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: 2015**

Instructions

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

2. Each question carries ten marks.

1. (a) Study the following instruments and provide in the space provided the name, application, and the correct reading from the scale.

(i)
- Name: Voltmeter
- A voltmeter is used to measure the electrical potential difference between two points in a circuit. It is essential in electrical and electronic circuits to determine the voltage supplied or dropped across components.
- Application: Measuring electric potential difference (voltage).
- The scale of the voltmeter shows a reading of 0.5 volts, indicating the voltage being measured.

(ii)
- Name: Hydrometer
- A hydrometer measures the relative density or specific gravity of liquids. It is commonly used in industries such as battery maintenance, brewing, and chemical processing.
- Application: Measuring the relative density (specific gravity) of liquids.
- The reading on the hydrometer scale is 1.1, which suggests that the liquid being measured has a higher density than water.

(iii)
- Name: Barometer
- A barometer measures atmospheric pressure and is widely used in meteorology to predict weather changes. Aneroid and mercury barometers are the most common types.
- Application: Measuring atmospheric pressure.
- The needle on the scale is pointing to 750 mmHg, which represents the atmospheric pressure at that moment.

(b) Suggest one precaution when taking readings of the instruments in (i) – (iii).

- The instrument should be placed on a level surface, and readings should be taken at eye level to avoid parallax errors. When a scale is viewed from an angle rather than directly in front, the reading may be incorrect. Positioning the eyes correctly ensures accurate measurements.

(c) Draw a warning sign for danger of electric shock and radioactive substances.
- A warning sign for electric shock includes a lightning bolt inside a triangle, which alerts individuals to electrical hazards. The warning sign for radioactive substances consists of a trefoil symbol, indicating radiation danger. These symbols are used in laboratories and industrial settings to prevent accidents.

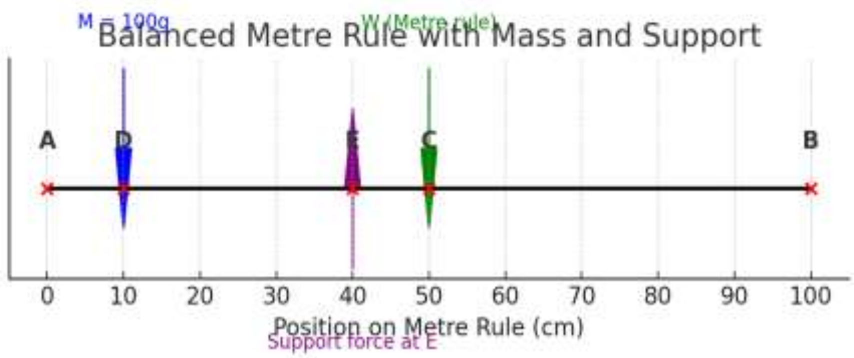
(d) Mention five vital safety measures in a physics laboratory.

- Wearing protective gear such as gloves and goggles reduces the risk of injury from chemical spills, sharp objects, or high-energy experiments.

- Avoiding direct contact with electrical equipment when wet prevents electric shocks since water is a conductor of electricity.
- Keeping flammable substances away from open flames reduces the risk of accidental fires caused by highly flammable chemicals.
- Proper disposal of chemicals after use prevents environmental contamination and avoids hazardous chemical reactions.
- Following instructions carefully when handling laboratory equipment ensures the safe use of instruments, minimizing the chances of accidents or incorrect experimental results.

2. In a certain experiment, Musa balances a uniform light metre rule AB at its centre C. When a mass M of magnitude 100g is hung at D 10cm from the end A, the new balance point E is 40cm from A.

(a) Illustrate this information by a diagram.
- A diagram should be drawn showing the positions of A, B, C, D, and E, with the forces acting at those points.



(b) Write the equation of the weight, W, of the metre rule in terms of the mass M, and the distances EC and ED.

- Taking moments about the new balance point E:
  M × ED = W × EC
- According to the principle of moments, the sum of clockwise moments about a pivot must be equal to the sum of anticlockwise moments for equilibrium to be maintained.

(c) Using the real values of EC, ED, and M, determine the mass of the metre rule AB.

- Given:
  - M = 100g = 0.1 kg
  - ED = 40 cm - 10 cm = 30 cm
  - EC = 50 cm - 40 cm = 10 cm
  - Let W = mass of metre rule = m × g

- Applying the moments equation:
  0.1 × 30 = m × 10

$m = (0.1 \times 30) / 10$
$m = 0.3$ kg

- The weight of the metre rule is balanced by the moment created by the applied mass. Solving the equation gives the mass of the metre rule.

