Serrata Pty. Limited
Tel: 02 9651 3033
Fax: 02 9651 2031
Email: contact_us@serrata.com.au
Web: www.serrata.com.au

Instructions for Cat No. 1052041-4

This section contains information about the discharge tubes available for use in most school laboratories. It includes the set of four Crooke's tubes, the six tubes for vacuum scale and the spectrum tubes. The induction coil has been included as it provides the high input voltage required to operate the tubes. Although the different discharge tubes are used to demonstrate a variety of principles many of the safety aspects are common.

Safety Precautions

- The induction coil itself does *NOT* produce X-rays. However, X-rays are produced in the discharge tubes when they are connected to the induction coil. The X-rays are emitted when the cathode rays are stopped suddenly by hitting glass or metal surfaces. When the equipment is set up using a *minimum operating voltage* from the induction coil the X-rays produced are of low energy and are significantly attenuated through the glass.
- Remove all metal jewellery and watches before using the induction coil.
- *Keep one hand behind your back when operating the apparatus.* This helps to ensure that you do not provide a short circuit for the high voltage electric current.
- Do not handle the glass tube while it is in operation.
- Do not leave this equipment on for longer than is necessary to perform the desired experiment.

X **Extra equipment for ALL the suggested learning experiences using the discharge tubes includes:**

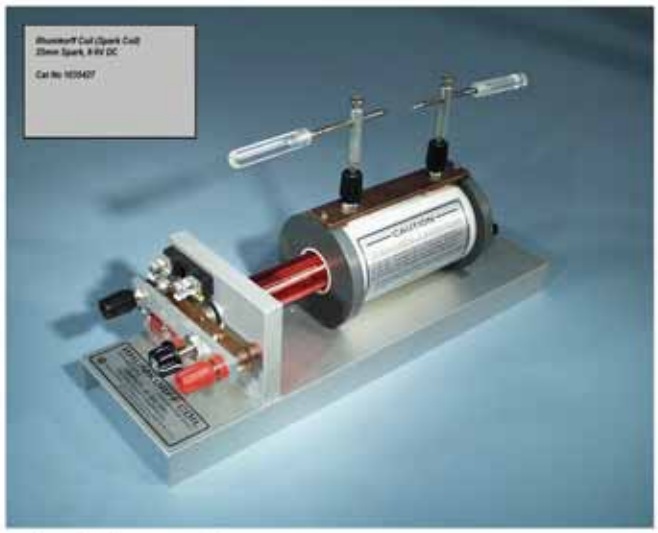
- induction coil
- black cardboard
- two long leads with alligator clips
- two leads with banana plugs
- power pack
- spare fuses for the induction coil

Handy Hint

For impressive results, darken the laboratory or set up in a large darkroom.

1) Induction Coil

The induction coil is used as a high voltage power source because it produces by electro-magnetic induction a very high voltage in its secondary coil. It pulsates a small direct input voltage of 6V in the primary coil to produce a variable output in the order of 15 000 volts in the secondary coil. The two electrodes, mounted on the secondary coil, are used as a high voltage supply.



Setting up and Using the Induction Coil

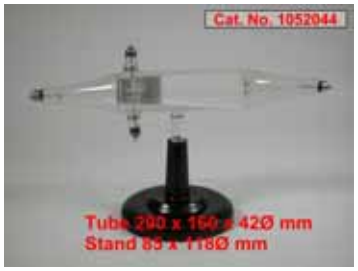
C **It is worth checking the following before setting up the equipment.**

- Make sure the contacts are clean and free of carbon deposits. If not, clean them with fine sandpaper.
- Use the screw to adjust the gap between the contacts so there is a very small space between them, and when turned on, there is a continuous oscillation and a spark jumping between the contacts. *Turn the power off before readjusting the screw.*
- Check to see that the fuse is unbroken.

