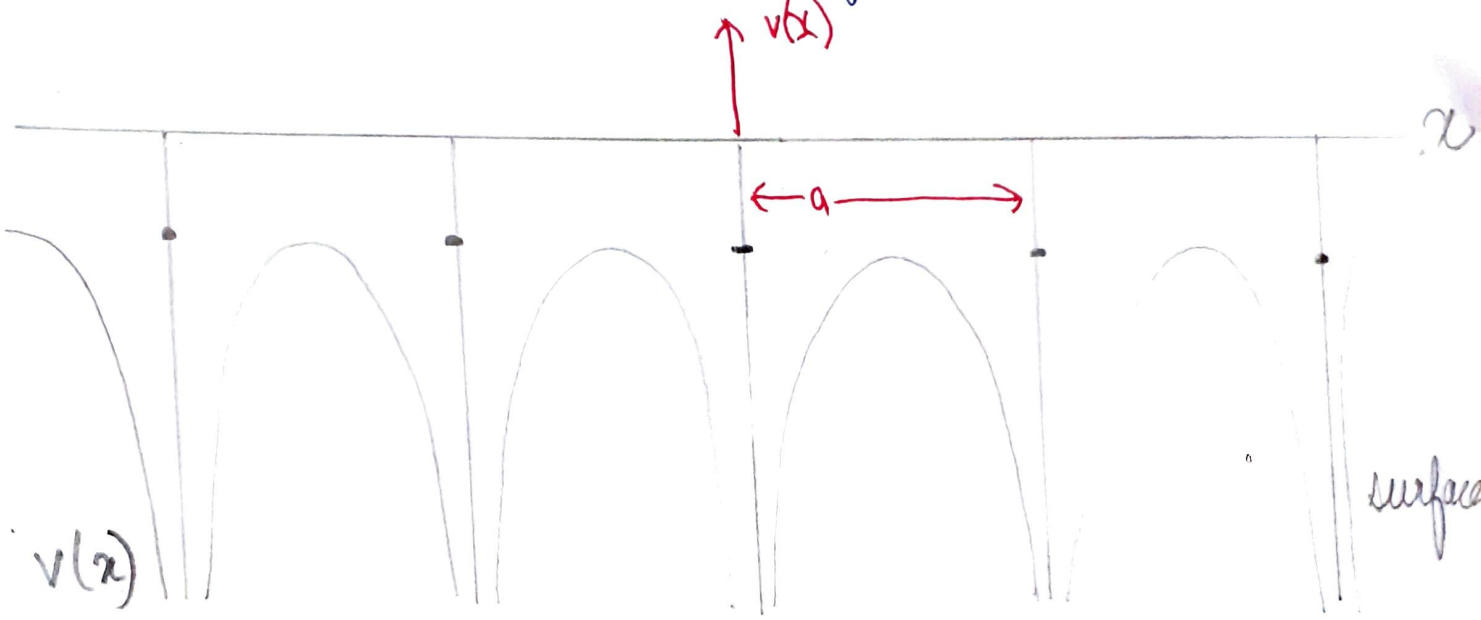
ENERGY BANDS

~~The free electron theory of metals discussed in the privious chap ter assumed that~~ A conduction electron in a metal crystal experiences a constant (zero) potential and so completely free to move about in the crystal, restrained only by the surface of the crystal. Obviously this is a very drastic assumption and does not seem to be at all reasonable. Nevertheless the theory has certainly been able to account for several of the properties of metals. e.g specific heat paramagnetism etc Yet there are several other properties for which this model can not help the least. For example it can not help us to distinguish a metal (or a conductor) form a nonmetal (or an insulator); the resistivity of a good conductor at low temperatures may be $\sim 10^{-8}$ ohm-cm and that of a good conductor may be as high as 10^{22} ohm-cm. Futher semi-conductor do not find any explanation on the bais of Theory. There are several other properties too which have similarly been treated by the free electron theory. The shortcomings of the theory are to traced in the oversimplified potential on which it is based.

A more reasonable approximation of the potential experianced by an electron in passing through the crystal is one which is perfectly periodic with the period of the lattice i.e one of the type shown in fig 1. It may be thought of as arising from the periodic distribution of the positive charge associated with the ion cores situated on the lattice sites, plus the constant (average) contribution due to all other free electrons of the crystals. The latter contribution to the potential accounts in an average sense the interaction effects of the single electrons with all others. The periodicity character of the potential exten ds to infinity in all direction inside the crystal. At the surface of the crystal it is interrupted however and the potential there looks somewhat as shown at the right hand edge of the figure. This is because the lattice spacing will not be quite uniform ~~here~~ there. We shall however ingore this irregularity and assume that it

that it is perfectly periodic right from the site of the surface. We now describe the behaviour of the electron in this potential using one electron - approximation throughout. This is done by finding the electron wave functions -



Fig① One dimensional representation of the potential experienced by an electron in a perfectly periodic lattice of constant a showing a sharp fall when electron approaches a positively charged nucleus.