Section 2.3.1 – Introducing & Planning the Practical Investigation

What is the Practical Investigation?

The student designed "practical investigation" is the third and final Area of Study in Unit 2 VCE Physics. It is not a standalone assessment tasks, rather it is an actual area of study for unit 2. Accordingly, it is part of the **end of year exam.**

Unit 2 Outcome 3 states that student will be required to:

"Design and undertake an investigation of a physics question related to the scientific inquiry processes of data collection and analysis, and draw conclusions based on evidence from collected data"

During the student designed Practical Investigation, students will design and conduct a practical investigation related to knowledge and skills. They will need to complete the following:

- develop a question (aim)
- plan a course of action (method) that attempts to answer the question
- undertake an investigation to collect the appropriate primary qualitative and/or quantitative data
- organise and interpret the data
- reach a conclusion in response to the question.

The student designs and undertakes an investigation involving **two independent variables**, both of which should be continuous variables.

A **practical logbook** must be maintained by the student for recording, authentication and assessment purposes.

The Key Knowledge for the Planning Phase of the PI.

Across the planning stage of the Practical Investigations student will need to consider the following key knowledge and components to their report:

- the physics concepts specific to the investigation and their significance, including definitions of key terms, and physics representations

- the characteristics of scientific research methodologies and techniques of primary qualitative and quantitative data collection relevant to the selected investigation, including experiments (thermodynamics, construction of electric circuits, mechanics), and/or the evaluation of a device; precision, accuracy, reliability and validity of data; and distinction between, uncertainty and error

- identification and application of relevant health and safety guidelines

- methods of organising, analysing and evaluating primary data to identify patterns and relationships including sources of error and uncertainty, and limitations of data and methodologies

- the nature of evidence that supports or refutes a hypothesis, model or theory

- the key findings of the selected investigation and their relationship to key physics concepts

- the conventions of scientific report writing including physics terminology and representations, symbols, equations and formulas, units of measurement, significant figures, standard abbreviations and acknowledgment of references.

Scientific investigation process

The following diagram represents a general process for undertaking scientific investigations:

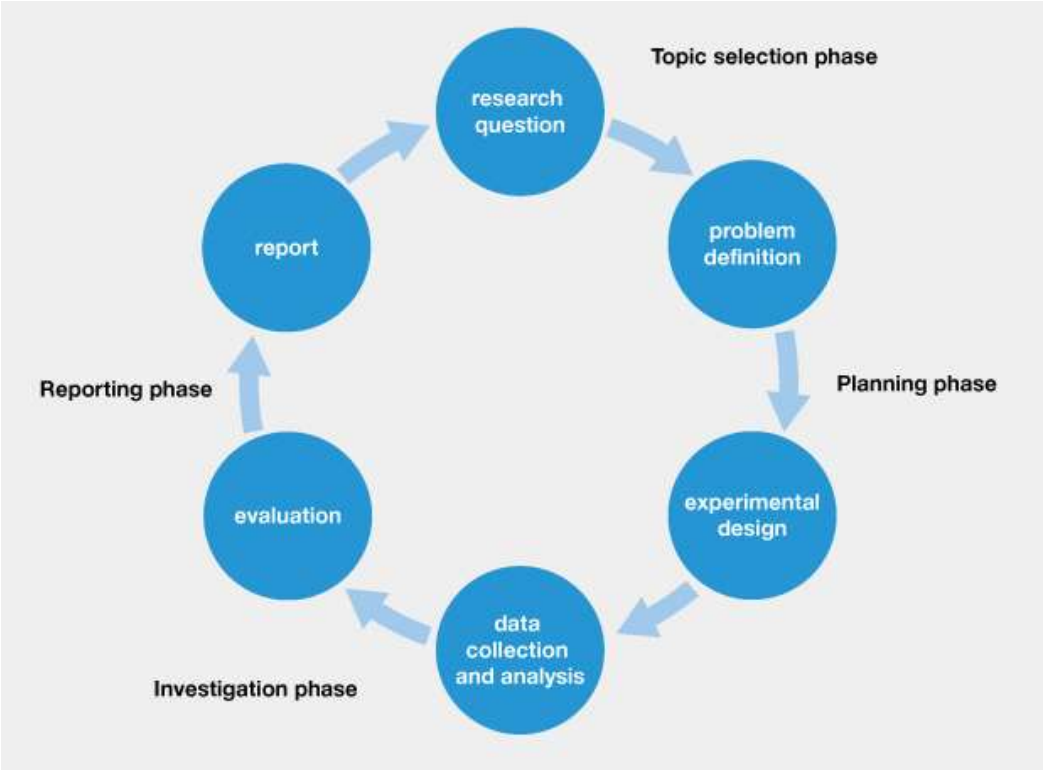

Figure 1 *- The Scientific investigation Process*

As can be seen in Figure 1 above, the scientific investigation process is cyclic and is used to continually **refine and improve** an investigation.

Choosing a topic to investigate.

When confronted with such a broad range of possible topics to investigate, effectively any investigation associated with the Unit 3 & 4 Physics course, students often find it difficult to settle upon just one topic.

From experience I would encourage student to select a topic that:

1. you have found most interesting
2. is associated with an interest or hobby of yours? (music, sport etc.)

The practical investigation will run from 7 – 10 hours in duration, including your poster production. Accordingly, you will enjoy the experience and do much better if you are engaged with an investigation that you are truly interested in.

For a list of possible practical investigations, please check your Jacaranda textbook or www.juddy.com.au . For an extensive Unit 4 list of possible investigations click onto the following link:
http://juddy.com.au/wp-content/uploads/2017/09/Experimental-investigations-for-Units-3-and-4.pdf

Construct a Research Question

Once you have a topic of interest you need to construct a research question. This question is essential for the entirety of the investigation. It is central to your aim, theory section, hypothesis, method, results, discussion and conclusion. Without a well thought out and specific research question it is likely you will lose focus and have a lack of direction.

Example.1

A possible research question might be:
"To investigate how temperature varies with time inside an air tight thermos, when filled with boiling water?"

The research question needs to be:

- one that experimenting can answer
- one worth investigating to you
- practicable, given your knowledge, time and the school resources
- asked in a way that indicates what you will do.

Submitting a research proposal

Before launching into a practical investigation, students need to complete a **research proposal** or an **investigation plan.**

Completing such a document serves many purposes. It assists in the consolidation of your ideas. It allows you to consider the variables being considered. It provides you with an opportunity to think about the entire investigation and what data you can generate and how this data can be presented and analysed. It also allows you to check the equipment and time frame necessary to complete your investigation.

Once completed your teacher will review your proposal with you. They will either support your proposal, encourage you to alter components of your proposal or recommend that you consider an alternative investigation.

Link to a practical investigation proposal/plan document:
http://juddy.com.au/wp-content/uploads/2017/09/Yr-12-Physics-Student-Proposal-Form.pdf

Developing a testable hypothesis

A **hypothesis** is developed from a research question of interest and provides a possible explanation of a problem that can be tested experimentally. A useful hypothesis is a testable statement that may include a prediction.

Tbale.1 below provides an example of how a hypothesis may be constructed from a research question using an '**If-then-when**' construction process:

Step 1: Ask a research question of interest. *Does the functionality of a yo-yo depend on string ply?*
Step 2: Identify the independent variable (IV): *thickness of a yo-yo string*
Step 3: Identify the dependent variable (DV): *number of oscillations of a yo-yo*
Step 4: Construct a hypothesis (a – f below):

a	b	c	d	e	f
If... the DV)...	relationship phrase to the IV	...then...	trend indicator effect on the DV	...when...	trend indicator action by the IV
	...depends on... ...results from... ...is affected by... ...is directly related to...		...show an increase/ decrease ... ...be greater than/ less than... ...be larger/smaller...		...increased/ decreased... ...greater/less... ...large/small...

