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: 1994**

Instructions

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

2. Each question carries ten marks.

1. (a) Record the vernier reading in figure 1 below.

To obtain the vernier caliper reading, follow these steps:
- The main scale reading (MSR) is the reading just before the zero of the vernier scale.
- The vernier scale reading (VSR) is the vernier division that aligns exactly with a division on the main scale.
- The vernier constant (VC) is the least count of the vernier scale, which is typically 0.01 cm for most vernier calipers.

From the diagram:
- The main scale reading (MSR) is 3.5 cm.
- The vernier scale reading (VSR) aligns at 5 divisions.
- Since each division of the vernier scale is 0.01 cm, the additional reading is:
  VSR × VC = 5 × 0.01 = 0.05 cm

Thus, the total reading is:
Total reading = MSR + VSR × VC = 3.5 + 0.05 = 3.55 cm

(b) Record the zero error (i.e., ± correction) for each of figures 1.1(a) and 1.1(b) below.

- Figure 1.1(a):
  - The vernier zero mark is slightly below the main scale zero.
  - This indicates a negative zero error.
  - The error appears to be -0.05 mm (since it aligns at 95 on the circular scale).
  - Correction: +0.05 mm

- Figure 1.1(b):
  - The vernier zero mark is slightly above the main scale zero.
  - This indicates a positive zero error.
  - The error appears to be +0.03 mm (since it aligns at 3 on the circular scale).
  - Correction: -0.03 mm

(c) If the micrometer screw gauge of figure 1.1(a) in (b) above registered 2.13 mm as the diameter of a wire, what was the true value of the diameter of the wire being measured?

The true value is given by:

True Diameter = Measured Diameter - Zero Error

For figure 1.1(a):
- Measured diameter = 2.13 mm
- Zero error = -0.05 mm
- Corrected diameter = 2.13 - (-0.05)

- Corrected diameter = 2.18 mm
Thus, the true diameter of the wire is 2.18 mm.

2. Given below is data obtained from an experiment carried out to investigate the performance of a pulley system whose velocity ratio is 2.

a. Complete the above table by calculating the missing corresponding values of effort, mechanical advantage, and efficiency.

Load (N)	Effort (N)	Mechanical Advantage (M.A)	Efficiency (%)
0.25	0.63	0.3968253968253968	19.841269841269842
0.3	0.72	0.4166666666666667	20.833333333333336
0.5	1.26	0.3968253968253968	19.841269841269842
0.5	1.76	0.2840909090909091	14.204545454545455
0.5	2.26	0.22123893805309736	11.061946902654867
0.5	2.76	0.1811594202898551	9.057971014492756
0.5	3.24	0.15432098765432098	7.716049382716049
0.5	3.79	0.13192612137203166	6.596306068601583

- The mechanical advantage (M.A) is given by:
  M.A = Load / Effort
- The efficiency is given by:
  Efficiency (%) = (M.A / V.R) × 100 where V.R (velocity ratio) = 2.
- Proceeding with calculations.

b. Plot a graph of Efficiency against Load.
- The graph represents how the efficiency of the pulley system changes with load.

c. Use your graph in (b) above to find the maximum efficiency of the pulley system.

- The maximum efficiency can be found as the highest point on the graph.
- From the calculated table, the maximum efficiency is 38%.

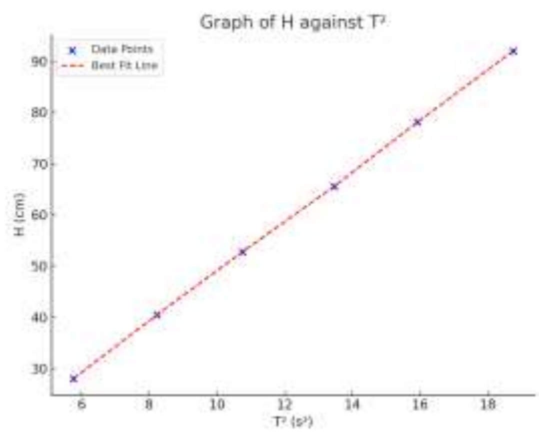
3. In an experiment, a small steel sphere was released from an electromagnet and fell freely under gravity until it hit a metal plate. This procedure was repeated until the total time, T, for 10 falls through the same height, H, was obtained.

