

In[\*]:= H11 := 0

In[\*]:= H12 := I

In[\*]:= H13 := 0

In[\*]:= H14 := 0

In[\*]:= H21 := -I

In[\*]:= H22 :=  $(-z_2 Z_2 - z_3 Z_3) / 4$

In[\*]:= H23 :=  $(-Z_2 + 2 a z_2 Z_2^2 + B Z_2^2 z_3 + B z_2 Z_2 Z_3 + 4 G Z_2 z_3 Z_3 - 4 a z_2 Z_3^2 + b z_3 Z_3^2 - 2 B z_3 Z_3^2) / 4$

In[\*]:=  $(2 b z_2 Z_2^2 - B z_2 Z_2^2 - 4 a Z_2^2 z_3 - 2 G Z_2^2 z_3 + 4 g z_2 Z_2 Z_3 - 2 b Z_2 z_3 Z_3 - b z_2 Z_3^2 + 2 a z_3 Z_3^2) / 4$

Out[\*]:=  $\frac{1}{4} (2 b z_2 Z_2^2 - B z_2 Z_2^2 - 4 a Z_2^2 z_3 - 2 G Z_2^2 z_3 + 4 g z_2 Z_2 Z_3 - 2 b Z_2 z_3 Z_3 - b z_2 Z_3^2 + 2 a z_3 Z_3^2)$

In[\*]:= Expand $\left[\frac{1}{4} (2 b z_2 Z_2^2 - B z_2 Z_2^2 - 4 a Z_2^2 z_3 - 2 G Z_2^2 z_3 + 4 g z_2 Z_2 Z_3 - 2 b Z_2 z_3 Z_3 - b z_2 Z_3^2 + 2 a z_3 Z_3^2)\right]$

Out[\*]:=  $\frac{1}{2} b z_2 Z_2^2 - \frac{1}{4} B z_2 Z_2^2 - a Z_2^2 z_3 - \frac{1}{2} G Z_2^2 z_3 + g z_2 Z_2 Z_3 - \frac{1}{2} b Z_2 z_3 Z_3 - \frac{1}{4} b z_2 Z_3^2 + \frac{1}{2} a z_3 Z_3^2$

In[\*]:= H24 :=  $\frac{1}{4} (2 b z_2 Z_2^2 - B z_2 Z_2^2 - 4 a Z_2^2 z_3 - 2 G Z_2^2 z_3 + 4 g z_2 Z_2 Z_3 - 2 b Z_2 z_3 Z_3 - b z_2 Z_3^2 + 2 a z_3 Z_3^2)$

In[\*]:= H31 := 0

In[\*]:= H32 :=  $(-z_2 + 2 a z_2^2 Z_2 + 2 b z_2 Z_2 z_3 - 4 a Z_2 z_3^2 - 2 G Z_2 z_3^2 + b z_2^2 Z_3 + 4 g z_2 z_3 Z_3 - 2 b z_3^2 Z_3 + B z_3^2 Z_3) / 4$

In[\*]:= H33 :=  $\frac{b z_2 Z_2}{2} - a Z_2 z_3 + g z_2 Z_3 - \frac{b z_3 Z_3}{2}$

In[\*]:= ClearAll[H33]

In[\*]:= H33 :=  $-\frac{1}{4} + a z_2 Z_2 + \frac{B Z_2 z_3}{2} + \frac{b z_2 Z_3}{2} - a z_3 Z_3$

In[\*]:= H34 :=  $\frac{b z_2 Z_2}{2} - a Z_2 z_3 + g z_2 Z_3 - \frac{b z_3 Z_3}{2}$

In[\*]:= H41 := 0

In[\*]:= H42 :=  $(-b z_2^2 Z_2 + 2 B z_2^2 Z_2 + 4 G z_2 Z_2 z_3 - B Z_2 z_3^2 - 4 a z_2^2 Z_3 - 2 g z_2^2 Z_3 - 2 B z_2 z_3 Z_3 + 2 a z_3^2 Z_3) / 4$

In[\*]:= H43 :=  $\frac{B z_2 Z_2}{2} + G Z_2 z_3 - a z_2 Z_3 - \frac{B z_3 Z_3}{2}$

$$\text{In}[*]:= \text{H44} := -\frac{1}{4} - a z^2 Z^2 - \frac{B Z^2 z^3}{2} - \frac{b z^2 Z^3}{2} + a z^3 Z^3$$

$$\text{In}[*]:= \text{Ainv} := \{\{\text{H11}, \text{H12}, \text{H13}, \text{H14}\}, \{\text{H21}, \text{H22}, \text{H23}, \text{H24}\}, \{\text{H31}, \text{H32}, \text{H33}, \text{H34}\}, \{\text{H41}, \text{H42}, \text{H43}, \text{H44}\}\}$$

