

## Guidelines for the Year-2 Quantum Essay

### Overview and learning objectives

In this assignment, you will write an essay concerning quantum physics for readers that are not experts in the subject. The primary learning objective is to further develop your ability to communicate challenging scientific content in writing. A second objective is to investigate a connection between the Quantum module content and published scientific literature. Additionally, writing the essay will help you consolidate key concepts in quantum theory.

To be successful, it will be important to introduce and explain aspects of quantum theory from our module that are essential to your chosen topic. To do this within the recommended word length, the content will need to be carefully planned and precisely presented.

Each submission will include a cover page and an essay:

#### **Cover page** (200-300 words recommended)

Include (1) your name and CID number, (2) a word count for the essay, and (3) a “Research & Writing Methods” section, as described on the next page.

#### **Essay** (2000-2400 words recommended, 2400 words maximum)

Present a topic related to quantum physics content taught in Term 1, by drawing upon published scientific literature. The target audience for the essay is typical Imperial physics students just starting their second year. Your essay should include an explanation of at least one core concept from our quantum lectures, appropriate for this target audience, and also extend to concepts beyond taught material.

### Further information

Please see the following pages for further details, advice, and assessment information.

### Submission

The essays should be submitted as a PDF document via the Quantum Physics Blackboard site. The deadline is **4 pm on Thursday, 22 January 2025.**

### Questions

Contact Steve Kolthammer by e-mail ([wkoltham@ic.ac.uk](mailto:wkoltham@ic.ac.uk)) for clarification about the assignment. If any response adds significantly to the provided guidance, it will be shared with all students.

## Further details

Anticipated workload: Based on previous feedback, most students will likely complete the assignment with 10-16 hours of total work.

Word limits: The recommended length for the essay is 2000-2400 words, and the maximum is 2400. The recommended length for the Research & Writing Methods is 200-300 words, and the maximum is 600.

Description of Research & Writing Methods: On your cover page, briefly describe how you went about your work, including selecting and researching the topic as well as writing and editing. Describe any use of generative AI. Acknowledge any direct help received from other people. The purpose of this narrative is for you to review your process, and to give instructors an opportunity to provide feedback on this.

This Methods section will be assessed separately from the main essay as either satisfactory or unsatisfactory. In the latter case, you may re-submit the section and respond to feedback to achieve a satisfactory assessment without any penalty of marks.

Equations and figures: You should use some equations in precisely introducing aspects of quantum theory. These should not overwhelm descriptive text, however, so use these judiciously and avoid lengthy derivations. Figures may also be included if they aid communication, in which case they should be explained within the main narrative. To get ideas for effective presentation of equations and figures, look at scientific publications such as textbooks and research journal articles.

Formatting: There are no specific requirements for formatting the article, and this should be done to prioritize clarity and make the article enjoyable to read. If in doubt, use a standard font (e.g., Times Roman, Arial, Helvetica), 12-point size, and 1.5 line spacing. A descriptive title for the essay is recommended. The article must be submitted as a PDF.

Referencing: A minimum of 3 references to published scientific literature (e.g. journal articles, textbooks) should be used, and 4-6+ are likely to be helpful, though more is not necessarily better. You might also have additional references to other sources, such as popular science articles. Cite your sources and include a reference section at the end of the essay, with a consistent style, such as the Harvard or Vancouver reference style. Further guidance is available from the Imperial College library.

Plagiarism: Writing an article that summarises work that is not your own can risk plagiarism. It is easy to accidentally plagiarise in small amounts by too closely paraphrasing a chunk of text or by using a copyrighted figure. Even minor acts of plagiarism can cause offence or lead to serious professional problems. General guidelines on plagiarism can be found on the university webpages. For generative AI, refer to the Department guidance “Generative AI Tools”, which is included below, noting that any direct use of text or ideas from generative AI should be referenced appropriately in the essay.

Assessment: Please see the “Assessment details” section below.

