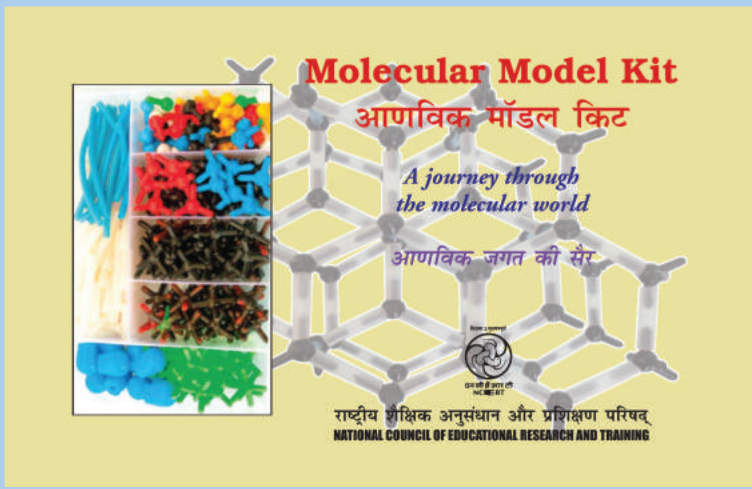
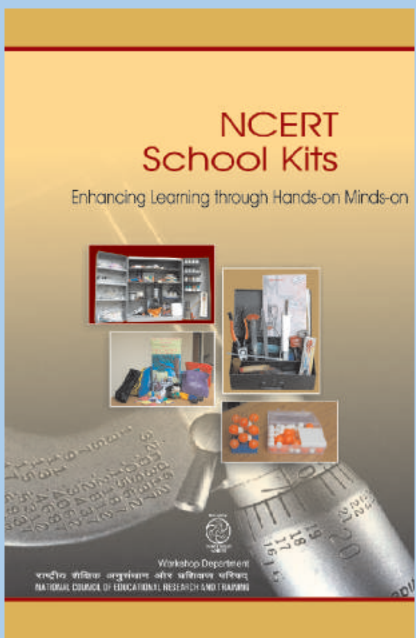
Manual of Solid State Model Kit

Workshop Department
National Council of Educational Research and Training



Molecular Model Kit
आणविक मॉडल किट



NCERT School Kits

SOLID STATE MODEL KIT

The Kit consists of a plastic moulded platform , dowels, and PVC hollow balls of two different diameters.

S No.	*Items*	*quantity*
1.	Plastic moulded platform	1
2.	Dowels	13
3.	PVC Balls(Big Size)	24
4.	PVC Balls(Small Size)	24

On the topside (A) of the platform, holes are made at the vertices and centres of squares, as shown in (Fig 1)

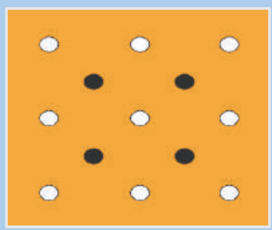


Figure 1 : Side A of the Model

On the bottom side (B), holes are drilled at the vertices and centre of regular hexagons, as shown in (Fig 2)

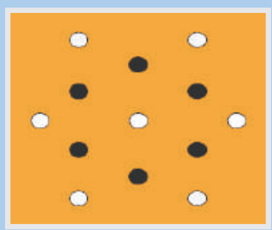


Figure 2 : Side B of the Model

Note that these holes show the positions of atoms in the unit cell. These holes can receive dowels, used for insertion into the balls. Various simple and giant molecules, a number of crystal structures can be clearly visualized and understood through this model.

(A) SIMPLE MOLECULES

(1) Regular tetrahedral-shaped molecules such as CH_4 can be made using side A of the model by putting four balls at the alternate corners of one of the eight small cubes (the cube on the side A can be visualized consisting of eight small cubes) and one in the centre. (Fig 3)

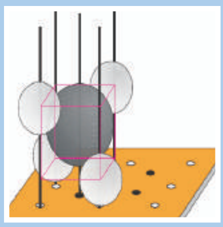


Figure 3 : Showing CH_4

(2) Regular octahedral– shaped molecules such as SF_6 can be made using side A of the model by placing six balls at the face-centred positions of the cube and one in the centre, using dowels in the appropriate holes.(Fig. 4)

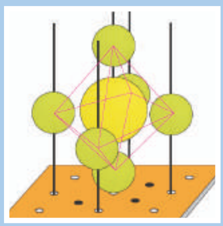


Figure 4 : Showing SF_6

(B) GIANT OR NETWORK STRUCTURES

The structures of the following metals, non-metals and compounds can be easily generated with this model.

