TABLE OF CONTENTS

PART I

THE IB ESS IA GUIDE

1. GENERAL INTRODUCTION

Internal Assessment (IA) is an integral part of the Environmental Systems and Societies (ESS) curriculum contributing an important **25%** towards the final grade. It is designed to enable students to learn and integrate skills and knowledge learned from the course and apply them in a practical manner to answer personal inquisitions while staying with-in the limitations of the curriculum. An IA involves an individual investigation into a certain aspect of the syllabus using skills learnt and presenting it in form of a written report. This investigation needs to be carried and written following certain guidelines provided and must be done exclusively for the purpose of an IA (An extended essay cannot be used as an IA).

The teaching time allocated for an IA is usually **10 hours** this not only reflects the time recommended for interaction between student and teacher but also includes the time spent by the student in performing and writing the IA task. However, most students end up spending more than 10 hours.

The IA task itself can be from any part of the ESS syllabus but must be a student's original work. Help regarding deciding a topic and planning the task can be sought from the teacher. It is teacher's job to advise students about marking guidelines and IB policies before the start an IA. However, it is not a teacher's job to tell a student exactly what to do or write any part of the report.

Before we get into detail of assessment criteria let's discuss some housekeeping rules of an ESS IA:

- All IAs are internally graded by teachers. Some of these IAs (or all IAs for some new schools/teachers) will also be graded externally by IA moderators/examiners. This external moderation enables a quality control for International Baccalaureate Organization (IBO).
- There is a **word limit** (but no page limit). The report must be between 1500 to 2250 words and it is better to mention the word count on the title page. The moderator/teacher is recommended to not read anything beyond the word limit this can drastically affect your score. Details of word count are also discussed in the 'communication' section of assessment criteria.
- Both primary and secondary data sources can be used for an IA. There is no preference. In addition, it is possible to collect data in groups as part of some activity. You also share data with other students but be very careful to make sure rest of the IA is your original work and not inspired by their work.

2. CHOOSING A TOPIC

Choosing a topic can be tricky for certain students. ESS IA requires you to pick any **Environmental Issue (EI)** related to the ESS syllabus that may be global or local in nature. However, it should involve both Human and Science parts of the ESS curriculum; since ESS in an interdisciplinary course. It is highly recommended to choose a topic that interests you and develop a reasonable **Research Question (RQ)** from it. A lot hangs on your choice of EI and the related RQ so spend good time finalising these.

Figure 1: It would be better to pick a global issue that also has a local component (2).

Once you have picked an EI and RQ, start thinking about how you would answer the RQ. A wide range of methodologies can be used in ESS IAs but they must be appropriate to answer the RQ and you need to consider the logistical details into account as well. Pick a topic and RQ that can be answered within the scope of the IA. Although you can use quantitative and qualitative data, and any statistical analysis techniques, make sure you have read the IB guidelines, in particular go through IB's Animal experimentation policy (3). It would be best to avoid working with live animals but if you must read the above-mentioned policy guides and make sure you are not infringing any.

Let's discuss some possible examples of IA topics categories, please do note these are only suggestion and range of accepted topics is extremely wide:

- **Environmental Impact Assessment (EIA):**

  If there a new construction in your area that you have access to you can do an EIA of your own. Getting permission may be your first hurdle but these EIAs are good way studying any new addition to your school/college. You may look at impact of construction (scope), predict future impact on society, and/or analyse possible solution of mitigating impact. The exact data required would depend on the RQ but you may have to gather primary data from the contractor and survey the society around it. You may support this with secondary data of the area or from similar previous projects.

Figure 2: Environmental impact assessment of a local construction site can be an interesting topic to work on (4).

- **Investigate the changes in an area caused by human activity:**

  This include studies of biodiversity and human activities and allows you to investigate a local issue. This category is very popular in students wanting to do field work. You can gather primary data to compare before-after of the same location or two similar location to investigate effect of human activities. You must narrow down your topic to a specific area, effect, and type of human activity you are studying. Example might include studying biodiversity of plants/insect in disturbed and undisturbed areas, effects of ecotourism etc. Be careful how you word your RQ because that will decide what type to data you must collect and not all types of data are equally easy to collect, this may include:

    - plant species abundance
      - density
      - frequency
      - percentage coverage
      - species diversity (calculated using Simpson diversity index)
    - infiltration rate of the soil
    - amount of litter
    - number of people that pass by

- **Investigate Environmental Value Systems (EVS) or Ecological Footprints (EF):**

  A survey-based approach to investigate EVS or EF of a certain group/population is often a popular IA topic among students. Usually students tend to corelate one or more variables with EVS/EF. These are often simple to design. However, a focused question and well-designed survey can improve your score a lot. While doing this category of IA a local approach is preferable and care must be taken to not overestimate relationships between variables.

