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: 2003**

Instructions

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

2. Each question carries ten marks.

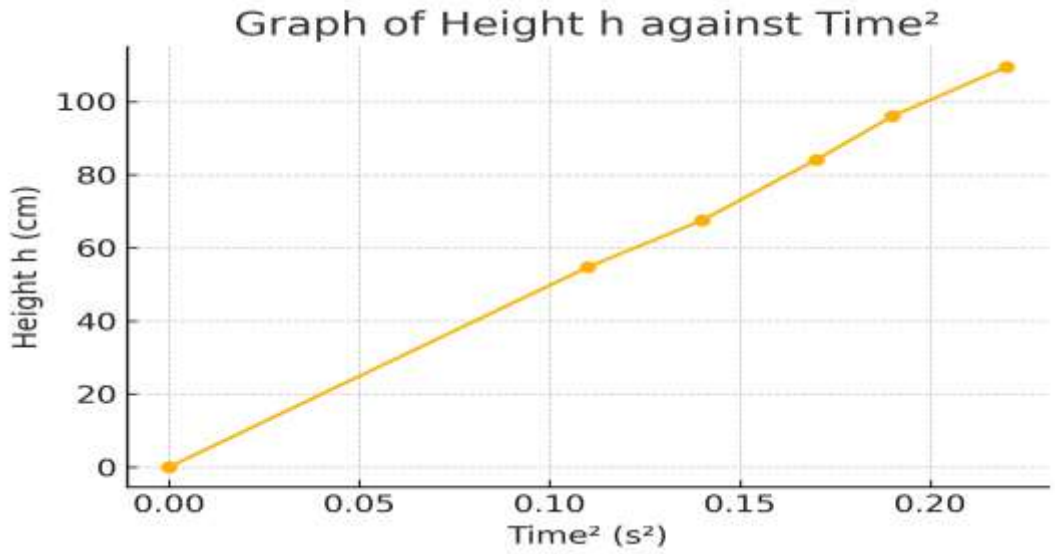
1. Fill in the gaps with the correct responses.

Name of Device	Sketch	(i) Physical Effect/Principle	(ii) Application (Uses)
(a) U-tube	(Image)	(i) Pascal's Principle (Pressure in Fluids)	(ii) Used in manometers to measure pressure differences
(b) Convex Lens	(Image)	(i) Refraction of Light	(ii) Used in magnifying glasses and cameras
(c) Inclined Plane	(Image)	(i) Mechanical Advantage (Simple Machines)	(ii) Used to reduce the effort required to lift objects
(d) Clinical Thermometer	(Image)	(i) Thermal Expansion of Liquids	(ii) Used to measure body temperature
(e) Inductor	(Image)	(i) Electromagnetic Induction	(ii) Used in electrical circuits for energy storage and filtering

2. The results in the table below were obtained from an experiment of a freely falling body.

Height h (cm)	Time t (s)	(Time)² t^2 (s^2)
0.00	0.00	0.00
54.70	0.33	0.11
67.50	0.37	0.14
84.10	0.41	0.17
96.00	0.44	0.19
109.50	0.47	0.22

(a) Plot a graph of height h (vertical axis) against t^2 (horizontal axis).



(b) Find the gradient G of the graph.
The gradient of a straight-line graph is given by the formula:
gradient G = (change in height h) / (change in time² t^2)
Using two points from the graph:

Point 1: (t^2 = 0.11, h = 54.70 cm)
Point 2: (t^2 = 0.22, h = 109.50 cm)

gradient G = (109.50 - 54.70) / (0.22 - 0.11)
gradient G = 54.80 / 0.11
gradient G ≈ 499.56
Thus, the calculated gradient G is approximately 499.56 cm/s².

(c) Using the relation h = (1/2) g t^2,
(i) determine the value of g in SI units.

The equation of motion is given by:

h = (1/2) g t^2
From the graph, the gradient represents (1/2) g.
Rearranging for g:
g = 2 gradient

Substituting the calculated gradient:
g = 2 x 499.56
g ≈ 999.12 cm/s²
Converting to meters per second squared:
g = 999.12 / 100
g ≈ 9.99 m/s²
Thus, the calculated acceleration due to gravity is approximately 9.99 m/s².

(ii) What is the physical significance of g?

I. The acceleration due to gravity (g) represents the rate at which objects accelerate towards the Earth when in free fall under the influence of gravity.
II. It is a fundamental physical constant that determines the gravitational pull exerted by the Earth on objects near its surface.
III. The standard value of g on Earth is approximately 9.81 m/s², meaning an object's velocity increases by 9.81 m/s every second when falling freely.

(iii) Suggest the aim of this experiment.

I. To determine the acceleration due to gravity (g) by analyzing the motion of a freely falling body.

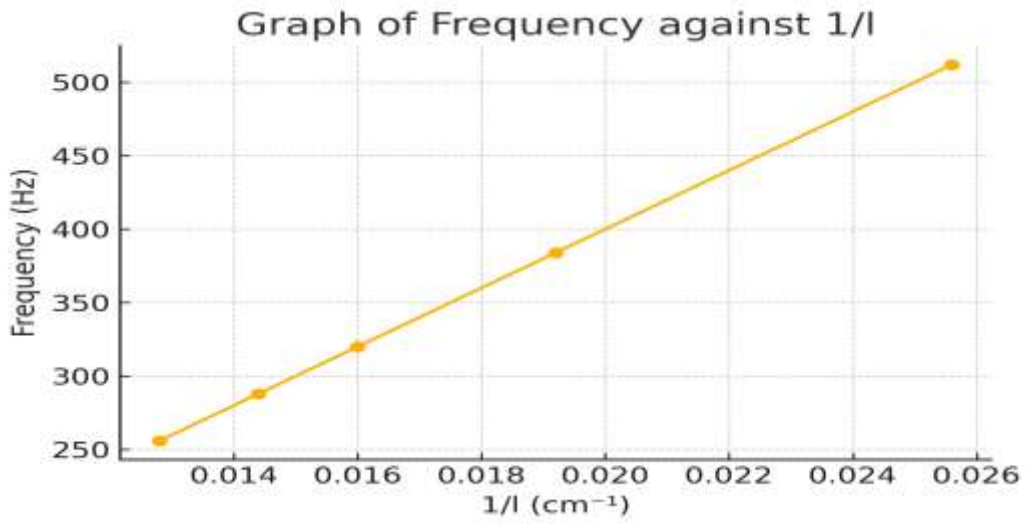
II. To verify the relationship between height (h) and time squared (t^2) in free-fall motion.
III. To understand the effect of gravity on objects in free fall and confirm that acceleration remains constant.

