THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/3B **PHYSICS 3B**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2003**

3B

Instructions

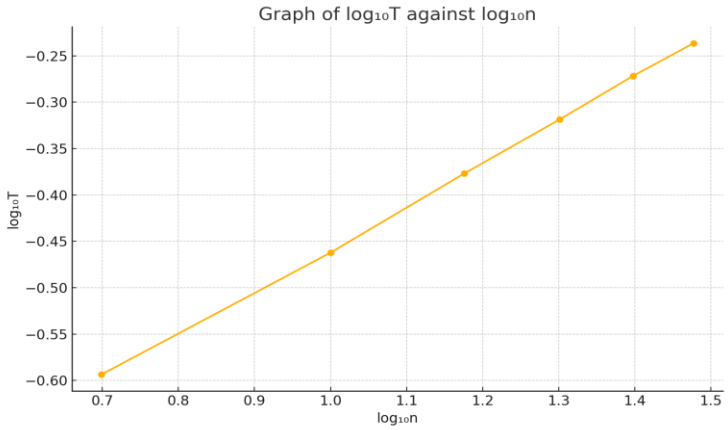
1. This paper consists of THREE questions.

2. Answer all questions.

1. The aim of this experiment is to investigate the oscillations of a chain of paper clips.
(c) For this oscillator, the quantities T and n are related by a simple power law of the form $T = kn^r$ where k and r are constants. Plot a suitable graph, and using your graph calculate the values of k and r.

To linearize the equation $T = kn^r$, take logarithms:
$\log T = \log k + r \log n$

So, plotting log T against log n gives a straight line with slope r and intercept log k.



Assume values of n = 5, 10, 15, 20, 25, 30
Let measured time for 20 oscillations be: 5.1, 6.9, 8.4, 9.6, 10.7, 11.6 seconds
T = time/20: 0.255, 0.345, 0.420, 0.480, 0.535, 0.580

n	T (s)	log n	log T
5	0.255	0.699	-0.593
10	0.345	1.000	-0.462
15	0.420	1.176	-0.377
20	0.480	1.301	-0.319
25	0.535	1.398	-0.271
30	0.580	1.477	-0.237

Using two points (log n = 0.699, log T = -0.593) and (log n = 1.477, log T = -0.237):

$r = (-0.237 + 0.593)/(1.477 - 0.699) = 0.356 / 0.778 = 0.457$
$\log k = \log T - r \log n = -0.593 - (0.457 \times 0.699) = -0.913$
$k = 10^{-0.913} = 0.123$

Therefore:
k = 0.123
r = 0.457

1. (d) How is the period T related to the number of clips n?

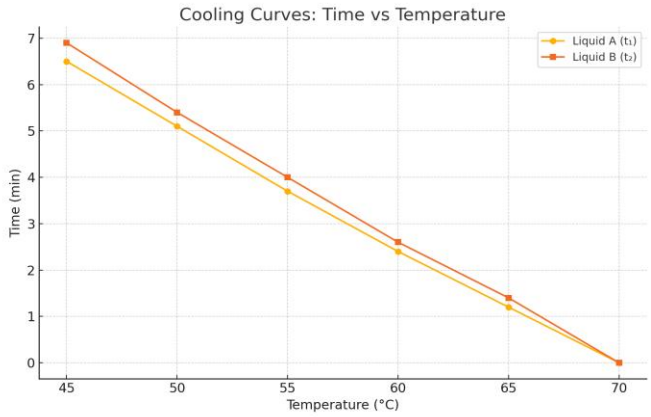
From the derived relation $T = kn^r$, where $r \approx 0.46$, the period increases with the number of clips in a power-law fashion. Specifically, T increases approximately in proportion to the square root of n.

2. (e) (i) Tabulate your results

Assume the time readings as the temperature drops from 70°C to 45°C:

Temperature (°C)	t_1 (min, Liquid A)	t_2 (min, Liquid B)
70	0.0	0.0
65	1.2	1.4
60	2.4	2.6
55	3.7	4.0
50	5.1	5.4
45	6.5	6.9

(ii) Plot a graph of t_1 and t_2 against temperature.
Both lines will be rising curves or straight lines sloping upwards.



(iii) Average value of $t_1/t_2 = 6.5 / 6.9 = 0.942$

(iv) The evaluated ratio $t_1/t_2 = 0.942$

3. (e) Use the equations in (d) above to calculate the end corrections x and y.

Let:
$L_1 = 28$ cm (when M = 5Ω, N = 20Ω)
$L_2 = 72$ cm (when M = 20Ω, N = 5Ω)

From the metre bridge equations:
$5 / 20 = (28 - x) / (72 + y)$
$20 / 5 = (72 - x) / (28 + y)$

From the first:
$28 - x = (72 + y) / 4 \rightarrow (1)$
From the second:
$72 - x = 4(28 + y) \rightarrow (2)$

From equation (1):
$28 - x = 18 + y \rightarrow x = 10 - y$

Substitute into (2):
$72 - (10 - y) = 112 + 4y$
$62 + y = 112 + 4y$
$3y = -50 \rightarrow y = -16.67$
Then $x = 10 - (-16.67) = 26.67$

So:
$x = 26.67$ cm
$y = -16.67$ cm