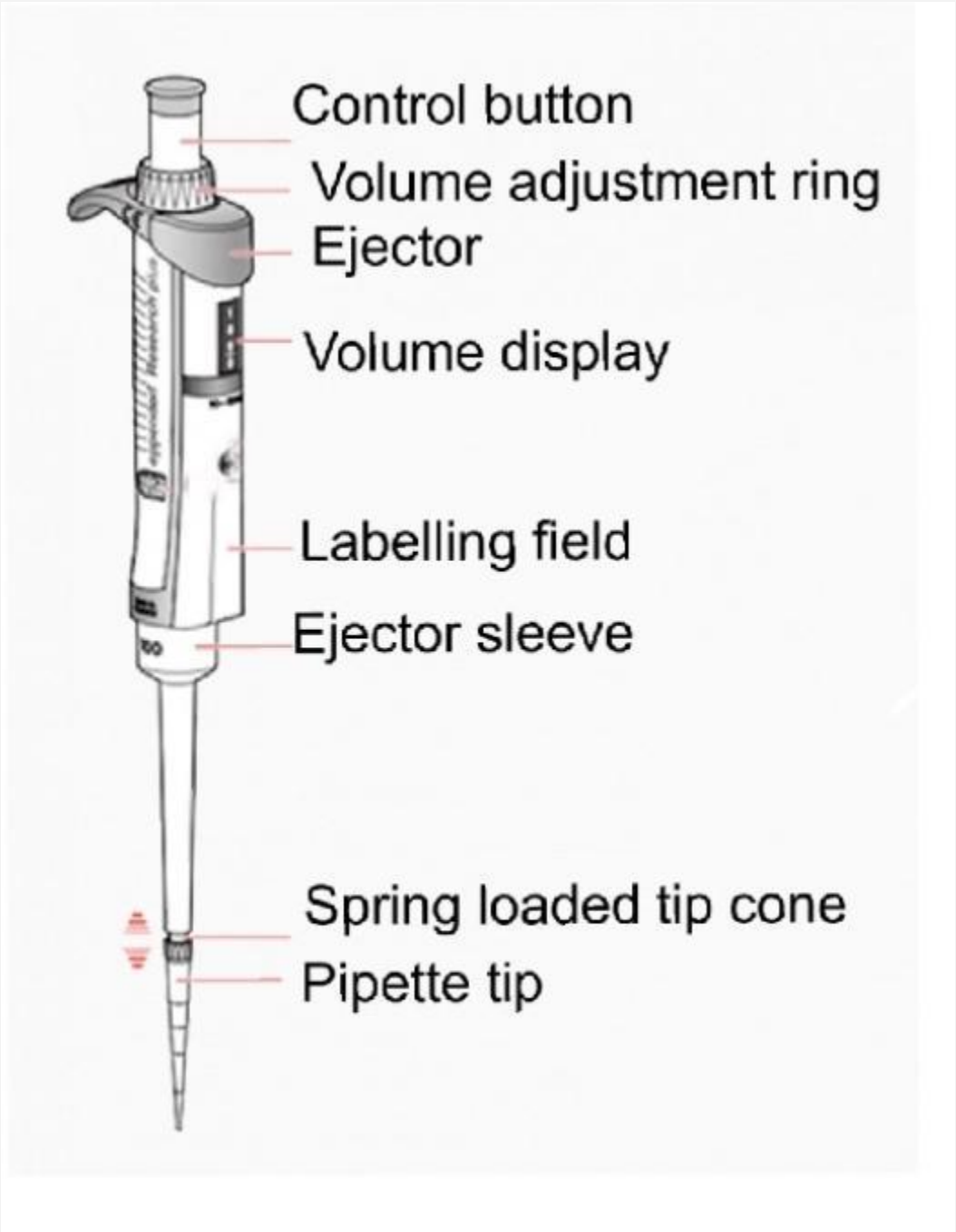
***Note that the hand holding the flask should be your dominant hand. RH is mentioned, assuming you are right-handed. If you are not, use your left hand and align the burette in the opposite direction.**

