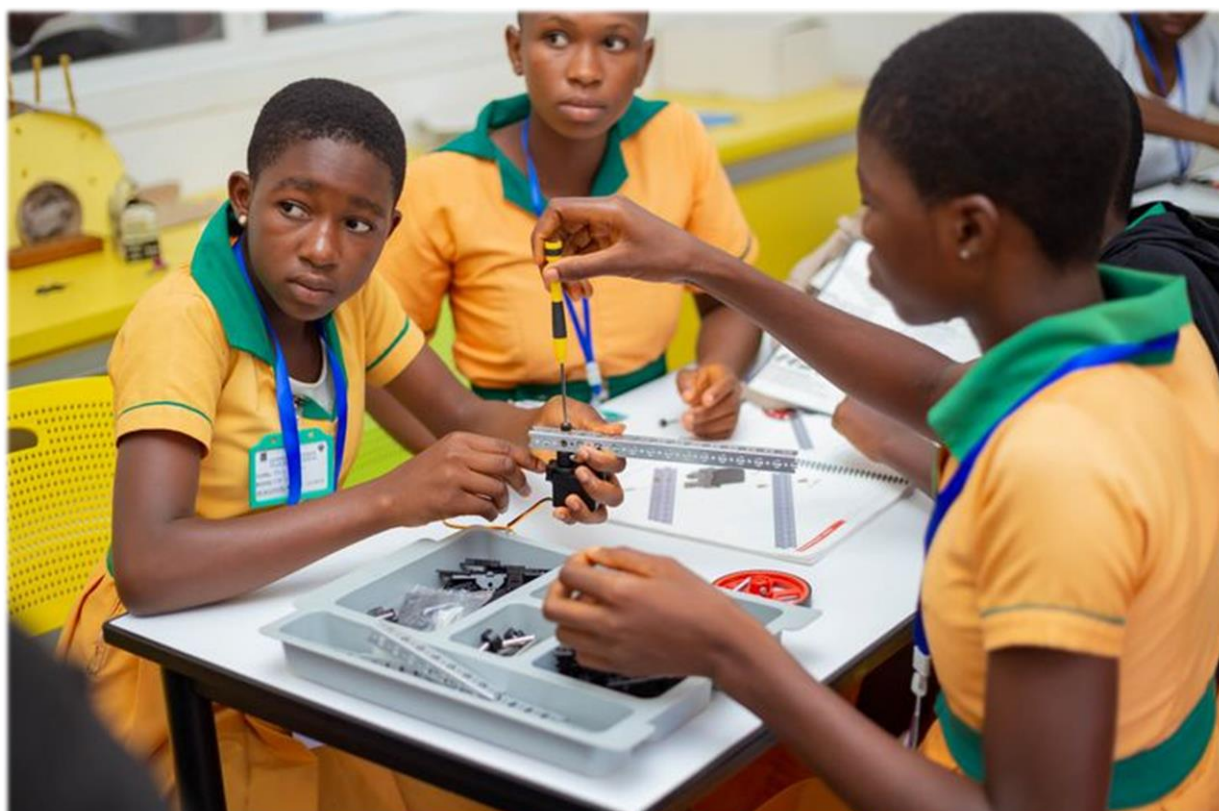


ADVANCED SECONDARY CURRICULUM

CBC SCENARIO BASED PHYSICS PRACTICAL GUIDE

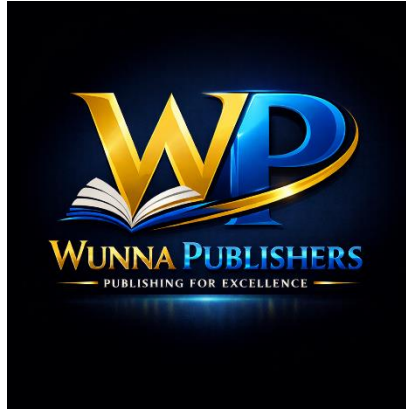
S.5 & S.6



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Student's Name:

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Zana along Entebbe road

Tel: +256750463703 /+256788463703

Website: wunnaeducationservices.com

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PREFACE

The Advanced Learner's Physics Practical Guide has been carefully developed to support both learners and teachers in mastering the essential skills required for success in A-Level physics practical examinations. In many classrooms, learners often find practical work challenging—not because of a lack of ability, but due to limited guidance on how to approach experiments, record observations, analyze data, and present clear scientific reports. This book is designed to bridge that gap.

The guide provides **simplified practical notes** that break down complex experimental concepts into clear, understandable steps. These notes are intended to build confidence and competence, enabling learners to approach practical work with precision and independence. Emphasis has been placed on clarity, accuracy, and relevance to ensure that every learner, regardless of background, can benefit.

In addition, the book offers **practical assessment and response guidelines** that equip learners with the skills needed to correctly interpret and respond to examination tasks. Understanding what examiners expect is key to success, and this guide provides structured approaches to answering questions, handling apparatus, making measurements, and presenting results effectively.

