Problem Sheet 1
Solid State Theory
Summer Semester 2021

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Problem 1) **(4 Points)**

The primitive translation vectors of a hexagonal space lattice may be specified as

$$\vec{a}_1 = (\sqrt{3}a/2)\vec{e}_x + (a/2)\vec{e}_y,$$
$$\vec{a}_2 = -(\sqrt{3}a/2)\vec{e}_x + (a/2)\vec{e}_y,$$
$$\vec{a}_3 = c\vec{e}_z.$$

(a) Show that the volume of the primitive unit cell is $(\sqrt{3}/2)a^2c$.

(b) Show that the primitive translation vectors of the reciprocal lattice are

$$\vec{b}_1 = (2\pi/\sqrt{3}a)\vec{e}_x + (2\pi/a)\vec{e}_y,$$
$$\vec{b}_2 = -(2\pi/\sqrt{3}a)\vec{e}_x + (2\pi/a)\vec{e}_y,$$
$$\vec{b}_3 = (2\pi/c)\vec{e}_z.$$

(c) Describe and sketch the first Brillouin zone of the hexagonal space lattice.

Problem 2) **(4 Points)**

Prove that the ideal c/a ratio for the hexagonal close-packed structure is $\sqrt{8/3}$.

Problem 3) **(4 Points)**

Show that the volume of the first Brillouin zone is $(2\pi)^3/V_c$ where V_c is the volume of a crystal primitive cell.