6118
Paper 3

GENERAL COMMENTS

The paper proved to be challenging to the average candidate, just like the preceding 2020 examination series. A significant number of candidates struggled to respond to questions which required Mathematical applications and manipulations. This includes, but not limited to; rounding answers correctly, giving answers to the appropriate numbers of significant figures, using usual mathematical instruments such as a protractor to measure angles (see question 2 (b)) and (c) and a ruler to measure length (see question 3 (a)(i)) and drawing graphs. In addition, a large number of candidates also struggled to demonstrate scientific experimental skills such as recording of data in tables in a logical manner including constancy and consistency in decimal places and significant figures, plotting graphs including the use of sensible scales, drawing lines of best fit (straight lines and smooth curves), calculation of gradient, using a given scale to determine the actual length (see question 3 (a)(ii)), drawing conclusions from given experimental quantitative data (see question 3 (e)).

Overall, the candidates' performance in this paper give an impression that they were not sufficiently exposed to assessment objective C (practical – experimental and investigative – skills and abilities) aspects of the syllabus that should prepare them to take an Alternative to Practical Paper. These include the suggested practical activities at the end of each topic; Topic 1 (scientific processes) as well as Annexe A (Practical assessment and Paper 3, Alternative to practical paper). It should be highlighted that the Annexes in the syllabus are there to provide additional information to teachers and candidates regarding aspects of the subject which cannot be explicitly stated in the specific objectives in the syllabus. It is therefore important that candidates are taken through and be informed about these Annexes plus all other additional information in the syllabus preamble and assessment sections.

It should also be emphasised that candidates need to have a thorough grounding in practical work during the NSSCO course, including reflection and discussion on the precautions taken to improve reliability and control of variables. Candidates should be aware that as this paper tests an understanding of experimental work, explanations will need to be based on data from the question and practical experience rather than theoretical considerations. Numerical answers should be expressed clearly, to the appropriate number of significant figures and with a correct unit, where applicable. Candidates should know that these techniques will be tested at some point in the paper. Candidates should be ready to apply their practical knowledge to unusual situations. Questions should be read carefully to ensure that they are answered appropriately.

COMMENTS ON INDIVIDUAL QUESTIONS

Question 1

(a) Well answered. Only a handful of candidates lost marks by making mistakes such as attaching a wrong unit to the answer.

(b) Poorly answered. Most of the candidates gave answers which were more befitting question 2 (d) rather than 2 (a). It appears that candidates missed the focus on this question that it is to ensure accurate temperature readings.

(c) **(i)** Fairly to satisfactorily answered. Some candidates lost marks because of including units in the column of the table. Candidates should be aware of the appropriate conventions of recording data in tables.

(ii) Poorly answered. It appears that many candidates did not recognise that they needed to find the difference between the initial and final temperature in each case to find the change in temperature.

(iii) Very poorly answered. Many candidates calculated average temperature rather than rate of cooling. Many failed to use their answer in (c)(i) to find the rate of cooling.

(d) Moderately answered. Some candidates specified incomplete factors for example 'temperature' in general without specifying whether they are referring to room temperature or 'initial temperature' of water. In general, candidates needed to use the understanding on how to make experiments fair.

Question	Answer	Additional guidance	Mark
1 (a) (i)	19 (ºC) ✓		**1**
(b)	• view perpendicular to the level of thermometer liquid (to avoid parallax error)✓ • stir before taking reading✓ • keep thermometer at same level / not touching container walls✓ • allow thermometer liquid to expand completely✓ • keep thermometer in water while taking readings✓	owtte any 2✓✓	**2**
(c) (i)	60, 120, 180, 240, 300, 360 ✓	all correct	**1**
(c) (ii)	**A** (79 – 64 =) 15 (ºC) AND **B** (76 – 65 =) 11 (ºC) ✓	both correct, accept negative values	**1**
(c) (iii)	(15/360 =) 0.042✓ ✓ ºC/s✓ **or** (15/6 =) 2.5 ºC/min	at least 2sf, ecf from c(ii)	**2**
(d)	Same volume of water ✓ Same initial temperature ✓ Same material for lid ✓ Same material/ type of container ✓ Same room temperature ✓	Any 1 ✓	**1**
		Total	**8**

Question 2

(a) Satisfactorily. A large number of candidates managed to score this mark.

