Physics 2019 v1.3

IA3: Sample assessment instrument

Research investigation (20%)

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Student name

Student number

Teacher

Issued

Due date

Marking summary

Criterion	Marks allocated	Provisional marks
Research and planning	6	
Analysis and interpretation	6	
Conclusion and evaluation	6	
Communication	2	
Overall	**20**	

Conditions

Technique	Research investigation
Unit	Unit 4: Revolutions in modern physics
Topic/s	Topic 1: Special relativity Topic 2: Quantum theory
Duration	10 hours of class time
Mode/length	Written (e.g. scientific essay): 1500–2000 words
Individual/group	Individual
Resources	School library (online: internet and school intranet, databases, journals)

Context

Investigate one of the following claims:

- The theory of relativity explains the cosmos and everything in it.
- Climate change can be modelled using blackbody radiation.
- Using electrons for microscopy means there is no limit to the resolution that can be achieved.
- Quantum theories explain the origin of life.
- Bruce Banner absorbs ambient gamma radiation, converting its energy into mass during the transformation into the Hulk.

You may identify an alternative claim in consultation with your teacher. This claim must be related to Unit 4 subject matter.

Task

Gather secondary evidence related to a research question to evaluate the claim. Develop your research question based on a number of possible claims provided by your teacher.

Obtain evidence by researching scientifically credible sources, such as scientific journals, books by well-credentialed scientists, and websites of governments, universities, independent research bodies or science and technology manufacturers. You must adhere to research conventions.

To complete this task, you must:

- select a claim to be evaluated
- identify the relevant scientific concepts associated with the claim
- pose a research question addressing an aspect of the claim
- conduct research to gather scientific evidence that may be used to address the research question and subsequently evaluate the claim
- analyse the data to identify sufficient and relevant evidence
- identify the trends, patterns or relationships in the evidence
- analyse the evidence to identify limitations
- interpret the evidence to construct justified scientific arguments
- interpret the evidence to form a justified conclusion to the research question
- discuss the quality of the evidence
- evaluate the claim by extrapolating the findings of the research question to the claim
- suggest improvements and extensions to the investigation
- communicate findings in an appropriate scientific genre, i.e. scientific essay.

Checkpoints

☐ Week 1: Select claim and develop research question.

☐ Week 2: Identify sources and conduct research.

☐ Week 3: Analyse and evaluate evidence.

☐ Week 4: Submit draft

☐ Week 5: Submit final response.

Authentication strategies

- The teacher will provide class time for task completion.
- Students will provide documentation of their progress at indicated checkpoints.
- The teacher will collect and annotate one draft.
- The teacher will conduct interviews or consultations with each student as they develop the response.
- Students will use plagiarism-detection software at submission of the response.
- Students must acknowledge all sources.

Scaffolding

The response must be presented using an appropriate scientific genre (i.e. empirical essay) and contain:

- a claim
- a research question
- a rationale for the investigation
- justified scientific arguments using evidence
- a conclusion to the research question based on the interpretation of the evidence
- evaluation of the claim and suggestions of improvements and extensions to the investigation
- a reference list.

An example of how one of the claims could be developed into a research question

Claim: Bruce Banner absorbs ambient gamma radiation, converting its energy into mass during the transformation into the Hulk.

Developing the research question:

Step	Description	Example
1	**Break down the claim.** Identify the key terms of the claim.	**Claim:** Bruce Banner absorbs ambient gamma radiation, converting its energy into mass during the transformation into the Hulk. **Key terms:** *gamma radiation*, *convert energy to mass*

2	**Question the key elements of the claim.** Generate questions that help clarify the key terms as they relate to the unit of study.	• How much ambient gamma radiation exists on Earth? • How much mass increase occurs during the transformation? • How much energy is equivalent to the mass increase?
3	**Pose possible research questions.** Extend the questions from Step 2 to ask how the key terms could be linked.	• Is there a biological structure that can convert energy into mass? • How much energy is required to convert Bruce Banner's mass into the Hulk?
4	**Critique the questions.** Examine the possible research questions for their suitability to the task: • Do they only consider one independent variable? • Do they include an element that can be measured using data? • Is the scope suitable to allow for a detailed 1500–2000-word answer?	• Is there a biological structure that can convert energy into mass? – Not relevant to the unit topics. • How much energy is required to convert Bruce Banner's mass into the Hulk? – Not specific to the type of radiation in the claim. – Not specific to a version of the Hulk, e.g. the Incredible Hulk or Grey Hulk.
5	**Finalise the research question.** Use the results of the critique to select and finalise the research question.	• Assuming there was a way to convert gamma radiation directly into mass, how much gamma radiation, and from what source, would change Bruce Banner's mass into the Incredible Hulk's mass?

Note: You cannot use this sample research question for your investigation.

