الباب الثامن
الحالة الصلبة
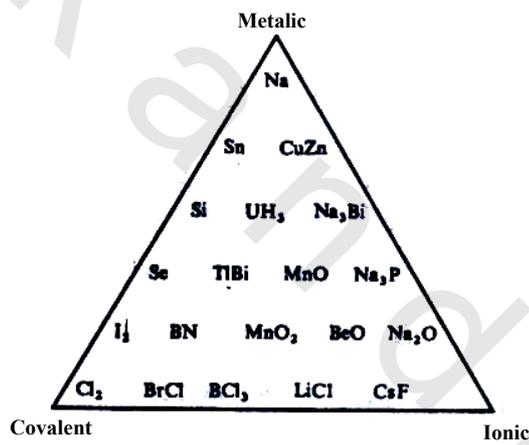
البـاب الثـامن
الحالـة الصلبـة

تصنيف الروابط بين الذرات والبلورات :

:

1- :

.

2- :

.

3- :

. .

_

. _

CCl_4 .

.

.

.

.

.

.

Metalic

Na

Sn   CuZn

Si   UH₃   Na₃Bi

Se   TIBi   MnO   Na₃P

I↓   BN   MnO₂   BeO   Na₂O

Cl₂   BrCl   BCl₃   LiCl   CsF

Covalent   Ionic

(2) .   **(1)** :

(3) .

(4) .

.

–   .

(**Xe، Kr ، Ar ، Ne** :)   (: **HCl**

(**SiF₄ H₂S**

.

.

:

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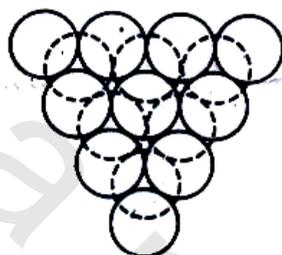
ABAB...

( )   (**ABCABC...**)

(.   **12**

0.7405
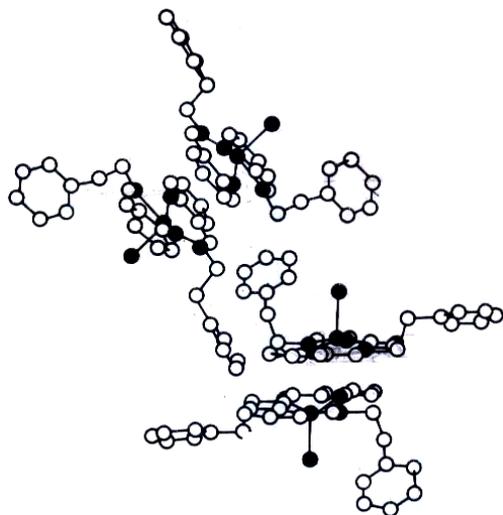
:

.
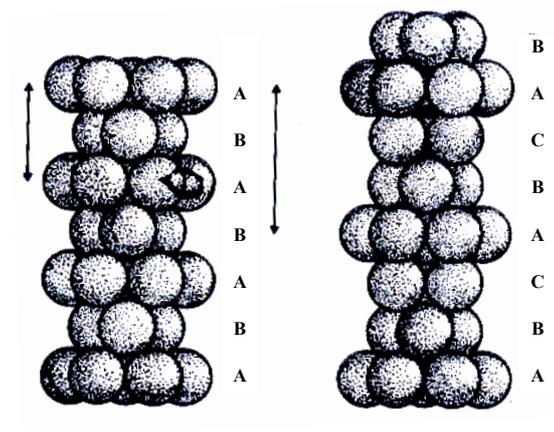
. **0.86**
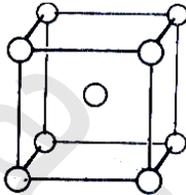
التركيب المكعبي
ذو الجسم المركزي

.

