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).

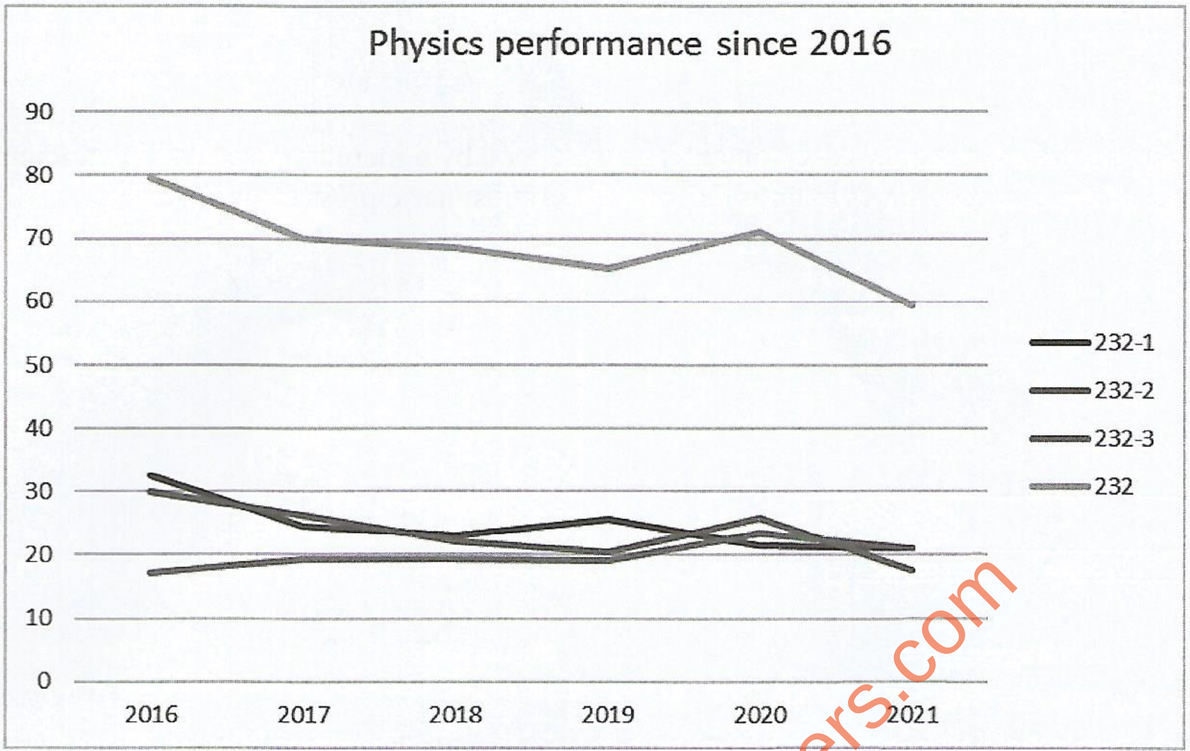
3.4.1 General Candidates' Performance

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

***Table 10**: Candidates' overall performance in the years 2016 to 2021.*

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**
2021	1		80	21.12	16.28
	2		80	17.59	11.21
	3		40	21.00	08.29
	overall	**253,922**	**200**	**59.39**	**33.00**

The chart below shows a summary of the trend in Physics for the last six years.



From the table and chart, it can be observed that:

(i) The candidature increased to 253,963 in 2021 from 217,126 in 2020. This was an increase of 36, 837 candidates (16.96 %).

(ii) There was a drop in the performance of Physics in all the three papers with the overall performance dropping to a mean of **59.39** in 2021 as compared to **71.03** in 2019.

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

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 3

Figure 3(a) shows a horizontal tube containing air trapped by a mercury thread of length 5cm. The length of the enclosed air column is 7.5 cm. The atmospheric pressure is 76 cmHg.

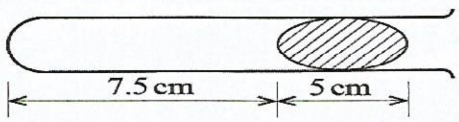


Figure 3(a)

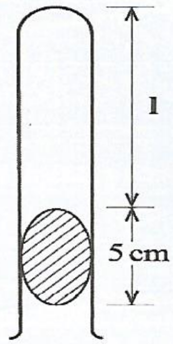


Figure 3(b)

The tube is then turned vertically with its mouth facing down as shown in **Figure 3(b).**

(a) Determine the length l of the air column. (3 marks)

(b) State the reason why the mercury thread did **not** fall out in **Figure 3(b).** (1 mark)

Candidates were expected to have understanding of Boyle's law, relate length to volume and find the total gas pressure with a horizontal and an inverted tube.