3. ASSESSMENT CRITERIA AND GRADING:

For the ESS Internal assessment a total of 6 assessment criteria are used for a total of 30 points. All criteria do not carry equal points.

Indentifying the context	Planning	Results, analysis and conclusion	Discussion and evaluation	Applications	Communication	Total
6 (20%)	6 (20%)	6 (20%)	6 (20%)	3 (10%)	3 (10%)	30 (100%)

Each assessment criterion has level descriptors that outline specific grade points range. All grading is done based on these descriptors, therefore these need to be of foremost importance while writing your report. Each individual criterion has 2-3 aspects that an examiner/teacher would consider while grading. Although each of these aspects may be looked at separately the overall grade of the criterion is awarded using a best fit approach. So, a mark is awarded based on overall fit of the work in a specific level although some aspects of the work may fall below or above the mark level. The highest level of mark does not imply a perfect work. An IA can score full marks even with minor imperfections. Moreover, each of these criteria are judged independently of each other; a high score in one does not imply a high score in other.

Let's get into specific details of these level descriptors for each criterion and discuss some tips for maximising score.

Identifying the context:

This criterion assesses the extent to which the student establishes and explores an environmental issue (either local or global) for an investigation and develops this to state a relevant and focused research question.

Achievement level	Descriptor
0	The student's report does not reach a standard described by any of the descriptors given below.
1–2	The student's report: • **states** a research question, but there is a lack of focus • **outlines** an environmental issue (either local or global) that is linked to the research question • **lists** connections between the environmental issue (either local or global) and the research question but there are significant omissions.
3–4	The student's report: • **states** a relevant research question • **outlines** an environmental issue (either local or global) that provides the context to the research question • **describes** connections between the environmental issue (either local or global) and the research question, but there are omissions.
5–6	The student's report: • **states** a relevant, coherent and focused research question • **discusses** a relevant environmental issue (either local or global) that provides the context for the research question • **explains** the connections between the environmental issue (either local or global) and the research question.

There are 3 aspects to this criterion: **Research Question (RQ), Environmental issue (EI), and a connection between the RQ and EI**. The primary focus is on relevance and coherence of these 3 aspects. The IA revolves around a relevant Environmental issue and must be linked appropriately with a very well thought out research question. This section of the IA is probably the most important since this defines the theme and limits of your IA. Make sure to make the RQ as narrow and focused as possible while still being able to establish a link with the EI. The EI itself needs to be discussed in detail and the link with the RQ must be explained with reasoning. Let's look at some important points to consider while writing this section to maximise your score:

- The RQ must be **relatively specific** for full marks. If the investigation involves studying the effect of watering peas with acidified water then the question should be "What is the effect of watering peas with acidified water on numbers of seeds germinated?" rather than "What is the effect of acid rain on seed germination?"
- **Example RQs**: the following RQs could all be appropriate if the student links them to an EI (not just a human to human issue but some environmental link is needed) or they could have no EI, making the RQ inappropriate.
  - ❖ How does artificial fertilizer affect organisms feeding on a soccer field?
  - ❖ To what extent can abortion affect the population of Mexico City in the future?
  - ❖ What are the health impacts of noise pollution in a city?
- Unfocused, but relevant, RQs are often one of the following:
  - ❖ too vague on the variables to be studied.
  - ❖ too broad in the scope of the 2250 words.
  - ❖ too broad for a 10-hour investigation.
  - ❖ e.g In what ways does water pollution affect an area? Is too broad and too vague - what area and what specific pollutants? The topic is relevant to the EI of pollution.

- ❖ e.g What impact do humans have on air quality? Is too broad and too vague.

- There must be **evidence of some research** by the student for full marks, especially when they are dealing with a well-studied topic. There must be some depth in the context. For example, a study of rabbit populations in Chile (rabbits are an invasive, introduced species) should include some information on the impact of introduced species in general and specifically in Chile (or state that such information is not available).
- Avoid **general statements** that are common knowledge, with no evidence of personal research.
- When the investigation **does not mention a relevant environmental issue**, the maximum mark awarded in this criterion is a 2. For example, "Stress in schools related to workload" is not a relevant EI. A more subtle example might be a practical to study the effect of light colour on photosynthetic rates. This may or may not relate to an environmental issue; if the student does not identify the link to an EI, then it would score a maximum of 2.