]

pentacarbouyl   Cl⁻ ⁽¹⁾   Pheuyleth‑2)   Fe⁺³ salicylaldimine
(tetra phosphorous trisulfide) molybdenum⁽²⁾

.

.

Fe(SANE)₂Cl

SANE = (N- (2-phenylethyl)
salicylaldimine
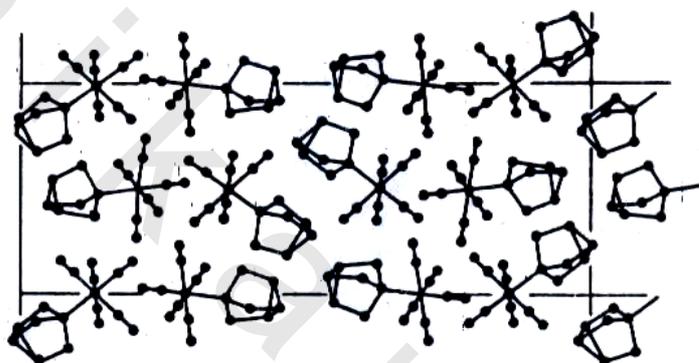
Mo(CO)₅P₄S₃

:   (2)

SiS₂   .

SiS₄

:

SiS₂

PdCl₂

PdCl₄

:

.   "   "

:

KCu(CN)₂ .

KCu(CN)$_2$.

:

. **amphiboles** **pyroxenes**

LiAl,(SiO₃)₂, spodumene, NaAl(SiO₃)₂, jadeite,]

[**CaMg(SiO₃)₂, diopside, MgSiO₃, ensTaTite**

SiO₄

.

( )

Na₃Mg₄Al(OH)₂(Si₄O₁₁)₂, arfredsonite,]

[**Ca₂Mg₅(OH)₂(Si₄O₁₁)₂, tremolite**

SiO₄

:

(b)
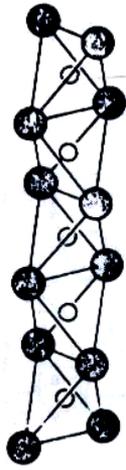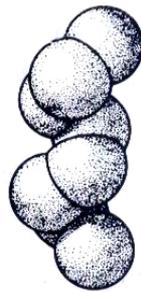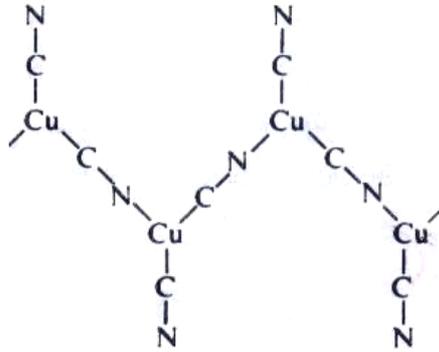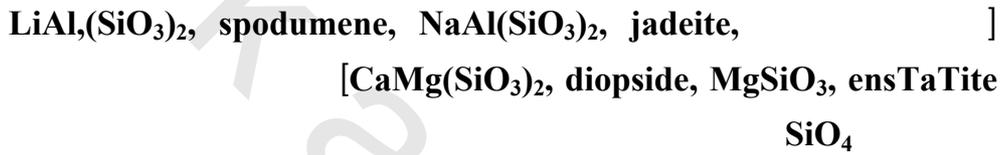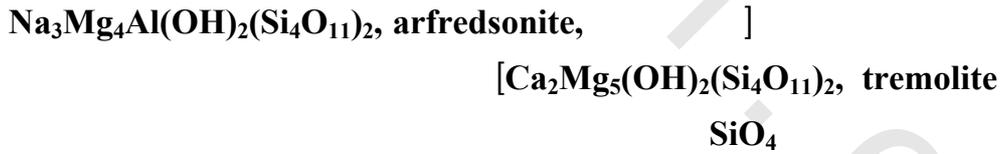
(3)   :

:(   )

