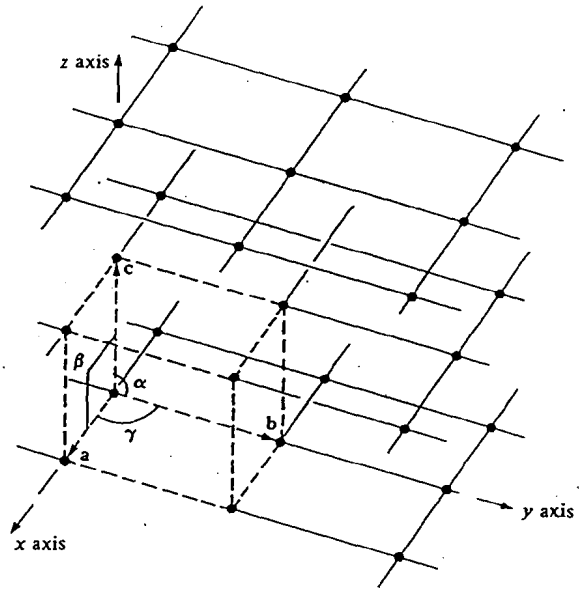


Table 1.2. The six crystal systems.

System	Lattices	Coordinates	Examples
Cubic (isometric)	3	$a = b = c$	α-Fe
		$\alpha = \beta = \gamma = 90°$	NaCl
Hexagonal			
Hexagonal subsystem	1	$a = b \neq c$	Graphite
		$\alpha = \beta = 90°$	MoS_2
Rhombohedral subsystem (trigonal)			$\gamma = 120°$
Tetragonal	2	$a = b \neq c$	White Sn
		$\alpha = \beta = \gamma = 90°$	PtS
Rhombohedral (trigonal) subsystem[a]	1	$a = b = c$	Calcite
		$\alpha = \beta = \gamma \neq 90° < 120°$	$K_2Cr_2O_4$
Orthorhombic	4	$a \neq b \neq c$	Rhombic S
		$\alpha = \beta = \gamma = 90°$	α-Np
Monoclinic	2	$a \neq b \neq c$	Monoclinic S
		$\alpha = \gamma = 90° \neq \beta$	$KICl_2$
Triclinic	1	$a \neq b \neq c$	$K_2Cr_2O_7$
		$\alpha \neq \beta \neq \gamma$	$Cu(ClO_4)_2 \cdot 6H_2O$

[a] The rhombohedral subsystem is sometimes categorized as an independent system; however, American crystallographers treat it as a hexagonal subgroup, since the rhombohedral cell can also be described with hexagonal coordinates.

