

# TELTRON

Atomic Physics Educational Apparatus

## Tel-X-Ometer

The Tel-X-Ometer TEL 580 is the only inexpensive apparatus which has been designed to perform the very wide range of experiments necessary to comprehend the subject of X-rays, whilst meeting in every respect the recommendations of the International Commission on Radiological Protection 1968, Directive 76/579/EURATOM of the European Atomic Energy Community Council and Administrative Memorandum 2/76 of the U.K. Department of Education and Science.





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## Atomic Physics Educational Apparatus

Severe limitations to the amount of both time and money available for each and every subject seems to be characteristic of all echelons of teaching establishments. Teltron Research and Design staff are acutely conscious of this and at every design stage they are guided by the Teachers needs. Our aim is to produce didactically sound equipment of high quality at economic prices. The world-wide demand for Teltron apparatus is adequate testimony to the success of our philosophy.

### TEACHING ATOMIC PHYSICS

The subject of Atomic Physics cannot be taught or learnt in depth in one single school grade or one university year. With the help of teachers, lecturers and researchers in modern physics, Teltron has prepared a programme entitled "**The Teltron Approach To Atomic Physics**" with the object of achieving better subject penetration in the minimum time without using a lot of apparatus. It is divided into a number of 'Series', each of which provide guidance on suitable 'starting' and 'stopping' points for those responsible for preparing syllabuses and curriculae. They may also be considered as suitable divisions for phased purchase of the relevant apparatus.

**TELTRON SERIES A**—The production and properties of the free electron.

**TELTRON SERIES B**—A concept of the electron within the atom.

**TELTRON SERIES D**—The production, properties and uses of X-rays.

**TELTRON SERIES C**—The production, properties and uses of radioactivity.\*

**TELTRON SERIES Q**—The Quantum Theory.\*

(\*series in preparation)

Also available are the following illustrated catalogues:—

### ● TELTRON TUBES

A comprehensive and unique range of evacuated, gas-filled and demountable tubes designed and manufactured to suit the contemporary requirements of the teaching and learning of Atomic Physics.

### ● TELTRON X-RAY EQUIPMENT

More than 10 years research is embodied in this range of X-ray equipment which has internationally pioneered the teaching and learning of the phenomenon of X-rays in all grades of educational establishments.

### ● TELTRON ELECTRONIC UNITS

A unique series of electronic accessories designed for use as polarising and monitoring modules in conjunction with the Teltron ranges of apparatus.



### Low Cost and Ultra -Safe

The phenomenon of X-rays, discovered at the end of the 19th century, has now been developed to yield valuable information about the structure of all kinds of materials and the application of X-ray technology is responsible for the discovery of much new knowledge in medicine, chemistry, metallurgy and many other fields.

The recent inclusion of the subject of X-rays in the educational curriculum was internationally pioneered by Teltron with the more powerful but much more expensive Tel-X-Set; the Tel-X-Ometer was introduced to meet the need for low cost apparatus which can universally serve all educational establishments whose responsibility it is to teach and train scientists and technicians in the uses and application of X-rays.

Hitherto X-ray apparatus has been the prerogative of highly trained and disciplined operators but with the expanding need to teach this subject it is imperative that any apparatus used incorporates adequate safety devices to protect both equipment and operators from the accidental hazards of radiation and high voltage. In 1968 the International Commission on Radiological Protection adopted new recommendations and Codes of Practice concerning Radiation Protection in Schools for pupils up to the age of 18 years.

ICRP Publication 13,  
Pergamon Press 1970, Library of Congress  
Cat. Card No. 79-121011

The Tel-X-Ometer is the only inexpensive apparatus which has been designed to perform the very wide range of experiments necessary to comprehend the subject of X-rays, whilst meeting in every respect the recommendations of the International Commission, Directive 76/579/EURATOM of the European Atomic Energy Community Council and Administrative Memorandum 2/76 of the U.K. Department of Education and Science.

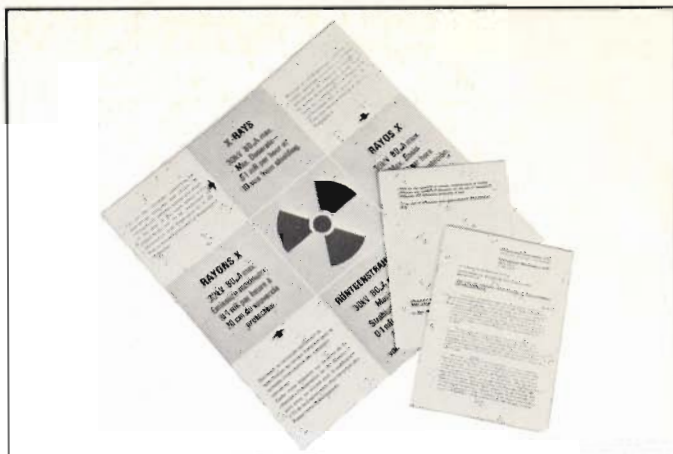
The number of local and national certifications that the Tel-X-Ometer has been granted throughout the world is adequate confirmation that a user with a minimum knowledge of X-rays may operate the instrument with full confidence in respect of the adequacy of radiation shielding and insulation at high voltages.



## Radiation Level

The radiation dose rate at 0.1m from the accessible surface of the apparatus under normal operating conditions does not exceed  $0.1\text{mrem h}^{-1}$ .

A card is included with each instrument, printed in French, German, Spanish and English, for affixing to the door of the room where the Tel-X-Ometer is to be operated; this is a recommendation of the International Commission.



