Overall 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

Assessment Type 1: Science Inquiry Skills Folio

Task 1: Accuracy of measurements

Introduction:
Blood pressure (BP) is an indicator of a person's state of health and wellbeing and measures the pressure of blood flowing through the circulatory system (Blood Pressure UK, 2008). Blood pressure is measured by millimetres of mercury (mmHg) and is comprised of a systolic value (the pressure exerted on the circulatory system when the heart beats) and a diastolic value (the pressure put on the arteries during the retraction of each pulse) (CDC, 2018).

Measuring blood pressure accurately is important to the successful diagnosis and treatment of a number health-related issues. Although a manual sphygmomanometer is considered as the 'gold standard' in terms of accuracy (A'Court et al., 2011), many medical staff and health professionals use a machine to automatically measure blood pressure. It is also possible to purchase electronic devices over the counter to monitor your own blood pressure on a daily basis. But just how does the accuracy of these automatic techniques compare to each other?

Aim: To investigate accuracy of measurement by testing and comparing blood pressures using different methods.

Task:
- Measure the systolic and diastolic blood pressure of a range of students using the three selected methods.
- Collect and organise all data in a table and represent the results in a suitable graph(s)
- Analyse and evaluation your data and method, providing sources of uncertainty
- Provide a conclusion with justifications

Materials:
- A Sphygmomanometer and Stethoscope
- Automatic Inflation blood pressure monitor
- iHealth wireless Bluetooth wristband

Method:
1. Start with s manual blood pressure reading by wrapping the Velcro inflatable pad of the sphygmomanometer around the subject's bicep.
2. Ensure the airflow tube rests on top of their arm when rested (palm up), in line with the bicep.
3. Once wearing the stethoscope, press the bell of the stethoscope against the brachial artery.
4. Watch the dial of the sphygmomanometer whilst inflating the pad by using the handheld pump. Ensure that the air valve is tightened so that no air can escape during the inflation.
5. Continue pumping until the dial reaches around 140 before slowly releasing the air valve
6. Allow the pump to deflate until a heartbeat can be heard. Once this happens, record the number immediately. This will be the subject's *systolic* blood pressure.
7. Continue to release the valve again until the heart beat can no longer be heard. When this happens, the number on the dial will correspond with the subject's *diastolic* blood pressure.
8. Use the automatic inflation blood pressure monitor and later, a wireless iHealth wristband monitor to take two more blood pressure readings for the subject.
9. Record all results for analysis.

Assessment Type: Practical Report

Format and length: Individual Task.

- Maximum 3 x A4 pages if written, or equivalent in multimedia form
- Minimum size 10 font

Assessment Criteria Covered:

IAE2 – Obtaining, recording, and representation of data, using appropriate procedures, conventions, and formats.

IAE3 – Analysis and interpretation of results to formulate and justify conclusions.

IAE4 – Evaluation of procedures and their effect on data.

Due Date: Friday Term 1 Week 4

References

A'Court C, Stevens R, Sanders S, Ward A, McManus R, Heneghan C. Type and accuracy of sphygmomanometers in primary care: a cross-sectional observational study. *British Journal of General Practise*. 2011; 61(590): e598–e603. doi:10.3399/bjgp11X593884

Bloodpressureuk.org. (2019). *Blood Pressure: What is blood pressure?* [online] Available at: http://www.bloodpressureuk.org/BloodPressureandyou/Thebasics/Bloodpressure [Accessed 26 Feb. 2019].

CDC.gov. (2019). *Measuring Blood Pressure | cdc.gov*. [online] Available at: https://www.cdc.gov/bloodpressure/measure.htm [Accessed 26 Feb. 2019].

Please note:

- This is one task from a folio comprising five tasks and may not be representatitve of the overall Folio grade.

- Any notes in coloured text boxes are added to provide information 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.

- This is not a full practical report because the students were provided with the method.

