

Swansea University: Department of Physics

PH-127: The Quantum World

Essay assignment

Hand out date: March 22 2011.

Due date: **May 9 2011**.

This work is assessed and comprises **50%** of the credit for the module.

Write an essay of around 2000 words on **one** of the following topics:

1. Combine the following topics in a coherent essay:
 - Wave particle duality
 - Bohr's complementarity principle
 - Collapse of the wave function
 - Heisenberg uncertainty principle
2. The Nobel prize website contains a wealth of information on Physics Nobel prizes given for Quantum Mechanics, see http://nobelprize.org/nobel_prizes/physics/
Read the Nobel lecture of Max Born (1954), *The Statistical Interpretations of Quantum Mechanics*. Write an essay summarizing Born's overview. Do you think Born supported Bohr or Einstein in the famous debates on Quantum Mechanics?
3. In the beginning of the twentieth century it had been observed that hydrogen only emits light with specific wavelengths. Describe how Bohr's model of the hydrogen atom explains this. Point out limitations of Bohr's model as well.
4. Discuss the Born interpretation of the wave function. Apply this to a particle in a harmonic well (harmonic oscillator). Compare the results with what would be expected classically for states with a low energy (groundstate, first excited state) and for states with a high energy.

Remarks:

Indicate on the first page of your essay which topic you have chosen.

In awarding credit, the following criteria will be considered:

- (a) scientific accuracy
- (b) liveliness of the presentation and clarity of the argument
- (c) use of material not covered in the lectures and properly cited in a bibliography
- (d) spelling, punctuation and neatness

You have to hand in your work by:

1. uploading it via the Turnitin software on the module's BlackBoard homepage.
2. handing in a hardcopy to Ray Squire in Vivian Tower office 617.

General tips on writing an essay:¹

A **bad** essay...

- ... is written the night before the due date.
- ... does not address one of the topics from the list.
- ... repeats literally what the lecturer said in class.
- ... tries to be vague to hide a lack of understanding.
- ... uses jargon to hide a lack of understanding.
- ... uses quotes from textbooks without putting them into context.
- ... is not proofread by yourself or by a friend.
- ... has not been checked by a spell-checker.
- ... is handed in after the due date.
- ...

A **good** essay...

- ... is based on having read a number of books/publications besides the compulsory textbook.
- ... is written about a topic you find interesting.
- ... has a clear structure: introduction, body, conclusion, bibliography.
- ... gives credit to **all** sources used: textbooks, lecture notes, wikipedia, ..., using footnotes and/or a bibliography at the end.
- ... avoids long stretches of word-by-word copying from other sources. Very rarely literal quotes are needed. In that case 'quotation marks' and a precise reference are compulsory:

As Einstein stated: 'I, at any rate, am convinced that He does not throw dice.'²

- ... is neatly written, using correct grammar and spelling.
- ... is written in a clear and straightforward form.
- ... is handed in before or on the due date.
- ...

¹Adapted from A.D. Irvine, *So you want to pass your first philosophy course?*, unpublished (2002).

²A. Einstein in a letter to M. Born (4 December 1926).

University policy on unfair practice

The University policy on unfair practice and plagiarism can be found in the online Academic Guide³, in particular in the section on Unfair practice⁴. Relevant are Sections 1.3 and 1.4:

1.3 Examples of unfair practice in non-examination conditions:

- Plagiarism. Plagiarism can be defined as using without acknowledgment another person's work and submitting it for assessment as though it were one's own work, for instance, through copying or unacknowledged paraphrasing (see 1.4 below). This constitutes plagiarism whether it is intentional or unintentional;
- Collusion. Collusion can be defined as involving two or more students working together in order to gain an unfair advantage without prior authorisation from the academic member of staff concerned (e.g Programme leader, lecturer etc) to produce the same or similar piece of work and then attempting to present this work entirely as their own. It is also considered unfair practice for a student/students to submit the work of another with or without the knowledge of the originator. An allegation of collusion may be amended during a hearing/investigation to allow a student to be exonerated of the offence whilst alleging plagiarism against another student(s);
- Commissioning of work produced by another;
- Falsification of the results of laboratory, field-work or other forms of data collection and analysis.

1.4 Examples of plagiarism:

- use of any quotation(s) from the published or unpublished work of other persons which have not been clearly identified as such by being placed in quotation marks and acknowledged;
- summarising another person's ideas, judgements, figures, software or diagrams without reference to that person in the text and the source in the bibliography;
- use of the services of 'ghost writing' agencies in the preparation of assessed work;
- use of unacknowledged material downloaded from the Internet;
- submission of another student's work as your own.

³www.swan.ac.uk/registry/academicguide/

⁴www.swan.ac.uk/registry/academicguide/AssessmentandProgress/UnfairPracticeProcedure/