## The Experimental Zone

The Tel-X-Ometer is basically a Spectrometer which can very simply be adapted to become

1. A Broad Beam of X-rays for analysis of the General Properties of X-rays.
2. A Single Crystal Bragg Diffractometer having a scale accuracy of 5 minutes of arc.
3. A Powder Camera for Debye/Scherrer experiments to an accuracy of 30 minutes of arc.
4. A Fluorescent Radiation Emitter for a study of the Moseley Theory that every element is characterised by its Atomic Number.
5. An Experimental Region for the mounting of innovative studies at the teacher's choice.

The Illustrations show how the unit has been designed to provide maximum didactic impact both for practical studies and for demonstration; the special X-ray tube, TEI 581 protrudes through the cast aluminium base of the spectrometer table and is mounted within a lead-glass transparent dome; this thick lead-glass dome is held in position by a special inter-lock system which incorporates two micro-switches connected in series — if the dome is not correctly located the unit cannot be operated.

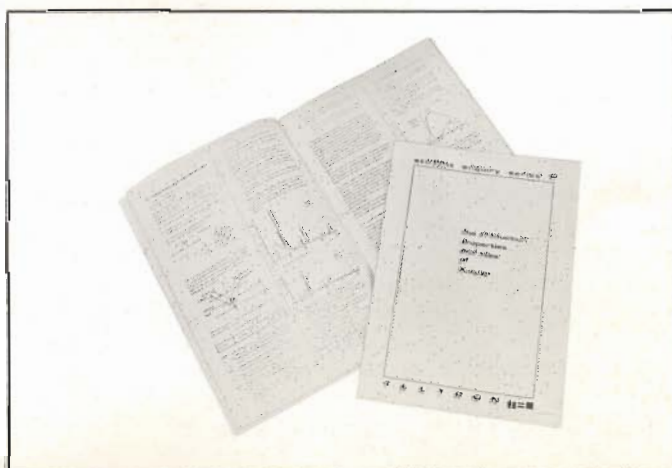
From one side of the dome is emitted the X-ray beam, the axis of which is parallel with the surface of the spectrometer table; the whole experimental zone is bounded by a transparent cover made of plastics, 4mm thick, containing a large proportion of chlorine to absorb scattered radiation. The direct beam is absorbed by a lead backstop, 1mm thick, permanently fixed to the plastics radiation cover; displayed on this backstop is the international radiation symbol where the outside diameter of the trefoil represents the maximum diameter of the uncollimated X-ray beam.

Access to the experimental zone is achieved by releasing the radiation cover and hinging upwards; a fail-safe inter-lock comprising two micro-switches in series is incorporated in the hinge mechanism such that the radiation cover cannot be raised without interrupting the high-voltage supply to the X-ray tube.



## Operating Instructions

A booklet is supplied with the Tel-X-Ometer giving comprehensive instructions on how to set-up and operate the instrument. Contained within the 50 page booklet are recommendations covering more than 60 different experiments which can be performed using the Accessory Kits, together with some "teacher's notes" concerning information which is not normally published in standard text-books.



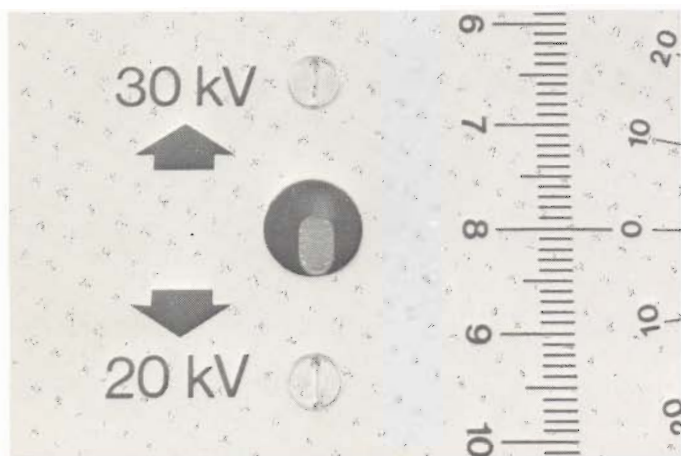
## The Electronic System

The Spectrometer Table is supported in the horizontal plane by the flanged metal cylinder in which is housed all the electronic circuits and on the front of which is located the control panel. The fuses and power supply selector switch are accessible on the underside of the cylinder.

The Tel-X-Ometer is supplied pre-set to operate at 30kV and 50 $\mu$ A; a small slide-switch on the surface of the spectrometer table permits an alternative voltage of 20kV to be selected.

The E.H.T. is derived from a solid state inverter circuit, followed by a Cockcroft-Walton type multiplier to provide a smooth d.c. output.

The regulation is such that when the optional 20kV anode voltage is selected the tube current will remain at 50 $\mu$ A; the operational characteristic of the circuit has been chosen to



ensure that at both settings of the anode voltage, the tube current can be continuously varied from 20 to 80 $\mu$ A, with the E.H.T. remaining within 1kV of the selected values, 30 or 20kV. The control for varying the tube current is recessed in the control panel and should not be adjusted without monitoring the current, using the jack-plug provided and an external 150 $\mu$ A meter.

When the plastics radiation cover is raised the micro-switches interrupt the supply to the anode of the X-ray tube; only on replacing the cover and then operating the spring-returned X-rays on push-button (RED) can the E.H.T. supply to the anode be re-established.