2. Volumetric pipette, graduated pipette, micropipette and pipette filler
    - Measures volume of liquid. They are more often used in chemistry than other subjects
    - Volumetric pipettes are calibrated to a **specific** volume. Graduated pipettes measure a **range** of volumes, following the scale. A pipette filler draws liquid into the pipette.
    - Micropipettes have a dial which allows you to **select** how much liquid to draw in (in microlitres, µL). It will suck up exactly that volume. They do **not** require a pipette filler.

- **Do not cover the bottom end of the pipette. It may shatter due to pressure increase (volumetric/graduated pipettes are glass). For micropipettes (plastic), this may still mess up its calibration.**
- **Common use: Titration (measuring the analyte, unknown concentration)**



(for volumetric and graduated pipettes)



(for micropipette) Source : [2]

Pipettes and burettes are more accurate than a measuring cylinder, but have a slower discharge rate

3. Crucible
    - Holds solid chemicals to be heated over a bunsen burner. While heating, it is placed on a tripod with a clay triangle

4. Evaporating dish
    - Holds solutions/supernatant liquids (liquid above solid precipitate) to be heated to dryness or saturation point. While heating, it is placed on a tripod with wire gauze

5. Volumetric flask
    - A flask which is calibrated to hold a specific volume of liquid (shown by the line on the neck)
    - **Common use: holding solutions produced by dilution (to be used after)**

6. Flat bottom and round bottom flasks
    - Holds liquids. Either can be used for heating
    - **Common use: distillation**

7. Gas syringe
    - Measures the volume of gas produced during a reaction.
    - The test tube with reactants is covered with a bung and connected to the syringe by a delivery tube.

8. Watch glass
    - Many uses. Can be used to hold solids while weighing, as a surface for evaporation, or as a cover for beakers

9. Melting point apparatus
    - Used to determine the melting point of a substance.
    - A capillary tube (containing the solid) is inserted, and the knob increases temperature. Record when it **starts** to melt (t1), and when it is **fully** melted (t2)
    - **Common use: Testing purity. Substance is pure if it has a narrow range (t2-t1<2°C) AND matches literature values**

