Physics

Assessing Outcome 3

Higher

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HIGHER STILL

Physics

Assessing Outcome 3

Higher

Support Materials

Higher Physics

HANDBOOK: ASSESSING OUTCOME 3

Contents **Page**

1. GENERAL INTRODUCTION

Purpose of the handbook

The purpose of this handbook is provide some examples to illustrate the standard expected for the attainment of Outcome 3. Examples are provided covering the three units of the Higher Physics course. Each example consists of a candidate instruction sheet and a student report with comments.

The 'Outcome 3: Teacher/Lecturer guide' on page 46 lists the performance criteria, given in the Arrangements for Physics documentation, which must be achieved in order to attain the outcome. This handbook has been developed in response to requests for additional exemplification of the standard expected. It should also help to ensure that such standards are applied evenly across the country.

One student report of an experiment is required per unit. Section 2 lists suggested experiments. Note that the choice of experiment is not prescribed in the unit specification. It is likely that different centres will use different equipment for similar experiments. Hence it is not possible to provide unique marking schemes.

The instruction sheets

The instruction sheets given in this handbook can be adapted for individual use, or centres can use their own instruction sheets. The main purpose of the instruction sheets is to provide guidance as to the amount of detail and help which the candidate might expect to receive. In no way do they suggest that any particular apparatus or method of approach is superior to any other.

The heading or title should imply the aim or objective. A detailed objective should not be given on the instruction sheet, but a diagram can be provided. Similarly a circuit diagram where appropriate will appear on the instruction sheet. It would *not* be appropriate to supply the candidate with a blank table to copy or complete.

The Core Skill: Using Graphical Information requires a student to 'select appropriate forms'. Hence the instruction sheet should not specifically indicate that a graph must be plotted to communicate the information. A typical sentence is: 'Use an appropriate format to show the relationship between yy and xx.'

The instruction sheet must be sufficient for the candidate to carry out the experiment but must not provide help for the recording and analysing of the information.

The student reports

The examples of students' responses are designed to illustrate where mistakes or omissions would constitute a reason for resubmission. Also their purpose is to indicate where less than perfect practice could be pointed out to the student, but which *would* be adequate for outcome attainment. It is important to distinguish between the ideal and the acceptable. Naturally, the learning and teaching will cover the ideal report, but the assessment of the report must meet the acceptable standard as specified by the performance criteria.

The comments on the reports in the right hand margin are designed to help clarify borderline issues. It is the intention that these comments should be taken in the broad sense and might be applied to a number of different experiments. It must be emphasised that *in practice* only a cross or omission mark would be placed on the student script. The reports included contain the actual details of the corrections required. This is for the purposes of exemplification only.

Experimental activities

The practical activities which students undertake to attain Outcome 3 will be part of the normal learning and teaching process. An introduction to relevant concepts will take place and possible investigations could be debated by the whole group. Thus the particular practical activity would be integrated into the topic under discussion. Practical work should not be set as an isolated task completely out of context. The students can work in groups. This avoids problems with limited apparatus and the need to rotate students among different experiments, some of which may be out of context.

Any mathematical skills required can be discussed by the whole group, for example the need for a straight line through the origin to verify a 'directly proportional' relationship. Reference to relevant equations and any manipulation of such equations may also require to be included in class discussions. Similarly it is expected that the students have covered the relevant theory or that any theoretical points are brought out in discussion during the experiment, for example it would not be expected that a student could inspect the results for the variation of acceleration with angle of slope and deduce that the sine of the angle is involved.

Report writing

At this level it is expected that the student completes the report without the assistance of a proforma report page. The student should receive an 'Outcome 3: Advice to Students' page which may be referred to during the experiment and report writing. The student can be reminded to use the specific headings to aid clarity and ensure completeness.

Using the handbook

You will find it useful to refer to the 'Outcome 3: Teacher/Lecturer guide' when you read through the exemplar student reports included in this handbook and consider how you would have assessed the submissions.

Section 6 contains some general comments on marking and recording.

Safety

Due attention must be given to safety in the laboratory. It is assumed that centres are familiar with statutory requirements, and will ensure that safe working practices are observed. The initial induction for students should include information on safety in the laboratory. All necessary safety notices should be clearly displayed. It is the centre's responsibility to ensure that an appropriate risk assessment is carried out for any experiment undertaken. All exemplars in this handbook are for illustrative purposes only.

2. LISTS OF SUGGESTED EXPERIMENTS

The following list is taken from the content statements and suggested contexts, applications, illustrations and activities detailed in the course specification in the Arrangements for Physics documentation. This list is not prescriptive nor does it indicate all the possible experiments. Centres can select practical exercises providing they relate to the unit content and are at an appropriate standard. It is expected that the students will perform the experiment in small groups. The experiments chosen must provide opportunities for the analysis of the information as required by the performance criteria.

Mechanics and Properties of Matter

- Variation of acceleration with the angle of slope
- Measurement of acceleration from a displacement-$(\text{time})^2$ graph for a uniformly accelerating object
- Measurement of acceleration from a velocity-time graph obtained for an object moving with constant acceleration
- Variation of pressure in a fluid with depth or density
- Variation of gas pressure with volume
- Variation of gas pressure with temperature
- Variation of volume of gas with temperature.

Electricity and Electronics

- Measurement of the internal resistance of a source
- Variation of out-of-balance p.d. with change of resistance for one resistor in the Wheatstone bridge
- Variation of charge with potential difference for a capacitor
- Variation of current with frequency in a capacitive circuit
- Variation of V_{out} with V_{in} for an inverting amplifier.

Radiation and Matter

- Variation of angle of incidence with angle of refraction for a perspex block
- Variation of intensity of light with distance from the source
- Variation of current with applied p.d. for a forward and reversed biased diode
- Variation of current with light intensity for a reversed biased photodiode
- Variation of intensity of gamma radiation with thickness of lead absorber*
- Variation of intensity of gamma radiation with distance from the source.*

* Due attention to safety requirements and age limitations with the use of radioactive sources is necessary for these experiments. Videos or simulations are not deemed acceptable at this level. Hence some centres may wish to use other experiments for the purposes of assessment.

3. MECHANICS AND PROPERTIES OF MATTER

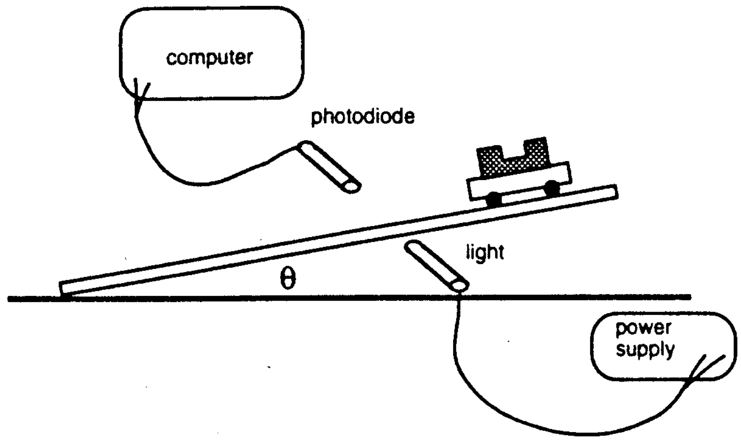
MECHANICS AND PROPERTIES OF MATTER (H)

Assessment for Outcome 3 -
Variation of acceleration with the angle of slope

Candidate instruction sheet

Apparatus

Trolley with runway, (or linear air track with vehicle,) double card, light gate, computer, clinometer.



Instructions

Set up the runway or linear air track at an angle.
Measure this angle of slope
Set up the light gate so that the double card cuts the light beam.
Organise the computer to measure acceleration.
Release the trolley or vehicle and measure the acceleration.

Measure the acceleration for other angles of slope.

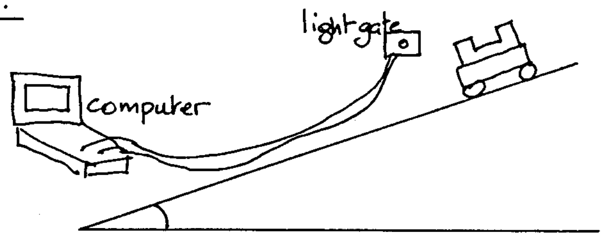
Use an appropriate format to show a relationship between the acceleration and angle of slope.

Title: Variation of Acceleration with the angle of a slope.

Comment

Aim: The aim of the experiment is to find the relationShip between the acceleration of a vehicle travelling down a slope with the angle of the slope.

Apparatus:



Clear diagram, although minimalist

Procedure: A runway was set up on a slope. The angle of the slope was measured with a clinometer. A trolley with a double card was released down the slope. The card cut a light gate as the trolley ran down the slope. The computer was set up with a programme to measure acceleration. The acceleration value was taken 3 times and the average value calculated. Then the angle of the slope was changed and the experiment was repeated for different angles of slope.

Some centres may require the size of the mask to be specifically stated.

Clear procedure, 3rd person used, Mention of repeated measurements

Results: The results were recorded in this table (The sin of the angle was calculated and entered in the table)

angle(°)	sin of angle	acc^n 1	acc^n 2	acc^n 3	AVERAGE acc^n (ms^{-2})	uncertainty (m s^{-2})
18	0.31	2.59	2.62	2.43	2.55	0.06
24	0.41	3.57	3.50	3.72	3.60	0.07
30	0.50	4.52	4.61	4.34	4.49	0.09
14	0.24	1.92	2.01	1.86	1.93	0.05
28	0.47	4.19	4.06	4.34	4.20	0.09

Clear table, No units for acc^n 2 or acc^n 3 but units given for average, this is adequate

Good practice to give independent variable in ascending or descending order

Uncertainties: The uncertainty in the readings was calculated using the formula:

$$\text{uncertainty} = \frac{\text{maximum reading} - \text{min. reading}}{\text{no. of readings of acc}^{n}}$$

The uncertainties are recorded in the table.