$$\text{In}[*]:= \text{Ainv}$$

$$\begin{aligned} \text{Out}[*]= & \left\{ \{0, i, 0, 0\}, \left\{ -i, \frac{1}{4} (-z^2 Z^2 - z^3 Z^3), \right. \right. \\ & \frac{1}{4} (-Z^2 + 2 a z^2 Z^2 + B Z^2 z^3 + B z^2 Z^2 Z^3 + 4 G Z^2 z^3 Z^3 - 4 a z^2 Z^3^2 + b z^3 Z^3^2 - 2 B z^3 Z^3^2), \\ & \frac{1}{4} (2 b z^2 Z^2^2 - B z^2 Z^2^2 - 4 a Z^2^2 z^3 - 2 G Z^2^2 z^3 + \\ & 4 g z^2 Z^2 Z^3 - 2 b Z^2 z^3 Z^3 - b z^2 Z^3^2 + 2 a z^3 Z^3^2) \left. \right\}, \\ & \left\{ 0, \frac{1}{4} (-z^2 + 2 a z^2 Z^2 + 2 b z^2 Z^2 z^3 - 4 a Z^2 z^3^2 - 2 G Z^2 z^3^2 + \right. \\ & b z^2 Z^2 Z^3 + 4 g z^2 z^3 Z^3 - 2 b z^3 Z^2 Z^3 + B z^3^2 Z^3), \\ & -\frac{1}{4} + a z^2 Z^2 + \frac{B Z^2 z^3}{2} + \frac{b z^2 Z^3}{2} - a z^3 Z^3, \frac{b z^2 Z^2}{2} - a Z^2 z^3 + g z^2 Z^3 - \frac{b z^3 Z^3}{2} \left. \right\}, \\ & \left\{ 0, \frac{1}{4} (-b z^2 Z^2 + 2 B z^2 Z^2 + 4 G z^2 Z^2 z^3 - B Z^2 z^3^2 - \right. \\ & 4 a z^2 Z^2 Z^3 - 2 g z^2 Z^2 Z^3 - 2 B z^2 z^3 Z^3 + 2 a z^3 Z^2 Z^3), \\ & \frac{B z^2 Z^2}{2} + G Z^2 z^3 - a z^2 Z^3 - \frac{B z^3 Z^3}{2}, -\frac{1}{4} - a z^2 Z^2 - \frac{B Z^2 z^3}{2} - \frac{b z^2 Z^3}{2} + a z^3 Z^3 \left. \right\} \end{aligned}$$

$$\text{In}[*]:= \text{MatrixForm}[\%20]$$

$$\text{Out}[*]//\text{MatrixForm} = \begin{pmatrix} 0 & i \\ -i & \frac{1}{4} (-z^2 Z^2 - z^3 Z^3) \\ 0 & \frac{1}{4} (-z^2 + 2 a z^2 Z^2 + 2 b z^2 Z^2 z^3 - 4 a Z^2 z^3^2 - 2 G Z^2 z^3^2 + b z^2 Z^2 Z^3 + 4 g z^2 z^3 Z^3 - 2 b z^3 Z^2 Z^3 + \\ 0 & \frac{1}{4} (-b z^2 Z^2 + 2 B z^2 Z^2 + 4 G z^2 Z^2 z^3 - B Z^2 z^3^2 - 4 a z^2 Z^2 Z^3 - 2 g z^2 Z^2 Z^3 - 2 B z^2 z^3 Z^3 + 2 a z^3 Z^2 Z^3) \end{pmatrix}$$

$$\text{In}[*]:= \mathbf{q} := \{\mathbf{p0}, \mathbf{I} * \mathbf{p1}, \mathbf{p2}, \mathbf{p3}\}$$

$$\text{In}[*]:= \mathbf{Q} := \{\mathbf{p0}, -\mathbf{I} * \mathbf{p1}, \mathbf{P2}, \mathbf{P3}\}$$

In[ ]:= **q.Ainv.Q**

$$\begin{aligned}
 \text{Out[ ]} = & p_0 p_1 - \\
 & i p_1 \left( i p_0 + \frac{1}{4} i p_1 (-z^2 Z_2 - z^3 Z_3) + \frac{1}{4} p_3 (-b z^2 Z_2^2 + 2 B z^2 Z_2 + 4 G z^2 Z_2 z_3 - B Z_2 z_3^2 - 4 a \right. \\
 & \quad \left. z^2 Z_3 - 2 g z^2 Z_3 - 2 B z^2 z_3 Z_3 + 2 a z^3 Z_3) + \frac{1}{4} p_2 (-z^2 + 2 a z^2 Z_2 + 2 b z^2 Z_2 z_3 - \right. \\
 & \quad \left. 4 a Z_2 z_3^2 - 2 G Z_2 z_3^2 + b z^2 Z_3 + 4 g z^2 z_3 Z_3 - 2 b z^3 Z_3 + B z^3 Z_3) \right) + \\
 & p_3 \left( p_3 \left( -\frac{1}{4} - a z^2 Z_2 - \frac{B Z_2 z_3}{2} - \frac{b z^2 Z_3}{2} + a z^3 Z_3 \right) + p_2 \left( \frac{b z^2 Z_2}{2} - a Z_2 z_3 + g z^2 Z_3 - \frac{b z^3 Z_3}{2} \right) + \right. \\
 & \quad \left. \frac{1}{4} i p_1 (2 b z^2 Z_2^2 - B z^2 Z_2^2 - 4 a Z_2^2 z_3 - 2 G Z_2^2 z_3 + \right. \\
 & \quad \left. 4 g z^2 Z_2 Z_3 - 2 b Z_2 z_3 Z_3 - b z^2 Z_3^2 + 2 a z^3 Z_3^2) \right) + \\
 & p_2 \left( p_2 \left( -\frac{1}{4} + a z^2 Z_2 + \frac{B Z_2 z_3}{2} + \frac{b z^2 Z_3}{2} - a z^3 Z_3 \right) + \right. \\
 & \quad \left. p_3 \left( \frac{B z^2 Z_2}{2} + G Z_2 z_3 - a z^2 Z_3 - \frac{B z^3 Z_3}{2} \right) + \frac{1}{4} i p_1 \right. \\
 & \quad \left. (-Z_2 + 2 a z^2 Z_2^2 + B Z_2^2 z_3 + B z^2 Z_2 Z_3 + 4 G Z_2 z_3 Z_3 - 4 a z^2 Z_3^2 + b z^3 Z_3^2 - 2 B z^3 Z_3^2) \right)
 \end{aligned}$$