Weakness

Many learners failed to relate the pressure to the length of the gas in the tube.

Expected response

(a) $P_1 l_1 = P_2 l_2$ $76 x 7.5 = (76-5) x l_2$ $l_2 = 8.028$ cm	3
(b) Atmospheric pressure is greater than the pressure due to the mercury thread.	1

Question 13

Figure 8 shows two pieces of ice A and B trapped using a wire gauze in a large beaker containing water.

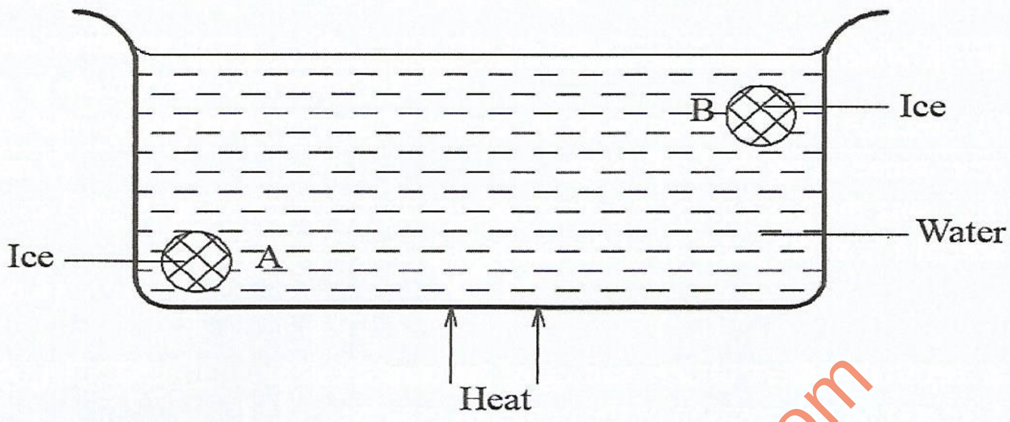


Figure 8

Heat is supplied at the centre of the base of the beaker as shown. State the reason why B melted earlier than A. (1 mark)

Candidates were expected to state the reason why heat moves to be B faster than to A causing B to melt faster.

Weakness

Many candidates failed to relate the transfer of heat to the convectional currents of the water particles.

Expected response

Hot water rises up due to lower density to heat ice B before which heats up before A due to convection. 1

Question 19

(a) State **two** conditions necessary for a body to be in equilibrium. (2 marks)

(b) **Figure 13** shows a non-uniform log of wood AB of length 4 m. The log is held horizontally by applying forces of 80 N at end A and 120 N at end B.

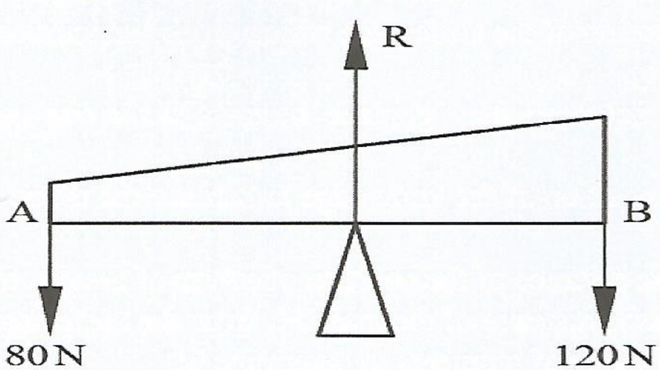


Figure 13

Determine:

(i) the value of R. (1 mark)

(ii) the position of the centre of gravity of the log from end B. (3 marks)

(c) You are provided with a metre rule, a knife edge and a mass m_1.

(i) Describe how the position of the centre of gravity of the metre rule can be determined using the knife edge. (2 marks)

(ii) Using the position of the centre of gravity determined in 19(c)(i) and the mass m_1, describe how the mass M of the metre rule can be determined. (4 marks)

Candidates were required to show understanding of the conditions of equilibrium, apply the principle of moments and determine the position of the center of gravity.