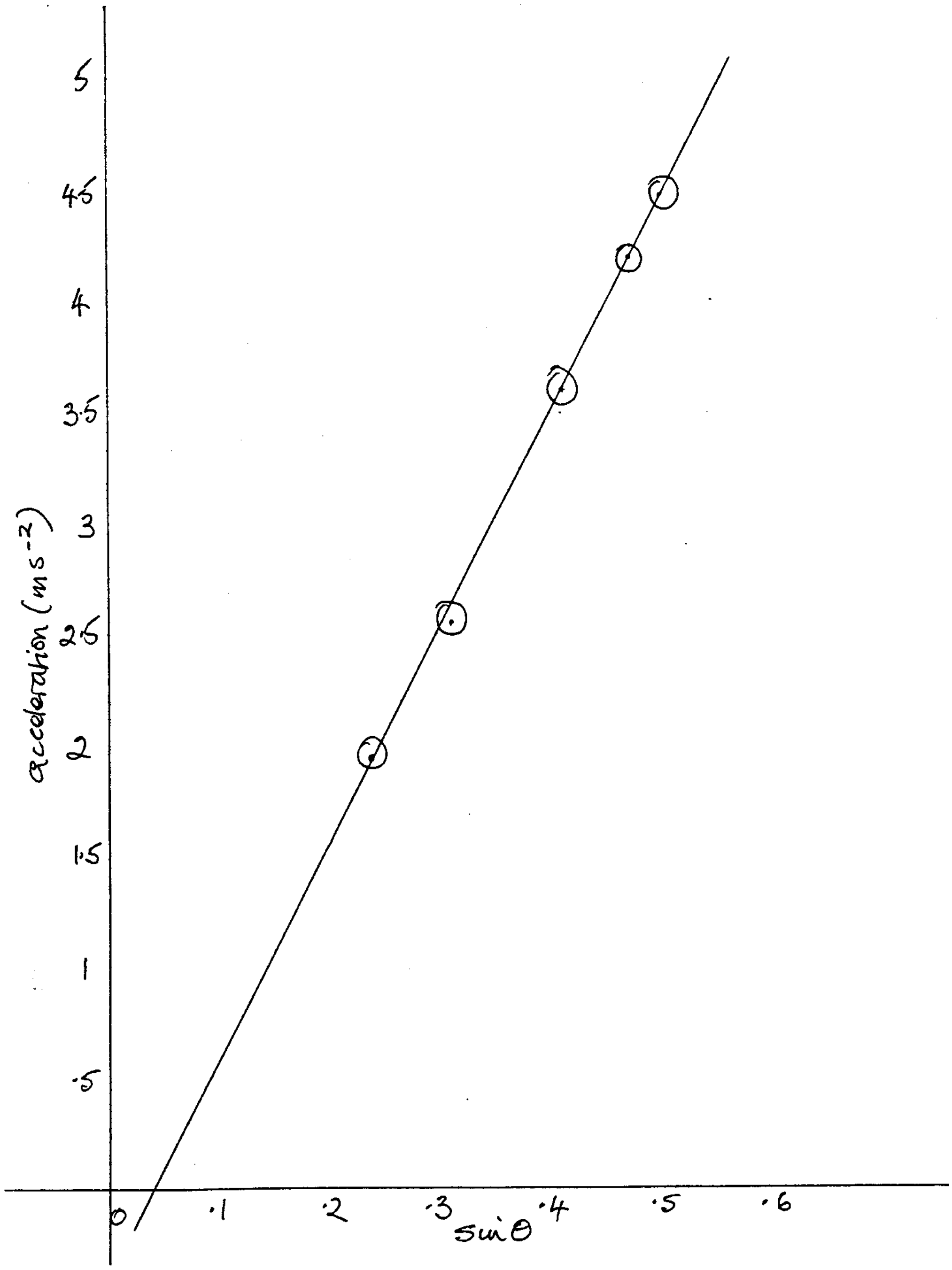
Conclusion: The graph of acceleration against the sin of the angle of the slope is a straight line graph. It almost goes through the origin! Therefore I conclude that acc^{n} is proportional to the sin of the angle of the slope.

Evaluation: The errors in taking the readings of acceleration have been taken account of by calculating the uncertainty.
Also, there is friction between the trolley and the slope, and air friction as the trolley runs down the slope. These will affect the readings i.e. acceleration will be slightly less than it should be. If the effect of friction had not been there, the graph would have been a straight line through the origin.

Uncertainty in angle not given or mentioned

A good report, a good graph which was not adjusted to go through origin!

Resubmission for PC e. only


acceleration (ms⁻²)
5
4.5
4
3.5
3
2.5
2
1.5
1
·5
0
·1
·2
·3
·4
·5
·6
sin θ

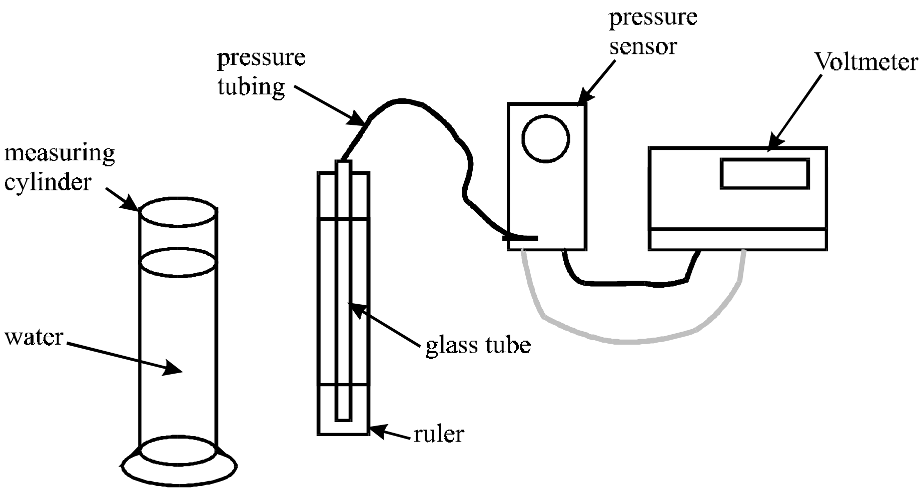
MECHANICS AND PROPERTIES OF MATTER (H)

Assessment for Outcome 3 - Variation of pressure in a fluid with depth

Candidate instruction sheet

Apparatus

Measuring cylinder, ruler, glass tube, pressure tubing, pressure sensor and voltmeter



Instructions

Fill the measuring cylinder with water.
The pressure sensor is connected to the glass tube using the pressure tubing.
The output from the pressure sensor is connected directly to the voltmeter.
The pressure sensor gives an output voltage which is directly proportional to the pressure.

With the open end of the glass tube in air, adjust the zero button on the pressure sensor to obtain a zero reading on the voltmeter.
Ensure that the zero on the ruler is aligned with the open end of the glass tube and secure in position.
Note the reading on the voltmeter before inserting the tube into the water.
Insert the tube into the water until the open end is at a depth of 5 cm from the surface. Record the depth and voltmeter readings

Repeat for other depths.

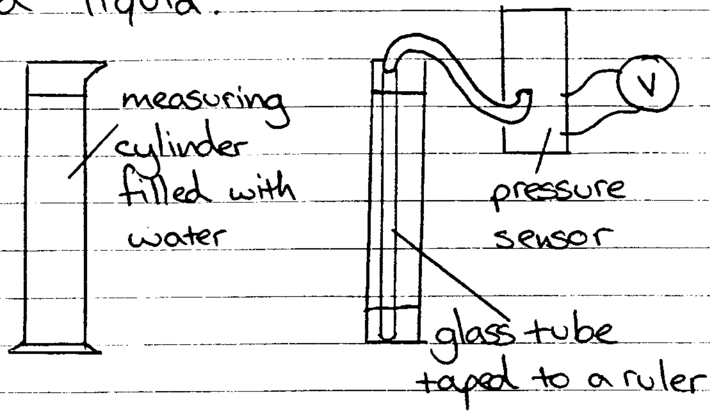
Use an appropriate format to show the relationship between pressure and depth.

Comments

Title. - Pressure and depth.

Objective - The aim of the investigation was to discover how pressure varies with depth in a liquid.

Apparatus.



Procedure: The reading on the voltmeter varies directly with the changes in the pressure sensor. A reading was taken in air and the depth was taken as zero. The glass tube and ruler were placed in the water. The ruler was used to read off the depth of the tube from the surface. The glass tube was lowered into the water to vary the depth. Measurements were taken from voltmeter.

Depth (cm)	0	5	10	15	20	25
Voltage (mV)	0	39	82	127	170	205
Voltage (mV)	0	41	82	126	170	203
Average Voltage (mV)	0	40	82	125	170	204

Uncertainties: The absolute error in depth ± 0.1cm
The absolute error in pressure ± 1mV

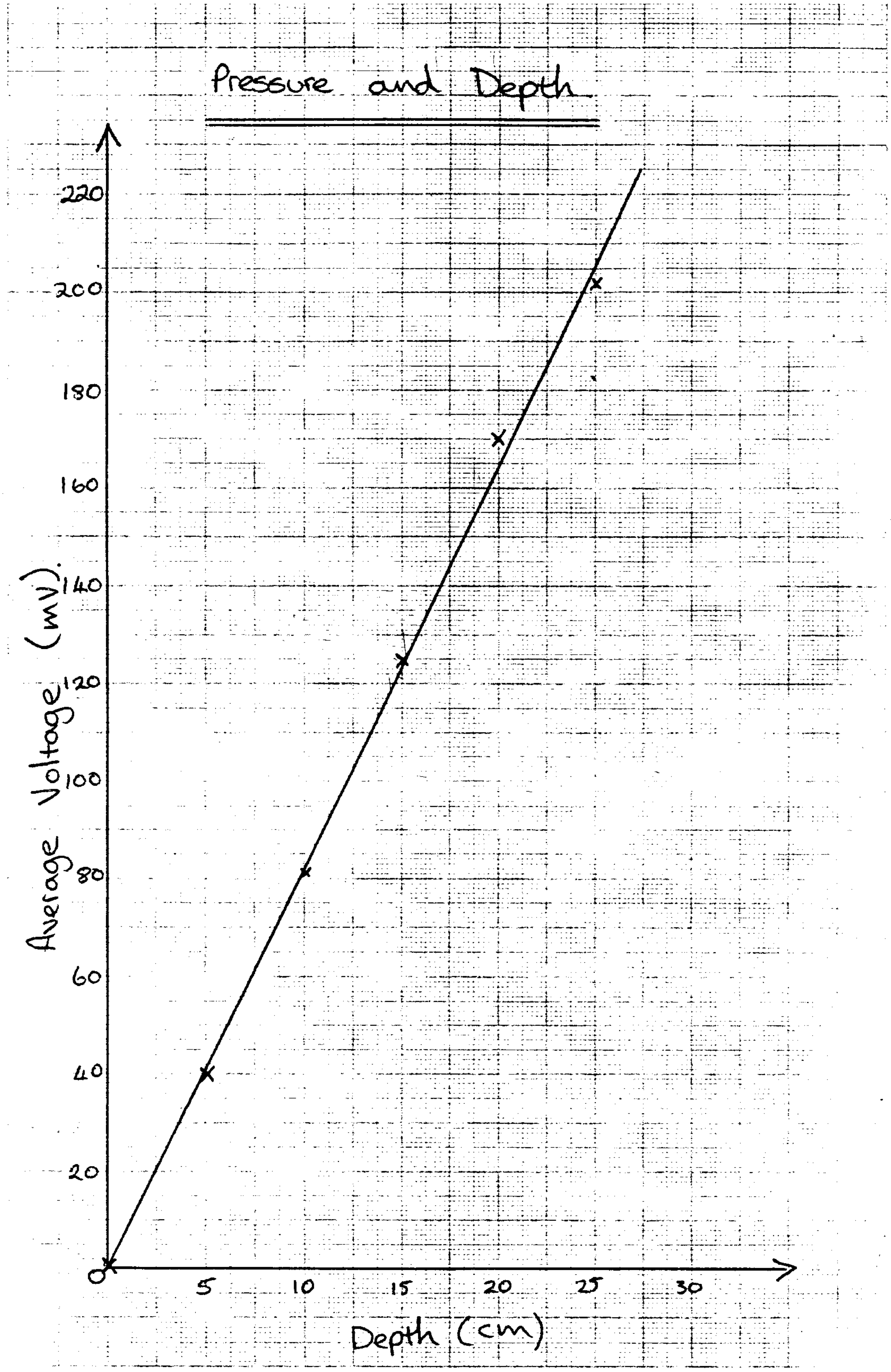
Conclusion: As depth increases, pressure increases. Pressure varies directly with depth.

include 'since graph is straight line through origin..'

