May 2021 subject reports

# Biology

## Overall grade boundaries

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| **Grade:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range:** | 0 - 16 | 17 - 33 | 34 - 45 | 46 - 54 | 55 - 63 | 64 - 72 | 73 - 100 |

## General comments

Feedback shared by teachers, candidates and examiners following the exam was overwhelmingly positive. This feedback offers valuable guidance in establishing grade boundaries and in developing future assessment tasks. It is hoped that a greater number of schools participating in the MYP eAssessments will actively encourage their teachers to provide feedback in future sessions.

The difficulty of the exam was thought to be appropriate, with the clarity of the questions and sources good or very good. The exam accurately reflected the published topic list. There is a greater understanding of the assessment blueprint; the equal weighting of the four assessment criteria within the exam.

The exam was appropriate in length and offered the majority of candidates the opportunity to demonstrate their knowledge and skills in MYP Biology. This was supported by data from the exam showing fewer questions left unanswered and the quality of candidate responses marked by examiners.

## The areas of the programme and examination which appeared difficult for the candidates

- The importance of variation in species and the mechanism of natural selection.
- Use of food webs to propose population changes based on feeding relationships.
- Formulating hypotheses supported by relevant and correct science. The identification of and use of equipment for specific purposes. Identifying a measurable dependent variable.

- The action of enzymes.
- The evaluation of data, hypotheses and methods.
- Explaining relationships shown by graphs after identifying trends.
- Justifying arguments using different perspectives or factors.

## The areas of the programme and examination in which candidates appeared well prepared

- Identifying organelles and evaluating models of cells.
- Genetic crosses and patterns of inheritance.
- Interpreting bar charts and contrasting data. Calculating averages and understanding why repeats are taken.
- Designing investigations to collect sufficient data in order to address stated research questions.
- Stating arguments from different perspectives and using these to construct concluding arguments.
- Evaluating the use of animal models, including ethical considerations, when looking at drug development.

## The strengths and weaknesses of the candidates in the treatment of individual questions

**Question 1**

Candidates were able to use the diagrams provided effectively. Organelles present in animal cells were more commonly identified than those in bacterial cells. 3D models of cells were sometimes evaluated too vaguely.

Candidates consistently labelled the nucleus and chromosome correctly, but mixed-up DNA, gene and nucleotide.

Candidates were able to correctly determine inheritance probabilities from parental genotypes.

Very few candidates reached the top marks in part f. The concept of survival of the fittest seems well understood but not the mechanisms leading to natural selection and the survival of a species.

**Question 2**

Candidates were generally able to identify a producer and primary consumer from the food web. Identification of an omnivore was more challenging.

Candidates were able to predict the effects of changes in the food web but often did not provide sufficient evidence to support these. A significant number of candidates incorrectly described relationships not shown in the web, for example the fox hunting the deer.

**Question 3**

Almost all candidates correctly identified plant B as the plant resulting in the highest percentage average survival. Many candidates then incorrectly stated the bar height when asked to suggest a reason for this.
Many candidates were able to contrast differences between the results for native and non-native plants but few offered a comparison. Simply stating percentages without qualification was not sufficient.

The importance of a control was generally well understood.

**Question 4**

Most candidates were able to construct a word equation for photosynthesis.

Candidates were able to correctly identify the independent variable from the equipment set up. The dependent variable was frequently incorrectly identified as rate of photosynthesis. Rate of photosynthesis was not credited as it is not directly measurable and must be calculated. Most candidates correctly identified relevant control variables but vague, unqualified responses such as temperature or time were not credited.

Candidates correctly identified that the rate of photosynthesis would decrease when the distance between the plant and light source increased. However, most did not link this to decreasing light level or temperature and then explain this sufficiently.

**Question 5**

Many candidates did not know that a water bath is used to maintain temperature in an experiment.

Candidates understood the need to repeat experimental trials but often suggested simple improvements to the method that would not affect whether the data obtained was sufficient to draw a conclusion.

