ZNOTES // A-LEVEL SERIES
visit www.znotes.org

Updated to 2019-21 Syllabus

CIE A2-LEVEL PHYSICS 9702

SUMMARIZED NOTES ON THE PRACTICALS SYLLABUS

1. Planning

1.1 Defining the Problem [3]

- Identify:
  - the **independent variable** in the experiment *[1]*
  - the **dependent variable** in the experiment *[1]*
  - the quantities to be **controlled** – kept constant *[1]*

The independent variable is the variable you change in order to see its relationship with the dependent variable

- The quantity to be kept constant can be many things however select the one which directly affects the variable being measured in a physical aspect
- Explain why, using scientific terminology, the reason to keep a variable constant

1.2 Methods of Data Collection [5] + [4]

- Draw a labelled diagram *[1]* to describe the arrangement of apparatus for the experiment
- Describe the method to be used to vary the independent variable *[1]* and state what instrument is used to measure it *[1]*
- Describe the method and state the instrument used to measure the dependent variable *[1]*
- Describe the method to keep the control variables mentioned before constant *[1]*
- Including above points; the answer should describe how the experiment will be carried out i.e. procedure
- Include 4 points of additional detail *[4]* regarding the method of collection, improvement in accuracy and detail on instrument usage

1.3 Method of Analysis [2]

- Algebraically manipulate to form a linear relationship from that given – choose what quantity should be on each axes to give a straight line graph *[1]*

Relationship	Graph	Gradient	y-intercept
$y = mx + c$	y against x	m	c
$y = ax^n$	$\lg a$ against $\lg x$	n	$\lg a$
$y = ae^{kx}$	$\ln a$ against $\ln x$	k	$\ln a$

- Describe what the graph should look like if the given relationship is true *[1]*

  e.g. relationship given is $A = k\sqrt{p}$

  The following graphs will give linear relationships

  A^2 against p or A against $\sqrt{p}$ or $\lg A$ against $\lg p$

  Relationship is true
  - A^2 or A used: straight line through the origin
  - $\lg A$ used: gradient should equal 0.5
- Write the equation of the line

1.4 Safety Considerations [1]

- Asses the risk of the experiment
- Describe precautions that be taken to keep risks to minimum *[1]*

2. Analysis

2.1 Treatment of Uncertainties

For a quantity $x = (2.0 \pm 0.1)mm$

- **Absolute uncertainty** $= \Delta x = \pm 0.1mm$
- **Fractional uncertainty** $= \frac{\Delta x}{x} = 0.05$
- **Percentage uncertainty** $= \frac{\Delta x}{x} \times 100\% = 5\%$
- **Logarithmic uncertainties:** e.g. uncertainty in $\ln x$

  Natural logarithm of best value of x is $\ln 2.0 = 0.693$

  Natural logarithm of max value of x is $\ln 2.1 = 0.742$

  Difference between values is $0.742 - 0.693 = 0.049$

  $$\therefore \ln(2.0 \pm 0.1) = 0.69 \pm 0.05$$
- **Combining errors:**
  - When values **added or subtracted**, add absolute error

    If $p = \frac{2x+y}{3}$ or $p = \frac{2x-y}{3}$, then $\Delta p = \frac{2\Delta x + \Delta y}{3}$
  - When values **multiplied or divided**, add % errors
  - When values are **powered** (e.g. squared), multiply percentage error with power

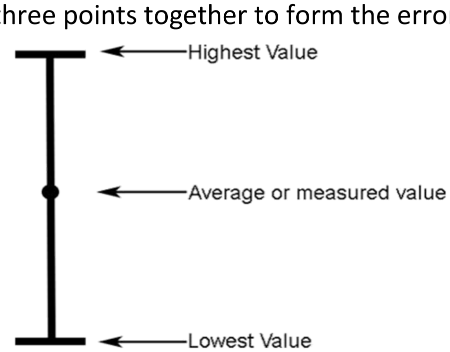
    If $r = 2xy^3$ or $r = \frac{2x}{y^3}$, then $\frac{\Delta r}{r} = \frac{\Delta x}{x} + \frac{3\Delta y}{y}$

2.2 Treatment of Significant Figures

- **Actual error:** recorded to only 1 significant figure
- Number of decimal places for a calculated quantity is equal to number of decimal places in actual error.

