Millikan's Apparatus

AP2130-001 (for external power supply)

AP2131-001 (with inbuilt power supply)

Description: This unit consists of the following sections:

- The cell containing two metal plates spaced 5 mm apart between which the migration of the charged latex particles is observed.
- The main body which contains the switching and circuitry for the operation of the illuminator and the control of the cell plate voltage.
- Small plastic bottle containing 25ml volume of a stabilised latex solution consisting of latex particles approx. 1 micron in diameter. These latex spheres are used as the particles under study.
- Light source and adjustable lens system in a small cover on the top of the instrument.
- The simple telescope containing a graticule through which the particles are observed.
- Atomiser and puffer used to expel the particles and force them along the small rubber hose to the needle.
- Hypodermic needle and rubber hose which feeds a few particles, which are electrostatically charged by the rubber hose, into the centre viewing area of the cell

AP2130-001: Model without inbuilt power supply

- Sockets are provided for connecting to 12V.AC or DC at 3A for the illuminator.
- Sockets are provided for connecting a high voltage DC power supply to provide approx.300V.DC. to the cell plates. A knob is provided to adjust the cell voltage from zero to about 300V.DC. during an experiment.
- A switch is provided to reverse the voltage polarity on the cell. The red socket is positive when the switch is in the 'forward' direction.
- Sockets are provided for a student bench meter or multimeter to monitor the cell voltage. This voltage does not reverse with the reversing switch.

AP2131-001: Model with inbuilt power supply

- When powered from mains, the light and the high voltage DC to the cell are on.
- A switch is provided to reverse the polarity on the cell. The red socket is positive when the switch is in the 'forward' direction.
- A knob is provided to adjust the cell voltage from zero to about 300V.DC. during an experiment.
- Sockets are provided for a student bench meter or multimeter to monitor the cell voltage. This voltage does not reverse with the reversing switch.

AP2130-001	Length: 300mm	Width: 165mm	Height: 165mm	Weight: 1.6kg
AP2131-001	Length: 300mm	Width: 165mm	Height: 165mm	Weight: 3.3kg

Typical Simple Set Up For An Experiment:

When the power connections are complete, the aim is to prepare the atomiser to inject particles into the cell for the observation of their behaviour.

Leaving the atomiser in its mounting clip, remove the plastic cap and hose from the atomiser and unscrew the upper section. From the bulk storage bottle, fill the atomiser with a very small amount of latex solution (about 2ml). The latex should just fill the tapered part, right at the bottom of the atomiser housing.

Do Not Overfill The Atomiser

Take the puffer bottle from its clip and, with the finger tips, give it a sharp squeeze. A fine mist should be seen from the open mouth of the atomiser. Gently refit the top section of the atomiser and replace the plastic cap and hose. Stretch the other end of the hose over the plastic head of the hypodermic needle. Insert the needle into the small hole provided in the cell so that the needle protrudes about 5 to 10mm into the cell. **Refer to the drawing.**

Give a short sharp squeeze on the puffer and the tiny particles should pass from the atomiser, along the latex rubber hose, through the hollow needle into the cell. The tiny particles should be clearly visible against the graticule as tiny dots of light against the dark cell background.

If the tiny dots of light do not appear, give another short sharp squeeze on the puffer and view again. Puff gently because too many particles in view makes the experiment more difficult to perform.

See below for more information, trouble shooting and setup notes.

Major Setting Up Routine:

1. Remove the cell from its base by lifting and pivoting the cell clamp spring blade away from the top of the cell. Unplug the red and black cables and lift the cell from its platform.

2. Swing the small target strip attached to the vertical pillar so that the hole in the tip is directly above the centre hole in the cell platform.

3. Position the bright filament image directly across the small hole at the tip of the strip. The lens in the front of the lamp housing can move by finger force both up and down and left and right. Adjust the lens position so that the bright filament image is visible fully across the vertical height of the strip while also across the small target hole in the end of the strip.

4. Remove the telescope from its storage clip and fit it into the mounting arrangement. Twist the telescope mount to align it with the hole in the end of the strip and, whilst viewing through it, move it longitudinally in its mount until a sharp image of the edge of the target hole is obtained. Be sure the strip is still over the centre point of the cell platform. At this stage both the light and the scope are focussed at the centre position of the cell. The large sponge pad is used over the eye piece and the small pad and sleeve fits over the small telescope extension tube. When the cell is in position, the small sponge sleeve is compressed against the cell viewing window to prevent unwanted ambient light from entering the cell.

