PHY101: Emergence midterm **Fall 2011**

Instructions: Answer **ALL** of part A. These call for short answers with a few sentences and perhaps a diagram. Answer **ONE** topic from part B in a paragraph or short essay format. You may do the questions in any order you like. Write everything in the exam book provided.
Total marks = 50.

Write your teaching assistant's name and seminar session time on the front of your exam book(s).

Part A. Answer all questions. [6 marks each]

1. When James Clerk Maxwell formulated the general laws for classical electricity and magnetism, he discovered that they also explained another, apparently unrelated physical phenomenon. Which one? What important consequence did Maxwell's theory have for Einstein's later theory of relativity?

2. Philosophers have distinguished "strong" and "weak" versions of the concept of emergence. What is the distinction between these two ideas?

3. Which of the fundamental forces was first scientifically formulated by Isaac Newton? State in words, and write an equation for, Newton's famous "universal law" which governs this force.

4. Sketch the Rutherford Scattering Experiment. What were Rutherford's basic observations and what did he conclude from them?

5. Make a rough cartoon sketch of the interior of a proton. Label the parts. What holds it together?

Part B. Pick one topic. [20 marks]

1. Describe the latest particle physics experiments now going on at CERN and elsewhere using the Large Hadron Collider and various detectors. What are some of the main objectives of the experiments? Describe and discuss some, perhaps controversial, recent results.

2. Describe the concept of a "symmetry". What does it mean for a symmetry to be "broken"? Give an everyday example of a symmetry which is "spontaneously broken". What is the significance of broken symmetry in Physics? What features of the Standard Model of Particle Physics are attributed to broken symmetries?

3. We used the metaphor of the "Great Chain of Being" in this course. Describe the Great Chain as originally conceived by mediaeval theologians, and compare this with the modern, scientific "Great Chain". Starting from the smallest, discuss the hierarchy of links in the modern version, ending with the largest. Which of the fundamental forces are important over which parts of the chain?