Results:

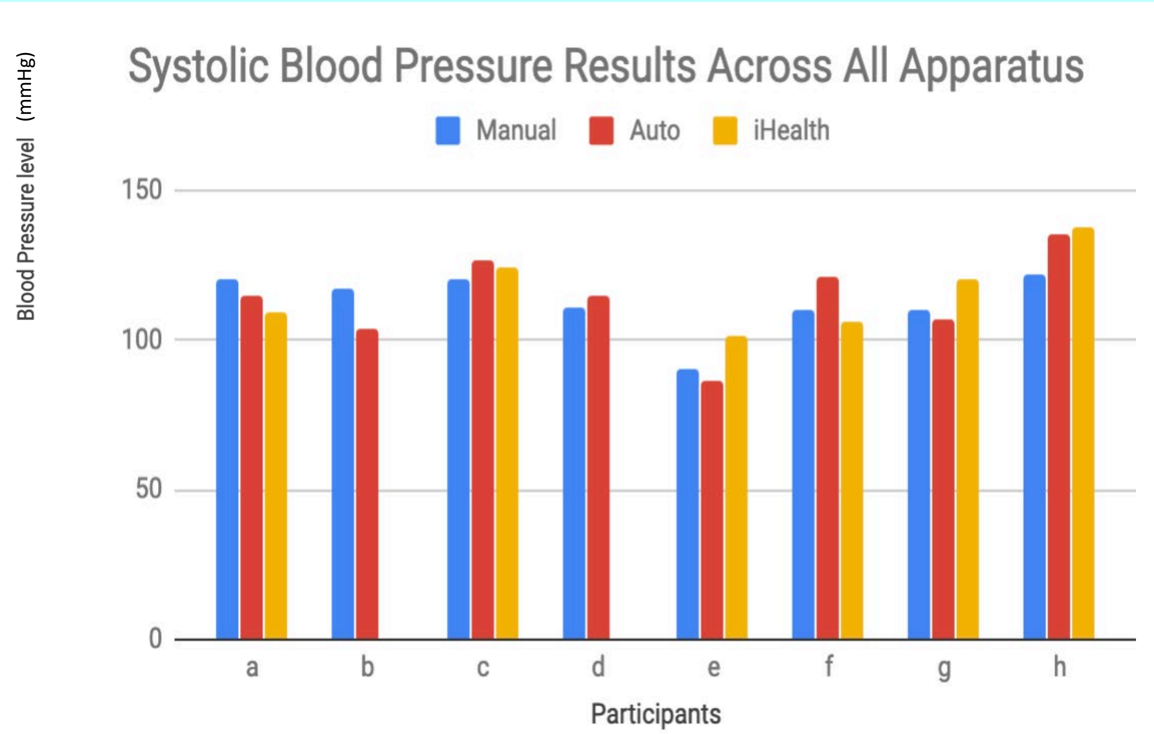
IAE2 - Table shows raw data that has been obtained and recorded by the student which is accurate and effective.

Raw data collection of blood pressures taken once with each apparatus for every participant (mmHg). For example, 120(systolic) /72 (diastolic). The systolic is always the number in front.

Participant	*Manual mmHg*	*Blood Pressure Machine mmHg*	*iHealth mmHg*
a	120/72	115/64	109/63
b	117/80	104/68	N/a
c	120/70	127/98	124/80
d	111/57	115/61	N/a
e	90/60	86/51	101/76
f	110/60	121/67	106/71
g	110/68	107/70	120/76
h	122/84	135/80	138/86

For greater effectiveness, the diastolic and systolic values could have been separated and individually analysed

Figure 1: Comparison between all systolic readings for each participant across all BP monitors.