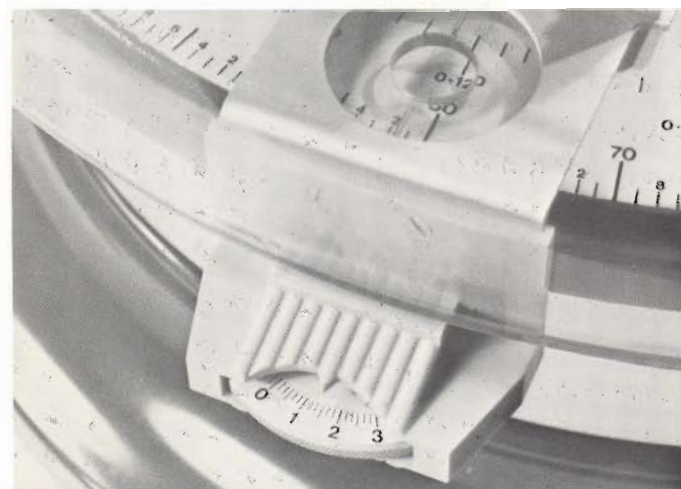
As a further safe-guard an electrically operated Time Switch is built into the system; lapsed times can be selected up to a maximum of 55 mins and a friction override is provided to shorten or lengthen the lapsed time as required.



## The Mechanical System

The rotary mechanism mounted at the axis of the spectrometer table is coupled by a planet-wheel 2 : 1 drive system to the spectrometer radial arm; a spring loaded clutch permits the 2 : 1 drive to be disengaged.

The slide-carriage fixed to the radial arm accepts 50mm square



slides, a Geiger-Muller tube holder and a variety of objects supplied in the accessory kits; the carriage arm can be rotated from 10 $^{\circ}$  to 130 $^{\circ}$  on either side of the beam axis, the spectrometer zero line; it can also be locked in the axis of the beam. The Manual Control for the arm and the Fine adjustment Control are located at the extremity of the carriage arm and outside the radiation cover.



## Visible and Audible Signals

The 'X-rays ON' lamp (RED) and the 'POWER ON' lamp (WHITE) are located on the surface of the spectrometer table where they can be readily observed from all round the instrument.

The heater of the X-ray tube is activated by the 'TIME SWITCH' and, being visible through the lead-glass dome, this acts as a secondary indicator.

The E.H.T. generator operates at high frequency which provides an audible indication that the instrument is operating; an external audible indicator can be interconnected if required by means of the jack-plug recessed in the control panel.



## Power Supply and Dimensions

Main power is supplied to the unit by means of a 3-core cable, 2 metres in length.

The Selector Switch on the underside of the flanged cylinder provides for the Tel-X-Ometer to operate from 110, 220 or 240 volts  $\pm$  10%, 50 or 60 Hz single phase.

**Dimensions:** Height 25 centimetres  
Diameter 37 centimetres  
Weight: 9 kilogrammes



## Teltron Filmpaks TEL 750/2 and 4

The teaching impact of being able to process photographic film in the classroom immediately after exposure and without a dark room need not be underlined.

High speed X-ray film is sealed in thin, black p.v.c. envelopes that have two apertures to accept the injector tube of a syringe without admitting light. After exposure to beta-, gamma- or X-rays, the film is developed rapidly by injecting the processing fluids into the envelope which is thin enough to permit the necessary agitation. After the processing is complete, about 2 minutes, the envelope is cut open and the film is removed with the special clip provided.

Filmpaks 2 and 4 are supplied complete with syringe, injector tube, developer and fixer fluids and film clip.

Two sizes of X-ray film are available



Cat. No.	TITLE	Qty.	Length	Width	Application
Tel 750	Filmpak 4*	12	150mm	12mm	Powder and single crystal photographs
Tel 750	Filmpak 2*	20	38mm	35mm	Flat film radiograph etc.

\*Refers to number of fixing holes

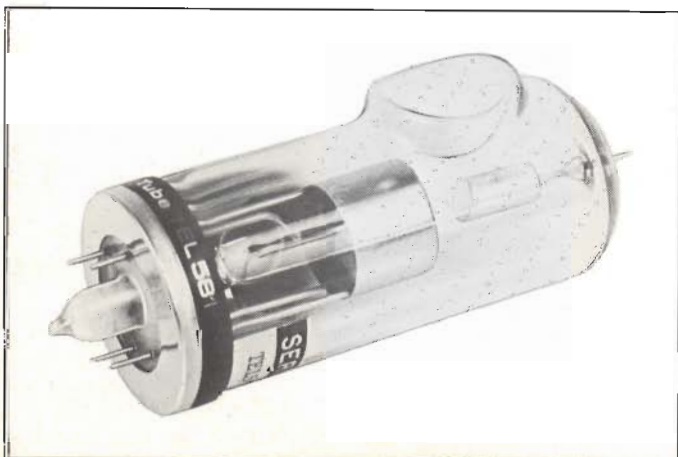
## Miniature X-Ray Tube TEL 581

This is a hard vacuum, hot cathode X-ray tube designed especially for the Tel-X-Ometer; it has a copper target anode.

A thin concave bubble window of 0.25mm thickness is hand blown into the borosilicate glass envelope to transmit a high proportion of the characteristic radiation without recourse to other more expensive window techniques.

The cathode is a helical filament made of tungsten wire and the cathode/anode geometry provides a very small focal spot.

