# Physics A, 3883

## AS Assessed Practical

## Elasticity of Copper Investigation

In this practical you will carry out all four experimental and investigative skills: Planning, Implementing, Analysing and Evaluating.

In this experiment, you will investigate how the extension **e** of a length of copper wire changes as the stretching force **F** is increased.

If a wire whose original length was **L** is subjected to a stretching force **F** then the wire will increase in length by an amount **e**. If the wire obeys Hooke's Law then **e** will be linearly proportional to **F** and, for as long as this is valid, we define the linear modulus of elasticity as:

$$\textbf{Young Modulus} = \frac{\textbf{Stress}}{\textbf{Strain}} = \frac{\textbf{F/A}}{\textbf{e/L}} = \textbf{E}$$

(A is the average cross sectional area of the copper wire)

You need to plan an experiment to measure the extension in a piece of copper wire paying careful attention to the safety of all occupants of the laboratory including yourself. Accuracy is of paramount importance so the choice of equipment needs to be thought about with this in mind. A suitable range of results needs to be taken in order to form a reliable basis for a worthwhile conclusion. Errors need to be kept to a minimum by careful use of the equipment.
A prediction of your expected findings should be given in detail using scientific knowledge about Hooke's Law.
A diagram and step-by-step instructions of your proposed experimental procedures is required with an explanation of what range of forces to use (preliminary tests will need to be undertaken).
All results need to be displayed in a suitable format with an appropriate number of significant figures given and correct units indicated. Repeats of measurements may be necessary in order to ensure accurate and reliable results.
A graph should be plotted showing how extension varies as the stretching force is increased, indicating the region where you think the wire behaved elastically.
You should determine the Young modulus for the copper wire used.

| | | AS Physics Assessed Practical | | |
|---|---|---|---|---|
| | | **Skill P - Planning** | **Elasticity of Copper Investigation** | |
| Mark | | Specification Descriptor | Experiment Descriptor | tick |
| 1 | P.1a | The candidate defines a question or problem in simple terms and plans a fair test or an appropriate practical procedure, making a prediction where relevant | A basic statement of the problem and the idea of a fair test, with a simple prediction about relationship between force applied and extension, linked to Hooke's Law | |
| | P.1b | The candidate chooses appropriate equipment | Diagram showing suitable equipment for the measurement of the extension of the copper wire | |
| 2 | | | | |
| 3 | P.3a | The candidate defines a question or problem using scientific knowledge and understanding; identifies the key factors to vary, control or take account of. | Young modulus equation used to identify key factors. Clear explanation of how variables will be controlled or varied | |
| | P.3b | The candidate decides on a suitable number and range of observations and/or measurements to be made | Indicates the need for a suitable range of at least 5 measurements of **e** and **F** to be taken. Plans to take several measurements of diameter of the wire in order to find average cross-sectional area | |
| 4 | | | | |
| 5 | P.5a | The candidate uses detailed scientific knowledge and understanding, and information from preliminary work or a secondary source to plan an appropriate strategy, taking into account the need for safe working and justifying any prediction made; produces a clear account and uses specialist vocabulary appropriately. | Scientific vocabulary used to explain predictions with particular reference to Young modulus. Preliminary results taken to decide range of forces to be used. Safety precautions given in detail | |
| | P.5b | The candidate describes a strategy, including choice of equipment, which takes into account the need to produce precise and reliable evidence | Sensitivity of equipment discussed and the need for repeated results to ensure reliability given | |
| 6 | | | | |
| 7 | P.7a | The candidate retrieves and evaluates information from a variety of sources, and uses it to develop a strategy which is well structured, logical and linked coherently to underlying scientific knowledge and understanding; uses spelling, punctuation and grammar accurately. | Various external sources used in order to justify use of equipment (e.g. sensitivity of equipment chosen compared with other possible equipment). Clear and lucid explanations of how the experiment is to be conducted with reasons for repetitions etc. | |
| | P.7b | The candidate justifies the strategy developed, including the choice of equipment, in terms of the need for precision and reliability | Explains why other strategies were dismissed after being considered | |
| 8 | | | For 8 marks, some of the following might be expected; temperature effects, zero errors, diameter of wire when stretched, accuracy of kg masses, sideways pull on spring balances, readings with weight increasing and decreasing | |

**Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded.**

CANDIDATE NAME _____

P Mark Awarded _____ out of a maximum possible of 8

| | | AS Physics Assessed Practical | | |
|---|---|---|---|---|
| | | **Skill I – Implementing** | **Elasticity of Copper Investigation** | |
| Mark | | Specification Descriptor | Experiment Descriptor | tick |
| 1 | I.1a | The candidate demonstrates competence in simple techniques and some awareness of the need for safe working. | Sets up equipment safely following diagram given in planning stage e.g. goggles are worn due to danger of breaking wires | |
| | I.1b | The candidate makes and records observations and/or measurements which are adequate for the activity | Takes appropriate measurements and records them | |
| 2 | | | | |
| 3 | I.3a | The candidate demonstrates competence in practised techniques and is able to manipulate materials and equipment with precision. | Uses micrometer accurately, manipulates equipment competently | |
| | I.3b | The candidate makes systematic and accurate observations and/or measurements which are recorded clearly and accurately | Records all measurements systematically and to the appropriate number of significant figures. Minimum of 5 readings of **F** and **e** | |
| 4 | | | | |
| 5 | I.5a | The candidate demonstrates competence and confidence in the use of practical techniques; adopts safe working practices throughout. | Works safely and with confidence at all times with due regard for other occupants of the laboratory | |
| | I.5b | The candidate makes observations and/or measurements with precision and skill records observations and/or measurements in an appropriate format; recognises sources of systematic and random error which could affect accuracy and reliability of results. | Records all measurements systematically in a suitable table format including the correct units. Repeats readings highlighting possible errors and takes these into account when taking averages | |
| 6 | | | | |
| 7 | I.7a | The candidate demonstrates skilful and proficient use of all techniques and equipment | Uses all equipment with confidence ensuring measurements are taken as accurately as possible e.g. care taken to ensure that there are no kinks in the wire | |
| | I.7b | The candidate makes and records all observations and/or measurements in appropriate detail and to the degree of precision permitted by the techniques or apparatus; responds to serious sources of systematic and random error by modifying procedures where appropriate. | Correct units, appropriate significant figures set out in a suitable table. Modifies experimental procedure, where necessary in order to eliminate serious errors | |