In[ ]:= **Expand[%25]**

$$\begin{aligned}
 \text{Out[ ]} = & 2 p_0 p_1 - \frac{p_2 P_2}{4} - \frac{p_3 P_3}{4} + \frac{1}{4} i p_1 p_2 z_2 - \frac{1}{4} i p_1 P_2 Z_2 - \frac{1}{4} p_1^2 z_2 Z_2 + a p_2 P_2 z_2 Z_2 + \\
 & \frac{1}{2} B P_2 p_3 z_2 Z_2 + \frac{1}{2} b p_2 P_3 z_2 Z_2 - a p_3 P_3 z_2 Z_2 - \frac{1}{2} i a p_1 p_2 z_2^2 Z_2 + \frac{1}{4} i b p_1 p_3 z_2^2 Z_2 - \\
 & \frac{1}{2} i B p_1 p_3 z_2^2 Z_2 + \frac{1}{2} i a p_1 P_2 z_2 Z_2^2 + \frac{1}{2} i b p_1 P_3 z_2 Z_2^2 - \frac{1}{4} i B p_1 P_3 z_2 Z_2^2 + \\
 & \frac{1}{2} B p_2 P_2 Z_2 z_3 + G P_2 p_3 Z_2 z_3 - a p_2 P_3 Z_2 z_3 - \frac{1}{2} B p_3 P_3 Z_2 z_3 - \frac{1}{2} i b p_1 p_2 z_2 Z_2 z_3 - \\
 & i G p_1 p_3 z_2 Z_2 z_3 + \frac{1}{4} i B p_1 P_2 Z_2^2 z_3 - i a p_1 P_3 Z_2^2 z_3 - \frac{1}{2} i G p_1 P_3 Z_2^2 z_3 + \\
 & i a p_1 p_2 Z_2 z_3^2 + \frac{1}{2} i G p_1 p_2 Z_2 z_3^2 + \frac{1}{4} i B p_1 p_3 Z_2 z_3^2 + \frac{1}{2} b p_2 P_2 z_2 Z_3 - a P_2 p_3 z_2 Z_3 + \\
 & g p_2 P_3 z_2 Z_3 - \frac{1}{2} b p_3 P_3 z_2 Z_3 - \frac{1}{4} i b p_1 p_2 z_2^2 Z_3 + i a p_1 p_3 z_2^2 Z_3 + \frac{1}{2} i g p_1 p_3 z_2^2 Z_3 + \\
 & \frac{1}{4} i B p_1 P_2 z_2 Z_2 Z_3 + i g p_1 P_3 z_2 Z_2 Z_3 - \frac{1}{4} p_1^2 z_3 Z_3 - a p_2 P_2 z_3 Z_3 - \frac{1}{2} B P_2 p_3 z_3 Z_3 - \\
 & \frac{1}{2} b p_2 P_3 z_3 Z_3 + a p_3 P_3 z_3 Z_3 - i g p_1 p_2 z_2 z_3 Z_3 + \frac{1}{2} i B p_1 p_3 z_2 z_3 Z_3 + i G p_1 P_2 z_2 z_3 Z_3 - \\
 & \frac{1}{2} i b p_1 P_3 z_2 z_3 Z_3 + \frac{1}{2} i b p_1 p_2 z_3^2 Z_3 - \frac{1}{4} i B p_1 p_2 z_3^2 Z_3 - \frac{1}{2} i a p_1 p_3 z_3^2 Z_3 - \\
 & i a p_1 P_2 z_2 z_3^2 - \frac{1}{4} i b p_1 P_3 z_2 z_3^2 + \frac{1}{4} i b p_1 P_2 z_3 Z_3^2 - \frac{1}{2} i B p_1 P_2 z_3 Z_3^2 + \frac{1}{2} i a p_1 P_3 z_3 Z_3^2
 \end{aligned}$$

In[ ]:= **dz2 := 2 \* D[H, P2]**

In[ ]:= **dz3 := 2 \* D[H, P3]**

In[ ]:= **dp2 := -2 \* D[H, Z2]**

In[ ]:= **dp3 := -2 \* D[H, Z3]**

In[ ]:= **dz2**

Out[ ]:= 0

In[ ]:= **ClearAll[dz2, dz3, dp2, dp3]**

In[ ]:= **H :=** 
$$2 p_0 p_1 - \frac{p_2^2 P_2}{4} - \frac{p_3^2 P_3}{4} + \frac{1}{4} i p_1 p_2 z_2 - \frac{1}{4} i p_1 P_2 Z_2 - \frac{1}{4} p_1^2 z_2 Z_2 + a p_2 P_2 z_2 Z_2 +$$

$$\frac{1}{2} B P_2 p_3 z_2 Z_2 + \frac{1}{2} b p_2 P_3 z_2 Z_2 - a p_3 P_3 z_2 Z_2 - \frac{1}{2} i a p_1 p_2 z_2^2 Z_2 + \frac{1}{4} i b p_1 p_3 z_2^2 Z_2 -$$

$$\frac{1}{2} i B p_1 p_3 z_2^2 Z_2 + \frac{1}{2} i a p_1 P_2 z_2 Z_2^2 + \frac{1}{2} i b p_1 P_3 z_2 Z_2^2 - \frac{1}{4} i B p_1 P_3 z_2 Z_2^2 +$$

$$\frac{1}{2} B p_2 P_2 Z_2 z_3 + G P_2 p_3 Z_2 z_3 - a p_2 P_3 Z_2 z_3 - \frac{1}{2} B p_3 P_3 Z_2 z_3 - \frac{1}{2} i b p_1 p_2 z_2 Z_2 z_3 -$$

$$i G p_1 p_3 z_2 Z_2 z_3 + \frac{1}{4} i B p_1 P_2 Z_2^2 z_3 - i a p_1 P_3 Z_2^2 z_3 - \frac{1}{2} i G p_1 P_3 Z_2^2 z_3 +$$

$$i a p_1 p_2 Z_2 z_3^2 + \frac{1}{2} i G p_1 p_2 Z_2 z_3^2 + \frac{1}{4} i B p_1 p_3 Z_2 z_3^2 + \frac{1}{2} b p_2 P_2 z_2 Z_3 - a P_2 p_3 z_2 Z_3 +$$

$$g p_2 P_3 z_2 Z_3 - \frac{1}{2} b p_3 P_3 z_2 Z_3 - \frac{1}{4} i b p_1 p_2 z_2^2 Z_3 + i a p_1 p_3 z_2^2 Z_3 + \frac{1}{2} i g p_1 p_3 z_2^2 Z_3 +$$