. HgI_2 $CrCl_3$ MoS_2 $CdCl_2$

( )   ( )

(   )   (   )
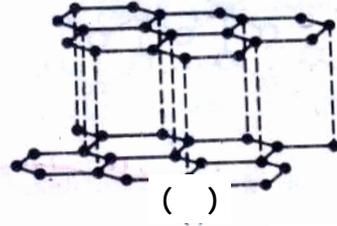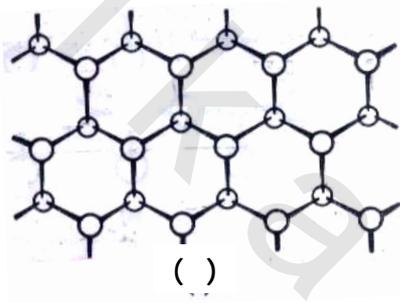
. $Al(OH)_3$

O Al

$CrCl_3$ Cl Cr

.
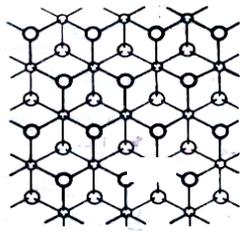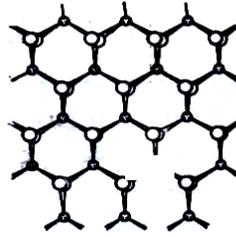
(a) ( )   (b) ( )
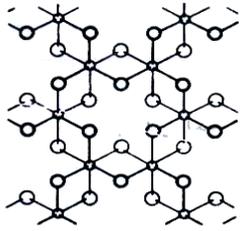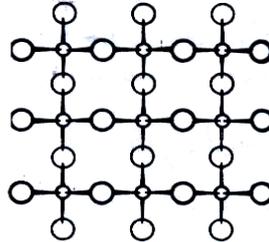
(c) ( )   (d) ( )
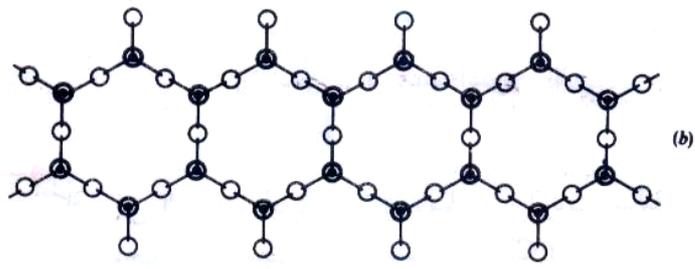
MX_3, MX_2

X

: .

HgI_2 ( ) $CrCl_3$ ( ) MoS_2 ( ) $CdCl_2$ ( )

$CaAl_2 Si_2O_8$.

:

_ _

:

. _ _

$Si(Al)$ (   )

$(AlSiO_4)^{n-}_n$.

- 235 -

Ca

Si(Al)

O

Ca^{2+}

CaAl$_2$ Si$_2$O$_8$

Ca^{+2}
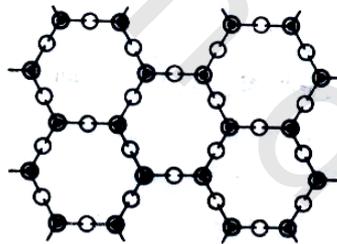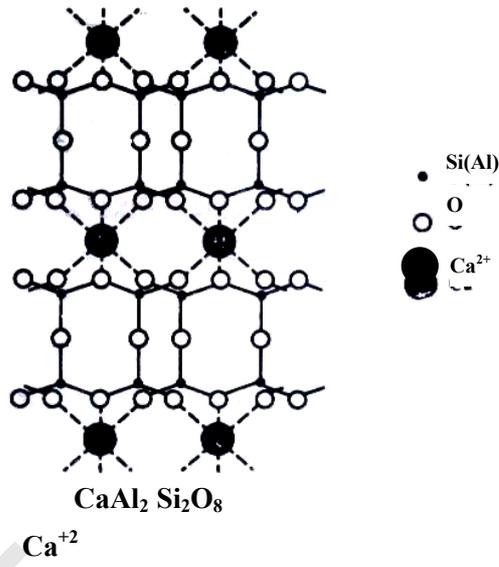
(4)