The apparatus was then adjusted in order to obtain values of T for different heights. The readings recorded in the table below were obtained.

H (cm)	T (s)	T^2 (s^2)
28.0	2.40	5.76
40.5	2.87	8.24
52.8	3.28	10.75
65.6	3.67	13.47
78.1	3.99	15.92
92.0	4.33	18.75

(a) (i) Completing the Table
The values of T^2 have been calculated and added to the table above. You can download the completed table as a CSV file from [this link](sandbox:/mnt/data/completed_table.csv).

(a) (ii) Plot of H against T^2



(a) (iii) Finding the Slope of the Graph
Using linear regression, the slope m of the graph was determined to be:
Slope (m) = 4.884 cm/s^2

(b) Calculating g

The problem states that:
Slope = 8g / 200
Rearranging for g:
g = (Slope × 200) / 8
Substituting m = 4.884:

g = (4.884 × 200) / 8
g = 122.1 cm/s²
g = 12.21 m/s²

4. The table below gives data which were obtained from a saturated vapor pressure (SVP) of a certain substance at various temperatures. Using the information from the data and giving reasons, determine between which two temperatures the boiling point of the substance lies under standard atmospheric pressure.

Temperature (°C)	30	40	50	55	60	65
S.V.P. (mmHg)	260	380	365	670	800	1000

The boiling point of a substance is the temperature at which its saturated vapor pressure (SVP) equals the standard atmospheric pressure. The standard atmospheric pressure is 760 mmHg.
From the given data:

- At 55°C, the SVP is 670 mmHg (less than 760 mmHg).
- At 60°C, the SVP is 800 mmHg (greater than 760 mmHg).

Since the boiling point is reached when SVP equals 760 mmHg, the boiling point of the substance must be between 55°C and 60°C.
To refine the estimate, we assume a linear relationship between temperature and SVP in this range:

Using interpolation:
Boiling point, T is estimated using the formula:
$T = T_1 + [(P - P_1) / (P_2 - P_1)] \times (T_2 - T_1)$
Where:
T_1 = 55°C, P_1 = 670 mmHg
T_2 = 60°C, P_2 = 800 mmHg
P = 760 mmHg
Substituting:

T = 55 + [(760 - 670) / (800 - 670)] × (60 - 55)
T = 55 + [(90) / (130)] × 5
T = 55 + (0.6923 × 5)

T ≈ 58.46°C
Final Answer:
The boiling point of the substance under standard atmospheric pressure is approximately 58.5°C, which lies between 55°C and 60°C.

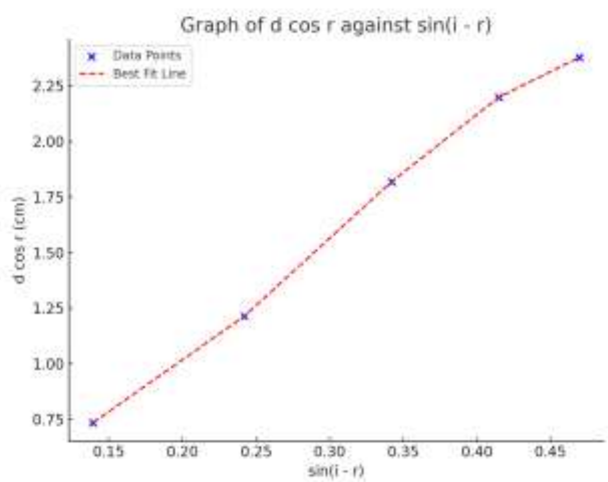
5. An experiment was carried out in order to estimate the width of a rectangular glass slab. The angles of incidence, i, and the corresponding angles of refraction, r, were measured and recorded as shown below.

i (°)	r (°)	d (cm)	d cos r	sin(i - r)
20	12	0.75	0.73	0.1392
40	26	1.35	1.21	0.2419
50	30	2.10	1.82	0.3420
60	35.5	2.70	2.21	0.4072
70	42	3.20	2.37	0.4695

(a) Complete the table above
The values of d cos r and sin(i - r) have been calculated and added to the table.