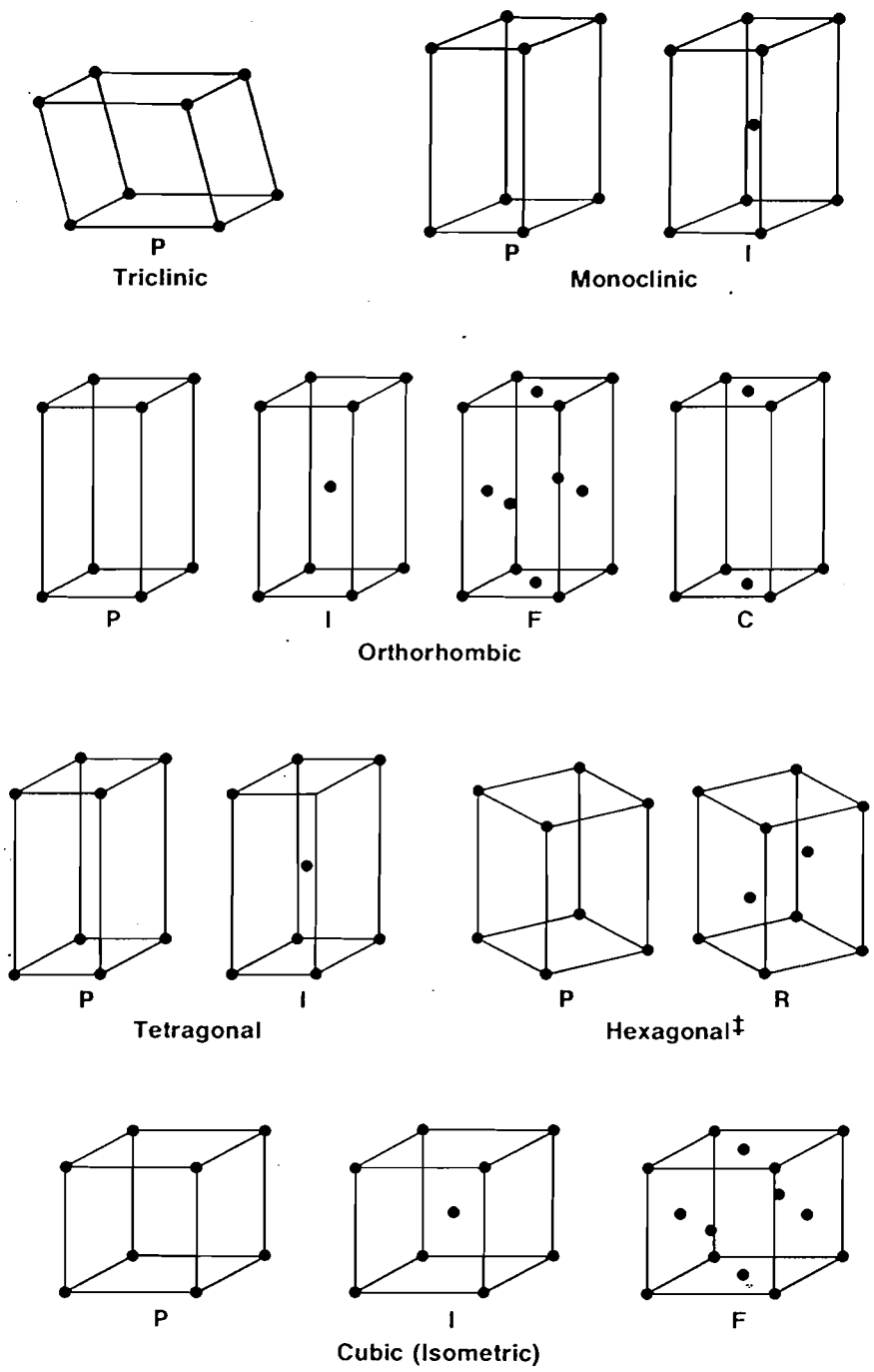


Figure 1.6.

The 14 Bravais lattices with the letters designating P (primitive), I (body-centered), F centered), C (end-centered), and R (rhombohedral). ‡Note that a rhomb, which is 1 hexagonal unit cell (see Fig. 1.20), contains all the symmetry elements of this structure.