:

X   **M$_m$X$_x$**

X

M

:

:

.
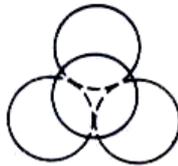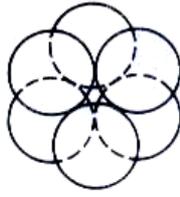
NaCl

.

.

NaCl

( )　　　**NaCl**

( )　( )

:

( )

( )
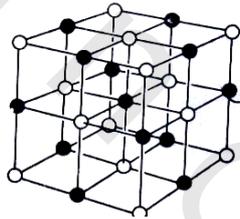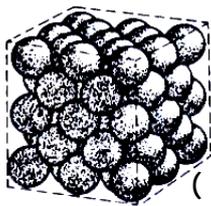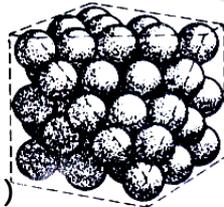
( )　( )　　　( )　**NaCl**
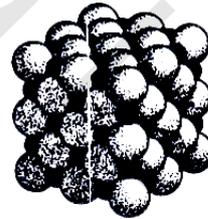
( )　**NaCl**

wurtzite

niekelarsenide, rutile, flurorite) X zinceblende

:

( )

( )

( )

( )

( )
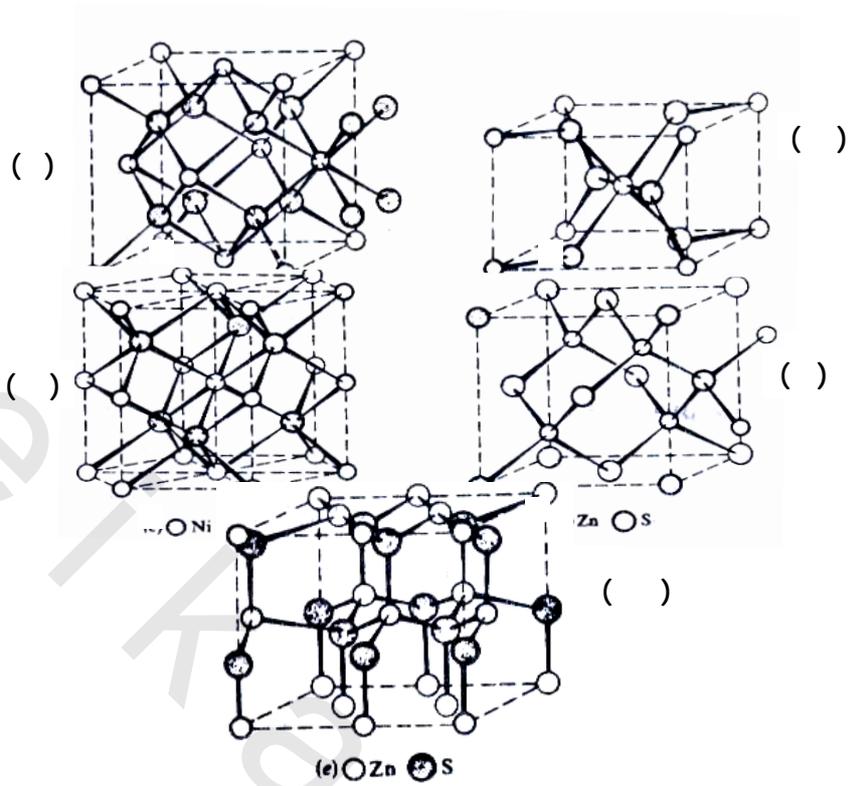
( )   (TiO$_2$) rut   ( )   (CaF$_2$) flurorite ( )
(ZnS)wurtzite （ ） (ZnS)zinc blende T   (NiAs) niekel arsenide

Al$_2$Br$_6$.