(d) State two possible sources of errors in this experiment.
I. Air resistance – This can slightly affect the motion of the falling object, causing deviations from ideal free-fall conditions.
II. Reaction time error – Delays in starting or stopping the timer can introduce small inaccuracies in measuring time.

3. In an experiment to study the behavior of a string, the tension of a vibrating string was kept constant and its length was varied in order to tune the strimg to a series of turning fork. The results obtained as follows.

Frequency of fork (Hz)	Length of string (cm)	1/l (cm^{-1})
256.0	78.1	0.0128
288.0	69.5	0.0144
320.0	62.5	0.016
384.0	52.1	0.0192
512.0	39.1	0.0256

(a) Plot a graph of frequency (vertical axis) against 1/l (horizontal axis)



(b)(i) Determine the relationship between the frequency of vibration and the length of the stretched string.
I. From the graph, the frequency of vibration (f) is directly proportional to the reciprocal of the string length (1/l).
II. This confirms the formula for a vibrating string:
$f \propto 1/l$
III. This means that as the length of the string decreases, the frequency increases.

(ii) Determine the frequency of an unmarked fork which was in tune with 41.70 cm of the string.
I. First, calculate the reciprocal of the string length:
$1/l = 1 / 41.70$
$1/l \approx 0.0240\ cm^{-1}$
II. Using interpolation from the graph, the estimated frequency for this value is 480.0 Hz.

4. If an object is placed at a distance of 20.0 mm from a concave mirror of focal length 50.0 mm and if the height of the object is 20.0 mm, determine graphically:

(a)(i) The position of the image from the mirror.
To determine the position of the image, we use the mirror formula.

$1/f = 1/u + 1/v$

where:
- f = 50.0 mm (focal length)
- u = 20.0 mm (object distance)
- v = image distance (to be determined)

Rearranging the formula for v:

$1/v = 1/f - 1/u$
$1/v = (1/50) - (1/20)$
$1/v = 0.02 - 0.05$
$1/v = -0.03$
$v = -1 / 0.03$
$v \approx -33.33$ mm

The negative sign indicates that the image is virtual and located behind the mirror at a distance of approximately 33.33 mm.

(ii) The linear magnification of the mirror.

The magnification (m) is given by the formula:
$m = - v / u$
Substituting values:
$m = - (-33.33) / 20$
$m = 33.33 / 20$
$m \approx 1.67$
Thus, the linear magnification of the mirror is 1.67, meaning the image is enlarged.

(b) State the nature of the image formed in 4(a) above.
I. The image is virtual because the value of v is negative, meaning the image is formed behind the mirror.
II. The image is upright since the magnification is positive.
III. The image is enlarged, as the magnification is greater than 1.

5. The graph given above (1/I against R) was obtained from an experiment to determine the electromotive force E and internal resistance r of a cell.

Use the graph to answer the following questions:
(a)(i) What is the current when the resistance is 4 Ω?
From the graph, when R = 4 Ω, the corresponding value of 1/I is approximately 0.85 A^{-1}.
Since I = 1 / (1/I),
I = 1 / 0.85
I ≈ 1.18 A
Thus, the current when the resistance is 4 Ω is approximately 1.18 A.
(a)(ii) What value of the resistance gives an ammeter reading of 4 A?
Since I = 4 A, we first calculate 1/I:
1/I = 1 / 4
1/I = 0.25 A^{-1}
From the graph, when 1/I = 0.25 A^{-1}, the corresponding resistance R is approximately 1.5 Ω.
Thus, the resistance that gives an ammeter reading of 4 A is 1.5 Ω.

(b) What is the Y-intercept of the graph?
From the graph, the Y-intercept (when R = 0 Ω) is approximately 0.60 A^{-1}.

(c) Determine the slope, G, of the graph.
The slope of the graph is given by:
slope G = (change in 1/I) / (change in R)
Using two points from the graph:
Point 1: (R = 1 Ω, 1/I = 0.30 A^{-1})
Point 2: (R = 4 Ω, 1/I = 0.85 A^{-1})
G = (0.85 - 0.30) / (4 - 1)
G = 0.55 / 3
G ≈ 0.183 $A^{-1}\Omega^{-1}$
Thus, the calculated slope G is approximately 0.183 $A^{-1}\Omega^{-1}$.

(d) If the graph is based on the equation:
1/I = (R / E) + (r / E), determine the value of E and r.

Comparing with the equation of a straight line y = mx + c,

- The slope G = 1 / E, so E = 1 / G

- The Y-intercept $c = r / E$, so $r = c * E$

Substituting values:
$E = 1 / 0.183$
$E \approx 5.46$ V
$r = 0.60 \times 5.46$
$r \approx 3.28\ \Omega$
Thus, the electromotive force $E = 5.46$ V and the internal resistance $r = 3.28\ \Omega$.