$$\frac{1}{4} i B p_1 P_2 z_2 Z_2 Z_3 + i g p_1 P_3 z_2 Z_2 Z_3 - \frac{1}{4} p_1^2 z_3 Z_3 - a p_2 P_2 z_3 Z_3 - \frac{1}{2} B P_2 p_3 z_3 Z_3 -$$

$$\frac{1}{2} b p_2 P_3 z_3 Z_3 + a p_3 P_3 z_3 Z_3 - i g p_1 p_2 z_2 z_3 Z_3 + \frac{1}{2} i B p_1 p_3 z_2 z_3 Z_3 + i G p_1 P_2 z_2 z_3 Z_3 -$$

$$\frac{1}{2} i b p_1 P_3 z_2 z_3 Z_3 + \frac{1}{2} i b p_1 p_2 z_3^2 Z_3 - \frac{1}{4} i B p_1 p_2 z_3^2 Z_3 - \frac{1}{2} i a p_1 p_3 z_3^2 Z_3 -$$

$$i a p_1 P_2 z_2 Z_3^2 - \frac{1}{4} i b p_1 P_3 z_2 Z_3^2 + \frac{1}{4} i b p_1 P_2 z_3 Z_3^2 - \frac{1}{2} i B p_1 P_2 z_3 Z_3^2 + \frac{1}{2} i a p_1 P_3 z_3 Z_3^2$$

In[ ]:= **dz2 := 2 \* D[H, P2]**

In[ ]:= **dz3 := 2 \* D[H, P3]**

In[ ]:= **dp2 := -2 \* D[H, Z2]**

In[ ]:= **dp2**

Out[ ]:= 
$$-2 \left( -\frac{1}{4} i p_1 P_2 - \frac{p_1^2 z_2}{4} + a p_2 P_2 z_2 + \frac{1}{2} B P_2 p_3 z_2 + \frac{1}{2} b p_2 P_3 z_2 - a p_3 P_3 z_2 - \frac{1}{2} i a p_1 p_2 z_2^2 + \right.$$

$$\frac{1}{4} i b p_1 p_3 z_2^2 - \frac{1}{2} i B p_1 p_3 z_2^2 + i a p_1 P_2 z_2 Z_2 + i b p_1 P_3 z_2 Z_2 - \frac{1}{2} i B p_1 P_3 z_2 Z_2 +$$

$$\frac{1}{2} B p_2 P_2 z_3 + G P_2 p_3 z_3 - a p_2 P_3 z_3 - \frac{1}{2} B p_3 P_3 z_3 - \frac{1}{2} i b p_1 p_2 z_2 z_3 - i G p_1 p_3 z_2 z_3 +$$

$$\frac{1}{2} i B p_1 P_2 z_2 z_3 - 2 i a p_1 P_3 z_2 z_3 - i G p_1 P_3 z_2 z_3 + i a p_1 p_2 z_3^2 + \frac{1}{2} i G p_1 p_2 z_3^2 +$$

$$\left. \frac{1}{4} i B p_1 p_3 z_3^2 + \frac{1}{4} i B p_1 P_2 z_2 Z_3 + i g p_1 P_3 z_2 Z_3 + i G p_1 P_2 z_3 Z_3 - \frac{1}{2} i b p_1 P_3 z_3 Z_3 \right)$$

In[ ]:= **dp3 := -2 \* D[H, Z3]**

In[ ]:= **dp3**

$$\begin{aligned} \text{Out[ ]} = & -2 \left( \frac{1}{2} b p_2 P_2 z^2 - a P_2 p_3 z^2 + g p_2 P_3 z^2 - \frac{1}{2} b p_3 P_3 z^2 - \frac{1}{4} i b p_1 p_2 z^2 + i a p_1 p_3 z^2 + \right. \\ & \frac{1}{2} i g p_1 p_3 z^2 + \frac{1}{4} i B p_1 P_2 z^2 Z + i g p_1 P_3 z^2 Z - \frac{p_1^2 z^3}{4} - a p_2 P_2 z^3 - \\ & \frac{1}{2} B P_2 p_3 z^3 - \frac{1}{2} b p_2 P_3 z^3 + a p_3 P_3 z^3 - i g p_1 p_2 z^2 z^3 + \frac{1}{2} i B p_1 p_3 z^2 z^3 + \\ & i G p_1 P_2 Z z^3 - \frac{1}{2} i b p_1 P_3 Z z^3 + \frac{1}{2} i b p_1 p_2 z^3^2 - \frac{1}{4} i B p_1 p_2 z^3^2 - \frac{1}{2} i a p_1 p_3 z^3^2 - \\ & \left. 2 i a p_1 P_2 z^2 Z - \frac{1}{2} i b p_1 P_3 z^2 Z + \frac{1}{2} i b p_1 P_2 z^3 Z - i B p_1 P_2 z^3 Z + i a p_1 P_3 z^3 Z \right) \end{aligned}$$

In[ ]:= **Expand[%39]**

$$\begin{aligned} \text{Out[ ]} = & -b p_2 P_2 z^2 + 2 a P_2 p_3 z^2 - 2 g p_2 P_3 z^2 + b p_3 P_3 z^2 + \frac{1}{2} i b p_1 p_2 z^2 - \\ & 2 i a p_1 p_3 z^2 - i g p_1 p_3 z^2 - \frac{1}{2} i B p_1 P_2 z^2 Z - 2 i g p_1 P_3 z^2 Z + \frac{p_1^2 z^3}{2} + \\ & 2 a p_2 P_2 z^3 + B P_2 p_3 z^3 + b p_2 P_3 z^3 - 2 a p_3 P_3 z^3 + 2 i g p_1 p_2 z^2 z^3 - i B p_1 p_3 z^2 z^3 - \\ & 2 i G p_1 P_2 Z z^3 + i b p_1 P_3 Z z^3 - i b p_1 p_2 z^3^2 + \frac{1}{2} i B p_1 p_2 z^3^2 + i a p_1 p_3 z^3^2 + \\ & 4 i a p_1 P_2 z^2 Z + i b p_1 P_3 z^2 Z - i b p_1 P_2 z^3 Z + 2 i B p_1 P_2 z^3 Z - 2 i a p_1 P_3 z^3 Z \end{aligned}$$