Candidates struggled with using the equipment available to them to improve the precision of measurements, with many again suggesting general improvement methods.

Candidates were able to consistently calculate average values of data from a table but could not consistently suggest improvements to its presentation.

Candidates could consistently identify anomalous data but struggled when asked how to analyse it.

Candidates could identify trends in the graph but did not use the data to fully explore the validity of the hypothesis. The point at which the data is no longer valid must be identified.

Stronger candidates could link the decrease in bubbles to a decrease in photosynthesis and explain this using the idea of enzymes denaturing. Weaker candidates often didn't comment on photosynthesis and suggested the plants died.

**Question 6**

Most candidates effectively used the bullet points in the question to logically structure their answers.

Candidates were able to identify the independent variable from the question stem and generally come up with appropriate control variables. Many candidates stated rate of photosynthesis as the dependent variable without explicitly stating how they would measure it. Since rate is not directly measurable it is not accepted alone as a dependent variable.

Candidates were able to consistently state testable hypotheses but struggled to explain them using appropriate science.

Many candidates provided equipment lists but did not make it clear what the equipment was being used for and therefore did not get credit for it. If the equipment was used correctly in the method or included in discussion of variables, then credit was given. Lists were not required.

Most candidates provided a method where relevant data could be collected. In order for similar data to be collected, the main control variables needed to be explicitly considered in the method and a clear procedure for collecting data established. Despite the information provided in earlier questions data collection methods were often very diffuse.

Many candidates planned to repeat at least three trials for five different lengths of stem. The five stem lengths must be explicitly stated.

**Question 7**

Many candidates received the first mark for correctly identifying one of the enzymes but did not appear to be familiar with the terms *substrate* and *product*.

Most candidates were able to identify the trends shown in the graphs referring to both axes. They were unable to explain these trends using appropriate science.

**Question 8**

Most candidates could state a simple difference between arteries and veins but struggled to outline how arteries were better able to withstand high pressure.

Candidates were generally able to identify advantages and disadvantages to health from exercise. Occasional repetition was seen in responses.

Most candidates could use the information in the video to outline how hypertension medication lowers blood pressure but very few could supplement this with the additional knowledge and scientific vocabulary required to explain this.

**Question 9**

Most candidates effectively used the bullet points in the question to logically structure their answers.

Candidates could use the information provided and their own scientific knowledge to identify positive and negative impacts to an individual's lifestyle. This was done more effectively than the impacts on wider society, where impacts on individuals were often discussed again.

For both individuals and societies, the impacts identified were often not discussed in sufficient detail for higher marks to be awarded. For example, considering the consequences or knock on effects of the impacts, or giving specific examples to support general claims.

Most candidates provided a concluding appraisal by expressing an opinion regarding how hypertension should be treated. Stronger answers saw candidates comparing the relative merits of two different aspects in sufficient detail, for example the short- and long-term consequences of different treatments.

A number of candidates did not explicitly discuss the use of medication to treat hypertension in their answers.

**Question 10**

Many candidates could link taking a melatonin pill to increased levels of melatonin in the body. Few candidates used the graph to identify the need for melatonin to be higher in stressed people to offset the increased cortisol.

Candidates could provide general benefits and limitations to using rats to test the long-term effects of melatonin.

Most candidates could identify an ethical consideration. Stress in the animal was the most common, with lack of consent being overlooked.

Most candidates could provide a concluding appraisal with justification.

Responses to this question highlighted many misconceptions surrounding the use of animal models in drug development.

## Recommendations and guidance for the teaching of future candidates

Teachers must use the full range of MYP command terms in their teaching and assessment to enable candidates to become more familiar with what is expected of them in terms of level of response.

Teachers should model how to answer questions using higher level command terms such as explain, discuss and evaluate, justify and compare and contrast to help candidates develop these skills.

Teachers must continue to expose candidates to a range of varied, open-ended practical tasks as well as partially completed lab plans and data sets during their MYP studies.