## Further Advice

### General advice

Read the Guidelines and Assessment Details carefully.

Here is a suggested process for tackling the assignment:

- 1) Make a list of possible topics. (See next section for advice.)
- 2) Make a rough outline for an essay, based on a preliminary literature search. The outline should indicate the main ideas and their logical ordering.
- 3) Repeat step 2 a few times for different topics, returning to step 1 as needed.
- 4) Select an outline that you think works best for the assignment.
- 5) Write an initial draft.
- 6) Use the self-assessment rubric to identify areas to improve.
- 7) Start early and leave time to edit.

Note that the marking will put no significance on choosing an original topic. I recommend you make an effort to identify and select a topic that makes the assignment relatively easy.

### Advice for identifying topics

Here is one method to get started. Skim the lecture notes and list some taught ideas that stand out. Alternately, go to the library and skim sections of textbooks on introductory quantum physics that cover similar material. To get inspiration for material that extends beyond lecture material, you might find ideas in footnotes or problems at the end of chapters (some textbooks even reference research papers).

Use this initial list to identify “keywords” as a starting point for web searches. For example, if a potential topic is quantum tunnelling, you might search Google for “experimental quantum tunnelling” to find some research papers, websites of academic research groups, discussion forums, and popular science media—all of which can suggest further ideas. As an alternate to a web search, you can use generative AI chat interface (such as the College provided Copilot) with a prompt such as “find 5 research papers published since 2010 on experimental quantum tunnelling”.

A main challenge is connecting published scientific literature, some of which is very advanced, to material we’ve learned. Take time to find a suitable topic that makes this task relatively easy. A good topic will likely include one, or possibly a few, new concepts that you can introduce and clearly relate to core material from Term 1, which you will have explained earlier in the essay.

### Advice for refining topics

Good scientific writing prioritizes precision and clarity. In searching literature, you will likely come across many ideas, and it may be tempting to cover too wide of a scope in your essay. This issue can be exacerbated by AI chat tools, which can encourage superficial engagement with a wide range of content. Take the time to refine your topic to one key idea, or a few closely related ideas, that you can thoroughly understand. Use your essay to teach these ideas to the target audience with the level of precision and clarity found in a good textbook or a good set of lecture notes.

## Assessment Details for the Year-2 Quantum Essay

### Overview

Assessment of the essay will consist of marks in five categories:

- Scientific Content (30%)
- Narrative (30%)
- Writing Quality (20%)
- Use of Mathematical Expressions (10%)
- Use of References (10%)

The final mark for the essay is the weighted average of these categories, using the weights given above. Additional feedback will highlight standout strengths of an essay and elaborate on the main areas for improvement.

### Rubric for self-assessment

The following tables show key elements that contribute to successful scientific writing, arranged according to the marking categories. These are intended as a learning resource to aid you in writing the essay, and they also indicate the main components that will factor into category marks.

You can use the descriptive text on each row as a tool for self-assessment (or peer-assessment) of essays, as part of your writing process. These descriptions are provided to indicate how characteristics of an essay align with a category mark. However, please note that an assessor's category marks will not simply be computed from these elements; instead these marks will represent a holistic evaluation of each category.