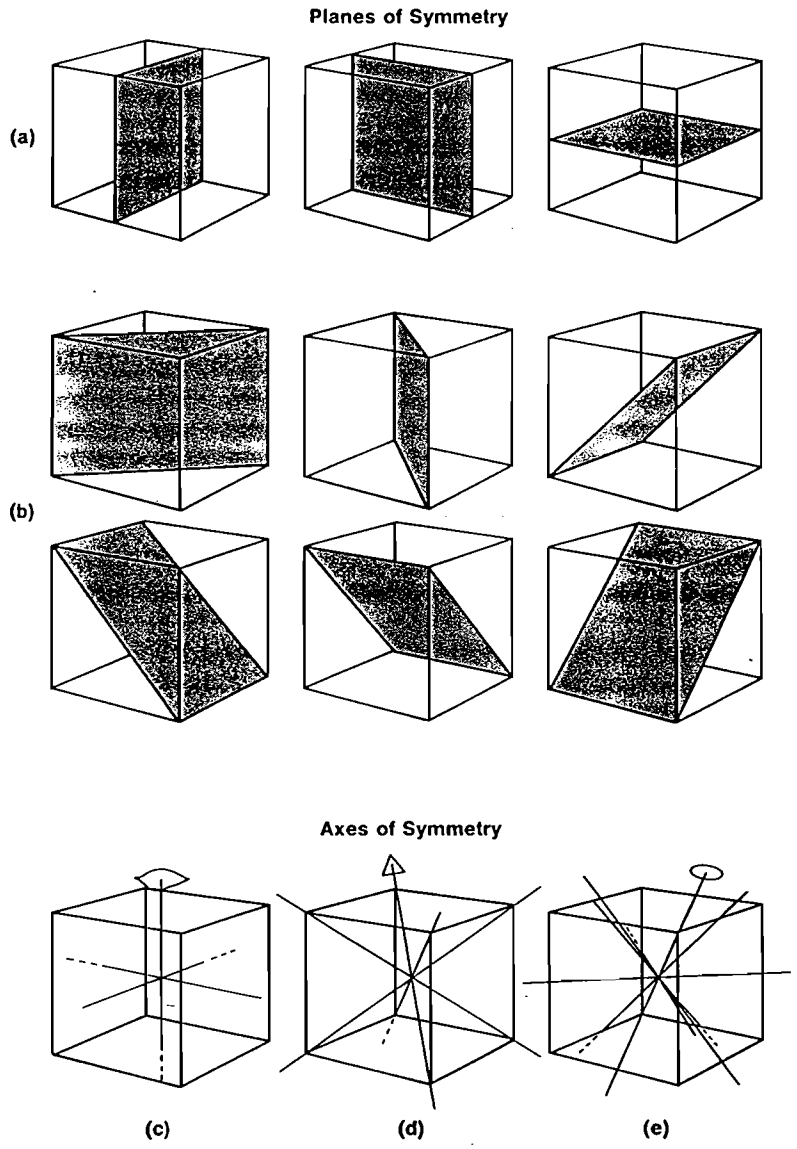
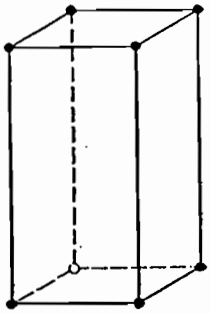
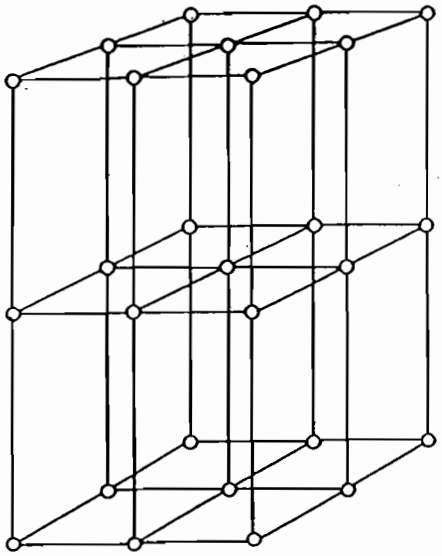


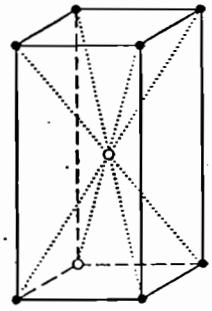
Figure 1.4.

Major planes and axes in the cubic system: (a) the three symmetry planes parallel to the cube faces, (b) the six diagonal mirror planes, (c) the three fourfold rotation axes ◇, (d) the four threefold axes △, and (e) the six twofold axes of rotation ○.

