Lab Investigation: Factors Affecting the Flow of Solvents

Imagine if you could test 100 molecules, at the same time, to see if they could start or stop breast cancer cells from dividing.

Also, what if it was just simple chemistry that allowed for that to happen?

When a drop of ink hits blotting paper, it "bleeds" much wider than the circumference of the original drop. And quickly, too. Although researchers have developed ways of containing water-based solutions to specific areas of paper, until now, there was no easy way to modify paper to restrict chemicals such as organic solvents, bases and acids or surfactants to particular areas.

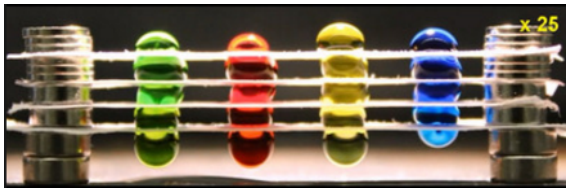
Under the leadership of Dr. Ratmir Derda at the University of Alberta in Edmonton, Alberta, Canada, Sentinel Bioactive Paper Network researchers Frédérique Deiss (lead author), Wadim L. Matochko, Natasha Govindasamy, Edith Y. Lin, and Derda himself introduced a grid of solvent-repelling Teflon barriers inside the paper, which confine liquid to where it is wanted. Why Teflon? It is resistant to a wide range of solvents, is non-toxic and non-fluorescent, and researchers can now use it to modify paper and generate arrays with 96 test-zones per sheet.

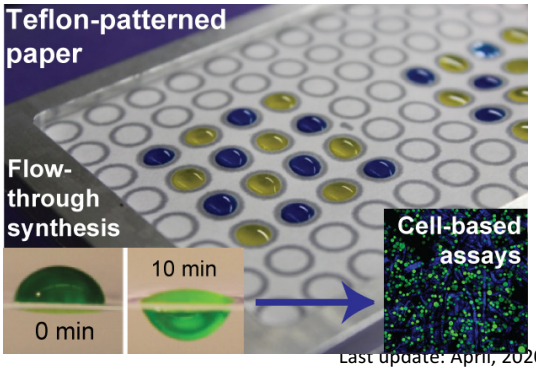
The Teflon barriers allow an excess of liquid to be delivered in each zone, generating a dynamic flow through the paper with mere gravity, and improving the mixing of reagents. When used for making molecules, the Teflon-patterned paper improves the yield of chemical reactions compared to making molecules on plain, non-patterned paper.

The Derda group demonstrated this idea with the synthesis of peptides (short chains of amino acids) on paper and used the resulting sheet of 96 peptides to test which peptides will allow breast cancer cells to adhere and grow.

The beauty of this discovery is that it dramatically expands the range of usable reagents and speeds up their efforts to develop multiple tests on the same sheet

Images: Derda Research Group





Last update: April, 2020

Group Members: _____

Aim: Investigate factors that affect the flow of solvents.

1. Research Question

2. Variables

Independent:

Dependent:

Controlled:

3. Hypothesis

4. Materials

5. Procedure

6. Data Table

Title:

Qualitative Observations:

7. Data Analysis

8. Conclusion and Evaluation

i. Conclusion

ii. Evaluating Errors

iii. Improvements

Guide to Writing Lab Reports

1. Research Question

Choose one independent (manipulated) variable. Use the independent variable and the dependent (responding) variable to phrase your research question.
Example: *What is the effect of a changing glucose concentration on cell respiration in yeast? Five different concentrations of glucose (0.0 M, 0.25 M, 0.50M, 0.75M and 1M) will be used to see how the growth of yeast changes. The growth of yeast will be measured by the amount of CO_2 produced which is an indication of the amount of cell respiration taking place.*

2. Variables

Remember to correctly categorize your variables and think of as many controlled variables as you can. That said, don't include controlled variables that aren't significant.

Independent: The variable that YOU change. Make sure that you choose only one independent variable to change. Some people inadvertently choose more than one.
Example: concentration of glucose solutions at 0.0 M, 0.25 M, 0.50M, 0.75M and 1M.

Dependent: The variable that changes when you change the independent variable. Ensure your dependent variable can be measured with a tool.
Example: The growth of yeast will be measured by the volume of CO_2 produced.

Controlled: All the aspects of the experiment that must be kept constant to ensure that the tests/experiment is fair. There will be several of these, not just one! Ensure that only significant variables (the ones that may affect your results) are controlled.
Example: you don't need to control Earth's gravitational pull or atmospheric pressure when dealing with yeast growth.