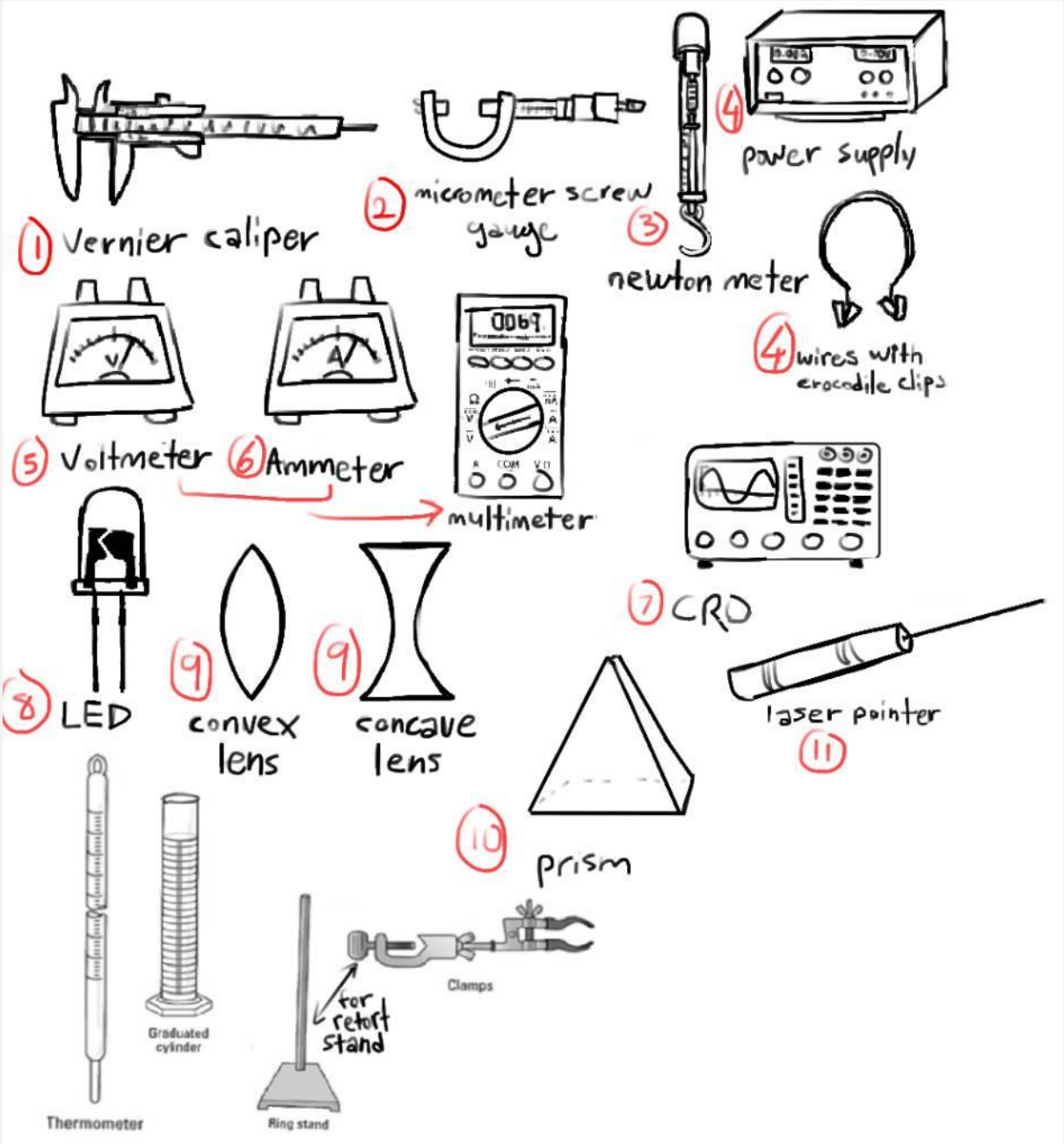
10. Spectrophotometer
    - Measure the absorbance of a dissolved substance
    - Set the wavelength depending on what the substance is. Using a dropping pipette, fill a cuvette (rectangular container for the spectrophotometer) with the solvent used. Insert it inside and press

the calibrate button. This is to **exclude the solvent** in the measurement (“setting a blank”)

- After, remove the blank and insert the cuvette with the desired solution to get its absorbance.
- **Make sure the cuvette is wiped clean before inserting.**

PHYSICS

Diagram of common apparatus for physics. Not all are explained, some are explained already above. The numbers show the bullet point where the apparatus in this section is explained.



1. Vernier calliper
    - Used to measure small lengths
    - Slide the vernier scale until the object is gripped. See where the line on the main and vernier scales align

- The length of the object in **cm** is **(reading on main scale) +(0.1 x reading on vernier scale)**

2. Micrometre screw gauge
    - Measures small lengths (smaller than vernier calliper)
    - Same process as the vernier calliper, except the thimble is rotated to grip the object
    - The length of the object in **mm** is **(reading on main scale) +(0.01 x reading on thimble scale)**

3. Newton meter
    - Measures weight of an object
    - Hang the object to the hook, and record the reading
    - **Check that it reads 0 when nothing hangs on it. If not, adjust all your readings by ±(error)**

The next section is still part of physics, but more specifically electricity.