Weakness

Many candidates were unable to state the conditions of equilibrium, and to determine the center of gravity of the knife edge.

Expected response

(a)	- The sum of forces in one direction is equal to the sum of the forces in the opposite direction. - The sum of clockwise moments about a point is equal to the sum of anticlockwise moments about the same point.	2
(b)	(i) R= 80 + 120 = 200N (ii) Taking moments about B, Sum of clockwise moments = sum of anti-clokwise moments 200 x x = 80 x 4 $x = \frac{80x4}{200}$ = 1.6 m	1 3
(c)	(i) – Place the metre rule on the knife edge and adjust it until it balances. - Mark the position of the knife edge which gives the position of the centre of gravity. (ii) - With the rule balanced at c.o.g. place the mass M_1 on one side of the knife edge. - Adjust the position of the knife edge to balance the metre rule with the mass. - Measure the distance of the position of centre of gravity from the knife edge and the distance of the mass M_1 from the knife edge. - Use the principle of moments to determine M.	2 4

3.4.3 Physics Paper 2 (232/2)

Question 6

Figure 4 shows a current carrying conductor placed between the poles of two magnets. (*The direction of the current is into the paper*).

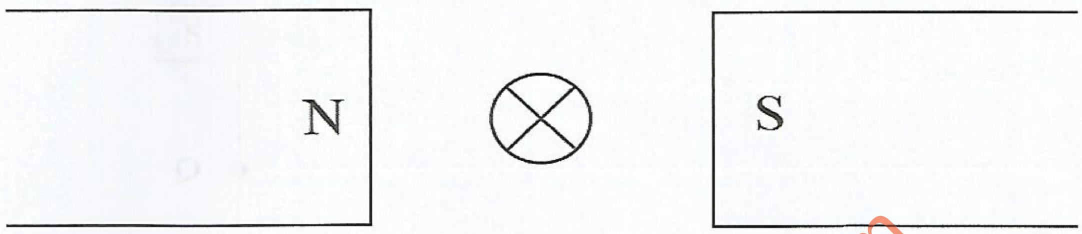


Figure 4

Sketch the magnetic field produced between the conductor and the poles of the magnets.

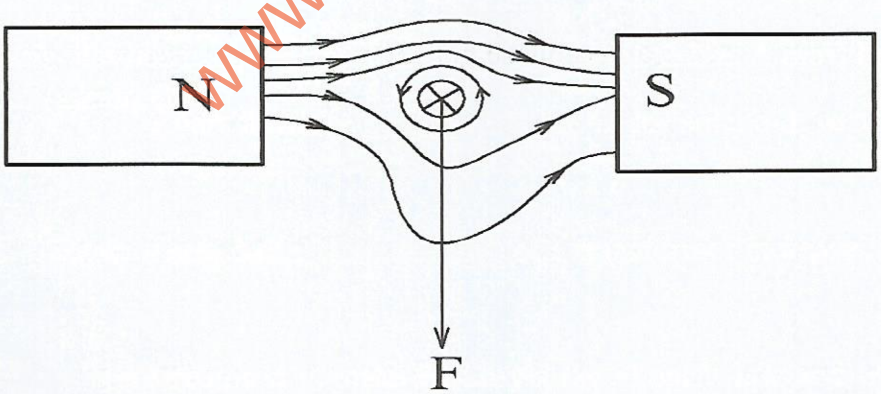
(2 marks)

Candidates were required to sketch the magnetic field pattern to show how the field due to current carrying conductor interacts with the field due to the magnets.

Weakness

Many candidates omitted the field around the conductor carrying current and missed the effect of the two fields causing a force. Many missed the direction of the magnetic field and the spacing between the field lines.

Expected response



- Direction of field
- Pattern

2 marks

Question 7

Figure 5 shows two coherent sources of sound A and B in phase. O is a point equidistant from A and B.

