注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 110 學年度碩士班考試入學試題

系所班組別：生命科學院
　　　　　　丙組(計算生物與人工智慧組)

科 目 代 碼：0602

考 試 科 目：近代物理

一作答注意事項一

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。

2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。

3. 考生限在答案卷上標記「┏ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。

4. 答案卷用盡不得要求加頁。

5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。

6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。
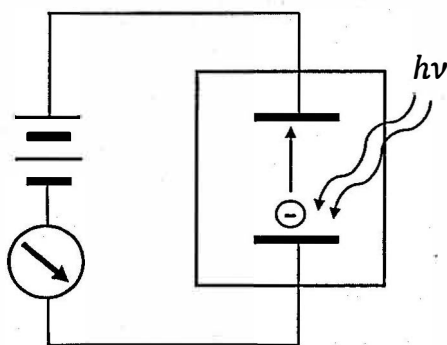
國立清華大學 110 學年度碩士班考試入學試題

系所班組別：生命科學院丙組

考試科目（代碼）：近代物理(0602)

1. (15%) A spacecraft moves at a high speed and the astronauts find that the onboard clock runs 3 s slower per day relative to an identical clock on Earth. What is the speed of the spacecraft relative to the speed of light?

   (Hint: $1/\sqrt{1-(v/c)^2} \approx 1 + \frac{1}{2}(v/c)^2$ for $v/c \ll 1$)

2. (15%) What is the weight change when two hydrogen atoms and an oxygen atom form a water molecule if the binding energy of water is 3eV?　(1eV = 1.6×10^{-19} J)

3. (30%) Albert Einstein won his Nobel prize in physics for his contribution in the theory of photoelectric effect. **A.** Please describe the photoelectric effect. You can take the plot below as a hint. **B.** What is the prediction of classical physics for this experiment? **C.** What is Einstein's solution to the discrepancy in photoelectric effect?

4. (30%) In a one-dimensional energy well with infinite walls as shown below, the wavelength λ of a particle is limited by the size L of the well with the following relationship: $L = n\frac{\lambda}{2}$. **A.** Use de Broglie's wave-particle duality $p = \frac{h}{\lambda}$ to show that the allowed energy E of the particle is given by $E = \frac{n^2 h^2}{8mL^2}$. **B.** What is a "zero-point energy"? Why is the zero-point energy necessary according to the Heisenberg Uncertainty Principle? **C.** If a particle is at the *n=4* energy state, what is the probability of finding the particle between $x = 0$ and $x = \frac{1}{4}L$?
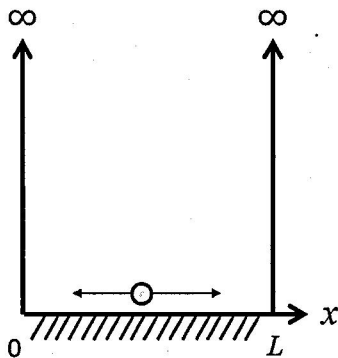
5. (10%) The scanning tunneling microscope (see below) uses the quantum tunneling effect to measure the distance between the tip and the surface of a sample. Please explain how.