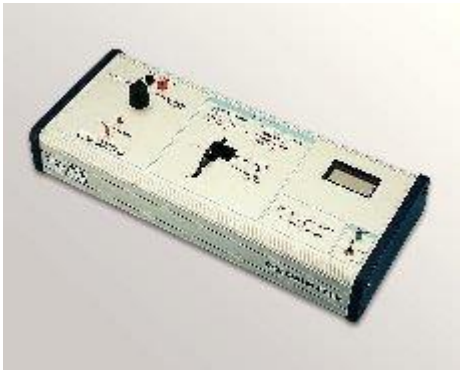
H28068 S Range Digital Colorimeter **NFU 208**



Purpose

The colorimeter is a mains operated, direct reading instrument designed for use in chemistry and biology courses up to advanced level.

As well as enabling the principles of colorimetric analysis to be taught in schools and colleges, it can be used for the quantitative determination of substances present in small amounts and to monitor the course of a reaction which is accompanied by a change in the absorption of transmitted light.

Ratings

Check the operating voltage rating label on the instrument

Mains input 210-250V 50/60Hz 3W

Mains cable Detachable 2m long

Temperature range: 10 to 40°C Humidity: 10 to 90% RH Mass: 4.8kg

Warnings

For your safety, this product should be used in accordance with these instructions, otherwise the protection provided may be impaired.

EMC

This equipment is Class A according to the EMC standard EN 55011 and is intended for use in a non-domestic environment only.

Do not open or remove covers or panels. Repairs and service may only be carried out by our repair agent, otherwise the warranty may be void.

version H28068.17.11

Use only the 3-core mains cable supplied with the unit. If the mains cable is replaced, the rating of the replacement must be the same or better than the original.

The unit must be earthed at all times. The unit is earthed/grounded through the 3-core mains lead, so no additional earth connection is required.

Always position the unit so that it can be disconnected from the mains, if an emergency arises.

This unit is intended for use in DRY conditions. Avoid spillage of water and other liquids on to the unit. If spillage occurs, disconnect the mains supply.

There is no specific requirement for insulation of external circuits as they cannot become hazardous live, as a result of connection to this unit. Limit the length of any connecting leads to 3 metres.

For your safety, this product should be used in accordance with these instructions; otherwise, the protection provided may be impaired. Risk of shock if the unit is opened. Use only the 3-core mains cable supplied with the unit.

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Theory of Colorimetry

Colorimetric analysis is defined as the technique of matching visually the colour of a solution containing the constituent to be determined against the colour of standard solutions containing known concentrations of that constituent.

In fact, colorimetric analysis is one branch of 'photometric chemical analysis', which also includes 'absorptiometry' and 'spectrophotometry', although nowadays colorimetric analysis includes the techniques of 'turbidimetric' and 'nephelometric' analysis which involve respectively the measurement of light absorbed or scattered by a suspension. Colorimetric analysis involves the determination of small concentrations of substances where the substance is coloured, or reacts with a suitable reagent to produce a coloured substance.

The colorimeter consists of a light source, a filter to select the appropriate range of wavelengths, a photocell whose electrical resistance is proportional to the intensity of light falling on it, and an LCD digital display. The sample is placed between the light source and the photocell.

The meter is usually calibrated to indicate the intensity of the light transmitted by the sample.

The Lambert-Beer law.

The passage of a beam of monochromatic light through a solution results in a fraction of the light being transmitted and the rest being reflected or absorbed. The amount of light penetrating the solution is know as transmittance.

$$T = It/I0$$

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Where:

T is transmittance

It is the intensity of light transmitted by the solution

I0 is the intensity of light incident upon the solution

The relationship between transmittance and absorbance is given as: A = log(1/T)

Where:

A is absorption

The Lambert-Beer Law (sometimes referred to simply as 'Beer's Law') relates the extent of absorption of monochromatic light by coloured solutions to their molar concentration, through the following equation:

$$E = \varepsilon cd$$

Where:

E is extinction

c is the concentration of the coloured species in mol dm-3

d is the length of the light path through the solution

ε is the molar extinction coefficient and is characteristic of the absorbing species and the wavelength of the light used.

The transmission of the coloured solution is shown as a percentage (0 to 100) on the LCD. The absorbance (or optical density) is shown on the LCD as a value between 0 and 2.

The absorbance is proportional to the concentration of the coloured species only if the length of the light path through the solution (d) is constant. This is ensured by using 'identical' cells (cuvettes) in the colorimeter.

Despite this, deviations from the LambertBeer Law will be observed if colour filters are used with wide pass bands. Such filters give rise to polychromatic light rather than the monochromatic source required. The filters supplied in the colorimeter are such that this error is reduced to a minimum, thus improving the accuracy of measurements made with the instrument.