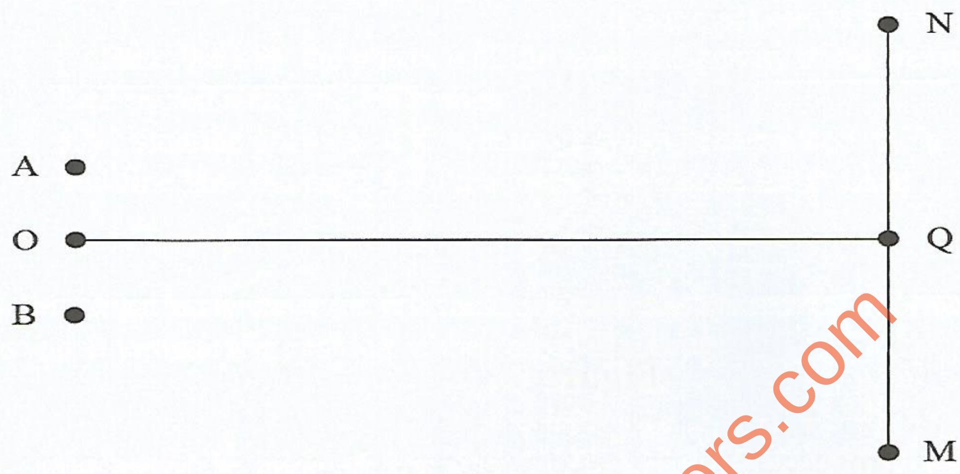


Figure 5

An observer moves from M to N through Q. Explain what is observed at point Q. (3 marks)

Candidates were required to explain how the sound waves interfere at point Q.

Weakness

Some candidates confused between destructive and constructive interference. Some used terms like fringes which are not applicable to sound.

Expected response

Loud sound is heard at Q. Sound from A and B are in phase hence interfere constructively since they arrive at Q at the same time. (3 marks)

Question 16

(a) State Faraday's law of electromagnetic induction. (1 mark)

(b) **Figure 12** shows a bar magnet being moved towards a solenoid. The solenoid is connected to a galvanometer.

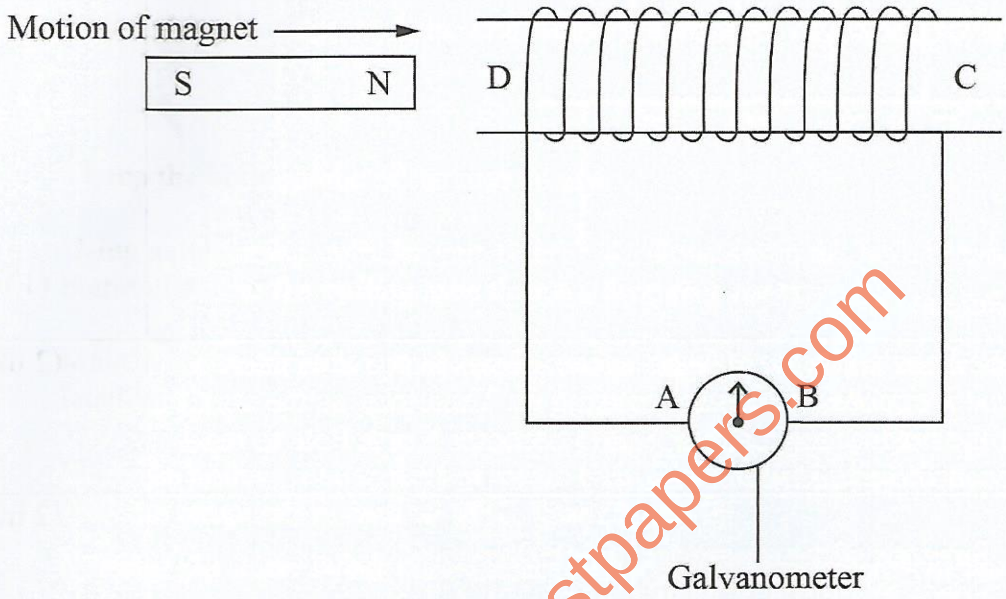


Figure 12

(i) Indicate on the diagram the direction of the induced current in the solenoid. (1 mark)

(ii) Identify the pole induced at D. (1 mark)

(iii) Explain the answer in 16(b)(ii). (2 marks)

(iv) Apart from the number of turns in the solenoid, state **two** factors affecting the magnitude of the induced current. (2 marks)

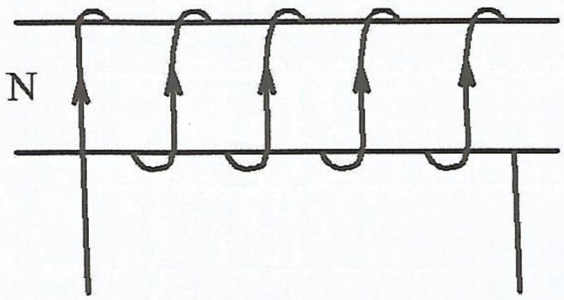
(c) Explain how laminating the core of a transformer increases its efficiency. (2 marks)

Candidates were required to state Faraday's law, Lenz's law and use it to identify the direction of induced current and to explain how the polarity of a point is determined. They were required to explain how laminating the core increases the efficiency of a transformer.