A major strength of this book lies in its **worked-out examples**, which demonstrate how to organize and present full investigation reports. These examples model proper scientific methods, including data collection, tabulation, graphical analysis, error evaluation, and conclusion writing. By studying these, learners can develop the ability to produce high-quality, well-structured practical reports.

To further enhance mastery, the guide includes **adequate scenario-based practical items for practice**. These scenarios simulate real examination conditions and encourage critical thinking, problem-solving, and application of theoretical knowledge to real-life situations. They are particularly useful for revision and self-assessment.

This book has been written in line with the **new Advanced Secondary Curriculum** provided by the National Curriculum Development Centre (NCDC). Every effort has been made to ensure that the content reflects current syllabus requirements, practical competencies, and assessment standards.

It is my hope that this guide will serve as a reliable companion for learners striving for excellence and a valuable resource for teachers dedicated to improving practical instruction. With consistent use, discipline, and curiosity, learners will not only succeed in examinations but also develop a deeper appreciation of physics as an experimental science.

KATO IVAN WUUNA

WUUNA SIMON PETER

WUUNA SIMON PHILIP

Physics and Mathematics Tutors

30 GREATEST PHYSICISTS AND THEIR CONTRIBUTIONS (BY FIELD)

MECHANICS

No.	Physicist	Greatest Contribution
1	Isaac Newton	Laws of Motion and Universal Gravitation
2	Galileo Galilei	Laws of Falling Bodies; Experimental Method
3	Johannes Kepler	Laws of Planetary Motion
4	Christiaan Huygens	Laws of Motion; Centrifugal Force
5	Leonhard Euler	Fluid Mechanics and Rigid Body Dynamics

HEAT (THERMODYNAMICS)

6	James Prescott Joule	Mechanical Equivalent of Heat
7	Sadi Carnot	Carnot Cycle (Heat Engine Efficiency)
8	Rudolf Clausius	Second Law of Thermodynamics; Entropy
9	Lord Kelvin	Absolute Temperature Scale
10	Ludwig Boltzmann	Statistical Mechanics; Entropy Theory

OPTICS

11	Isaac Newton	Theory of Light and Colour
12	Thomas Young	Wave Theory of Light; Double-Slit Experiment
13	Augustin-Jean Fresnel	Wave Optics; Diffraction Theory
14	Christiaan Huygens	Wave Theory of Light
15	Max Planck	Blackbody Radiation (Quantum Basis of Light)

ELECTRICITY

16	Michael Faraday	Electromagnetic Induction
17	André-Marie Ampère	Laws of Electric Current (Ampere's Law)
18	Alessandro Volta	Electric Battery (Voltaic Cell)
19	Georg Simon Ohm	Ohm's Law
20	Nikola Tesla	Alternating Current (AC) System

MAGNETISM

21	William Gilbert	Study of Magnetism; Earth as a Magnet
22	Hans Christian Ørsted	Link Between Electricity and Magnetism
23	James Clerk Maxwell	Electromagnetic Field Theory
24	Michael Faraday	Magnetic Fields and Field Lines
25	Pierre Curie	Magnetic Properties of Materials

MODERN PHYSICS

26	Albert Einstein	Theory of Relativity
27	Niels Bohr	Atomic Structure Model
28	Werner Heisenberg	Uncertainty Principle
29	Erwin Schrödinger	Wave Mechanics
30	Richard Feynman	Quantum Electrodynamics

Summary Insight

- **Mechanics** forms the foundation of classical physics.
- **Heat (Thermodynamics)** explains energy transformations.
- **Optics** studies light behavior (wave and quantum nature).
- **Electricity & Magnetism** combine into electromagnetism.
- **Modern Physics** explains atomic, nuclear, and cosmic phenomena.

QUOTATIONS FROM 30 GREAT PHYSICISTS

Physicist

Quotation

Isaac Newton

"If I have seen further, it is by standing on the shoulders of giants."

Albert Einstein

"Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world."

Marie Curie

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

Richard Feynman

"The first principle is that you must not fool yourself—and you are the easiest person to fool."

Galileo Galilei

"All truths are easy to understand once they are discovered; the point is to discover them."

Niels Bohr

"An expert is a person who has made all the mistakes that can be made in a very narrow field."

Werner Heisenberg

"What we observe is not nature itself, but nature exposed to our method of questioning."

Erwin Schrödinger

"The task is not so much to see what no one has yet seen, but to think what nobody has yet thought about that which everybody sees."

Stephen Hawking

"However difficult life may seem, there is always something you can do and succeed at. It matters that you don't just give up."

Max Planck

"Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery we are trying to solve."

Michael Faraday

"Nothing is too wonderful to be true, if it be consistent with the laws of nature."

James Clerk Maxwell

"Thoroughly conscious ignorance is the prelude to every real advance in science."

Physicist

Quotation

Paul Dirac

"The measure of greatness in a scientific idea is the extent to which it stimulates thought and opens up new lines of research."