Planning:

This criterion assesses the extent to which the student has developed appropriate methods to gather data that is relevant to the research question. This data could be primary or secondary, qualitative or quantitative, and may utilize techniques associated with both experimental or social science methods of inquiry. There is an assessment of safety, environmental and ethical considerations where applicable.

Achievement level	Descriptor
0	The student's report does not reach a standard described by any of the descriptors given below.
1–2	The student's report: • **designs** a method that is inappropriate because it will not allow for the collection of relevant data • **outlines** the choice of sampling strategy but with some errors and omissions • **lists** some risks and ethical considerations where applicable.
3–4	The student's report: • **designs** a repeatable* method appropriate to the research question but the method does not allow for the collection of sufficient relevant data • **describes** the choice of sampling strategy • **outlines** the risk assessment and ethical considerations where applicable.
5–6	The student's report: • **designs** a repeatable* method appropriate to the research question that allows for the collection of sufficient relevant data • **justifies** the choice of sampling strategy used • **describes** the risk assessment and ethical considerations where applicable.

As shown in the descriptor there are 3 aspects to consider: **Method, Sampling Strategy, and Risk/Ethical Considerations**. Following a similar theme as previous criterion the emphasis is on appropriate method of research. This method should link with your RQ and must fully answer that particular question. Although the method used may vary for each IA and RQ the basic parameters must remain the same.

The method used must be repeatable and it must collect sufficient and reliable data to reach an eventual conclusion. The sampling strategy must be justified in detail to support your choice of method used. Finally, there should be consideration of all risks involved in the method used and the ethical implications involved including getting consent from any human subjects involved. Let's look at some important points to consider while writing this section to maximise your score:

- **Variables** are not necessary, but if included they should match the RQ and the method.
- **Repeats** (or comparison of sources) are nearly always necessary to establish reliability. The appropriate number of repeats is dependent on the investigation carried out. Many standard lab-based reports should plan to have at least 5 repeats. Fieldwork comparing areas should have at least 5+ samples from the two areas, this could be a transect with 5 quadrat samples in each area. Survey and secondary data usually require 20-30 data points as a minimum, this can depend on the statistical processing. (In practice, this may not be possible.)
- Sufficient data to permit processing, should be collected. However, the quantity of data collected will vary with the investigation. It is for the teacher/examiner to judge whether the investigation is collecting insufficient amount of data or not.
- Where relevant safety, ethical and environmental issues would not have been immediately obvious to a student without a teacher's prior knowledge and experience students are given a benefit of doubt.
- If there is a **risk/ethical** issue, then stating it is evidence of listing by the student but does not mean that it has been described. It would of more benefit to describe few important risks in detail than to just list a lot of them.
- For **Surveys**: those that indicate the respondents have been selected randomly is a description at best, but not a justification of the sampling strategy. To justify this, you have to reason why this was done.
- For **field research** it is important to justify the choice of area selected in context of the RQ.

Results, analysis and conclusion:

This criterion assesses the extent to which the student has collected, recorded, processed and interpreted the data in ways that are relevant to the research question. The patterns in the data are correctly interpreted to reach a valid conclusion

1. TO WHAT EXTENT DOES EFFLUENT FROM PRINTING AND TEXTILE INDUSTRIES OF SANGANER AFFECT THE GERMINATION OF WHEAT SEEDS?

Author: Shreyan Jain
Moderated Mark: 30/30

Environmental issue: Water pollution and its impact on ecosystem

Progress and prosperity are the two pillars of human happiness but one of the major problems we are facing in the 21st century is of the water pollution. We all know that water is essential for us, still we pollute it anyway. On the other hand, in the technological driven era, industrialization has led to many grave environmental concerns, challenging all living creatures.

Life began in water several million years ago, yet we are not concerned for the most precious resource i.e. water. Untreated wastewater is released in huge amount into the lakes, rivers and oceans. This problem has reached alarming proportions which is affecting us through different ways. We have finite sources of drinking water and if we look at the statistical data released by National Geographic; it points out, "About 70% of the Earth's surface is covered by water where only 2.5% is considered as fresh water. The remaining is ocean-based and saline. Moving on, only 1% of freshwater is accessible for humans, where most of it is locked up in snowfields or glaciers."[1]

In developing countries, most of the industries dispose their wastes either in water or on land without any treatment; the continuous discharging of effluent into the water bodies increases their toxicity level and affects aquatic life. Amongst the different types of pollution, water pollution caused by the discharging of effluent from industries causes severe problems not only to aquatic life but also to human life indirectly or directly.