Evaluation: Errors could result in an incorrect reading of the ruler due to bad experimental practice. Larger depths would reduce the relative error.

sources of bad practice to be identified.

Resubmission for PC f. and g.


Pressure and Depth
Average Voltage (mV)
220
200
180
160
140
120
100
80
60
40
20
0
5
10
15
20
25
30
Depth (cm)

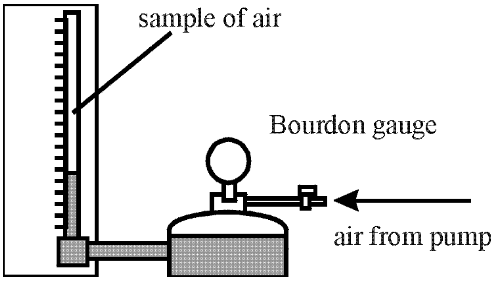
MECHANICS AND PROPERTIES OF MATTER (H)

Assessment for Outcome 3 -
Variation of volume of a gas with pressure

Candidate instruction sheet

Apparatus

A glass tube with some air trapped above oil, pressure gauge, pump.



Instructions

Open the tap and use the pump to increase the pressure as much as possible.
Close the tap.
Record readings of volume of air and pressure.

Reduce the pressure and repeat.

Plot a graph of volume against pressure.

Consider this graph and your readings and use an appropriate format to show the relationship between volume and pressure.

The Variation of Volume of a Gas with Pressure

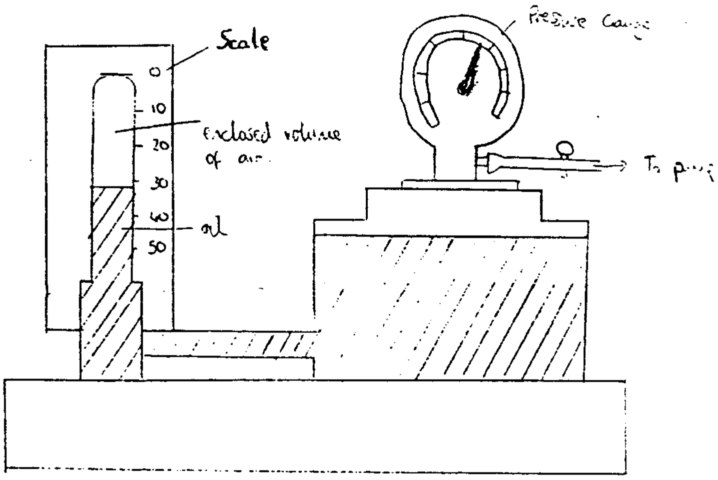
Comments

Aim. To investigate the relationship between the pressure of a gas and its volume

X

Fixed mass of gas: fixed temperature

Apparatus; The equipment used is shown in the diagram below:



Method: The tap was opened. The pump was pumped until the oil was furthest up the tube. The tap was closed. Read the volume (length) of air, and read the pressure.
Release the pressure a little. Read the new length and pressure.

Repeat the readings until back at atmospheric pressure. ✗

Temperature stabilised? Oil creep?

RESULTS

PRESSURE (lb/in²)	44.0	37.0	33.0	29.0	25.5	20.0	16.0
VOLUME ('cm')	5.5	6.5	7.4	8.4	9.6	12.5	16.3

Why no repeated readings ?

✗

The graph of Volume vs pressure was not a straight line. It was decided to try $\frac{1}{V}$.

✗

Make another table

$\frac{1}{V}$ $\left(\frac{1}{\text{'cm'}}\right)$ 0.18 0.15 0.14 0.12 0.10 0.08 0.06

units for volum required on graph

The graph of $\frac{1}{V}$ vs pressure was a good straight line. ✗

'through origin' most important

CONCLUSION $\frac{1}{V}$ for a gas is directly proportional to p

$$\frac{1}{V} \propto p.$$

ERRORS The % error in pressure goes from $\frac{0.5}{16} \times 100 = 3\%$ to $\frac{0.5}{44} \times 100 = 1\%$

REPORT

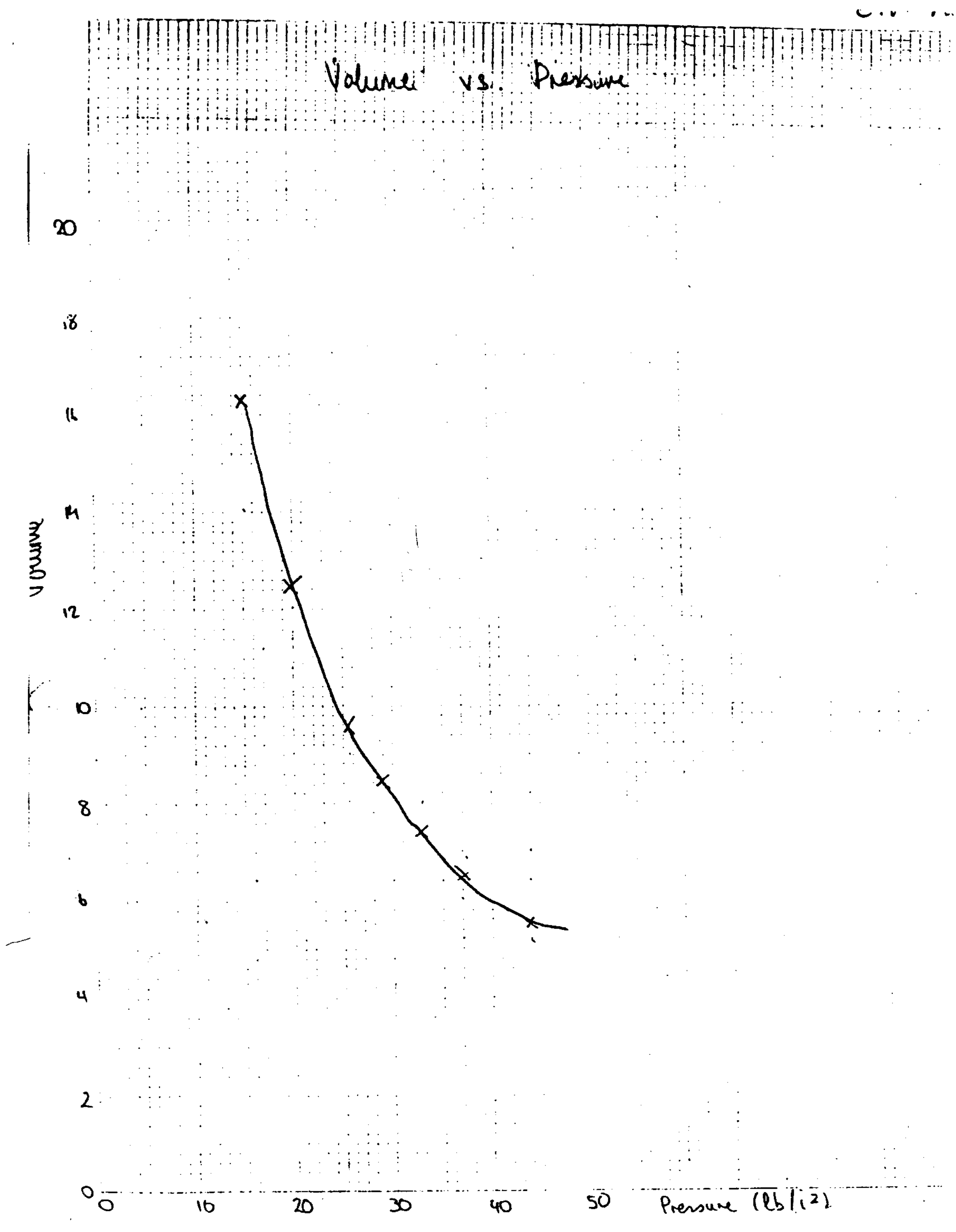
The uncertainty in volume is $\frac{0.1 \times 100}{5}$ = 2% to $\frac{0.1 \times 100}{16}$ = 0.6%.