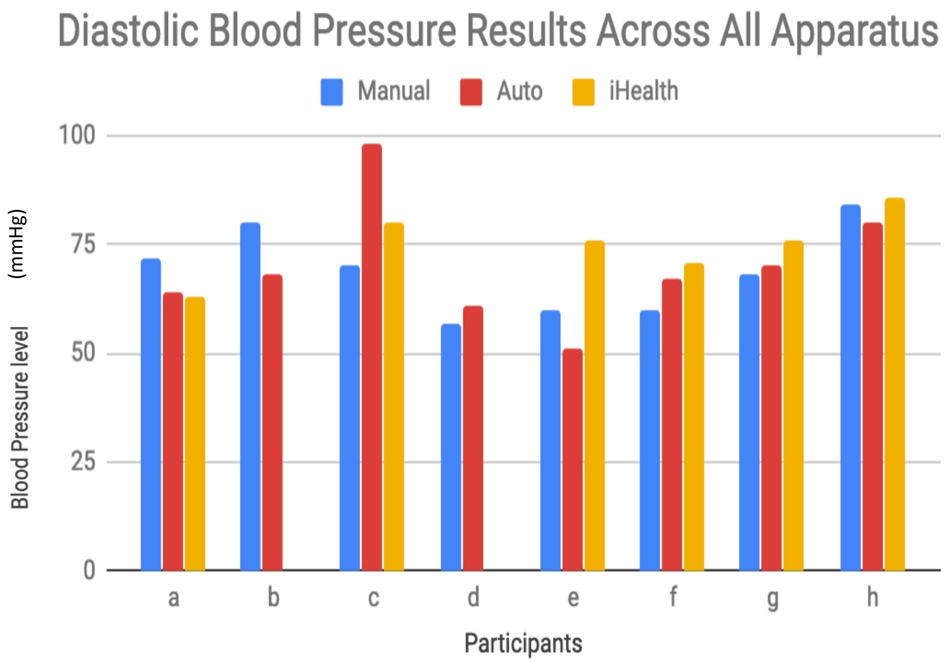


IAE2 - Graphs present the raw data accurately and uses colour and a key to differentiate between the different measurements. However, plotting the raw blood pressure data of individuals, makes it difficult to analyse and interpret patterns.

Please note:
To determine accuracy, results need to be compared with a 'true' value. Given that there is no published 'true' blood pressure values for these subjects, the best option is calculate the average percentage difference between for the 'Auto' and 'iHealth' methods and compare these against the Manual results which is deemed to be the 'gold standards' in terms of accuracy. This approach would have improved the quality of the analysis and conclusion about the accuracy of the methods more valid.

Please note:
When the dependent variable is based on a performance measure of individuals (such as blood pressure, heart rate, number of goals scored etc), variations between individuals in their inherent skill or ability level are reflected in the raw data. Therefore, the use of this raw data alone is not comparable and thus any conclusions drawn, have limited validity. To make data more comparable, it needs to be represented differently to reduce the impact of these individual differences. One way to do this could be to represent (and plot) the data as the change in the dependent variable, rather than its absolute value.

Figure 2: Comparison between all diastolic readings for each participant across all BP monitors.



IAE 3 - Some interpretation and analysis provided, with basic justification. Some inaccuracies evident.
Additionally, there were a number of unsubstantiated comments that needed further detail.
Student identified an outlier
The response could have considered the expected average what was expected for the age of participants compared to recorded data.

Discussion:

The results presented above represent the various blood pressure levels recorded across a group of 8 participants by using three methods of measurement. In all of these graphs, the red bars represent the diastolic pressure while the blue bars represent the systolic. Throughout these graphs, the diastolic pressure is commonly just over half the quantity of the systolic, which is at a normal rate for an average person due to the nature systolic and diastolic (beating and resting) pressures have on the heart. In *Figures 2,3*, there are two spaces missing where participants *b* and *d* did not take readings using the iHealth device. This had an effect on the results as having two less readings decreases the accuracy of the overall average. In *Figure 2*, participant *c's* diastolic result is a bit of an outlier as it was the highest result, reaching almost 20 mmHg more than the average expected diastolic blood pressure of 80 mmHg. Participant *h* was also quite a bit older than the rest of the participants as a middle-aged woman. There were also five boys and two girls (all aged 16-17) who took part in the experiment. Participant h's results were consistently the highest achieved across all three methods used which, while still in the healthy blood pressure range, may have skewed the overall average results.