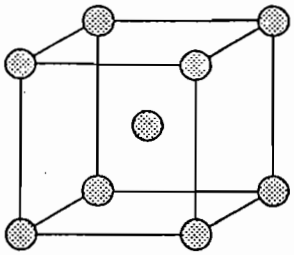


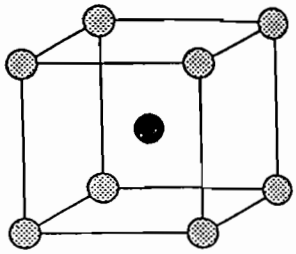
P

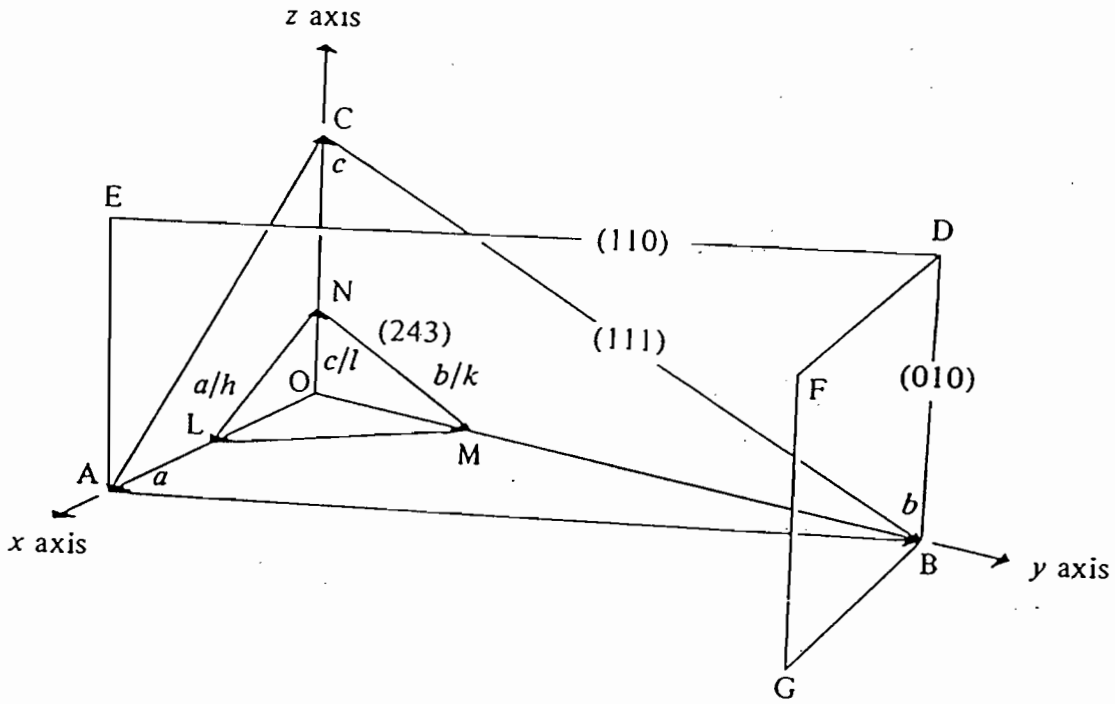




I







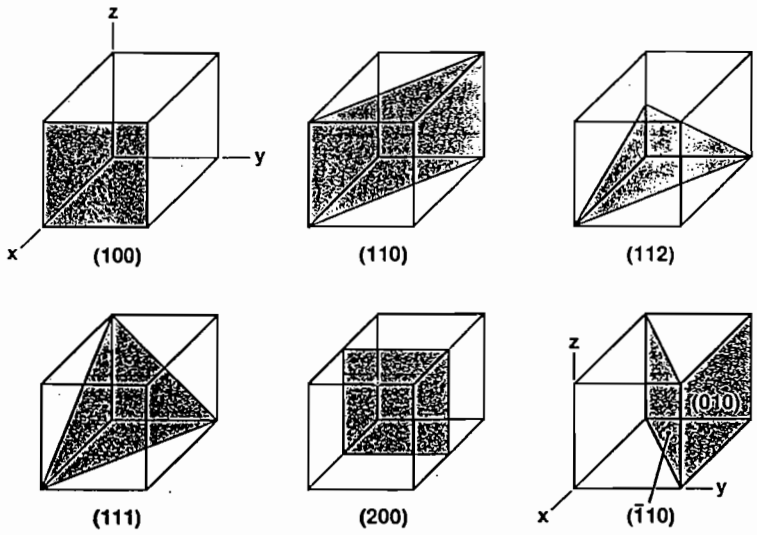


Figure 1.11.

Prominent planes of the cubic system.

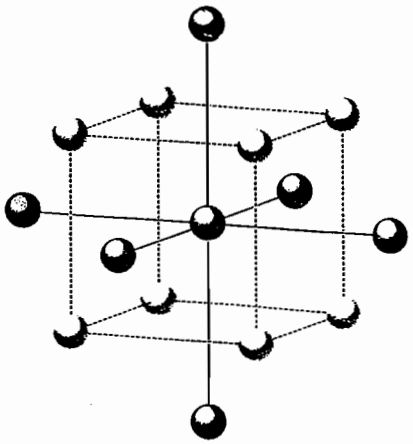


Figure 1.12.

The body-centered cubic structure showing the eight nearest neighbors and six next-n neighboring atoms.

