Preamble to Template Document

This is a template document, which should be considered as a guideline for the format of your written report. Applicants might notice that this structure is similar to that of a conventional scientific publication or student laboratory report.

This document can be used as a template for both the Phase 1 and Phase 2 submissions. However, the Phase 1 submission does not require the Results, Discussion or Conclusion section. The Phase 1 report must only include only background theory and motivation in an Introduction section and a Methods section or Proposed Methods section. That is, we appreciate that depending on the nature of your project, you may or may not be able to carry out your procedures until after Phase 1. In this case, you can submit a proposal of what you expect your methods to be. We do not expect any substantial results in the Phase 1 submission, although demonstration that the proposed avenue of research is viable will benefit the application.

Quantum Solutions for the Environment Challenge

Quanteam

Team Members:
Jane Doe, School of Physics Master's Student
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University of Template
123 University Street
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Typeset with LaTeX

Date of Submission

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1 Team Introduction

We encourage each team to submit a short introduction to each member of the team. This should be no more than a paragraph per person, such that if you have 4 team members, the introduction will not exceed one page. The information that you include can include both personal or academic information. There is no specific information that you must include, but you might like to share the following:

- Your university and your course
- A specific area of quantum science and technology in which you are interested
- What initially motivated your studies and your interest in quantum science and technology
- If you are part of a multi-person team, what role you fulfilled within the team
- Any achievements, academic or otherwise, that you're proud of that have helped you along your chosen path of study
- What direction you hope to take after you have finished your studies

You are welcome to add photographs, if desired.

2 Introduction

Here, you should contextualise the problem that you are attempting to solve. This section should briefly remind the reader about anthropological climate change and answer questions such as:

- What exactly is climate change?
- How is climate change caused?
- How will climate change impact society?
- To what extent will this impact occur if we do not take steps to mitigate it?

This introduction is an opportunity to give specific and quantitative examples of climate change effects and should therefore include references as appropriate.

Once you have done this, you can highlight a specific problem associated with climate change and describe it. The problem that you tackle could be a *cause* of climate change, for example, you could examine how to reduce vehicular emissions using quantum technologies. However, you could also explore the mitigation of already existing *effects* of climate change, for example, can you propose a way for quantum technologies to better predict extraordinary adverse weather events?

This Introduction section will introduce the requisite background theory regarding your climate change-related problem, but also the theory surrounding your solution. For example, if you choose to model and simulate heavy rainfall and flooding events, you may need to describe fundamental theory regarding computational fluid dynamics as well as quantum neural networks. Be mindful that, given the domain of this competition, the focus of your text should lean more towards quantum-specific theory rather than climate science. Your text should be written in such a way that it is digestible not only by those working in quantum science and technology, but also to the wider scientific community.

Your Introduction section should justify why your chosen area of investigation is valuable to humanity. Will your idea help to improve hardware design? Have you noticed an efficiency improvement that could be implemented in power generation through the use of quantum technology? Have you created a tool that can help school students become more knowledgeable and excited about quantum physics?

3 Methods (or Proposed Method in Phase 1)

In the Methods section, you should describe what you did and what tools you used. For example, if you used QuTip for Bloch sphere illustrations, or Cirq for building and running a quantum circuit, you should state this and state why you chose what you used. If you use a given quantum algorithm, again you should explain why you selected it. It might also be necessary to give background information in your Introduction section supporting its use and explaining its foundational principles. For example, if you use the variational quantum eigensolver, your report may benefit from including an explanation of the variational method in quantum mechanics. Your Methods section should give the reader sufficient information such that they could accurately replicate and repeat the steps you have taken. Psuedocode might be included in this section, if required. Links to GitHub repositories, or similar, are also welcome.

Depending on the extent of your work, you may choose to include a brief Methods section at this point while providing a more comprehensive section in an Appendix. This may be a preferable alternative to having a very lengthy Methods section within the main text.

We emphasise here that the project is not limited to quantum-software-centric submissions. However, we note that there are more software tools in the public domain than hardware tools; there is no "Build Your Own Dilution Refrigerator Kit" but there are dozens of open-source quantum technology tools online. Despite this, physical devices or models of physical devices are worthy of inclusion in a report. If you have an idea for a device design whose features you can justify, this could be a worthy project. Additionally, your submission may include a quantum technology solution in the broad sense, for example, you could design a program, tool or apparatus that might help students to better understand a challenging topic in quantum mechanics. Given the scope of the competition, projects which show a clear interplay between quantum technology and the combat of climate change will have an advantage. Applicants are welcome to send queries to the support email listed on the competition webpage if they would like to confirm the eligibility of their project idea.

4 Results (Phase 2 Only)

When presenting the Results, you should provide *only* the results to the reader, be this in the form of tables, figures or in some other form. You should answer the question of *What are my results?* rather than *What do my results mean?* For example, if you identify a significant graphical feature, such as a peak on a curve, highlight it in this section to draw the reader's attention. You can then elaborate on its significance in the Discussion section, referring back to the observation noted here in the Results section.

5 Discussion of Results & Project Impact (Phase 2 Only)

This section, much like a conventional Discussion section, presents an opportunity to reflect on your results and your method, but also an opportunity to examine the impact of your proposed solution. You can justify why you chose the given approaches, tools, and/or materials that you described in your Methods section. If applicable, you should comment on whether or not your

results align with existing scientific research on the topic. If you find that your results deviate from what might be expected given other data, explain why this might be the case. You also can critique the approach that you took, comment on whether there were any methods that you used which you consider to be worthy of improvement. Finally, you can clearly explain how your results relate to the theory that was introduced during the Introduction section of the report. This will ideally lead to a comparison with existing literature.

Projects could also offer some application as a product or service. Therefore, you might choose to include how your proposed solution might be benefit the market. Bear in mind, you should have already provided a description of the problem and the motivation for solving it in your Introduction section, so any revision of the above should be concise.

6 Conclusion (Phase 2 Only)

This is a place for synopsising your report and highlighting key takeaways. It is not a place for introduction of new theory or new results. Ideally, the reader will understand the basics of your motivation, approach and the outcome of your work, simply by reading your Conclusion.

References