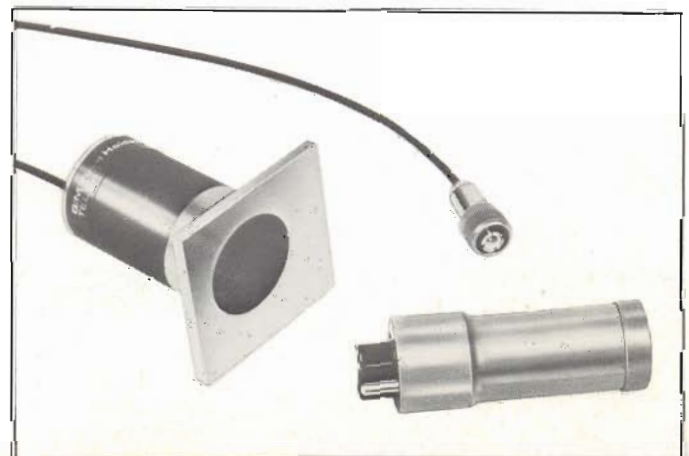
- Continuous rating      o      30kV, 80 $\mu$ A
- Heater supply            o      4V, 1A
- Dimensions              o      100mm long, 32 diameter
- Mounting                 o      B13G type



## Geiger-Muller Tube TEL 546 & Holder TEL 547

The majority of experiments which can be performed with the Tel-X-Ometer require the X-rays to be detected by a G.M. Tube in association with a Ratemeter or Scaler.

The typical intensities and recommended geometric conditions detailed in the laboratory manual are all relevant to the G/M Tube TEL 546 (MX 168) mounted in Holder TEL 547; the Ratemeter Monitor TEL 807 and the Scaler Monitor TEL 806 (in conjunction with Lapsed Time Unit TEL 805) have been designed to monitor Tel-X-Ometer experiments with both simplicity and maximum didactic impact.



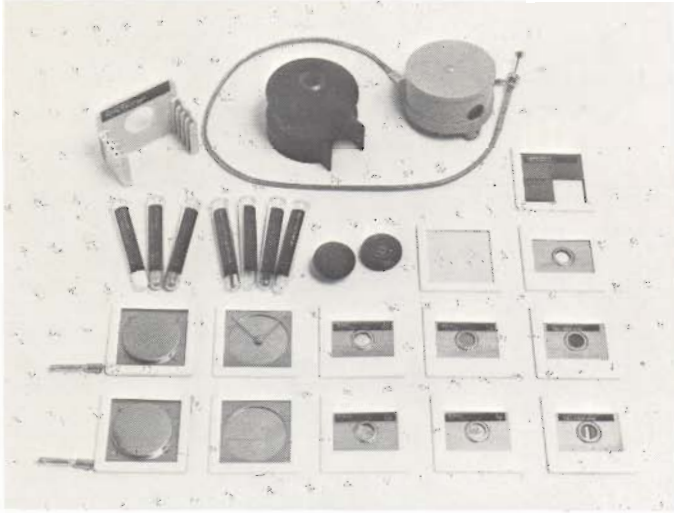


A series of accessories are available to enable the educational potential of the Tel-X-Ometer to be fully exploited

### Basic Accessory Kit TEL 582

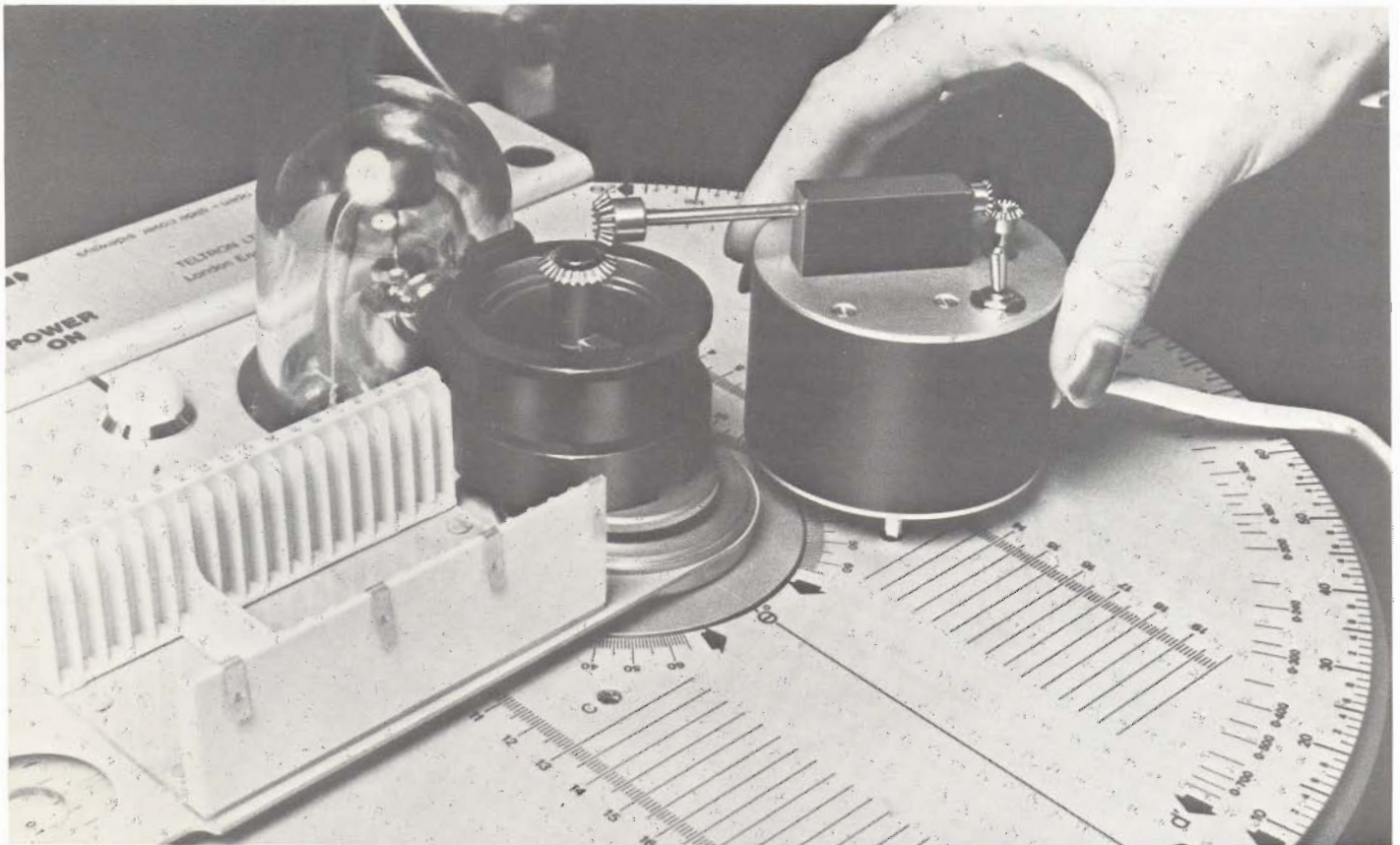
A Kit of 26 components including Collimators, Luminescent Screen, Film Cassettes and all the items necessary to perform more than 30 experiments.