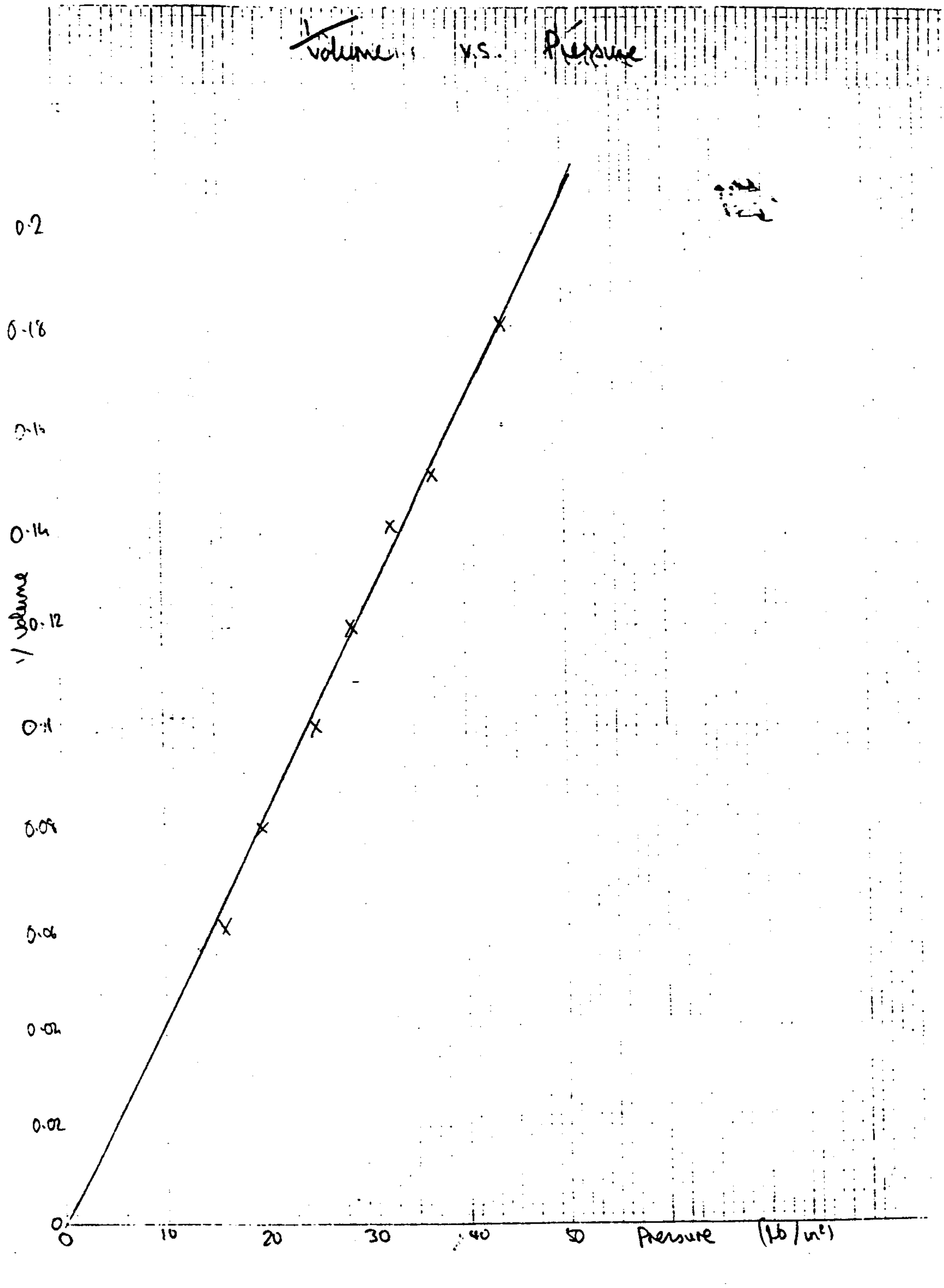
EVALUATION An electronic gauge for pressure would be better The round end of the tube might not be accurate.

explanation needed

Resubmission for PC b. d. f. and g

Centres may consider that this student should submit a report of another experiment.


Volume vs. Pressure
Volume
Pressure (lb/i²)



1/Volume v.s. Pressure
0.2
0.18
0.14
0.12
0.1
0.06
0.02
0
10
20
30
40
50
Pressure (lb/in²)
1/Volume

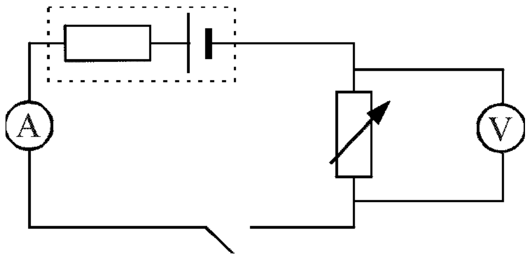
4. ELECTRICITY AND ELECTRONICS

ELECTRICITY AND ELECTRONICS (H)
Assessment for Outcome 3 -
Internal resistance of a cell

Candidate instruction sheet

Apparatus

1.5 V cell, variable resistor (1 Ω-10 Ω), voltmeter (0-5 V) and ammeter (0-1 A)



Instructions

Connect the apparatus as shown in the circuit diagram.

Set the variable resistor to its maximum setting.
Record the readings on the ammeter and voltmeter.

Adjust the variable resistor and take a range of readings.

For each pair of readings determine the lost volts.

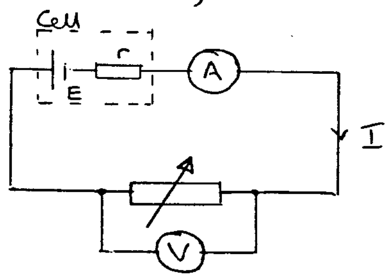
Use an appropriate format to determine the internal resistance of the cell.

Internal Resistance of a cell

Aim To determine the internal resistance of a cell.

Apparatus

Cell (1·5v), Ammeter (0–1A), Voltmeter (0–5v), Variable resistor (0–10Ω)



Procedure

The circuit was set up as shown above. The variable resistor was set to maximum and the meter readings were noted.

The variable resistor setting was decreased to give further values of voltage and current, see table.

The value of the internal resistance was calculated using

$$r = \frac{E - V}{I} = \frac{\text{lost volts}}{I}$$

A value can also be taken from the graph of Lost volts v Current (See over)

Results

Emf, E	Voltmeter reading, V	Ammeter reading, I	Lost volts (E − V)	Internal resistance
1·50	1·25	0·12	0·25	2·08
1·50	1·16	0·18	0·34	1·89
1·50	1·04	0·21	0·46	2·19
1·50	0·93	0·27	0·57	2·11
1·50	0·92	0·32	0·58	1·81
1·50	0·76	0·39	0·74	1·90

Uncertainties

Average Internal resistance $= \frac{11.98}{6} = 2$

Error $= \frac{2.11 - 1.81}{6} = 0.05$

Conclusion

The internal resistance of the cell is $2 \pm 0.05\,\Omega$

Comments

Units not given

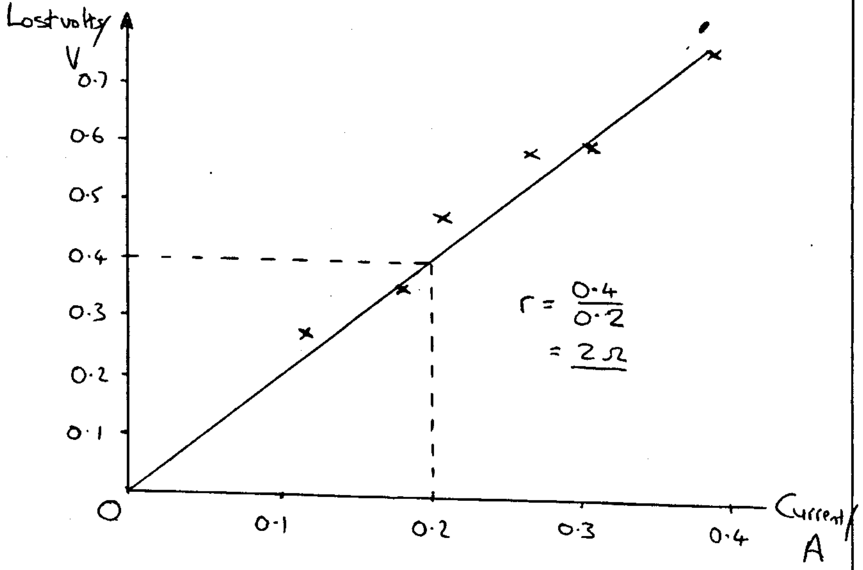
Look at the use of decimal places

What about uncertainty in meter readings?

Evaluation

The emf of the cell may not have been 1·5v, as stated. It could have been measured using a very high resistance voltmeter.

The cell was starting to get warm, which could have affected its internal resistance.



The graph is a useful additional analysis of the information

A clear report

Resubmission for PC c. and e.

ELECTRICITY AND ELECTRONICS (H)

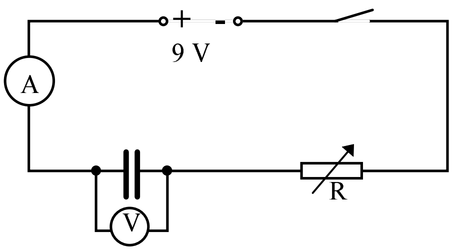
Assessment for Outcome 3 -

Charge - potential difference relationship for a capacitor

Candidate instruction sheet

Apparatus

9 V battery, 25 kΩ variable resistor, 2000 μF capacitor, switch, leads, ammeter (mA), stop clock, voltmeter.



Instructions

Connect the circuit as shown in the diagram.

Make sure that the capacitor is fully discharged.

Close the switch and start the clock.

Continually reduce the value of R to keep the current constant.
Measure the potential difference across the capacitor every 5 seconds until the capacitor is fully charged.

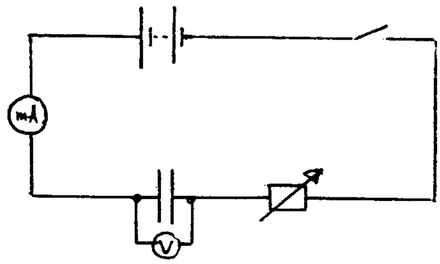
Note the current value and determine the charge at each time.

Use an appropriate format to show the relationship between charge against potential difference.

Title Charge – voltage relationship for a capacitor.

Aim An experiment was done to find out the change in voltage across a capacitor as it charged.

Apparatus The following circuit was used for the experiment:



Procedure The variable resistor was used to maintain a constant current through the circuit.
The voltage readings were taken at 5s intervals and the experiment was conducted 3 times giving the following results:

Results

Set 1	Set 2	Set 3	Average/Uncertainty
0·88	0·83	0·86	0·86 ± 0·02
1·68	1·71	1·66	1·68 ± 0·02
2·55	2·52	2·57	2·55 ± 0·02
3·42	3·40	3·38	3·40 ± 0·01
4·29	4·28	4·26	4·28 ± 0·01
5·16	5·15	5·05	5·12 ± 0·04
5·95	6·02	5·98	5·98 ± 0·02
6·82	6·80	6·78	6·80 ± 0·01
7·69	7·65	7·56	7·63 ± 0·04
8·52	8·52	8·50	8·51 ± 0·01
9·29	9·30	9·32	9·30 ± 0·01
9·64	9·64	9·64	9·64 ± 0