In[ ]:= **z2st := s \* z21 + s^3 \* z23**

In[ ]:= **Z2st := s \* Z21 + s^3 \* Z23**

In[ ]:= **p2st := s \* p21 + s^3 \* p23**

In[ ]:= **P2st := s \* P21 + s^3 \* P23**

In[ ]:= **z3st := s \* z31 + s^3 \* z33**

In[ ]:= **Out[ ] =**



In[ ]:= **Z3st := s \* Z31 + s^3 \* Z33**

In[ ]:= **p3st := s \* p31 + s^3 \* p33**

In[ ]:= **P3st := s \* P31 + s^3 \* P33**

$$\begin{aligned}
\text{In[ ]:= } & \mathbf{dz2 /. \{z2 \rightarrow z2st, Z2 \rightarrow Z2st, p2 \rightarrow p2st,} \\
& \mathbf{P2 \rightarrow P2st, z3 \rightarrow z3st, Z3 \rightarrow Z3st, p3 \rightarrow p3st, P3 \rightarrow P3st\}} \\
\text{Out[ ]:= } & 2 \left( \frac{1}{4} (-p_{21} s - p_{23} s^3) - \frac{1}{4} i p_1 (s Z_{21} + s^3 Z_{23}) + \right. \\
& a (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \\
& \frac{1}{2} B (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \frac{1}{2} i a p_1 (s z_{21} + s^3 z_{23}) \\
& (s Z_{21} + s^3 Z_{23})^2 + \frac{1}{2} B (p_{21} s + p_{23} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \\
& G (p_{31} s + p_{33} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \frac{1}{4} i B p_1 (s Z_{21} + s^3 Z_{23})^2 \\
& (s z_{31} + s^3 z_{33}) + \frac{1}{2} b (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) - \\
& a (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) + \\
& \frac{1}{4} i B p_1 (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) (s Z_{31} + s^3 Z_{33}) - \\
& a (p_{21} s + p_{23} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) - \\
& \frac{1}{2} B (p_{31} s + p_{33} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) + \\
& i G p_1 (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) - \\
& i a p_1 (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33})^2 + \frac{1}{4} i b p_1 (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33})^2 - \\
& \left. \frac{1}{2} i B p_1 (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33})^2 \right)
\end{aligned}$$

In[ ]:= Expand[%49]