Thin foils of Nickel, Copper, Cobalt and Zinc are included which are used to evaluate the Mass Absorption Co-efficient; they are also used in conjunction with a Rotary Radiator which presents the above 4 elements, and in addition Iron, Vanadium, Manganese and Chromium, to the primary X-ray beam; these 8 elements are sequential in the Periodic Table and secondary emission from them is analysed to verify Moseley's Law.



The classical Bragg relationship can be established using large single crystals of Sodium Chloride and Lithium Fluoride and additionally Planck's Constant can be derived from the minimum wave-length cut-off; small mini-crystals of LiF are included to record Laue and upper layer-line photographs; finely divided LiF powder and copper wire strands can be used to demonstrate Debye-Scherrer analytical techniques with a special self-locating Powder Camera.

The Powder Camera and Film Cassettes included in Kit 582 have been designed for use with the Teltron Filmpaks.



### Motorised Drive Unit TEL 587

Rotation within the Powder Camera of single crystals and powders can be achieved using a Motorised Drive Unit which can be easily installed within the radiation scatter shield.

The unit is mains driven, is switched and is supplied complete with key to adjust the drive bevel position.



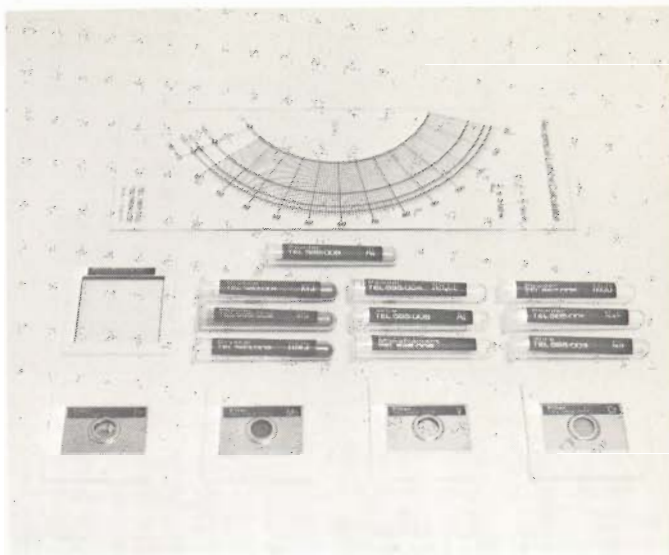
## X-Ray Crystallography Kit TEL 583

This kit of 16 specially prepared elements is intended to supplement the Basic Kit for educational establishments offering comprehensive practical work studies.

For a more comprehensive study of Moseley's Law four more thin foil slides are included, those of Iron, Vanadium, Manganese and Chromium; together with the 4 slides of the Basic Kit there can now be 8 thin foil filter slides to be used in conjunction with the 8 element Rotary Radiator.

There are 5 phials of finely divided powders, 2 phials of drawn wire and large single crystals of Potassium Chloride and Rubidium Chloride; all these materials are used in a carefully integrated study of the salient features of crystallographic analysis.

The Kit contains a Reciprocal Lattice Calculator for ascertaining at which angles of the G.M. tube carriage ( $2\theta$ ) reflections may be expected from each of the four single crystals.

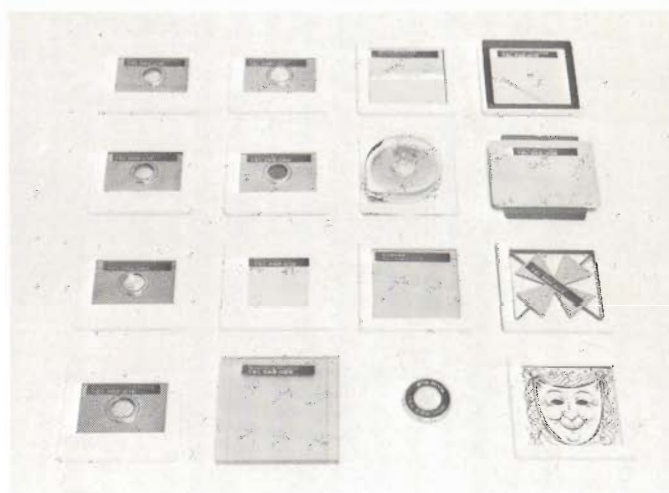


## X-Ray Radiography Kit TEL 584

This kit is also intended to supplement the Basic Kit but for establishments teaching the application of X-rays; non-destructive testing apprentices, colleges of art, teaching hospitals and for adult education courses.