4. Power supply, wires (with crocodile clips), switches
    - Common items required to build a complete circuit

5. Voltmeter
    - Measures potential difference of a component in the circuit
    - Must be connected in **parallel** to the component
    - **Common use: calculating resistance of a component**

6. Ammeter
    - Measures the current in a circuit
    - Must be connected in **series** to the circuit
    - **Common use: calculating resistance of a component**

A mustimeter is an apparatus which combines the functions of an ammeter and voltmeter. It can be used as either but must be connected correctly. (in parallel for p.d. and series for current)

7. CRO (cathode ray oscilloscope)
    - Shows the waveform of alternating voltage and direct voltage

8. LEDs (light emitting diodes)
    - A diode which emits light when a circuit is connected properly. They do not measure any values, but they are used in conjunction with voltmeters and ammeters.
    - **Do not exceed their maximum forward voltage, as LEDs can burn/explode.**
    - **Common use: calculating threshold voltage of LED, calculating optical power (using P=IV), finding either h (proving planck's constant) or f (finding frequency) using E=qV=hf**

The next section is still part of physics, but more specifically optics.

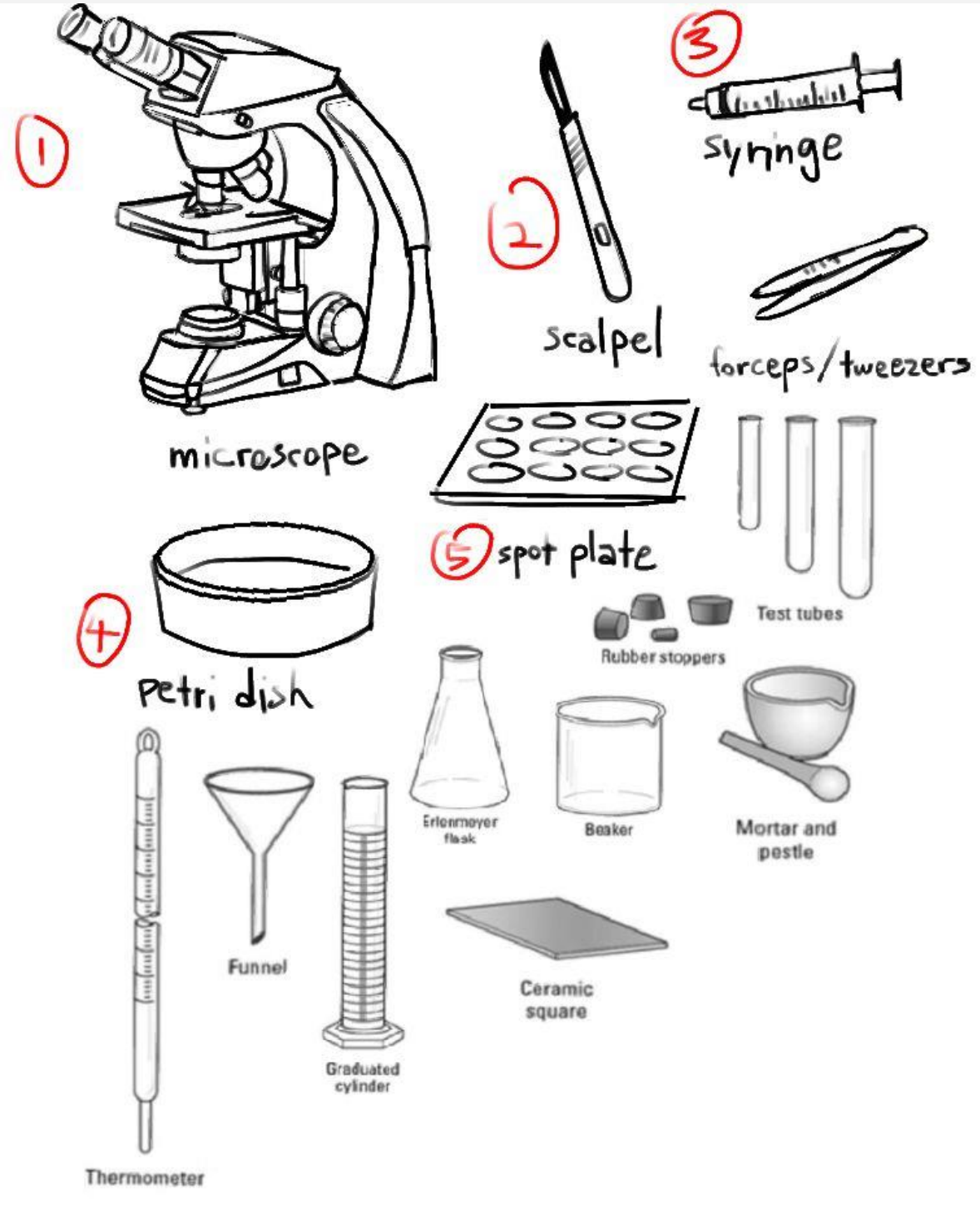
9. Concave/convex lenses
    - Concave lenses are thinner in the middle. Convex lenses bulge in the middle.
    - They refract light in a certain way, which produces images at certain distances depending how far an object is. The principal focus is where all parallel rays of light converge. This point is called F. 2F is twice the distance of F
    - **Be careful with lenses as they are glass.**
    - **Common use: calculating focal length (distance from the middle of lens to F)**

