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 2016 to 2020

Year	Paper	Candidature	Maximum score	Mean score	Standard deviation
2016	1		80	32.49	19.3
	2		80	29.91	19.19
	3		40	17.15	6.56
	overall	**149,790**	**200**	**79.53**	**42.40**
2017	1		80	24.57	15.82
	2		80	26.22	18.22
	3		40	19.33	8.33
	overall	**160,182**	**200**	**70.09**	**39.59**
2018	1		80	22.98	14.87
	2		80	22.13	14.15
	3		40	19.43	8.5
	overall	**172,676**	**200**	**68.54**	**35.31**
2019	1		80	25.63	13.83
	2		80	20.43	14.28
	3		40	19.13	7.98
	overall	**184,559**	**200**	**65.18**	**33.96**
2020	1		80	21.58	12.96
	2		80	25.93	15.89
	3		40	23.55	9.04
	overall	**217,126**	**200**	**71.03**	**35.03**

From the table it can be observed that:

(i) The candidature increased to 217,126 in 2020 from 184,559 in 2019. This was an increase of 32, 567 candidates (17.64 %); the highest increase in Physics entries in the last 5 years.

(ii) There was a drop in the performance of paper 1 from a mean of 25.63 in the year 2019 to 21.58 in the year 2020. Paper 2 registered an improvement from a mean of 20.43 in 2019 to 25.93 in 2020. Paper 3 registered an improvement from a mean of 19.13 in 2019 to 23.55 in 2020 as shown in **table 1**.

(iii) The standard deviation in all the Physics papers is near normal. This shows proper discrimination between the high and low achievers.

(iv) The overall performance of physics improved from a mean of 65.18 in 2019 to 71.03 in 2020.

An analysis of the student's responses revealed that there is still lack of knowledge on comparative words that show the differences in the physical characteristics or behavior of materials. Application of the knowledge in the new tasks is challenging most candidates.
The following is a discussion of some of the questions in which candidates performed poorly.

3.4.1 Physics Paper 1 (232/1)

Question 5

Figure 3 shows a traditional stool resting on a level surface.

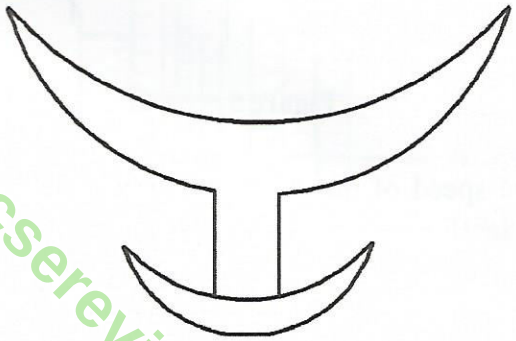


Figure 3

(a) Identify its state of equilibrium. (1 mark)
(b) State the reason for the answer in (a). (1 mark)

Candidates were expected to identify the state of equilibrium and explain why the state of equilibrium is as identified in part (a).

Weakness

Many Candidates were able to identify the state of equilibrium but failed to explain why the object was in the stable state of equilibrium.

Expected response

a) Stable equilibrium

b) Returns to original position after slight displacement.

Question 9

Figure 5 shows a roof of a house over which wind is blowing.

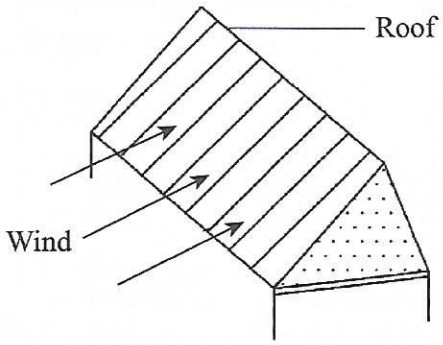


Figure 5

It was observed that, when the speed of the wind increased, the roof was blown off. Explain this observation. (2 marks)

Candidates were expected to explain why the roof is blown off when the speed of the wind blowing across the roof increases.

Weakness

Many candidates were not able to relate the blowing off to the reduced pressure above the roof caused by the increased speed.

Expected response

Due to the shape, the wind at the top moves at a higher speed creating a region of lower pressure at the top. The pressure difference between the top and the inside produces an upward force causing the roof to be blown off.

Question 13

An object placed on the surface of water in a beaker starts to sink immediately. It is observed that it stops sinking when half of its volume is below the water surface. State the reason for this observation. (1 mark)

Candidates were required to explain why an object starts sinking when placed in water but stops when half of it gets immersed.