- Take the opportunity to focus on and model different aspects of the scientific method; it is not always necessary to complete the full process to practice the skills needed.
- Candidates must be given opportunities to construct research questions and hypotheses, as well as evaluate and improve them.
- The selection of pieces of equipment or particular experimental techniques should be discussed in terms of accuracy, precision and reliability. When circumstances (lack of equipment, space, or time) do not allow for, this the impact on the reliability and validity of the data should be explored using the correct terminology.
- Data must be referred to when conclusions are being made or evaluated. Generalisations or trends must be supported or falsified.
- Improvements or extensions must be relevant to the initial research question.

Teachers should provide candidates with regular opportunities to engage with source material linked to real world issues. Candidates need time to plan and produce extended responses where they are challenged to consider relevant factors beyond the environment and economy. Teachers must model how information found in the source material can be used as a starting point for justification and developed accordingly**.**

# Chemistry

## Overall grade boundaries

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| **Grade:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range:** | 0 - 18 | 19 - 37 | 38 - 49 | 50 - 59 | 60 - 69 | 70 - 79 | 80 - 100 |

## General comments

Based on the teacher feedback and the grade award meeting, the standard of the assessment was appropriate and aligned with the MYP criteria.

The assessment allowed the whole range of grades to be achieved and questions could be answered. Teacher feedback raises concerns that the topic lists provided do not provide detailed content.

The length of the examination was suitable for the candidates and it had a good foundation in the topics covered within chemistry. The candidate answers were good on the whole with fewer questions not attempted than in previous assessments.

Teacher feedback and examiners commented that the assessment provided a whole range of questions which allowed access for the lower ability candidates and challenged the higher ability candidates.

The examination team agreed that the assessment tasks were fair, linked to the topic list available and assessed the MYP objectives.

## The areas of the programme and examination which appeared difficult for the candidates

- Candidates struggled to distinguish differences in bonding in group 1 elements and noble gases and the reasons for these differences.
- Candidates struggled to relate increase of temperature with the decomposition of a compound.
- Candidates missed marks by not selecting relevant numbers from drop down menus when balancing equations.
- Candidates struggled to determine the pH range of a solution given relevant data.
- Candidates struggled with relevant significant figures and scientific notation.
- Candidates could not always identify safety symbols.

- Candidates struggled to produce suitable scales for graphs when looking at bar graphs using strategies that would be appropriate for scatter graphs. Candidates also did not use correct values for units.
- Candidates did not always state how many values of the independent variable should be investigated and did not include this detail within the method.
- Candidates also struggled to use their wider MYP knowledge to answer questions.

## The areas of the programme and examination in which candidates appeared well prepared

- Candidates were well prepared to identify trends and properties of the periodic table.
- Candidates were able to identify and name unknown organic compounds using IUPAC nomenclature
- Candidates were able to identify independent, dependent and control variables and understood the need to produce repeats to calculate averages
- Candidates were able to make valid links to the environment.
- Candidates were well prepared for data analysis questions and were able to compare information to make valid judgements.

## The strengths and weaknesses of the candidates in the treatment of individual questions

**Question 1**

Candidates were able to identify groups and periods as well as part of the periodic table but a number of candidates were not able to explain differences in bonding in group 1 elements and noble gases.

**Question 2**

Candidates were able to identify how a catalyst worked. A surprisingly large number of candidates, however, had issues with calculating the mass number of an atom and describing the function of a catalyst. Many candidates were unable to recognise that getting closer to a star will result in a higher temperature and were unable to link this to a change in rate of reaction.

**Question 3**

Candidates were able to name organic compounds using IUPAC nomenclature. Candidates were able to identify issues with a graphical representation of experimental data. A number of candidates did not interact with the dropdown menu to show the correct balanced equation for the combustion of pentane. Many candidates confused rate with the time that a candle burned and increase or decrease of wax melting.