(b) Poorly answered. It seems that it was a struggle for many candidates to use a protractor and only a handful of candidates measured the angle correctly.

(c) Well answered. This question was accessible to the majority.

(d) (i) Moderately answered. Many candidates managed to get at least 1 out of 2 marks. Many candidates lost a mark due to inconsistency in significant figure or incorrect rounding.

(ii) Poorly answered. Only a handful of candidates scored in the range of 1 to 3 out of 5 marks. Candidates lost marks for a variety of reasons such as:

- Labelling of axes: Many candidates swopped the axes although the guidance in the question was clear as to which quantity ought to be labelled on the x-axis and which one on the y-axis. Some candidates left the axes unlabelled altogether while some included wrong units in the label such as°.
- Scale: Many candidates lost marks by using complicated scales which made them struggle to have uniform intervals, and as a result, lost marks for the scale. Some candidates used small scales which did not cover at least half of the grid either in the vertical (y-axis), horizontal (x-axis) or both directions, and lost marks. Some candidates ignored the guidance which is already given in the question that they did not need to start their axes at the origin (0, 0).
- Plotting: Most of the candidates who used complicated scales struggled to plot their data according to their scale and lost marks as a result. Some candidates struggled to plot points within half a square (1 mm). Some candidates plotted blobs (very large plots) which covered more than half a small square (1mm) up to a complete square or even more, making it difficult to judge where exactly a particular point was plotted.
- Line of best fit: Most of the candidates were unable to draw the line of best fit (which is a straight line in this case). Many candidates lost marks for various reasons such as joining the plotted points dot to dot with a ruler or by free hand, or drawing straight lines of best fit which are waving, hairy or feathering, or drawing a straight line which is not balancing the plotted points appropriately.

  Teachers are encouraged to put more emphasis on drawing of graphs (Topic 1.2.3 and Annexe A 2 (l).

(iii) Very poorly answered.

Only a handful of candidates obtained the correct answer. Most candidates were unable to determine the gradient from their straight line of best fit, some candidates chose plotted points which are not on their straight line of best fit. Others swopped the equation to determine gradient by wrongly using $\frac{\Delta x}{\Delta y}$ instead of using the correct one which is $\frac{\Delta y}{\Delta x}$. Some candidates had the formula correct as $\frac{\Delta y}{\Delta x}$ but they substituted incorrectly and got a negative gradient instead of a positive gradient for instance.

Question	Answer	Additional guidance	Mark
2 (a)	line at the centre and ⊥ to AB **and** O labelled ✓	judge by eye	**1**
(b)	*i* = 25° ± 1° drawn to the left of the normal ✓	measure the angle	**1**
(c)	(180° - 170° =) 10° ✓	c.a.o	**1**
(d) (i)	<table><tr><th>sin *i*</th><th>sin *r*</th></tr><tr><td>0.54</td><td>0.34</td></tr><tr><td>0.63</td><td>0.42</td></tr><tr><td>0.78</td><td>0.52</td></tr><tr><td>0.88</td><td>0.59</td></tr><tr><td>0.97</td><td>0.64</td></tr><tr><td>1.0</td><td>0.66</td></tr></table>	All 12 values correctly calculated ✓✓ penalise inconsistency in significant figures (2 sf)	**2**
(ii)	axes labelled with quantity with no units ✓ scales suitable **and** range values covering at least half of grid ✓ all six plots correct to ½ small square ✓✓ well judged thin line (≤½ small square) of best fit✓	ecf from 2d(i) award (✓) for 3 to 5 plots correct to ½ small square	**5**
(iii)	indication on graph in both x and y dimensions ✓ substitution of points (✓) 1.3 – 1.6 ✓✓	Indicate with a triangle, coordinates or clearly drawn lines, the distance between points taken should cover over half of graph consider ecf from graph	**3**
		Total	**13**