Weakness

Some candidates failed to explain in terms of the upthrust.

Expected response

As it sinks upthrust increases and stops when the upthrust is equal to the weight of the object.

Question 16

(a) **Figure 11** shows a setup that can be used to verify Charles' Law.

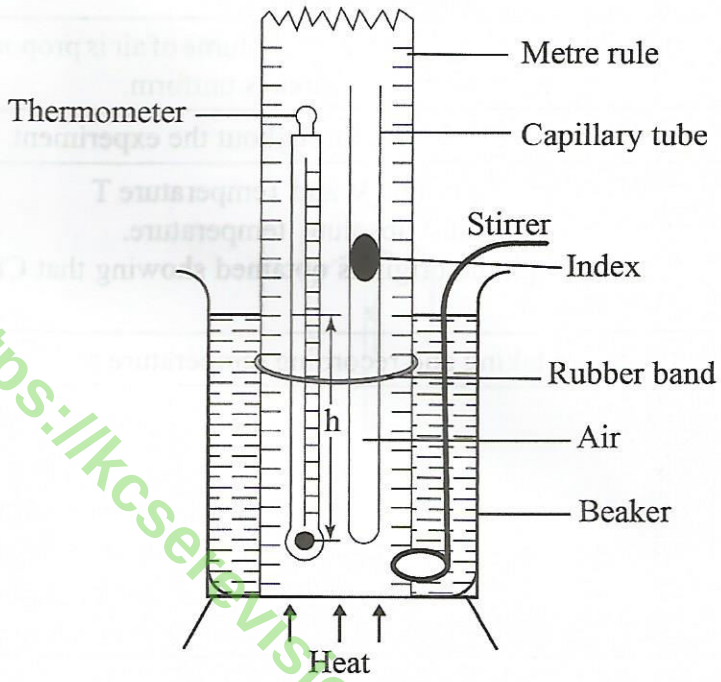


Figure 11

(i) Explain how the:

I. temperature of air in the tube is measured; (2 marks)

II. volume of air in the tube is measured. (2 marks)

(ii) State how the pressure is kept constant during the experiment. (1 mark)

(iii) State how the measurements in (i) can be used to verify Charles' law. (3 marks)

(iv) State **one** precaution that must be taken to ensure that the temperature of air is accurately measured. (1 mark)

(b) A fixed mass of gas initially at 20 °C is heated at constant pressure until its volume doubles. Determine its final temperature. (4 marks)

Candidates were required to study the diagram and describe how the set up could be used to verify Charles law, stating how the measurements are taken and utilized in the experiment.

Weakness

Some candidates failed to relate the measurement of the volume to the height of the air column. Many were not able to state the precaution taken in the experiment. Some candidates had a challenge visualizing the doubled volume without quantitated values.

Expected response

(a)	(i)	By measuring the temperature of water since the temperature of air is equal to that of water.	2
	(ii)	By measuring the length of the air column. Volume of air is proportional to the length since the cross-sectional area is uniform.	2
	(iii)	Keeping the tube verticle and open throughout the experiment.	1
	(iv)	– Obtain several values of volume V and Temperature T -Plot a graph of volume against absolute temperature. - A straight line through the origin is obtained showing that Charles' law is obeyed.	3
	(v)	Stirring water before taking and recording temperature and volume.	1
(b)		$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $V_2 = 2V_1$ $T_2 = \frac{2V_1}{V_1}(20+273) = 586K$	3

Question 17

(a) **Figure 12** shows a simple machine.

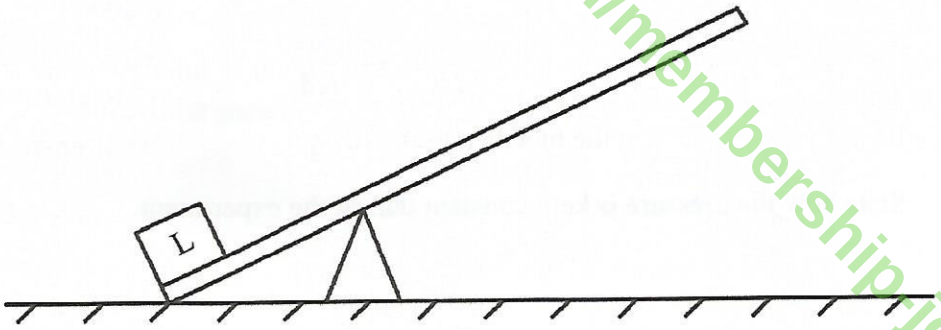


Figure 12

On the same figure, mark and label the following parts:

(i) Effort arm (1 mark)

(ii) Load arm (1 mark)

(b) Figure 13 shows a pulley system used to raise a mass of 5 kg through a height of 2 m when a force of 60 N is applied. (*Acceleration due to gravity g is* 10 ms^{-2})

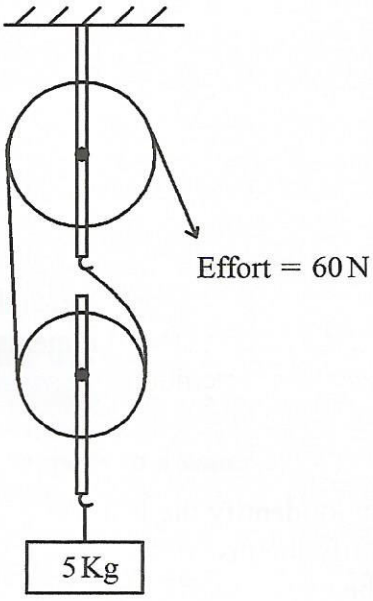


Figure 13

Determine the:

(i) Distance moved by the effort (1 mark)

(ii) work done on the Load (3 marks)

(iii) Potential energy gained by the load ($g = 10\ Nkg^{-1}$) (1marks)

(c) **Figure 14** shows a setup that can be used to determine the specific latent heat of vaporisation of water. A beaker containing some water was placed on a weighing balance and an immersion heater rated 500 W immersed in the water.

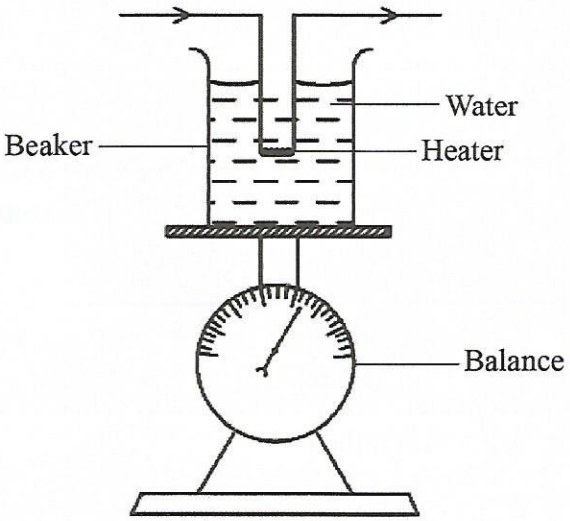


Figure 14

The water was then heated until it boiled. When the water started boiling, the initial reading on the balance was noted and the stopwatch started immediately. The final reading on the balance was then noted after a time t seconds.

(i) State how the mass of steam can be measured using this setup. (1 mark)
(ii) Write down an expression for the heat supplied by the heater. (1 mark)

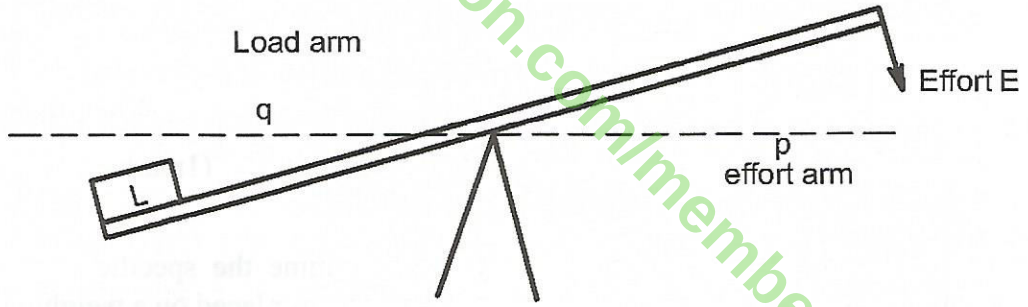
(iii) Determine the specific latent heat of vaporization of water. (3marks)

Candidates were required to identify the load and effort and solve numerical problems on machines. In part (c) the candidates were required to state measurements done when determining the specific latent heat of vaporization using the electrical method.