Weakness

Many candidates were unable to distinguish between emf and current. Some confused between electromagnetic induction and magnetic effect of current while others confused between hysteresis and lamination.

Expected response

a)	The magnitude of the induced e.m.f is directly proportional to the rate of change of the magnetic flux linkage	(1 mark)
b) (i)		(1 mark)
(ii)	North Pole at D	(1 mark)
(iii)	From the Lenz's law the induced current flows in the direction Such that it opposes the change causing it. Therefore, as the north pole of the magnet approaches, end D becomes North Pole to repel the approaching North Pole	(2 marks)
(iv)	– Strength of the magnet/magnetic flux – Speed of motion of the magnet	(2 marks)
c)	Lamination increases the resistance of the core hence resistance to the flow of eddy current. This reduces heating effect thus efficiency increases	(2 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 1
You are provided with the following:
1. A thermometer
2. A boiling tube
3. A retort stand, boss and clamp
4. A weighing balance (*to be shared*)
5. A watch glass
6. A measuring cylinder
7. A beaker labelled **X**
8. A metre rule
9. An optical pin mounted on a cork
10. Water in a beaker
11. A liquid **L** in a beaker labelled **L**

12 A plane mirror
13. A stopwatch
14. Tissue paper
15. A piece of manila paper with a hole in the middle (***paper cover***)
16. Boiling water (*to be provided*)

Proceed as follows:

PART A

(a) Using the weighing balance, measure and record the mass M_b of the boiling tube in grammes.

M_b = ... g. (1 mark)

(b) (i) Clamp the boiling tube in the retort stand.

(ii) Using a measuring cylinder, put 40 cm^3 of cold water in the boiling tube and insert the thermometer in the boiling tube through the paper cover.

(iii) Make a hot water bath by putting approximately 500 ml of hot water into the beaker labelled **X**.

(c) (i) Place the boiling tube in the hot water. Using the thermometer, stir the water in the tube until the temperature rises to 48°C. (See **Figure 1**)

(***Ensure the water in the tube mixes properly to be at the same temperature***)

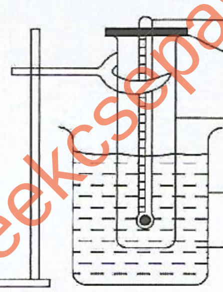


Figure 1

(ii) With the boiling tube still clamped in the stand, remove the hot water bath. Let the water in the boiling tube cool as you stir throughout using the thermometer.

(iii) Immediately the temperature falls to 46°C start the stopwatch and record the time in seconds when the temperature falls to the values shown in **Table 1**.

HINT:
The time recorded is cumulative and the stopwatch should not be stopped until the time at the last temperature (40°C) is recorded.
Stirring the water in the tube should also be continuous.

Table 1 (Water) (3 marks)

Temperature (°C)	46	45	44	43	42	41	40
Time (s)	0						

(d) (i) Pour out the water from the boiling tube and use some tissue paper to wipe out the water in the tube. Use the measuring cylinder to put 40 cm^3 of liquid **L** in the boiling tube.

(ii) Repeat part c(i), (ii) and (iii) using liquid **L** in place of water and record the results in the **Table 2**.

Table 2 (Liquid L) (3 marks)

Temperature (°C)	46	45	44	43	42	41	40
Time (s)	0						

(e) Use the results to determine:

(i) time T_1 taken by the water to cool from 45°C to 40°C

T_1 = ... seconds (1 mark)

(ii) time T_2 taken by liquid **L** to cool from 45°C to 40°C

T_2 .... seconds (1 mark)

(iii) constant K given that $K = \frac{T_2}{T_1}$ (1 mark)

(f) Given that the densities of liquid **L** and water are 0.8 gcm^{-3} and 1.0 gcm^{-3} respectively determine the:

(i) mass M_L of liquid **L**. (2 marks)

(ii) mass M_w of water. (1 mark)

(g) Use the results to determine the constant **C** given that

$K(84M_b + 420M_w) = 84M_b + 100M_L$ **C** (2 marks)

PART B

(h) (i) Place the watch glass on the plane mirror on the bench.

