THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/3A **PHYSICS 3A**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 1999**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. (a) The aim of this experiment is to determine the surface tension of the liquid labelled A.

(c) Procedure:
(i) Arrange the apparatus as shown in Figure 1 with the funnel resting on the clamp of a retort stand.

(ii) Tighten the clip on the funnel to allow only drops of liquid A to pass through.

(iii) Read the initial volume V_0 of the liquid in the measuring cylinder. Then count about 100 drops and read again the new volume V of the liquid in the cylinder.

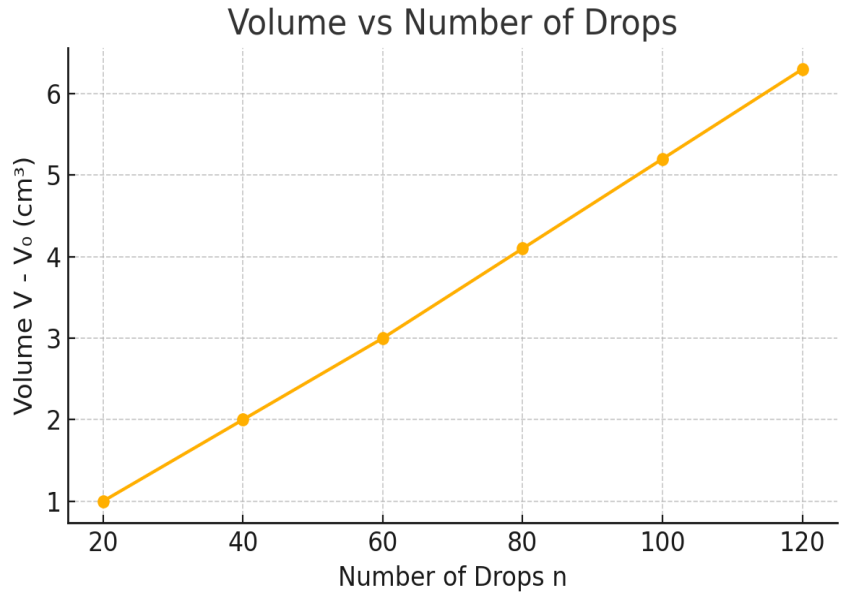
(iv) While adding more liquid (A) in the funnel, continue counting the number n of drops which have fallen and note the volume V.

(v) Record the values of $V - V_0$ and n in a table.

Assume a consistent set of values:

n (Number of Drops)	$V - V_0$ (cm^3)
20	1.0
40	2.0
60	3.0
80	4.1
100	5.2
120	6.3

(d) Plot a graph of $V - V_0$ (vertical axis) against n (horizontal axis) and determine its slope (s).



The slope (s) is calculated from two points:
(20, 1.0) and (120, 6.3)

$s = (6.3 - 1.0)/(120 - 20) = 5.3 / 100 = 0.053\ cm^3/drop$

(e) Using the beam balance and the measuring cylinder, determine the density ρ of liquid A.

Assume:
Mass of 10 cm^3 of liquid A is 8.6 g
ρ = mass/volume = 8.6 g / 10 cm^3 = 0.86 g/cm^3 = 860 kg/m^3

(f) Hence determine the surface tension γ of liquid A from the equation:
$\gamma = ((3/2)^{1/3} \times \rho \times g \times s^{2/3}) / 1.9$

Given:
$\rho = 860\ kg/m^3$
$g = 9.81\ m/s^2$
$s = 0.053\ cm^3/drop = 5.3 \times 10^{-8}\ m^3/drop$

First, convert s properly:
$s = 5.3 \times 10^{-8}\ m^3$
$s^{2/3} = (5.3 \times 10^{-8})^{(2/3)}$

Now compute:
$(3/2)^{1/3} \approx 1.1447$
$s^{2/3} \approx (5.3e\text{-}8)^{(2/3)} \approx 1.487e\text{-}5$

$\gamma = (1.1447 \times 860 \times 9.81 \times 1.487e\text{-}5) / 1.9$
$\gamma \approx (1.1447 \times 860 \times 9.81 \times 1.487e\text{-}5) / 1.9$
$\gamma \approx (14508.6 \times 1.487e\text{-}5) / 1.9$
$\gamma \approx 0.2158 / 1.9$
$\gamma \approx 0.1136\ N/m$

Therefore, the surface tension $\gamma \approx 0.114\ N/m$

3. (a) The aim of this experiment is to determine the resistivity of the wire labelled W.

