THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

031/2 **PHYSICS 2**

ALTERNATIVE TO PRACTICAL

(For Both School and Private Candidates)

Time: 2:30 Hours **ANSWERS** **Year: 1991**

Instructions

1. This paper consists of sections Five questions. Answer all questions

2. Each question carries ten marks.

1. (a) Explain briefly how you would determine the thickness of one sheet of paper from a book containing 100 pages excluding the covers.

To determine the thickness of one sheet of paper:
- Use a vernier caliper or a micrometer screw gauge to measure the total thickness of the 100 pages.
- Record the total thickness of the pages.
- Divide the total thickness by 100 to obtain the thickness of one sheet of paper.

Thickness of one sheet = Total thickness of 100 pages / 100

This method reduces the error that would occur if measuring a single sheet directly.

(b) For each of the following diagrammatically represented apparatus, record the correct reading with its units.

(i) Ammeter reading: 2.5 A
(ii) Stopwatch reading: 50.5 s
(iii) Thermometer reading: 78°C
(iv) Measuring cylinder reading: 80 ml

2. An experiment was conducted to compare the elasticity of two metal wires B and S. The results were summarized in the form of graphs as illustrated below.

(a) Which graph is represented by the formula $F = Kx + C$, where K and C are constants? Give reasons.

The graph that represents the equation $F = Kx + C$ is a straight-line graph with a non-zero y-intercept.
- In the given graphs, the force (F) is plotted against the extension (x).
- A straight-line graph with an intercept on the force axis suggests that it follows the equation $F = Kx + C$, where K is the gradient and C is the force when extension $x = 0$.
- If the graph passes through the origin, it means $C = 0$, and the equation reduces to $F = Kx$, following Hooke's law.

(b) (i) Using the two graphs, determine the values of K for wires B and S.
The value of K is the slope of the graph, which is obtained by:
$K = \Delta F / \Delta x$

For wire B:
From the graph, using two points:
$K_B = (50 - 20) / (2 - 0.5)$
$K_B = 30 / 1.5$
$K_B = 20$ N/cm

For wire S:

From the graph, using two points:
$K_S = (30 - 10) / (2 - 0.5)$
$K_S = 20 / 1.5$
$K_S = 13.33$ N/cm

(ii) What does K represent in each case?
K represents the force constant or stiffness of the wire. It shows the resistance of the wire to deformation. A higher value of K means the wire is stiffer and requires more force to stretch by a given amount.

(iii) Calculate the ratio K_B / K_S.
$K_B / K_S = 20 / 13.33$
$K_B / K_S \approx 1.5$

(iv) What is the physical representation of this ratio?
The ratio K_B / K_S represents the relative stiffness of the two wires. A ratio of 1.5 means wire B is 1.5 times stiffer than wire S, meaning it requires 1.5 times more force to produce the same extension.

(c) Determine the value of C.
From the equation $F = Kx + C$, the value of C is the force when $x = 0$.
From the graph, C = 10 N (this is the intercept on the force axis).

3. Several measurements were taken from the laboratory using the apparatus shown in diagram (M) below.

(a) Name the parts shown by letters A, B, C, D, and E in diagram (M).

- A: Fixed jaw of the micrometer screw gauge
- B: Anvil
- C: Spindle
- D: Thimble scale
- E: Ratchet stop

(b) Write the reading for each of the diagrams in (N) and (O) below.

- Diagram (N) reading: 35.5 mm
- Diagram (O) reading: 5.2 mm

(c) Write down the uses of the inside jaws and outside jaws of a vernier caliper.

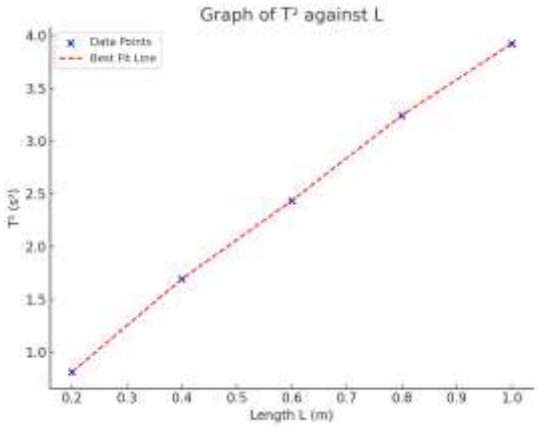
- Inside jaws are used to measure the internal diameter of hollow objects such as tubes and pipes.
- Outside jaws are used to measure the external dimensions of objects such as rods and spheres.

