Colorimeter Sensor

for the LogIT Microsense® system

Instructions & Resources

Overview

The basic principal of colorimetry is to measure the absorbance of a coloured solution to different colours of light shone through it as this has a direct relationship with its mole concentration (eg Beer's Law and Lambert's Law).

The LogIT Colorimeter is an easy to use sensor which has a three colour solid state LED light source of known Red, Green and Blue bandwidths which are passed through the sample and measured by a visible light level sensor.

The measured value is either displayed in Transmittance (%T) or Absorbance (Abs), depending on the experiment type and method. (For information, Absorbance is derived from log (100/%T), but this is usually done for you by selecting the Abs scale in your datalogging software)

Using the LogIT Microsense Colorimeter

Cuvettes

Solutions to be measured are put into a small square test tube like vessel called a Cuvette. The LogIT Colorimeter uses standard 10mm size cuvettes which are available in a number of grades and made of plastic or glass - a sample is included with the set.

They are readily available from most lab and chemical suppliers as a low cost consumable and depending on your budget can be disposed of after use or thoroughly washed then reused.

Note that it is crucial that all samples are only put into a cuvette and never directly into the colorimeter itself or damage will certainly result - the colorimeter labelling makes this very clear for the benefit of new users.

Each cuvette varies slightly optically, so when the procedure involves changing the concentration of a solution best practice is to use the same cuvette for the complete experiment. Most cuvettes have only two optical faces which are very clear, the other two usually being duller or sometimes embossed to make them easier to grip.

When filling a cuvette with a solution it is best to use a syringe or pipette and fill to no more than 10mm from the top of the cuvette. Always ensure the outside of the cuvette is completely clean and dry before inserting into the Colorimeter otherwise you will probably damage the instrument and will not achieve good or consistent results.

Ensure that the two clear optical faces are inserted into the colorimeter facing the light path inside the instrument, indicated by arrow heads on the label.

Measurement units

Where the experiment is looking at a continuous change or a rate of reaction is being measured, then Transmittance (%T) against time is usually used and is the default scale on all LogIT displays.

Where you wish to plot absorbance against set concentration levels such as in Beer's Law (usually done manually as a set of single 'snap-shot' readings), then you should select the alternative Absorbance (Abs) scale - this is usually available as a scale option in most software package such as LogIT Lab, Insight etc.

The resources shown overleaf are available in PDF form at www.logitworld.com

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Stability

Note that all Colorimeters are very sensitive instruments and for best results use them in a constant temperature and switch them on for enough time for the electronics to stabilise before using - most LogITs have a 'Meter stay on' function to easily enable this.

Pack contents:

- Colorimeter with fitted cable
- Cuvette cover (located and stored in compartment underneath)
- Sample Standard Cuvette
- Instruction booklet (this document)

General instructions for use

Preparation

- Remove the cap from storage compartment underneath the Colorimeter and stand in a clear dry area near the datalogger (and computer if being used).
- Connect Colorimeter to LogIT DataLogger and computer if required and switch on for 10 minutes or more prior to using - this gives time for the light source to stabilise.
- Do not use in extremely bright light such as direct sunlight which may affect readings
- Always ensure the outside of the cuvette is completely dry.
- Familiarise yourself with the optical sides of the particular cuvettes you use (usually transparent) and be sure to insert them so that these sides face the light path as marked

Recording changes in a sample over time with %T - ie rates of reaction

- If using computer to record and display results check scale is set to %T
- Carefully insert cuvette containing pure distilled water as reference, checking light path direction
- Cover sample with cap
- Select wavelength - normally opposing colour to sample, eg Blue for a Red sample, Red for Green, Green for a Blue sample.
- Adjust calibrate until display reads 100%T
- Carefully remove cuvette & replace water with sample, keeping outside of cuvette dry
- Carefully insert cuvette with sample into Colorimeter and cover with cap
- Start logging, either by pressing green button on LogIT or clicking Start on software
- Watch readings on LogIT screen or computer & stop logging when reaction ceased