In practice, the accuracy of photometric methods of analysis is limited at both high and low values of concentration. At low concentrations, the error in reading the meter is large when compared with the concentration of the species present whilst at high concentrations of absorbing species so little of the light passes through that the sensitivity of the instrument is often inadequate.

For this reason, and the fact that all photocells have differing physical characteristics, it is important to realise that suitable concentrations for specific experiments depend on the characteristics of the instrument being used. It is therefore vital that experimental details specified for one instrument are checked in the actual colorimeter to be used, prior to student use, thus ensuring that satisfactory results can be obtained. The instrument can also be used for turbidmetric analysis, without any

modification, where the precipitate produced is relatively heavy. In such experiments, it is advisable to use a blue filter for the greatest accuracy.

Filter:

Filters are used in colorimetry to select light from a specific spectral region, which in turn improves the accuracy of the determinations made. The most suitable filter is one which selects the range of wavelengths most strongly absorbed by the coloured species. The correct filter thus gives maximum absorption or minimum transmission for the particular solution under test.

The obvious method to choose when deciding on the filter to use is therefore to test each one in turn with the coloured solution to be used, selecting the one which gives the characteristics specified above. Another method of selection is to choose a filter having a colour which is complementary to the colour of the solution, e.g. for red coloured solutions, a blue-green filter is suitable.

The filters provided in the colorimeter are the Ilford Standard Spectrum Filters, a series of eight narrow pass filters. The transmission ranges (in nanometres) of the filters, along with their colour and Ilford Number, are given below:

Filter Number	Colour	Wavelength Range (nm)
601	Violet	380 - 470
602	Blue	440 - 490
603	Blue/Green	470 - 520
604	Green	500 - 540
605	Yellow/Green	530 - 570
606	Yellow	560 - 610
607	Orange	580 - 700
608	Red	625 – IR

A list of complementary colours, to aid filter selection, is given below:

Colour of Solution	Complementary (Filter) Colour
Violet	Yellow/Green
Blue	Yellow
Blue/Green	Red
Green	Purple
Yellow/Green	Violet
Yellow/Green	Blue
Orange	Green/Blue
Red	Blue/Green
Purple/Red	Green

Apparatus details

The instrument is mains operated and is housed in a metal case with moulded plastic ends. It is protected by a mains fuse mounted on the internal circuit board.

All the controls are on the top panel.

The instrument comprises essentially a stabilised power supply circuit which maintains a constant light output from an incandescent bulb. The light beam passes from right to left through the cuvette, then through a filter, selected by a rotatable disc, to a silicon photo-detector.

The photo-detector is connected to a logarithmic amplifier to produce a linear absorbance output indicated on a moving coil meter. The transmission range is obtained by inserting an exponential amplifier after the logarithmic amplifier to produce a linear output.

Two ranges of absorbance, 0 - 1 and 0 - 2, and a single transmission range, 0 - 100%, are selected by a 3-position rotary switch. The circuitry features electronic control of gain providing automatic zeroing with a single press of a push button.

The cuvette holder is part of a subassembly, moulded in plastic, which comprises the light source, infra-red glass filter, rotating disc filter selector and photo-detector. The design of this unit is such that the instrument is insensitive to normal ambient lighting. In the event of the accidental spillage of a solution, the liquid drains through a hole in the base.

The disc filter holder may be removed for cleaning or replacement by pulling it vertically from its socket.

In addition to the moving coil meter, a 0 - 1V output provided for use with a data logger.

Operator controls include:

- An ON/OFF mains switch with neon indicator.

- A3-position switch which selects one of two absorbance ranges or the transmission range

- A push button PRESS to ZERO switch

- A filter selector disc control

Operating Procedure

1. Connect the instrument to a mains supply of the correct voltage, switch on, and allow 10 - 15 minutes for it to warm up and stabilise.

2. Rotate the filter disc until the required filter number is at the top of the disc.

Ensure that it clicks into the correct position.

3. Set the range switch to:

(i) Absorbance 0 - 2, or

(ii) Transmission 0 - 100%

The LCD will display values according to the range setting.

4. Insert a reference cuvette. This will normally be a cuvette containing a clear solution or water. As the light path is from right to left, the ground glass or ribbed sides of the cuvette must be at the top and bottom.

5. Press the 'PRESS TO ZERO' button. The red indicator light above it, will turn on and the display will set to 0 for the absorbance range or to 100% for the transmission range. If the absorbance of the reference solution is too great, the red light will remain on and the display will flicker between values. This will only occur if an absorbing reference solution is used. The concentration of the reference solution will then have to be reduced (see Specification).

6. After adjustment and zeroing, the reference solution is replaced by a cuvette containing the solution to be tested and reading is taken.

Changing ranges

For the greatest accuracy, the instrument should be zeroed regularly, with the reference solution, on the range on which readings are to be taken. Whenever the filter is changed, the instrument should be reset to zero, using the reference solution.