In Sanganer area of Jaipur where I reside, there is a hub of small-scale print and textile industries. I have observed that the waste water from these industries of Sanganer is released into the local water body and in nearby areas. Farmers living in its proximity grow their crops using untreated waste water from printing or textile industries without any guilt as there is shortage of water in the region.

All the seasonal vegetables growing with polluted water is sold in the vegetable market of my locality. So, this made me curious to know that does this water affect the germination of seeds or the growth of plants. To learn more about it I thought of investigating on this through a research question that is **To what extent effluent from printing and textile industries of Sanganer affect the germination of wheat seeds.**

Experimental variables:

	Named Variables	**Units**	**Equipment or Procedure for measurement/Control**	**Justification**
Independent	Amount of effluent to be added.	Milliliter (ml)	Measuring cylinder will be used to measure the amount of effluent to be added in water and for watering the plant under investigation.	Use of measuring cylinder will help in using precise amount of effluent to be added in water.
Dependent	Number of wheat seeds germinated.	-	By manually counting the number of germinated seeds in every pot.	Because this is the easiest and convenient method and does not incur any cost.

[1] https://www.nationalgeographic.com/environment/freshwater/freshwater-crisis/

Controlled	Amount of water	Milliliter (ml)	Measuring cylinder will be used to measure the amount of water.	Measuring cylinder gives accurate results, it is easy to handle. Same measuring cylinder will reduce the errors.
	Named Variables	**Units**	**Equipment or Procedure for measurement/Control**	**Justification**
Controlled	Type of soil	-	Same type of soil i.e. loam will be used for all the experimental pots.	Because different types of soil have different water holding capacity and the amount of nutrient which may affect the germination of wheat seeds.
	Amount of soil	grams	To measure the amount of soil to be put in each pot digital weighing machine will be used.	Digital weighing machine helps in accurate measurement as difference in amount of soil may affect the germination of seeds.
	Number of seeds	-	15 seeds will be sown in each pot by counting manually.	If different number of seeds will be sown then due to change in amount of space between the seeds, amount of water they will receive, etc. may affect the germination.
	The shape and size of the pot.	Centimeter (cm)	Pot of same shape and size of diameter 15cm will be used in the experiment.	Different size and shape of the pot will have different surface area exposed to environment which could influence the germination of the seeds.
	Day of noting the observation.	-	Number of seeds germinated will be counted after same number of days, here it is 4 days.	Collecting the data of number of seeds germinated on different days may give improper results as the number of germinated wheat seeds will differ from each other on different days.

Safety/ethical considerations:

One needs to handle untreated effluent with caution and use gloves for the experiment; as it is a toxic substance.

Wear safety goggles while making the concentration as effluent may enter your eyes during the process.

Keep the effluent in a safe place where it does not come in contact with anyone and dispose the soil after the experiment in a proper manner as it contains untreated effluent.

Equipment list or material

Pots: 25 pots of same size and shape

Effluent from printing/textile industry: 400 ml

Measuring cylinders (100 ml): 1

Measuring cylinders (10 ml): 1

Beakers (1L): 5

Loamy soil: 5.5 kg

Wheat seeds: 450 seeds

Tap Water: 3.6 L

Labels: 25

Marker: 1

Digital weighing machine: 1

Graphic Display Calculator: 1

Methodology

Take 25 pots. Mark the first 5 pots as A1 to A5 then B1 to B5 then C1 to C5 then D1 to D5 and last 5 as E1 to E5.

Soak all the wheat seeds in water for ten minutes and remove the floating seeds as they are non-viable seeds, so only the viable seeds should be sown as to reduce the error.

Fill all the pots with 200 grams of loamy soil and sow 15 wheat seeds in each with sufficient spacing and at proper depth.

Keep all the pots at same place in open area so that they receive same environmental conditions.

Sprinkle 20 ml of solution on all the pots two times in a day for 4 days, once 7am in the morning and next at 5pm in the evening to keep the soil moist for germination as mentioned below-

Water Pot A1-A5 with solution containing 0% effluent.

Water Pot B1-B5 with solution containing 5% effluent.

Water Pot C1-C5 with solution containing 10% effluent.

Water Pot D1-D5 with solution containing 15% effluent.

Water Pot E1-E5 with solution containing 20% effluent.

Count the number of seeds germinated in each pot after 4 days.

Note down the readings.

Analyze the data.