.

.

MX

M X

(CsCl)

M M_mX_x

X

$Mg(NH_3)_6]I_2, \ [Co(NH_3)_6]I_2]$

– $K_2SnCl_6, \ K_2ptCl_6)I_2$ (CaF_2)

Ca^{+2}

. F

. CsCl $[Ni(H_2O)_6][SnCl_6]$

- 239 -
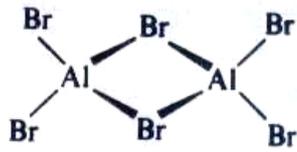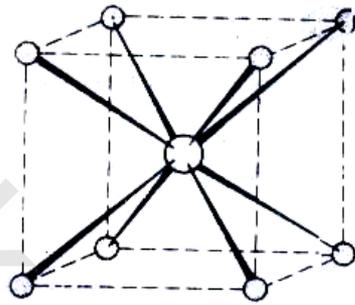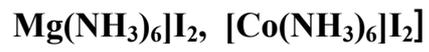
. SH^- , CN^- , NO_3^- , NH_4^+

M_mX_x

.

NaCl CaC_2

: C_2^{-2}
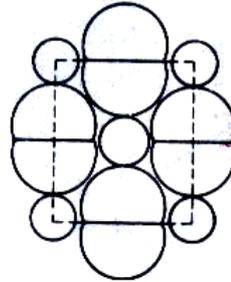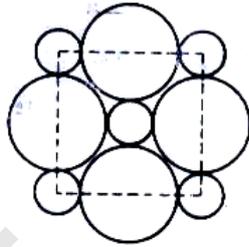
(CaC_2, NaCl   )

NaCl $CaCo_3$

:
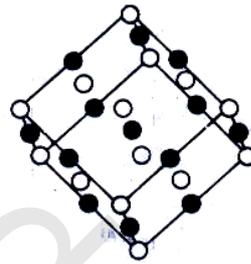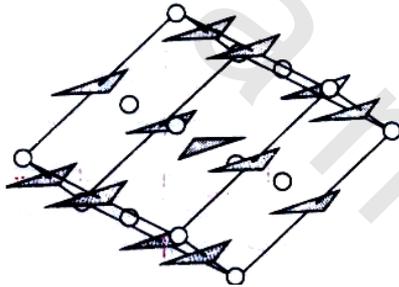
(NaCl, $CaCo_3$)

.

تأثير نسبة نصف القطر والشحنة على التركيب :

.

.

NaCl

.

: **AgBr ZnO**

.

:

NaF 988ºC	MgF₂ 1266ºC	AlF₃ 1291ºC	SiF₄ – 90ºC	PF₅ – 94ºC	SF₆ – 50ºC

SiF₄ AlF₃

1.5 1.8   **Si Al**

SiF₄

.

.

.

.

$^rM\,/$

$. M$ X ^rX

.

.

.

$^rM\,/\,^rX$

.

$^rM\,/\,^rX$

. $^rM\,/\,^rX$

. $^rM\,/\,^rX$ $X\ M$

$X\ M$

.

(		) (		)	
Ag^+	1.26	Fe^{2+}	0.76	Pd^{4+}	0.84
Al^{3+}	0.50	Fe^{3+}	0.64	P^{3-}	2.12
As^{3-}	2.22	Ga^+	1.13	P^{5+}	0.34
As^{5+}	0.47	Ga^{3+}	0.62	Pd^{2+}	0.86
Au^+	1.37	Ge^{2+}	0.93	Ra^{2+}	1.40
B^{3+}	0.20	Ge^{4+}	0.53	Rb^+	1.48
Ba^{2+}	1.35	H^-	1.40	S^{2-}	1.84