It comprises 16 components with which the Production and Properties of X-rays can be studied and additional emphasis is directed to scattering, differential absorption and linear absorption co-efficients; to the relationship between penetration, resolution and exposure time, accelerating voltage and tube current.

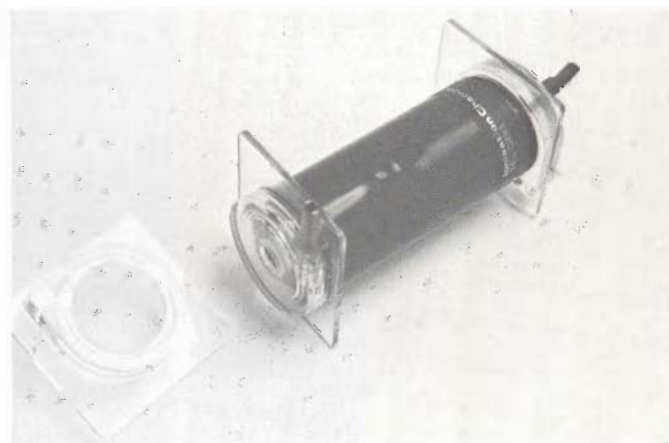
Experimental evidence of the importance of shielding materials, half-thickness and radiation terminology are all highlighted through simple practical experiences involving the components of the Kit.



## Ionisation Chamber TEL 588

A simple didactic ionisation chamber which can be mounted on the slide carriage of the Tel-X-Ometer to Investigate the ionising intensity of the X-ray beam; it can be used to calibrate the G.M. Tube.

The chamber is demountable and can be used at atmospheric pressure, evacuated or gas-filled; supplied complete with open and closed windows and connectors; polarisation is up to 2,000 Volts d.c. and a d.c. amplifier is required, capable of measuring currents down to  $10^{-11}$  Amps.







## Lapsed Time Unit TEL 805

A self-contained electronic stop-watch with six preset times; allows the student to perform calculations, progressively draw graphs, prepare absorbers, scatterers etc. during the course of an experiment, thereby making the most of valuable practical work periods, avoiding the laborious use of manual stop-watches.

Particularly convenient in atomic physics experiments where low count rates require the use of a Scaler rather than a Ratemeter.

**Lapsed Times:** Low Count rates: 10s, 30s, 100s (for counts per second). Very low count rates: 1 min, 3 min, 10 min, 10 min (for counts per minute).

**Accuracy:**  $\pm 1\%$

**Power Input:** 110, 220, 240V  $\pm 10\%$ , 50/60 Hz.

**Power Selector:** 'Power On' neon indicator lamp. 'Event ON' indicator lamp.

### General:

**Housing:** Aluminium Alloy diecast box.

**Ambient Temp.:** 35°C (95°F) max.

**Dimensions:** W, 120; D, 210; H, 100mm. **Weight:** 1.0kg.

### Controls:

**Lapsed time Selector:** 6-way rotary switch.

**Start Switch:** Locking press-button; press to start, release to zero.

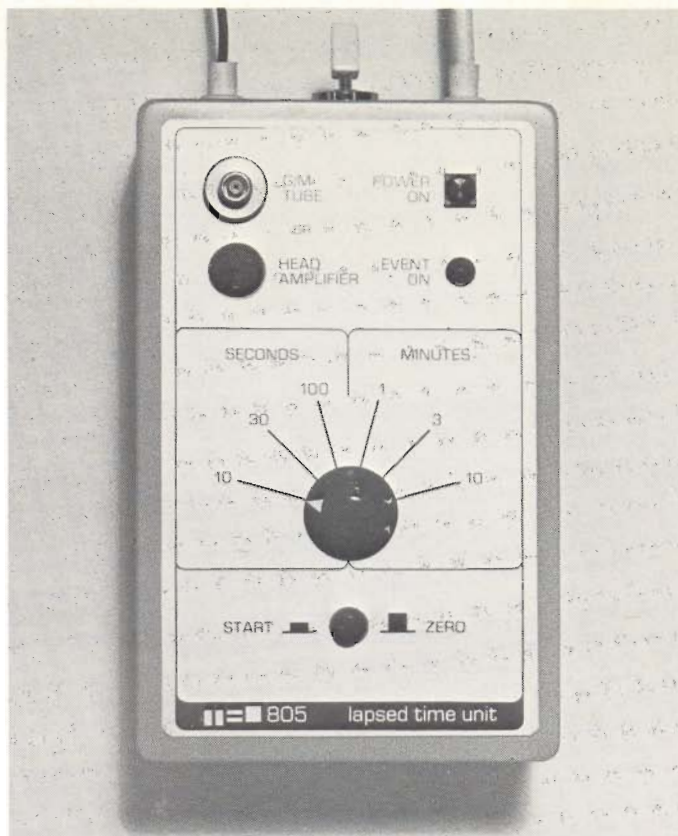
**Note:** Scalers should be reset to zero after each timed interval.

### Connections:

**Input:** G.M. Tube; co-axial socket type PET 142. Head Amplifier, 6-pin DIN socket.

**Output:** Integral cable, 30 cms long terminated with PET plug type 101.

**Mains Cable:** Integral, two metres long.



## Scaler Monitor TEL 806

A very versatile digital scaler, particularly applicable to atomic physics investigations; a built-in variable polarising supply provides the direct connection of Geiger-Muller tubes for  $\alpha$ ,  $\beta$ ,  $\gamma$  and X radiation experiments; a miniature secondary meter displays the G.M. Tube polarising voltage and can be switched to monitor external current sources up to 100 $\mu$ A fsd.

