1. Using Newtonian mechanics show that in an elastic collision between a light object and a stationary heavy object, the change in momentum of the light object can be large, whilst its energy change is small.

2. Show that taking the reciprocal lattice of the reciprocal lattice gives the real space lattice back again.

3. For a hcp (hexagonal close packed) lattice calculate the four possible values of $|S|^2$, where S is the structure factor:
$$S = \sum_p f_p \mathrm{e}^{-\mathrm{i}\vec{K}\cdot\vec{r}_p} .$$
The vectors $\vec{r}_p$ are the positions of the atoms in the basis relative to the lattice point. $\vec{K} = h\vec{a}^* + k\vec{b}^* + l\vec{c}^*$ is the reciprocal lattice vector with h, k, l integers and $\vec{a}^*, \vec{b}^*, \vec{c}^*$ are the primitive reciprocal lattice vectors.

4. To be handed in. Derive the conditions that must be satisfied by h, k, l for diffraction from a bcc (body centre cubic) structure when the conventional cubic unit cell is used to label the beams. Show that these conditions convert the simple cubic reciprocal lattice of the conventional unit cell into the fcc (face centre cubic) reciprocal lattice of the primitive cell. (Use the structure factor.)