

# PX2132: Coursework

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## Contents

<b>1</b>	<b>The brief</b>	<b>1</b>
<b>2</b>	<b>Assessment</b>	<b>1</b>
<b>3</b>	<b>Notes</b>	<b>2</b>
<b>4</b>	<b>References</b>	<b>3</b>
<b>5</b>	<b>Weekly questions</b>	<b>3</b>
5.1	Week 1 . . . . .	3
5.2	Week 2 . . . . .	3
5.3	Week 3 . . . . .	3
5.4	Week 4 . . . . .	3
5.5	Week 5 . . . . .	3
5.6	Week 6 . . . . .	4
5.7	Week 7 . . . . .	4
5.8	Week 8 . . . . .	4
5.9	Week 9 . . . . .	4
5.10	Week 10 . . . . .	4
<b>6</b>	<b>Marking Rubrics</b>	<b>5</b>

## 1 The brief

- In teams of 6 you will present a defence of an interpretation of quantum mechanics.
- You must explain your interpretation at a level suitable for the rest of the year group.
- You must illustrate your defence using a particular mathematical result from the course. You are free to choose anything from the syllabus.
- You will only have a short time each week to work together in the live session. This time is intended to co-ordinate tasks outside the live sessions. It is expected that you will spend around 1-2 hours per week working on this outside the live session.
- In week 11 we will hold a conference with a poster session and presentations by each group.

## 2 Assessment

- **This project will count for 20% of your overall mark.** The marks will divide as follows.
  - Your peers from the other groups, as well as some staff, will assess your poster, including the presentation given by the poster presenters. Each member of the team will receive this mark. **This mark will be 5% of your overall grade for the course.**

- Your peers from the other groups, as well as some staff, will assess your spoken presentation. This presentation will last 3 minutes, with 1 minute for questions from the audience. Each member of the team will receive this mark. **This mark will be 5% of your overall grade for the course.**
- You will provide a dossier detailing your personal contributions to your group’s work. This should include a 1-page written summary, in your own words, of your group’s arguments. It can contain as many additional pages detailing your contributions however you wish to present them.
- Your peers from within your own group will assess your contributions to the project, and you will assess your own performance. You will also submit a dossier of evidence of your individual contributions.
  - \* If your own assessment of your contribution matches your peers’ average assessment to within 5 marks out of 100 you will receive your peers’ mark.
  - \* Otherwise your dossier will be inspected and a mark assigned based on the evidence you present.
  - \* If your group’s scores for the poster and presentation are 60% or below, your dossier will be taken into account.
  - \* **This mark will be 10% of your overall grade for the course.**

### 3 Notes

- Look for the good in your peers’ work. When marking, assign full marks if there are no flaws.
- If there are common objections to your chosen interpretation make sure to address them.
- Many interpretations rely on entanglement, which is beyond this course. If you choose to bring arguments from entanglement into your defence you must explain what you mean, at a level which can be understood by other groups. You can only assume knowledge of syllabus content.
- Your assessments of your peers should be thoughtful and meaningful. You do not need to write essays for each point (please don’t), but one word answers or lack of justification may lead to your marks being disregarded.
- Submit one assessment of each of the other group’s talks and presentations, as a group. Make your own individual notes then discuss afterwards.
- You are free to divide up tasks within your groups as you see fit. Here are some tasks which will need to be accomplished.
  - Decide each week on individual and collective tasks to accomplish before the next week.
  - Make sure those tasks are completed. You may wish to set up regular discussions or chat groups.
  - Research your interpretation, keeping track of references. Use a variety of resources: books, academic papers (search arxiv.org), internet sources (wikipedia is fine but follow links; Stanford encyclopedia of Philosophy is a bit more in depth). **Feel free to refer to fiction if it inspires you and has something defensible to say.**
  - Choose an example from the course with which to illustrate your case and work through it in detail. For example, if you want to use superposition, pick a specific case such as spin-1/2 and the Stern Gerlach experiment and explain what the interpretation says is happening.
  - Produce the poster.
  - Present the poster (maybe one or two people).
  - Produce the talk slides, bearing in mind the strict 3 minute duration.
  - Present the talk (any number of people).
  - Answer questions after the talk. This could be the whole team, or however many people are comfortable doing so.
  - Assess the posters of other groups. This can be done by whoever in your group is not presenting your poster.
  - Assess the talks of other groups.