3. Hypothesis

Write a hypothesis to help focus your research question that includes the independent and dependent variables. Your hypothesis should be supported with an explanation.
*Example: **If** the glucose concentration is increased, **then** the amount of CO_2 produced will also increase. This is because glucose is used by yeast to make ATP through cellular respiration. The more glucose that is available, the faster the rate of cell respiration, and more CO_2 will be produced. CO_2 is a product of cell respiration in yeast, so the more CO_2 the faster the rate of cell respiration.*

4. Materials

Choose the apparatus and submit an equipment request. Make sure you plan thoroughly and don't leave anything out.

Make sure when writing up your equipment list that you include:

- The sizes of glassware such as beakers, flasks, etc.
- The concentration of chemicals (eg hydrochloric acid, 2.0 M).
- The amounts of chemicals (eg magnesium, 0.50 g).
- The range of a thermometer (eg –20°C to 120°C)
- The amount of each solution (eg 200 mL)

5. Method / Procedure

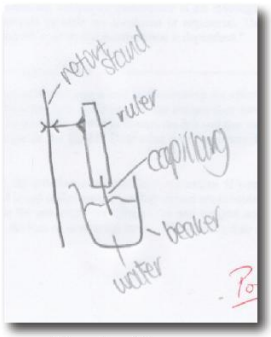
You will write your own procedure using numbered steps.

Example:

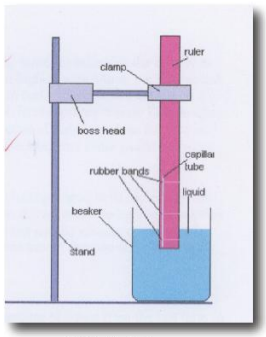
1. *Add 0.5 g magnesium to 200 mL of 2M hydrochloric acid measured in a graduated cylinder.*

Your method must explicitly indicate how each controlled variable identified in your variables section was controlled.

Sometimes the best thing to do for your method is to draw a diagram of the experimental set up and refer to it.



Poorly Done



Well Done

When designing a method ensure that you change the independent variable enough times to collect enough points for a reasonable line of best fit. A minimum of **five data points** is required for any graph and more should be collected if time and materials allow.

6. Data Table

There are several aspects to data collection. Don't overlook any of the following:

- Quantitative data (i.e. numerical values)
- Qualitative data (i.e. observations)

When preparing your tables, you must address the following:

- The units must be included.
- All data in a column must be given to the same number of decimal places.
- The table needs a suitable and descriptive heading ("Table 1", "Data Collection" or "Results" are not suitable headings).

Eg: **Table 1:** Gas evolved from magnesium on addition of hydrochloric acid.

Temperature (°C ± 0.05°C)	Amount of H_2 evolved in 10 minutes (cm^3 ± 0.5 cm^3)
10.2	12
22.3	24
30.4	38
40.1	41[a]

a. Time taken in this instance was only 5 minutes

7. Data Analysis

Graph your data. Choose an appropriate type of graph that represents your data: line graph, bar graph, scatter graph etc.

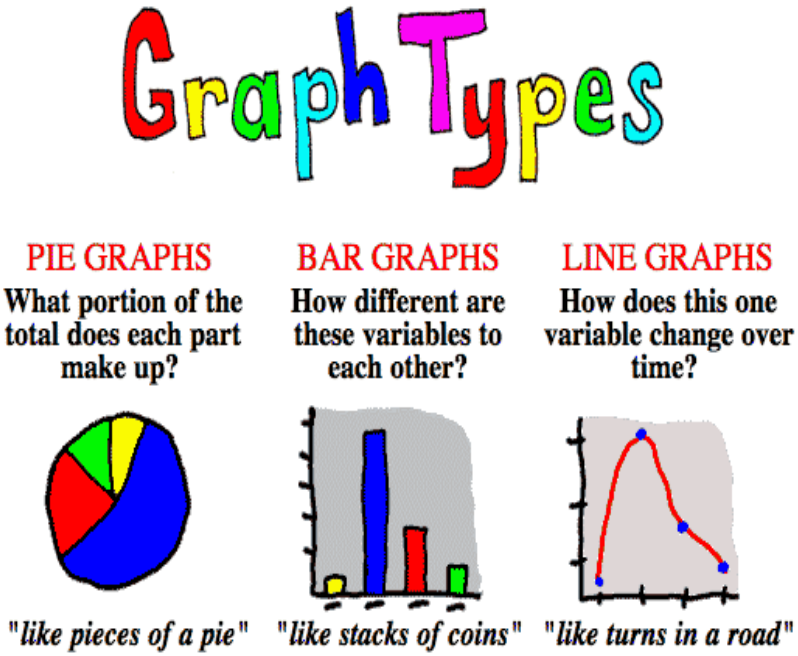


Image: Mr. Covington's Science Wiki,

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8. Conclusion and Evaluation

i. Conclusion

State the relationship your data provides. Draw conclusions from them. Relate to scientific principles.

