$AlPO_4$-41 Structure: AB4C_mP60_4_5a_20a_5a-001

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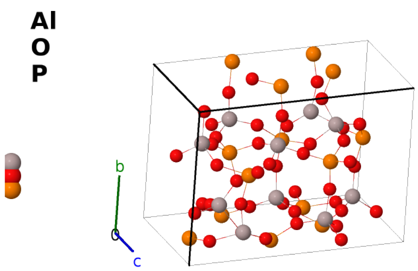
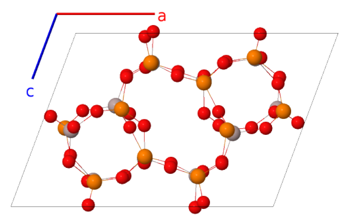
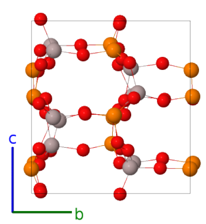
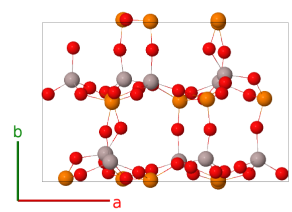
https://aflow.org/prototype-encyclopedia/5V2E

https://aflow.org/prototype-encyclopedia/AB4C_mP60_4_5a_20a_5a-001









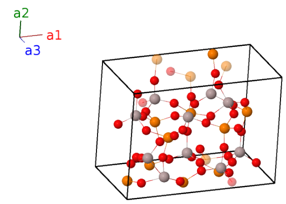
Prototype	AlO_4P
AFLOW prototype label	AB4C_mP60_4_5a_20a_5a-001
ICSD	75906
CCDC	1636548
Pearson symbol	mP60
Space group number	4
Space group symbol	$P2_1$
AFLOW prototype command	`aflow --proto=AB4C_mP60_4_5a_20a_5a-001` `--params=`$a, b/a, c/a, \beta, x_1, y_1, z_1, x_2, y_2, z_2, x_3, y_3, z_3, x_4, y_4, z_4, x_5, y_5, z_5, x_6, y_6, z_6, x_7, y_7, z_7, x_8, y_8, z_8, x_9, y_9, z_9, x_{10}, y_{10}, z_{10}, x_{11}, y_{11}, z_{11}, x_{12}, y_{12}, z_{12}, x_{13}, y_{13}, z_{13}, x_{14}, y_{14}, z_{14}, x_{15}, y_{15}, z_{15}, x_{16}, y_{16}, z_{16}, x_{17}, y_{17}, z_{17}, x_{18}, y_{18}, z_{18}, x_{19}, y_{19}, z_{19}, x_{20}, y_{20}, z_{20}, x_{21}, y_{21}, z_{21}, x_{22}, y_{22}, z_{22}, x_{23}, y_{23}, z_{23}, x_{24}, y_{24}, z_{24}, x_{25}, y_{25}, z_{25}, x_{26}, y_{26}, z_{26}, x_{27}, y_{27}, z_{27}, x_{28}, y_{28}, z_{28}, x_{29}, y_{29}, z_{29}, x_{30}, y_{30}, z_{30}$

- This is yet another of the many possible crystal structures in the silica/aluminum phosphate system. Like all such crystals, it consists of connected AlO_4 and PO_4 tetrahedra. In some cases silicon can replace the aluminum and phosphorous atoms (Ma, 2011).

- While the view of this structure along the unique axis suggests that this is a layered compound, the distance between the aluminum and phosphorous atoms in different layers (roughly 3Å) is approximately the same it is in an Al-O-P chain in other parts of the structure. This allows us to define an effective microporous ring with a minimum distance of 7.06Å.
- (Kirchner, 1994) give the structure in the unique axis c setting of space group $P2_1$ #4. We rotated the axes so that $c \rightarrow b \rightarrow a \rightarrow c$ to change this to the standard unique axis b setting.