(ii) Clamp the optical pin horizontally in the retort stand such that its tip is vertically above the pole of the watch glass.

(iii) Put a little water into the watch glass. Adjust the height h of the pin above the mirror until it coincides with its inverted image tip to tip. (*check for parallax to confirm).* See **Figure 2**.

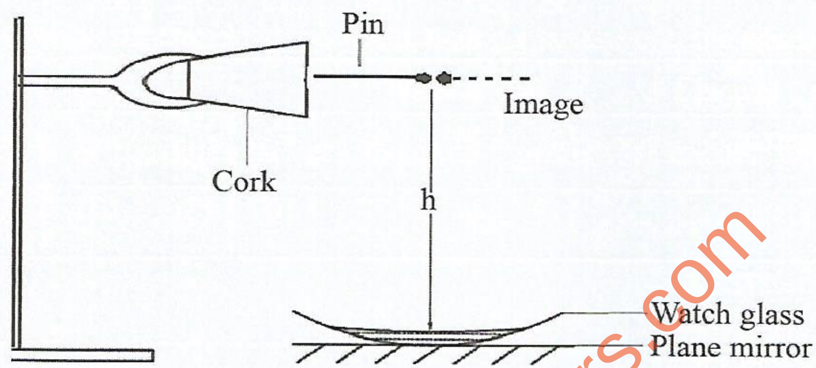


Figure 2

(iv) Measure the height h_1 of the pin above the mirror.

h_1 = ... cm (1 mark)

(v) Determine r given that $r = \frac{h_1}{3}$ (1 mark)

(i) Pour out the water and wipe the watch glass dry. Repeat part h(iii) using liquid **L** instead of water.

(i) Measure and record the height h_2 of the pin above the mirror.

h_2 = ... cm (1 mark)

(ii) Determine Z given that, $Z = \frac{h_2 + r}{h_2}$ (2 marks)

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

PART A

1. a)	M_b=29.3 ± 2 g (*may vary*)	**(1 mark)**
b) (iii)	**Table 1 (water)** (6x $\frac{1}{2}$ marks) <table><tr><td>Temperature (C°)</td><td>46</td><td>45</td><td>44</td><td>43</td><td>42</td><td>41</td><td>40</td></tr><tr><td>Time (s/seconds))</td><td>0</td><td>55</td><td>95</td><td>151</td><td>211</td><td>259</td><td>327</td></tr></table>	**(3 marks)**
d	**Table 2 (Liquid L)** (6x $\frac{1}{2}$ marks) <table><tr><td>Temperature (C°)</td><td>4 6</td><td>45</td><td>44</td><td>43</td><td>42</td><td>41</td><td>40</td></tr><tr><td>Time (s))</td><td>0</td><td>119</td><td>44</td><td>77</td><td>107</td><td>136</td><td>173</td></tr></table>	**(3 marks)**
e)	(i) $T_1 = 272$ s	**(1 mark)**
	(ii) $T_2 = 154$ s	**(1 mark)**
	(iii) $K = \frac{T_2}{T_1}$ $\frac{154}{272} = 0.5667$	**(1 mark)**
f)	(i) M = P x V $M_L = 0.8 \times 40 = 32$g	**(2 marks)**
	(ii) $M_w = 1 \times 40 = 40$g	**(1 mark)**
g	$K(84M_b+420M_w) = 84M_b+100M_Lc$ $0.5667(84 x 31.2 + 420x 40+ 100x 32x c$ c = 2.45 Jg^{-1} $°C^{-1}$	**(2 marks)**
h	**PART B** (iv) h_1 = 23.3 ± 5 cm	**(1 mark)**
	(v) $r = \frac{22.1}{3}$ = 7.36	**(1 mark)**
i.	(i) h_2 = 17.9 ± 5 cm	**(1 mark)**
	(ii) ~~Z~~ = $\frac{16.5+7.36}{16.5}$ = 1.446 (Correct evaluation from candidates' values)	**(2 marks)**

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.
- The accuracy of the instrument used while making measurements should be considered all the time.
- Logical analysis of concepts and critical thinking must be encouraged during the teaching/ learning process.