Enrico Fermi

"There are two possible outcomes: if the result confirms the hypothesis, then you've made a measurement. If the result is contrary to the hypothesis, then you've made a discovery."

Carl Sagan

"Somewhere, something incredible is waiting to be known."

Freeman Dyson

"The purpose of thinking about the future is not to predict it but to raise people's hopes."

Lise Meitner

"Science makes people reach selflessly for truth and objectivity; it teaches people to accept reality, with wonder and admiration."

Ernest Rutherford

"All science is either physics or stamp collecting."

John Archibald Wheeler

"We live on an island surrounded by a sea of ignorance. As our island of knowledge grows, so does the shore of our ignorance."

Murray Gell-Mann

"Imagine how hard physics would be if electrons could think."

Lev Landau

"Cosmologists are often in error but never in doubt."

J. Robert Oppenheimer

"The best way to send information is to wrap it up in a person."

Hans Bethe

"If an experiment works, something has gone wrong."

Abdus Salam

"From time immemorial, man has desired to comprehend the complexity of nature in terms of as few elementary concepts as possible."

Richard P. Feynman

"Physics is like sex: sure, it may give some practical results, but that's not why we do it."

Katherine Johnson

"I loved going to work every single day. I loved my job and I loved the people I worked with."

Physicist

Quotation

Arthur Eddington

"The universe is not only stranger than we imagine, it is stranger than we can imagine."

Wolfgang Pauli

"I don't mind your thinking slowly; I mind your publishing faster than you think."

Subrahmanyan
Chandrasekhar

"The pursuit of science, with the realization that its findings are relevant to our understanding of ourselves, is a supremely humanistic activity."

Chien-Shiung Wu

"There is only one thing worse than coming home from the lab to a sink full of dirty dishes; that is not coming home from the lab at all."

30 OF THE GREATEST BREAKTHROUGHS IN PHYSICS

Breakthrough	Key Physicist(s)	Year	Description & Significance
Heliocentric Theory	Nicolaus Copernicus	1543	Proposed that the Sun, not the Earth, is the center of the solar system, fundamentally changing humanity's understanding of our place in the cosmos.
Laws of Planetary Motion	Johannes Kepler	1609–1619	Discovered that planets move in elliptical orbits with specific mathematical laws, providing crucial support for heliocentrism.
Telescopic Observations	Galileo Galilei	1609–1610	Observed moons of Jupiter, craters on the Moon, and phases of Venus, providing direct observational evidence against the geocentric model.
Laws of Motion & Universal Gravitation	Isaac Newton	1687	Formulated the three laws of motion and the law of universal gravitation, unifying celestial and terrestrial mechanics into a single framework.
Conservation of Energy	Julius von Mayer, James Joule, Hermann von Helmholtz	1840s	Established that energy cannot be created or destroyed, only transformed—a unifying principle across all of physics.
Classical Electromagnetism (Maxwell's Equations)	James Clerk Maxwell	1861–1864	Unified electricity, magnetism, and light into a single theory, predicting the existence of electromagnetic waves.

Breakthrough	Key Physicist(s)	Year	Description & Significance
Discovery of the Electron	J. J. Thomson	1897	Demonstrated the existence of subatomic particles (electrons) through cathode ray experiments, marking the birth of particle physics.
Quantization of Energy (Blackbody Radiation)	Max Planck	1900	Proposed that energy is emitted in discrete quanta, initiating the quantum revolution.
Theory of Special Relativity	Albert Einstein	1905	Revolutionized concepts of space, time, and simultaneity, establishing that the speed of light is constant and $E=mc^2$.
Photoelectric Effect (Light Quanta)	Albert Einstein	1905	Explained the photoelectric effect by proposing light consists of quanta (photons), crucial for establishing quantum theory.
Brownian Motion & Atomic Theory	Albert Einstein	1905	Provided theoretical explanation for Brownian motion, offering strong experimental evidence for the existence of atoms.
Atomic Nucleus & Rutherford Model	Ernest Rutherford	1911	Discovered the atomic nucleus through gold foil experiments, replacing the "plum pudding" model with the nuclear model of the atom.
Theory of General Relativity	Albert Einstein	1915	Redefined gravity as the curvature of space time, predicting black holes, gravitational lensing, and the bending of light.
Bohr Model of the Atom	Niels Bohr	1913	Introduced quantum orbits for electrons, successfully explaining hydrogen's spectral lines and laying groundwork for quantum mechanics.
Wave-Particle Duality	Louis de Broglie	1924	Proposed that particles (like electrons) exhibit wave-like behavior, fundamental to modern quantum theory.
Quantum Mechanics (Matrix Mechanics)	Werner Heisenberg, Max Born, Pascual Jordan	1925	Developed the first complete formulation of quantum mechanics using matrix mathematics.