Simple Monoclinic primitive vectors

$$
\begin{aligned}
\mathbf{a_1} &= a\,\hat{\mathbf{x}} \\
\mathbf{a_2} &= b\,\hat{\mathbf{y}} \\
\mathbf{a_3} &= c\cos\beta\,\hat{\mathbf{x}} + c\sin\beta\,\hat{\mathbf{z}}
\end{aligned}
$$



Basis vectors

		Lattice coordinates		Cartesian coordinates	Wyckoff position	Atom type
$\mathbf{B_1}$	=	$x_1\,\mathbf{a}_1 + y_1\,\mathbf{a}_2 + z_1\,\mathbf{a}_3$	=	$(ax_1 + cz_1\cos\beta)\,\hat{\mathbf{x}} + by_1\,\hat{\mathbf{y}} + cz_1\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al I
$\mathbf{B_2}$	=	$-x_1\,\mathbf{a}_1 + \left(y_1 + \frac{1}{2}\right)\mathbf{a}_2 - z_1\,\mathbf{a}_3$	=	$-(ax_1 + cz_1\cos\beta)\,\hat{\mathbf{x}} + b\left(y_1 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_1\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al I
$\mathbf{B_3}$	=	$x_2\,\mathbf{a}_1 + y_2\,\mathbf{a}_2 + z_2\,\mathbf{a}_3$	=	$(ax_2 + cz_2\cos\beta)\,\hat{\mathbf{x}} + by_2\,\hat{\mathbf{y}} + cz_2\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al II
$\mathbf{B_4}$	=	$-x_2\,\mathbf{a}_1 + \left(y_2 + \frac{1}{2}\right)\mathbf{a}_2 - z_2\,\mathbf{a}_3$	=	$-(ax_2 + cz_2\cos\beta)\,\hat{\mathbf{x}} + b\left(y_2 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_2\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al II
$\mathbf{B_5}$	=	$x_3\,\mathbf{a}_1 + y_3\,\mathbf{a}_2 + z_3\,\mathbf{a}_3$	=	$(ax_3 + cz_3\cos\beta)\,\hat{\mathbf{x}} + by_3\,\hat{\mathbf{y}} + cz_3\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al III
$\mathbf{B_6}$	=	$-x_3\,\mathbf{a}_1 + \left(y_3 + \frac{1}{2}\right)\mathbf{a}_2 - z_3\,\mathbf{a}_3$	=	$-(ax_3 + cz_3\cos\beta)\,\hat{\mathbf{x}} + b\left(y_3 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_3\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al III
$\mathbf{B_7}$	=	$x_4\,\mathbf{a}_1 + y_4\,\mathbf{a}_2 + z_4\,\mathbf{a}_3$	=	$(ax_4 + cz_4\cos\beta)\,\hat{\mathbf{x}} + by_4\,\hat{\mathbf{y}} + cz_4\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al IV
$\mathbf{B_8}$	=	$-x_4\,\mathbf{a}_1 + \left(y_4 + \frac{1}{2}\right)\mathbf{a}_2 - z_4\,\mathbf{a}_3$	=	$-(ax_4 + cz_4\cos\beta)\,\hat{\mathbf{x}} + b\left(y_4 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_4\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al IV