10. Prism
    - Refracts and disperses white light in such a way that a rainbow forms.

11. Laser pointer
    - Emits a narrow beam of monochromatic light. It shows us how light travels in a certain medium.
    - **Do not point a laser to anyone's eyes. It can cause blindness/vision loss.**
    - **Common use: investigating reflection/refraction, calculating refractive index**

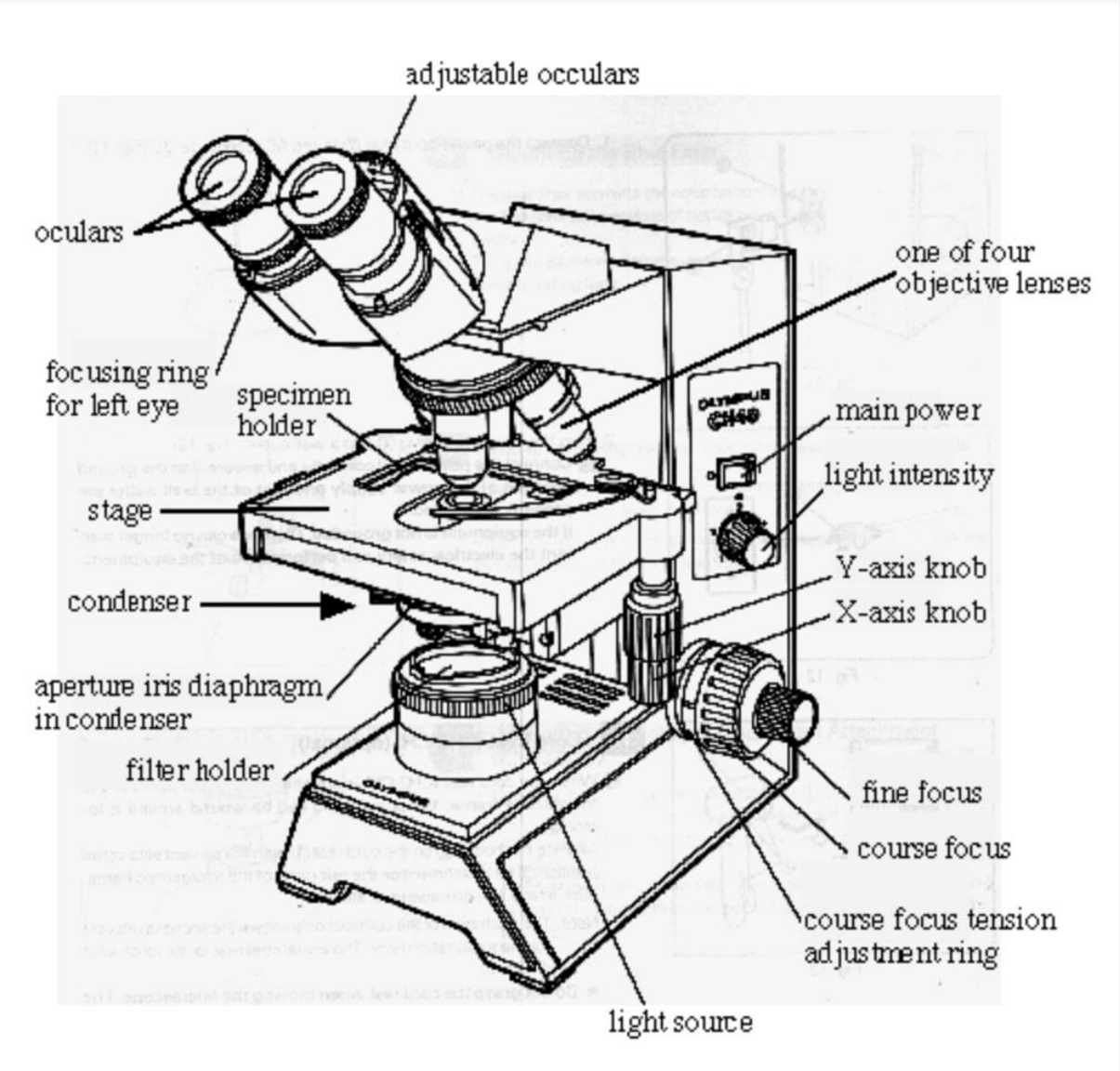
BIOLOGY

Diagram of common apparatus for biology. Not all are explained; some are explained already above. The numbers show the bullet point where the apparatus in this section is explained.



1. Microscope
    - Used to see individual cells of a specimen by magnifying

- Place the specimen (cut very thin with a scalpel) on a slide and place a cover slip on top. Then insert and adjust position until it can be seen
- **You may need to dye the sample for better visibility (for example using iodine solution/methylene blue/safranin etc.)**



Source : [3]

The focus knobs can be adjusted to make the image clearer. The x and y axis knobs control the position of the table so that we can look at different areas of a specimen.

2. Scalpel
    - A sharp blade used for dissection, or to cut a thin specimen to be put under a microscope

