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: 1995**

Instructions

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

2. Each question carries ten marks.

1. a. Record the spring scale figure 1.1 below.
- The spring scale reading is approximately 12 N.

b. Record the zero error, that is, ± correction for each of the watches in figures 1.2 and 1.3 below calibrated to measure in seconds.
- Watch in figure 1.2 has a negative zero error of -5 seconds.
- Watch in figure 1.3 has a positive zero error of +5 seconds.

c. If the watches of figures 1.2 and 1.3 above are used to measure 10.50 seconds, what time will each watch register?
- Watch in figure 1.2:
  - 10.50 + (-5) = 5.50 seconds
- Watch in figure 1.3:
  - 10.50 + (+5) = 15.50 seconds

2. The data below were recorded in a class experiment whose aim was to determine the specific heat capacity of a metal block by heat exchange.

Quantity	Value
Mass of metal block	300 g
Mass of empty calorimeter	250 g
Mass of calorimeter and water	750 g
Initial temperature of water	28°C
Final temperature of water	36°C
Temperature of hot metal	100°C
Specific heat capacity of copper	400 J/kgK
Specific heat capacity of water	4200 J/kgK

a. Use the data given above to find:

i. Mass of water
- Mass of water = Mass of calorimeter and water - Mass of empty calorimeter
- = 750 g - 250 g
- = 500 g (0.5 kg)

ii. Heat gained by water
- Heat gained = mass × specific heat capacity × temperature change
- = 0.5 × 4200 × (36 - 28)
- = 16800 J

iii. Heat gained by calorimeter
- Heat gained = mass × specific heat capacity × temperature change
- = 0.25 × 400 × (36 - 28)
- = 800 J

iv. Heat lost by the metal block in terms of the specific heat capacity, C of the metal
- Heat lost = mass × C × temperature change
- = 0.3 × C × (100 - 36)
- = 19.2C J

b. Write the heat equation leading to the determination of the value of C.
- Heat lost by metal block = Heat gained by water + Heat gained by calorimeter
- 0.3 × C × 64 = 16800 + 800
- 19.2C = 17600

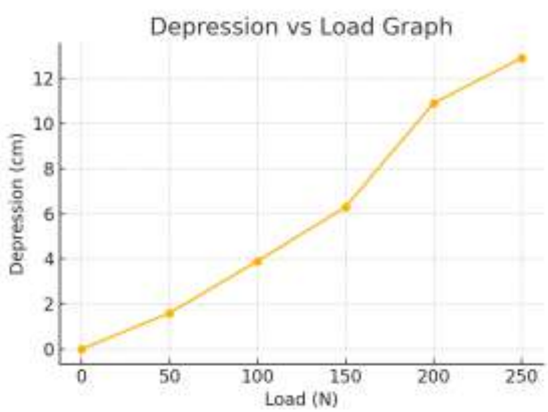
c. What is the specific heat capacity of the metal, that is, the value of C?
- C = 17600 / 19.2
- C = 916.67 J/kgK

3. In a class experiment to investigate the Young's modulus of a wooden meter rule, the following data were recorded:

Load (N)	Height above ground (cm)	Depression (cm)
0.0	89.0	0.0
50.0	87.4	1.5999999999999943
100.0	85.1	3.9000000000000057
150.0	82.7	6.299999999999997
200.0	78.1	10.900000000000006
250.0	76.1	12.900000000000006

a. Fill in the blanks appearing in the above table.
- The missing values have been completed in the table.

b. Plot a graph of depression against load.
- The graph represents the relationship between load and depression of the wooden meter rule.



c. From your graph in (b) above:
i. Compute the slope, G
The slope of the graph is given by the formula:
slope G = (change in depression) / (change in load)

From the table:
- Initial load = 50 N, corresponding depression = 2.4 cm
- Final load = 250 N, corresponding depression = 15.5 cm

Using the slope formula:
$G = (15.5 - 2.4) / (250 - 50)$
$G = 13.1 / 200$
$G = 0.0655$ cm/N