$\mathbf{B_9}$	=	$x_5\,\mathbf{a}_1 + y_5\,\mathbf{a}_2 + z_5\,\mathbf{a}_3$	=	$(ax_5 + cz_5\cos\beta)\,\hat{\mathbf{x}} + by_5\,\hat{\mathbf{y}} + cz_5\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al V
$\mathbf{B_{10}}$	=	$-x_5\,\mathbf{a}_1 + \left(y_5 + \frac{1}{2}\right)\mathbf{a}_2 - z_5\,\mathbf{a}_3$	=	$-(ax_5 + cz_5\cos\beta)\,\hat{\mathbf{x}} + b\left(y_5 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_5\sin\beta\,\hat{\mathbf{z}}$	(2a)	Al V
$\mathbf{B_{11}}$	=	$x_6\,\mathbf{a}_1 + y_6\,\mathbf{a}_2 + z_6\,\mathbf{a}_3$	=	$(ax_6 + cz_6\cos\beta)\,\hat{\mathbf{x}} + by_6\,\hat{\mathbf{y}} + cz_6\sin\beta\,\hat{\mathbf{z}}$	(2a)	O I
$\mathbf{B_{12}}$	=	$-x_6\,\mathbf{a}_1 + \left(y_6 + \frac{1}{2}\right)\mathbf{a}_2 - z_6\,\mathbf{a}_3$	=	$-(ax_6 + cz_6\cos\beta)\,\hat{\mathbf{x}} + b\left(y_6 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_6\sin\beta\,\hat{\mathbf{z}}$	(2a)	O I
$\mathbf{B_{13}}$	=	$x_7\,\mathbf{a}_1 + y_7\,\mathbf{a}_2 + z_7\,\mathbf{a}_3$	=	$(ax_7 + cz_7\cos\beta)\,\hat{\mathbf{x}} + by_7\,\hat{\mathbf{y}} + cz_7\sin\beta\,\hat{\mathbf{z}}$	(2a)	O II
$\mathbf{B_{14}}$	=	$-x_7\,\mathbf{a}_1 + \left(y_7 + \frac{1}{2}\right)\mathbf{a}_2 - z_7\,\mathbf{a}_3$	=	$-(ax_7 + cz_7\cos\beta)\,\hat{\mathbf{x}} + b\left(y_7 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_7\sin\beta\,\hat{\mathbf{z}}$	(2a)	O II
$\mathbf{B_{15}}$	=	$x_8\,\mathbf{a}_1 + y_8\,\mathbf{a}_2 + z_8\,\mathbf{a}_3$	=	$(ax_8 + cz_8\cos\beta)\,\hat{\mathbf{x}} + by_8\,\hat{\mathbf{y}} + cz_8\sin\beta\,\hat{\mathbf{z}}$	(2a)	O III
$\mathbf{B_{16}}$	=	$-x_8\,\mathbf{a}_1 + \left(y_8 + \frac{1}{2}\right)\mathbf{a}_2 - z_8\,\mathbf{a}_3$	=	$-(ax_8 + cz_8\cos\beta)\,\hat{\mathbf{x}} + b\left(y_8 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_8\sin\beta\,\hat{\mathbf{z}}$	(2a)	O III
$\mathbf{B_{17}}$	=	$x_9\,\mathbf{a}_1 + y_9\,\mathbf{a}_2 + z_9\,\mathbf{a}_3$	=	$(ax_9 + cz_9\cos\beta)\,\hat{\mathbf{x}} + by_9\,\hat{\mathbf{y}} + cz_9\sin\beta\,\hat{\mathbf{z}}$	(2a)	O IV
$\mathbf{B_{18}}$	=	$-x_9\,\mathbf{a}_1 + \left(y_9 + \frac{1}{2}\right)\mathbf{a}_2 - z_9\,\mathbf{a}_3$	=	$-(ax_9 + cz_9\cos\beta)\,\hat{\mathbf{x}} + b\left(y_9 + \frac{1}{2}\right)\hat{\mathbf{y}} - cz_9\sin\beta\,\hat{\mathbf{z}}$	(2a)	O IV
$\mathbf{B_{19}}$	=	$x_{10}\,\mathbf{a}_1 + y_{10}\,\mathbf{a}_2 + z_{10}\,\mathbf{a}_3$	=	$(ax_{10} + cz_{10}\cos\beta)\,\hat{\mathbf{x}} + by_{10}\,\hat{\mathbf{y}} + cz_{10}\sin\beta\,\hat{\mathbf{z}}$	(2a)	O V