[Content]  (30%) Holistic mark: Does the scientific content serve the aims of the essay?	Minimal (0%)	Inadequate (30%)	Satisfactory (50%)	Good (60%)	Very good (70%)	Excellent (85%)	Outstanding (100%)
<b>C1.Accuracy</b>  Feedback: Is the content correct? Does it avoid ambiguity (considering the audience)?	Minimal: Nearly all content is incorrect or too unclear to evaluate.	Inadequate: much of the essential content is incorrect, or too unclear to evaluate.	Satisfactory: Some essential content is incorrect or ambiguous.	Good: Nearly all essential content is correct and reasonably unambiguous.	Very good: The essential content is correct and reasonably unambiguous.	Excellent: There are only very minor points of ambiguity.	Outstanding: There are no significant suggestions for improvement.
<b>C2.Level</b>  Feedback: Is the level of content appropriate for the audience?	Minimal: Most of the content is TOO ADVANCED for the audience.	Inadequate: Substantial essential content is TOO ADVANCED for the audience.	Satisfactory: Substantial essential content is TOO FAMILIAR to the audience.	Good: Mostly appropriate, but a significant part is TOO ADVANCED for the audience.	Very good: Mostly appropriate, but a significant part is TOO FAMILIAR to the audience.	Excellent: There are only very minor instances that are not appropriate for the audience.	Outstanding: There are no significant suggestions for improvement.
<b>C3.Subject</b>  Feedback: Does the essay's subject appropriately respond to the assignment prompt? (Note: originality in the choice of topic does not contribute to assessment.)	Minimal: The prompt is not significantly addressed by the essay.	Inadequate: The prompt is partly addressed by the essay.	Satisfactory: The prompt is mostly addressed by the essay.				Outstanding: There are no significant suggestions for improvement.

<b>[Narrative]</b> <b>(30%) Holistic mark: Does the narrative serve the aims of the essay?</b>	Minimal (0%)	Inadequate (30%)	Satisfactory (50%)	Good (60%)	Very good (70%)	Excellent (85%)	Outstanding (100%)
<b>N1.Background</b> <b>Feedback: Does the essay describe the background context of its subject? Does it indicate why the reader should be interested?</b>	Minimal: No relevant background information is given.	Inadequate: The background information is too general, lacking clear connections to the specific topic of the essay.	Satisfactory: Some appropriate background is presented, but insufficient motivation is established for the main topic.	Good: The background and motivation are explained, but there are significant aspects to improve.	Very good: The background and motivation are explained, but better clarity is needed to improve.	Excellent: There are only very minor issues with the background and motivating information.	Outstanding: There are no significant suggestions for improvement.
<b>N2.Logic</b> <b>Feedback: Is the content developed in a logical manner, with the reasoning of each step appropriately explained?</b>	Minimal: The narrative does not contain any logical development.	Inadequate: The narrative's logic is largely difficult to follow.	Satisfactory: The narrative's logic is apparent in some significant parts.	Good: The narrative's logic is generally good, but a significant aspect is difficult to follow.	Very good: The narrative's logic is good throughout, and there are only a few specific steps to improve.	Excellent: There are only very minor issues with the narrative's logic.	Outstanding: There are no significant suggestions for improvement.
<b>N3.Add</b> <b>Feedback: Would the essay be improved by adding some particular content, considering the length limitations?</b>	Minimal: The essay is missing most of the content needed to meet its aims.	Inadequate: A substantial addition of concepts are needed for the essay to meet its aims.	Satisfactory: The essay covers most of the essential concepts needed to meet its aims.	Good: The essay covers all essential concepts, but one or a few additional elements would be substantial improvement.	Very good: Addition of specific elements would improve the essay.	Excellent: Addition of specific elements would be a minor improvement.	Outstanding: There are no significant suggestions for improvement.
<b>N3.Remove</b> <b>Feedback: Would the essay be improved by removing some content?</b>	Minimal: Most of the concepts do not contribute to the essay's aims.	Inadequate: Substantial concepts do not contribute to the essay's aims.	Satisfactory: Most of the main concepts presented are relevant to the essay's aims.	Good: The main concepts are appropriate. Removing specific elements would be a substantial improvement.	Very good: Removing specific elements would improve the essay.	Excellent: Removing specific elements would be a minor improvement.	Outstanding: There are no significant suggestions for improvement.
<b>N4.Conclusion</b> <b>Feedback: Do concluding comments, even if brief, reinforce the main points and describe their implications?</b>	Minimal: The reader is left with little understanding of the main learning points.	Inadequate: The reader is left with a poor understanding of the intended main learning points.	Satisfactory: The reader can partly identify the intended main learning points.	Good: The reader is left understanding the main points, but they are unclear on the implications.	Very good: The conclusion is successful, but specific elements could be improved.	Excellent: The conclusion is successful, and there are only minor elements to improve.	Outstanding: There are no significant suggestions for improvement.