(d) Name and state the principle governing this experiment.
- Principle: Principle of Moments
- This principle states that for a body to be in equilibrium, the sum of the clockwise moments about a pivot must be equal to the sum of the anticlockwise moments.

(e) State any two sources of error in this experiment.

- Small errors in measuring the distances can lead to incorrect calculations and affect the accuracy of the final result.
- Air movement may cause slight instability in the balance point, leading to fluctuations in the readings.

3. In an experiment to determine the specific heat capacity, Cm, the following data were collected:

(a) Determine the mass of water Mw.

- Mw = Mass of calorimeter with water - Mass of calorimeter
- Mw = 140.5 g - 80 g
- Mw = 60.5 g

- The mass of water is found by subtracting the mass of the empty calorimeter from the total mass of the calorimeter with water.

(b) Compute the heat gained by water.

- $Qw = Mw \times Cw \times \Delta T$
- $Qw = 60.5 \times 4.2 \times (19 - 14)$
- $Qw = 60.5 \times 4.2 \times 5$
- $Qw = 1270.5$ J

- The heat gained by water is calculated using the heat equation, where mass, specific heat capacity, and temperature change are multiplied.

(c) Find the heat gained by calorimeter.

- $Qc = Mc \times Cc \times \Delta T$
- $Qc = 80 \times 0.4 \times (19 - 14)$

- $Q_c = 80 \times 0.4 \times 5$
- $Q_c = 160$ J
- Since the calorimeter also absorbs heat, its heat gain is calculated separately using its own specific heat capacity.

(d) Calculate the heat lost by metal in terms of its specific heat capacity Cm.
- $M_m \times C_m \times (\theta - \theta_2) = Q_w + Q_c$
- $50 \times C_m \times (100 - 19) = 1270.5 + 160$
- $50 \times C_m \times 81 = 1430.5$
- $C_m = 1430.5 / (50 \times 81)$
- $C_m = 0.353$ J/gK
- The heat lost by the metal is assumed to be equal to the total heat gained by the water and calorimeter. By rearranging the heat equation, the specific heat capacity of the metal is determined.

(e) Using the appropriate heat equation, calculate the specific heat capacity Cm of the metal.

- The calculation was completed in the previous step, yielding $C_m = 0.353$ J/gK.

(f) State any source of error in this experiment.

- Some heat may be lost to the surroundings, which would lead to an underestimation of the heat transferred.
- Temperature readings may not be perfectly accurate due to limitations in the thermometer's precision.

(g) State two precautions for accurate specific heat capacity measurement.

- Using an insulated calorimeter minimizes heat loss to the surroundings, ensuring more accurate heat transfer calculations.
- Stirring the water thoroughly ensures uniform heat distribution, preventing localized temperature differences that could affect the measurement.

4. In an experiment to determine the relationship between the diameter of a vibrating string and its frequency when the length of the string is kept constant, its diameter was varied in order to tune the string to a series of tuning forks. The results for frequency and diameter were recorded as follows:

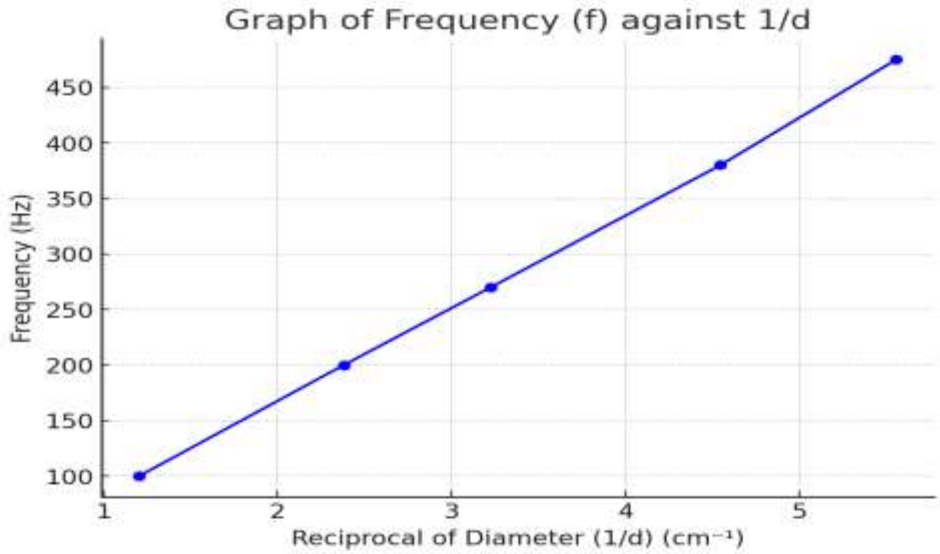
(a) Complete Table 1.

To complete the table, we calculate the reciprocal of the diameter 1/d in cm^{-1}.