Breakthrough	Key Physicist(s)	Year	Description & Significance
Quantum Mechanics (Wave Mechanics)	Erwin Schrödinger	1926	Formulated the Schrödinger equation, providing a wave-based approach to quantum mechanics.
Uncertainty Principle	Werner Heisenberg	1927	Established fundamental limits on the precision with which certain pairs of properties (like position and momentum) can be known simultaneously.
Discovery of the Neutron	James Chadwick	1932	Discovered the neutron, explaining nuclear structure and enabling the development of nuclear physics and nuclear energy.
Positron & Antimatter	Carl D. Anderson	1932	Discovered the positron (anti-electron), confirming the existence of antimatter predicted by Dirac.
Nuclear Fission	Otto Hahn, Lise Meitner, Fritz Strassmann	1938	Discovered that uranium nuclei split when bombarded with neutrons, leading to nuclear power and weapons.
Quantum Electrodynamics (QED)	Richard Feynman, Julian Schwinger, Sin-Itiro Tomonaga	1940s–1950s	Developed the relativistic quantum theory of electromagnetism, one of the most accurate theories in physics.
Transistor Effect	John Bardeen, Walter Brattain, William Shockley	1947	Invented the transistor at Bell Labs, revolutionizing electronics and enabling modern computing.
Discovery of the Cosmic Microwave Background (CMB)	Arno Penzias, Robert Wilson	1965	Detected the CMB, providing overwhelming evidence for the Big Bang theory.
Standard Model of Particle Physics	Multiple (Weinberg, Salam, Glashow, Gell-Mann, et al.)	1960s–1970s	Unified electromagnetic and weak forces (electroweak theory) and classified fundamental particles and forces.
Bell's Theorem & Quantum Entanglement Experiments	John Bell, Alain Aspect	1964–1982	Demonstrated that quantum entanglement is real, challenging local realism and confirming non-local quantum correlations.
Higgs Boson Discovery	Peter Higgs, François Englert, CERN (ATLAS & CMS)	2012	Confirmed the existence of the Higgs boson at the Large Hadron Collider, completing the Standard Model.

Breakthrough	Key Physicist(s)	Year	Description & Significance
Gravitational Wave Detection	LIGO Collaboration	2015	Directly observed gravitational waves from merging black holes, confirming a key prediction of general relativity.
Quantum Computing & Shor's Algorithm	Peter Shor, David Deutsch	1990s–Present	Laid theoretical and experimental foundations for quantum computers, promising exponential speedup for certain computations.
First Image of a Black Hole	Event Horizon Telescope Collaboration	2019	Captured the first direct image of a black hole's shadow (M87*), providing visual confirmation of general relativistic predictions.

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INTRODUCTION

Physics is fundamentally an experimental science built on observation, measurement, and logical reasoning. At the Advanced Level, practical work is not only a core component of the curriculum but also a critical skill that enables learners to connect theory with real-world applications.

Today, scientists are focusing on innovations and discoveries that address societal problems. Through scientific investigation, physics continues to offer solutions to various challenges, advancing both knowledge and practical applications.

The steps taken in a scientific investigation are;

1. Observing a situation,
2. Identifying a problem or question,
3. Identifying variables involved,
4. Formulating a hypothesis,
5. Designing and carrying out an experiment,
6. Collecting and presenting data,
7. Analysing data and drawing conclusion
8. Writing a report for the investigation.

OBSERVING A SITUATION

This involves using the senses i.e., smell, touch, taste, hearing and sight to gather all the valuable information. E.g., after experimenting with two concave mirrors A and B, where A had a smaller focal length than B, Ivan observed that the images formed by two mirrors were different in size and clarity.

IDENTIFYING A PROBLEM OR QUESTION

After an observation is made, a suitable question is suggested for a scientific investigation i.e., “how does the focal length of a concave mirror affect the size and nature of the image it forms at different object distances?”

IDENTIFYING VARIABLES INVOLVED

These are factors or physical quantities that change in the course of a scientific investigation.

There are three (3) basic types of experimental variables that a learner must identify and note down while performing a scientific investigation in physics practicals. And these include;

1. Independent/ Manipulated Variable

This is a variable that we can change or control in a scientific experiment or investigation.

OR: This is a variable which the experimenter (or investigator) changes to test its dependence on other variables. i.e., the focal length of a concave mirror (e.g., using mirrors of different focal lengths)

2. Dependent variable/ Responding variable

This is the one which we can test in a scientific investigation in order to get results.

The dependent variable depends on the independent variable.

When taking data during a scientific investigation, the dependent variable is the one being measured. i.e., the size and the nature of the image (e.g., magnified, diminished, upright or inverted)

3. Controlled/ Fixed/ Control variable

This is the one the investigator/ experimenter holds constant during a scientific investigation.

The control variable is not part of an experiment, but it is important because it has an effect on the results.

One of the most common control variables is temperature, and if not taken account of it might nullify the correlation between the dependent and independent variable. Other control variables include; amount of light, humidity, wind speed, duration of an experiment etc.