<b>[Writing]</b> <b>(20%) Holistic mark. Does the writing quality serve the aims of the essay?</b>	Minimal (0%)	Inadequate (30%)	Satisfactory (50%)	Good (60%)	Very good (70%)	Excellent (85%)	Outstanding (100%)
<b>W1.Elements</b> <b>Feedback: Does the sentence and paragraph construction achieve clear communication?</b>	Minimal: The reader cannot understand most ideas due to these elements.	Inadequate: The reader can clearly understand few ideas due to these elements.	Satisfactory: The reader can understand all main ideas with considerable effort.	Good: These elements are generally successful, but there is scope for substantial improvement.	Very good: These elements are successful, but specific changes would improve the essay.	Excellent: There are only very minor issues with these writing elements.	Outstanding: There are no significant suggestions for improvement.
<b>W2.Tone</b> <b>Feedback: Does the style and tone achieve clear communication and foster careful thought? (Note: a formal tone is not necessary.)</b>	Minimal: The style and tone prevent most content from being communicated.	Inadequate: The style and tone consistently discourage the reader's engagement.	Satisfactory: The style and tone enable most of the content to be communicated, but inconsistencies are a significant distraction.	Good: The style and tone enable all content to be communicated, but there is scope for substantial improvement.	Very good: The overall tone is too formal or informal, but this is only a minor issue for communication.	Excellent: There are only very minor instances where the tone could be improved.	Outstanding: There are no significant suggestions for improvement.
<b>W3.Accuracy</b> <b>Feedback: Do grammatical errors, poor word choices, spelling errors, or typos obstruct clear communication?</b>	Minimal: Inaccurate writing prevents most content from being communicated.	Inadequate: Inaccurate writing prevents substantial content from being communicated.	Satisfactory: The writing accuracy enables most of the content to be communicated.	Good: The number of writing errors cause a distraction to the reader in multiple places.	Very good: A few writing errors were noticeable, and changes would improve the readability of the essay.	Excellent: A few minor writing errors were noticeable, but these would likely only hinder some readers.	Outstanding: There are very few, if any, errors, and these do not significantly detract from clear communication.
<b>W4.Layout</b> <b>Feedback: Does the layout and formatting of the text enable clear communication?</b>	Minimal: The layout or formatting prevents most content from being communicated.	Inadequate: The layout or formatting prevents substantial content from being communicated.	Satisfactory: The layout or formatting enables content to be communicated, but considerable effort is required of the reader.		Very good: The layout and formatting is generally appropriate, with a few specific issues to improve.		Outstanding: The formatting and layout of the essay is appropriate.
<b>W5.Figures</b> <b>Feedback: Figures are optional. If figures are used, do these appropriately improve communication?</b>	Minimal: The figures used are a significant detriment to the essay.	Inadequate: The figures generally do not help the essay achieve its aims.	Satisfactory: The figures partly enhance the essay, but there are major aspects to improve.	Good: The figures are appropriate, but they are not integrated into the narrative.	Very good: The figures are appropriate, but they are only partly integrated into the narrative.	Excellent: There are only minor suggestions for how the use of figures could be improved.	Outstanding: There are no significant suggestions for improvements. (Or no figures are used.)