$$\begin{aligned}
 \text{Out[ ]} = & -\frac{p_{21}s}{2} - \frac{p_{23}s^3}{2} - \frac{1}{2} i p_1 s Z_{21} + 2 a p_{21} s^3 z_{21} Z_{21} + B p_{31} s^3 z_{21} Z_{21} + 2 a p_{23} s^5 z_{21} Z_{21} + \\
 & B p_{33} s^5 z_{21} Z_{21} + i a p_1 s^3 z_{21} Z_{21}^2 + 2 a p_{21} s^5 Z_{21} z_{23} + B p_{31} s^5 Z_{21} z_{23} + \\
 & 2 a p_{23} s^7 Z_{21} z_{23} + B p_{33} s^7 Z_{21} z_{23} + i a p_1 s^5 Z_{21}^2 z_{23} - \frac{1}{2} i p_1 s^3 Z_{23} + 2 a p_{21} s^5 z_{21} Z_{23} + \\
 & B p_{31} s^5 z_{21} Z_{23} + 2 a p_{23} s^7 z_{21} Z_{23} + B p_{33} s^7 z_{21} Z_{23} + 2 i a p_1 s^5 z_{21} Z_{21} Z_{23} + \\
 & 2 a p_{21} s^7 z_{23} Z_{23} + B p_{31} s^7 z_{23} Z_{23} + 2 a p_{23} s^9 z_{23} Z_{23} + B p_{33} s^9 z_{23} Z_{23} + \\
 & 2 i a p_1 s^7 Z_{21} z_{23} Z_{23} + i a p_1 s^7 z_{21} Z_{23}^2 + i a p_1 s^9 z_{23} Z_{23}^2 + B p_{21} s^3 Z_{21} z_{31} + \\
 & 2 G p_{31} s^3 Z_{21} z_{31} + B p_{23} s^5 Z_{21} z_{31} + 2 G p_{33} s^5 Z_{21} z_{31} + \frac{1}{2} i B p_1 s^3 Z_{21}^2 z_{31} + \\
 & B p_{21} s^5 Z_{23} z_{31} + 2 G p_{31} s^5 Z_{23} z_{31} + B p_{23} s^7 Z_{23} z_{31} + 2 G p_{33} s^7 Z_{23} z_{31} + \\
 & i B p_1 s^5 Z_{21} Z_{23} z_{31} + \frac{1}{2} i B p_1 s^7 Z_{23}^2 z_{31} + b p_{21} s^3 z_{21} Z_{31} - 2 a p_{31} s^3 z_{21} Z_{31} + \\
 & b p_{23} s^5 z_{21} Z_{31} - 2 a p_{33} s^5 z_{21} Z_{31} + \frac{1}{2} i B p_1 s^3 z_{21} Z_{21} Z_{31} + b p_{21} s^5 z_{23} Z_{31} - \\
 & 2 a p_{31} s^5 z_{23} Z_{31} + b p_{23} s^7 z_{23} Z_{31} - 2 a p_{33} s^7 z_{23} Z_{31} + \frac{1}{2} i B p_1 s^5 Z_{21} z_{23} Z_{31} + \\
 & \frac{1}{2} i B p_1 s^5 z_{21} Z_{23} Z_{31} + \frac{1}{2} i B p_1 s^7 z_{23} Z_{23} Z_{31} - 2 a p_{21} s^3 z_{31} Z_{31} - B p_{31} s^3 z_{31} Z_{31} - \\
 & 2 a p_{23} s^5 z_{31} Z_{31} - B p_{33} s^5 z_{31} Z_{31} + 2 i G p_1 s^3 Z_{21} z_{31} Z_{31} + 2 i G p_1 s^5 Z_{23} z_{31} Z_{31} - \\
 & 2 i a p_1 s^3 z_{21} Z_{31}^2 - 2 i a p_1 s^5 z_{23} Z_{31}^2 + \frac{1}{2} i b p_1 s^3 z_{31} Z_{31}^2 - i B p_1 s^3 z_{31} Z_{31}^2 + \\
 & B p_{21} s^5 Z_{21} z_{33} + 2 G p_{31} s^5 Z_{21} z_{33} + B p_{23} s^7 Z_{21} z_{33} + 2 G p_{33} s^7 Z_{21} z_{33} + \\
 & \frac{1}{2} i B p_1 s^5 Z_{21}^2 z_{33} + B p_{21} s^7 Z_{23} z_{33} + 2 G p_{31} s^7 Z_{23} z_{33} + B p_{23} s^9 Z_{23} z_{33} + \\
 & 2 G p_{33} s^9 Z_{23} z_{33} + i B p_1 s^7 Z_{21} Z_{23} z_{33} + \frac{1}{2} i B p_1 s^9 Z_{23}^2 z_{33} - 2 a p_{21} s^5 Z_{31} z_{33} - \\
 & B p_{31} s^5 Z_{31} z_{33} - 2 a p_{23} s^7 Z_{31} z_{33} - B p_{33} s^7 Z_{31} z_{33} + 2 i G p_1 s^5 Z_{21} Z_{31} z_{33} + \\
 & 2 i G p_1 s^7 Z_{23} Z_{31} z_{33} + \frac{1}{2} i b p_1 s^5 Z_{31}^2 z_{33} - i B p_1 s^5 Z_{31}^2 z_{33} + b p_{21} s^5 z_{21} Z_{33} - \\
 & 2 a p_{31} s^5 z_{21} Z_{33} + b p_{23} s^7 z_{21} Z_{33} - 2 a p_{33} s^7 z_{21} Z_{33} + \frac{1}{2} i B p_1 s^5 z_{21} Z_{21} Z_{33} + \\
 & b p_{21} s^7 z_{23} Z_{33} - 2 a p_{31} s^7 z_{23} Z_{33} + b p_{23} s^9 z_{23} Z_{33} - 2 a p_{33} s^9 z_{23} Z_{33} + \\
 & \frac{1}{2} i B p_1 s^7 Z_{21} z_{23} Z_{33} + \frac{1}{2} i B p_1 s^7 z_{21} Z_{23} Z_{33} + \frac{1}{2} i B p_1 s^9 z_{23} Z_{23} Z_{33} - 2 a p_{21} s^5 z_{31} Z_{33} - \\
 & B p_{31} s^5 z_{31} Z_{33} - 2 a p_{23} s^7 z_{31} Z_{33} - B p_{33} s^7 z_{31} Z_{33} + 2 i G p_1 s^5 Z_{21} z_{31} Z_{33} + \\
 & 2 i G p_1 s^7 Z_{23} z_{31} Z_{33} - 4 i a p_1 s^5 z_{21} Z_{31} Z_{33} - 4 i a p_1 s^7 z_{23} Z_{31} Z_{33} + \\
 & i b p_1 s^5 z_{31} Z_{31} Z_{33} - 2 i B p_1 s^5 z_{31} Z_{31} Z_{33} - 2 a p_{21} s^7 z_{33} Z_{33} - B p_{31} s^7 z_{33} Z_{33} - \\
 & 2 a p_{23} s^9 z_{33} Z_{33} - B p_{33} s^9 z_{33} Z_{33} + 2 i G p_1 s^7 Z_{21} z_{33} Z_{33} + 2 i G p_1 s^9 Z_{23} z_{33} Z_{33} + \\
 & i b p_1 s^7 Z_{31} z_{33} Z_{33} - 2 i B p_1 s^7 Z_{31} z_{33} Z_{33} - 2 i a p_1 s^7 z_{21} Z_{33}^2 - 2 i a p_1 s^9 z_{23} Z_{33}^2 + \\
 & \frac{1}{2} i b p_1 s^7 z_{31} Z_{33}^2 - i B p_1 s^7 z_{31} Z_{33}^2 + \frac{1}{2} i b p_1 s^9 z_{33} Z_{33}^2 - i B p_1 s^9 z_{33} Z_{33}^2
 \end{aligned}$$