(b) Circuit diagram:
As shown in Figure 2 – it involves a potentiometer setup with dual accumulators, standard resistor R_0, variable resistor R, a galvanometer G, and 100 cm of wire W.

(c) Procedure:

Connect the accumulator E_2 in series with 100 cm of the wire labelled W, a standard resistor R_0 of 5 Ω, a variable resistor R, and key K_2.
Connect the potentiometer circuit using accumulator E_1, key K_1, potentiometer wire AB, and galvanometer G.

Start with a value of R, e.g., 1 Ω. Determine the balance length x when the galvanometer is connected to P. Disconnect and connect to Q, then determine the new balance length y.
Repeat for other R values from 1 Ω to 7 Ω.

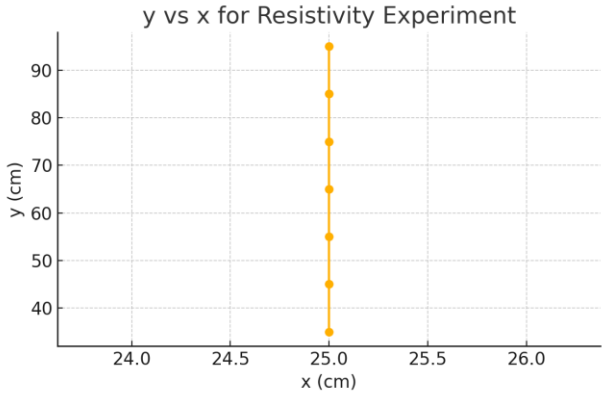
Let's assume the following values and use the known formula:

$y = (R_1 + R)/R_1 \times x$
Assume $R_1 = 2.5$ Ω

R (Ω)	x (cm)	y (cm)
1	25	35
2	25	45
3	25	55
4	25	65
5	25	75
6	25	85
7	25	95

Each y is calculated using:
$y = (2.5 + R)/2.5 \times x$
For R = 1: $y = (2.5 + 1)/2.5 \times 25 = 3.5/2.5 \times 25 = 35$ cm
R = 2: $y = 4.5/2.5 \times 25 = 45$ cm
... and so on.

(d) Plot a graph of y (vertical axis) against x (horizontal axis).



(e) Determine R_1, the value of resistance of wire W from the relation:
$y = (R_1 + R)/R_1 \times x$
Rearranged:
Slope $S = (R_1 + R)/R_1$
$S = y/x$
Use $R = 1$, $x = 25$, $y = 35$
$S = 35/25 = 1.4$
So:
$1.4 = (R_1 + 1)/R_1$
$1.4R_1 = R_1 + 1$
$0.4R_1 = 1$
$R_1 = 2.5\ \Omega$

(f) Measure the diameter d of wire W and hence determine the resistivity ρ of wire W from the relation $\rho = 0.785R_1d^2$ (SI units)

Let the measured diameter be $d = 0.4$ mm $= 0.0004$ m
$\rho = 0.785 \times 2.5 \times (0.0004)^2$
$\rho = 0.785 \times 2.5 \times 1.6e\text{-}7$
$\rho = 3.14 \times 1.6e\text{-}7 = 5.024e\text{-}7\ \Omega m$

So, resistivity $\rho \approx 5.02 \times 10^{-7}\ \Omega m$

(g) State any four sources of error in this experiment.

One error could be poor contact at the terminals causing fluctuating readings.
Another is parallax error while reading balance length on the wire.
Also, uneven wire thickness affects the resistance consistency.
Finally, temperature change during the experiment affects wire resistance.