Flinders University

SLSS

SCIENTIFIC LAB REPORTS

The purpose of a laboratory report or research report is to communicate to others the data you have collected in an experiment that you have performed, and what you think this data means. A typical report contains the following sections:

TITLE

The title of a report should indicate exactly what you have studied.

The Effects of Light and Temperature on the Growth of the Bacterium *Escherichia coli*.

If a large number of variables or organisms were used, the title could say *'Several Factors...'* or *'Various Chemicals...'* However, you should aim to be as specific as possible. It is unnecessary to include words such as 'Observations on the Effects of…' or 'A Study on the Effects of ...'

ABSTRACT

The abstract is a condensed version of the entire paper. It allows a reader to determine the purpose, methods, results, and significance of your report quickly without having to read the entire paper. To reflect the content of the paper accurately, the abstract should be written after the final draft of your paper is complete, even though it is placed at the beginning of the paper.

INTRODUCTION

Why did you study this problem? The introduction should:

- name the problem or issue and give background information (historical and/or theoretical) about that problem.
- contain a brief literature review which should describe previous research done on the topic and how the current experiment will help to clarify or expand the knowledge. All references to previous study should be properly cited using the appropriate style, e.g. APA, Harvard or Note style. Check with your tutor if unsure.
- end with a purpose statement. This is sometimes expressed in the form of a hypothesis, i.e. one sentence which specifically states the question your research is designed to answer. If a statistical hypothesis test is being conducted for the experiment, a null hypothesis should be stated. In short, the null hypothesis asserts that the results arose due to chance alone. Check with teaching staff for clarification.

MATERIALS AND METHODS

What did you do? How did you do it? The materials and methods section describes how you did your work, including:

- experimental design
- experimental apparatus
- methods of gathering and analysing data
- types of control.

This section must be detailed and clear enough so that readers could duplicate the experiment if they so wished. It is written in the past tense because you have already done the experiment. Methods adapted from other sources should be referenced. Photographs, maps and diagrams may be useful to help describe the experimental set-up.

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RESULTS

What did you find?

In this section, you should simply present your observations and data, with no interpretations or conclusions about what they mean. Tables and graphs should be used to supplement the text, and to present the data in a more condensed form. Trends are best illustrated or summarised in graphical form. Use the past tense to describe your results, e.g. 'At the highest temperatures tested, bacterial growth was reduced…'.

DISCUSSION

What does your data mean? How does it relate to previous work in the field?

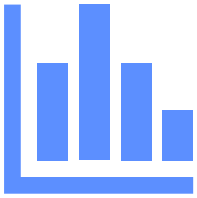
- Describe patterns and relationships that emerged from your data.
- Explain what you think your data mean. Compare your results to trends described in the literature and to theoretical behaviour.
- Offer alternative explanations as to why your results may have differed or been similar to related experiments. Explain any changes to, or problems with, the experimental procedure that may have affected the results.
- Support interpretations, whenever possible, by references to the lab manual, the text, data presented or other studies from the literature.
- Remind the reader of your own results, when relevant, without repeating large sections from the Results section. If your lab manual includes questions to be answered in the Discussion, integrate your responses into a logical discussion rather than answering them one by one (unless you have been instructed to do so). Do not include only the answers to the questions. Use them as guidelines for supplementing your own discussion, not limiting it.

LITERATURE CITED

Also called References or References Cited, this is a list of only those papers mentioned (cited) within the report.

TABLES AND FIGURES

Tables and figures are often used in a report to present complicated data. Use the following guidelines to incorporate them effectively:



- Each table or figure must be introduced within the text, and the comment should highlight the main points.
- Tables and figures are numbered independently of each other (i.e. Table 1 and 2, and then Figure 1 and 2 as well). Numbers are assigned according to the order of first mention in the text.
- Each table and figure must have a self-explanatory title so that the reader can understand its content without referring to the text.
- Tables are referred to as tables, and all other items (graphs, photographs, drawings, diagrams, maps, etc.) are referred to as figures.
- Tables and figures may be placed at the end of a paper, or within the text. Check with teaching staff for their preference. If placing them within the text, do so as soon as possible after they are mentioned, without interrupting the text, i.e. at the end of a paragraph or section.

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ANALYSE THE TASK → BACKGROUND RESEARCH → **WRITE A DRAFT** → EDIT & PROOFREAD

Can the Great Wall of China be seen from the Moon?
Determining the angular resolution of the human eye.

Begin with an **abstract** that summarises the main features of the article including its aims, methods, findings, and conclusions.

Abstract

Assuming a fixed wavelength of light and pupil diameter, an astronaut's ability to see the Great Wall of China from the Moon is limited by both the size of the wall (16 m), and its distance from the Moon (384,400 km). To determine if this visualisation is possible, the angular resolution of the human eye was investigated. To be visible from 384,400 km at the experimentally determined angular resolution of 0.023°, the object would need to be no smaller than 154,308 m. As the Great wall is just 16 m at its widest point, this experiment indicates the Great Wall is not visible from the Moon.

Unless you need to include a separate **literature review**, your introduction might include a brief discussion of the literature to contextualise and position your research.

The **introduction** should introduce the topic, its background, and significance.

