3.4 PHYSICS (232)

The KCSE physics syllabus was tested in two theory papers (232/1 and 232/2) and one practical paper (232/3).

3.4.1 GENERAL CANDIDATES PERFORMANCE

The candidate's performance statistics in the KCSE physics examination for the last five years are as shown in the table below.

Table 12: candidates overall performance in the years 2010 to 2014

Year	Paper	Candidature	Maximum score	Mean score	Standard deviation
2010	1		80	26.11	16.95
	2		80	21.82	13.82
	3		40	22.37	07.81
	overall	**109,811**	**200**	**70.22**	**35.73**
2011	1		80	21.64	14.49
	2		80	29.43	16.41
	3		40	22.24	8.84
	overall	**120,074**	**200**	**73.28**	**36.72**
2012	1		80	26.46	13.72
	2		80	31.91	17.00
	3		40	17.40	6.88
	overall	**119,654**	**200**	**75.72**	**34.58**
2013	1		80	36.03	19.66
	2		80	21.34	14.37
	3		40	22.85	7.98
	overall	**119,819**	**200**	**80.20**	**38.07**
2014	1		80	30.41	17.24
	2		80	27.62	16.15
	3		40	19.68	6.78
	overall	**131,410**	**200**	**77.68**	**37.30**

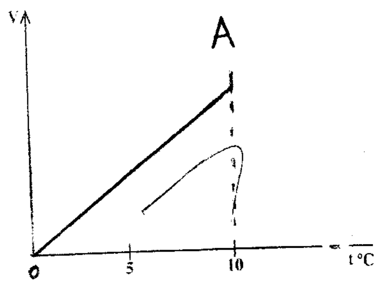
From the table it can be observed that:

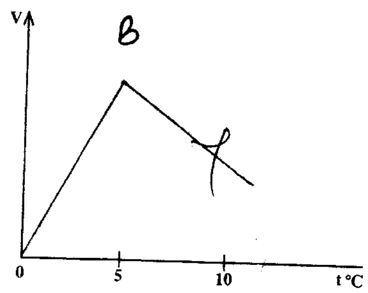
(i) The candidature increased to 131,410 in 2014 from 119,819 in 2013. This was an increase of 11,591 candidates (9.67 %); this is low compared to the overall increase in candidature.

(ii) There was improvement in the performance of papers 2. Paper 2 improved from a mean of 21.34 in the year 2013 to 27.62 in the year 2014 while Paper 1 and 3 registered a drop in the performance as is shown n the table.

(iii) The standard deviation in all the Physics papers continues to be large but normal. This shows a clear discrimination between the high and low achievers.

(iv) There overall performance of physics dropped from a mean of 80.20 in 2013 to 77.68 in 2014. On analyzing the candidates' responses to a number of questions it was observed that some candidates proceed to respond without thinking critically and logically as is required of Physics. For example to have candidates plot the graph of volume against temperature for water starting at zero as shown in the responses below is an indication that the candidate does not understand the meaning of the y- axis starting at zero in terms of the volume.





The following is a discussion of the questions in which candidates performed poorly.

3.4.2 Physics Paper 1 (232/1)

Question 3

State the reason why it is **not correct** to quote the weight of solid objects in kilograms. (1 mark)

Candidates were required to state the reason why it is not right to quote the weight of objects in kilograms.

Weakness
Most students were not able to show the difference between mass and weight in terms of the force involved when dealing with weight.

Expected response

Weight = Mass x gravity

kilograms is the unit of measuring the mass and does not depict the force of gravity.

Question 6

An oil drop of volume V m^3 introduced on the surface of water spreads to form a patch whose area is A m^2. Derive an expression for obtaining the diameter, d of a molecule of oil. (2 marks)

Candidates were required to derive an expression for obtaining the diameter D of an oil molecule given the volume and area of the patch formed.

Weakness

Most candidates worked without realizing that the height of the cylinder formed when the oil spreads is equivalent to the diameter of the molecule. They failed to equate the volume of the drop to the volume of the oil patch.