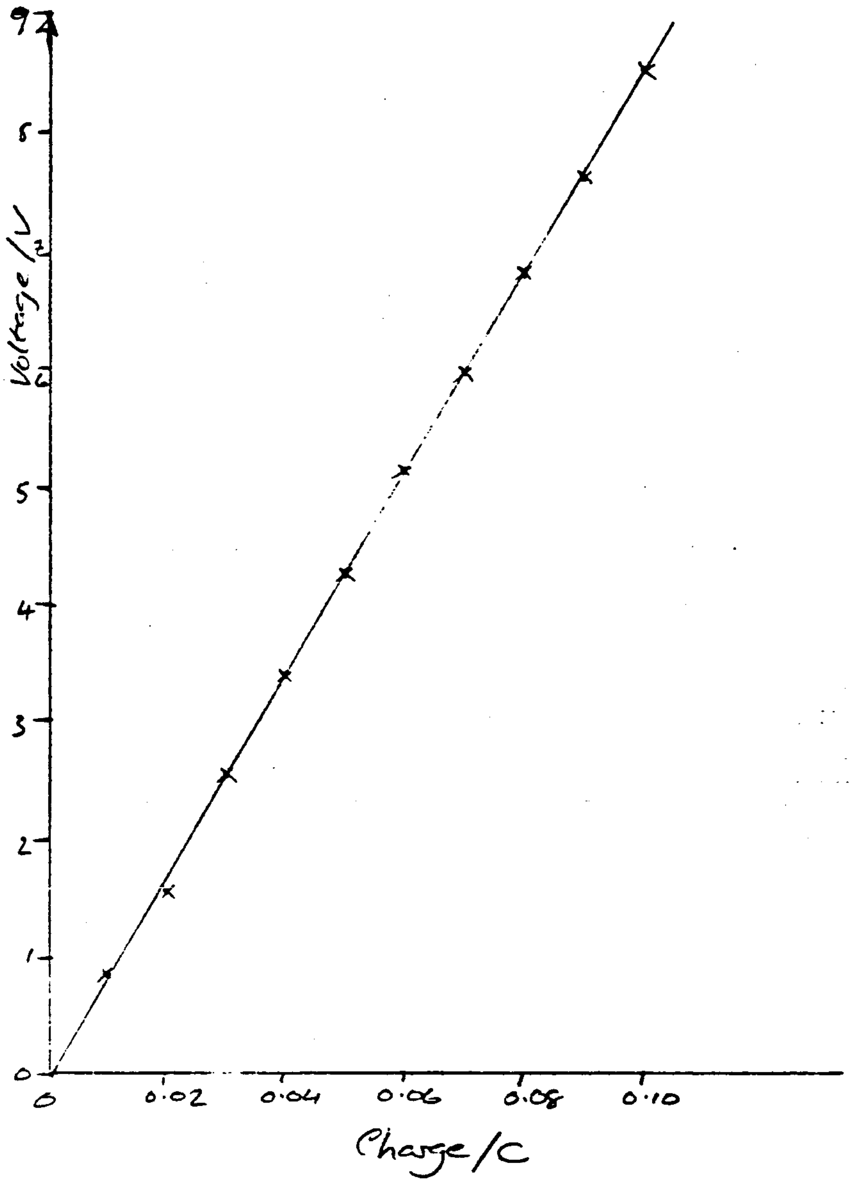
Comments

use of potential difference not voltage expected

Lack of labels in diagram and use of clock implied - are not reasons for resubmission

What was done with variable R?

Table has no column for time, no headings or units for p.d. Another column needed for Q values


Voltage/V
9
8
5
4
3
2
1
0
0
0·02
0·04
0·06
0·08
0·10
Charge/C

As the current was kept constant at 2mA, the charge could be calculated using the formula $Q = It$
The voltages and charge values were then plotted on a graph.

Uncertainties: The uncertainty in each set of readings was calculated from

$$\text{random error} = \frac{\text{largest} - \text{smallest}}{\text{number}}.$$

Uncertainties for voltmeter and clock required

Conclusion: In conclusion, the graph shows that voltage and charge are directly proportional.

$$\therefore V \propto Q$$
$$V = kQ.$$

Conclusion should state straight line through origin

Evaluation: It was important that the time reading and the voltage reading were done at the same times so that human error could be eliminated.
A larger value of capacitor would make the method easier.

'easier' - needs explanation

Resubmission for PC b. c. e. f. and g.
This report illustrates a number of points

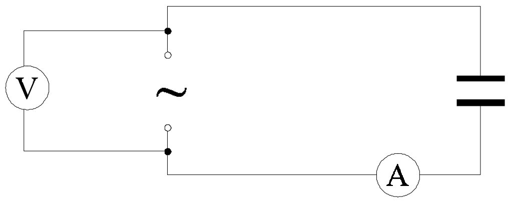
ELECTRICITY AND ELECTRONICS (H)

Assessment for Outcome 3 -
Variation of current and frequency in a capacitive circuit

Candidate instruction sheet

Apparatus

Signal generator, a.c. voltmeter or oscilloscope, a.c. ammeter, 4.7 μF capacitor.



Instructions

Connect the signal generator, ammeter, voltmeter and capacitor as shown in the circuit diagram.
An oscilloscope may be used in place of the voltmeter.

Set the output of the signal generator to about 3 V.

Vary the source frequency and record readings of current and frequency, using a range of 100 Hz to 1 kHz,.

Ensure that the supply voltage remains constant throughout.

Use an appropriate format to show the relationship between current and frequency.

Name: Scott Allen

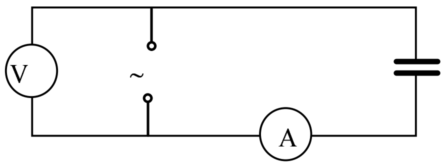
Variation of current and frequency in a capacitive circuit

Objective

To determine the relationship between the current and frequency in a capacitive circuit.

Apparatus

Signal generator, voltmeter or oscilloscope, ammeter, 4.7 μF capacitor.



Procedure

The frequency was increased in steps of 100 Hz by adjusting the signal generator. Readings of current and frequency were taken from the ammeter and signal generator. The supply voltage was kept constant.

Readings

Reading on the voltmeter was kept at 3 V

Frequency / Hz	*Current / mA*			*Mean I/mA*
100	10	11	10	10
200	17	18	16	17
300	25	26	25	25
400	36	35	35	35
500	44	43	45	44
600	56	57	56	56
700	65	64	66	65
800	71	70	71	71
900	78	79	80	79
1000	85	85	85	85

[excellent graph not included]

Uncertainties

The uncertainties in both the ammeter and frequency readings were estimated at one half the scale division.

Uncertainty in the ammeter readings ± 1 mA

The uncertainty in the frequency readings varied for the different settings since the scale is non linear e.g. 400 ± 30 Hz and 700 ± 50 Hz.

Conclusions

The graph is a straight line through the origin. Hence the current is directly proportional to the frequency.

Evaluations

The output voltage of the source was monitored and maintained constant, otherwise the current could alter due to the change in voltage. The oscilloscope could have been used measure the frequency, but this would be time consuming.

Comments

This is the only example of an acceptable report.

No resubmission is required.

an acceptable alternative is to include uncertainties in f in this table

this is sufficient, uncertainties in both *I* and *f* mentioned. Ideally the uncertainties in f should be in the table

if oscilloscope is not mentioned, then one evaluation point is adequate

Robert Bowen 5Pi

Higher Physics Lab Report

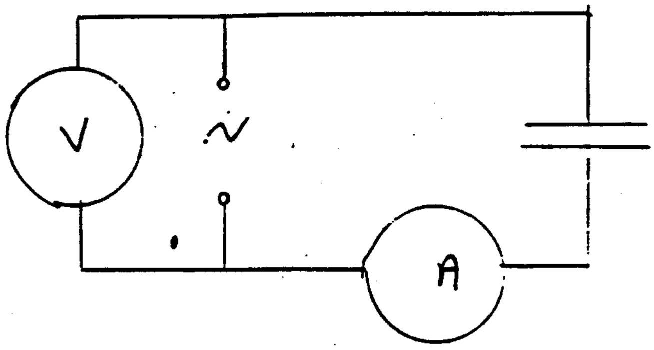
Comments

Aim

To determine the relationship between the current and the frequency in a capacitor circuit.

Apparatus

The appartus was used in~~t~~ the circuit.



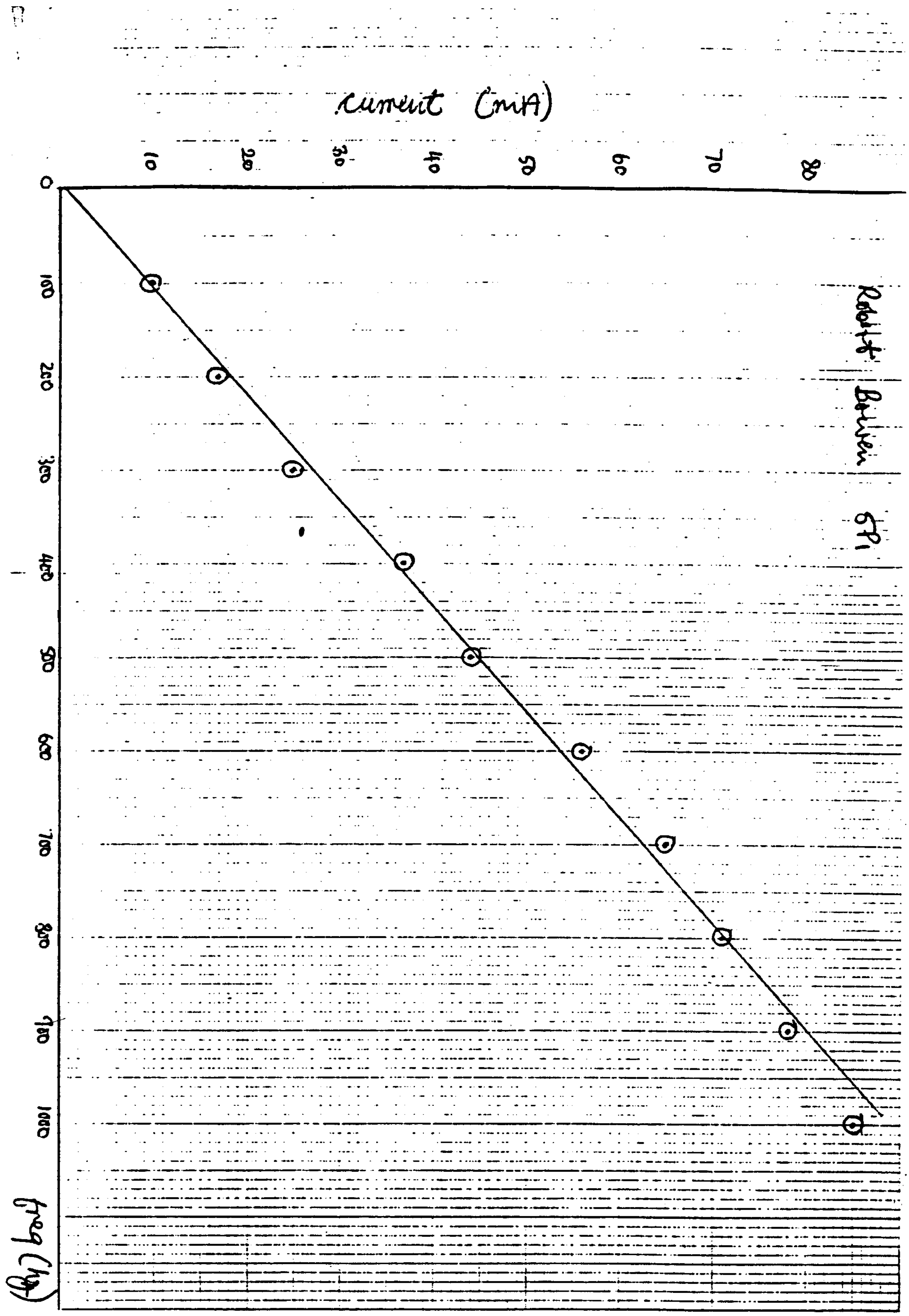
Procedure

The current got recorded in the table starting at 100 hertz and going up to 1000 hertz of frequency. Altogether their were 10 readings got taken.