This statement is not supported by the data.

The student should explain in more detail what this effect is.

This statement needs be supported with an explanation.

Based on the results achieved throughout this experiment, it is possible to state that this experiment has moderate validity. This is due to the amount of controls put into place before the experiment as well as how many errors occurred. In order to increase the validity of this, the participants should have been recommended guidelines of what to eat and drink beforehand, as well as scheduled times for sleeping and exercise prior to the date this was performed. This is due to a wide range of variables that would have had an effect on those who participated in the experiment. Extraneous variables that influence a person's physical, emotional and mental state are also able to influence blood pressure depending on the person's current and previous state. Some of these can include physical fitness, health and wellbeing, food, fluid and /or caffeine intake, quality of sleep, stress, medication and mood. Blood pressure can also be affected by fixed factors such as age and gender. These are all able to influence the participant's heart rate as well as blood pressure, which makes it difficult to tell if a one-off blood pressure reading is an entirely accurate representation of that person's health or not.

Throughout the duration of this experiment multiple errors occurred. One notable error that affected the results of the experiment was to do with the types of equipment used. Some of the stethoscopes were faulty and gave inaccurate readings, which lead to the measurements having to be taken again. Due to the use of different kinds of the same apparatuses, it is highly likely that there were slight differences within the performance and results given via each one, particularly with the automatic monitors. Human error was much more likely to occur when using the sphygmomanometer manually, and some participants required assistance from a professional helper whilst taking these readings. Another error that could have occurred would be the positioning of the stethoscope on the participant's arm when using the sphygmomanometer. In order to get an accurate reading, the bell of the stethoscope needed to be placed directly onto the brachial artery within the elbow crease. Misplacement of this could lead to incorrect results due to difficulty in hearing the participant's heartbeat.

What evidence is there of this?

What kind of human error? How does this affect the results?

A clear explanation of how the procedures would impact the results.

A few improvements that could make this experiment more accurate would be to maintain the use of the same equipment across all participants in order to reduce the chance of faulty equipment, leading to misinterpreted results, and to replicate the same participant using the same type of method in order to find an average. Another suggestion could be to have all of the participants quietly in a room beforehand for 10 minutes. This would reduce the risk of factors that may impact heart rates, particularly reducing feelings of stress or anxiety, or giving various participants time to rest after possibly performing physical activity prior to the experiment. There are not many improvements that can be made around setting limits on food intake, sleep or caffeine consumptions beforehand without crossing certain ethical boundaries.

IAE4 - Student has provided examples of random and systemic errors and suggests how to reduce these e.g. by resting subjects. Explaining how to reduce them is not necessary but implies an understanding of how the errors affect the results.

The results from this experiment can relate to the outside world as they give an indication of how blood pressure levels can be tested for people when in need, whether it be to support a diagnosis, to help prevent an illness, or for a general check-up. The most appropriate form of taking blood pressure would be with the use of an automatic calibrated machine. This would ideally be performed by a medical profession who knows exactly where to place the band. The iHealth device would be most suited to people who are of moderate fitness who may be casually taking their blood pressure for a brief indication or taking it on the go.

No limitations considered e.g. how to incorporate testing these devices in a variety of situations e.g. exercise, food, rest, stress etc.

Conclusion:

In conclusion, the results of this experiment indicate that the most accurate and efficient way to take someone's blood pressure is by taking it automatically with a calibrated machine. However, this is not always possible in remote situations. Therefore the manual method is a reasonable alternative. This will give a reading that is accurate enough to indicate any problems with blood pressure and therefore get assistance where required.

IAE3 - Conclusion given but data to support this is unclear.