Overall grade: C+

Performance Standards for Stage 2 Scientific Studies

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Critically deconstructs a problem and designs a logical, coherent, and detailed scientific investigation using a scientific method and/or engineering design process. Obtains, records, and represents data, using appropriate procedures, conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data. Critically and perceptively evaluates the effectiveness of collaboration and its impact on results/outcomes.	Demonstrates deep and broad knowledge and understanding of a range of science inquiry skills and scientific concepts. Applies science inquiry skills and scientific concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of science concepts coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Logically deconstructs a problem and designs a well-considered and clear scientific investigation using a scientific method and/or engineering design process. Obtains, records, and represents data, using appropriate procedures, conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data. Critically evaluates the effectiveness of collaboration and its impact on results/outcomes.	Demonstrates some depth and breadth of knowledge and understanding of a range of science inquiry skills and scientific concepts. Applies science inquiry skills and scientific concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of science concepts with mostly coherent and effective use of appropriate terms, conventions, and representations.
C	Deconstructs a problem and designs a considered and generally clear scientific investigation using a scientific method and/or engineering design process. Obtains, records, and represents data, using generally appropriate procedures, conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data. Evaluates the effectiveness of collaboration and its impact on results/outcomes.	Demonstrates knowledge and understanding of a general range of science inquiry skills and scientific concepts. Applies science inquiry skills and scientific concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of science concepts with generally effective use of appropriate terms, conventions, and representations.
D	Prepares a basic deconstruction of a problem and an outline of a scientific investigation using a scientific method and/or engineering design process. Obtains, records, and represents data, using procedures, conventions, and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data. Attempts to evaluate the effectiveness of collaboration and its impact on results/outcomes.	Demonstrates some basic knowledge and partial understanding of science inquiry skills and scientific concepts. Applies some science inquiry skills and scientific concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic scientific information, using some appropriate terms, conventions, and/or representations.
E	Attempts a simple deconstruction of a problem and a procedure for a scientific investigation using a scientific method and/or engineering design process. Attempts to use some procedures and record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data. Acknowledges the effectiveness of collaboration and its impact on results/outcomes.	Demonstrates limited recognition and awareness of science inquiry skills and/or scientific concepts. Attempts to apply science inquiry skills and/or scientific concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about science.

Stage 2 Scientific Studies

SIS: Representing and Analysing Experimental Data

Performance Standards assessed:

- IAE2 - Obtaining, recording, and representation of data, using appropriate procedures, conventions, and formats.
- IAE3 - Analysis and interpretation of results to formulate and justify conclusions.
- KA4 - Communication of knowledge and understanding of scientific concepts, using appropriate terms, conventions, and representations.

Please note:
- This is one task taken from a folio comprising of five tasks and may not be representative of the overall Folio grade.
- The original student's work has been adapted to incorporate the task detail, which were orognially provided on a separate sheet.
- Notes in coloured text boxes are added to provide infromation and support for teachers. Parts of the student report have been highlighted with the colour that corresponds to the colour of the relevant text box.

RAW DATA SET 1:

Students balanced on one foot with different weights attached to the lifted foot. The largest mass lifted was 800g.

Balance times were recorded in seconds.

Weight	Trial 1	Trial 2	Trial 3
0	34	28	20
200	26	24	22
400	23	19	21
600	20	15	15
800	12	14	8

1. Display the data for SET 1 in a more suitable raw data table. (IAE2)
2. Create a scatter graph with raw data (IAE2)
3. Identify anomalous results in SET 1, decide what to do with them and explain your decision (KA4)
4. Using excel for calculations, create a processed data table for SET 1. (IAE2)
5. Using excel create a graphical representation of processed data SET 1. (IAE2)
6. Analyse data SET 1 to identify the trend. Use data to justify your analysis. (IAE3)