**Question 4**

Candidates were able to identify the independent and dependent variables from information provided. Many candidates, however, had difficulties producing results with appropriate significant figures and/or scientific notation. Many candidates were not able to evaluate hypotheses and data presented or offer additional improvements to investigations.

**Question 5**

Candidates were able to plot graphs with correctly labelled axis and appropriate units but some candidates did not start the scale on the y axis of a bar chart from 0.

**Question 6**

Most candidates were able to identify the independent and control variables and provided a suitable method which would produce relevant data but some forgot to state that they planned to calculate the average (mean) of the results.

Some candidates incorrectly identified energy density as the dependent (measured) variable which limited their mark. Several candidates also forgot that the fuel was a solid and not liquid so tried to fill the spirit burner with a solid fuel.

**Question 7**

Candidates were able to identify pore size as the most important feature of a water filter and were able to correctly identify the advantages and disadvantages of two different types of water filter.

**Question 8**

Candidates were able to compare the economic and environmental impacts of the three methods of water purification. It was demonstrated that they understood and knew how to use the information provided by the question. Where it was required to select an inappropriate technology, very few considered the existence of heavy metals. There was also difficulty in expressing the social impact. Most included a conclusion.

## Recommendations and guidance for the teaching of future candidates

- Teachers should provide opportunities for candidates to strengthen their experimental work, including and emphasizing the identification of variables, method design and data treatment. Candidates should be given opportunities to explain how to improve investigations such as increasing the number of trials and reasons justifying this when provided with suitable data.
- Teachers should work with candidates to expand their knowledge and understanding of various types of graph.
- Candidates should understand the importance of carefully reading the question and not making assumptions.
- Candidates need to know how to differentiate between significant figures and decimal places and need to understand standard form/scientific notation.

# Integrated Sciences

## Overall grade boundaries

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| **Grade:** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Mark range:** | 0 - 14 | 15 - 29 | 30 - 42 | 43 - 51 | 52 - 59 | 60 - 68 | 69 - 100 |

## General comments

This Integrated Sciences on-screen examination was developed considering the four assessment objectives and criteria, key and related concepts, the topic list, and skills for this subject group.

Based on comments from teachers, the general structure of this exam allowed candidates to demonstrate a wide range of knowledge and skills through the exam.

The comments also indicated that there was good coverage of the assessment objectives and criteria. Also, the use of media and stimulus material was clear and appropriate for candidates.

Some teachers commented that the exam was more biased towards physics rather than chemistry and biology and some questions or topics covered within the exam had medium or high difficulty since some of them are not part of their national curriculum or local requirements.

Finally, most teachers stated that the language and accessibility and the time frame for the exam were fair enough for all candidates. Although most pictures and videos worked very well, the alveoli illustration seemed not to be clear enough for all candidates.

## The areas of the programme and examination which appeared difficult for the candidates

There were several parts of the exam that seemed to be difficult for the candidates.

- Explaining biological processes using correct and precise scientific terminology.
- Using the metric multiplier sheet to convert a value and express it in standard form.
- Combining their understanding of chemical and biological processes to provide an explanation.

- Drawing a circuit diagram.
- Justifying control variables in an experiment.
- Selecting appropriate data to cover the full range available.
- Plotting a graph and drawing a line of best fit.
- Stating a weakness in a method and suggesting an improvement.
- Most candidates were not able to suggest specific safety precautions linked to the specific experiment described in the exam.

## The areas of the programme and examination in which candidates appeared well prepared

- Candidates were able to select numbers to balance chemical equations given the chemical formulas and coefficients for the reactants.
- Most candidates were able to plan a complete lab investigation using the information provided.
- Candidates appeared to be well prepared to identify a research question and label graphs according to the information provided.
- Candidates were able to identify dependent, independent and control variables.
- Candidates appeared to be well prepared to answer short and extended responses. Most of the candidates used the prompts provided in the question to organize their ideas.

## The strengths and weaknesses of the candidates in the treatment of individual questions

The following comments are made on individual questions.