$$\mathbf{B_{20}} = -x_{10}\,\mathbf{a}_1 + \left(y_{10}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{10}\,\mathbf{a}_3 = -\left(ax_{10}+cz_{10}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{10}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{10}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O V}$$

$$\mathbf{B_{21}} = x_{11}\,\mathbf{a}_1 + y_{11}\,\mathbf{a}_2 + z_{11}\,\mathbf{a}_3 = \left(ax_{11}+cz_{11}\cos\beta\right)\,\mathbf{\hat{x}} + by_{11}\,\mathbf{\hat{y}} + cz_{11}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O VI}$$

$$\mathbf{B_{22}} = -x_{11}\,\mathbf{a}_1 + \left(y_{11}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{11}\,\mathbf{a}_3 = -\left(ax_{11}+cz_{11}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{11}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{11}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O VI}$$

$$\mathbf{B_{23}} = x_{12}\,\mathbf{a}_1 + y_{12}\,\mathbf{a}_2 + z_{12}\,\mathbf{a}_3 = \left(ax_{12}+cz_{12}\cos\beta\right)\,\mathbf{\hat{x}} + by_{12}\,\mathbf{\hat{y}} + cz_{12}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O VII}$$

$$\mathbf{B_{24}} = -x_{12}\,\mathbf{a}_1 + \left(y_{12}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{12}\,\mathbf{a}_3 = -\left(ax_{12}+cz_{12}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{12}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{12}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O VII}$$

$$\mathbf{B_{25}} = x_{13}\,\mathbf{a}_1 + y_{13}\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3 = \left(ax_{13}+cz_{13}\cos\beta\right)\,\mathbf{\hat{x}} + by_{13}\,\mathbf{\hat{y}} + cz_{13}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O VIII}$$

$$\mathbf{B_{26}} = -x_{13}\,\mathbf{a}_1 + \left(y_{13}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{13}\,\mathbf{a}_3 = -\left(ax_{13}+cz_{13}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{13}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{13}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O VIII}$$

$$\mathbf{B_{27}} = x_{14}\,\mathbf{a}_1 + y_{14}\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = \left(ax_{14}+cz_{14}\cos\beta\right)\,\mathbf{\hat{x}} + by_{14}\,\mathbf{\hat{y}} + cz_{14}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O IX}$$

$$\mathbf{B_{28}} = -x_{14}\,\mathbf{a}_1 + \left(y_{14}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{14}\,\mathbf{a}_3 = -\left(ax_{14}+cz_{14}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{14}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{14}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O IX}$$

$$\mathbf{B_{29}} = x_{15}\,\mathbf{a}_1 + y_{15}\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = \left(ax_{15}+cz_{15}\cos\beta\right)\,\mathbf{\hat{x}} + by_{15}\,\mathbf{\hat{y}} + cz_{15}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O X}$$

$$\mathbf{B_{30}} = -x_{15}\,\mathbf{a}_1 + \left(y_{15}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{15}\,\mathbf{a}_3 = -\left(ax_{15}+cz_{15}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{15}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{15}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O X}$$

$$\mathbf{B_{31}} = x_{16}\,\mathbf{a}_1 + y_{16}\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3 = \left(ax_{16}+cz_{16}\cos\beta\right)\,\mathbf{\hat{x}} + by_{16}\,\mathbf{\hat{y}} + cz_{16}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XI}$$

$$\mathbf{B_{32}} = -x_{16}\,\mathbf{a}_1 + \left(y_{16}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{16}\,\mathbf{a}_3 = -\left(ax_{16}+cz_{16}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{16}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{16}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XI}$$

$$\mathbf{B_{33}} = x_{17}\,\mathbf{a}_1 + y_{17}\,\mathbf{a}_2 + z_{17}\,\mathbf{a}_3 = \left(ax_{17}+cz_{17}\cos\beta\right)\,\mathbf{\hat{x}} + by_{17}\,\mathbf{\hat{y}} + cz_{17}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XII}$$

$$\mathbf{B_{34}} = -x_{17}\,\mathbf{a}_1 + \left(y_{17}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{17}\,\mathbf{a}_3 = -\left(ax_{17}+cz_{17}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{17}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{17}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XII}$$

$$\mathbf{B_{35}} = x_{18}\,\mathbf{a}_1 + y_{18}\,\mathbf{a}_2 + z_{18}\,\mathbf{a}_3 = \left(ax_{18}+cz_{18}\cos\beta\right)\,\mathbf{\hat{x}} + by_{18}\,\mathbf{\hat{y}} + cz_{18}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XIII}$$

$$\mathbf{B_{36}} = -x_{18}\,\mathbf{a}_1 + \left(y_{18}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{18}\,\mathbf{a}_3 = -\left(ax_{18}+cz_{18}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{18}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{18}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XIII}$$