Stage 2 Scientific Studies

SIS: Representing and Analysing Experimental Data

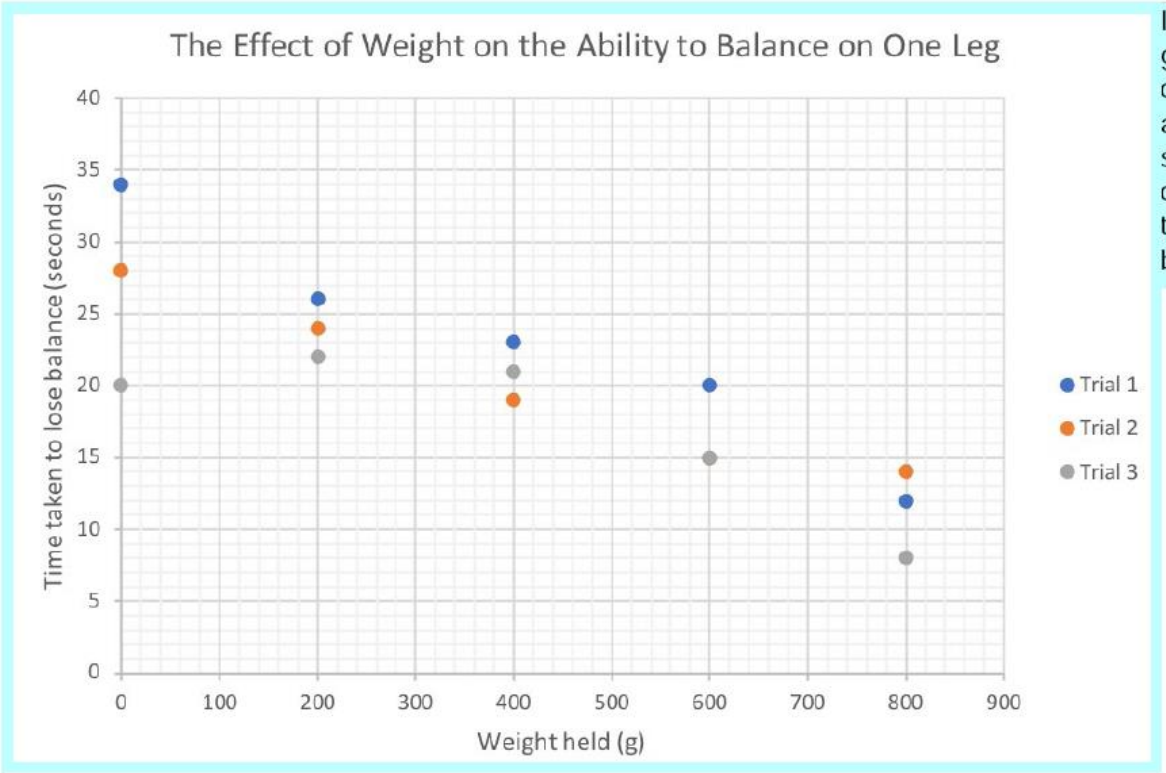
Data Set 1:

Table 1: The Effect of Weight on the Ability to Balance on One Leg (seconds)

	Time taken to lose balance whilst holding weights (seconds)		
Weight (g)	Trial 1	Trial 2	Trial 3
0	34	28	20
200	26	24	22
400	23	19	21
600	20	15	15
800	12	14	8

IAE2 - identified the need to include units, appropriate title in raw data table.

Raw data Graph 1:



IAE2 - Scatter graph produced is conventional and appropriate, showing the correct units. No trendline has been included.

There is only one anomalous result in SET 1 which is in the third trial for 800g weight, this can be seen in the raw data table and graph. This data will be taken out for the rest of the experiment to minimize skew. The processed data will be calculated and display averages of each weight without the 8 second increment included. The 8 second increment is classified as anomalous data as they do not follow any correlation. There is a trend which can be seen and that is as the weight increases the amount of time to balance on one leg decreases.

IAE3 - student identified 800g anomaly, however, didn't discuss 0g weight and why there was a range of 14 seconds difference between these results.

Processed Data

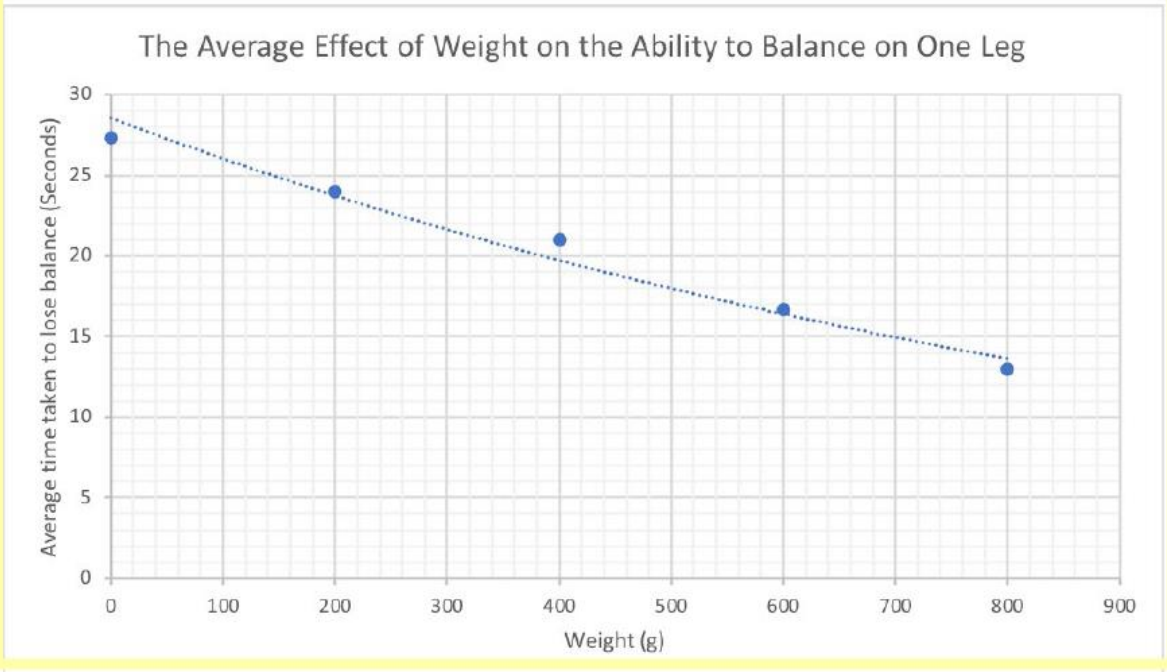
KA4 - student states what they will do with the anomaly, but does not explain what 'to minimize skew' means.