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CANDIDATE NAME _____

I Mark Awarded _____ out of a maximum possible of 7

| | | AS Physics Assessed Practical | | |
|---|---|---|---|---|
| | | **Skill A - Analysing** | **Elasticity of Copper Investigation** | |
| Mark | | Specification Descriptor | Experiment Descriptor | tick |
| 1 | A.1a | The candidate carries out some simple processing of the experimental evidence. | Finds averages for each set of readings | |
| | A.1b | The candidate identifies trends or patterns in the evidence and draws simple conclusions. | States clearly any patterns in the results and gives a simple conclusion about how the wire behaves, linked to Hooke's Law | |
| 2 | | | | |
| 3 | A.3a | The candidate processes and presents experimental evidence including, where appropriate, the use of appropriate graphical and/or numerical techniques. | Plots accurate graphs of **e** against **F** | |
| | A.3b | The candidate links conclusions drawn from processed evidence with the associated scientific knowledge and understanding. | The candidate comments on the shape of the graph indicating where the wire behaved elastically | |
| 4 | | | | |
| 5 | A.5a | The candidate carries out detailed processing of evidence and analysis including, where appropriate, the use of advanced numerical techniques such as statistics, the plotting of intercepts or the calculation of gradients. | Suitable graph for the region where the wire obeys Hooke's Law. Calculates average cross-sectional area of the wire using values of average diameter. Obtains a value for the gradient of the graph | |
| | A.5b | The candidate draws conclusions that are consistent with the processed evidence and links these with detailed scientific knowledge; produces a clear account which uses specialist vocabulary appropriately. | Using the processed evidence writes a clear conclusion of what has been determined | |
| 6 | | | | |
| 7 | A.7a | The candidate, where appropriate, uses detailed scientific knowledge and understanding to make deductions from the processed evidence, with due regard to nomenclature, terminology and the use of significant figures (where relevant). | Using scientific language gives explanations and finds the value of the Young modulus | |
| | A.7b | The candidate draws conclusions which are well structured, appropriate, comprehensive, concise and accurate and which are coherently linked to underlying scientific knowledge and understanding; uses spelling, punctuation and grammar accurately | Conclusions are logical and structured, written in good English | |
| 8 | | | Some of the following might be considered; plasticity, molecular discussion, comparison with data obtained from other sources, yield points, need for an expansion of scales for different parts of the graph | |

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CANDIDATE NAME _____

A Mark Awarded _____ out of a maximum possible of 8

| | | AS Physics Assessed Practical | | |
|---|---|---|---|---|
| | | **Skill E - Evaluation** | **Elasticity of Copper Investigation** | |
| Mark | | Specification Descriptor | Experiment Descriptor | tick |
| 1 | E.1a | The candidate makes relevant comments on the suitability of the experimental procedures. | The candidate makes relevant comments on the suitability of the experimental procedures. | |
| | E.1b | The candidate recognises any anomalous results. | The candidate recognises any anomalous results if there are any. | |
| 2 | | | | |
| 3 | E.3a | The candidate recognises how limitations in the experimental procedures and/or strategy may result in sources of error. | Limitations noted e.g. small forces for elastic area, measuring techniques for long length of wire to give measurable extensions for small stretching forces | |
| | E.3b | The candidate comments on the accuracy of the observations and/or measurements, suggesting reasons for any anomalous results. | Notes accuracy of readings, some numerical analysis, percentages, error bars etc. Reasons for anomalous results suggested | |
| 4 | | | | |
| 5 | E.5a | The candidate indicates the significant limitations of the experimental procedures and/or strategy and suggests how they could be improved. | What improvements might be made in the experiment e.g. strain gauges, use of ICT (not constrained by what is available in Centre) | |
| | E.5b | The candidate comments on the reliability of the evidence and evaluates the main sources of error. | Numerical evaluation of uncertainties, max/min gradients, intercepts | |
| 6 | | | | |
| 7 | E.7a | The candidate justifies proposed improvements to the experimental procedures and/or strategy in terms of increasing the reliability of the evidence and minimising significant sources of error. | Improvements outlined in increasing reliability of result e.g. work done on measuring small diameter (then used to find area) gives greater improvement in final answer than work on measurement of a long length | |
| | E.7b | The candidate assesses the significance of the uncertainties in the evidence in terms of their effect on the validity of the final conclusions drawn. | Real work on uncertainty brought through to final result expressed properly. Comments on what faith candidate would put on these results if they were to be used in another calculation of major significance | |

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CANDIDATE NAME _____

Mark Awarded _____ out of a maximum possible of 7