Procedure needs detail of how f is altered.
The poor grammar should be pointed out to the student but this is *not* a reason for resubmission

Results

frequency (Hz)	current (mA)			mean current (mA)
100	10	11	10	10
200	17	17	16	17
300	24	26	25	25
400	36	37	35	36
500	42	45	45	44
600	56	57	56	56
700	65	64	65	65
800	70	71	71	71
900	79	79	77	78
1000	84	85	86	85


current (mA)
0
10
20
30
40
50
60
70
80
100
200
300
400
500
600
700
800
900
1000
freq (Hz)

Robert Bowen 5P1

Uncertainties

There was an uncertainty in the ammeter readings which was estimated at 0.5 scale divisions. The signal generator got set exact every time so there is no uncertainty in it's readings.

Ammeter uncertainty = ±0.5 mA

Conclusion

Because the graph is a straight line it means that they are proportional.

This is to say that current $\propto$ freq.

Evaluation

The voltage of the signal generator had to be kept the same so that it did not affect the results.

A cathode ray oscilloscope would have made the experiment more accurate.

uncertainty in f required

'through origin' most important

Evaluation - if oscilloscope is mentioned a reason must be given

Resubmission for PC b, e. f. and g.

5. RADIATION AND MATTER

RADIATION AND MATTER (H)

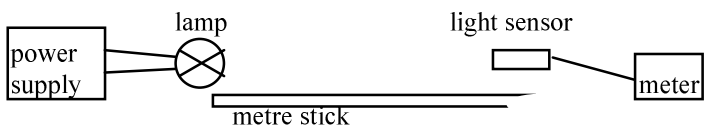
Assessment for Outcome 3 -

Variation of light intensity with distance from a point source of light

Candidate instruction sheet

Apparatus

Small lamp, power source, light intensity meter, metre stick.



Instructions

Place the light sensor a distance from the lamp.

Measure the distance from the light sensor to the lamp and the intensity of the light at this distance.

Repeat these measurements for different distances between sensor and lamp.

Plot a graph of light intensity against distance from the lamp.

Consider this graph and your readings and use an appropriate format to find the relationship between light intensity and distance from the lamp.

Higher Physics Lab Report

I. M. LEIGHT

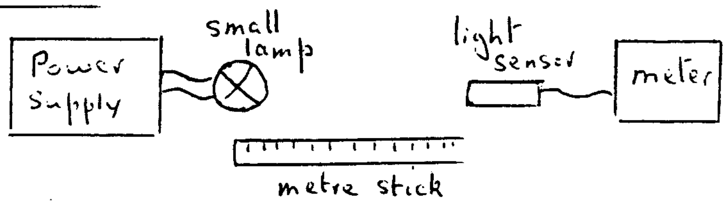
Radiation and Matter - Higher

Variation of Light Intensity with distance from lamp (point source)

Comments

The aim of the experiment is to investigate how the intensity of light varies with the distance from a lamp.

Apparatus



Method

The light sensor was placed at a distance from the lamp and this distance measured with a metre stick. The lamp was switched on and the light intensity measured using the light sensor.

The light sensor was now moved to another position and the light intensity measured at this new distance.

Results

Distance from lamp cm	Intensity of light lux	Average intensity of light lux
25	554, 556	555
30	381, 385	383
40	232, 234	233
50	152, 154	153
60	110, 114	112
70	81, 79	80

Include values of $1/d^2$ in table

Uncertainties

Uncertainty in distance because of filament position and sensor = ±0·2 cm

Uncertainty in light intensity = ± 5 lux.

These uncertainties give percentage errors of

in distance $\frac{0\cdot 2}{40} \times 100 = \pm 0\cdot 5\ \%$

in intensity $\frac{5}{233} \times 100 = \pm 2\ \%$

Conclusion

From the graph it was found that as the distance from the lamp was increased the light intensity decreased. The graph of distance against light intensity was not a straight line.

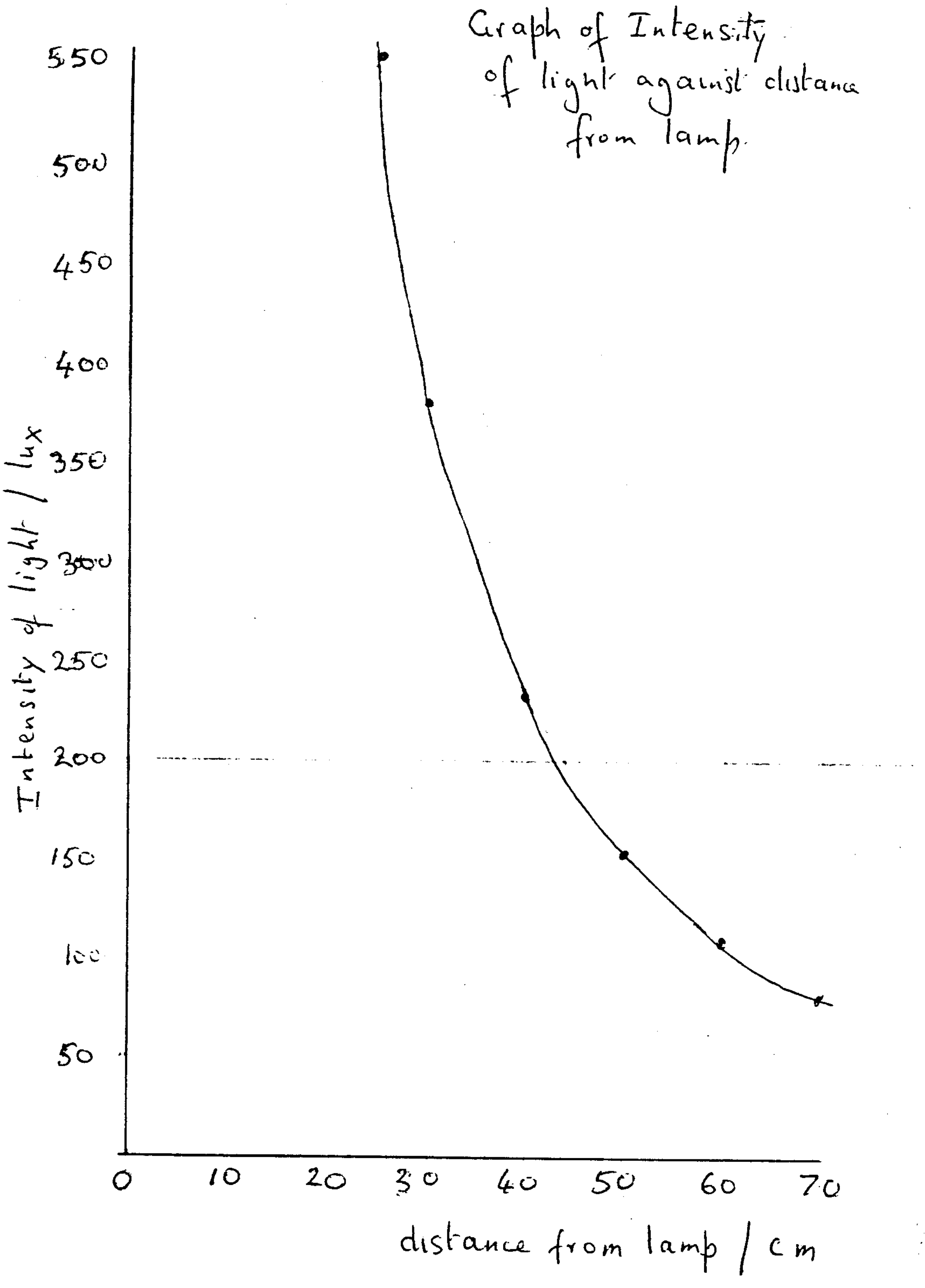
Plot additional graph and give a conclusion

Evaluation

Although the lamp used was small it may not have been a point source.

Mention background light, was dark room used?

Resubmission for PC d. f. g.



Graph of Intensity of light against distance from lamp.
550
500
450
400
350
300
250
200
150
100
50
Intensity of light / lux
0
10
20
30
40
50
60
70
distance from lamp / cm

RADIATION AND MATTER (H)

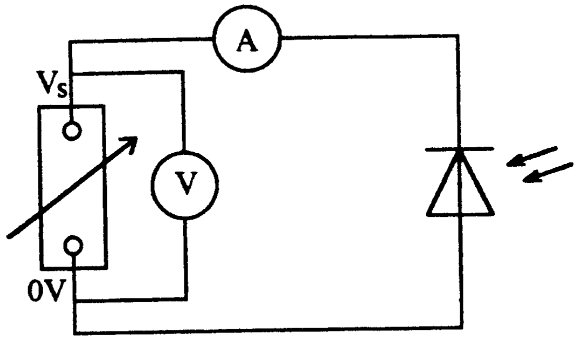
Assessment for Outcome 3 -

Variation of current with applied p.d. for a reversed biased photodiode

Candidate instruction sheet

Apparatus

Low voltage power pack, variable voltage supply board (0-10 V)
photodiode board. 2 digital multimeters (20 mA and 20 V), lamp



Instructions

Set up the circuit as shown above. Take care to ensure the photodiode is connected to the supply so that it is reverses biased.

Position the lamp so that light falls on to the photodiode.

Keep the light intensity constant and adjust the variable supply through the range 0 to 10 V.

Measure the current in the circuit for different values of applied p.d.

Use an appropriate format to show a relationship between current and applied p.d.

10 January   Steven Campbell, $S5_2$

Radiation and Matter (H)

Variation of current with applied p.d. for a reversed biased photodiode

Comments

Aim

The aim of this experiment is to find out how the current varies as the p.d. applied to the photodiode is changed.

Aim must state reversed biased

Apparatus

A variable voltage supply board and power pack.
A photodiode
2 multimeters
A lamp.

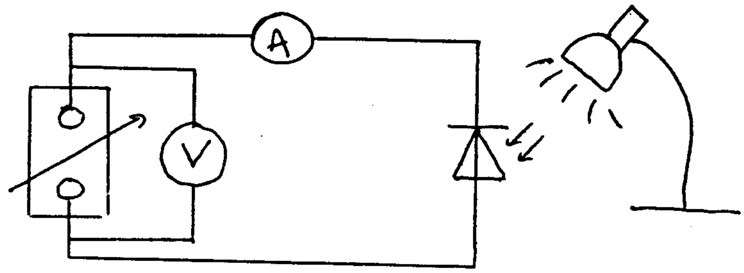


Diagram should show diode is reversed biased

Procedure

The circuit was set up as shown in the circuit diagram.
The lamp was set 25 cm away from the photodiode.
The p.d. from the supply board was increased from 0V to 10V.