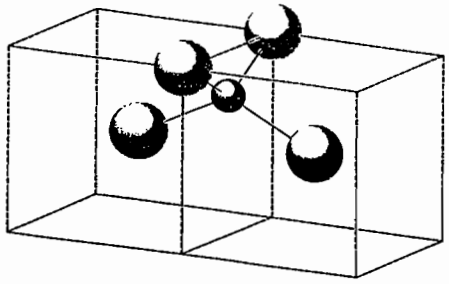


Figure 1.13.

The tetrahedrally coordinated interstitial atom in the bcc structure.

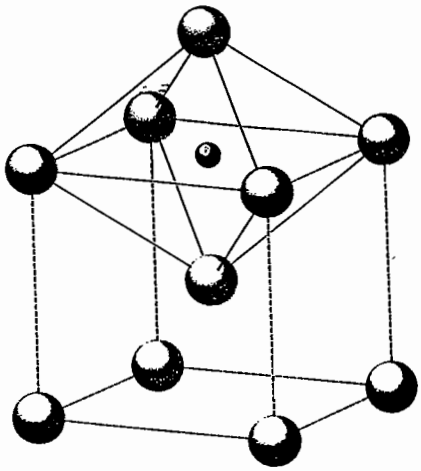


Figure 1.14.

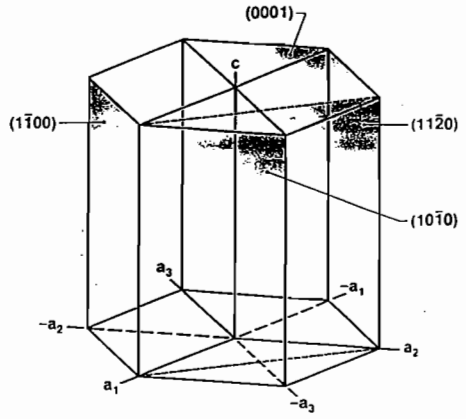
The octahedral interstitial site in the bcc crystal structure.

Table 1.3. Bcc elements.

Element	Temperature Range (K)[a]	a_0 (Å)[b]	T_m (K)	Element	Temperature Range (K)	a_0 (Å)	T_m (K)
Ba		5.025	1002	β-Sm	1190–T_m	—	1345
β-Ca	720–T_m	5.38 (773)	1112	γ-Sr	830–T_m	4.85 (887)	1041
δ-Ce	999–T_m	—	1071	Ta		3.3058	3269
Cr		2.8839	2130	β-Tb	150–T_m	—	1630
Cs		6.067 (78)	301.5	β-Th	1636–T_m	4.11 (1723)	2028
β-Dy	1657–T_m	—	1682	β-Ti	1155–T_m	3.3065 (1173)	1943
Eu		4.606	1090	β-Tl	507–T_m	3.882	577
α-Fe	<1183	2.8665		γ-U	1048–T_m	3.474	1405
δ-Fe	1667–T_m	2.94 (1698)	1809	V		3.0240	2175
β-Gd	1533–T_m	—	1595	W		3.16469	3653
β-Hf	2013–T_m	—	2227	β-Yb	1033–T_m	—	1097
β-Ho	1701–T_m	—	1843	β-Zr	1036–T_m	3.62 (1123)	2125
K		5.247 (78)	336.4				
γ-La	1134–T_m	—	1193				
β-Li	80–T_m	3.5093	454				
δ-Mn	1410–T_m	3.0806 (1407)	1517				
Mo		3.1473	2890				
β-Na	40–T_m	4.2906	371				
Nb		3.3004	2740				
β-Nd	1128–T_m	4.13 (1156)	1283				
β-Pr	1068–T_m	4.13 (1094)	1204				
ε-Pu	753–T_m	3.638 (773)	913				
Rb		5.605 (78)	312				
β-Sc	1608–T_m	—	1812				

[a] Where no temperature range is given, the element has only one crystal structure.

[b] All lattice parameters are given for 298 K unless otherwise noted in parentheses.



gure 1.20.

ıe axes and indices of some of the prominent planes in the hexagonal system.