Expected response

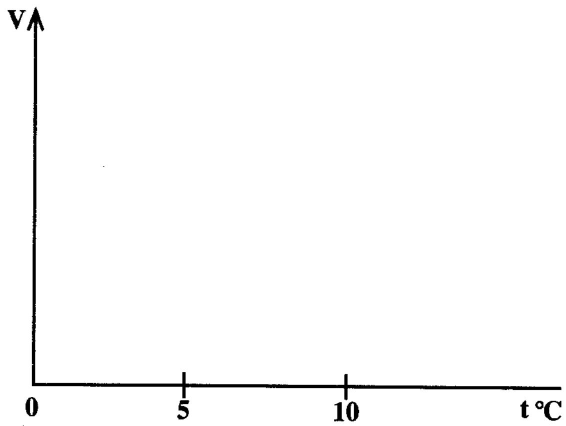
Volume of drop = Volume of patch

$$Ad = V$$

$$d = \frac{V}{A}$$

Question 12

On the axis provided, sketch the graph which shows the relationship between volume and temperature of a fixed mass of water in the temperature range 0°C to 10°C. (1 mark)

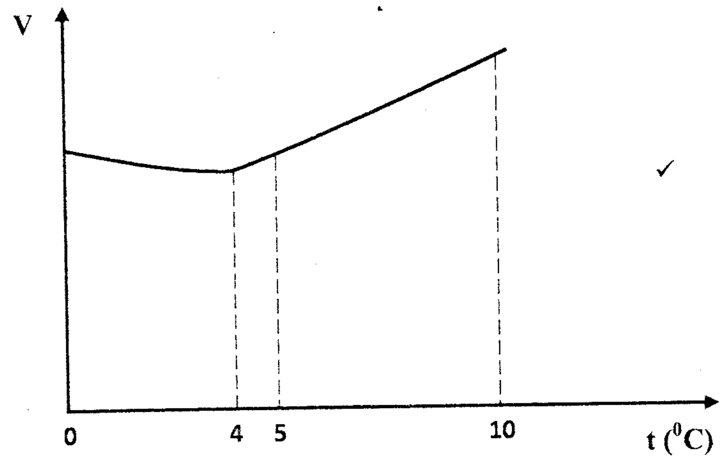


Candidates were required to plot the graph of volume against temperature for water between 0^0 c and 10^0 c.

Weakness

Some students were not aware of the fact that the slope cannot be so steep between 0^0 c and 10^0 c. Some even had graphs starting at the origin.

Expected response



✓ (1)

Question 14

In a smoke cell experiment to demonstrate Brownian motion, smoke particles are seen moving randomly. State the cause of the randomness. (1 mark)

Candidates were required to state the cause of the randomness in Brownian motion experiment.

Weakness

Though students had knowledge of Brownian option the actual cause of randomness was not coming out of their response.

Expected response

- Collisions / bombardment of particles with air molecules which are in random motion.

Question 17

(a) A long horizontal capillary tube of uniform bore sealed at one end contains dry air trapped by a drop of mercury. The length of the air column is 142 mm at 17°C. Determine the length of the air column at 25°C. (3 marks)

(b) The pressure of the air inside a car tyre increases if the car stands out in the sun for some time on a hot day. Explain the pressure increase in terms of the kinetic theory of gases. (3 marks)

(c) In an experiment to determine the specific latent heat of vapourization of water, steam of mass 10 g at 100°C is passed into 100 g of water initially at 20°C in a container of negligible heat capacity. The temperature of the water rises to 70°C.
(Take the specific heat capacity of water as 4.2×10^3 *J kg*$^{-1}$ *K*$^{-1}$ *and the boiling point of water as 100°C)*

(i) Determine the specific latent heat of vapourization of water. (4 marks)

(ii) State **two** sources of error in this experiment. (2 mark)

The question had several parts testing on different topics.
Candidates were required to explain the determine the length of an air column for a horizontal capillary tube, explain pressure increase in terms of kinetic energy and determine the specific latent heat of vaporization.

Weakness
The candidates were not able to bring out the explanations on the increase in air pressure in terms of the kinetic theory of gasses well. They failed to point out that the increased temperatures result in higher energy of the air molecules. Many candidates were not able to compute the specific latent heat of vaporization of water from the given quantities. Most candidates were not able to state the sources of error in the outlined experiment.

Expected response

(a) $l_1 = 142$, $T_1 = 290$ K, $T_2 = 298$ K, $l_2 = ?$

$$\frac{l_1}{T_1} = \frac{l_2}{T_2} \text{ or } \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$l_2 = 142 \times \frac{298}{290}$$

$$= 145.9 \text{ mm}$$

(b) In the hot sun the temperature of the air increases; therefore the speed of the air molecules increases hence the rate of collisions between the molecules and tyre increases; The rate of change of momentum (pressure) of the molecules also increases.

(c) (i) Heat lost = Heat gained

$$mLv + M\,\Delta\theta C_{steam} = M\,\Delta\theta C_{water}$$

$$0.01\,Lv + 0.01 \times 30 \times 4200 = 0.1 \times 4200 \times 50$$

$$0.01\,Lv = 21000 - 1260$$

$$Lv = \frac{19740}{0.01}$$

$$= 1.974 \times 10^6 \text{ J Kg}^{-1}\text{K}^{-1}$$

(ii) - All the heat lost by the steam is not absorbed by the water alone.
- Reading the thermometer at wrong meniscus resulting in wrong temperatures.

