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.

Please note:

- Parts of the student report have been highlighted with the colour that corresponds to the colour of the relevant text box.
- Any notes in coloured text boxes are added to provide information and support for teachers

TITLE: *The effects different carbohydrates have on short distance performance*

Introduction:

Carbohydrates are macronutrients that fuel many of the bodies functions. These carbohydrates can be categorised into 3 different carbohydrates, these being monosaccharide, disaccharide (two monosaccharides bonded with hydrogen bonds) and polysaccharide (three or monosaccharides bonded with 2 or more hydrogen bonds)[i]. This investigation aims to show the effects that different carbohydrates have on short distance performance.

KA1 - basic introduction with no basis given for why they are doing the investigation or implications for enhancing performance. Some scientific knowledge provided, with errors.

Proposal Summary:

The test initially proposed for this investigation is 15 male subjects sprinting 200m. Initially, the subjects are to sprint with no carbohydrate supplementation on an empty stomach. After 3 days from initial test the subjects are then given 100g of monosaccharide carbohydrate in the form of glucose powder dissolved in 400ml of water and conducted the same 200m sprint. A further 3 days later the investigation will be conducted again however this time the subjects are given 100g of disaccharide carbohydrates in the form of fructose powder dissolved in 400ml of water. After each test, sprint times will be recorded and graphed allowing for comparison. However, after teacher feedback it was determined the class size could not accommodate using 15 subjects, due to this modification had to be made therefore reducing the number of subjects to 8.

KA4 - clear summary of method given, including changes made due to feedback received. No mention of hypothesis at the start of the report.

Results:

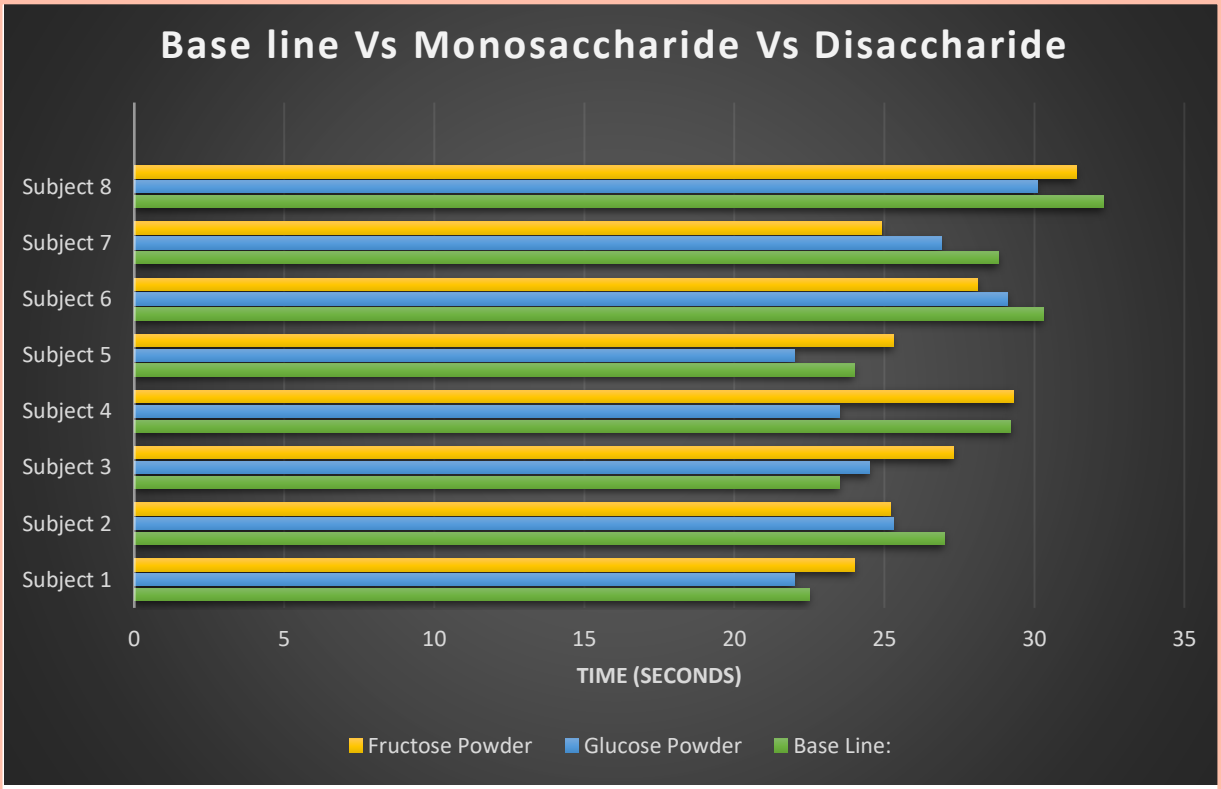

Figure 1.0 – Base line Vs Monosaccharide Vs Disaccharide

IAE2, No table showing experimental data. Graph reasonably effective, but interpretation is limited by the number of bars shown. There are also some errors with labelling. As data collected was continuous (time) a line graph would have been more conventional.

Discussion:

IAE3 - interpretation of data is only partially accurate

The results indicate that there is a clear improvement in performance over a short distance when using either monosaccharide or disaccharide carbohydrate when compared to baseline testing.

Figure 1.0 encapsulates the times of 8 subjects over a 200m sprint. These subjects had no supplements and were running on an empty stomach. Figure 1.0 shows that the fastest time was 22.5 and the slowest being 32.3 with the rest of the group averaging a time of 27.2 seconds. These times were used as a baseline, however the errors that occurred during this test must be controlled throughout the rest of the tests.

IAE3 reference to data made, drawing general conclusions based on scientific justification with some errors.

Figure 1.0 represents the results gathered from the 8 subjects from the 200m run after consuming the Monosaccharide supplementation (100g of glucose powder). Figure 1.0 also shows the comparison between the baseline test and the Monosaccharide (glucose powder) supplementation. This resulted in the faster running times for 7 out of the 8 subjects (87.5%). With the fastest runner being 0.5 seconds faster than his baseline. However, the biggest change was subject 4 being 5.8 seconds faster after consuming monosaccharides. This is an improvement of 23% from his baseline time. A possible reason for this increase may be due to monosaccharides being a fast releasing source of energy, due to their =single hydrogen bond allowing it to be easily broken down to enter the cells. The mitochondria can break down this bond and store its energy in the form of Adenosine Triphosphate (ATP)[ii]. This ATP molecule is now used to preform everyday tasks such as breathing, muscle contraction, repair and growth and much more[iii]. The ATP made from this glucose powder would have been used for energy in the body's muscles, lessening the effect of fatigue over the 200m sprint.

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This graph (figure 1.0) also shows the comparison between the baseline test and the disaccharide test (fructose powder). Figure 1.0 shows 50% of subjects benefitted from the supplementation of disaccharides over a 200m distance. The fastest time being 24.9 seconds, 2.4 seconds slower than the fastest baseline test. The reasoning's behind this could vary, however the most provident is the fact that these disaccharides require more time covert into the previously mentioned Adenosine Triphosphate. This is because the disaccharides have 2 hydrogen bonds holding 2 simple sugars together, meaning although containing more energy, it takes longer to be broken down into ATP molecules. Therefore, in the time given, the body didn't have enough time to both store and use this energy. Although it was shown to benefit 50% of the subjects this carbohydrate is known to benefit longer distance runners due to its slow release of energy over a longer time[iv]. Due to this reason many athletes who require a slow energy release such as long-distance runners consume fruits and vegetables high in fructose before their event.

KA1, shows a reasonable understanding of the breakdown of carbohydrates based on size and the effect on work output. Some factual inaccuracies present

Figure 1.0 shows the averages of the all the tests conducted (monosaccharide, disaccharide and baseline test). Overall it is clear to see that be best times recorded by a majority of subjects is after consuming the monosaccharide carbohydrate (glucose powder). This proved to be on average 30% faster than the baseline and 26% faster than the disaccharide fructose powder.