- **Make sure to cut on a white tile, and away from you to prevent getting cut.**

3. Syringe
    - Used to transfer small amounts of liquids. Liquid is drawn and expelled using the plunger

4. Petri dish
    - Used as a container to hold agar jelly, or samples/specimens.
    - **Common use: culturing microorganisms**

5. Spot plate
    - A plate containing many depressions, for small scale reactions.
    - Usually used to observe colour changes when a reagent is added to a sample (for example when iodine is added to multiple samples, testing for the presence of starch)

References (3)

*All third-party content is used under fair use for educational and non-commercial purposes.

[1] – Zazmi Z. (2012). *Chemistry Form 4: Chapter 7 - Titration Method.* [online] Blogspot. Available at : <https://student-sc.blogspot.com/2012/12/chemistry-form-4-chapter-7-titration.html?m=1> [Accessed 27 Sep. 2025]

[2] – NimishaArora, (2022). *LPA Laboratory Equipment: Micro Pipettes*. [online] NTEP. Available at : <https://ntep.in/node/1475/CP-lpa-laboratory-equipment-micro-pipettes> [Accessed 27 Sep. 2025]

[3] – jinmenchie (2019). *Parts and Function of a Microscope*. [online] Scribd. Available at : <https://www.scribd.com/doc/152904535/Parts-and-Function-of-a-Microscope> [Accessed 27 Sep. 2025]