Whenever it is possible, control variables should be identified, measured and recorded i.e., to ensure a fair test, Tony must ensure the following variables are constant (object distance, object size, light source intensity, mirror quality, etc)

FORMULATING A HYPOTHESIS

The hypothesis is a concept or an idea that is to be tested through research and experiments.

OR: A hypothesis is the prediction about what the scientific investigation will find.

OR: It's simply a statement that is to be proven at the end of the scientific experiment or investigation. It shows the relationship between dependent variables and a single independent variable i.e., "the shorter the focal length of a concave mirror, the larger and more magnified the image it forms at the same object distance"

DESIGNING AND CARRYING OUT AN EXPERIMENT

This is an implementation phase where you follow the design plan

(a) Setup

Arrange the equipment as planned, ensuring all control variables are consistent.

Ensure that the measurements are precise and tools are calibrated.

(b) Execution

Perform the experiment step-by-step as outlined in the procedure

Observe, measure and document all results carefully.

(c) Troubleshooting

Adjust for unexpected issues, such as poor image clarity, by refining distances or angles.

(d) Repetition

Conduct multiple trials to confirm consistency in results.

COLLECTING AND TABULATING DATA

Tabulating data is a structured way to organise and to present observations and measurements collected during an experiment. It involves arranging data in rows and columns to make analysis clear and efficient.

ANALYSING DATA

Analysis of data is done by plotting a suitable graph, interpreting the graph and drawing conclusions.

Plotting a graph of focal length against image size,

A downward slope in focal length vs image size graph would confirm the inverse relationship.

Based on the trends and calculations, conclude whether the hypothesis is supported.

WRITING A REPORT FOR THE INVESTIGATION

A complete report is finally written for the investigation.

INDICATORS FOR PHYSICS SCIENTIFIC INVESTIGATION REPORT

The learner must write a practical work report which will include the following;

(a) Aim of the scientific investigation (experiment).

Variables of the experiment (Independent variables, dependent variables and controlled variables)

(b) Hypothesis

(c) List of apparatus and materials

(e) Procedure of the experiment and setup

(f) Presentation of data (table of results, graphs and calculation of the slope)

(g) Sources of errors

(h) Precautions

(i) Conclusion; conclusions can come from the value of the graph, the value of the slope or intercepts etc.

Note:

The conclusion will either qualify or disqualify the hypothesis. It is the conclusion that shows that whether the hypothesis is correct or not.

EXAMPLES OF INDEPENDENT, DEPENDENT AND CONTROL VARIABLES

Example 1.

In an experiment to determine acceleration due to gravity, one commonly used method involves the following steps:

1. Varying the length, L , of the pendulum bob
2. Measuring the time, t , for 20 oscillations
3. Calculating the period, T , and T^2
4. Tabulating the values in a suitable table
5. Plotting a graph of T^2 against L
6. Calculating the slope, S , of the graph
7. Determining the acceleration due to gravity, g , from the slope.

In this experiment, the variables to be identified and recorded are:

1. Independent Variable:

- Length of the pendulum, L

2. Dependent Variables:

- Time for 20 oscillations, t
- Period, T
- T^2 (square of the period)

3. Control Variables:

- Air resistance and reaction time. Reaction time refers to the time taken by a person to start and stop the timing clock during the counting of oscillations, which can affect the accuracy of measurements.
- Mass or material of the pendulum.

Example 2

In the experiment to determine the focal length f of a concave mirror using an illuminated object, the following steps are followed:

1. An illuminated object is placed in front of a concave mirror.
2. The mirror is positioned at a known distance u from the object.
3. The position of the screen is adjusted until a sharply focused image I appears on it.
4. The distance v of the image (screen) from the mirror is measured and recorded.
5. The procedure is repeated for different values of u , each time recording the corresponding values of u .
6. The results are recorded in a table, including the calculated values of uv and $(u+v)$.
7. A graph of $(u+v)$ against uv is plotted.
8. The slope S of the graph is determined.
9. The focal length of the mirror is calculated from the expression: $f = \frac{1}{S}$

In this experiment, the key variables are:

1. Independent Variable:

Object distance,

2. Dependent Variables:

Image distance, v , uv and $(u + v)$

3. Control Variable:

Light intensity (amount of light)