Question 3

(a) (i) Well answered. A significant number of candidates managed to measure correctly using a ruler and gave answers within the expected range. Although it was expected that all candidates score this mark, a few candidates lost marks for example by measuring in cm while the guidance on the paper includes mm on the answer space, or stating a measurement in mm which was completely out of the expected range. This was unexpected because a ruler is one of the simplest measuring instruments that all candidates ought to be able to use comfortably and correctly.

(ii) Many candidates were unable to convert their measured values to $\frac{1}{5^{th}}$ full scale. Most candidates divided their answers to **(a) (i)** by 5 (or multiplied it by $\frac{1}{5^{th}}$) instead of multiplying their answer by 5. This was quite surprising as this is expected to be a simple mathematical skill.

(b) Fairly answered. Some candidates lost marks due to swopping of ammeter and voltmeter, this means that they could not identify from the connection of the electric circuit in Fig.3.1 (series and parallel connection of the meters) to deduce the instruments. Some candidates lost marks due to misspelling of 'ammeter' and 'voltmeter'. A common misspelling was "*volmeter*".

(c) Poorly answered. Many candidates seemed to have missed how to read the scales and what each division on the meter represents. Only a few candidates managed to score 1 to 2 marks at this part.

(d) (i) Poorly answered. Some candidates were able to score 1 out of 2 marks at this part, they mostly lost the second mark due to inconsistency in the recording of data, and instead of recording as

4.00 they recorded as either 4 or 4.0, which was penalised.

(ii) Satisfactorily answered. This mark was accessible to the average candidate. Some candidates lost marks by writing completely wrong units such as ampere and watts, it appears that some were just guessing random units.

(e) Satisfactory. Many candidates were able to score 1 out of 2 marks at this part, which was mostly for the statement. Hardly any candidates scored any marks for the justification. It is expected that candidates are able to explain direct proportionality by making deductions in the context of given experimental data.

Question	Answer	Additional guidance	Mark
3 (a) (i)	20 ±1 (mm) ✓	whole number only	**1**
(ii)	(20 × 5) = 100 (mm) ✓	ecf from 3(a)(i)	**1**
(b)	1 – ammeter ✓ 2 – voltmeter ✓		**2**
(c)	indication of V = 0.3 (V) indication of I = 0.58 (A)		**2**
(d) (i)	4.00 ✓ ✓ 3 significant figures	penalise inconsistency in significant figures (3 sf)	**1**
(ii)	(V /) V <u>and</u> (R /) Ω ✓	accept units in words	**2**
(e)	Yes ✓ x/R is a constant value/ x and R increase in ratio / when x doubles, R also doubles ✓	owtte	
		Total	**11**

Question 4

Poorly answered. This question proved that the majority of candidates did not have much exposure to this or a similar practical activity as they appeared clueless on how to approach the question. The majority of candidates ended up describing different practical activities such as Hooke's law.

The marks were categorised according to marking points (MP) as follow:

1 Method: 5 marks

- **MP1 –** this was satisfactorily answered. Many candidates who scored 1 out of 8 marks were able to score this mark.
- **MP2 –** this was satisfactorily answered. It was expected that the candidates make reference to measuring of the physical quantity (length of string), using the appropriate measuring instrument given in the list of apparatus (metre ruler).
- **MP3 –** Poorly answered. The candidates were expected to indicate how to manipulate the setup to carry out the experiment by displacing the mass at an angle and release it to oscillate. In most cases, the action was missing in this part. Candidates were expected to mention what they would do to initiate the oscillations.
- **MP4 –** Poorly answered. It was expected that candidates make reference to the given measuring instrument in the list of apparatus (stopwatch) to measure the physical quantity (time for a number of oscillations). Many candidates made reference to measuring only one oscillation. Other candidates made reference to measuring time from when the oscillations start up to when the oscillations completely stop. This was penalised.
- **MP5 –** Satisfactorily answered. Some candidates were able to indicate that they would adjust the length and repeat time measurements as expected. A vague reference to repeats was not sufficient as it is not clear whether the candidate was referring to using adjusting the length of the string or repeating the measurements of time at the same length. Other candidates missed the point of the aim of the investigation altogether and went on to mention adjusting mass instead.