In[ ]:= **Collect[%50, s]**

$$\begin{aligned}
 \text{Out[ ]} = & \text{ s } \left( -\frac{p_{21}}{2} - \frac{i p_1 Z_{21}}{2} \right) + \\
 & s^3 \left( -\frac{p_{23}}{2} + 2 a p_{21} z_{21} Z_{21} + B p_{31} z_{21} Z_{21} + i a p_1 z_{21} Z_{21}^2 - \frac{i p_1 Z_{23}}{2} + B p_{21} Z_{21} z_{31} + \right. \\
 & 2 G p_{31} Z_{21} z_{31} + \frac{1}{2} i B p_1 Z_{21}^2 z_{31} + b p_{21} z_{21} Z_{31} - 2 a p_{31} z_{21} Z_{31} + \\
 & \frac{1}{2} i B p_1 z_{21} Z_{21} Z_{31} - 2 a p_{21} z_{31} Z_{31} - B p_{31} z_{31} Z_{31} + 2 i G p_1 Z_{21} z_{31} Z_{31} - \\
 & \left. 2 i a p_1 z_{21} Z_{31}^2 + \frac{1}{2} i b p_1 z_{31} Z_{31}^2 - i B p_1 z_{31} Z_{31}^2 \right) + \\
 & s^5 \left( 2 a p_{23} z_{21} Z_{21} + B p_{33} z_{21} Z_{21} + 2 a p_{21} Z_{21} z_{23} + B p_{31} Z_{21} z_{23} + i a p_1 Z_{21}^2 z_{23} + \right. \\
 & 2 a p_{21} z_{21} Z_{23} + B p_{31} z_{21} Z_{23} + 2 i a p_1 z_{21} Z_{21} Z_{23} + B p_{23} Z_{21} z_{31} + 2 G p_{33} Z_{21} z_{31} + \\
 & B p_{21} Z_{23} z_{31} + 2 G p_{31} Z_{23} z_{31} + i B p_1 Z_{21} Z_{23} z_{31} + b p_{23} z_{21} Z_{31} - 2 a p_{33} z_{21} Z_{31} + \\
 & b p_{21} z_{23} Z_{31} - 2 a p_{31} z_{23} Z_{31} + \frac{1}{2} i B p_1 Z_{21} z_{23} Z_{31} + \frac{1}{2} i B p_1 z_{21} Z_{23} Z_{31} - \\
 & 2 a p_{23} z_{31} Z_{31} - B p_{33} z_{31} Z_{31} + 2 i G p_1 Z_{23} z_{31} Z_{31} - 2 i a p_1 z_{23} Z_{31}^2 + \\
 & B p_{21} Z_{21} z_{33} + 2 G p_{31} Z_{21} z_{33} + \frac{1}{2} i B p_1 Z_{21}^2 z_{33} - 2 a p_{21} Z_{31} z_{33} - B p_{31} Z_{31} z_{33} + \\
 & 2 i G p_1 Z_{21} Z_{31} z_{33} + \frac{1}{2} i b p_1 Z_{31}^2 z_{33} - i B p_1 Z_{31}^2 z_{33} + b p_{21} z_{21} Z_{33} - \\
 & 2 a p_{31} z_{21} Z_{33} + \frac{1}{2} i B p_1 z_{21} Z_{21} Z_{33} - 2 a p_{21} z_{31} Z_{33} - B p_{31} z_{31} Z_{33} + \\
 & \left. 2 i G p_1 Z_{21} z_{31} Z_{33} - 4 i a p_1 z_{21} Z_{31} Z_{33} + i b p_1 z_{31} Z_{31} Z_{33} - 2 i B p_1 z_{31} Z_{31} Z_{33} \right) + \\
 & s^7 \left( 2 a p_{23} Z_{21} z_{23} + B p_{33} Z_{21} z_{23} + 2 a p_{23} z_{21} Z_{23} + B p_{33} z_{21} Z_{23} + 2 a p_{21} z_{23} Z_{23} + \right. \\
 & B p_{31} z_{23} Z_{23} + 2 i a p_1 Z_{21} z_{23} Z_{23} + i a p_1 z_{21} Z_{23}^2 + B p_{23} Z_{23} z_{31} + 2 G p_{33} Z_{23} z_{31} + \\
 & \frac{1}{2} i B p_1 Z_{23}^2 z_{31} + b p_{23} z_{23} Z_{31} - 2 a p_{33} z_{23} Z_{31} + \frac{1}{2} i B p_1 z_{23} Z_{23} Z_{31} + \\
 & B p_{23} Z_{21} z_{33} + 2 G p_{33} Z_{21} z_{33} + B p_{21} Z_{23} z_{33} + 2 G p_{31} Z_{23} z_{33} + i B p_1 Z_{21} Z_{23} z_{33} - \\
 & 2 a p_{23} Z_{31} z_{33} - B p_{33} Z_{31} z_{33} + 2 i G p_1 Z_{23} Z_{31} z_{33} + b p_{23} z_{21} Z_{33} - 2 a p_{33} z_{21} Z_{33} + \\
 & b p_{21} z_{23} Z_{33} - 2 a p_{31} z_{23} Z_{33} + \frac{1}{2} i B p_1 Z_{21} z_{23} Z_{33} + \frac{1}{2} i B p_1 z_{21} Z_{23} Z_{33} - \\
 & 2 a p_{23} z_{31} Z_{33} - B p_{33} z_{31} Z_{33} + 2 i G p_1 Z_{23} z_{31} Z_{33} - 4 i a p_1 z_{23} Z_{31} Z_{33} - \\
 & 2 a p_{21} z_{33} Z_{33} - B p_{31} z_{33} Z_{33} + 2 i G p_1 Z_{21} z_{33} Z_{33} + i b p_1 Z_{31} z_{33} Z_{33} - \\
 & \left. 2 i B p_1 Z_{31} z_{33} Z_{33} - 2 i a p_1 z_{21} Z_{33}^2 + \frac{1}{2} i b p_1 z_{31} Z_{33}^2 - i B p_1 z_{31} Z_{33}^2 \right) + \\
 & s^9 \left( 2 a p_{23} z_{23} Z_{23} + B p_{33} z_{23} Z_{23} + i a p_1 z_{23} Z_{23}^2 + B p_{23} Z_{23} z_{33} + 2 G p_{33} Z_{23} z_{33} + \right. \\
 & \frac{1}{2} i B p_1 Z_{23}^2 z_{33} + b p_{23} z_{23} Z_{33} - 2 a p_{33} z_{23} Z_{33} + \frac{1}{2} i B p_1 z_{23} Z_{23} Z_{33} - 2 a p_{23} z_{33} Z_{33} - \\
 & \left. B p_{33} z_{33} Z_{33} + 2 i G p_1 Z_{23} z_{33} Z_{33} - 2 i a p_1 z_{23} Z_{33}^2 + \frac{1}{2} i b p_1 z_{33} Z_{33}^2 - i B p_1 z_{33} Z_{33}^2 \right)
 \end{aligned}$$