THE ADVANCED SECONDARY CURRICULUM PHYSICS

ASSESSMENT OBJECTIVES, CONSTRUCTS AND THE TOPICS IN THE SYLLABUS

Assessment Objective	Construct	Construct Description	Topics in the syllabus
AO1	Force and Motion	Analysis of how force affects the state of bodies	1. Measurement and Dimensions of Physical Quantities 2. Statics 3. Linear Motion 4. Motion Under Gravity 5. Work, Energy and Power 6. Solid Friction 7. Fluid Mechanics 8. Mechanical Properties of Matter 20. Circular Motion 22. Gravitation
AO2	Energy	Exploration and application of energy forms and transformations.	9. Thermometry 10. Heat Quantities 11. Transfer of Heat 12. Behaviour of Gases 13. Thermodynamics 14. Reflection of Light 15. Refraction of Light 16. Optical Instruments 21. Simple Harmonic Motion 23. Progressive Waves 24. Stationary Waves 25. Sound Waves
AO3	Charges and Fields	Exploration of how electric and magnetic fields interact in systems and devices.	17. Electrostatics 18. Capacitors 19. Digital Electronics 26. Current Electricity 27. Magnetism in Matter 28. Magnetic Effect of an electric Current 29. Electromagnetic Induction 30. A.C Circuits
AO4	Particles	Investigation of atomic, quantum, and nuclear phenomena and their applications	31. Atomic Particles 32. Quantum Theory 33. Nuclear Processes

ASSESSMENT FORMAT FOR THE ADVANCED SECONDARY PHYSICS

There will be two examination papers for Physics at Advanced Secondary Curriculum. Each examination paper will be divided into different sections with each section addressing an assessment objective.

Paper 1 (Theory Paper) contains seven scenario-based items from four sections A, B, C and D. Section A contains of one item set from construct 4 (Particles) addressing assessment objective 4. Section B contains of two items set from construct 1; Force and Motion addressing assessment objective 1. Section C contains of two items set from construct 2; Energy addressing assessment objective 2.

Section D contains of two items set from construct 3 Charges and Fields addressing assessment objective 3

The learner attempts four items, including the one compulsory item from section A and one item from each of the sections B, C and D. The entire paper will take 2hours and 40 minutes.

Paper 2 (Practical Paper) contains **two items**. Items in this paper come from any of the four constructs. The items assess Practical abilities of the learners in the different constructs. The items in the paper are scenario based and the entire paper takes 2 hours and 45 minutes (including time for reading, analysis of the scenario, planning and carrying out the investigation).The learner attempts only **one item**.

Skills to be assessed:

- i. Planning to select techniques, apparatus and materials;
- ii. Identifying variables and controlling them;
- iii. Making predictions based on prior knowledge and hypotheses;
- iv. Manipulation of the apparatus and performing experiments to obtain readings/results;
- v. Making and recording observations and measurements to the right accuracy of instruments and calculation;
- vi. Presentation of data in an appropriate form, such as graphical and any other suitable form.
- vii. Manipulating graphical data by determining gradients, intercepts or any other required points and identifying patterns in outcomes;
- viii. Drawing conclusions from observations made;
- ix. Assessing the suitability of procedure by identifying errors, limitations of measurements and /or experimental procedures used and suggesting methods of minimizing the errors for better results;

**SAMPLE OF ADVANCED LEVEL PHYSICS PRACTICAL EXAMINATION
P510/2 ASSESSMENT**

Time Allowed: 2 hours 45 minutes

Instructions to Candidates:

Attempt **only one** item

1. For each task:
 - a) Identify the problem or relationship and hypothesis to investigate.
 - b) Design and carry out a valid experiment.
 - c) Record and present your data clearly.
 - d) Analyze your results and draw reasoned conclusions.
 - e) Reflect on accuracy of the results and suggest improvements.
2. Support materials for each task are provided.

Item 1

A local boda-boda (motorcycle) garage is interested in improving the fuel efficiency and safety of motorcycles by reducing unnecessary load and friction. Mechanics often claim that heavier loads make motorcycles harder to accelerate, but they cannot quantify this effect. The garage consults physics students to investigate the above phenomenon using a trolley model.

Task: As a Physics student, you are required to conduct an experiment to reassure the mechanics about their claim.

Item 2

An electrician observes that a wire in a household circuit heats up significantly when current flows through it. He suspects that this wire may have an unusual electric behaviour and fears that it might cause fire and burn the house. He therefore wishes to replace the wire with another one, but has two alternatives to choose from.

Task

- a) As a physics student, carry out an investigation to help the electrician to select the right wire for replacing the wire that heats up.

b) At a chosen value of V , compare the power generated from each conductor and advise the electrician accordingly.

END

SCORING RUBRIC FOR ADVANCED LEVEL PRACTICAL PHYSICS EXAMINATION

Item 1

Output / Task	Basis of Evaluation	Score				
		5	4	3	2	1
Aim	Clarity and relevance of the aim	Clear, concise, and fully relevant aim linked to investigation relating mass to acceleration.	Mostly clear and relevant aim linked to investigation relating mass to acceleration.	Relevant aim linked to investigation relating mass to acceleration.	Aim linked to investigation relating mass to acceleration.	Aim has little or no link to the investigation.
Hypothesis	Appropriateness and testability	Well-stated, testable hypothesis; clearly predicts the relationship between mass and acceleration.	Relevant and testable hypothesis; clearly predicts the relationship between mass and acceleration.	Partially stated hypothesis to predict the relationship between mass and acceleration.	Unclear hypothesis stated that does not lead to prediction of the relationship between mass and acceleration.	Irrelevant or no hypothesis stated.
Independent Variable	Correct identification	Correctly identifies and accurately explains the independent variables.	Correctly identifies and partially explains the independent variables.	Correctly identifies the independent variables without explanation.	Partial identification of independent variables.	Variables not distinguished.
Dependent Variable	Correct identification	Correctly identifies and accurately explains the dependent variables.	Correctly identifies and partially explains the dependent variables.	Correctly identifies the dependent variables without explanation.	Partial identification of dependent variables.	Variables not distinguished.
Controlled Variables	Completeness and correctness	Correctly identifies and accurately explains the controlled variables.	Correctly identifies and partially explains the controlled variables.	Correctly identifies the controlled variables without explanation.	Partial identification of controlled variables.	Controlled Variables not distinguished.