3.4.3 Physics Paper 2 (232/2

Question 6

It is observed that when the cap of an uncharged electroscope is irradiated with light of high frequency, the leaf of the electroscope rises. Explain this observation. (3 marks)

Candidates were required to explain the effect of irradiating an uncharged electroscope with a light of high frequency.

Weakness
Many students were unable to relate the light of high frequency to photoelectric emission that causes electrons to be dislodged from the electroscope hence creating a net positive charge. Many students did not state the reason for increased leaf divergence as repulsion between the leaf and stem

Expected response

Electrons arbsorb enough energy and are ejected leaving the electroscope positively charged the leaf is repelled by the stem.

Question 8

Figure 5 shows a graph of current against voltage for a semiconductor diode.

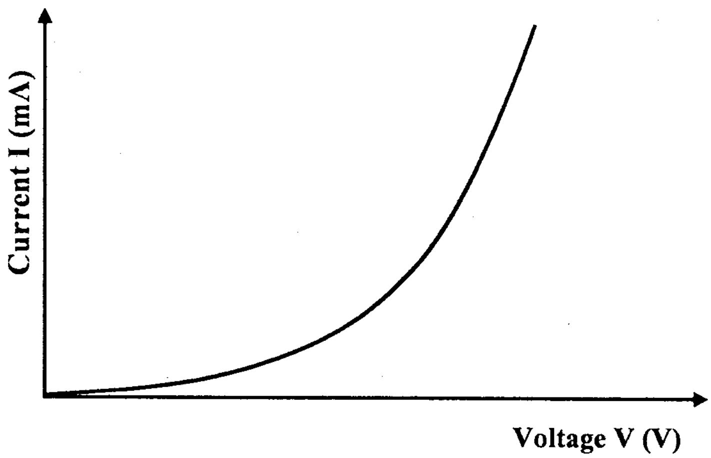


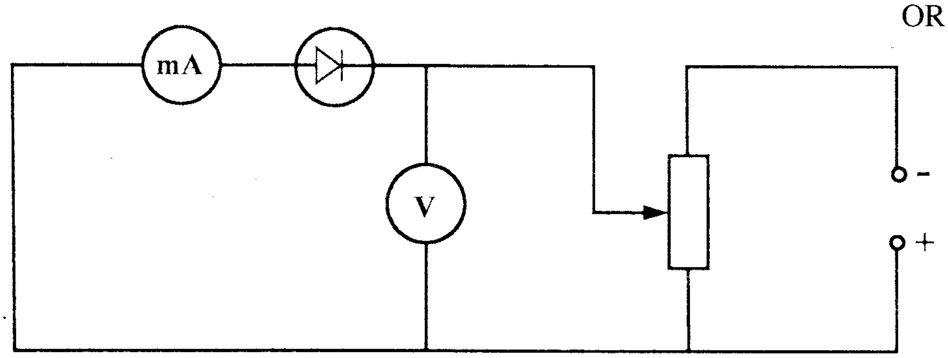
Figure 5

In the space provided, draw a circuit diagram that may be used to obtain values needed to draw the graph in **figure 5**. (3 marks)

Candidates were required to draw a circuit diagram showing how to derive forward biased diode characteristics.

Weakness
Some candidates did not bias the diode i.e failed to indicate the positive and negative terminals, some did not use conventional meter symbols and others did not include ammeter, or voltemeter. Many used a normal resistor in the place of a varying resistor.

Expected response



OR equivalent

Question11

The anode of an x-ray tube becomes hot when the tube is in use. State the reason for this. (1 mark)

Candidates were required to state the reason why heat is produced at the anode of an X ray tube. Most candidates are aware of how the x – ray tube operates but failed to link the heat energy to the kinetic energy of the electrons.

Expected response

It stops the fast moving electrons √ whose kinetic energy is converted to heat.

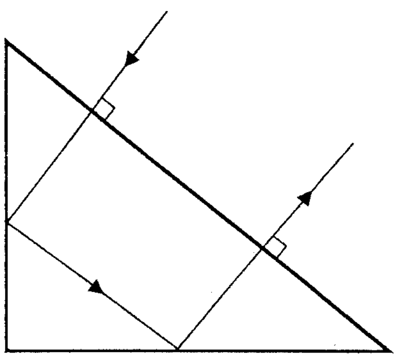
Question12

Draw a ray diagram to show how a ray of light may be totally internally reflected two times in an isosceles right - angled glass prism. (*Assume that the critical angle of glass is 42°*) (2 marks)

Weakness

Many candidates were not able to draw a right-angled glass prism in two dimensions. They were not able to have the incident ray on the hypotenuse for it to undergo internal reflection twice.