$1/d = 1$ / diameter (cm)

Frequency of fork, f (Hz)	100	200	270	380	475
Diameter of string, d (cm)	0.83	0.42	0.31	0.22	0.18
Reciprocal of diameter 1/d (cm^{-1})	1.205	2.381	3.226	4.545	5.556

(b) Plot the graph of frequency, f, against 1/d.



(c) What is the nature of the graph?

The graph of frequency f against the reciprocal of diameter 1/d is a straight line that passes through the origin. This indicates that frequency is directly proportional to the reciprocal of the string's diameter. This means that as the diameter of the string decreases, the frequency increases proportionally. The linear relationship suggests that the equation governing the frequency can be written as:

$f = k\,(1/d)$

where k is a proportionality constant.

(d) Find the slope of the graph.
The slope S of the graph is given by the formula:

$S = \Delta f / \Delta(1/d)$

Using two points from the table:
Point 1: (1.205, 100)
Point 2: (5.556, 475)
$S = (475 - 100) / (5.556 - 1.205)$
$S = 86.19$ Hz·cm
This slope represents the rate of change of frequency with respect to the reciprocal of the diameter.

(e) What is the physical meaning of the slope obtained in 4(d)?
The slope of the graph represents how quickly the frequency increases as the diameter of the string decreases. A higher slope means that a small change in diameter results in a significant change in frequency.

The slope is influenced by the properties of the string, including its tension and density, which affect the speed of wave propagation through the string.

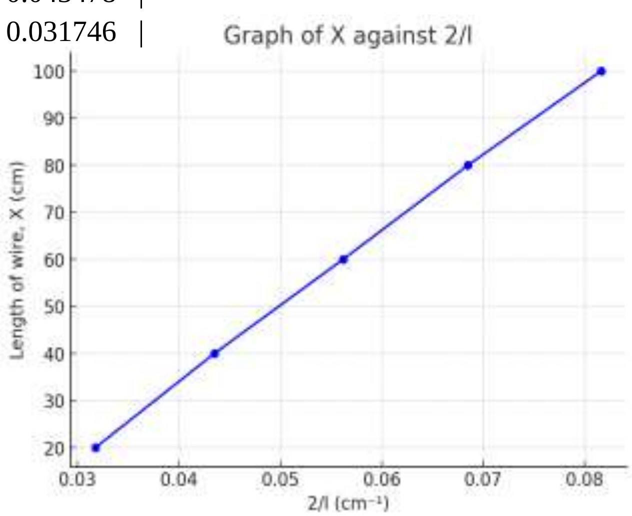
(f) State the relationship between the frequency of the vibrations and the diameter of the string.
From the graph, the relationship between frequency and diameter is given by:

f = k / d
where k is a constant. This shows that frequency is inversely proportional to the diameter of the string. When the diameter of the string is reduced, the frequency of vibration increases proportionally. This relationship follows the principles of wave motion in stretched strings, where thinner strings produce higher frequencies.

(g) State a source of error in this experiment.
One possible source of error is inaccuracies in measuring the diameter of the string. If the measurement is incorrect, it affects the calculated values of 1/d and distorts the proportional relationship.
Another source of error could be variations in the tension of the string. If the tension is not kept constant, it could affect the frequency independently of the diameter, leading to inconsistent results.

5. In an experiment to determine the resistance per metre, σ, of a given constantan wire, the following results were obtained:
(a) Complete Table 2.

Length of wire, X (cm)	Balance length, l ($\times 10^{-2}$ cm)	2/l (cm^{-1})
100	24.50	0.081633
80	29.20	0.068493
60	35.60	0.056180
40	46.00	0.043478
20	63.00	0.031746



(b) Plot the graph of X against 2/l.

(c) Determine the slope, S, of the graph.
The slope of the graph is given by:
S = ΔX / Δ(2/l)
Using two points from the graph:

Point 1: (0.081633, 100)
Point 2: (0.031746, 20)

$S = (20 - 100) / (0.031746 - 0.081633)$
$S = 1603.64\ cm^2$

(d) Find the X-intercept.
The X-intercept is the value of X when $2/l = 0$. Using the equation of a straight line:
$X = S(2/l) + c$
Substituting a known point:

$c = 100 - (1603.64 \times 0.081633)$
$c = -30.91$ cm

(e) Calculate the resistance per unit square metre, σ, of the wire given:
$2 / \sigma = (X + 2) / \sigma$
Rearranging for σ:
$\sigma = (X + 2) / (2S)$
Substituting values:
$\sigma = (\text{mean of } X + 2) / (2 \times 1603.64)$
$\sigma = 0.0193\ \Omega m^2$