5. Swing the target strip to one side, take the cell and locate it in the centre hole of the platform. The cell must not be upside down. When the cell viewing windows are aligned with the light source and the telescope, the small needle hole should be pointing towards the rear at about 45 degrees to the axis of the lamp housing so that the needle injects the particles at 90 degrees to the viewing axis of the scope. If wrong, invert the cell, re-align the windows and check again. Swing the cell clamp spring blade over the cell and engage it over the location pip on the top surface of the cell to hold the cell firmly to the platform.

6. Take the needle and insert it so that the tip protrudes about 5 to 10mm into the cell.

7. The final check is for even illumination inside the cell. Look through the telescope into the cell. The illumination of the upper and lower cell faces should be visible through the telescope. If they are not of approximately even intensity, slightly adjust the lens in the lamp housing to make them similar brightness.

WHEN THE ABOVE MAJOR ADJUSTMENTS ARE PERFORMED AND THE POSITIONS ARE LOCKED, THEY SHOULD NOT REQUIRE REPEATING UNLESS A USER DISTURBS THEM.

Using the Instrument and Performing the Experiment

Give a short sharp squeeze on the puffer and the tiny particles should pass from the atomiser, along the latex rubber hose, through the hollow needle into the cell. The tiny particles should be clearly visible against the graticule as tiny dots of light against the dark cell background.

If the tiny dots of light do not appear, give another short sharp squeeze on the puffer and view again. Puff gently because too many particles in view makes the ex periment more difficult to perform.

Important Notes:

1. If the latex rubber hose from the atomiser to the cell becomes wet with latex solution the particles will be trapped on the wall of the hose before they can reach the hollow needle. Do not repetitively squeeze the atomiser puffer for prolonged periods.

2. As the particles are 'puffed' along the rubber hose, they gain a static charge and so become charged particles by the time they reach the cell chamber. Ideally, only a few particles should enter the cell through the needle, so search for them carefully. Typically, about 10 particles may be visible in the field of view at any time - some will be in focus and some will be out of focus. Move the telescope back and forth axially in its clip very slightly to focus on another 'plane' of particles.

   Due to the inversion of the image through the telescope, **the particles will appear to fall UPWARDS** and the lower cell plate as viewed through the telescope is really the upper plate.

3. The 'Cell Voltage' control knob adjusts the voltage between the plates from zero to the full Polarising Voltage by rotating the control clockwise. Using this voltage control, the particles can be 'held' suspended against gravity for observation. Normally experiments are performed under various cell potentials.

4. The voltage adjustment on the cell plates is linear with the rotation of the knob. Terminals are provided on the front panel for the connection of a voltmeter to monitor and document the cell voltage.

During An Experiment:

- If the particles are not brightly illuminated, check the lamp voltage. The lamp must be about **30 watts, should be axial filament and operating at its full brilliance** at close to 12 Volts.
- When the field of view has cleared and only a few particles are remaining, an experiment may be performed.
- **Be sure that the voltage on the plates is reversed to cause their direction of motion to reverse before the particles have reached the plates, otherwise they will be captured on the plate and will no longer be visible.**
- If a different field of particles is desired, slightly adjust the telescope in its mount to focus at a new plane. The scope can also be moved slightly if the focus of a particular particle is to be improved.
- Be sure not to inject too many particles into the cell by squeezing the puffer too vigorously otherwise regular cleaning of the cell will be necessary. (See below).
- The experiment consists of selecting one single particle to view against the graticule and to time its motion up and down between the charged plates.
- **GRAVITY:** The free fall due to gravity is measured by a stopwatch with the plates **not charged** and allowance is made in the calculations for this constant error aiding the motion downwards and reducing the motion upwards. Alternatively, take the average of several passes of the rising time and the falling time to obtain the average time to pass a certain distance - as seen on the graticule in the telescope.
- Remember that due to the inversion of the image through the telescope, the particles will appear to fall UPWARDS and the lower cell plate as viewed through the telescope is really the upper plate.
- The information being gathered is: Distance between the cell plates by counting the graduations in the telescope. Average time taken to pass between 2 points on the graticule without allowing the particle to get to the plates. The voltage being applied to the 2 cell plates. Voltage is raised through 100V, 150V, 200V, 250V then 300V.DC. The average time is found for each voltage. Normally two students perform the experiment with one student observing the motion of the charged particle and reversing the polarity whilst the other times the motion and logs the results. The cell voltage versus rise and fall times is averaged over several passes of a single particle between the plates **while being careful not to allow the particle to actually reach either plate.**
- The observer then chooses another particle perhaps after another 'puff' into the cell and again several passes are measured and averaged at several different voltages. The voltage, distance travelled as seen on the graticule and the time taken are all logged in a table.
- A graph is then plotted of average time against cell voltage. For different particles, the sudden changes in positions of graphed points indicate multiple charges on the particle.
- For calculations and theory behind the measurement of the electric charge on an electron, refer to your physics manuals.