Taking a series of individual readings with Abs mode - eg Beer's Law

- Select single reading (snapshot) mode on LogIT or computer
- If using a computer select Abs scale option if available
- Carefully insert cuvette containing clear water as reference - ensure outside is DRY
- Cover sample with cap
- Select wavelength - normally opposing colour to sample, eg Blue for a Red sample
- Adjust calibrate until display reads 100%
- Carefully remove cuvette & replace water with sample 1, keeping cuvette dry
- Carefully insert cuvette with sample into Colorimeter and cover with cap
- Take a single reading - normally by pressing green button once or Take reading on PC
- Remove cuvette & replace water with sample 2, keeping cuvette dry
- Carefully insert cuvette with sample into Colorimeter and cover with cap
- Take another reading - normally by pressing green button once or Take reading on PC
- Repeat above until you have recorded required number of samples then press stop

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Care

- Never let any liquid or moisture get near electrical equipment or into the Colorimeter except inside a cuvette which is dry outside. If an accident does happen, immediately disconnect the Colorimeter, remove the storage compartment lid and try to gently drain most of the liquid through the holes there. Then leave unit to thoroughly dry out near a source of warmth (not high heat). After a suitable period the unit can be tested but if water or other chemical corrosive damage has occurred please contact DCP for service.

- Keep Cuvettes clean. Generally they are designed as disposable items but with care can be reused. Take special care that they are clean and are not left with any corrosive or potentially dangerous chemicals inside.

- Do not overfill cuvettes - the maximum filling volume is 4 ml

- These notes are offered in addition to the standard safety and risk assessment guidelines applicable to your organisation.

Troubleshooting

If the sensor is not recognised by your software or datalogger, see www.logitworld.com
To upgrade the software click on the 'Support' tab and follow the on screen instructions.
To upgrade the datalogger, select the logger icon and then select 'Update' from the list on the left of the page. Note: Sensorlink, LogIT SL and LIVE only require a software update and so do not have an 'update' option on their respective pages.
Note the Colorimeter sensor is not compatible with CheckIT.

Specifications

Transmittance range: Typically 0.0 to110.0%T
Absorbance range: 0.05 to 1.05 Abs
Red source wavelength: 625nm
Green source wavelength: 568nm
Blue source wavelength: 455nm
Cuvette size: 10mm square type
Power supply: Powered from LogIT

"Water analysis"

Subject: Biology/Environment

Sensor: Colorimeter

Overview:
The Colorimeter can be used as a method of monitoring the formation of algae in water. When eutrophication occurs in streams and ponds, it is usually a result of human activity where the amount of nitrogen and phosphorus inorganic plant nutrient levels have been artificially increased due to fertilizer wash off from fields. This process without human interference, normally happens over a long period of time as dead organic matter accumulates.
Where an increase in either the phosphorus or nitrogen nutrients occurs then an algae bloom can result. Anyone who has set up an aquarium at home knows that this can be a real problem as the light struggles to reach plants and fish at the bottom, particularly if it is a deep tank.
This procedure uses the Colorimeter to monitor the light transmission through the water samples to see when algae is formed and what effect differing levels of liquid fertilizer has on the algae formation.

Equipment required: LogIT DataLogger
1 Colorimeter
1 Cuvette
1 Pipette or small burette
Some 2 litre plastic drink bottles
Liquid household fertilizer
Pond water
Aquarium fluorescent light or lights (You can of course use natural sunlight)
Distilled water
Paper towels or tissue paper to dry the cuvette
Large cardboard box to cover the water bottles

Hazards:
Any sample of water must never be consumed.
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous materials or chemicals.

Calibration:
1. Fill a cuvette with 4 ml of distilled water and place it in the colorimeter.
2. Place the cap on and then adjust the calibration dial until you obtain 100% T (Transmission)

Monitoring:
1. Take 4 ml of water from the plastic bottle being monitored.
2. Place the water into a cuvette and place in the colorimeter. (Select the BLUE light source)
3. Take a 'snapshot' reading of the sample.
4. Repeat for each of the bottles.