**Question 1**

- For question 1b, candidates were able to complete a balanced chemical equation given the chemical formulas and coefficients for the reactants.
- For question 1c, candidates found it difficult to state a structural difference between alveoli in healthy lungs and in diseased lungs based on the picture provided.
- For question 1d, candidates also found it difficult to explain how lung diseases affect the gas exchange process using correct scientific terminology.

**Question 2**

- For question 2b, some candidates were not able to convert values using the metric multiplier sheet.
- For question 2c, candidates were able to interpret the information given to find the difference in values and suggest the country with the highest standards with regards to air pollution.

**Question 3**

- For question 3a, some candidates were not able to identify correctly if the pH of the blood was alkaline, acidic or neutral given the value of 7.4. Some of the candidates stated that the pH was neutral.
- For question 3c, most of the candidates did not get full marks when trying to explain how an increase in breathing rate due to exercising could regulate the pH of the blood.
- For question 3d, most candidates were not able to outline how a decrease in the

number of red blood cells affects the respiration process.

- For question 3e, most candidates were able to formulate a research question using the graph provided.

**Question 4**

- For question 4a, some candidates were not able to correctly draw a circuit diagram based on the equipment provided. Some candidates added unnecessary equipment to the diagram.
- For question 4b, most candidates were able to identify the control variables although incomplete or incorrect justifications were provided.
- For question 4c, most candidates were able to use the simulation to complete the data table although some of them did not label the missing units correctly or did not use the full range.
- For question 4d, most candidates were able to plot the graph, although some candidates did not use equal increments for the axes scale and a few of them labelled the x and y axes incorrectly. Due to this, some candidates were not able to draw the line of best fit according to the requirement.
- For question 4e, some candidates were not able to use the data from the graph to calculate the resistance of the wire.

**Question 5**

- For questions 5b and 5c, most candidates performed very well. Most of them identified a research question and the independent, dependent and control variables in this investigation. Some of them struggled to state additional equipment for the experiment as they just repeated the same equipment provided in the background information.
- Most candidates provided a good description of the method and a justification on how data would be collected, although more details were often necessary to get full marks.
- Finally, most candidates were not able to state and justify a safety precaution linked to a specific hazard with regards to the experiment.

**Question 6**

- Candidates seem to be very well prepared to answer extended responses. It was clear to the examining team that the prompts provided in the question proved to be a good help for candidates. Many candidates demonstrated excellent critical thinking and communication skills.

The marks of some candidates were limited as they gave unclear strengths and limitations of the function of the earthquake early warning system app. Also, some candidates addressed only one social and one economic issue without appropriate justifications. To get better marks, candidates should have addressed at least two social issues and two economic considerations with full justification.

## Recommendations and guidance for the teaching of future candidates

- Candidates need to be familiar with the use of media resources and stimulus material (interactive tools, videos, graphics, images, others).
- Candidates should be able to use knowledge and understanding of the integrated sciences subjects to provide a complete explanation of a process. Candidates need to be aware of the importance of the correct use of scientific terminology.
- Candidates should be able to write a complete method, fully described that could be

easily followed. If required, the method should include all variables and must consider 5 values of the independent variable, 3 trials and plans to calculate an average.

- Candidates should be able to state additional equipment, if required, according to the experiment.
- Candidates should be able to state and justify precise safety precautions linked to the experiment. Standard safety precautions such as the use of lab coats, safety glasses or teacher´s supervision while essential, are not specific to the experiment.
- Candidates should be able to collect a full range of data according to the information or simulation provided.
- Candidates should be capable of processing data using data from graphs with different methods. Also, candidates should be able to draw a line of best fit on a graph.
- Candidates should use all the information provided to answer a question, especially the prompts when scaffolding extended responses.
- It is highly recommended to use the familiarization material provided by the IB to enhance a candidate's preparation for the exam.