Errors:

IAE4 Sources of error are identified and effect of error referred to. Impact on results is not fully apparent. Also biological differences (which would likely have the biggest impact) between participants have not been considered e.g. fitness level of individual participants which might impact metabolism of carbohydrates and their VO2 max

Error	*Type of Error*	*Effect of Error*	*Improvement*
Skill Level	Systematic	It was evident some athletes were more familiar with running and had a higher athletic level to the others, showing us why some subjects recorded results much higher or lower than results others.	The only practical way to improve this error would be to increase sample size of athlete subjects in order to attain a greater range of skill levels, therefore creating a more balanced study.
Unannounced Distractions	Random	This is due to other people who were not actively taking part in the testing possibly causing a distraction for the subject, therefore impacting performance within the testing aspects of the data collection.	This could have been achieved through securing an area to undertake the testing in via contacting teachers to reserve an area.
Shoes worn	Random	Using either the same type of shoe or a brand of shoe, as it would impact how subjects run. Eg. Subject 6 forgot his running shoes for his baseline test, meaning he had to run in leather dress shoes. This could have caused him to run slower over the 200m sprint	In order to eliminate this error prior to testings making sure everyone is wearing the same type of shoe (running, cross)
Weather	Random	Change in weather, can either improve or disadvantage a subject run. This is due to the runner having to slow down around the corners when wet, the muscles cooling down in the cold, over fatigue in the heat.	In order to eliminate this uncontrollable variable, conducting the tests on the same day during the same temperature range, would reduce this error.
Uniform	Systematic	Winter uniform could have restrictied his movement throughout the run therefore slowing him down.	In order to eliminate this error, the subjects need to wear the same clothes during each test.

Evaluation of Procedure:

It is not possible to determine the accuracy of my findings as there is no published data to compare these to. However, as there were some outlays in the pattern (subjects 6 and 7 where the disaccharide performed better than the monosaccharide and subjects 1, 2 and 8 where all fairly close), it can be suggested that my results were not completely reliable. This is because I only tested each subject once per supplement which meant there were no averages to calculate. Repeated tests would have increased the reliability of data as the impact of errors would be reduced. Also, the recovery time of subjects between runs might be too little for some subjects' to recover, meaning times were affected more by fatigue rather than supplement, meaning the validity of the results was reduced. Lastly, increasing the number of subjects from 8. This would have allowed the results to have a broader spectrum, lowering random errors and outlays in data.

IAE4 Brief, but valid attempt at evaluation where student has provided some explanation of the effect of these procedures on the reliability and validity of their findings

Conclusion:

The hypothesis of this investigation stated that the subjects that had taken the monosaccharide glucose powder would run quicker when compared to their baseline and disaccharides times. This was in part supported with the evidence gathered from this investigation however as fore mentioned in the evaluation of procedure, this investigation remains inconclusive and further investigations will need to be conducted to eliminate or minimise the errors.

KA4 - Hypothesis mentioned and linked to conclusion. Evidence of research and correctly formatted list. In-text referencing is also evidence particularly in the discussion.

Word count: 1332

Reference List:

[i] livescience.com. (2019). *What Are Carbohydrates?*. [online] Available at: https://www.livescience.com/51976-carbohydrates.html [Accessed 7 Sep. 2019].

[ii] Susha Cheriyedath, M. (2019). *Adenosine Triphosphate (ATP) Function in Cells*. [online] News-Medical.net. Available at: https://www.news-medical.net/life-sciences/Adenosine-Triphosphate-(ATP)-Function-in-Cells.aspx [Accessed 7 Sep. 2019].

[iii] Susha Cheriyedath, M. (2019). *Adenosine Triphosphate (ATP) Function in Cells*. [online] News-Medical.net. Available at: https://www.news-medical.net/life-sciences/Adenosine-Triphosphate-(ATP)-Function-in-Cells.aspx [Accessed 7 Sep. 2019].

[iv] Skerrett, P. (2019). *Is fructose bad for you? - Harvard Health Blog*. [online] Harvard Health Blog. Available at: https://www.health.harvard.edu/blog/is-fructose-bad-for-you-201104262425 [Accessed 7 Sep. 2019].

Student demonstrated a reasonable level of understanding of the effect of carbohydrates on work output. There were errors throughout, however, in general demonstrated a sound level of communication and knowledge to support an overall passing grade. Areas for improvement would have been a greater focus on linking their results with sports science and athlete performance, improved results representations including a table. Their discussion and analysis was fairly accurate, however, difficult to follow due to the display of data.