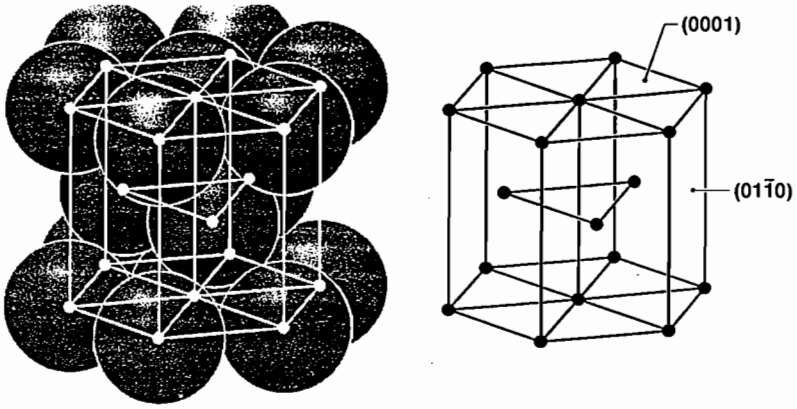


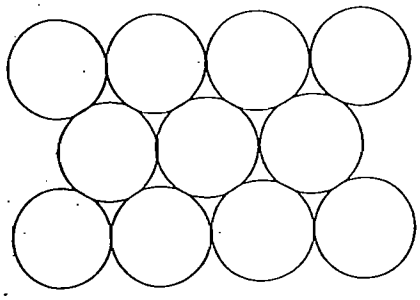
Figure 1.16.

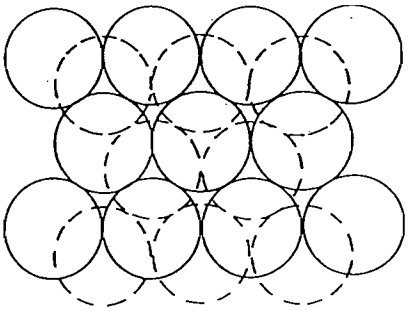
The hcp unit cell as constructed from equidimensional spheres and the lattice upon which this structure is based.

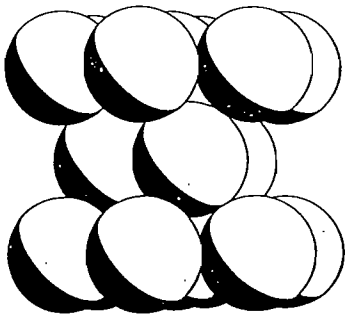
Table 1.5 Hcp elements.

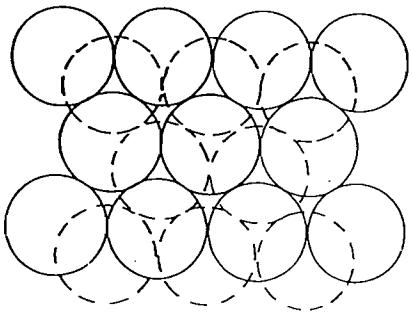
Element	Temperature Range (K)	a_0 (Å)[a]	c_0 (Å)	T_m (K)
Be		2.2866	3.5833	1527
Cd		2.97887	5.61765	594
β-Ce	125–350 (dhcp)[b]	3.65	5.96	
α-Co	< 700	2.5071	4.0686 (293)	
α-Dy	< 1657	3.5903	5.6475 (293)	
Er		3.5588	5.5874	1795
α-Gd	< 1533	3.6360	5.7026 (293)	
α-Hf	< 2013	3.1967	5.578 (299)	
α-Ho	< 1701	3.5773	5.6158 (293)	
α-La	< 550 (dhcp)	3.75	6.07	
α-Li	< 80	3.111	5.093 (78)	
Lu		3.5031	5.5509	
Mg		3.20927	5.21033	
α-Na	< 40	3.767	6.154 (5)	
α-Nd	< 1128 (dhcp)	3.657	5.902	
Os		2.7352	4.3190	3300
α-Pr	< 1068 (dhcp	3.669	5.920	
Re		2.7608	4.4582	3453
Ru		2.70389	4.28168	2523
α-Sc	< 1608	3.3090	5.2733 (293)	
α-Tb	< 1560	3.6010	5.6930 (293)	
Tc		2.735	4.388	2473
α-Ti	< 1155	2.950	4.686 (298)	
α-Tl	< 507	3.456	5.525	
Tm		3.5375	5.5546 (293)	1818
α-Y	< 1752	3.6474	5.7306 (293)	

[a] All lattice parameters are given for 298 K unless otherwise noted in parentheses.