Expected response



1 mark for ray incident on hypotenuse

1 mark for showing two internal reflections

Question17

(a) **Figure 9** shows two speakers S_1 and S_2 which produce sound of the same frequency. They are placed equidistant from a line AB and a line PQ. (*PQ is perpendicular to line AB*).

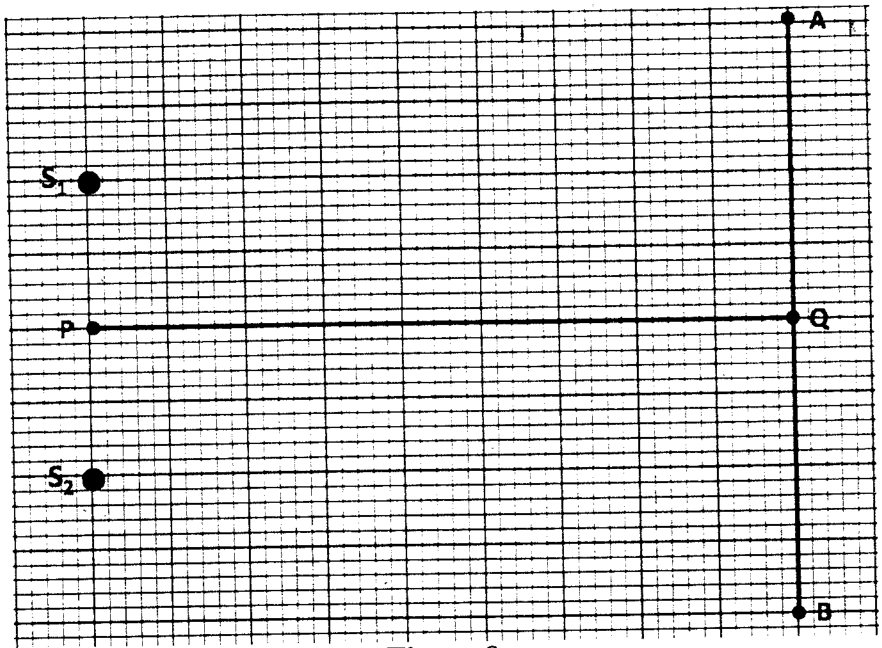


Figure 9

(i) A student walking from A to B hears alternating loud and soft sounds. Explain why at some point the sound heard is soft. (2 marks)

(ii) The student now walks along line PQ. State with reason the nature of the sound the student hears. (3 marks)

(b) **Figure 10** shows sound waves in air produced by a vibrating tuning fork. R is an air molecule on the path of the waves.

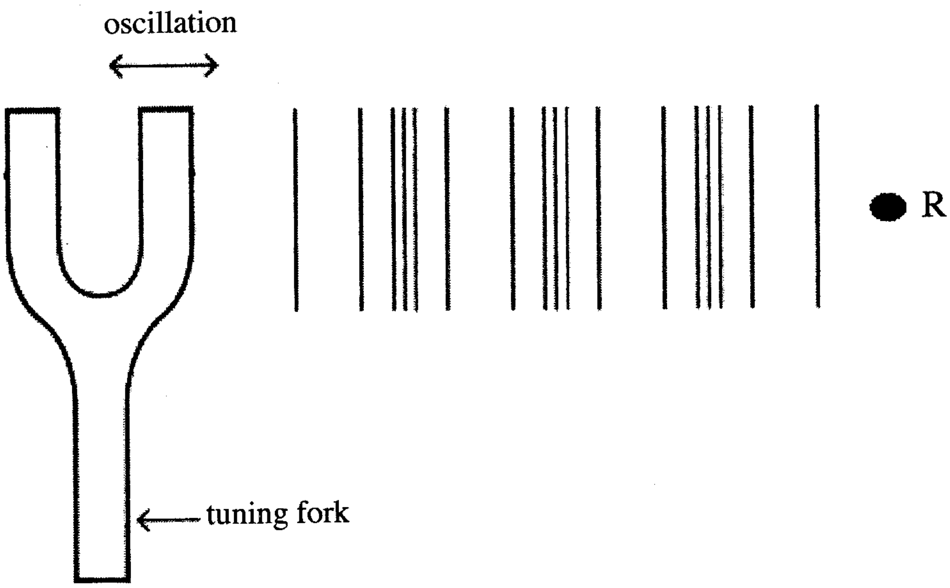


Figure 10

(i) Using a line, indicate on the diagram a distance **d** equal to one wavelength of the wave. (1 mark)

(ii) In the space provided, show with an arrow the direction of motion of the air molecule R as the waves pass. (1 mark)

This question was on the topic sound and required candidates to show knowledge of characteristics of sound waves, types of waves – longitudinal and transverse.