Instrument-specific marking guide

IA3: Extended response — Research investigation (20%)

Criterion: Research and planning

Assessment objectives

2. apply understanding of special relativity, quantum theory or the Standard Model to develop research questions
5. investigate phenomena associated with special relativity, quantum theory or the Standard Model through research

The student work has the following characteristics:	Marks
• informed application of understanding of special relativity, quantum theory or the Standard Model demonstrated by a considered rationale identifying clear development of the research question from the claim • effective and efficient investigation of phenomena associated with special relativity, quantum theory or the Standard Model demonstrated by – a specific and relevant research question – selection of sufficient and relevant sources.	5–6
• adequate application of understanding of special relativity, quantum theory or the Standard Model demonstrated by a reasonable rationale that links the research question and the claim • effective investigation of phenomena associated with special relativity, quantum theory or the Standard Model demonstrated by – a relevant research question – selection of relevant sources.	3–4
• rudimentary application of understanding of special relativity, quantum theory or the Standard Model demonstrated by a vague or irrelevant rationale for the investigation • ineffective investigation of phenomena associated with special relativity, quantum theory or the Standard Model demonstrated by – an inappropriate research question – selection of insufficient and irrelevant sources.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Analysis and interpretation

Assessment objectives

3. analyse research evidence about special relativity, quantum theory or the Standard Model
4. interpret research evidence about special relativity, quantum theory or the Standard Model

The student work has the following characteristics:	Marks
• systematic and effective analysis of qualitative data and/or quantitative data within the sources about special relativity, quantum theory or the Standard Model demonstrated by – the identification of sufficient and relevant evidence – thorough identification of relevant trends, patterns or relationships – thorough and appropriate identification of limitations of evidence • insightful interpretation of research evidence about special relativity, quantum theory or the Standard Model demonstrated by justified scientific argument/s.	5–6
• effective analysis of qualitative data and/or quantitative data within the sources about special relativity, quantum theory or the Standard Model demonstrated by – the identification of relevant evidence – identification of obvious trends, patterns or relationships – basic identification of limitations of evidence • adequate interpretation of research evidence about special relativity, quantum theory or the Standard Model demonstrated by reasonable scientific argument/s.	3–4
• rudimentary analysis of qualitative data and/or quantitative data within the sources about special relativity, quantum theory or the Standard Model demonstrated by – the identification of insufficient and irrelevant evidence – identification of incorrect or irrelevant trends, patterns or relationships – incorrect or insufficient identification of limitations of evidence • invalid interpretation of research evidence about special relativity, quantum theory or the Standard Model demonstrated by inappropriate or irrelevant argument/s.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Conclusion and evaluation

Assessment objectives

4. interpret research evidence about special relativity, quantum theory or the Standard Model
6. evaluate research processes, claims and conclusions about special relativity, quantum theory or the Standard Model

The student work has the following characteristics:	Marks
• insightful interpretation of research evidence about special relativity, quantum theory or the Standard Model demonstrated by justified conclusion/s linked to the research question • critical evaluation of the research processes, claims and conclusions about special relativity, quantum theory or the Standard Model demonstrated by – insightful discussion of the quality of evidence – extrapolation of credible findings of the research to the claim – suggested improvements and extensions to the investigation that are considered and relevant to the claim.	5–6
• adequate interpretation of research evidence about special relativity, quantum theory or the Standard Model demonstrated by reasonable conclusion/s relevant to the research question • basic evaluation of the research processes, claims and conclusions about special relativity, quantum theory or the Standard Model demonstrated by – reasonable description of the quality of evidence – application of relevant findings of the research to the claim – suggested improvements and extensions to the investigation that are relevant to the claim.	3–4
• invalid interpretation of research evidence about special relativity, quantum theory or the Standard Model demonstrated by inappropriate or irrelevant conclusion/s • superficial evaluation of the research processes, claims and conclusions about special relativity, quantum theory or the Standard Model demonstrated by – cursory or simplistic statements about the quality of evidence – application of insufficient or inappropriate findings of the research to the claim – ineffective or irrelevant suggestions.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Communication

Assessment objectives

7. communicate understandings and research findings, arguments and conclusions about special relativity, quantum theory or the Standard Model

The student work has the following characteristics:	Marks
• effective communication of understandings and research findings, arguments and conclusions about special relativity, quantum theory or the Standard Model demonstrated by – fluent and concise use of scientific language and representations – appropriate use of genre conventions – acknowledgment of sources of information through appropriate use of referencing conventions.	2
• adequate communication of understandings and research findings, arguments and conclusions special relativity, quantum theory or the Standard Model demonstrated by – competent use of scientific language and representations – use of basic genre conventions – use of basic referencing conventions.	1
• does not satisfy any of the descriptors above.	0