## 4 References

**Finding references is a major part of this project.** However, here are one or two to get started.

- First, you probably want to read the wikipedia page to get an idea what's out there. There are many interpretations not on wikipedia's list, though.  
[wikipedia.org/wiki/Interpretations\\_of\\_quantum\\_mechanics](http://wikipedia.org/wiki/Interpretations_of_quantum_mechanics)
- Probably the biggest divide between interpretations is  $\psi$ -ontic versus  $\psi$ -epistemic. The former claim the wavefunction describes reality, while the latter say it merely quantifies our knowledge of reality. Most interpretations are firmly in one camp or the other. There is a good technical introduction here.  
[arxiv.org/abs/1409.1570](http://arxiv.org/abs/1409.1570)
- As stated above you do not need to invoke entanglement unless you want to, and if you choose to you have to explain what you mean. The best description I know of is provided by N. David Mermin :  
<https://www-f1.ijs.si/~ramsak/km1/mermin.moon.pdf>

## 5 Weekly questions

Your group is completely free to prepare its presentation and poster however it sees fit. If you prefer to have some structure, the following list of questions can be discussed as a group each week. There is no requirement to do so, but they may help guide your understanding.

**Personal task (optional):** I would be interested to read which interpretation, if any, you subscribe to, and to see how this changes as you learn more about the topics. If you would like to include your personal thoughts on each question below in your dossier, I will be happy to read and discuss.

### 5.1 Week 1

Group: provide a brief survey of the different interpretations of QM.

Personal: state your preferred interpretation (if any).

### 5.2 Week 2

Group: explain the distinction between  $\psi$ -ontic and  $\psi$ -epistemic interpretations. Which is your group's interpretation?

Personal: which do you prefer? Has this updated your preferred interpretation?

### 5.3 Week 3

Group: should observers play a role in quantum theory? Does your interpretation feature a necessary role for observers?

Personal: should observers play a role in quantum theory? Has this updated your preferred interpretation?

### 5.4 Week 4

Group: explain the meaning of determinism in a quantum theory. Is your group's interpretation deterministic?

Personal: should an interpretation be deterministic? Has this updated your preferred interpretation?

### 5.5 Week 5

Group: explain the meaning of (non-local) hidden variables in a quantum theory. Is your group's interpretation a hidden variable theory?

Personal: should interpretations contain hidden variables? Has this updated your preferred interpretation?

## 5.6 Week 6

Group: explain the role of locality in quantum theory. Is your group's interpretation local?

Personal: should an interpretation local? Has this updated your preferred interpretation?

## 5.7 Week 7

Group: explain the concept of a universal wavefunction in quantum theory. Does your group's interpretation feature a universal wavefunction?

Personal: does a universal wavefunction exist? Has this updated your preferred interpretation?

## 5.8 Week 8

Group: explain the idea of wavefunction collapse. Does your group's interpretation feature wavefunction collapse?

Personal: does wavefunction collapse exist? Has this updated your preferred interpretation?

## 5.9 Week 9

Group: explain the concept of a unique history in quantum mechanics. Does your group's interpretation feature a unique history?

Personal: should an interpretation feature a unique history? Has this updated your preferred interpretation?

## 5.10 Week 10

Personal: has your view changed since week 1?

## 6 Marking Rubrics

The following pages contain marking rubrics for

- (i) your individual group members
- (ii) other groups' posters
- (iii) other groups' presentations.

# Group projects: marking rubric

Complete this form for each of the six people in your team, including yourself.