Weakness

Candidates lacked knowledge on the concept of waves being in phase or out of phase. Many candidates were not able to visualize the motion of a particle in the path of a longitudinal wave.

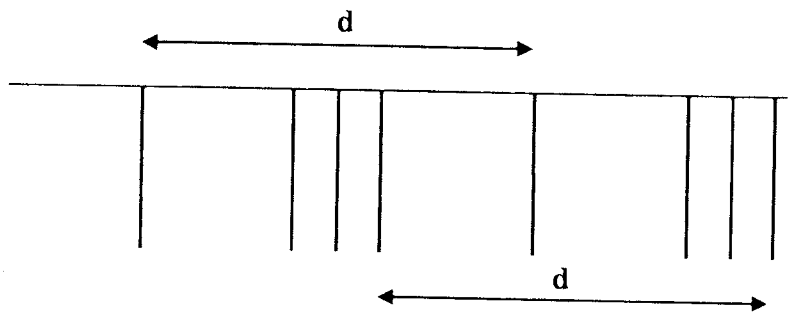
Expected response

(a) (i) (I) sound is soft when the waves arrive out of phase; √
such waves undergo destructive interference.

(ii) same sound - loud. √

- Along PQ the waves undergonconstructive intereference as they arrive in phase. √

(b) (i)



✓ -any correct d

(ii)

√

(iii) As the longitudinal waves pass √ molecule R moves along to either side.
For a crest, R moves away from source.

3.4.4 Physics Paper 3 (232/3)

In this practical paper some candidates seemed to have pre conceived results that could otherwise not be obtained from the outlined procedure. They obtained unrealistic readings in the tables.
However form the responses that were analyzed the following practical tasks were poorly performed.

Question 1 part B

(e) Set up the circuit shown in **Figure 2.** S and T are crocodile clips.

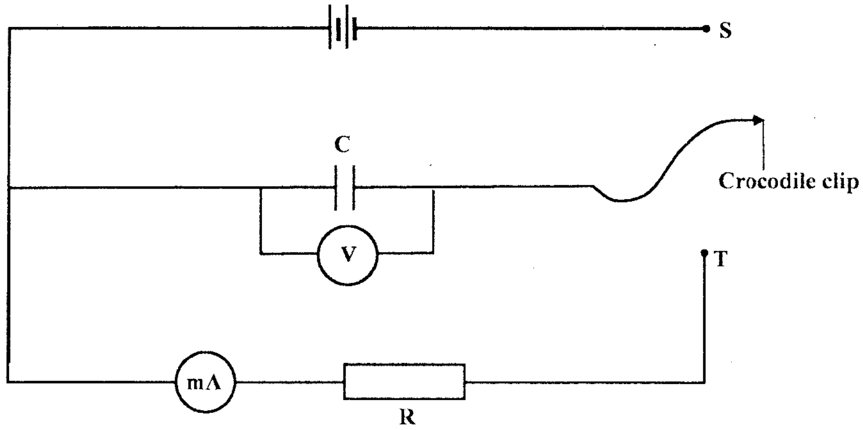


Figure 2

(i) Charge the capacitor **C** by connecting the crocodile clip to **S**. Record the reading of the voltmeter, **V**.

V = ______________________ (1 mark)

(ii) Calculate the value of the current I_0, given that $I_o = \frac{V}{R}$ (where $R = 4.7 \times 10^3\ \Omega$) (3 marks)

(f) (i) Discharge the capacitor by disconnecting the crocodile clip from **S** and connecting it to **T**. Observe and record the highest reading of the milliammeter I_1. (This is the current at $t_o = 0$).
(You may have to repeat the process to obtain an accurate value).

I_1 = ________________ (1 mark)

(ii) Recharge the capacitor by connecting the crocodile clip to **S**.

(iii) Discharge the capacitor and at the same time start the stop watch to measure the time $\mathbf{t_1}$ taken for the current to decrease to half the value of $\mathbf{I_1}$ i.e $\left(\frac{1}{2}I_1\right)$.

$\mathbf{t_1}$ = ____ (1 mark)

(g) (i) Recharge the capacitor and repeat the procedure in f(iii) to measure the time $\mathbf{t_2}$ taken for the current to decrease to one tenth of the value of $\mathbf{I_1}$ i.e $(\frac{1}{10}I_1)$.

$\mathbf{t_2}$ = ____________________

(1 mark)

(ii) Use the values of the currents $I_1, \frac{1}{2}I_1, \frac{1}{10}I_1$ and their corresponding times to draw a graph of current I (y axis) against time on the grid provided.