# Physics

## Overall grade boundaries

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## General comments

The feedback given by schools and teachers was overwhelmingly positive. Although some candidates referred to a lack of time to complete all of the questions, and to the difficulty of some of the elements of the exam, it should be noted that the majority of candidates were able to complete all of the elements required. The higher level of difficulty of some of the questions should be expected, as any assessment should include varying levels of demand.

Candidates showed familiarity with the tools of the on-screen exam and were able to present their work in the correct format throughout. It is expected that candidates will show equations and units in the correct format, this involves the use of superscripts when appropriate. It is also expected that candidates are able to access the formula sheet, the periodic table, and to use the on-screen calculator as part of the assessment.

## The areas of the programme and examination which appeared difficult for the candidates

The organisation and presentation of data in tables seemed to cause problems for a number of candidates. This was slightly surprising as formatting tables is usually considered to be a low-level skill. However, the question in this year's assessment was slightly trickier than in previous years.

Relatively few candidates were able to apply scientific knowledge and understanding to explain a hypothesis at a complex level. Candidates found the explanation of why a ball accelerates down a ramp challenging. In addition to this, few candidates were able to explain changes to the force of air resistance when surface area increases by reference to the particle model.

Many candidates simply need more practice with the graphical analysis of relationships. If 'y is directly proportional to x', then the graph is a straight-line that goes through the origin. When a straight-line does not pass through the origin (hence, it has a significant y-intercept), the

variables are only linearly related. Only the strongest candidates were able to make the link between the formula of a relationship and its representation on a graph. Not all relationships in Physics involve finding the gradient from a directly proportional relationship and in question 6 candidates were required to find the intercept from a relationship that was processed to a linear form. Similarly the processing of data and the deduction of units from unfamiliar relationships was found to be challenging by many.

## The areas of the programme and examination in which candidates appeared well prepared

The majority of candidates gave a clear and structured plan for the scientific investigation that was the subject of question 5b. The standard of the extended response planning questions has improved, and it was pleasing to see how the structure of the candidate responses clearly matched the requirements of the task.

The extended responses for question 8 were also of a good standard on the whole. Most candidates were able to respond to the context of the question to give interesting insights and opinions on the use of drones in surveillance. The structure of these extended responses seems to be improving and are matched to the requirements of the task. The responses to 7b were similarly good.

Candidates, on the whole, seemed to be comfortable with the identification of the variables from a scientific investigation, as evidenced by question 4. Also, the suggestion of the variables for a follow-up investigation was well done.

Most candidates were comfortable in performing simple calculations involving the selection of the correct formula, for example when calculating kinetic energy of the moving car in question 3.

## The strengths and weaknesses of the candidates in the treatment of individual questions

**Question 1**

1a was designed to be a low demand question but it was surprising how many candidates thought that radio waves travelled at a different speed to light waves in a vacuum. Also, identifying the phenomenon of diffraction in 1b was not done successfully by a number of candidates. The calculation of time in 1c was relatively well done on the whole but the use of scientific notation caused problems for some. 1d had a broad range of acceptable answers. Candidates that were familiar with the use of radio waves in technology were capable of answering this question comfortably although it seemed many candidates were not. Some candidates simply repeated the information given in the question to no avail.

**Question 2**

2a was relatively low demand and most candidates were successful in answering it. Some candidates selected 63 as the number of electrons seemingly without recognising the end of the sentence as being 'in the nucleus'. 2b had mixed levels of success. It seemed that a number of candidates were not familiar with beta emissions being high speed electrons. A number of candidates did not select the correct path for the radiation which meant that they couldn't get any marks for this question. 2c was well done and most candidates were able to use the graph to identify the half-life of the isotope correctly. The responses to 2d were a little mixed and some candidates mistook the question to be about imaging – this has been the subject of previous Physics MYP questions. However, the question specifically referred to the treatment of medical conditions such as cancer.