Procedure	Clarity, completeness, logical sequence	Clear, concise, replicable and fully relevant step-by-step procedure establishing the relationship between mass and acceleration	Clear, replicable and fully relevant step-by-step procedure establishing the relationship between mass and acceleration.	Replicable and relevant step-by-step procedure establishing the relationship between mass and acceleration	Partially relevant procedure establishing the relationship between mass and acceleration	Totally illogical procedure which does not lead to establishing the relationship between mass and acceleration
Data Presentation	Organization, tables, units	Data presented clearly in correct columnar table with units and labels indicated; measurements recorded to the accuracy of the instrument used.	Data presented clearly in correct columnar table with some errors in units and labels; measurements recorded to the accuracy of the instrument used.	Data presented in columnar table with some errors in units and labels; measurements recorded to the accuracy of the instrument used.	Data presented in an incomplete table with errors in units and labels; measurements recorded inconsistently.	Totally illogical data with no trends presented
Errors and Precautions	Identification and explanation	Accurately identifies errors; accurately explains their sources and proposes appropriate precautions	Accurately identifies errors; partially explain their sources and proposes appropriate precautions.	Identifies errors; and proposes appropriate precautions	Identifies some errors and suggests inappropriate precautions	Irrelevant sources of errors and precautions stated
Data Analysis (Graphical)	Accuracy, interpretation	Title clearly stated; axes drawn and labeled; Appropriate scale; points correctly plotted; trend analyzed accurately	Title clearly stated; axes drawn and labeled with missing units; Appropriate scale; points correctly plotted; trend analyzed accurately.	Title stated; axes drawn and labeled with missing units; inappropriate scale; points plotted; trend analyzed.	Major errors in either axes labels, finding the scale, plotting, or analyzing trends.	Irrelevant analysis of data, like plotting wrong graph

Conclusion/ Recommendation	Justification using physics principles	Accurate, logical conclusion, fully justifying the investigation carried out; recommendations appropriate basing on the results.	Clear, logical conclusion, fully justifying the investigation carried out; recommendations basing on the results.	Makes a conclusion partly justifying the investigation carried out with partial recommendation.	Makes a conclusion that hardly justifies the investigation carried out with some recommendation.	Irrelevant conclusion or incorrect recommendation.
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Item 2

Output / Task	Basis of Evaluation	Score				
		5	4	3	2	1
Aim	Clarity and relevance of the aim	Clear, concise, and fully relevant aim linked to investigation relating I to V.	Mostly clear and relevant aim linked to investigation relating I to V.	Relevant aim linked to investigation relating I to V	Aim linked to investigation relating I to V.	Aim has little or no link to the investigation
Hypothesis	Appropriateness and testability	Well-stated, testable hypothesis; clearly predicts the relationship between I to V.	Relevant and testable hypothesis; clearly predicts the relationship between I to V.	Partially stated hypothesis to predict the relationship between I to V.	Unclear hypothesis stated that does not lead to prediction of the relationship between I to V.	Irrelevant or no hypothesis stated
Independent Variable	Correct identification	Correctly identifies and accurately explains the independent variables.	Correctly identifies and partially explains the independent variables.	Correctly identifies the independent variables without explanation	Partial identification of independent variables	Variables not distinguished
Dependent Variable	Correct identification	Correctly identifies and accurately explains the dependent variables.	Correctly identifies and partially explains the dependent variables	Correctly identifies the dependent variables without explanation	Partial identification of dependent variables	Variables not distinguished