(3 marks)

Candidates were required to set up a circuit and charge a capacitor before they timed the discharging rates.

Weakness

Many candidates were not able to get the highest reading of the milliammeter in part f, and the subsequent readings. They were therefore not able to get the correct trend of the curve expected in g(ii)

Expected response

V = 3.1 volts ± 0.1

$$I_0 = \frac{V}{R} = \frac{3.1}{4.7 \# 10^3} \quad A$$

= 0.659 mA

(3 marks)

I_1 = 0.63 mA

For $\frac{I_1}{2}$

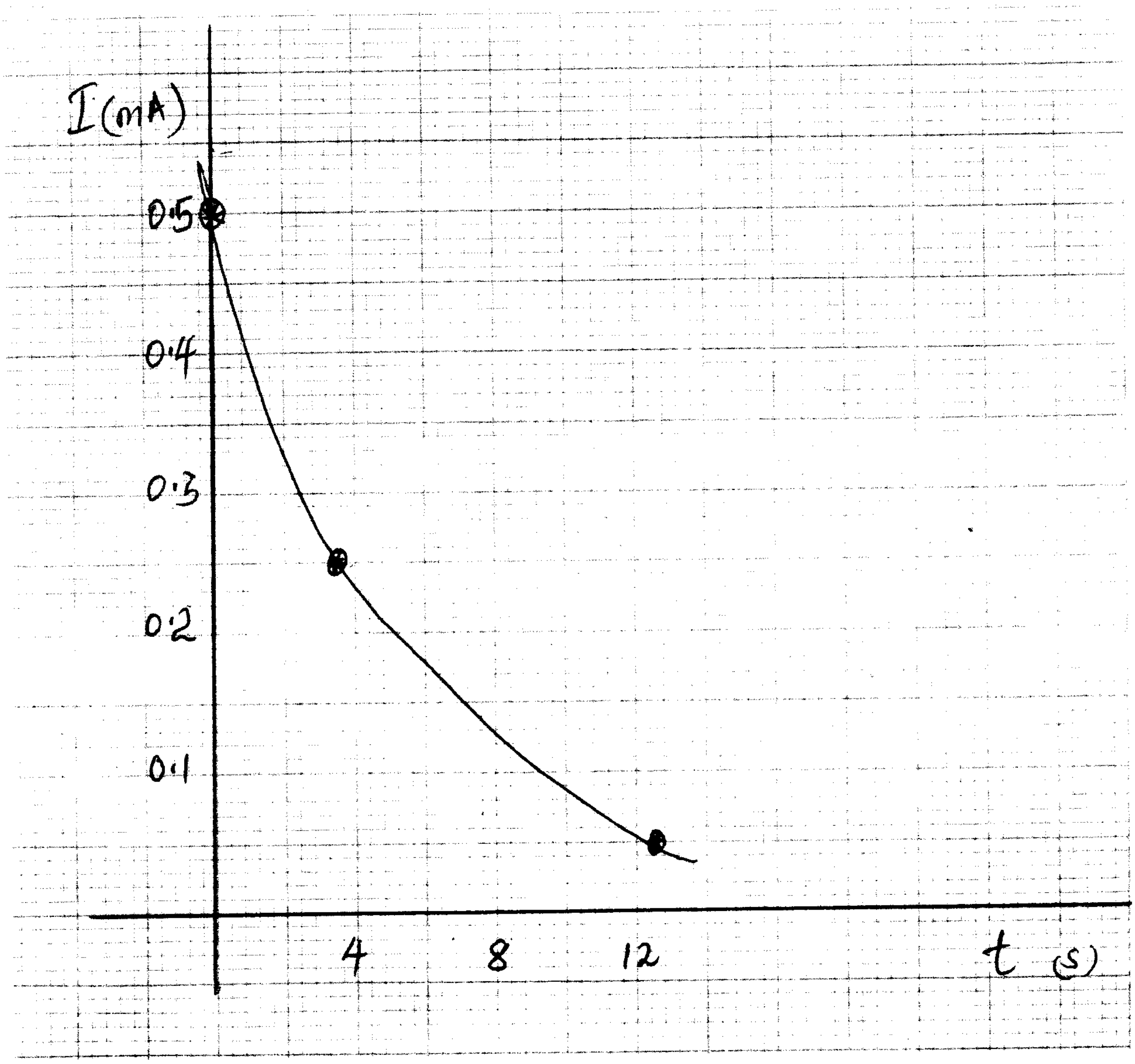
t_1 = 3.9 s

(1 mark)

For $\frac{I_1}{10}$

t_2 = 13.5 s (1 mark)

I	0.5	0.25	0.05
t	0	3.6	12.5



Question 2

You are provided with the following:

- a stand boss and clamp
- two wooden blocks
- a stopwatch
- a half metre rule or metre rule
- a mettallic rod
- a bare copper wire labelled **M** attached to a crocodile clip
- a bare copper wire labelled **N** attached to a crocodile clip.