$$\mathbf{B_{37}} = x_{19}\,\mathbf{a}_1 + y_{19}\,\mathbf{a}_2 + z_{19}\,\mathbf{a}_3 = \left(ax_{19}+cz_{19}\cos\beta\right)\,\mathbf{\hat{x}} + by_{19}\,\mathbf{\hat{y}} + cz_{19}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XIV}$$

$$\mathbf{B_{38}} = -x_{19}\,\mathbf{a}_1 + \left(y_{19}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{19}\,\mathbf{a}_3 = -\left(ax_{19}+cz_{19}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{19}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{19}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XIV}$$

$$\mathbf{B_{39}} = x_{20}\,\mathbf{a}_1 + y_{20}\,\mathbf{a}_2 + z_{20}\,\mathbf{a}_3 = \left(ax_{20}+cz_{20}\cos\beta\right)\,\mathbf{\hat{x}} + by_{20}\,\mathbf{\hat{y}} + cz_{20}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XV}$$

$$\mathbf{B_{40}} = -x_{20}\,\mathbf{a}_1 + \left(y_{20}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{20}\,\mathbf{a}_3 = -\left(ax_{20}+cz_{20}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{20}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{20}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XV}$$

$$\mathbf{B_{41}} = x_{21}\,\mathbf{a}_1 + y_{21}\,\mathbf{a}_2 + z_{21}\,\mathbf{a}_3 = \left(ax_{21}+cz_{21}\cos\beta\right)\,\mathbf{\hat{x}} + by_{21}\,\mathbf{\hat{y}} + cz_{21}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XVI}$$

$$\mathbf{B_{42}} = -x_{21}\,\mathbf{a}_1 + \left(y_{21}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{21}\,\mathbf{a}_3 = -\left(ax_{21}+cz_{21}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{21}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{21}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XVI}$$

$$\mathbf{B_{43}} = x_{22}\,\mathbf{a}_1 + y_{22}\,\mathbf{a}_2 + z_{22}\,\mathbf{a}_3 = \left(ax_{22}+cz_{22}\cos\beta\right)\,\mathbf{\hat{x}} + by_{22}\,\mathbf{\hat{y}} + cz_{22}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XVII}$$

$$\mathbf{B_{44}} = -x_{22}\,\mathbf{a}_1 + \left(y_{22}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{22}\,\mathbf{a}_3 = -\left(ax_{22}+cz_{22}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{22}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{22}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XVII}$$

$$\mathbf{B_{45}} = x_{23}\,\mathbf{a}_1 + y_{23}\,\mathbf{a}_2 + z_{23}\,\mathbf{a}_3 = \left(ax_{23}+cz_{23}\cos\beta\right)\,\mathbf{\hat{x}} + by_{23}\,\mathbf{\hat{y}} + cz_{23}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XVIII}$$

$$\mathbf{B_{46}} = -x_{23}\,\mathbf{a}_1 + \left(y_{23}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{23}\,\mathbf{a}_3 = -\left(ax_{23}+cz_{23}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{23}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{23}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XVIII}$$

$$\mathbf{B_{47}} = x_{24}\,\mathbf{a}_1 + y_{24}\,\mathbf{a}_2 + z_{24}\,\mathbf{a}_3 = \left(ax_{24}+cz_{24}\cos\beta\right)\,\mathbf{\hat{x}} + by_{24}\,\mathbf{\hat{y}} + cz_{24}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XIX}$$

$$\mathbf{B_{48}} = -x_{24}\,\mathbf{a}_1 + \left(y_{24}+\tfrac{1}{2}\right)\,\mathbf{a}_2 - z_{24}\,\mathbf{a}_3 = -\left(ax_{24}+cz_{24}\cos\beta\right)\,\mathbf{\hat{x}} + b\left(y_{24}+\tfrac{1}{2}\right)\,\mathbf{\hat{y}} - cz_{24}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XIX}$$

$$\mathbf{B_{49}} = x_{25}\,\mathbf{a}_1 + y_{25}\,\mathbf{a}_2 + z_{25}\,\mathbf{a}_3 = \left(ax_{25}+cz_{25}\cos\beta\right)\,\mathbf{\hat{x}} + by_{25}\,\mathbf{\hat{y}} + cz_{25}\sin\beta\,\mathbf{\hat{z}} \quad \text{(2a)} \quad \text{O XX}$$