The unit is especially suitable for use with the TEL-X-OMETER.

**Signal Input** Square and Sinusoidal Waveforms and pulses.

**Sensitivity:** Squarewaves and pulses: 50mV  
Sinusoidal waves: 250mV

**Resolution:** Better than 1.0 $\mu$ S.

**Frequency Range** 10 Hz-200 kHz

**Display, Visual:** five in-line seven segment digital indicators, height 14mm, with non-reflecting, high definition, red filter and 100 degree viewing angle.

**Count Range:** 0-99999, with suppression of leading zeros and overspill indicator for final 9.

**Timer Range:** (with Timer Module TEL 805) 0-9,9999 seconds, with decimal point and all zeros displayed and overspill indicator on final nine.

### Meter

**Calibration:** 1-10

**Scale length:** 25mm, 100 $\mu$ A, linear

### Power Input

110, 220, 240V  $\pm 10\%$ , 50/60Hz.

**Power Selector** Situated underneath

**Power On Neon** indicator lamp.

### General

**Housing:** Glass fibre reinforced resin moulding on cast aluminium base.

**Ambient Temp.:** 35°C (95°F) max.

**Dimensions:** W: 180; D: 230; H: 150mm

**Weight:** 3.5 Kg.

### Controls

**Display** Four press-button switches:

(1) and (2) START and STOP, interlocked.

(3) RESET – non locking displaying five zeros when depressed, blank screen on release.

(4) 99999 – non-locking; displaying five nines both when depressed and when released.

### Meter Function Selectors

Two non-locking press-button switches:

(1) Press to read external current, 100 $\mu$ A fsd.

(2) Press to read GM Tube Voltage, 1000 Volts fsd.

### Set GM Tube Volts

A screw-driver slot preset: 350-450 Volts DC.

**Audio Control Knob** Volume control of integral loudspeaker, giving audio indication of count rate.

**Power On/Off Switch** Situated at back.

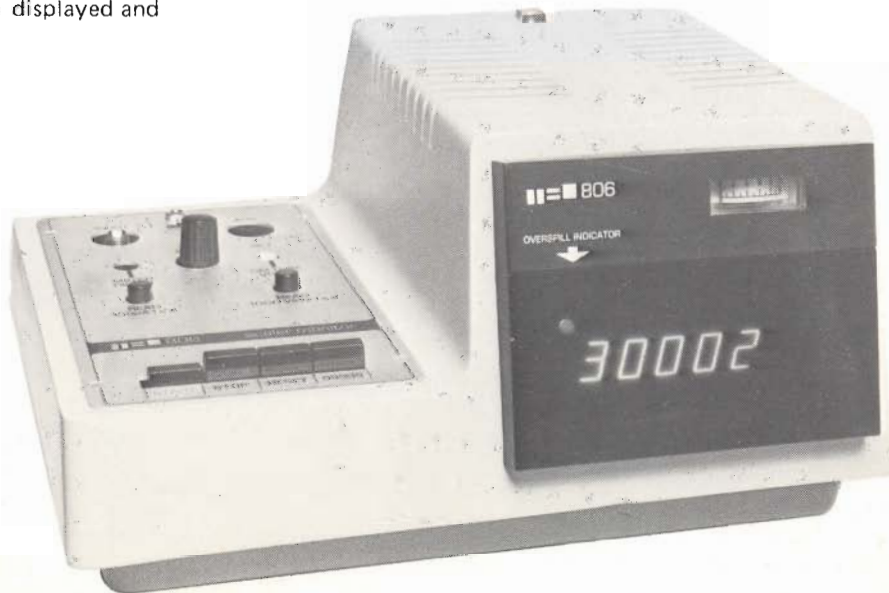
**Connections** **Signal Input:** Co-axial socket, type PET 142

**Meter Direct,** for external current:

Miniature jack socket; plug supplied

**Auxiliary Connector:** 6-pin DIN socket for add-on modules.

**Earth:** 1 x 4mm socket. **Mains Cable:** Integral, 2 metres long.





## Ratemeter Monitor TEL 807

A general purpose ratemeter fully metered, especially suitable for use with the TEL-X-OMETER.

A built-in variable polarising supply permits the direct connection of Geiger-Muller tubes for  $\alpha$ ,  $\beta$ ,  $\gamma$  and X radiation experiments; the large meter can be switched on to monitor both the G.M. Tube polarising voltage and an external current source up to  $100\mu\text{A}$  fsd.

### Signal Input

Square and Sinusoidal Waveforms and pulses.

**Sensitivity:** Squarewaves and pulses: 50mV

Sinusoidal waves: 250mV

**Resolution:** Better than  $1.0\mu\text{S}$ . Frequency 10 Hz - 75 kHz

### Metering

**Calibration:** Scale A: 0-100. Scale B: 0-250; Scale C: 0-750

**Scale length:** 119mm,  $100\mu\text{A}$ , linear

**Accuracy:** Better than  $\pm 2\%$  of fsd.

**Drift:** Less than  $\pm 2\%$  of fsd in 1 hour

**Power Input** 110, 220, 240V  $\pm 10\%$ , 50/60 Hz.

**Power Selector.** Situated underneath

**Power On Neon** indicator lamp.

### General

**Housing:** Glass fibre reinforced resin moulding on cast aluminium base.

**Ambient Temp:**  $35^{\circ}\text{C}$  ( $95^{\circ}\text{F}$ ) max.

**Dimensions:** W: 280; D: 230; H: 150mm. **Weight:** 2.7Kg.

### Controls

**Meter Function Selector (Primary).** Four press-button switches interlocked:

- (1) 100; count rate range 0-100 counts per second, time constant: 20 seconds.
- (2) 250; count rate range 0-250 counts per second. time constant: 10 seconds.
- (3) 750; count rate range 0-750 counts per second, time constant: 10 seconds.
- (4) 7500; count rate range 0-7500 counts per second, time constant: 10 seconds.