Method:
1. Fill 5 plastic bottles with pond water.
2. Label the bottles 1 to 5
3. Put 5 ml of liquid fertilizer into bottle 1 and add 5 ml increments to bottles 2, 3 and 4. (ie. bottle 4 has 20 ml of liquid fertilizer) Don't add any to bottle 5.
4. Put an aquarium fluorescent tube over the bottles in a large cardboard box.
5. Monitor the light transmission using the Colorimeter daily. (You can note the results in a spreadsheet)

Note: You might like to use more bottles so as to have repeat data on each of the fertilizer concentrations. Also, don't forget to calibrate the Colorimeter and also use the same cuvette.

Results:
Hopefully the results will show an algae 'bloom' occurring either sooner or later in the bottles and the time taken should relate to the levels of fertilizer in the water.

Going further:
You may like to monitor a real aquarium. If so, do so with a newly set up one as these very often develop algae problems early on in their life.
Try monitoring an aquariums light, pH and dissolved oxygen levels. Can produce some interesting results.

Product number: D200245 Document number: D773245/1

"Concentration of liquid (Beer's Law)"

Subject: Chemistry

Sensor: Colorimeter

Overview:
This procedure shows how the colorimeter can be used to measure the concentration of an unknown sample using Beer's Law. In low concentrated solutions the amount of light absorbed at a specific wavelength is directly proportional to the concentration of the solution, this is Beer's Law. At higher concentrations, the proportionality is lost.

This procedure will use a blue food dye to plot an Absorbance (Abs) against concentration (%) calibration graph and then use the graph to show how unknown concentrations can be found.

Equipment required: LogIT DataLogger
1 Colorimeter
1 Pipette or Micro Burette
1 Cuvette
Blue food colouring
Distilled water
Paper towels or tissue paper to dry the cuvette

Hazards:
Goggles should be worn.
Food colours can stain clothing so possible use of aprons or trays to prepare samples could be used.
If using this procedure for obtaining concentrations of other chemicals such as Copper II Sulphate, always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or chemical.

Setup of solutions and datalogger:

1. Make up a 100% solution of food colouring and distilled water. (We used 5 drops in 1 litre)
2. Make up a selection of concentrations. We used 20%, 40%, 60% and 80%

Hint: This can be done either in large beakers for the class to use or they can be made up by the pupils in the cuvettes. This is a good procedure for pupils to learn about accurate liquid measurement.
Using 5 ml cuvettes, it is a good idea to use a total of 4 ml in the cuvette so as not to run the risk of the liquid sample spilling into the colorimeter.
The samples were then made up as follows:-

80% = 3.2 ml of 100% solution + 0.8 ml of distilled water
60% = 2.4 ml of 100% solution + 1.6 ml of distilled water
40% = 1.6 ml of 100% solution + 2.4 ml of distilled water
20% = 0.8 ml of 100% solution + 3.2 ml of distilled water

These are the 'known' concentrations. All five (4 above plus 100%) could be used for the calibration graph, you would then need to make up some 'unknown' samples for the pupils to test or you could use three for calibration and then 2 of the above samples for the pupils to try and obtain from their graphs. For this example we used all five for the calibration and then made up a 25% and then a 65% solution for the 'unknown'

3. Connect the colorimeter to a channel on the datalogger.
4. Start the datalogging software.

"Concentration of liquid (Beer's Law)" (continued)

Setup of software:
This setup uses LogIT Lab as an example, Insight setup is similar.

1. From the 'Select New Activity' screen, select 'Set Up'
2. Select 'Snapshot' from the setup wizard and click 'Next'
3. Click the down arrow next to the Colorimeter 0 to 110 %T scale and select 'Colorimeter, 0.000 to 1.300 Abs' as shown in fig 1 and then click 'next'.