**Group number:**

**Your name:**

**Name of person being assessed:**

	4	3	2	1	mark
Research	Compiled key findings from a wide variety of sources. presented with recommendations to the group.	Searched for information and summarised for the group.	Searched for information but did not clearly report back to the group.	Did not contribute to research.	
Ideas	Brought a variety of well-developed ideas to meetings. Helpfully evaluated suggestions of others.	Brought well-developed ideas to meetings but did not critically evaluate ideas of others.	Only had some spontaneous ideas in response to discussion.	Did not contribute original ideas, or did not develop them beyond the discussion.	
Participation	Well prepared for meetings. Punctual and encouraged the participation of others.	Well prepared for meetings. Punctual. Fully participated.	Attended meetings but was ill-prepared or late.	Missed meetings seemingly without a valid excuse.	
Assistance	Always willing to go above and beyond in providing assistance to others.	Offers helpful and needed assistance to others without being asked.	Provides assistance when asked.	Unable or unwilling to assist others.	
Effectiveness	Work performed was invaluable and contributed significantly to the final project.	Work performed was useful and contributed to the final project.	Work performed was incomplete and contributions were less than expected.	Work performed was ineffectual and largely useless towards the final project.	

**Justifying comments:**

# Group presentations: marking rubric

Complete this form once, as a group, for each of the other group presentations.

**Your group number:**

**Group number being assessed:**

**Presentation title:**

	4	3	2	1	mark
Slide detail	Slides contain the perfect level of detail. They complement the talk without distracting.	Slides contain too much or too little detail, but do not detriment the talk significantly.	Slides contain too much or too little detail, to the significant detriment of the talk.	Slides are far too dense, or are almost devoid of content.	
Content	The level of content was perfect for the audience. The key points were clear and well defended.	The level of content occasionally strayed from the appropriate level.	The content was far from the appropriate level. The key points were unclear.	The content was totally inappropriate for the audience.	
Pace	The talk was perfectly timed to 4 minutes. The pace was even and appropriate throughout.	The pace was occasionally too fast or slow, but generally appropriate. The talk was well timed.	The timing was significantly off. The pace was regularly inappropriate.	The talk was over a minute off / the pace made the talk frequently unfollowable.	
Questions	Questions were answered well. Sensible questions had been anticipated and responses planned.	Questions were answered acceptably, although could have been answered better.	Questions were not answered well, but reasonable attempts were made.	Reasonable questions could not be answered.	
Style	The slides were beautiful. Clear thought was put into the style of presentation.	The slides had a number of blemishes. The presentation had some slips.	The slides were unappealing. The presentation style needed a lot of work.	The slides were hideous. The presentation was unwatchable.	

**Justifying comments:**

# Group posters: marking rubric

Complete this form once, as a group, for each of the other group posters.

**Your group number:**

**Group number being assessed:**

**Poster title:**

	4	3	2	1	mark
Detail	The poster contained the perfect level of detail.	The poster contained too much or too little detail, but the key points remained clear.	The poster contained too much or too little detail, and the key points were unclear	The poster was far too dense, or was almost devoid of content.	
Content	The level of content was perfect for the audience. References were clear.	The level of content occasionally strayed from the appropriate level.	The content was far from the appropriate level. The key points were unclear.	The content was totally inappropriate for the audience.	
Layout	The poster was divided helpfully into sections with a clear progression between them.	Some layout choices made the poster harder to follow.	The layout was illogical and confusing.	The layout was unfathomable.	
Questions	Questions were answered well. Sensible questions had been anticipated and responses planned.	Questions were answered acceptably, although could have been answered better.	Questions were not answered well, but reasonable attempts were made.	Reasonable questions could not be answered.	
Style	The poster was beautiful. Clear thought was put into the style of presentation.	The poster had a number of blemishes.	The poster were unappealing. The presentation style needed a lot of work.	The poster was so ugly it could be a modern art masterpiece.	

**Justifying comments:**