Table 2: The effect of different weights on time taken to balance

Weight (g)	Total	Average	Range	Percentage relative range (%)
0	82	27.33	14	51.23
200	72	24.00	4	16.67
400	63	21.00	4	19.05
600	50	16.67	5	29.99
800	26	13.00	2	15.38

Processed data

Graph 2:



IAE2 - Graph produced is conventional and appropriate, showing averages and a suitable trend line has been included.

The graph displays a negative linear trend between the weight which is held, on the ability to balance on one leg. As the weight increased the amount of time balancing on one leg decreased, this is evident through the graph as the trend starts at the weight 0g with the average equalling 27.33 seconds and it ends at 800g with 13 seconds. This shows a 14.33 second difference between the highest and lowest weight.

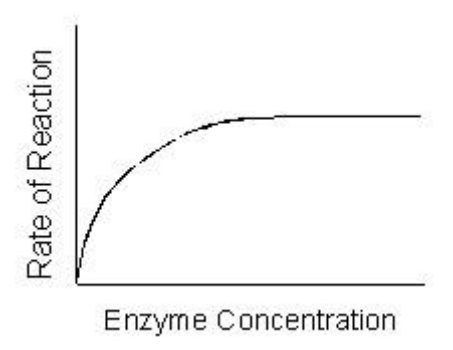
IAE3 - trend line is discussed. General analysis of all results with specific mention of data. No mention of accuracy, particularly around 0g due to the range.

RAW DATA SET 2

While completing an investigation into the effect of amylase on reaction rate, the class ran out of the enzyme before data collection was finished. Therefore a new batch of 8% amylase was created to be used to finish the experiment.

With enzyme catalyzed reactions, a rate of reaction is always calculated from the time recorded. We assume the amount of starch at the start of each trial is 1 A.U (arbitrary unit). In this practical when all the starch was removed, the time was recorded.

Theoretically, we assume a graph for enzyme catalysed reactions should look something like this:



Amylase concentration	Time for starch to be digested by the amylase
2%	780, 1560, 650, 475, 600 seconds
4%	432, 369, 498, 660, 400
6%	220, 230, 240
8%	420, 360, 360

1. Display the data for SET 2 in a more suitable raw data table, indicate anomalous results (IAE2)
2. Justify what you have done with the anomalous results (KA4)
3. Write sample calculations for SET 2 as required. (IAE2)
4. Display processed data as a table and graph. (IAE2)
5. Analyse data SET 2 to identify the trend. Use data to justify your analysis. (IAE3)
6. Compare the graph to the theoretical results, suggest reasons for any differences (KA4)
7. Suggest, with reasoning, two possible improvements to this method (KA4)

Raw Data set 2:

Table 1: Time taken for amylase to digest in different concentrations (%)

	Time for Amylase to digest Starch (Seconds)				
Amylase Concentration (%)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
2	780	1560	650	475	600
4	432	369	498	660	400
6	220	230	240		
8	420	360	360		

IAE2 - identified the need to include units, appropriate title in raw data table.

**Anomalous results are highlighted in yellow.

For data SET 2 there was still only one anomalous data result which is displayed in the table above, in trial 2 for 2% amylase concentration. In trial 2, the amount of time it took for starch to digest in 2% concentration was 1560 seconds. The anomalous data results will not be calculated or included in the processed data due to the effects the increments would have on the calculations.

