1. (8) Electrons are accelerated through a potential difference of 45 V. Calculate (a) their energy in J, and (b) their de Broglie wavelength in nm and Å. (See board for fundamental constants.)

2. (7) Atomic term notation.
   (a) Give the values of $S$ and $L$ and all possible values of $J$ for a $^5F$ term.

   (b) Determine the total degeneracy of the $^5F$ term by
       (i) adding up the contributions from all the $J$ levels.

       (ii) calculating the spin and orbital degeneracies and their product.

3. (8) The hydrogenic 1s wavefunction $\psi_{1s}$ is proportional to $\exp[-Zr/\alpha]$. In spherical coordinates, the Hamiltonian operator for hydrogenic atoms is

   \[ \hat{H} = -\frac{\hbar^2}{2\mu} \left( \frac{\partial^2}{\partial r^2} + \frac{2}{r} \frac{\partial}{\partial r} \right) + \frac{\hat{L}^2}{2\mu r^2} + V(r) \]

   (a) Give the potential energy $V(r)$ for a hydrogenic atom having nuclear charge $Ze'$. 

   (b) $\psi_{1s}$ is an eigenfunction of angular momentum. Hence what is the value of $\hat{L}^2 \psi_{1s}$ ?

   (c) Using these results, show that $\psi_{1s}$ is an eigenfunction of $\hat{H}$. What is the eigenvalue?