Introduction

The Great Wall of China is the only man-made object visible from the moon; this commonly held, but contentious belief has been challenged by scientists and astronauts alike (López-Gil, 2008). The Great Wall of China spans 21,196 km but is just 16 m at its widest point (People's Republic of China, 2016). The immense length of this structure has led many to believe it can be seen by astronauts on the moon, which on average orbits 384,400 km from Earth (Gimsa, 2020). However, an optical system's ability to produce images with angular resolution is determined by its theoretical limit, defined by the diameter of light (wavelength), the atmosphere between object and observer and diameter of the aperture (Brandner & Hormuth, 2016), in this case the pupil. This limit determines the size of an object and the required distance from the observer to be clearly defined by the human eye.

Clearly state your **aims**, **objectives**, or **hypotheses** in the introduction.

The aim of this investigation is to determine if the Great Wall of China can be seen from the moon. This observed by measuring the smallest angular separation of two objects to determine the size required for an object to be seen from 384,400 km.

The **methods** section outlines the materials and procedures used to conduct the research so they can be replicated.

Methods

The image shown in Figure 1 was resized and printed to ensure the width of each vertical line, and the distance between them was 2mm. The image was hung on the wall at the eye level of the observer whose angular resolution was being measured. Beginning at a distance of 1 m, the observer moved away from the image until the individual lines on the left of the image could no longer be distinguished from the grey box on the right. The experiment was repeated three times and the average distance was used to calculate the angular resolution of the observer.

Figure 1: Image used to determine the angular resolution of the human eye

In scientific writing, use **clear**, **concise**, and **specific language**, typically in the **passive voice**.

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You may need to represent your **results** data visually using clearly labelled **graphs or tables.**

Results

The angular resolution of the human eye was determined to be 0.023°, requiring an object to be at least 154, 308 m in size to be visible from a distance of 384, 400 km.

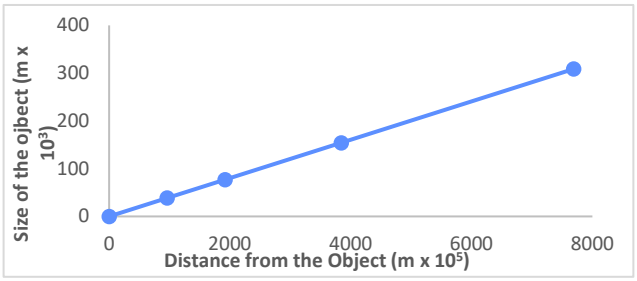

Figure 2: The size of an object required to be seen from a given distance by a human eye with an angular resolution of 0.023°. Line of best fit represents the linear relationship between size of an object and its observable distance.

Discuss your results without bias, using **reasoning** and **links to evidence** to support your interpretations of the data.

Discussion

An observer's ocular angular resolution determines the maximum distance an object can be seen and thus if the Great Wall would be visible from the moon. Given the average maximum distance of 5 m before the blurring of Figure 1, the angular resolution of the observer's eye was calculated as 0.023° and the minimum size of a visible objects determined for a range of distances (Figure 2). As shown in Figure 2, for an object 384,400 km away to be visible to the observer in this experiment, it would need to be at least 154,308 m in size. Comparatively, at 16 m wide, the Great Wall would need to be no further than 40,000 m from the observer. The angular resolution determined experimentally is similar to the theoretical angular resolution of 0.017° (Spencer *et al.*, 2013) despite this theoretical value assuming a singular wavelength of 500nm, a fixed pupil diameter of 6mm and ideal atmospheric conditions…

Paraphrase evidence from the literature to support your points.

Use logically structured **paragraphs** throughout.

The **conclusion** summarises and synthesises the main findings with respect to the aims or hypothesis.

Conclusion

Given the angular resolution of the observer calculated at 0.023°, for an object to be visible from the moon it would need to be at least 154,308 m in size. This report suggests that at just 16 m wide, the Great Wall of China is not be visible from the moon.

Provide all **references** in-text and in a reference list according to your topic's preferred style.

References

Brandner, W., & Hormuth, F. (2016). Lucky Imaging in Astronomy. In H. M. J. Boffin, G. Hussain, J-P. Berger, & L. Schmidtobreick (Eds.), *Astronomy at High Angular Resolution A Compendium of Techniques in the Visible and Near-Infrared* (1st ed. 2016. ed.). Cham: Springer International Publishing: Imprint: Springer.

Gimsa, A. (2020). Development of the Distance Earth-Moon. *International Journal of Scientific Research and Management*, *8*(03), 10-13. https://doi.org/10.18535/ijsrm/v8i03.aa01

López-Gil, N. (2008). Is it Really Possible to See the Great Wall of China from Space with a Naked Eye? *Journal of optometry*, *1*(1), 3-4. https://doi.org/10.3921/joptom.2008.3

People's Republic of China. (2016). *Protection and Management of the Great Wall of China*. China Retrieved from https://whc.unesco.org/document/157507

Spencer, L., Jakobsen, M., Shah, S., & Cairns, G. (2013). Minimum required angular resolution of smartphone displays for the human visual system. *Journal Society for Information Display*, *21*(8), 352-360. https://doi.org/10.1002/jsid.186

This template represents a *short and incomplete* report and should be used as a general guide only! Always check your assignment guidelines and rubric.