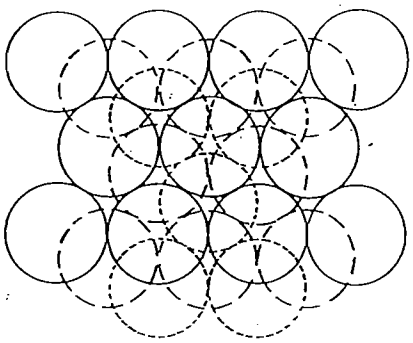




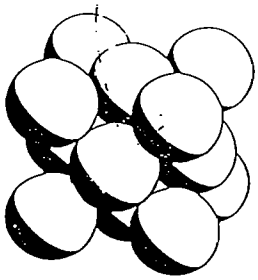




(b)



(c)



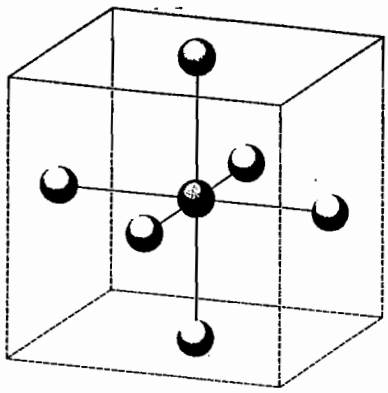


Figure 1.18.

The solid circle is the octahedrally coordinated interstice at the center of a face-centered cubic cell.

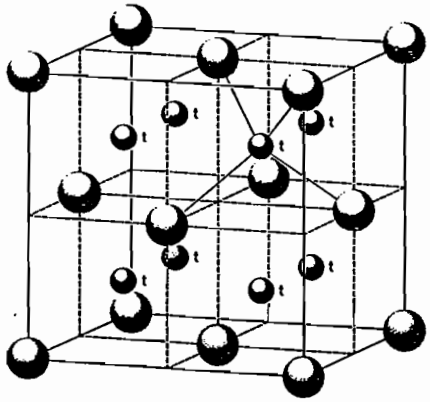


Figure 1.19.

Illustrating the eight tetrahedral interstitial positions in the fcc unit cell.

Table 1.4. Fcc elements.

Element	Temperature Range (K)	a_0 (Å)*	T_m(K)
Ac		5.311	1323
Ag		4.0862	1234
Al		4.04958	933
Au		4.07825	1337
α-Ca	<720	5.576	
α-Ce	<125	4.85 (77)	
γ-Ce	160–999	5.1601	
β-Co	700–T_m	3.548	1768
Cu		3.61496	1356
γ-Fe	1184–1665	3.5910 (320)	
Ir		3.8394 (321)	2716
β-La	550–1134	5.296	
γ-Mn	1360–1410	3.52	
Ni		3.52387	1726
Pb		4.9505	601
Pd		3.8896	1825
Pt		3.9231	2042
δ-Pu	480–588	4.6370	
Rh		3.8031	2233
α-Sr	<830	6.0847	
α-Th	<1636	5.0843	
α-Yb	<1033	5.4862	

* All lattice parameters are given for 298 K unless otherwise noted in parentheses.

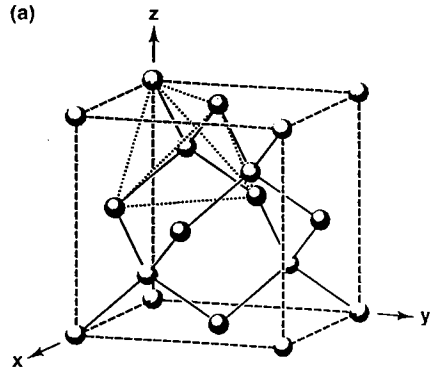


Figure 1.21a.

The diamond cubic unit cell presents a face-centered cubic exterior.

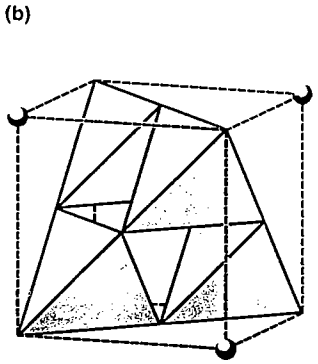


Figure 1.21b.

The sp^3 hybridization leads to tetrahedral bonding with a bond angle of 109°28′.