The values for p.d. and current were written in a table.

Results

p.d. (V)	0	1	2	3	4	5	6	7	8	9	10
current (A)	0·21	0·21	0·22	0·22	0·22	0·22	0·22	0·22	0·22	0·22	0·22
current (A)	0·20	0·21	0·21	0·22	0·22	0·22	0·22	0·22	0·22	0·22	0·22
current (A)	0·21	0·21	0·22	0·22	0·22	0·22	0·22	0·22	0·22	0·22	0·22

Uncertainties

The p.d. values were measured on the 20V scale and were ± 0·01 V.
The currents were ± 0·01 mA.

Conclusion

As the p.d. applied to the photodiode was increased the current did not change.

Evaluation

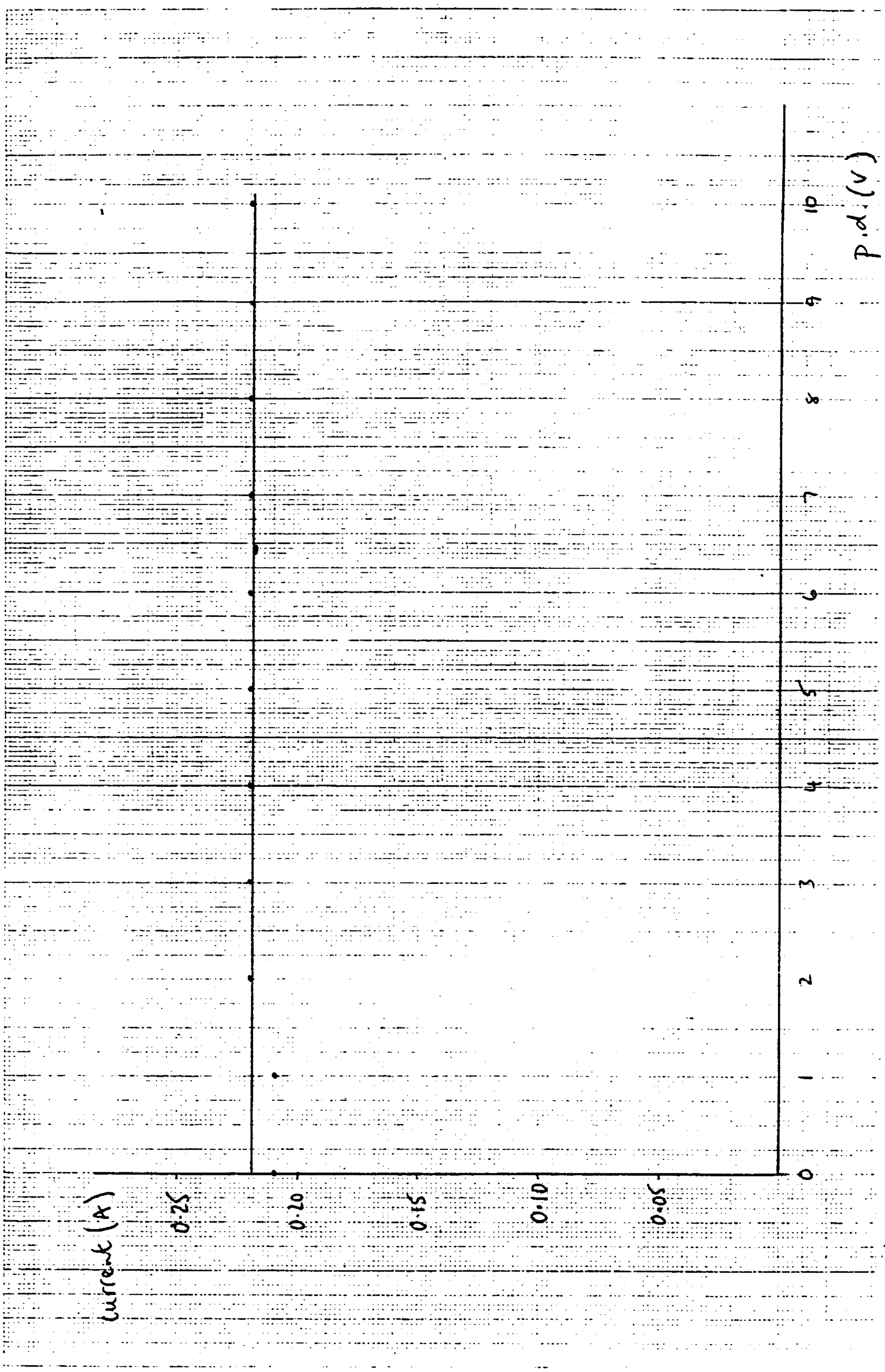
The experiment could have been made better by doing the experiment in a totally dark room so that only the light from the lamp hit the photodiode.

table and graph- current units

Conclusion and Evaluation - suitable to only have *one* sentence for each for this activity

A good report

Resubmission for PC b. c. and d. all minor


current (A)
0.25
0.20
0.15
0.10
0.05
p.d. (V)
0
1
2
3
4
5
6
7
8
9
10

RADIATION AND MATTER (H)

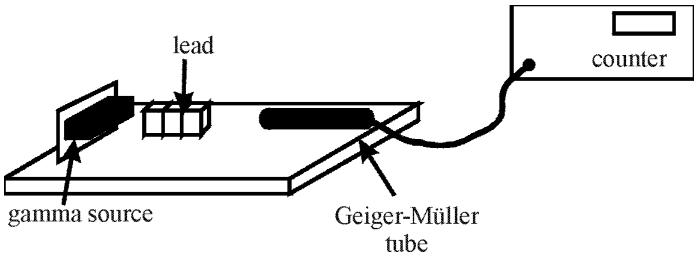
Assessment for Outcome 3 -

Half-value thickness of lead for gamma radiation from a ^{60}Co source

Candidate instruction sheet

Apparatus

Geiger Müller tube, counter, gamma source, lead absorbers.



Instructions

Connect the Geiger Müller tube to the counter.

Determine the background count rate.

Place the gamma source in position with due attention to safety requirements.
Record the count rate with the source alone.

Place a piece of lead of known thickness between the source and detector.
Record the count rate.

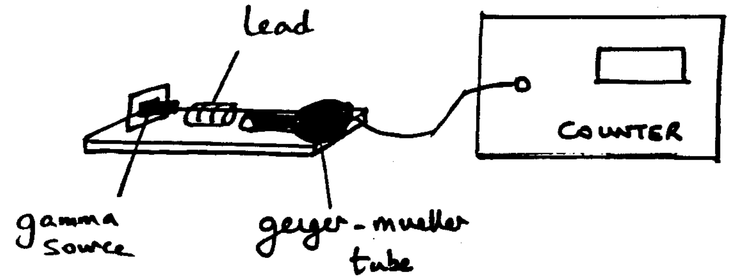
Repeat using pieces of lead of different known thickness.

Use an appropriate format to determine the half-value thickness.

Title The half-thickness of lead for a Cobalt 60 source

Aim The aim of the experiment is to find out the thickness of lead which will half the counts from a gamma source

Apparatus



Procedure We set up the apparatus shown and took a reading with no lead between the source and the tube. We then put different thicknesses of lead in place and took a reading of the number of counts per minute. This was repeated and an average calculated. We had to remember to subtract the background reading. For safety, the source should only be handled with forceps and be pointed away from the body.

Results

Background count = 30 per minute

Comments

Mention that - half the corrected count rate is more precise.

Thickness of Lead (mm)	Counts per minute (Corrected)	Average corrected count per min.
0	786, 824, 863	824 ± 26
6	502, 481, 492	492 ± 7
12	360, 362, 376	366 ± 5
18	285, 281, 292	286 ± 4
24	224, 203, 199	209 ± 8

The actual readings taken are not recorded. Table should give values before 30 is subtracted.

Uncertainties

The uncertainty in the counts are calculated from $\frac{\text{max} - \text{min}}{\text{number}}$. These are shown in the table.

Uncertainty in thickness required

Conclusion

From the graph the average value of half-thickness = 12.9 mm ± 1 mm

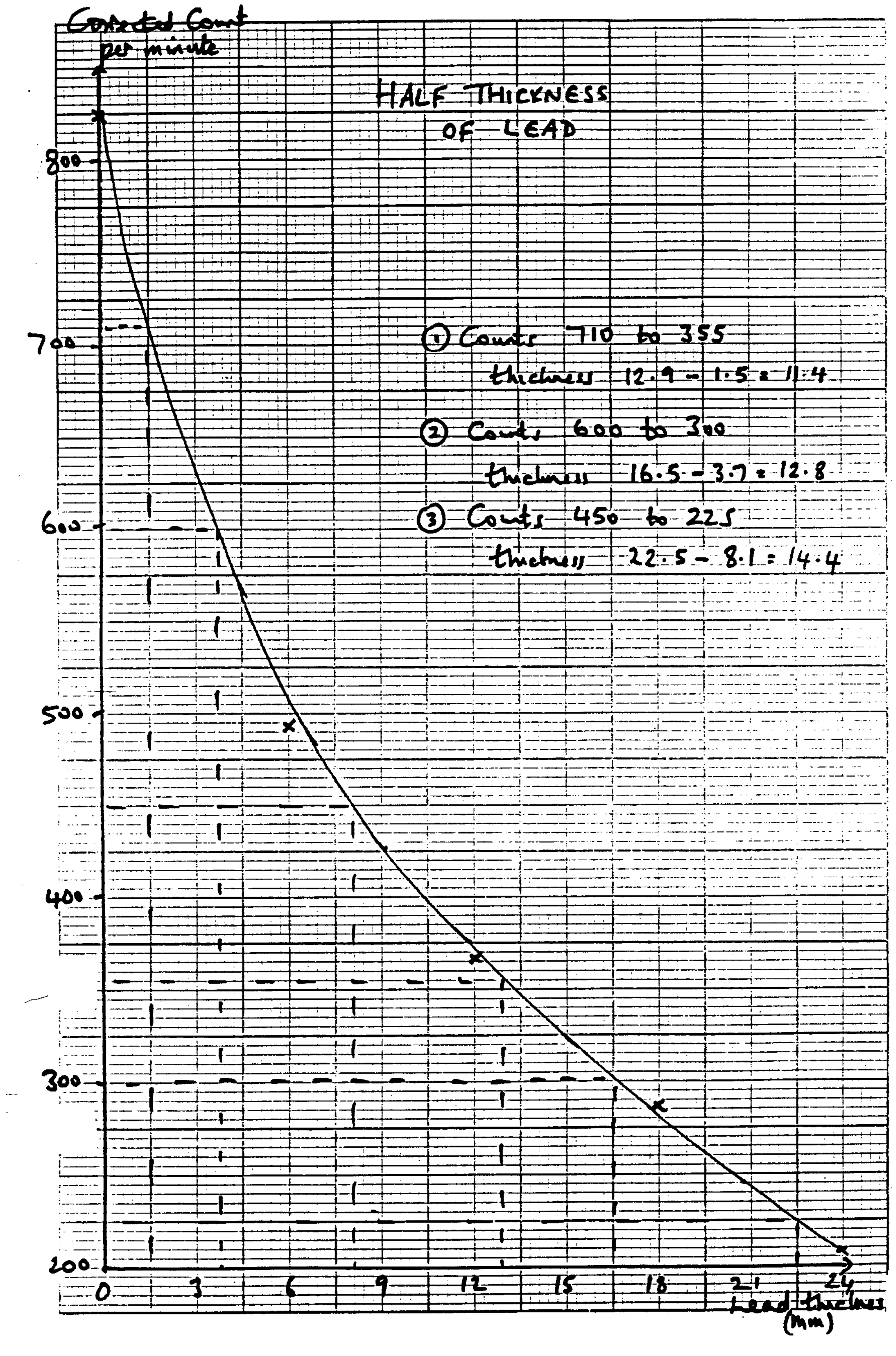
Conclusion - suitable to only have *one* sentence for this activity

Evaluation

It is possible that the background count may be varying so we should check this during the experiment and work out an average. The lead thickness was difficult to measure on a ruler. This could be improved.