$$\mathbf{B_{50}} = -x_{25}\,\mathbf{a}_1 + \left(y_{25}+\frac{1}{2}\right)\,\mathbf{a}_2 - z_{25}\,\mathbf{a}_3 = -\left(ax_{25}+cz_{25}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{25}+\frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{25}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{O XX}$$

$$\mathbf{B_{51}} = x_{26}\,\mathbf{a}_1 + y_{26}\,\mathbf{a}_2 + z_{26}\,\mathbf{a}_3 = \left(ax_{26}+cz_{26}\cos\beta\right)\,\hat{\mathbf{x}} + by_{26}\,\hat{\mathbf{y}} + cz_{26}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P I}$$

$$\mathbf{B_{52}} = -x_{26}\,\mathbf{a}_1 + \left(y_{26}+\frac{1}{2}\right)\,\mathbf{a}_2 - z_{26}\,\mathbf{a}_3 = -\left(ax_{26}+cz_{26}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{26}+\frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{26}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P I}$$

$$\mathbf{B_{53}} = x_{27}\,\mathbf{a}_1 + y_{27}\,\mathbf{a}_2 + z_{27}\,\mathbf{a}_3 = \left(ax_{27}+cz_{27}\cos\beta\right)\,\hat{\mathbf{x}} + by_{27}\,\hat{\mathbf{y}} + cz_{27}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P II}$$

$$\mathbf{B_{54}} = -x_{27}\,\mathbf{a}_1 + \left(y_{27}+\frac{1}{2}\right)\,\mathbf{a}_2 - z_{27}\,\mathbf{a}_3 = -\left(ax_{27}+cz_{27}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{27}+\frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{27}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P II}$$

$$\mathbf{B_{55}} = x_{28}\,\mathbf{a}_1 + y_{28}\,\mathbf{a}_2 + z_{28}\,\mathbf{a}_3 = \left(ax_{28}+cz_{28}\cos\beta\right)\,\hat{\mathbf{x}} + by_{28}\,\hat{\mathbf{y}} + cz_{28}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P III}$$

$$\mathbf{B_{56}} = -x_{28}\,\mathbf{a}_1 + \left(y_{28}+\frac{1}{2}\right)\,\mathbf{a}_2 - z_{28}\,\mathbf{a}_3 = -\left(ax_{28}+cz_{28}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{28}+\frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{28}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P III}$$

$$\mathbf{B_{57}} = x_{29}\,\mathbf{a}_1 + y_{29}\,\mathbf{a}_2 + z_{29}\,\mathbf{a}_3 = \left(ax_{29}+cz_{29}\cos\beta\right)\,\hat{\mathbf{x}} + by_{29}\,\hat{\mathbf{y}} + cz_{29}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P IV}$$

$$\mathbf{B_{58}} = -x_{29}\,\mathbf{a}_1 + \left(y_{29}+\frac{1}{2}\right)\,\mathbf{a}_2 - z_{29}\,\mathbf{a}_3 = -\left(ax_{29}+cz_{29}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{29}+\frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{29}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P IV}$$

$$\mathbf{B_{59}} = x_{30}\,\mathbf{a}_1 + y_{30}\,\mathbf{a}_2 + z_{30}\,\mathbf{a}_3 = \left(ax_{30}+cz_{30}\cos\beta\right)\,\hat{\mathbf{x}} + by_{30}\,\hat{\mathbf{y}} + cz_{30}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P V}$$

$$\mathbf{B_{60}} = -x_{30}\,\mathbf{a}_1 + \left(y_{30}+\frac{1}{2}\right)\,\mathbf{a}_2 - z_{30}\,\mathbf{a}_3 = -\left(ax_{30}+cz_{30}\cos\beta\right)\,\hat{\mathbf{x}} + b\left(y_{30}+\frac{1}{2}\right)\,\hat{\mathbf{y}} - cz_{30}\sin\beta\,\hat{\mathbf{z}} \quad \text{(2a)} \quad \text{P V}$$

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