2.3 Graphs

- Firstly, plot the best value of each variable on the graph
- Next, add and subtract the error and plot this above and below the best value.
- Join the three points together to form the error bar



An Error Bar

- **Line of best fit:** should pass through most 'best' values and must be passing through each error bar

- **Worst acceptable line:** the shallowest or steepest possible line that passes through or close to every error bar e.g. lowest value and highest value (label the line) Join the top of the topmost point's error bar and the bottom of the bottommost error bar and the line should touch every error bar

Determining error in gradient and y-intercept:

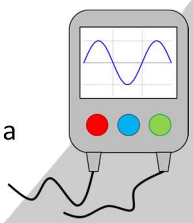
- After plotting both lines, calculate the gradient of each line by forming a triangle with a hypotenuse of length greater than half the graph. Leave all construction lines
- Calculate the gradient of the line of best fit and subtract from the worst fit to find error in gradient.
- If broken axis used, form equation of both lines and find the y-intercept
- If normal axis used, read off value from the graph
- Subtract the two y-intercepts to find the error

Finding constants in given relationship:

- Using values calculated i.e. gradient and y-iintercept, equate coefficients of the equation of the line with relationship to find constants.

3. Apparatus & Additional Details

3.1 General Experiments



Apparatus:

- **Signal generator:** can be used to produce a sound/voltage/current and can vary frequency settings on device
- **Micrometer:** can be used to measure small distances
- **Vernier calipers:** can be used to measure small distances
- **Set square:** used to make sure apparatus perpendicular
- **Magnets:** can be used with metal objects in experiment
- **Balance:** can be used to weigh a mass
- **Burette:** accurately measuring volume of liquid
- **Diffraction grating:** can be used to measure wavelength of a monochromatic light source

Additional Details:

- **Measuring amplitude and period using a c.r.o**
  - Adjust time-base and y-gain to achieve a suitable waveform
  - Calculate amplitude by finding height in terms of boxes on grid of waveform and multiplying by y-gain
  - Calculate period by counting boxes of grid occupied by a full waveform and multiply by time-base setting
- **Measuring diameter:** repeat measurements in different positions and average
- Wear safety googles/use a safety screen to protect eyes when heating/pouring liquids or handling stretched wire
- Ensure apparatus stable & not easily knocked over by placing weights (e.g. on retort stand) and working on a flat surface
- Use a sand tray under heavy weights and make sure weights don't fall on your foot
- Keep radioactive substances in a lead-lined container
- To ensure surface is horizontal, use a spirit level
- **Sound experiment:** perform experiment in a quiet room
- **Light experiment:** perform experiment in a dark room
- Repeat experiment & determine average

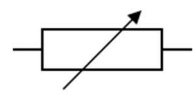
3.2 Pressure Experiments

Apparatus:

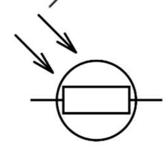
- **U-Tube (manometer):** measures pressure difference between two fluids
- **Bourdon gauge:** measuring pressure of a gas or liquid
- **Pump:** can be used to alter pressure in a container

3.3 Electrical Experiments

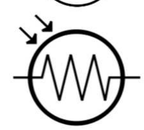
Apparatus:



- **Variable resistor (rheostat):** can be used to alter voltage/current supplied in a circuit or can be used to keep current constant



- **LDR:** resistance decreases with increasing light intensity



- **Photocell:** sensors that allow you to detect light – generate an e.m.f when light is incident

Additional Details:

- Use a protective resistor to reduce current
- Switch off currents when not in use so that wires/coil do not overheat
- Use microammeter and galvanometer for small voltages and currents
- When using ammeter and voltmeter to measure resistance, a power supply is required
- **Type of current to use:**
  - Large current to create a large magnetic field
  - Large current to produce measurable e.m.f./voltage
  - Small current to reduce heating effect

3.4 Magnetic Field Experiments

- **Hall probe:** used to measure magnetic fields
- Keep Hall probe at right angles (perpendicular) to magnetic field by fixing to rule
- Calibrate Hall probe in a known magnetic field
- Repeat experiment with Hall probe reversed and average
- In magnetic experiments, avoid external alternating magnetic fields

3.5 Falling Bodies & Oscillations Experiments

- **Measuring velocity using light gate:**
  - Measure distance between light gates
  - Connect light gates to time loggers
  - Calculate time of fall by using data from loggers – time difference between when the first and second beam are broken
- For experiments with light weights or wind, close windows & switch off air conditioning to avoid draughts
- For measuring time period of oscillations, find time for 10 oscillations and then divide
- Use fiducial markers to time oscillating objects
- To measure quantities in an experiment with fast motions, record experiment with a video camera and playback in slow motion
- In an experiment with object being dropped, make sure object released with no/constant velocity. Can use electromagnets or a spring loaded device
- For falling objects, use a guide to keep motion in correct direction

CIE A2-LEVEL PHYSICS//9702

WWW.ZNOTES.ORG