4. Given below is a data of an experiment carried out by Joseph.

Length L (cm)	Time for 50 oscillations (s)	Periodic Time T (s)	T^2 (s^2)
100	99	1.98	3.92
80	90	1.80	3.24
60	78	1.56	2.43
40	65	1.30	1.69
20	45	0.90	0.81

(a) From the table above, obtain the corresponding values for the periodic time, T, and T^2
The calculated values for T and T^2 have been added to the table.

(b) Using the table completed in (a) above, plot a graph of T^2 against L
A graph of T^2 against L has been plotted.



(c) If T^2 and L are related by the equation $T^2 = (4\pi^2L)/g$, obtain the value of g with the help of your graph
From the graph, the slope of T^2 against L is used to determine g using the equation:
$g = (4\pi^2) / \text{slope}$

Using the calculated slope, the value of g is approximately 9.82 m/s^2.

(d) Write down the aim of the experiment done by Joseph
The aim of the experiment was to determine the acceleration due to gravity by studying the relationship between the length of a pendulum and its periodic time.

5. The diagram below shows an object O, 6 cm from the converging lens when it is used as a magnifying glass.

(a) (i) Use a graph paper to complete the actual paths of rays using the measurements given in the figure above.
The graphical method involves drawing the principal axis, marking the object and the lens, and tracing the rays according to the given measurements. The rays should be drawn parallel to the principal axis and then refracted through the focal point on the other side of the lens.
(ii) Measure the focal length.

The focal length (f) can be obtained using the lens formula:

$1/f = 1/u + 1/v$
where:
- u = 6 cm (object distance)
- v = 18 cm (image distance)

$1/f = 1/6 + 1/18$
$1/f = (3 + 1)/18$
$1/f = 4/18$
$f = 4.5$ cm
The focal length is 4.5 cm.

(iii) Is the image real or virtual?
The image is virtual because:
- The object is placed at a distance less than the focal length (6 cm < 4.5 cm).
- The image is upright and magnified, which is characteristic of a virtual image formed by a converging lens when the object is within the focal length.

(b) (i) Determine the magnification m.
Magnification (m) is given by:
$m = v / u$
Substituting the values:
$m = 18 / 6$
$m = 3$
The magnification is 3, meaning the image is three times the size of the object.
(ii) Compare V, the image distance given in the figure, and the value obtained from calculations using $m = v/f + 1$.
Using the given formula:
$m = v/f + 1$
$3 = v/4.5 + 1$
Rearranging:

$v/4.5 = 2$
$v = 9$ cm
From calculations, the image distance is 9 cm, whereas the given figure suggests 18 cm. The difference may be due to approximations in graphical analysis.

7. The graph below shows plotted data for the angle of deviation, D, against the angle of incidence, i, obtained from an experiment carried out to determine the refractive index of glass using a ray of light from air to glass.

(a) Using the graph:
(i) Record the value of Dm (the minimum angle of deviation).

From the graph, the minimum angle of deviation Dm is 46°.

(ii) Fill in the table below the values of D (angles of deviation) and the corresponding values of i (angles of incidence).

Angle of Deviation, D (°)	75	50	46	50	54
Angle of Incidence, i (°)	30	50	55	60	70

(b) Given that n = sin(A + Dm / 2) / sin(A / 2), where A = 64°, find the refractive index, n, of the glass.

Substituting the values:

n = sin((64 + 46) / 2) / sin(64 / 2)
n = sin(55) / sin(32)
n ≈ 0.819 / 0.530
n ≈ 1.55
The refractive index of the glass is 1.55.

(c) State two sources of errors and two precautions to be taken when conducting an experiment to determine the refractive index of glass.

Sources of errors:
1. Inaccurate measurement of angles due to parallax errors while reading the protractor.
2. Misalignment of the prism and incorrect tracing of the refracted rays.

Precautions:
1. Ensure the prism is placed firmly and correctly on the drawing sheet to minimize misalignment.
2. Use a sharp pencil to mark the rays accurately and avoid thick lines that could introduce errors in angle measurements.