Weakness

Many candidates were not able to identify the load and arm in the crowbar like set up. In the pulley system they also failed to identify the distance moved by the effort. Many candidates failed to state how the mass of steam could be measured in the set up. Many were unable to determine the specific latent heat of vaporization.

Expected response

1. (a)		2
(b)	(i) Effort distance = 2 load distance = 2 x 2 = 4m	1
	(ii) Work done F × d = 5 × 10 × 2 = 100J	3
	(iii) PE = Work done = 100J	1
(c)	(i) Obtain the difference between the initial reading of the balance and the final reading of the balance. (Mass = (Initial reading of the balances – Final reading at the)	1
	(ii) E = 500t	1

	(iii) Heat supplied = Heat gained by steam $500t = ML_v$ $L_v = \frac{500t}{m}$ Jkg^{-1}	3

3.4.3 Physics Paper 2 (232/2)

Question 4

Explain what happens to the speed of a water wave as it moves from the shallow to the deep end in a ripple tank. (2 marks)

Candidates were required to explain what happens to a water wave as it moves from shallow end to the deep end in a ripple tank.

Weakness

Many students were unable to relate the increased speed to the increased wavelength, some failed to state that the frequency remains constant.

Expected response

From the relation $v = \lambda f$, the speed increases √ since the wavelength λ increases but the frequency is the same because source is the same√

Question 8

When iron filings are sprinkled onto a bar magnet, it is observed that there are more iron filings at the ends than in the middle. Explain this observation.

Candidates were required to explain the cause of a stronger magnetic field at the ends of a magnet.

Weakness

Many students failed to relate the magnetic force to the presence of the field lines.

Expected response

There is greater√ magnetic force at the ends due to increased√ field lines at the ends of the bar magnet than at the center of the bar magnet.

Question 14

(a) State two ways minimizing power losses during transmission of electric power. (1 mark)

(b) An electric cooker is rated 2.5 kW, 250 V state the meaning of these values. (1mark)

(c) A consumer has the following appliances in the house:

–An electric iron rated 1500 W
–A water heater rated 500 W
–An electric cooker rated 2500 W
–Three bulbs each rated 60 W.

The house is fitted with a fuse determine:

(i) whether the consumer can connect all the appliances to the 240 V power supply at the same time; (4 marks)

(ii) the resistance of the heating element used in the electric cooker. (3 marks)

Candidates were required to state ways of minimizing power losses during the transmission of electric power and solve numerical problems involving electric power.

Weakness

Some candidates were not able to state the ways of reducing power losses during transmission. Many students were not able to solve the numerical problems on electric power. Some failed to get the total power produced by the listed appliances.

Expected response

14.	(a) – Stepping up the voltage – Use of good conductor cables	(1mark)
	(b) The electric cooker has a power output of 2500W, and operates at a potential 250V, ie P=VI	(1 mark)
	(c) Total power = $1500+2500+500+(60\times3)$ $=4680$ W√ Total current required = $\frac{4680}{240}=19.5A$ √ Hence fuse blows and disconnects the current when it exceeds 10 A√ ie all appliances can't be connected at the same time. √	(4 marks)

	(ii) $V = IR$ √ $I = \frac{p}{v}$ $= \frac{2500}{240}$ R= $240 \div \left(\frac{2500}{240}\right)$ √ $= \frac{240 \times 240}{2500}$ $= 23.04\Omega$ √	3 marks

3.4.4 Physics Paper 3 (232/3)

In this practical paper many candidates displayed knowledge of the apparatus and mastery of experimental procedure. The accuracy of the apparatus used continues to be a challenge for many candidates. Interpretation of results in the correct significant figures need to be emphasized.

However, from the responses that were analyzed the following practical tasks were poorly performed.

Question 2

You are provided with the following:

– a metre rule;

– a biconvex lens;

– a source of light (bulb in a bulb holder, cells in a cell holder and a switch);

– a stand boss and clamp;

– a lens holder;

– a screen;

– a half metre rule;

– three pieces of plastic pipes A, B and C;

– a vernier callipers (to be shared);

– a stopwatch;

– some plasticine.

Proceed as follows:

PART A

(a) Clamp the bulb holder onto the stand. Arrange the bulb, the lens and the screen along the metre rule as shown in **Figure 2**.