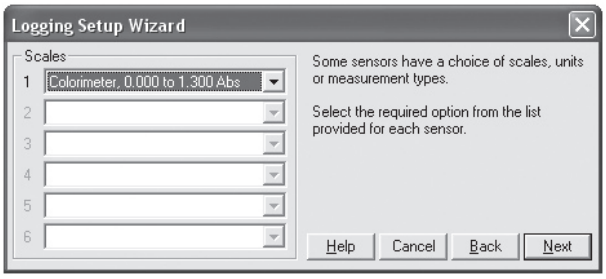


fig 1.

fig 2.

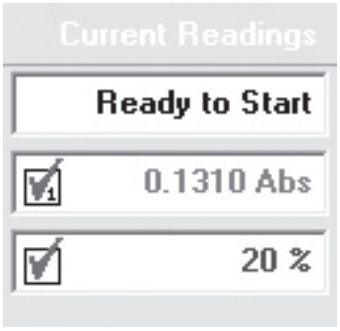


fig 3.

4. Click 'Finish'.
5. Now you need to set up the concentration on the x-axis.
6. Place the cursor into the Abs readings box on the right of the LogIT Lab screen and right click. A menu should appear as shown in fig 2.
7. Select 'Add Field..' and enter 'Concentration' in the Name field, '%' in the Units field and then the concentration value of your first known sample eg. if measuring the 20% sample, enter 20 in the Value field. Then click 'OK' and then click on the small white box to the left of the 20%. (fig 3.)
8. Now, right click on the X axis and select ' X Axis Scale' from the list and select 'Concentration'.
9. Press 'F4' to select lines to be plotted between the points.
10. The software is ready for use.

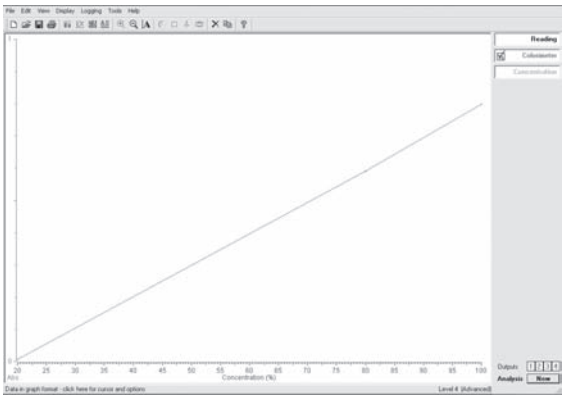
Calibration:

To calibrate the colorimeter, select the RED light source and place 4 ml of 100% solution into a cuvette and into the colorimeter. Adjust the calibration dial until you obtain 0.80 Abs.

Method:

1. Place the first sample into the colorimeter. eg. 20%
2. Right click on the concentration field shown in fig 3 and select 'Edit details' from the list (fig2) which should appear. Enter the concentration of the sample and then click 'OK'
3. Click on the camera icon to store the reading.
4. Place the second sample into the colorimeter and then follow steps 2 & 3 to select the new concentration and take a reading.
5. When you have finished the known samples you will have a calibration graph.

The unknown samples can now be measured and read off the calibration graph. This can be done within the software or the graph can be printed and used in a group.



Notes on procedure:
This procedure can liberate some very good results so long as pupils perform basic laboratory practise.
Cuvettes should be washed out with distilled water between readings. Measurements should be accurate. A burette may be used although pipettes might be more common and easier to use.
This procedure can be used with Iron tablets, Copper Sulphate etc. You could also use molarity of a solution as opposed to the percentage concentration.

"Rates of Reaction"

Subject: Chemistry

Sensor: Colorimeter

Overview:
When Sodium Thiosulphate and Hydrochloric Acid are reacted together, a precipitation of sulphur is produced and the solution becomes cloudy. By measuring the light intensity through the solution, timing how long the precipitate takes to form, the rate of reaction can be found.
The use of a colorimeter has some distinct advantages over the traditional cross and observation method in that only small amounts of chemical are used which reduces waste and limits the small amount of sulphur dioxide given off to the atmosphere. The products of this reaction are Sodium Chloride, Sulphur, Water and Sulphur Dioxide.