Care Of The Instrument:

The design of this instrument is such that the major set up procedure is not required unless the alignment has been seriously disturbed between uses. All that has to be done is to load the atomiser, 'puff' the particles, place the scope in its mount and adjust it until the particles are seen.

It is important to keep the injection system clean. If the latex material is permitted to dry out in the atomiser or tubes it is most difficult to remove it. It is advised that, at the completion of an experiment session, the latex should be poured back into the storage bottle and the atomiser, hose and needle should be well rinsed with water and 'puffed' a few times before coagulation occurs. Wash everything in warm water.

During re-assembly, be sure that the plate with the red cable attached is on the top of the cell when the viewing windows are lined up with the light and scope and the needle hole is facing 45 deg. towards the rear of the instrument. This is then at right angles (90º) to the scope viewing line.

The two cell cables fit into the small slots provided in the edge of the cell body and the top and bottom mouldings fit in similar way. Be sure that the windows are free from smudges and the rubber hose is perfectly dry internally before fitting. This dryness of the rubber hose is very important since the passage of the latex particles through the hose induces the charge that resides on the particles.

Spare Parts:

PA2043-002
Lamp (axial filament) 12V 30W, 2 pin halogen.
(The lamp is the same as used in the "HODSON" LIGHT BOX.)

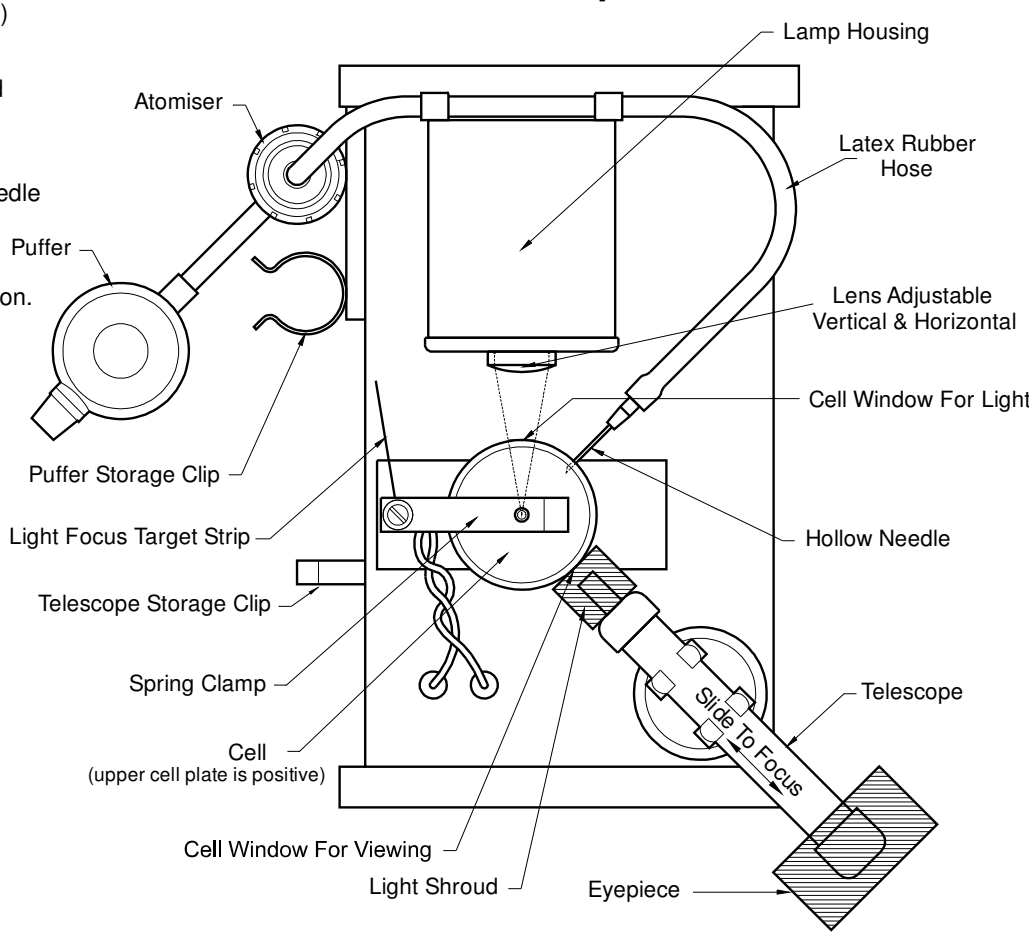
PA2130-004
Cell complete with plates and cables

PA2130-008
Atomiser, puffer, hose & needle (new model)

PA2130-006
Bottle of stabilised latex solution. Approx.25ml

PA2130-007
Telescope with graticule.

Orientation of Components



Designed and Manufactured in Australia