15605 Spectrum Analysis Apparatus

Purpose:

To investigate bright line spectra from a variety of light sources as well as from chemicals burned in a flame.

Please refer to the safety data sheets at the end of this instruction sheet before handling any chemicals.

Additional Required Materials:

Bunsen burners
Wire cutters/pliers
Tweezers

Assembly:

Select a card of press out slit disks. These die cut disks are circular with a rectangular slit punched across the diameter. Remove one of these disks and press out the rectangular center piece.

Insert the slit disk into one spectroscope tube cap. This is a friction fit and it will fit tightly. Be careful not to bend the slit disk as it is being inserted.

Select a card of diffraction grating holders. One die cut holder appears on the card as two circles that touch. Remove one diffraction grating holder from the card being careful not to tear the two halves apart. Push out the circular center of each half.

Using tweezers, remove one piece of diffraction grating from the envelope and insert it between the folded halves of the grating holder. *AVOID* getting fingerprints on the diffraction grating. Press fit the grating holder into one end cap.

Blow or shake out any dust or particles that may be in the spectroscope tube and mount the prepared end caps on opposite ends of the tube.

With the grating end of the assembled spectroscope nearest you eye, look at a florescent or incandescent bulb.

Turn the spectroscope so that the slit in the end is vertical. Turn the grating cap so that the colored spectrum appears on the side of the tube and at right angles to the slit.

What is a spectrum and how to make one:

When an electron in an atom drops from one energy level to a lower energy level, it loses energy. Where does this energy go? It shows up as a single photon of light. A photon's energy is described by its frequency or color. Light that is blue in color is made up of photons with higher energy than light that is red in color.

Materials can be made to give off light by a number of methods such as heating in a flame, sparking from electrodes, or passing an electric current through a low pressure gas. Heating a compound in a flame is the simplest method of exciting atoms. The electrons in the compound will absorb energy from the heat of the flame, then as the electrons fall back to their low energy "ground" state, photons are emitted with energies that are characteristic to that compound.

How can we tell what colors are in the light coming from the chemical in the flame? Recall that sunlight shining through a prism creates a small "rainbow". This rainbow is the spectrum of sunlight with the lower energy (red) light on one side and higher energy (blue) light on the other. We can use the same prism to separate the colors of the flame we are testing or we can use a diffraction grating. A diffraction grating behaves in a fashion similar to the Young's double slit experiment where two narrow slits were used to spread light of different wavelength through different angles.

Observing Spectra:

After you've assembled your spectroscope, you can use it to look at a variety of light sources; florescent lights, ordinary incandescent bulbs, mercury vapor and sodium vapor street lamps, and neon signs. DO NOT look at the sun. It is far too bright and will damage your eyes. Record your observations and compare the similarities and differences between these light sources.

To investigate spectra produced by certain chemicals when they are placed in a flame, you must first assemble some sampling probes. You should make one probe for EACH chemical. Label the probe with a chemical name and do not use that probe for any other chemical. To make the probe, cut the nichrome wire supplied into 10 equal lengths and make a tight loop in one end of each piece. This loop will act as a small spoon to scoop up chemicals to be tested. Force the straight end of the wire into the end of the small styrofoam handle (provided).

To flame test a chemical, place a few crystals of a chemical on the loop and hold it in the flame of a Bunsen burner. The flame color will change and when viewed through a spectroscope, colored lines characteristic of that chemical will be visible. It is best to work in pairs for this part of the experiment. Have someone hold the chemical in the flame while you observe its spectrum. Record your observations then trade places. After you've observed all of the chemical's spectra, see if you can identify a chemical without telling you what it is and place it in the flame. Compare the spectra you observe with the notes you've taken. Can you tell which chemical was chosen?

Spectrum Analysis - Chemical Safety Data:

Calcium Chloride $CaCl_2$
Safety Precautions:
Wear safety glasses, proper gloves, and safety clothing.
Eye Irritant

Cupric Chloride $CuCl_2 \cdot H_2O$ Copper (II) Chloride
Safety Precautions:
Wear safety glasses, proper gloves and safety clothing. Do not take internally.
Wash thoroughly after handling and before eating. Keep out of reach of children.
Caution! Harmful if swallowed. Irritant. Copper material may cause allergic reaction.

Cupric Nitrate $Cu(NO_3)_2 \cdot 2H_2O$ Copper (II) Nitrate
Safety Precautions:
Wear safety glasses, proper gloves and safety clothing. Keep container closed in a cool, dry place. Deliquescent: this chemical has a tendency to dissolve in its surface moisture.
Warning! Strong oxidizer. Contact with combustible material may cause fire or explosion. May cause eye or skin irritation or allergic reaction.

Lithium Chloride LiCl
Safety Precautions:
Wear safety glasses, proper gloves, and safety clothing. Wash thoroughly after handling.
Caution! Harmful if swallowed.

Potassium Chloride KCl
Safety precautions:
Wear safety glasses, proper gloves, and safety clothing.

Potassium Nitrate KNO_3
Safety Precautions:
Wear safety glasses, proper gloves, and safety clothing. Store in a tightly closed container. Remove and wash contaminated clothing promptly. Keep away from organic material.
Warning! Strong oxidizer. Harmful if swallowed. Contact with combustible material may cause fire or explosion.

Sodium Bicarbonate $NaHCO_3$ Baking Soda; Sodium Hydrogen Carbonate.
Safety Precautions:
Wear safety glasses.
A mild eye, mucous membrane and skin irritant.

Sodium Chloride NaCl Salt
Safety Precautions:
Wear safety glasses.
May cause eye irritation

Strontium Chloride $SrCl_2 \cdot 6H_2O$
Safety Precautions:
Wear safety glasses, proper gloves and safety clothing. Do not inhale or take internally. Use proper ventilation.
Caution! May be harmful if swallowed. May cause eye irritation.

Strontium Nitrate $Sr(NO_3)_2$
Safety precautions:
Wear safety glasses, proper gloves and safety clothing. Do not inhale or take internally. Keep container closed.
Warning! Strong oxidizer. Contact with other material may cause fire. May be harmful if inhaled or swallowed. Skin and eye contact causes irritation.

Time Allocation:

To prepare this product for an experimental trial should take less than ten minutes. Actual experiments will vary with needs of students and the method of instruction, but are easily concluded within one class period.

Feedback:

If you have a question, a comment, or a suggestion that would improve this product, you may call our toll free number**.**