**Question 3**

3a was a low demand question and was very well done by the candidates. 3b was more challenging and fewer candidates were successful in this question. Further practice with the use of the kinematic equations may be of benefit here. Rounding the answer to 3 significant figures was not done successfully by all candidates, even if they had calculated the correct answer. The concept of wasted energy was not clearly communicated by all candidates in 3c despite different terminology being allowed - (energy not readily available for performing work, energy that cannot be used by the car, energy that is not useful etc.) The possibly unfamiliar context of 3d was challenging for some although on the whole this was done well. 3e required the candidates to state that the battery could be used to power the car but many candidates simply repeated that the battery was recharged without stating what purpose this was meant to serve. 3f had many responses including the correct reference to climate change but not all of these correctly linked the gas carbon dioxide to this phenomenon.

**Question 4**

4a and 4b were low demand questions. However, candidates should always read the questions carefully. It is clearly stated that the candidate decides to change the distance that the ball rolls and measure the time taken. Despite this, some candidates referred to the angle of the slope as the independent variable. 4c was not answered successfully by many candidates and this was surprising given the demand of the question. All that was required was a correct reference to Newton's laws and the identification of the unbalanced force that was present. Some candidates communicated that this situation was an example of a constant state of motion and referenced Newton's first law but this is clearly incorrect as acceleration is a changing state of motion. 4d was designed to be more challenging and some candidates did well here but it is clear that other candidates need more practice in the linearization of functions that would not normally give a straight-line graph. The distinction between a proportional function and a straight line or linear graph was made in the marking the question and candidates should be accurate with the terminology that they use here. For 4e, rounding caused problems as did using appropriate units, these are skills that should be routinely practised as part of practical work. 4f required a specific response to the limitations of the use of the water clock. Candidates that referred to a lack of accuracy or precision were given no credit as this is a stock response

which doesn't meet the requirements of the question. 4g and 4h were well done by the majority of candidates.

**Question 5**

For 5a the majority of candidates made a valid hypothesis that referred to air resistance as the explanation. However, relatively few candidates made a correct reference to particle theory to explain this hypothesis in detail. It should be emphasised that correct terminology should be used with an explanation so the idea of the collisions of air particles with the surface of the parachute is communicated clearly.

5b was well done on the whole and candidates were able to write down well-structured experimental plans with clear sections that met the requirements of the task. The best responses for 5b included valid justifications for the 2 control variables and quantitative information in the method that made it more detailed and descriptive. It should also be noted that if repeated trials are performed then it should be clear what is to be done with these measurements in the processing. There was one point awarded for a safety precaution but this had to be relevant to the situation – e.g. precautions when working at height or when using cutting equipment.

**Question 6**

Question 6 involved the collection of data and the processing of this data to determine the focal length of a lens. There is no requirement for the candidates to have prior experience of this investigation, or to have any knowledge about the phenomena involved, to complete the question. Some candidates seemed to be uncomfortable in attempting data collection for an investigation with which they may be unfamiliar but following instructions and the application of knowledge and skills to unfamiliar situations is a vital skill. In 6a a number of candidates gave the scale reading correctly (42.8cm) but didn't use this to find the distance the lens by subtracting 30cm from it. 6b involved the organization and presentation of data in a table. This is a basic skill and to make it non-trivial there were some things that needed to be corrected, such as mixed units and inconsistent decimal places. Relatively few candidates were able to get all the marks for this question. 6c involved some data processing. Most candidates wrote 5.87 but a number of candidates gave an incorrectly rounded version of f and incorrect units for the last column. Most candidates identified the anomaly in 6d. In 6e candidates needed to ignore the anomaly and to consider the numbers of points above and below the line to get the correct answer of C. 6f required the candidates to use the intercept of the graph to find f – this information was given in the question. Some candidates used a gradient calculation, even though this was not what was required. Relatively few candidates were able to achieve full marks for this last question.

**Question 7**

7a was generally well done. 7b was also well done on the whole, although some candidates failed to give a clear conclusion to the discussion. Also it was notable that the more detailed

responses here made specific reference to the situation of delivering medical supplies and the advantages and disadvantages linked to this particular situation.