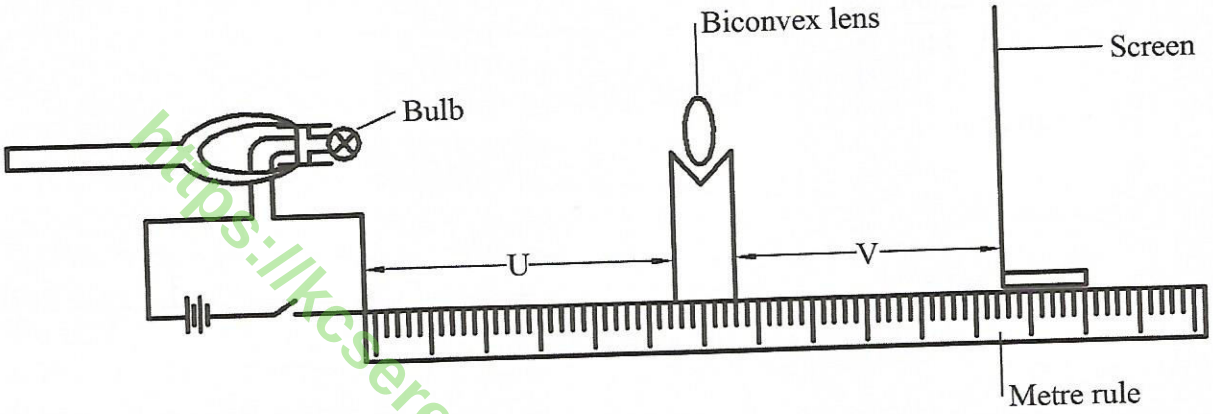


Figure 2

(b) Adjust the distance of the bulb from the lens to U = 25 cm. Put on the switch and adjust the position of the screen from the lens so that a sharp image of the bulb is observed. Record the distance V between the screen and the lens in **Table 2**.

(c) Repeat part (b) for the other values of U shown in **Table 2**. Complete the table. (7 marks)

Table 2

U cm	25	30	35
V cm			
$M = \frac{V}{U}$			
$F = \frac{V}{M+1}$			

(d) Determine the average value of F. (2 marks)

PART B

(e) Using the vernier callipers measure and record the diameters of the three pipes.

d_A, d_B and d_C

d_A = ... cm ..... m (1 mark)

d_B = ... cm ..... m (1 mark)

d_C = ... cm ..... m (1 mark)

(f) Measure and record the thickness X of the half metre rule.

X = ... cm ..... m (1 mark)

(g) From the graph, determine the:

(i) gradient S; (3 marks)

(ii) intercept C on the $\frac{1}{I}$ axis. (1 mark)

(h) Given that:

(i) $\frac{4K_1}{\pi d^2 E} = S$ determine the value of K_1. (2 marks)

(ii) $\frac{K_2}{E} = C$ determine the value of K_2. (1 mark)

(g) Place the pipe marked A on the bench and use the plasticine to stop it from rolling. **(see Figure 3 (a)).**

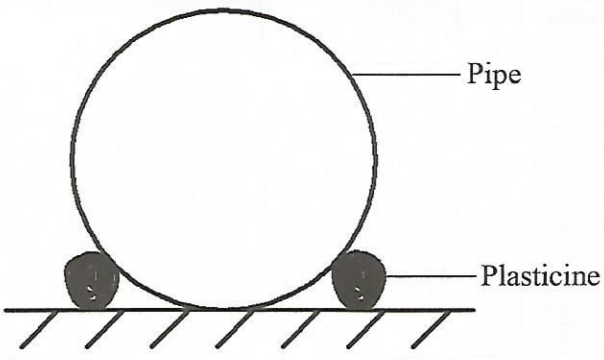


Figure 3 (a)

(h) Place the half metre rule onto the pipe such that it balances horizontally. Ensure that the half metre rule is perpendicular to the axis of the pipe.
(see Figure 3 (b)).