<b>[Maths]</b>  <b>(10%) Holistic mark: does the use of mathematics serve the aims of the essay?</b>	Minimal (0%)	Inadequate (30%)	Satisfactory (50%)	Good (60%)	Very good (70%)	Excellent (85%)	Outstanding (100%)
<b>M1.Precise</b>  <b>Do the equations and mathematics used suitably add precision to the content?</b>	Minimal: The maths used do not add any precision to the content.	Inadequate: The maths used do not add significant precision to the content.	Satisfactory: The maths used is only partly successful in adding precision to the content.	Good: The use of maths is generally successful, but there is scope for substantial improvement.	Very good: In one or a few notable instances, the use of maths could be improved.	Excellent: There are only a few minor instances where the use of maths could be improved.	Outstanding: There are no significant suggestions for improvement.
<b>M2.Quantity</b>  <b>Is the quantity of mathematical expressions appropriate? Are there enough to be precise, but not so many as to disrupt the narrative?</b>	Minimal: The quantity of maths used prevents most content from being communicated.	Inadequate: The quantity of maths used is appropriate only in limited areas.	Satisfactory: The quantity of maths is partly appropriate, but adding more could substantially improve the essential content.	Good: The quantity of maths enables precision, but the essay's narrative is significantly overwhelmed.	Very good: The quantity of maths used in one or a few notable instances could be improved.	Excellent: There are only a few minor instances where the quantity of maths could be improved.	Outstanding: There are no significant suggestions for improvement.
<b>M3.Integrated</b>  <b>Are mathematical expressions integrated seamlessly into the prose? Are all variables described?</b>	Minimal: The maths are minimally integrated into the prose.	Inadequate: The maths is presented in a manner that significantly disrupts the prose.	Satisfactory: The maths is mostly integrated, but expressions are often insufficiently defined.	Good: The maths is often not presented grammatically. (See literature for examples.)	Very good: In one or a few notable instances, this could be improved.	Excellent: There are only a few minor instances where this could be improved.	Outstanding: There are no significant suggestions for improvement.
<b>M4.Typeset</b>  <b>Are mathematical expressions displayed in a manner that can be easily understood by the reader?</b>	Minimal: The typesetting of often prevents comprehension.	Inadequate: The typesetting often causes difficulty in comprehension.	Satisfactory: The reader can interpret mathematical expressions with considerable effort.	Good: The typesetting is generally good, but there is scope for substantial improvement. (See literature for examples.)	Very good: In one or a few notable instances, the typesetting could be improved.	Excellent: There are only a few minor instances where the typesetting could be improved.	Outstanding: There are no significant suggestions for improvement.
<b>[References]</b>  <b>(10%) Holistic mark: does the use of references support the aims of the essay?</b>	Minimal (0%)	Inadequate (30%)	Satisfactory (50%)	Good (60%)	Very good (70%)	Excellent (85%)	Outstanding (100%)
<b>R1.Quality</b>  <b>Do the references cited appropriately support the text?</b>	Minimal: The references do not appropriately support the text.	Inadequate: Few of the references appropriately support the text.	Satisfactory: Most of the references appropriately support the text.	Good: The references are appropriate, but better sources are readily available (e.g. primary sources).	Very good: The references are appropriate, but better sources are available (e.g. more relevant literature)	Excellent: There are only a few minor suggestions how the quality of sources could be improved.	Outstanding: There are no significant suggestions for improvement.
<b>R2.Sufficient</b>  <b>Is the content of the essay sufficiently supported by references?</b>	Minimal: References do not sufficiently support any content.	Inadequate: Some essential content is supported by references, but major additions are needed.	Satisfactory: Most essential content is supported by references, but additional references are needed.	Good: The essential content is supported by references, but there are gaps in this support.	Very good: This area is generally very good, but the addition of a key reference is needed to fully support the essay.	Excellent: There are only a minor specific suggestions of how to improve.	Outstanding: There are no significant suggestions for improvement.
<b>R3.Number</b>  <b>Are at least 3 references to published scientific literature (e.g. peer-reviewed journal articles or textbooks)?</b>	Minimal: The essay uses fewer than 3 references to published scientific literature.						Outstanding: There are no significant suggestions for improvement.
<b>R4.Cites</b>  <b>Are citations in the text positioned appropriately to be easily interpreted?</b>	Minimal: The positions of citations do not communicate how sources are used.	Inadequate: The position of citations do not typically communicate how sources are used.	Satisfactory: The position of some citations indicate how sources are used.	Good: The positions of citations indicate how sources are used, but there is often some ambiguity that could be improved.	Very good: The positions of most citations clearly communicate how sources are used, with one or a few notable instances for improvement.	Excellent: In one or a few instances, a citation's position causes minor ambiguity that should be avoided.	Outstanding: There are no significant suggestions for improvement.
<b>R5.Refs</b>  <b>Are references listed in a clear and consistent format that includes essential information?</b>	Minimal: The list of reference does not communicate the essential information.	Inadequate: The list of references communicates essential information for only some references.	Satisfactory: The list of references contains essential information for most references.	Good: The list of references contains all essential information, but there is scope for substantial improvement.	Very good: The list of references contains all essential information, but inconsistent formatting is notable.	Excellent: The list of references is complete with only one or a few very minor errors that are notable.	Outstanding: There are no significant suggestions for improvement.