**Question 8**

The use of drones in surveillance was a context that gave candidates the opportunity to respond in different ways. A number of candidates made interesting and insightful discussion points. Across the cohort there was a wide variety of responses and different ideas and opinions that were communicated. The best responses included specific and detailed references to how drones can be used in environmental monitoring. Some responses were not balanced in terms of positive and negative implications when it came to the social and political implications and this limited the points that were achieved by these candidates. Candidates should be reminded that a discussion should have two sides. Higher-level responses recognised the need for some kind of regulation regarding the use of drones in surveillance and suggested scenarios in which their use would be appropriate.

## Recommendations and guidance for the teaching of future candidates

Some candidates seemed uncomfortable with the application of the skills of data collection, data processing and analysis when performing an investigation that they haven't seen before. There are a number of classic labs that are performed in physics classrooms around the world, for example; Hooke's law, the period of a pendulum, Ohm's law etc. but candidates should develop the skills required to be able to transfer to new situations rather than learning the process of performing certain investigations. Candidates should be given experience with different kinds of data and different kinds of relationships in order to practice their processing and presentation. The presentation of data in tables and graphs is something that is best learned through classroom experience and practice.

Explicitly teaching the skill of graphical analysis would benefit candidates. More specifically, teaching how to linearize data and the difference between a linear relationship that has a y-intercept and a proportional relationship that has no y-intercept. Not all relationships in Physics are direct proportion with a gradient that refers to a constant of proportionality. Candidates should be given practice with powered relationships and inverse proportion so that they can learn how to linearize different data sets. Graphical analysis should involve the analysis of an intercept as well as the calculation of a gradient. Candidates can be given a task similar to question 6 in which they collect data, process the data and find a result based on graphical analysis in a classroom activity.

Candidates will become stronger in their experimental design questions if teachers create an inquiry-based learning environment where teachers provide guidance and let candidates design/select their own procedures. Remind candidates that they need to list each piece of equipment that would be required to make measurements of the key variables. Candidates need to reflect on what kind of data they will record and what equipment is needed to make the

appropriate measurements. Sometimes thinking of the end result data table is helpful before listing equipment.

The use of scientific knowledge and understanding to explain a hypothesis is something that requires practice. It is clear that candidates can formulate a testable hypothesis but the statement of 'what' is less challenging than making the link to 'why'. Candidates should be given the opportunity to explain certain phenomena, or stated hypotheses, without being told the principles that they should use to make this explanation. This is part of the development of the inquiry-based learning environment that was mentioned previously.

Sometimes candidates will answer questions with stock responses such as using the terms "accuracy" or "precision". It is fine to use these terms but they need to be specifically referenced to details about the experiment or scenario. Too often candidates fail to elaborate and apply their knowledge to the specific situation. In general, candidates need to work on justifying their claims with the evidence provided. For example, candidates will know which is the correct graph but struggle to provide the correct evidence for their choice.

Further practice with the use of the kinematic equations is suggested, together with developing an understanding of when these equations are appropriate.

Candidates should be reminded to elaborate beyond what is given in the question. Often candidates tend to restate given information but they need to elaborate and show comprehension of the concepts applied to the situations and give further details to be awarded credit.
With essay questions where candidates are required to discuss and evaluate the advantages or disadvantages of a scenario, candidates need to practice answering these types of questions and answer them correctly. Sometimes candidates restate facts that are given (recycling information that is already given in the video or script). Candidates need to realize that this gives minimal reward. Their responses need to show interpretation with appropriate justification. It is helpful for candidates to be taught the CER (Claim Evidence Reasoning) approach. They can use certain facts to make a claim but they need to justify their claim with evidence. The evidence is used to justify their claim with appropriate reasoning. It is crucial that candidates need to justify their identified advantages and disadvantages. It also helps when candidates write their responses in a logical order (a paragraph for the advantages and a paragraph for the disadvantages). Candidates need to practice explaining physical principles linking science to the scenario. Simply recycling information that is given in the question is not enough.