Equipment required: LogIT DataLogger
1 Colorimeter
1 Cuvette
1 Pipette or small burette
0.15 Molar Sodium Thiosulphate
1 Molar Hydrochloric Acid
Distilled water
Paper towels or tissue paper to dry the cuvette

Hazards:
Goggles must be worn.
Avoid inhalation of any gas given off if not contained in the colorimeter.
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous materials or chemicals.

Setup:
1. Connect the colorimeter to a channel of the datalogger.
2. Set your logging software to record with no timespan eg. if using LogIT Lab select 'AutoLog'

Calibration:

1. Fill a cuvette with 4 ml of distilled water and place it in the colorimeter.
2. Place the cap on and then adjust the calibration dial until you obtain 100% T (Transmission)

Varying the concentration:
In this procedure the amount of Acid was kept constant at 1 ml. You may like to increase/decrease the amount of acid depending on time.
The amount of Sodium Thiosulphate was altered by adding varying amounts of distilled water.

Sodium Thiosulphate (ml)	3	2.5	2.0	1.5	1.0
Distilled water (ml)	0	0.5	1.0	1.5	2.0
Hydrochloric Acid (ml)	1	1	1	1	1
Total volume of liquid (ml)	4	4	4	4	4

Note: 4 ml is a good volume of liquid as it reduces the danger of spillage into the Colorimeter.

For each sample the Sodium Thiosulphate and distilled water were premixed in the cuvette when required.
The Acid would then be added via a pipette into the very bottom of the solution. This aided mixing and the cuvette could then be placed in the colorimeter.

"Rates of Reaction" (continued)

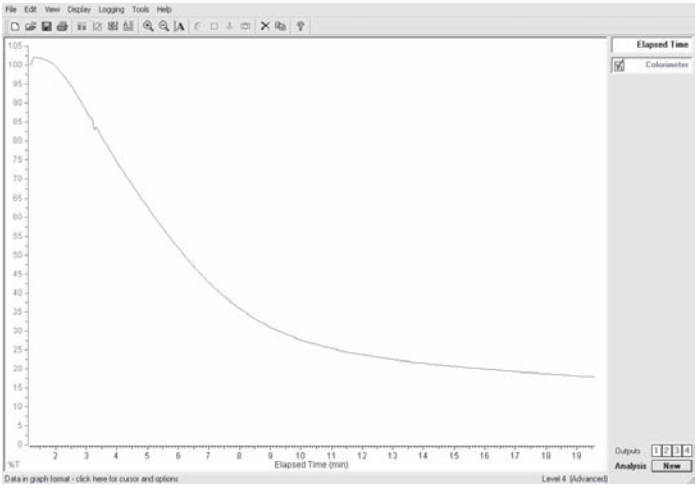
Method:

1. Place the proportion of Sodium Thiosulphate and distilled water into the cuvette.
2. Place 1 ml of acid into a pipette.
3. Place the pipette into the cuvette at the bottom and add the acid.
4. Place the cuvette into the Colorimeter and start the logging software.
5. A graph of Transmission against time will be recorded.
6. Repeat the experiment overlaying the graphs or simply noting the reaction time from each graph.

Note: It is not a good idea to add liquid to a cuvette already inside the Colorimeter as this may cause damage due to accidental spillage.

Results:

Once the reaction has occurred, you should obtain a graph showing the reduction in %age Transmission as the precipitate is formed.



The reaction time can be obtained from the graph from where the plot starts to fall to where the plot levels off again. (The above graph has been zoomed in to show the time of the reaction)

Going further:

The rate of the reaction can be determined by calculating how much sulphur was produced in the recorded time. Since we can assume that the amount of sulphur obtained is the same, the rate of reaction can be expressed as:-

$$\text{Rate of reaction} = \frac{1}{\text{Time taken}}$$

This experimental procedure can be used to further investigate rates of reaction by investigating the effect of temperature on reaction rate. This could be achieved using the same basic method.

Chemistry