Volume of solution required

The light path through the cuvette is near to the bottom so that it only needs to be 2/3 to 3/4 full. Always check that the outside of the cuvette is clean and dry before inserting it in the instrument.

The cuvette protrudes out of the holder to enable it to be easily gripped. Do not place cuvettes containing liquids on top of the instrument. The top surface is not flat. They should be kept well away so that spilt chemicals can do no harm.

Maintenance and servicing

Removing the filter disc

The filter disc can be removed by pulling it vertically out of its socket. Avoid touching filters with fingers. Filters can be cleaned with a very soft (lens) brush or a clean dry soft cloth.

Replace the disc with the numbers on the right. Do not force it in the wrong way round.

Changing the lamp

1. Remove the cuvette, unplug the unit at the mains and take the instrument away from chemicals.

2. Unplug the detachable mains lead from the instrument.

3. Remove the filter disc as explained above, turn the unit upside down and remove the centre and two end screws.

4. Remove the two larger screws holding each end cap in place.

5. Pull off the end caps and remove the bottom plate.

6. The bulb can now be changed. Do not attempt to alter the position of the lamp socket. The correct replacement is a 11mm E10 round MES lamp 6.5V 0.15A.

7. Replace bottom plate, end caps and screws. Do not over tighten the centre bottom screw. Replace the filter disc.

Fault finding

If the instrument does not work and the mains indicator is on, but there is no light through the cuvette socket, the bulb probably needs to be changed.

If the fuse in the mains plug is operational and the mains indicator does not go on, either the mains connecting lead or the instrument itself is likely to be faulty.

If the internal mains fuse is open circuit, there is likely to be another fault and the instrument should be tested before replacing the fuse.

Specification

Operating ranges

(i) Absorbance 0-2, photometric linearity ±0.04A

(ii) Transmission 0-100% photometric linearity ±2%

Maximum Range (i) Absorbance 1.0A recommended initial absorbance of

(ii) Transmission 10% reference solution

Adjustment Automatic push-button zeroing with LED indicator

Drift after 15 minutes Range (i) ±0.01A/hr typical warm-up time

(ii) ±3%/hr typical

Indicator 3 digit liquid crystal display

Output 0-1V, external meter or computer, maximum recommended current 2mA internal resistance 500Ω

Light source Round E10 11mm diameter (MES) tungsten lamp 6.5V 0.15A.

Typical life 3000 hours

Detector Silicon photodiode

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Filters 8 Ilford filters on a removable, indexed disc, 75mm diameter

Cuvette socket to take standard 10mm square cuvettes

Circuit protection Internal 20mm fuse F50mA

Dimensions	380 x 160 x 80mm
Weight	1.5kg approximately
Spare filter discs with filter	A58750
Spare lamp 6.5V 0.15A	A58762
Spare cuvettes	Plastic -A60069 Glass - A60070

Periodic testing

Check the mains lead and plugs at either end, for any damage.

Periodically check the earth bonding and insulation, by performing a Portable Appliance Test (PAT). Most schools and local authorities have a regular schedule for such testing.

Check that the fuse in the mains plug (5A recommended) are of the correct rating.

Instructions for authorized service technicians

Ensure that any replaceable mains cord is of the correct rating.

Ensure that all earth conductors and protective earth bonding is maintained after service work.

Please refer to the detailed service procedures, safe servicing and continued safety – contact techsupport@philipharris.co.uk for advice.

For any manufacturer specific parts please refer to our recommended repairer.

Please refer to product specific risks that may affect service personnel, the protective measures and verification of the safe state after repair.

Disclaimer

If the equipment is used in a way not specified by Philip Harris, then the protection provided may be impaired.

Warranty, repairs and spare parts

The power supply is guaranteed for a period of one year from the date of delivery to the customer. This warranty does not apply to defects resulting from the action of a user such as misuse, improper wiring, any operations outside of its specification, improper maintenance or repair, or unauthorized modification.

Our liability is limited to repair or replacement of the product. Any failure during the warranty period should be referred to Customer Services.

version H28068.17.11

In the event of a fault, apart from replacing the instrument fuse in the IEC socket, the power supply should be referred to the Philip Harris recommended repair agent.

Disposal of Waste Electrical and Electronic Equipment (WEEE)

Do not dispose of this product with household waste

- For the proper treatment, recovery and recycling please take this product to an appropriate collection point.
- If you are unsure where this is, contact your Local Authority.
- By disposing of this product correctly you will be providing positive help to the environment.

Supplier Details

Philip Harris Education, 2 Gregory Street, Hyde, Cheshire, SK14 4RH

Orders and Information Tel: 0845 120 4521

Fax: 0800 138 8881

Repairs Tel: 0845 120 3211

E-mail: techsupport@philipharris.co.uk

Website: www.philipharris.co.uk

version H28068.17.11