Maltese Cross

Magnetic Effect

Paddle Wheel



Electrostatic Deflection

Serrata Crooke's Tubes

S Setting up the Induction Coil

- Make sure that the induction coil is connected only to 6V DC current (middle setting on the power pack).
- Connect the positive terminal of the induction coil to the positive terminal of the DC power supply and the negative terminals similarly.
- Pull the terminals on the secondary coil apart before connecting to a discharge tube.

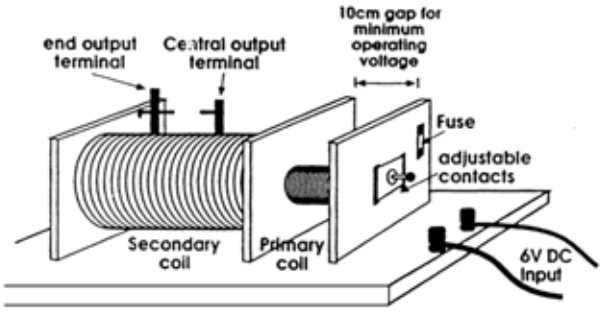


figure 1

- To achieve a *minimum operating voltage*, move the position of the secondary coil so there is a gap of 10cm between the front section of the primary and secondary coils *as shown in the diagram.*

2) Crooke's Tubes

Crooke's tubes are a set of 3 discharge tubes which, when connected to a high voltage power supply such as the induction coil, demonstrate the existence and some of the properties of 'cathode rays'. They are all clear glass evacuated tubes with a plate cathode (–) and nipple-shaped anode (+). The magnetic deflection tube has a vertical fluorescent screen in the tube to highlight the path of the cathode rays. The Maltese cross tube has a metal cross in the tube which can be flipped up into the path of the cathode rays. The paddlewheel tube sits horizontally in a wooden cradle with a glass paddlewheel positioned to turn in the path of the cathode rays.

Setting up and Using Crooke's Tubes

C It is worth checking the following before setting up the equipment.

- Use a large horseshoe magnet or electromagnet for deflecting the beam.
- Position the discharge tube to point towards the wall so that the student is one metre away and any X-rays produced when the cathode rays hit the glass will be absorbed by the wall.

S Setting up Crooke's Tubes

- Connect up the induction coil to the power pack *as described in the section on the induction coil.*
- For the magnetic deflection and Maltese cross tubes connect the central output terminal on the induction coil (*see figure 1*) to the cathode plate electrode in the tube, and the end terminal of the induction coil to the nipple-shaped anode in the tube. If a green fluorescence is not clearly visible at the 'cross' end of the tube opposite the cathode then change the polarity of the connections.
- Position the paddlewheel tube exactly horizontally on the wooden cradle. The paddlewheel should be resting at one end of the tube. Connect this end, as the cathode, to the central terminal of the induction coil. Connect the end terminal to the anode.

By using the Electrostatic Deflection Tube, demonstrate that Cathode Rays are deflected by a Electrostatic field and therefore carry charge.
By changing the direction of the Electrostatic field demonstrate that the Cathode Rays are negatively charged particles (what is called Electron Current)

Suggested Learning Experiments:

Use the Maltese Cross tube to demonstrate the following characteristics of Cathode Rays:
- they are emitted at right angles to the Cathode.
- they travel at straight lines in a vacuum (they form a shadow of the cross on the glass)
- they are interrupted by a thin piece of metal.

HINT - Use black piece of material to provide a dark background at the end of the tube to see the fluorescence more easily.

By using the Magnetic Deflection Tube, demonstrate that Cathode Rays are deflected by a magnetic field and therefore carry charge. Set up the equipment as described earlier and place a large horseshoe magnet over the tube so the magnetic field is at right angles to the path of the Cathode Rays. Reverse the polarity of the magnet and check the result.

By using the Paddle Wheel Tube, demonstrate that Cathode Rays have Momentum and therefore Mass. Set up the equipment as described and switch it on. The paddles on the wheel are painted with fluorescent paint to show when the Cathode Rays are hitting then. The Paddle Wheel is propelled along by the impact of collisions with the rays, revealing that they must have mass.