Be^{2+}	0.31	Hf^{4+}	0.81	Sb^{3-}	2.45
Br^-	1.95	Hg^{2+}	1.10	Sc^{3+}	0.81
C^{4-}	2.60	I^-	2.16	Se^{2-}	1.98
C^{4+}	0.15	In^+	1.32	Sr^{2+}	1.13
Ca^{2+}	0.99	In^{3+}	0.81	Sn^{2+}	1.12
Cd^{2+}	0.97	K^+	1.33	Sn^{4+}	0.71
Ce^{3+}	1.11	La^{3+}	1.15	Te^{2-}	2.21
Ce^{4+}	1.01	Li^+	0.60	Ti^{2+}	0.90
Cl^-	1.81	Lu^{3+}	0.93	Ti^{3+}	0.76
Co^{2+}	0.74	Mg^{2+}	0.65	Ti^{4+}	0.68
Co^{3+}	0.63	Mn^{2+}	0.80	Ti^+	1.40
Cr^{2+}	0.84	Mn^{3+}	0.66	Tl^{3+}	0.95
Cr^{3+}	0.69	Mo^{6+}	0.62	U^{3+}	1.11
Cr^{4+}	0.52	N^{3-}	1.71	U^{4+}	0.97
Cs^+	1.69	N^{5+}	0.11	V^{2+}	0.88
Cu^+	0.96	Na^+	0.95	V^{3+}	0.74
Cu^{2+}	0.70	NH_4^+	1.48	V^{4+}	0.60
Eu^{2+}	1.12	Ni^{2+}	0.72	Y^{3+}	0.93
Eu^{3+}	1.03	O^{2-}	1.40	Zn^{2+}	0.74
F^-	1.36	Pd^{2+}	1.20		

:

. MX
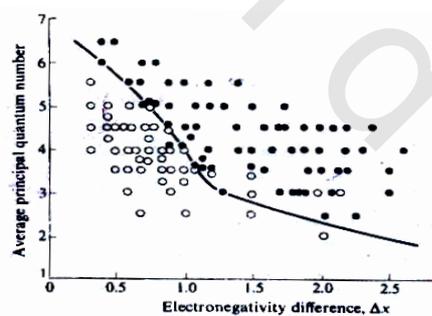
( )

. ( )

. MX

–

:

.

:

Si^+ ( )

$(2 = 4/4 + 4/4)$.

Al^{+3} Si^{+4} ( )

$(2 = 4/4 + 3/6 + 3/6)\ Al_2SiO_4F_2$.

Mg^{+2} Si^{+4} ( )

$(2 = 4/4 + 2/6 + 2/6 + 2/6)\ Mg_2SiO_4$.

Be^{+2} Si^{+4} ( )

$(2 = 4/4 + 2/4 + 2/4)Be_2SiO_4$.

:

.

.

SiO_4

.

.

$$\text{SiS}_4$$

$$\text{SiS}_2$$

.

.

طـاقـة الشبكيـة :

U :

$$M_m X_x(s) \rightarrow m\,M^{z_M}(g) + x\,X^{z_M}(g)$$

.
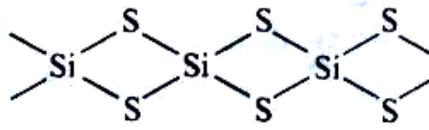
Ue

r $\quad$ zX $\quad$ zM $\quad\quad$ L $\quad$ x $\quad$ m

$\bar{M}$:

$$U_e = M' \frac{z_M z_X (m+x) e^2}{2r}$$

$(M'\!-\!1)$ $\quad\quad\quad$ $m = x = 1$

$M')$.

- 245 -

. (1

1.7   M′

.

M   μ

M′

:

$$U_e = \mu \frac{z_M z_X e^2}{r} \qquad\qquad U_e = M\,\frac{e^2}{r}$$

zMzX   M

,μ M′   .