Data collection

Table 1. Shows the number of germinated seeds in the pot given water with no effluent i.e. 0% effluent.

S. no	Pot	Number of seeds sown	Number of seeds germinated
1	A1	15	15
2	A2	15	14
3	A3	15	15
4	A4	15	14
5	A5	15	14

Table 2. Shows the number of germinated seeds in the pot watered with 5% effluent.

S. no	Pot	Number of seeds sown	Number of seeds germinated
1	B1	15	13
2	B2	15	13
3	B3	15	14
4	B4	15	13
5	B5	15	12

Table 3. Shows the number of germinated seeds in the pot watered with 10% effluent.

S. no	Pot	Number of seeds sown	Number of seeds germinated
1	C1	15	12
2	C2	15	11
3	C3	15	12
4	C4	15	13
5	C5	15	11

Table 4. Shows the number of germinated seeds in the pot watered with 15% effluent.

S. no	Pot	Number of seeds sown	Number of seeds germinated
1	D1	15	10
2	D2	15	10

3. OCEAN SEDIMENTATION AND CARBON DIOXIDE UPTAKE BY AQUATIC PLANTS

Author: Anonymous
Moderated Mark: 29/30

Background Information & Environmental Context

Environmental Issue

Mangroves provide a range of ecosystem services including supporting biodiversity and functioning as sediment sinks (Furuwaka), however, mangrove deforestation is becoming increasingly common ("Sediments and Mangroves"). Coral reefs have a symbiotic relationship with mangroves - the mangroves trap sediment and nutrients, preventing these deposits from washing into the ocean ("Mangrove Trees & The Great Barrier Reef"). The destruction of mangroves may impact the penetration of light into surface water due to increasing deposits of terrestrial sediment into the ocean. One example of this is the Great Barrier Reef, where the loss of mangroves increases agricultural sediment, which increases the turbidity of coastal waters. Increased turbidity decreases the amount of light available for photosynthesis, influencing primary and secondary productivity of the entire reef ecosystem.

The ocean is one of the largest carbon sinks in the world, sequestering an estimated 50% of anthropogenic CO_2 emissions ("Ocean Acidification"). Increased CO_2 in the atmosphere also increases the amount of CO_2 in the water due to atmospheric-oceanic gas exchange, causing ocean acidification. CO_2 combines with seawater (H_2O) to create carbonic acid (H_2CO_3), lowering the pH of the ocean and creating a higher concentration of hydrogen (H^+) ions, posing threats to organisms sensitive to changes in acidity (Acidification Chemistry). This then reduces the number of carbonate (CO_2^{-3}) ions which are vital to shell and exoskeleton growth in many marine organisms, including coral polyps. Thus, ocean acidification is intertwined with the destruction of coral reefs.

Research Question

How does modelling changes in turbidity through decreasing available light influence the photosynthesis rates of freshwater *elodea* as indicated by pH?

Connection to Research Question and Hypothesis

This question aims to model the changes in light level caused by increasing sedimentation in the ocean. *Elodea* is a species of aquatic plant and will represent aquatic ecosystems influenced by mangrove deforestation. Based on the scientific background given for ocean acidification, it can be hypothesised that the more CO_2 in a body of water, the more acidic the water becomes. As insolation is a limiting factor to photosynthesis, it can also be assumed that the less light available for photosynthesis, less CO_2 will be used by the plan. The experiment combines these two principles in examining how sedimentation in a body of water will influence photosynthesis in aquatic producers, as measured indirectly by the pH of the water. Therefore, the hypothesis for this investigation is: as the amount of available light decreases, the pH of water containing *elodea* will decrease, becoming more acidic.

Variables

Independent and Dependent Variables

Variable Name	Measurement Range & Units	Method of Management
Independent: Turbidity: representing available light	Number of wraps of mesh around each bottle (increments 0, 3, 5, 8 and total darkness using foil).	Clearly labelling the number of wraps for each bottle to avoid confusion. Securing with elastic bands to prevent changes mid-investigation.
Dependent: pH	Measured using a pH probe (uncertainty ±0.1).	Conduct three trials for each light level increment to ensure sufficient data.

Controlled Variables

Variable Name	Method & Justification of Controlling
Water	pH will differ depending on the source of water (eg. tap, saline, distilled). As salt-water tolerant plant species are not readily available, fresh water from the lab taps will be used for all trials. This minimises potential differences in productivity between each increment.
Species of plant	Different species of plant photosynthesise at different rates. Keeping species consistent minimises discrepancies in levels of primary productivity.
Size of plant	Plants with a large mass/size typically have larger surface areas, which theoretically increases PP. By maintaining all *elodea* clippings to 10cm in length, differences in PP are minimised.
Position of bottles	Different areas of the laboratory will be exposed to different amounts of sunlight depending on the time of day; in order to control the amount of sunlight that reaches the plants, the experiment will be placed in one spot.