Controlled Variables	Completeness and correctness	Correctly identifies and accurately explains the controlled variables.	Correctly identifies and partially explains the controlled variables.	Correctly identifies the controlled variables without explanation	Partial identification of controlled variables	Controlled Variables not distinguished
Procedure	Clarity, completeness, logical sequence	Clear, concise, replicable and fully relevant step-by-step procedure establishing the relationship between I to V.	Clear, replicable and fully relevant step-by-step procedure establishing the relationship between I to V.	Replicable and relevant step-by-step procedure establishing the relationship between I to V.	Partially relevant procedure establishing the relationship between I to V.	Totally illogical procedure which does not lead to establishing the relationship between I to V.
Data Presentation	Organization, tables, units	Data presented clearly in correct columnar table with units and labels indicated; measurements recorded to the accuracy of the instrument used.	Data presented clearly in correct columnar table with some errors in units and labels; measurements recorded to the accuracy of the instrument used.	Data presented in columnar table with some errors in units and labels; measurements recorded to the accuracy of the instrument used.	Data presented in an incomplete table with errors in units and labels; measurements recorded inconsistently.	Totally illogical data presented, with no trends
Errors and Precautions	Identification and explanation	Accurately identifies errors; accurately explains their sources and proposes appropriate precautions	Accurately identifies errors; partially explain their sources and proposes appropriate precautions	Identifies errors; and proposes appropriate precautions	Identifies some errors and suggests inappropriate precautions.	Irrelevant errors and precautions stated
Data Analysis (Graphical)	Accuracy, interpretation	Title clearly stated; axes drawn and labeled; Appropriate scale; points correctly	Title clearly stated; axes drawn and labeled with missing units; Appropriate scale; points	Title stated; axes drawn and labeled with missing units; inappropriate	Major errors in either axes labels, finding the scale, plotting,	Irrelevant analysis of data, like plotting wrong graph

		plotted; trend analyzed accurately.	correctly plotted; trend analyzed accurately.	e scale; points plotted; trend analyzed	or analyzing trends	
Conclusion/ Recommendation	Justification using physics principles	Accurate, logical conclusion, fully justifying the investigation carried out; recommendations appropriate basing on the results.	Clear, logical conclusion, fully justifying the investigation carried out; recommendations basing on the results	Makes a conclusion partly justifying the investigation carried out with partial recommendation	Makes a conclusion that hardly justifies the investigation carried out with some recommendation	Irrelevant conclusion or incorrect recommendation

The Structure of the Assessment

The practical assessment typically consists of **scenario-based questions**. Instead of a direct instruction like "Measure the length of the wire," the learner is presented with a real-life situation or a "problem" that needs solving using Physics principles (typically from Mechanics, Light, or Electricity). Learners choose one out of two provided scenarios and carries out a scientific investigation.

The Step-by-Step Learner Response

When responding to a scenario, the learner is expected to follow the **Scientific Method**. A complete report should include the following sections:

1. Aim of experiment.

Write down a relevant aim having correct statement with quantity and correct purpose

2. Purpose of experiment.

Write down the purpose of the experiment (reason or goal for conducting the experiment).

3. Variables for the experiment.

Identify and present independent variable and all the required dependent and controlled variables

4. Hypothesis (Prediction).

Write down a relevant hypothesis with correct statement having the range or value from the scenario

5. Procedure.

Procedure of the experiment with relevant apparatus and diagram (strictly apparatus that are relevant must be stated)

- Draw relevant experimental set-up with key apparatus
- Write all the necessary steps that are coherent
- Write values of independent variables

6. Errors and Precautions.

State relevant errors and corresponding precautions that are related to the experiment

7. Data Presentation

- Present organised data, independent and corresponding dependent variables
- Present atleast 6 sets of independent and dependent variables
- Write atleast 3 of the quantities and their corresponding units correctly
- Record data in the expected trend and accuracy for independent and dependent variables

8. Recorded Data Accuracy

- Record atleast 3 dependent variables within the expected range

- Record dependent variable(s) that has/have appropriate decimal place(s); (read from the instrument used)
- Use correct significant figures/ decimal places for calculated values

9. Data analysis

- Write the title of the graph correctly
- Draw both axes
- Label both axes correctly with units (when expected) and no units (when nonexistent)
- Use uniform scales on both axes
- Plot atleast 5 points correctly
- Draw the line of best fit balancing the plotted points well

10. Data interpretation

- Substitute all the 4 values correctly in the slope formula
- Obtain correct value
- Write correct unit (when expected) or no unit (when nonexistent)
- Correctly relate the value obtained to what is being investigated (conclusion)

Or

- Read and record the value of the intercept correctly with unit (when expected) or no unit (when nonexistent)
- Correctly relate the value obtained to what is being investigated (conclusion)

11. **Conclusion.** Use the value obtained to make a correct conclusion.

12. **Recommendation.** Use findings to suggest improvements or next step.

MEASURING INSTRUMENTS AND THEIR ACCURACY

The smallest value that can be measured by the measuring instrument is called its least count.

Measured values are good only up to this value. The least count error is the error associated with the resolution of the instrument

Note.

The least count of an instrument determines the number of decimal places to which the measured values are to be recorded.

1. Meter rule

A meter rule is one metre long and contains 100cm. It measures length to 1 d.p in centimetres. When required in metres it's recorded to 3 d.p. e.g **20.0cm**, and when required in metres **0.200m**



10 divisions = 1.0cm

1 div = $\frac{1}{10}$ cm

1 div = 0.1cm (1d.p)

Least count for a metre rule = **0.1cm**. All values read from a metre rule are recorded to 1 d.p