.

M^{+n}X^{-n} M′ = μ = 1.7476
M = 6.9902,   M = 1.7476   （MnD   ）
                                    . n = 2   n = 1

"   "

NaCl   .

.

NaCl(s) → Na(s) + ½Cl$_2$(g)	$-\Delta H^o_f$(NaCl) = 98.2 kcal mol^{-1}
Na(s) → Na(g)	S(Na) = 25.9 kcal mol^{-1}
½ Cl$_2$(g) → Cl(g)	½ D(Cl$_2$) = 29.0 kcal mol^{-1}
Na(g) → Na$^+$(g) + e$^-$(g)	I(Na) = 118.5 kcal mol^{-1}
Cl(g) + e$^-$(g) → Cl$^-$(g)	$-$A(Cl) = $-$ 83.5 kcal mol^{-1}
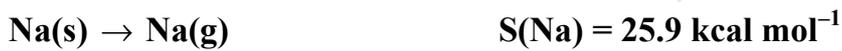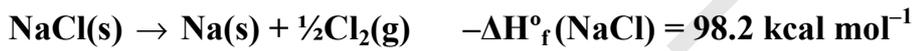
$$U(NaCl) = -\Delta H^o_f (NaCl) + S(Na) + \frac{1}{2} D(Cl_2) + I(Na) - A(Cl)$$
$$= 188.1 \text{ kcal mol}^{-1}$$

188.1 Kcal mol⁻¹ → $188.1 \text{ Kcal mol}^{-1}$

.

(2.814) NaCl

$$U_e = \frac{1.7476 \times \left(4.803 \times 10^{-10}\right)^2 \times 1.4394 \times 10^{13}}{2.814 \times 10^{-8}} = 206.2 \text{ kcal mol}^{-1}$$

1–18 /

:

$$U = U_e \left(1 - \frac{\rho}{r}\right)$$

ρ 0.31 .

$\pm 2\%$.

CaI_2 %13.2

.

.

- 247 -

.

CaI₂

.

. **InSb, ZnS** :

ΔH°f

ΔH°f   **LiF   CsF**

LiI   CsI

:

$$\Delta H^{o}_{f} = S(M) + \frac{1}{2}D(X_2) + I(M) - A(X) - U(MX)$$

(U(MX), I(M), S(M   LiX   CsX

.

ΔH°f

ΔH°f   **[(S(M) + I (M) - U(MX)]**

. **[U(MX)   (S(M)2I(M)]**

[U(MF)]   **ΔH°f**

ΔH°f   **[s(M) + I(M)]**

. **[U(MI)]**   **[S(M) + I(M)]**

r   **[U(MI)]**

.

LiI   CsI   **r**

.

.

.

.

III V BN , AlP $GaAs$ $InSb$.

II , VI $ZnSe$ $CdTe$.

I VII

$CuBr$ AgI .   : $ZnGeAs_2$

.

.

B^- MgB_2

. $LiGa$, $CaGa_2$ Ga

.

CaC_2

(C_2^{-2}) N_2 . $LiAs$

.

❋ ❋ ❋

1-

.

2-   **BaO**
$O(g) + 2e^-(g) \rightarrow O^{-2}(g)$.

3-   **CaCl(s)** .   **CaCl(s)**
.

4-   **M**   **MX₃**   **X** .

5-   **BeCl₂**   **Be**   **Cl** .
    Be   **Cl** .

.

6-
MoS₂ .

7-

.

8-
O⁻   **O⁻²**   **O⁻**   **O**
.   **MgO**   **Mg⁺²O⁻²**   **Mg⁺O⁻** .

9-   **CsCl**   **NaCl** .

:

MgO	2.10A°	MgS	2.60A°	MgSe	2.73A°
MnO	2.24A°	Mus	2.59A°	MnSe	2.73A°

S^{-2}

.

❊ ❊ ❊