Proceed as follows:

(a) Clamp wire **M** between the wooden blocks so that the length ***l*** of wire between the wooden blocks and the point of its attachment on the crocodile clip is 5 cm. Clamp the mettallic rod at its mid point using the crocodile clip attached to wire **M**. **(See figure 3)**

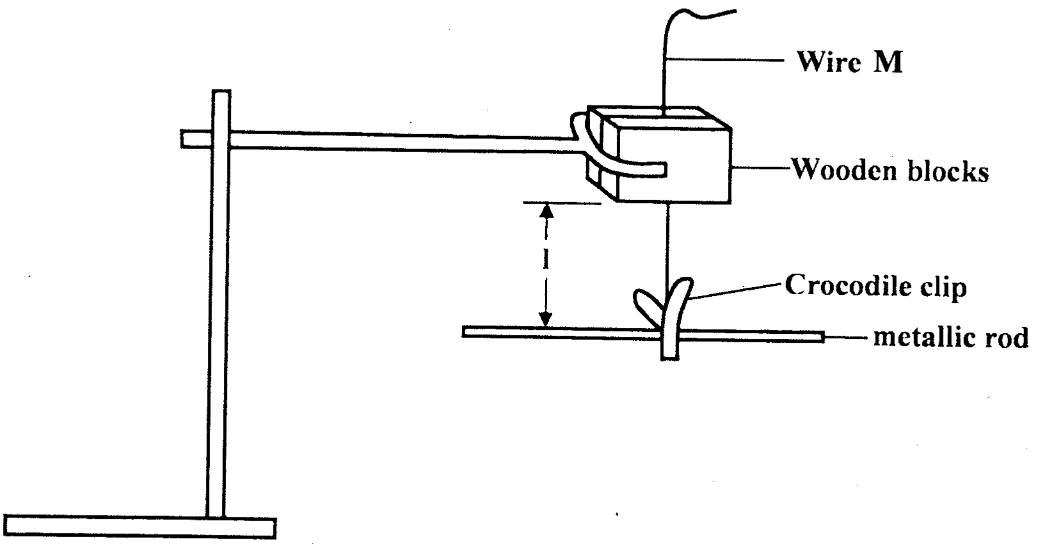


Figure 3

(b) Displace the rod through a small angle in a horizontal plane about its mid point so that when released, it oscillates in the same plane. Record the time t for 10 oscillations and determine the period **T** in **Table 1**.

(c) Repeat part (b) for the other lengths of wire **M** shown in **Table 1**.

(d) Complete **Table 1**. (6 marks)

Table 1

l (cm)	5	10	15	20	25	30
t (s)						
T (s)						
T^2 (s^2)						

(e) Plot a graph of ***l*** (y axis) against T^2. (5 marks)

(f) Determine the gradient of the graph, S. (3 marks)

(g) Now replace wire **M** with wire **N** in the set up.

(i) For l = 20 cm, displace the rod through a small angle in a horizontal plane and measure the time $\mathbf{t_N}$ for 10 oscillations.

$\mathbf{t_N}$ = ____________ (1 mark)

(ii) Determine the period $\mathbf{T_N}$ = ____________ (1 mark)

(iii) Calculate $\mathbf{T_N^2}$ (1 mark)

(iv) Determine the value of H given that $H = \frac{0.2}{T_N^2}$.

(1 mark)

(v) Calculate the value of $\frac{H}{S}$. (2 marks)

Candidates were required to measure the oscillations of a wire in a horizontal plane with varying heights of the supporting wire.