***Table.1** – Construct a hypothesis*

Example.2

Following the above hypothesis construction, to make a hypothesis for the yo-yo question.

Hypothesis: ***If*** *the number of oscillations of a yo-yo is inversely related to string ply,* ***then*** *the number of oscillations of a yo-yo using low-ply string will be greater than* ***when*** *higher-ply string is used.*

Example.3

Construct a hypothesis for the following research question:

"How does the density of a liquid effect the speed of rising bubbles?"
(As seen in Figure 2)

Hypothesis: ***If*** *an increase in density inhibits the bubbles* ***then*** *the speed of rising should be decreased* ***when*** *the density is greater.*

***Figure 2** – bubbles in a solution*

Variables

Variables can be used to classify data. There are two main classifications for data, that being **Numerical Data (Quantitative)** and **Categorical Data (Qualitative).**

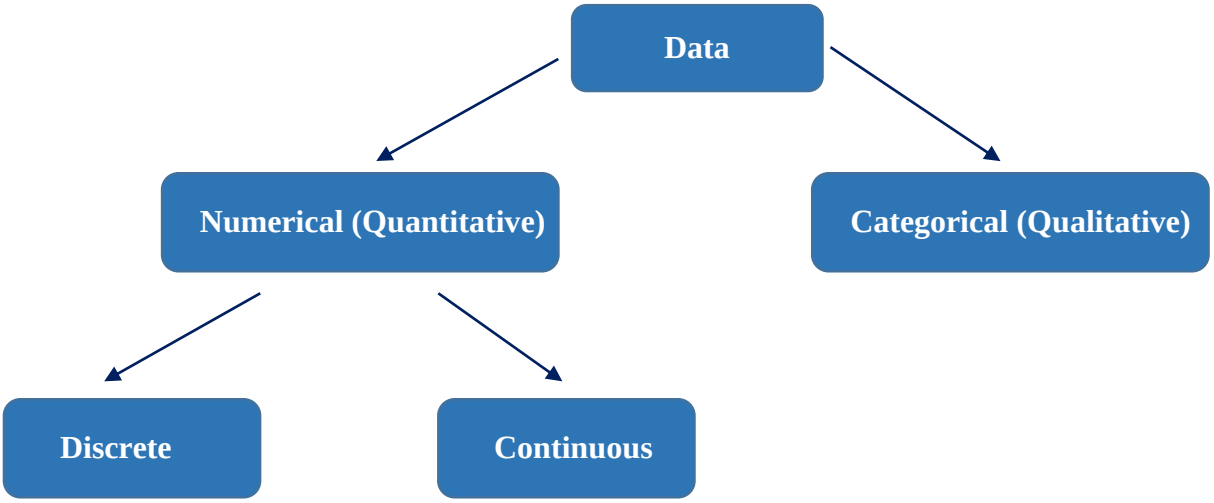

Figure 3 *– Data classification*

Categorical Data are best represented using bar charts or pie charts**.**
Numerical Data are displayed using scatter plots and line graphs.

Numerical data is typically the best option for Physics based Practical Investigations. Such data can be further sub classified:

- **Continuous variables** can take any value between a certain set of real numbers, for example, distance (2.85 kilometres), length of time (12.5 seconds) or temperature (25.4 °C)
- **Discrete variables** can take a value based on a count from a set of distinct whole values and cannot take the value of a fraction between one value and the next closest value, for example, number of carbon atoms in a polysaccharide or number of electrons in an atom.

In a Physics Practical Investigation variables need to be classified into one of the three groups:

An **independent variable** is the variable for which quantities are manipulated (selected or changed) by the experimenter, and assumed to have a direct effect on the dependent variable. Independent variables are plotted on the horizontal axis of graphs.

A **dependent variable** is the variable the experimenter measures, after selecting the independent variable that is assumed to affect the dependent variable. Dependent variables are plotted on the vertical axis of graphs.

A **controlled variable** is a variable that has been held constant in an experiment to test the relationship between the independent and dependent variables.