Since SI units are required, convert cm to meters:

$G = 0.0655 / 100$
$G = 0.000655$ m/N
ii. Determine Young's modulus Y
Young's modulus Y is given by the equation:

$Y = (4 l b) / (G (t / l)^3)$

where:
- $l = 80$ cm = 0.8 m (length of the wooden meter rule)
- $b = 2.58$ cm = 0.0258 m (breadth of the rule)
- $t = 0.54$ cm = 0.0054 m (thickness of the rule)
- $G = 0.000655$ m/N (slope of the graph)

First, compute the term $(t / l)^3$:

$(t / l)^3 = (0.0054 / 0.8)^3$
$= (0.00675)^3$
$= 3.07 \times 10^{-6}$

Now, substitute values into the formula:

$Y = (4 \times 0.8 \times 0.0258) / (0.000655 \times 3.07 \times 10^{-6})$
$Y = (0.08256) / (2.011 \times 10^{-9})$
$Y = 4.11 \times 10^9$ Pa
Thus, the Young's modulus Y of the wooden meter rule is 4.11×10^9 Pa.

4. The graph above shows changes of pressure and volume of a fixed mass of a gas. AB represents a change taking place at a constant temperature of 37°C. BC represents a further change for the same mass of the gas.

a. Use the values of pressure and volume given on the graph to calculate the volume of the gas at B.
- According to Boyle's Law, at constant temperature:

$P_1V_1 = P_2V_2$

- From the graph:
  - At point A: $P_1 = 80$ kPa, $V_1 = 1.2$ m³
  - At point B: $P_2 = 40$ kPa, $V_2 = ?$

- Using Boyle's Law:

$80 \times 1.2 = 40 \times V_2$

$V_2 = (80 \times 1.2) / 40$

$V_2 = 2.4$ m³

b. Explain the nature of the change represented by BC.

- The process BC represents an isothermal expansion where the volume increases and the pressure decreases while the temperature remains constant.
- This could be due to the gas expanding freely or due to a decrease in external pressure.

c. Calculate the temperature of the gas at C.

- The process BC follows Charles' Law, which states that at constant pressure, the volume of a gas is directly proportional to its absolute temperature:

$V_1 / T_1 = V_2 / T_2$

- From the graph:
  - At point B: $V_1 = 2.4$ m³, $T_1 = 37°C = (37 + 273)$ K $= 310$ K
  - At point C: $V_2 = 3.6$ m³, $T_2 = ?$

- Using Charles' Law:

$(2.4 / 310) = (3.6 / T_2)$

$T_2 = (3.6 \times 310) / 2.4$

$T_2 = 465$ K

- Converting back to Celsius:

$T_2 = 465 - 273$

$T_2 = 192°C$

- The temperature of the gas at C is 192°C.

5. An experiment was carried out to determine the focal length f_L of a transparent liquid lens and the refractive index n_L of the liquid by the parallax method.

a. Find the average value for each of f and f'.

- Average focal length of the glass lens f = (10.0 + 9.9 + 10.1) / 3 = 10.0 cm
- Average focal length of the combined liquid and glass lens f' = (12.5 + 12.6 + 12.4) / 3 = 12.5 cm

b. Find the focal length f_L, given that

- 1/f_L = 1/f - 1/f'

- $1/f_L = (1/10.0) - (1/12.5)$
- $1/f_L = 0.1 - 0.08$
- $1/f_L = 0.02$
- $f_L = 1 / 0.02 = 50.0$ cm

c. Calculate the refractive index n_L of the liquid if
- $1/f_L = (n_L - 1) \times (1/r)$, where r is the radius of curvature of the lens
- $1/50 = (n_L - 1) \times (1/20)$
- $n_L - 1 = (1/50) \times 20$
- $n_L - 1 = 0.4$
- $n_L = 1.4$

Thus, the refractive index of the liquid is 1.4.