# Generative AI Tools – Physics Department Guidance

## Background

Generative Artificial Intelligence (GAI) tools, such as ChatGPT, Scribe, GitHub Copilot, etc., are becoming ubiquitous in industry and academia. These tools can help carry out research, increase understanding, and improve output. However, serious risks are involved if misused or used without carefully reviewing the outputs. We outline some general points based on the latest College Guidance on [Generative AI Tools](#).

- AI models are powerful and can be used effectively to check the quality of your written work, prompt new ideas, or generate simplified explanations of complex topics to support your learning. However, the models display limited success in handling mathematical information, scientific evidence, and code. The training of the models is based on limited, sometimes stale information. The predictive nature of the AI models means they often cannot distinguish between accurate references and fabrications. Therefore, it can often return incorrect, irrelevant, or false information.
- Submitting work and assessments created by someone or something else as if it were your own is plagiarism and is a form of cheating. This includes AI-generated content. Please refer to the College's [Academic Misconduct Policy](#) for more information (see also [Physics Plagiarism Guidance](#)).
- Increasingly sophisticated “AI detection tools” are available. These can spot the use of GAI tools in submitted work. The College will use these tools routinely. To ensure quality assurance is maintained, the Department may invite a random selection of students to 'authenticity interviews' on their submitted assessments.

## Guidance for all students submitting academic work

Academic integrity has, and always will be, a core principle in academia. The use of AI models is simply another tool that will be held to account against this principle. Remember, it is the student's responsibility to use GAI tools correctly. Follow these rules if you use GAI or other AI tools.

1. **Verify.** Research the statements and find the sources. You must reference sources for the content generated (including whatever GAI tool you used and an outline of your input to it) and verify the GAI's output (which may be incorrect, irrelevant, or which may itself be presenting the work of others without appropriate acknowledgement). The responsibility for verification of correctness and avoidance of plagiarism is yours alone. If you plagiarise or use unattributed results or content, even unwittingly, you will fall foul of the College's Academic Misconduct Policy.
2. **Review & edit.** Any content created with the help of GAI tools must be appropriate. For example, your work must be written in a style appropriate for the intended purpose or learning outcome. Scientific reports should be written in a concise and precise scientific style without making unsupported assertions. If the style or content of any submitted work is inappropriate, you will lose marks. Thus, GAI output may need significant editing before submission. It is particularly easy to spot the use of GAI tools in narrative content. If you have not acknowledged the use of GAI or other AI tools, you will be challenged in these cases.
3. **Acknowledge.** You must declare the use of GAI or other AI tools when producing academic work. All tools will have standard acknowledgement statements you can include to attribute their use. You cannot submit work generated by GAI for assessment and present it as yours. Doing so is against the College's Academic Misconduct Policy. In many cases, even acknowledgement is not sufficient. For example, if the learning objective is to summarise a scientific paper, you cannot simply use GAI to do this for you.

AI detection tools will be used. Be safe and acknowledge the use of any AI tools.