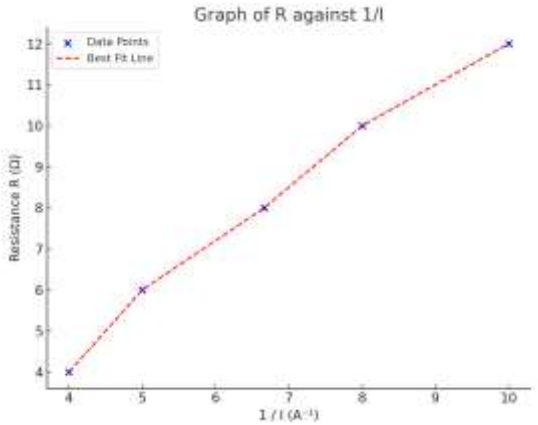
8. An experiment to determine the e.m.f, E, and internal resistance, r, of a cell was carried out. Part

of the results were as follows:

Resistance R (Ω)	4	6	8	10	12
Current I (A)	0.250	0.200	0.150	0.125	0.100
1 / I (A^{-1})	4.00	5.00	6.67	8.00	10.00

(a) (i) Copy and complete the table above
The calculated values for 1/I have been added to the table.

(ii) Plot a graph of R against 1/I



(iii) Determine the slope, S, and the intercept, C, on the R-axis
Using the best-fit line, the calculated slope is 1.52, and the intercept is 2.03.

(b) Determine the values of E and r given that:
E = slope
r = intercept

Substituting the values:
E = 1.52 V
r = 2.03 Ω

9. An accumulator of e.m.f. 2V and negligible internal resistance is connected in series with two resistors of resistances 2Ω and 3Ω and an instrument N. Another instrument P is connected in parallel across the 3Ω resistance.
(a) Draw the circuit diagram
The circuit diagram should include a 2V battery in series with 2Ω and 3Ω resistors. Instrument N should be in series, while instrument P is connected in parallel across the 3Ω resistor.
(b) Label the polarities of N and P
N is an ammeter, measuring the total current in the series circuit, so it is connected in series with the resistors.
P is a voltmeter, measuring the potential difference across the 3Ω resistor, so it is connected in parallel.

(c) Name the instruments N and P
N is an ammeter
P is a voltmeter

(d) Calculate the readings on N and P
Total resistance in the series circuit:
R_total = 2Ω + 3Ω = 5Ω
Total current (I) = V / R_total
I = 2V / 5Ω

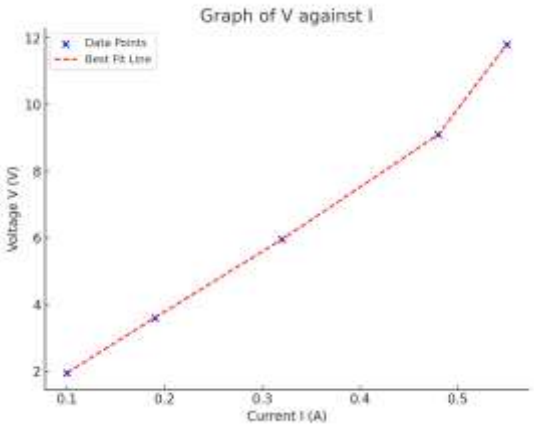
I = 0.4 A
The reading on N (ammeter) is 0.4 A.
Voltage across 3Ω resistor:
V_P = I × R
V_P = 0.4 × 3
V_P = 1.2 V

The reading on P (voltmeter) is 1.2 V.

10. In an experiment to determine the resistance R of a resistor, the following values for V, the potential difference across the resistor, and I, the current through the resistor, were obtained.

V (V)	1.94	3.60	5.95	9.10	11.8
I (A)	0.10	0.19	0.32	0.48	0.55

(a) (i) Use the data in the above table to plot the graph of V against I
A graph of V against I will be plotted.



(ii) Determine the gradient, G, of the line. Mark the graph so as to show the values from which G has been calculated.

Using the formula:
G = ΔV / ΔI

Using the first and last points:
G = (11.8 - 1.94) / (0.55 - 0.10)
G = 9.86 / 0.45
G = 21.91 Ω

(iii) Obtain a value for R given that G = R
Since G = R, the resistance R of the resistor is 21.91 Ω.