Material allowed in the exam: a calculator and the sheet of paper with your own pre-prepared notes.
The maximum from the following three problems is 60 points.

1. (24 points) A right-hand circularly polarized light hits a fresh water surface obliquely from above so that the incident angle is the Brewster angle. Find the Brewster angle θ_B and the refracted (transmitted) angle θ_t. Determine the fraction of incident power that is reflected and describe the polarization of the reflected wave.

   In this problem, you can assume that fresh water is a lossless dielectric with $n = 1.33$ and the medium above it is air. The incident light oscillates at an optical frequency and can be viewed as a plane wave.

2. (16 points) Explain in your own words Faraday's law. In Figure 1, a magnet is dropped through a conducting loop that is attached to a voltmeter. Sketch qualitatively the electromotive force (emf) induced in the loop by the falling magnet against time until the magnet has fallen fully through the loop. Assume the sign of emf to be positive if the current is flowing in the anti-clockwise direction when looking at it from the top. Please explain by words and/or formulas each step in your solution of the problem. A simple guess of the sketch without argumentation will not be graded.

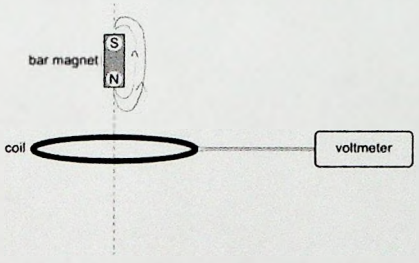

Figure 1: Magnet dropping through a conducting loop

3. (20 points) Find an expression for the magnitude of the electric field at a point P located on the perpendicular central axis of a uniformly charged ring of radius a and total charge $Q > 0$. The ring is located at the origin of the coordinate system. What is the magnitude of the electric field at the center of the ring? Assume the cross-section of the ring to be negligibly thin.

   (Hint: you can calculate the electric field directly or by the use of the electric potential concept)

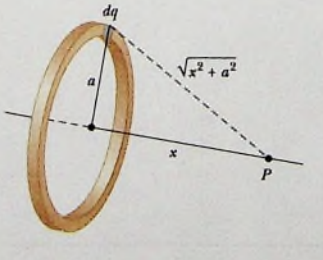

Figure 2: A uniformly charged ring of radius a lies in a plane perpendicular to the x axis.