Additional press-button for frequency measurements:

- (5) 75000; count rate range 0-75000 counts per second, time constant: 10 seconds.

**Meter Function Selectors (Secondary).** Two non-locking press-button switches:

- (1) Press to read external current, SCALE A,  $\mu\text{A}$ .
- (2) Press to read GM Tube Voltage, SCALE C, volts.

**Set GM Tube Volts.** A screw-driver slot preset; 350-450 volts DC

**Audio Control Knob.** Volume control of integral loudspeaker giving audio indication of count rate.

**Power On/Off Switch:** Situated at back.

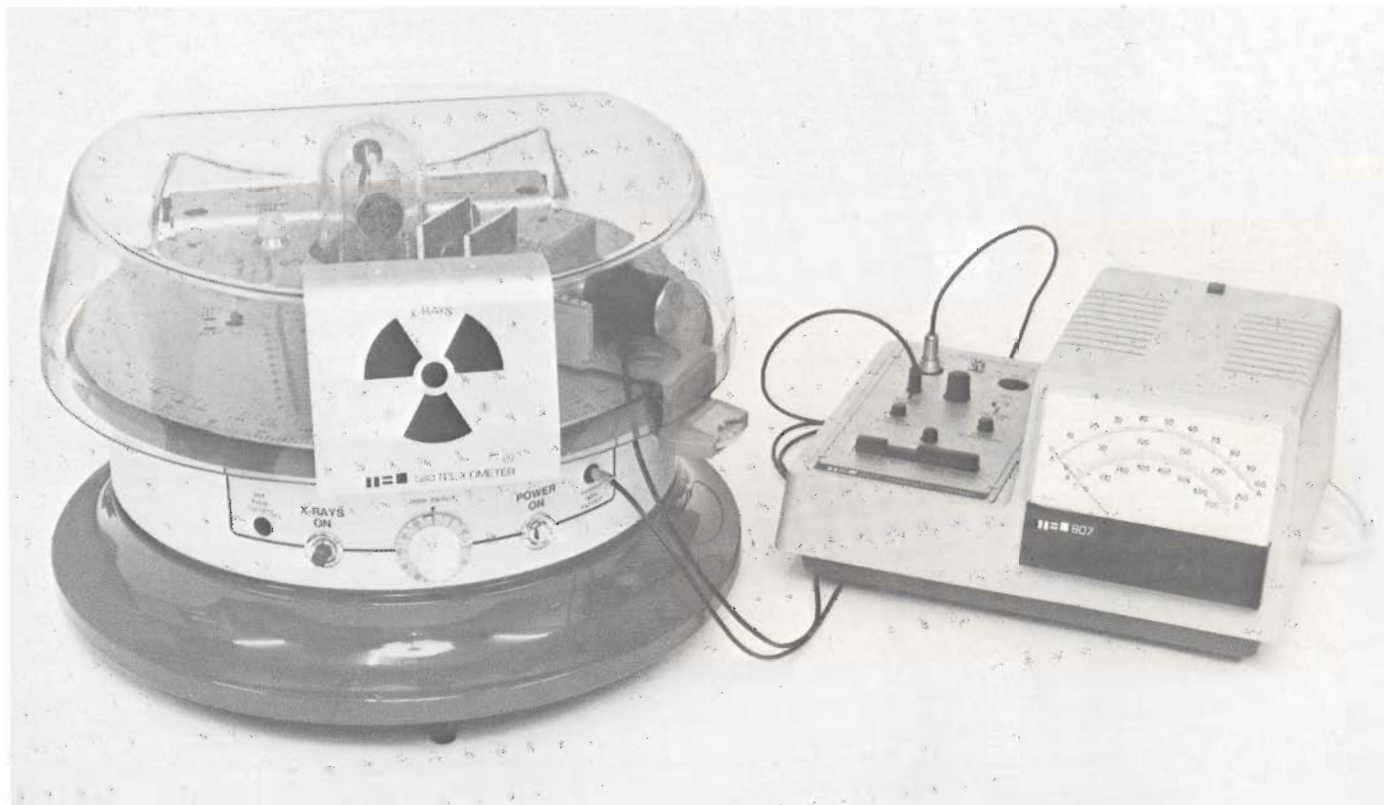
### Connections

**Signal Input.** Co-axial socket, type PET. 142.

**Meter Direct,** for external current; Miniature jack socket: plug supplied.

**Auxiliary Connector.** 6-pin DIN socket for recorder.

**Earth:** 1 x 4mm socket. Mains Cable' Integral, 2 metres long





# TELTRON

## Atomic Physics Educational Apparatus

The TELTRON philosophy of educational equipment takes account of the changing needs of the many different countries throughout the World. However, the basic needs of educationalists everywhere hardly changes; sound teaching principles, good equipment and solid value for money are universal requirements. TELTRON aims are to provide that and more. We at TELTRON look ahead and anticipate future teaching needs, we do this with the teachers help. Our equipment is developed in consultation with teachers and based on the research of educationalists. Our policy of continuing development incurs, however, a possibility that the equipment described and illustrated in this brochure may be subject to modification without notice.

### Worldwide Distribution

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