Some information concerning the Final Exam.

(1) Answer ALL 4 Questions.

(2) Essay & Math Questions.

(3) Please bring a calculator.

(4) Students are allowed to bring in ONE (1) hand-written, double-sided help-sheet no larger than A-4 size.
About 400 years ago, Descartes expounded a theory in which he drew analogy of light with sound waves.

Almost 200 hundreds later, Faraday proposed that light was a electromagnetic wave with different wavelengths.
Abbe’s foresight.

Resolution \sim \frac{\text{(wavelength)}}{2}.

Green light has wavelength $\sim 400\text{nm}$. Thus the Abbe limit is $\sim 200\text{nm}$ (make sense of the unit).
During the whole summer of 1961, Shimomura and Johnson gathered jellyfish, whose outer edge glows green when the jellyfish is agitated. One day when Shimomura poured some of the squeezate into the sink, it flashed brightly. He realised that there was seawater in the sink and that it was calcium ions in the seawater that had caused the chemical reaction. Strangely enough, the flash of light was not green like the edges of the jellyfish. It was blue.
In 1988 at a seminar when Chalfie heard of a glowing protein, he fantasized with the idea on using GFP to map the various activities inside a cell. Eventually, Chalfre, succeeded in reproducing the GFP in E. Coli bacteria.
Stefan Hell was convinced that there had to be a way of circumventing Abbe’s limit. The thought of challenging such an established principle was tantalizing. But senior scientists had met his enthusiasm with skepticism.

When Hell read about stimulated emission, a new line of thought dawned in him. "I had finally found a concrete concept to pursue – a real thread. I realized that cracking the barrier would be easiest in fluorescence imaging." He was so excited about this idea that he decided to take the risk and go for it.
From idea to fruition.
Juxtaposition.

Non-invasive.

25nm routinely achieved.

http://zeiss-campus.magnet.fsu.edu/tutorials/superresolution/stedfundamentals/indexflash.html
Tired of the academy – but not the idea.

In 1996, Betzig left academia to become vice president of at Ann Arbor Machine Company, then owned by his father. At around the same time, he began to ponder if different molecules glowed with different colour.

**Personal use of imagination.**

The real breakthrough came in 2005, when he stumbled across fluroscent proteins that could be activated at will. Betzig realised that this is the tool to implement the idea came to him 10 years ago.

**Serendipity.**
Figure 5

Super-imposed