How improved?

Resubmission for PC c. e. g.



Corrected Count per minute
HALF THICKNESS OF LEAD
① Counts 710 to 355
thickness 12.9 − 1.5 = 11.4
② Counts 600 to 300
thickness 16.5 − 3.7 = 12.8
③ Counts 450 to 225
thickness 22.5 − 8.1 = 14.4
800
700
600
500
400
300
200
0
3
6
9
12
15
18
21
24
Lead thickness (mm)

Some general comments on the reports

It has already been mentioned that all the performance criteria must be achieved in order to attain this Outcome 3. Although poor grammar, poor sentence construction and bad spelling would be drawn to the student's attention, these aspects are not in any of the performance criteria. We hope that our students will enter employment able to write a good clear report. However in this handbook we are directing our attention to the acceptable minimum level for meeting the specified performance criteria.

Procedure

A brief statement of the aim or objective is expected.
All reports should briefly but clearly state how the independent variable was altered and how measurements were taken.
A diagram should be labelled. However if a circuit diagram is drawn with standard symbols, it is not necessary to label those standard symbols, for example to label A as an ammeter is unnecessary.

Tables of readings and results calculated from the readings

This does not seem to generate difficulties in marking. All tables require suitable headings with the correct units.

Graphs

Graphs must have correctly labelled axes and a line or curve of best fit. Straight line graphs should not be 'adjusted' to go through the origin. An appropriate scale for each axis should be chosen.

Uncertainties

Uncertainties must be stated for all the measuring instruments used. This is the purpose of the first bullet point in the 'suggested items to aid professional judgement'. For some experiments a mean may also be calculated together with the approximate random uncertainty. In most of the examples the uncertainties have been expressed in absolute form rather than as percentages.

Conclusions

The number of points given depends on the experiment, in many cases this could be two. In some cases, for example the photodiode experiment a single sentence is sufficient. Usually it is necessary to complete statements that '.xx.. is directly proportional to ..yy.' with the comment that the 'graph is a straight line through the origin'.

Evaluations

The number of points given will depend on the experiment selected and apparatus used. If the readings are not repeated a reason should be given. It is necessary that all evaluations are given 'with supporting argument' as stated in the performance criteria.

6. MARKING AND RECORDING

Marking

The 'Outcome 3: Teacher/Lecturer guide' on the next page summarises the performance criteria together with suggested items which might aid the professional judgement of the assessor. It is important to consider the individual experiments. For certain experiments there may be only one conclusion or only one sentence for the evaluation. Students should be encouraged to avoid writing trivial remarks.

It is suggested that the report is marked with crosses or omission marks in the margin to indicate to the student where improvement is required before resubmission. It is *not* expected that details of the actual corrections required would be provided. The student can then amend the report and resubmit.

Centres may wish to produce departmental marking schemes for their particular practical activities and apparatus. The one marking scheme provided on page 47 for the 'Variation of pressure in a fluid with depth' experiment is for illustrative purposes only. It is recognised that the type of apparatus used can be important when considering the evaluation.

It is intended that the comments in the right hand margins of these sample student reports will be of help in enabling centres to assess to an acceptable standard.

Recording

An example of an overall record of attainment for the Mechanics and Properties of Matter unit is provided on page 48. For Outcomes 1 and 2 there is space to record any reassessments. For Outcome 3 it is likely that more than one experimental activity will be used to generate evidence because of student absences. The space in this column could be used to record the name of the activity completed by that student.

Some centres may wish to use an additional class list to record the attainment of the performance criteria of Outcome 3 for each individual student. An example is given on page 49. If preferred an individual sheet can be maintained for each student.

Reassessment

It is recommended that only two resubmissions of a corrected report should be allowed.

Outcome 3: Teacher/Lecturer guide

All the performance criteria given in the left-hand column must be achieved in order to attain the outcome. The right-hand column gives suggested items which might aid the professional judgement of the assessor.

PERFORMANCE CRITERIA	SUGGESTED ITEMS TO AID PROFESSIONAL JUDGEMENT
a. The information is collected by active participation in the experiment	The candidate should be involved.
b. The experimental procedures are described accurately.	A clear statement of the • aim or objective of the experiment A few brief concise sentences as appropriate: • a labelled diagram or brief description of apparatus, instruments used • how the independent variable was altered • how measurements were taken or observations made. There is no need for a detailed description The use of the impersonal passive voice is to be encouraged as an example of good practice but this is not mandatory for meeting the performance criteria.
c. Relevant information and observations are recorded in an appropriate format.	Readings or observations recorded in a clear table which must include: • correct headings • appropriate units • readings/observations entered in the correct positions.
d. Recorded information is analysed and presented in an appropriate format.	Readings should be analysed and presented in tabular or graphical form as appropriate: For a tabular presentation this may be an extension of the table used for performance criteria c. above, e.g. the calculation of the inverse or square of a variable, and must include: • a table with suitable headings and units • a table showing appropriate computations. For a graphical presentation this must include: • a graph with independent and dependent variables plotted on appropriate axes • a graph with suitable scales and axes labelled with quantity and units • a graph with data correctly plotted with a line or a curve of best fit.
e. Uncertainties are treated appropriately.	Depending on the activity the following should be included as appropriate: • uncertainties in individual readings • mean value and approximate random uncertainty in the mean • uncertainties expressed in absolute or percentage form.
f. Conclusions drawn are valid.	Conclusions should contain, as appropriate, a statement of: • overall pattern to readings or observations • trends in analysed information or results • connection between variables • measurement of a physical quantity.
g. The experimental procedures are evaluated with supporting argument.	The evaluation is likely to contain, as appropriate, a few sentences commenting on: • possible sources of error • control of variables • possible improvements • limitations of equipment

Sample marking scheme: Variation of pressure in a fluid with depth

Performance criteria(abbreviated)	**Suggested items to aid professional judgement**
a. information collected	
b. procedures	• aim or objective *To find the relationship between pressure and depth in a liquid* • labelled diagram *Similar to instruction sheet* • how independent variable altered *The depth altered by lowering the tube into the water* • how measurements were taken *Depth measured by the ruler.* *Pressure measured using the pressure sensor and voltmeter.*
c. table for readings	• headings and unit *depth/cm* *potential difference (pressure)/mV*
d. graph for analysis	• variables on appropriate axes *horizontal axis - depth; vertical axis - pressure* • suitable scales and labels *depth/cm; potential difference/mV* • correctly plotted and line of best fit
e. uncertainties	• individual readings • absolute form *potential difference ± 1 mV; depth ± 0.05 cm or ± 0.1 cm*
f. conclusions	• connection between variables *The pressure varies directly with the depth because the graph is a straight line through the origin.*
g. evaluation	• possible sources of error - one of the following *The end of tube not exactly on line with zero of the ruler. This would give a systematic error as all the depth readings would be either too high or too low.* *The tube not always held vertically. This would make some of the depth readings too high.* • possible improvements *Use a longer tube and deeper cylinder to reduce the relative error in depth.*

MECHANICS AND PROPERTIES OF MATTER - HIGHER

Record of attainment: Class... Year..........

CANDIDATE NAME	ASSESSMENTS FOR OUTCOMES 1 AND 2			ASSESSMENT FOR OUTCOME 3
	Ass	resit 1	resit 2	

Mechanics and Properties of Matter - Higher

Experiment ………………………………………………………..

Outcome 3 - Record of attainment: Class....................................... Year..........

CANDIDATE NAME	ALL	PERFORMANCE CRITERIA						
	PC	a. collect	b. procedure	c. read/ obs	d. analyse	e. uncert	f. conclude	g. evaluate

7. OUTCOME 3: ADVICE TO STUDENTS

Producing a scientific report of an experiment

In the report you should try to use what is known as the impersonal passive voice using the past tense.
You should try to write in the form: "the light gate was connected to a computer" and not "I connected the light gate to a computer".
Sentences should be brief, clear and to the point. A lengthy description of the procedure is not required, a few short sentences are sufficient.

It is useful to structure your report under specific headings to avoid missing out important sections. The following headings can be used:

Title ***Check***

This can be *copied* from your instruction sheet

Aim or Objective

A brief *statement* of the *purpose* of the experiment. ❒

Apparatus

A simple list can be *copied* from the instruction sheet. A simple line *diagram* of the experimental arrangement with *labels* is useful to avoid the need for lengthy descriptions. ❒

Procedure

A few brief sentences describing briefly, how the independent *variable* was altered and *how* measurements were *taken* or observations made. Reference may be made to the diagram. ❒

Readings/ Results

These are usually presented in a clear *table* with suitable headings giving the *quantity* and its *unit*. ❒

You may then have to use these readings to:

- calculate other quantities which again should be given in a clear *table*. In some cases the same table as above can be used
- plot a *graph* which should have clearly *labelled axes*, correctly *plotted* points and a line or curve of *best fit*. ❒

Uncertainties

Depending on the activity the following should be included *as appropriate*: ❒

- uncertainties in individual readings
- mean value and approximate random uncertainties in the mean
- uncertainties expressed in absolute or percentage form.

Conclusion

Conclusions should contain, *as appropriate*, a statement of: ❒

- overall pattern to observations
- trends in analysed information or results
- connection between variables
- measurement of a physical quantity.

Evaluation

The evaluation is likely to contain, *as appropriate*, a few sentences commenting on: ❒

- possible sources of error
- control of variables
- possible improvements
- limitations of equipment.