2 Control variables: 1 mark

- MP6 – Poorly answered. It appears that many candidates did not understand what it means to have control variables because they were mostly writing a long list of variables, implying that they will control almost all variables in the experiment, which is unexpected. Topic 1.2.1 on page 6 of the 6118 Physics syllabus clearly states that learners should be able to "distinguish between dependent, independent and control variables". Candidates were expected to identify at least one variable to keep constant. The mass or angle of swing were correct suggestions. Some candidates suggested keeping the length constant and changing mass.

This meant that they are deviating from the intended investigation because they are required to investigate whether the length of the string affects the period of a pendulum.

3 Table: 1 mark

- **MP7 –** very poorly answered. It was expected that candidates indicate which readings would be displayed in their table or tables, which would enable them to investigate whether the length of a string affects the period of a pendulum. It was expected that they would have length (of string) and time taken (for a number of oscillations) as raw data, as well as period as processed data from the time taken.

4 Conclusion

- **MP8 –** very poorly answered. Many candidates could not demonstrate how they would use their data / readings to reach a conclusion. Instead, many just quoted the relationship between length and period of pendulum from theory, which was penalised.

Question	Answer	Additional guidance	Mark
4	**Method** • **MP1** Attach string to solid mass and attach to retort stand ✓ • **MP2** Measure length of string using a metre ruler ✓ • **MP3** Pull pendulum to one side and release so that it oscillates ✓ • **MP4** Start the stopwatch and measure the time taken for a number (at least 5) of oscillations ✓ • **MP5** Change the length of string and repeat time measurements (for at least 4 or 5 different lengths of string) ✓		**5**
	Control variables • **MP6** use same mass piece for various lengths / keep the mass constant / keep same angle of release ✓	Any 1	**1**
	Table • **MP7** A table to show length (of string), time taken for a number of oscillations and period ✓		**1**
	Conclusion • **MP8** Plot a graph of period against string length with a line of best fit to show the relationship/compare the changes in period and string length to see if there is a pattern. ✓		**1**
		Total	**8**

POSITIVE SUGGESTIONS TO TEACHERS

First and foremost, it is important to highlight that in terms of assessment objectives, there is a significant difference in the NSSCO Physics Paper 3 compared to the old curriculum NSSCO Physical Science Paper 3. Page 39 of the NSSCO Physics syllabus specifies that Paper 3 is only comprised of Assessment Objective C questions, the entire 40 marks, whilst the old curriculum NSSCO Physical Science Paper 3 used to be comprised of a combination of Assessment Objective A, B and C questions. This means that teachers need to put a great emphasis on assessment objective C and also make practical work an integral part of teaching and learning.

Once again, the manner in which learners responded to the questions in this paper, to a large extent, demonstrated that candidates lack conceptual understanding and exposure to practical experiences. Teachers are encouraged to use easily accessible and locally available / familiar materials to conduct practical activities in their classrooms. Annexe A on Page 43 of the syllabus outlines the experimental contexts that guide the assessment objective C skills. At the end of each topic in the syllabus, there are also suggested practical activities. These should serve as a guide regarding the expectations of Paper 3.

Lastly, although NSSCO Physics used to be an integral part of NSSCO Physical Science as a Physics section (together with Chemistry), it is important to highlight that when Physics became a standalone subject, it became much more demanding compared to when it was just one of the two sections in the old NSSCO Physical Science curriculum. Thus, the teaching of the NSSCO Physics needs to be done in the depth that it deserves and not just exactly the same way we have been teaching the old NSSCO Physical Science curriculum.