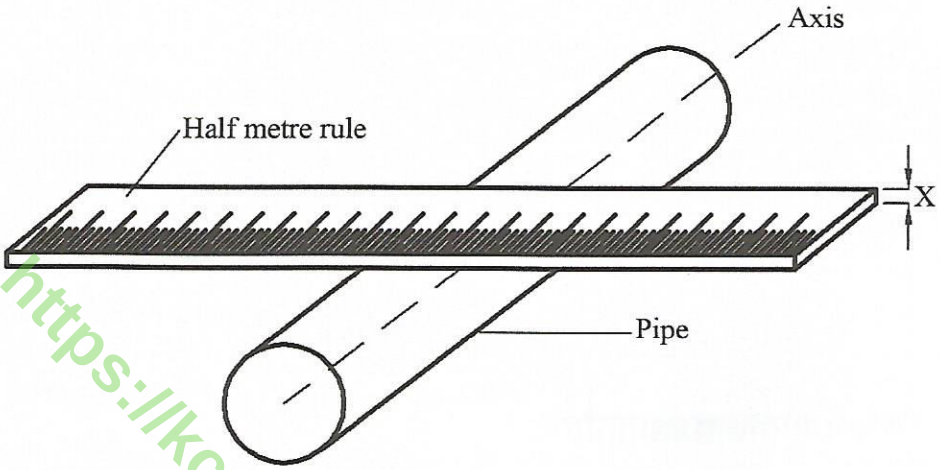


Figure 3 (b)

(i) Push one end of the balanced half metre rule slightly downwards and release it so that it oscillates up and down. Measure and record in **Table 3** the time for five complete oscillations.

(j) Repeat the procedure in (g), (h) and (i) for the other pipes B and C. Complete **Table 3.**

(5 marks)

Table 3

	Pipe A	**Pipe B**	**Pipe C**
Diameter d (m)			
Time for five oscillations			
Periodic time T (s)			
$Z = T\sqrt{\frac{3(d-x)}{2}}$			

(k) Determine the average value of Z. (2 marks)

Candidates were required to assemble apparatus, take measurements accurately and manipulate the data to the required values.

Weaknesses

Many candidates indicated wrong readings from the measuring instruments, failed to write down the values in the expected units of the measuring instrument and failed to work with the correct significant figures and units.

Expected response

<table>
<tr><td>c)</td><td>(i) Table 2
<table>
<tr><td>U(m)</td><td>25</td><td>30</td><td>35</td><td></td></tr>
<tr><td>V (cm)</td><td>48</td><td>38.8</td><td>32.5</td><td>3 marks</td></tr>
<tr><td>$m = v/u$</td><td>0.93</td><td>1.299</td><td>1.92</td><td>2 marks</td></tr>
<tr><td>$f = v/m+1$</td><td>16.43</td><td>16.94</td><td>16.84</td><td>2 marks</td></tr>
</table></td><td>7 marks</td></tr>
<tr><td>d</td><td>F(average) $= \frac{16.43+16.94+16.84}{3}$ √
$= 16.74\text{cm}$ √</td><td>(2 marks)</td></tr>
<tr><td></td><td>PART B</td><td></td></tr>
<tr><td>e</td><td>$d_A = 3.40cm = 3.4\times10^{-2}m$</td><td>1 mark</td></tr>
<tr><td></td><td>$d_B = 4.33cm = 4.33\times10^{-2}m$</td><td>1 mark</td></tr>
<tr><td></td><td>$d_c = 5.70\text{cm} = 5.70\times10^{-2}m$</td><td>1 mark</td></tr>
<tr><td>F</td><td>X = 0.52 $= 5.2\times10^{-3}m$</td><td>1 mark</td></tr>
<tr><td>j</td><td>
<table>
<tr><td></td><td>Pipe A</td><td>Pipe B</td><td>Pipe C</td></tr>
<tr><td>Diameter of pipe d(m)</td><td>0.034</td><td>0.0433</td><td>0.0570</td></tr>
<tr><td>Time for five oscillations</td><td>13.57</td><td>11.11</td><td>10.24</td></tr>
<tr><td>Periodic time</td><td>2.71</td><td>2.22</td><td>2.05</td></tr>
<tr><td>$Z = \sqrt[T]{\frac{3(d-x)}{2}}$</td><td>0.56</td><td>0.53</td><td>0.57</td></tr>
</table>
Z average $= \frac{0.56+0.53+0.57}{3}$ √
$= 0.55\text{m}$√</td><td>5 marks

2 marks</td></tr>
</table>

ADVICE TO TEACHERS

- There should be emphasis on use of key words in given concepts and proper explanation of the physics behind the concepts.
- Candidates should be advised to follow the procedure during practical examinations and use their results appropriately.
- Practical lessons must be carried out as is required in the syllabus to have learners master the concepts.
- Logical analysis of concepts and critical thinking must be encouraged during the teaching / learning process.