Sample Calculations: For amylase concentration 4%

$$Percentge\ range = \left(\frac{Range}{Average\ Value}\right) \times 100 = \frac{660-369}{472} \times 100$$

Statistical tests are not specified in the Subject Outline

$$Rate\ of\ Reaction = \frac{1\ Arbitary\ Unit}{Average\ Time\ for\ starch\ to\ digest\ Amylase\ (seconds)} = \frac{1}{472}$$

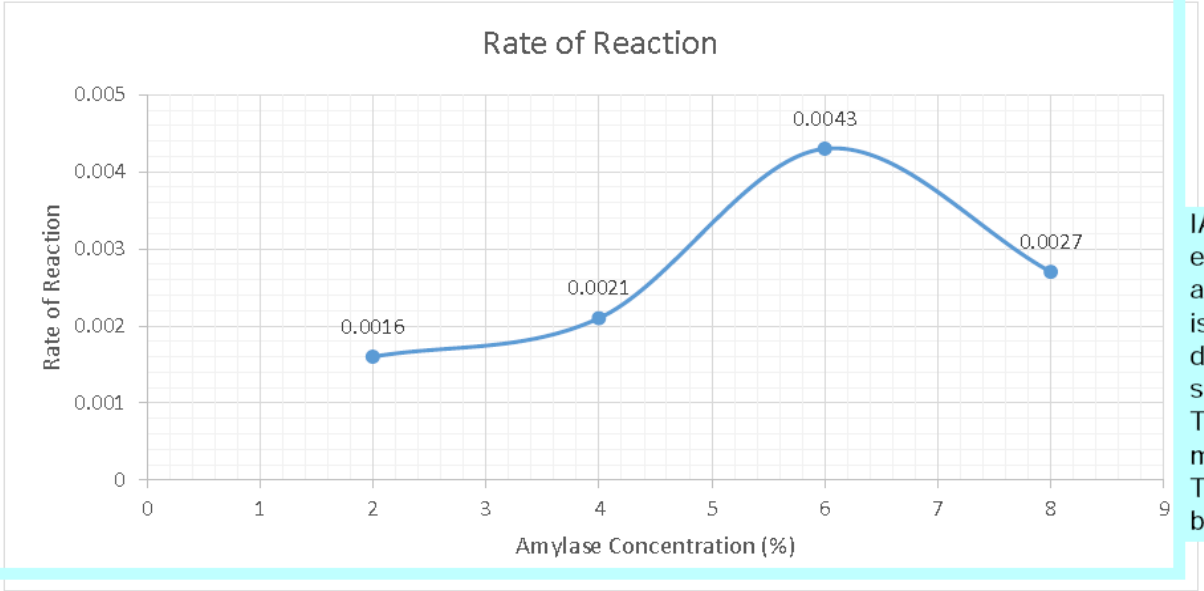
Processed Data:

Table 2: The effect of amylase concentration on the rate of reaction

Amylase Concentration (%)	Total	Average	Range	Percentage Relative Range (%)	Rate of Reaction (1 A.U/average time)
2	2,505	626	305	48.70	0.0016
4	2,362	472	291	61.68	0.0021
6	690	230	20	8.70	0.0043
8	1,140	380	60	15.79	0.0027

IAE2 - appropriate calculations including reaction rate and range as well as representations.

Graph 1:



IAE2 - Graph, is effective, although the title is could refer directly to the specific reaction. The *y* axis is missing the units. Trend line has been added.

In data set 2, the trend is displayed as the amylase concentration increased so did the rate of reaction until the point of 0.0043 at 6% amylase concentration. Once it reached the highest point (0.0043) there was a dramatic decrease which dropped to 0.0027 at 8% amylase concentration.

IAE3 - trend line is described making specific reference to data. Also, no reference made to Percentage Relative Range.

The graph shown above is very different to the theoretical results. The trend for the theoretical results and the trend for the calculated results differ as the theoretical trend starts at 0 and increases to a certain point until it plateau's and for the calculated results, it starts at 2% and increases to a certain point before decreasing again.

IAE3 - identified and described a difference between theoretical results and own data, but does not attempt to analyse or explain possible reasons for this.

If this experiment was to be investigated again, some improvements which would help develop more precise and accurate results would be to ensure there is the correct amount of enzyme (amylase) for every trial before starting the experiment. By having the correct amounts it will reduce the possible errors and the missing increments. Another improvement would be to ensure that there was the same amount of increments in every trial, as some were missing and may have caused the results to skew.

Improvements do not feature in the Subject Outline.

The student represented data appropriately and mostly effectively. However, their analysis often lacked depth. There was also little evidence of KA4 throughout as the student did not draw any conclusions using the data. To improve on this grade the following was required: greater discussion regarding accuracy, validity, reliability, limitations, linking to data and science.