1 Metals

(i) Hexagonal close-packing, e.g. Sc, Ti, Co, Zn, Be, Mg, using balls in the dowels in the holes on side B of the model.

(ii) Cubic close-packing using side B, or face- centred cubic using side A, e.g. Pb, Cu, Ag, Fe (above 800^{0}C), Ca, Al, Au. The equivalence of cubic close-packing and face-centred cubic can be easily seen using side B.

(iii) Body-centred cubic, e.g. Li, Na, K, Rb, Cs, Fe (below 800^{0}C), Ba, Cr, Ca, Al, Au.

2 Non-Metals

Unit cell of diamond (Fig. 5) is generated layer by layer. In the first layer, four out of five balls are inserted in the dowels at the cube corners and fifth one at the face-centre. The second layer consists of two balls at (¼, ¼, ¼) and ¾, ¾, ¼) positions along one diagonal. The third layer consists of four balls at face-centres. The fourth layer has two balls at (¼,¾, ¾) and ¾, ¼, ¾) positions along the other diagonal .The fifth layer has five balls, four at the corners and fifth one at the face-centred position. It can be easily visualized that the diamond unit cell has four tetrahedral units of carbon atoms at alternate small cubes (the unit cell of diamond can be divided into eight equal small cubes) and the arrangement of atoms along a body diagonal can be viewed.

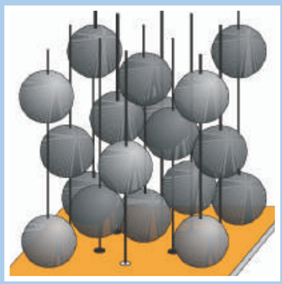


Figure 5 : Showing the Unit Cell structure of diamond

3 *Ionic solids*

(i) Zinc blende structure : ZnS, CuCl, CdS, HgS, GaP, InAg, CuF, AgI, ZnSe, SiC, AlP

It is an ordered arrangement of the diamond structure in which Zn atoms are placed on one face-centred cubic lattice and sulfide ions are on the other face -centred cubic lattice. The sulfide ions are in the alternate tetrahedral sites. (Fig.6)

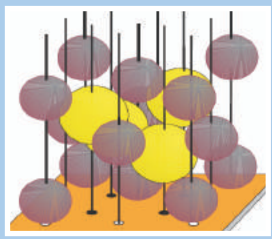


Figure 6 : Showing the Unit Cell Structure of Zinc Blende

(ii) Fluorite structure : CaF_2, LiO_2, PbO_2, HgF_2, $BaCl_2$

It is generated from that of zinc blende by filing in the other set of tetrahedral sites. (Fig.7).

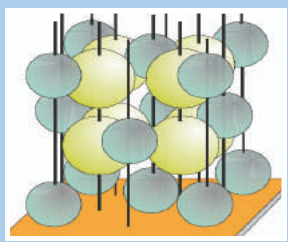


Figure 7 : Showing the Unit Cell Structure of Calcium Fluorite

(iii) Sodium chloride structure:

NaCl, LiCl, KBr, Rbi, AgCl, AgBr, MgO, TiO, FeO, ScN, SnAs, MnO, LiH, PbS (Fig.8)

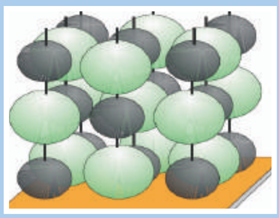


Figure 8 : Showing the Unit Cell Structure of Sodium Chloride

(iv) Caesium chloride structure : CsCl, CaS, TlSb, CsCN, CuZn, TiBr, Til, NH_4Cl, RbCl, AlNi can be generated using side A of the model.

(v) Wurtzite structures. **(**Hexagonal ZnS**)** : ZnO, ZnS, ZnSe, ZnTe, SiC, CdS, BeO, MnS, Agl, NH_4F, AIN, SiC can be generated using side B of the model.

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