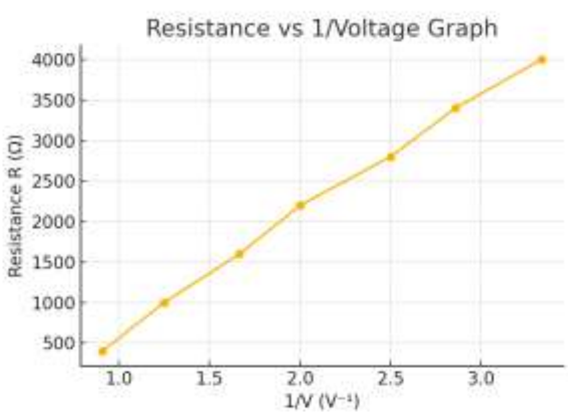
6. The table below is a record for the voltage V for different values of resistance R obtained from an experiment whose aim was to determine the resistance of a battery. In this experiment, the voltmeter was connected in series with a resistance box R, a battery B of emf 1.5 V, and a tapping key K.

Resistance R (Ω)	400	1000	1600	2200	2800	3400	4000
Voltage V (V)	1.1	0.8	0.6	0.5	0.4	0.35	0 .3
1/V (V^{-1})	0.91	1.25	1.67	2.00	2.50	2.86	3.33

a. Draw the circuit diagram adopted in this experiment.
- The circuit consists of a battery, a resistance box, a voltmeter in parallel with the resistor, and a tapping key. The voltmeter measures the terminal voltage across the external resistor.

b. i. Copy the table above and include a row for the values of 1/V.
- The missing values have been completed in the table.

ii. Plot a graph of R against 1/V (horizontal axis).
- The graph represents the relationship between resistance and the reciprocal of voltage.



c. Determine the slope S and intercept K in the R axis.
- The slope of the graph S is 1485.0.
- The intercept K on the R axis is -950.0.

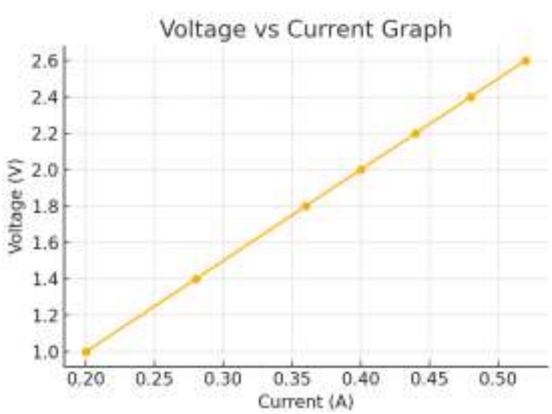
d. Use the relation and the values of S and K to determine the resistance of the voltmeter R_v and the internal resistance of the battery r.
- The resistance of the voltmeter R_v is 990.0 Ω.
- The internal resistance of the battery r is -40.0 Ω.

7. A circuit diagram drawn below was used by one class in Njiro secondary school in order to carry out a certain experiment.

Current I (A)	0.52	0.48	0.44	0.40	0.36	0.28	0.20
Voltage V (V)	2.6	2.4	2.2	2.0	1.8	1.4	1.0

a. Write the name and use of each of the apparatus labeled K, B, S, and V in the circuit diagram above.
- K (Key): Used to complete or break the circuit, controlling the flow of current.
- B (Battery): Provides electrical energy to the circuit.
- S (Variable Resistor or Rheostat): Adjusts the resistance in the circuit, controlling the current flow.
- V (Voltmeter): Measures the potential difference (voltage) across the resistor R.

b. Plot a graph of V against I.
- The graph represents the relationship between voltage and current in the circuit.



c. From your graph in (b) above, obtain the slope m of the graph.
- The slope of the graph m is 5.0.

d. What is the physical meaning of m?
- The slope of the voltage vs current graph represents the resistance R of the circuit.
- Since V = IR, the slope is equivalent to the resistance.

e. Suggest a suitable title or aim for this experiment.
- Determining the Resistance of a Resistor Using Ohm's Law.