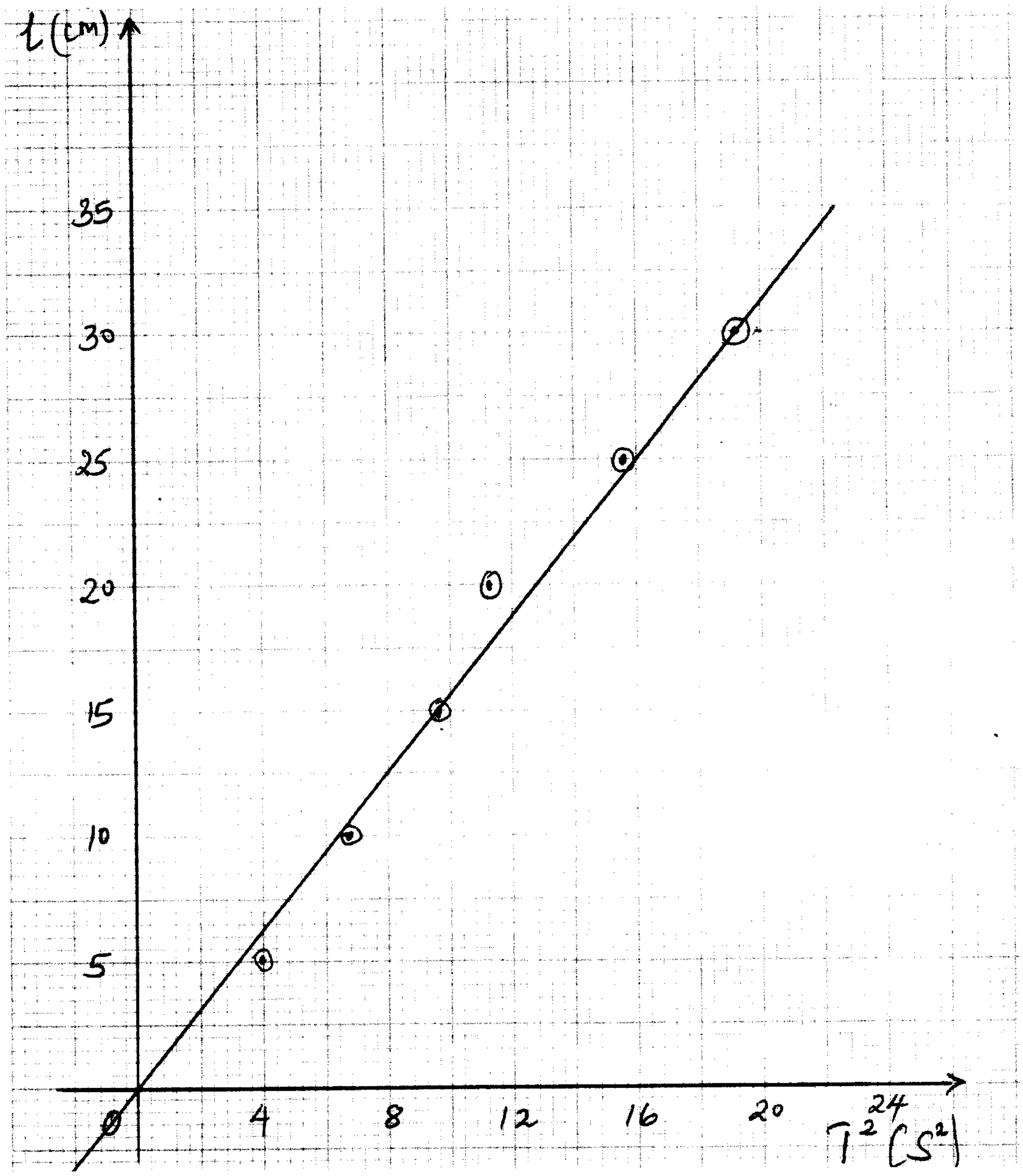
Weakness

Form the readings that were observed some candidates displaced the wire in a vertical plane and not the horizontal plane. Many candidates slacked knowledge on vertical and horizontal plane orientations.

Expected response

l (cm)	5	10	15	20	25	30
t (s)	20.1	26.3	31.2	33.0	39.6	43.4
T (s)	2.01	2.63	3.12	3.3	3.96	4.34
T^2 (S^2)	4.04	6.92	9.73	10.89	15.68	19.84

(e) Graph.



(f) Gradient $= \frac{20}{16}\ cm/s^2$

$= \frac{0.20}{16}\ cm/s^2$

$= 0.015625\ ms^{-2}$

(g) l_N = 20 cm = 0.2 m

(i) t_N = 52.0

(ii) T_N = 5.2

(iii) $T_N^2 = 27.04$

$$H = \frac{0.2}{27.04} = 0.007396$$

(iv) $$\frac{H}{S} = \frac{0.007396}{0.015625}$$

$$= 0.4737$$

ADVICE TO TEACHERS

- Candidates must be advised to follow instructions in the practical paper and use the recorded data appropriately.
- Practical lessons must be carried out as is required in the syllabus to have learners master the concepts.
- During teaching learners must be made to relate the concepts to real life experiences. The Physics behind every concept must be clearly explained during the teaching / learning process and key learning points emphasized.
- Logical analysis of concepts and critical thinking must be encouraged during the teaching / learning process.

The graph below shows clearly the performance trends in physics since 2006.