You must explain why/how your results support or invalidate your hypothesis. You can do this by referring to specific observations, the gradients/shapes of graphs or values collected/calculated. You need to show that you understand how your results support or invalidate your hypothesis.

ii. Evaluating Errors

Analyze your sources of error.

Consider some of the following when preparing your evaluation:

- Are there flaws in the procedure, and what was the specific effect of each flaw?
- Were important variables not controlled?
- Are the measurements and observations reliable?
- Is the accuracy of a result unknown because of a lack of replication?
- What assumptions are being made?

iii. Improvements

You must suggest improvements to the design of the experiment**.** Complaining about not having enough time or being disorganized has nothing to do with the procedure. **You need to suggest a minimum of three significant improvements that would have an effect on your results.**

Reference:

This guide was adapted from: Mr. Covington's Science Wiki. "IB Biology Lab Report Guide (website is now closed)." https://mrcovingtonsciencepage.wikispaces.com/IB+Biology+Lab+Report+Guide.

Evaluation Rubric

Name:

Lab Title:

Date:

Time:

Total:

Experimental Design

Criteria / Mark	Research Question	Control of Variables	Procedure	Marks/6
Complete/2	Formulates a focused problem/research question and identifies the relevant variables.	Designs a method for the effective control of the variables.	Develops a method that allows for the collection of sufficient relevant data	
Partial/1	Formulates a problem/research question that is incomplete **or** identifies only some relevant variables	Designs a method that makes some attempt to control the variables.	Develops a method that allows for the collection of insufficient relevant data.	
Not at all/0	Does not identify a problem/research question **and** does not identify any relevant variables.	Designs a method that does not control the variables.	Develops a method that does not allow for any relevant data to be collected.	

Data Collection and Processing

Criteria / Mark	Data Collection	Data Processing	Data Presentation	Marks/6
Complete/2	Records appropriate quantitative and associated qualitative raw data, including units and uncertainties where relevant.	Processes the quantitative raw data.	Presents processed data appropriately and, where relevant, includes errors and uncertainties.	
Partial/1	Records appropriate quantitative and associated qualitative raw data, but with some mistakes or omissions.	Processes quantitative raw data, but with some mistakes and/or omissions.	Presents processed data appropriately, but with some mistakes and/or omissions.	
Not at all/0	Does not record any appropriate quantitative raw data **or** raw data is incomprehensible.	No processing of quantitative raw data is carried out **or** major mistakes are made in processing.	Presents processed data inappropriately **or** incomprehensibly.	

Conclusion and Evaluation

Criteria / Mark	Concluding	Evaluating procedure(s)	Improving the investigation	Marks/6
Complete/2	States a conclusion, with justification, based on a reasonable interpretation of the data.	Evaluates weaknesses and limitations.	Suggests realistic improvements in respect of identified weaknesses and limitations.	
Partial/1	States a conclusion based on a reasonable interpretation of the data.	Identifies some weakness and limitations, but the evaluation is weak or missing.	Suggests only superficial improvements.	
Not at all/0	States no conclusion or the conclusion is abased on an unreasonable interpretation of the data.	Identifies irrelevant weakness and limitations.	Suggests unrealistic improvements	

Laboratory Skills

Criteria / Mark	Follows Instructions*	Carrying out Techniques	Working Safely	Marks/6
Complete/2	Follows instructions accurately, adapting to new circumstances (seeking assistance when required.)	Competent and methodical in the use of a range of techniques and equipment.	Pays attention to safety issues.	
Partial/1	Follows instructions but requires assistance.	Usually competent and methodical in the use of a range of techniques and equipment.	Usually pays attention to safety issues.	
Not at all/0	Rarely follows instructions **or** requires constant supervision.	Rarely competent and methodical in the use of a range of techniques and equipment.	Rarely pays attention to safety issues.	

*Instructions may be in a variety of forms: oral, written worksheets, diagrams, photographs, videos, flow charts, audio tapes, models, computer programs, and so on, and need not originate from the teacher.