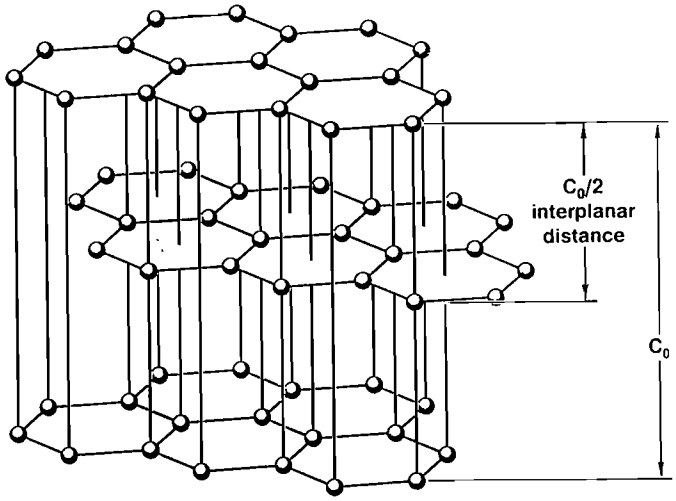
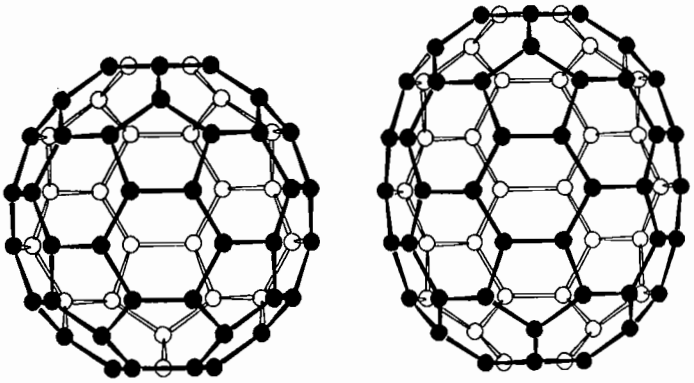


Figure 1.22.

The hexagonal crystal structure of graphite.



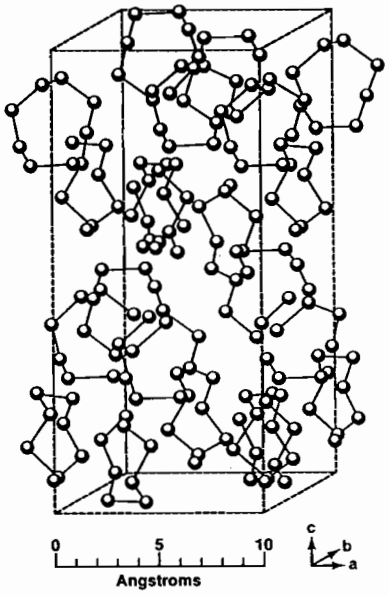


Figure 1.26.

The unit cell of rhombic sulfur.

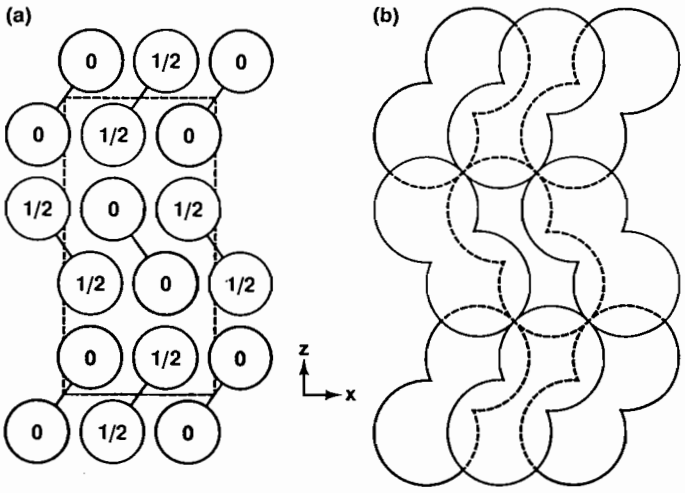


Figure 1.30.

(a) The orthorhombic unit cell of I_2 projected on the xy plane, the numbers denoti distance in and above plane of the page. (b) The atoms drawn with correct van radii to illustrate the close packing. (After Ref. 3.)