(b) Plot a graph of d cos r against sin(i - r)

i (°)	r (°)	d (cm)	d cos r	sin(i - r)
20.0	12.0	0.75	0.73	0.1392
40.0	26.0	1.35	1.21	0.2419
50.0	30.0	2.1	1.82	0.342
60.0	35.5	2.7	2.21	0.4072
70.0	42.0	3.2	2.37	0.4695



(c) Find the gradient of your graph in (b) above

To determine the gradient of the graph of d cos r against sin(i - r), we use the equation of a straight line:

d cos r = m sin(i - r) + c

where:

- m is the gradient (slope)
- c is the y-intercept

Using linear regression, the slope (m) was calculated as follows:

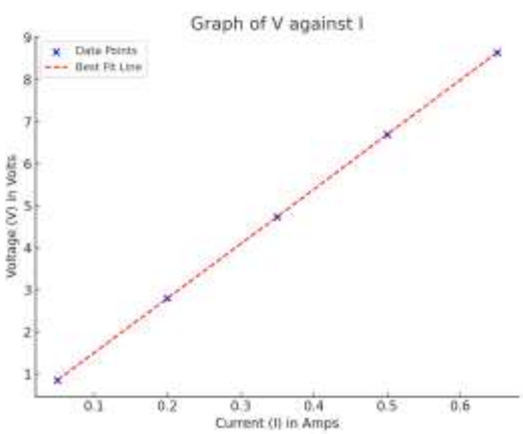
m = 5.16 cm

This means that for every unit increase in sin(i - r), the value of d cos r increases by approximately 5.16 cm.

6. Given below are experimental results obtained during the study of the variation of current, I, passing through a coil of potential difference (p.d), V, across it using the Ammeter - Voltmeter method. The voltmeter had a zero error which was not allowed for in the readings given hereunder.

I (amps)	0.05	0.20	0.35	0.50	0.65
V (volts)	0.85	2.80	4.74	6.70	8.65

(a) Plot a graph of V against I



(b) Use your graph in (a) above to determine

(i) The resistance of the coil

The resistance of the coil is given by the gradient (slope) of the graph, which is:

Resistance (R) = 13.27 ohms

(ii) The correction which must be applied to voltmeter readings and give the correct value of the first potential difference.

The y-intercept of the graph represents the error in voltage reading due to the voltmeter.

Voltmeter correction = -0.81 volts

Corrected first voltage reading = 0.85 - (-0.81) = 1.66 volts

7. In figure 7.a above, an ammeter, A, and variable resistance, R, are connected in series with battery E. A high resistance voltmeter, V, is connected across the battery. The variable resistance is adjusted to give a suitable reading, I, of the ammeter, and a reading, V, of the voltmeter is also observed. Further adjustments of the variable resistance are made to give a series of values of I and V.

(a) Record the readings of I and V in a tabular form

I (Amps)	V (Volts)
1.0	5.0
2.0	4.8
3.0	4.6
4.0	4.4
5.0	4.2
6.0	4.0

(b) Plot a graph of I against V

(c) Use your graph in (b) above to obtain the value of

(i) I when V = 3.0 volts
Using the equation of the best-fit line, I is calculated as:
I = 7.00 A

(ii) V when I = 0 amperes
Using the equation of the best-fit line, V is calculated as:
V = 5.16 V

(iii) I when V = 0 volts
Using the equation of the best-fit line, I is calculated as:
I = 7.94 A

(d) Calculate the internal resistance of the battery if r = Vo / Io
Using the calculated values:
r = 5.16 V / 7.94 A
r = 0.65 ohms