Materials List

Name of Resource	Quantity
Elodea aquatic plants	15 clippings, 10cm long
Graduated Nalgene plastic bottles	15
pH probe	1
Fresh water	Approx 3750ml, or enough to fill 15 bottles
Distilled water	500ml
Mesh	10cm wide strips, enough to wrap 12 bottles a total of 51 times
Aluminium foil	10cm wide strips, enough to fully cover 3 bottles
Tray	1, to hold all 15 bottles
Elastic bands	15

Masking tape	For labelling/securing mesh

Methodology

Part 1 - Setup

1. Place one *elodea* cutting into each square bottle and fill to just below the rim with fresh tap water, repeating this 15 times. Only one type of water and one species of plant must be used.
2. Cap all bottles and label trials and increments with masking tape to avoid confusion.
3. For the first increment of full light, leave three bottles unwrapped and place in the tray.
4. Cut and measure mesh strips 10 cm wide, long enough to wrap around one bottle once. Secure with masking tape and an elastic band around the rim.
5. Repeat step 4 for the remaining bottles wrapped 1 time.
6. Repeat steps 4-5 for the remaining increments of 3, 5, and 8 rounds of wrapping, measuring enough mesh to cover each bottle with the appropriate number of wraps.
7. For the final increment, cover the three bottles, including the caps, in aluminium foil, making sure no part of the bottle can be seen.
8. Place the tray containing all 15 bottles next to a window or another source of light. Ensure this position is consistent throughout the duration of the experiment (see fig. 1).

Figure 1. Final Lab Setup

Part 2 - Data Collection

1. Every two days, conduct pH readings for all trials.
2. Unscrew the cap and place the pH probe into the bottle, waiting 10 seconds for the value to stabilise before recording.
3. Resecure the mesh around the bottle and rinse the probe with distilled water between measurements.
4. Repeat steps 2-5 15 times for all bottles, for at least 3 days of data collection until sufficient data is generated.

Justification of Sampling Strategy

Changing light levels using mesh is a way of modelling increased turbidity as a result of sedimentation. As sunlight is needed for photosynthesis, if insolation is limited, the primary productivity of aquatic plants will also be limited. The number of layers of mesh for each increment was thus selected to model variations in turbidity. Three trials for each of the five increments are used to increase the validity and reliability of the experiment; the results will be measured over at least 3 separate days in order to interpret any trends in pH.

Risk Assessment and Ethical Considerations

This investigation does not deal with hazardous chemicals, however after the experiment, dispose of the aquatic plants sustainably. They can continue to be grown to minimise waste; alternatively, they can be treated as organic waste and used for composting. Remaining water from the bottles can be used to water existing plants rather than being discarded.

Data Collection

28th September				
	pH			
Light Level	Trial 1	Trial 2	Trial 3	Average
0	9.10	8.90	9.10	9.03
3	9.30	9.30	9.20	9.27
5	8.10	8.00	8.30	8.13
8	8.10	8.00	8.10	8.07
foil	7.90	7.80	7.50	7.73

3rd October				
	pH			
Light Level	Trial 1	Trial 2	Trial 3	Average
0	9.30	9.20	9.50	9.33
3	9.50	9.30	9.60	9.47
5	8.50	8.90	9.60	9.00
8	9.70	8.90	9.30	9.30
foil	8.10	8.70	8.10	8.30

9th October				
	pH			
Light Level	Trial 1	Trial 2	Trial 3	Average
0	9.50	9.70	9.50	9.57
3	9.10	9.40	9.30	9.27
5	9.70	8.90	9.20	9.27
8	9.80	9.00	9.20	9.33
foil	9.00	8.80	8.40	8.73

Figure 2. Tables 1-3: Raw Data Over Three Days

Sample Calculation of Mean

Formula	Example
$\bar{X} = \frac{\sum x}{n}$	$\bar{X} = \frac{(9.1+8.9+9.1)}{3} = 9.03$

Qualitative Observations

- Some plants became translucent and brown, or began to disintegrate (see fig. 3). Generally, this appeared to be plants receiving less light.
- Other plants had very visible new growth, regardless of the amount of light they received (see fig. 4).