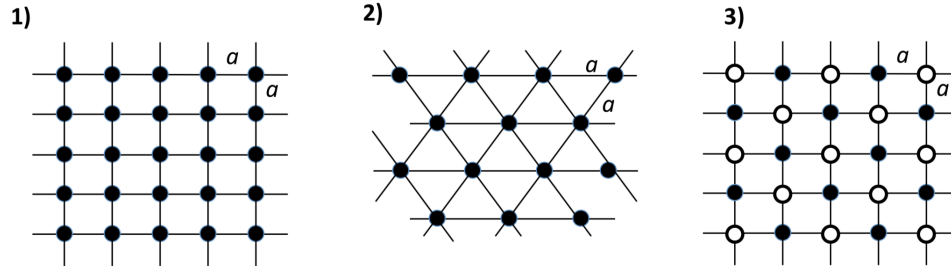


Consider the three two-dimensional lattices, corresponding to three two-dimensional solids, depicted in the figure below:



These are respectively the simple cubic lattice, the regular triangular lattice (the atoms are at the apices of equilateral triangles) and the 2D rock-salt lattice.

- A. For all the three solids identify the primitive unit cell (the smallest unit cell you can construct) and the associated translational vectors.
- B. Since these are all periodic solids Bloch theorem applies and a general expression for the wave function can be derived. Write down explicitly the wave function for the three solids considering that:
- The simple cubic lattice is made of C and each atom is described by a p_x and a p_y orbital.
 - The triangular lattice is made of H atoms described by a single $1s$ orbital.
 - The rock-salt lattice is made of H (dark circles) and Li (white circles). H is described by $1s$ orbitals, while Li by $2s$ ones.
- C. Now consider the two-dimensional rock-salt lattice described by an orthogonal nearest neighbour tight-binding model where the on-site energy of H is ϵ_H that of Li is ϵ_L and the hopping parameter is $t < 0$. Calculate the expression of the band structure.
- D. Plot the band structure along the following directions:

$$(k_x, k_y) : (\pi/a, 0) \rightarrow (\pi/a, \pi/a) \rightarrow (0, 0) .$$

For the plot use the following values of the parameters $\epsilon_H = 0$, $\epsilon_L = 2$, $t = -2$.

Marking Scheme: A) 6 points, B) 6 points, C) 9 points, D) 4 points.