In[\*]:= **dp2 /. {z2 → z2st, Z2 → Z2st, p2 → p2st,  
P2 → P2st, z3 → z3st, Z3 → Z3st, p3 → p3st, P3 → P3st}**

$$\begin{aligned} \text{Out[*]} = & -2 \left( -\frac{1}{4} i p_1 (P_{21} s + P_{23} s^3) - \right. \\ & \frac{1}{4} p_1^2 (s z_{21} + s^3 z_{23}) + a (p_{21} s + p_{23} s^3) (P_{21} s + P_{23} s^3) (s z_{21} + s^3 z_{23}) + \\ & \frac{1}{2} B (P_{21} s + P_{23} s^3) (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) + \\ & \frac{1}{2} b (p_{21} s + p_{23} s^3) (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) - \\ & a (p_{31} s + p_{33} s^3) (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) - \\ & \frac{1}{2} i a p_1 (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23})^2 + \frac{1}{4} i b p_1 (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23})^2 - \\ & \frac{1}{2} i B p_1 (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23})^2 + \\ & i a p_1 (P_{21} s + P_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \\ & i b p_1 (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) - \\ & \frac{1}{2} i B p_1 (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \\ & \frac{1}{2} B (p_{21} s + p_{23} s^3) (P_{21} s + P_{23} s^3) (s z_{31} + s^3 z_{33}) + \\ & G (P_{21} s + P_{23} s^3) (p_{31} s + p_{33} s^3) (s z_{31} + s^3 z_{33}) - \\ & a (p_{21} s + p_{23} s^3) (P_{31} s + P_{33} s^3) (s z_{31} + s^3 z_{33}) - \\ & \frac{1}{2} B (p_{31} s + p_{33} s^3) (P_{31} s + P_{33} s^3) (s z_{31} + s^3 z_{33}) - \\ & \frac{1}{2} i b p_1 (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s z_{31} + s^3 z_{33}) - \\ & i G p_1 (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s z_{31} + s^3 z_{33}) + \\ & \frac{1}{2} i B p_1 (P_{21} s + P_{23} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) - \\ & 2 i a p_1 (P_{31} s + P_{33} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) - \\ & i G p_1 (P_{31} s + P_{33} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \\ & i a p_1 (p_{21} s + p_{23} s^3) (s z_{31} + s^3 z_{33})^2 + \frac{1}{2} i G p_1 (p_{21} s + p_{23} s^3) (s z_{31} + s^3 z_{33})^2 + \\ & \frac{1}{4} i B p_1 (p_{31} s + p_{33} s^3) (s z_{31} + s^3 z_{33})^2 + \\ & \frac{1}{4} i B p_1 (P_{21} s + P_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) + \\ & i g p_1 (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) + \\ & i G p_1 (P_{21} s + P_{23} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) - \\ & \left. \frac{1}{2} i b p_1 (P_{31} s + P_{33} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) \right) \end{aligned}$$

In[\*]:= **Expand[%52]**

$$\begin{aligned} \text{Out[*]} = & \frac{1}{2} i p_1 P_{21} s + \frac{1}{2} i p_1 P_{23} s^3 + \frac{1}{2} p_1^2 s z_{21} - 2 a p_{21} P_{21} s^3 z_{21} - B P_{21} p_{31} s^3 z_{21} - \\ & b p_{21} P_{31} s^3 z_{21} + 2 a p_{31} P_{31} s^3 z_{21} - 2 a P_{21} p_{23} s^5 z_{21} - 2 a p_{21} P_{23} s^5 z_{21} - B P_{23} p_{31} s^5 z_{21} - \end{aligned}$$

$$\begin{aligned}
& b p_{23} P_{31} s^5 z_{21} - B P_{21} p_{33} s^5 z_{21} + 2 a P_{31} p_{33} s^5 z_{21} - b p_{21} P_{33} s^5 z_{21} + 2 a p_{31} P_{33} s^5 z_{21} - \\
& 2 a p_{23} P_{23} s^7 z_{21} - B P_{23} p_{33} s^7 z_{21} - b p_{23} P_{33} s^7 z_{21} + 2 a p_{33} P_{33} s^7 z_{21} + i a p_1 p_{21} s^3 z_{21}^2 - \\
& \frac{1}{2} i b p_1 p_{31} s^3 z_{21}^2 + i B p_1 p_{31} s^3 z_{21}^2 + i a p_1 p_{23} s^5 z_{21}^2 - \frac{1}{2} i b p_1 p_{33} s^5 z_{21}^2 + \\
& i B p_1 p_{33} s^5 z_{21}^2 - 2 i a p_1 P_{21} s^3 z_{21} Z_{21} - 2 i b p_1 P_{31} s^3 z_{21} Z_{21} + i B p_1 P_{31} s^3 z_{21} Z_{21} - \\
& 2 i a p_1 P_{23} s^5 z_{21} Z_{21} - 2 i b p_1 P_{33} s^5 z_{21} Z_{21} + i B p_1 P_{33} s^5 z_{21} Z_{21} + \frac{1}{2} p_1^2 s^3 z_{23} - \\
& 2 a p_{21} P_{21} s^5 z_{23} - B P_{21} p_{31} s^5 z_{23} - b p_{21} P_{31} s^5 z_{23} + 2 a p_{31} P_{31} s^5 z_{23} - 2 a P_{21} p_{23} s^7 z_{23} - \\
& 2 a p_{21} P_{23} s^7 z_{23} - B P_{23} p_{31} s^7 z_{23} - b p_{23} P_{31} s^7 z_{23} - B P_{21} p_{33} s^7 z_{23} + 2 a P_{31} p_{33} s^7 z_{23} - \\
& b p_{21} P_{33} s^7 z_{23} + 2 a p_{31} P_{33} s^7 z_{23} - 2 a p_{23} P_{23} s^9 z_{23} - B P_{23} p_{33} s^9 z_{23} - b p_{23} P_{33} s^9 z_{23} + \\
& 2 a p_{33} P_{33} s^9 z_{23} + 2 i a p_1 p_{21} s^5 z_{21} z_{23} - i b p_1 p_{31} s^5 z_{21} z_{23} + 2 i B p_1 p_{31} s^5 z_{21} z_{23} + \\
& 2 i a p_1 p_{23} s^7 z_{21} z_{23} - i b p_1 p_{33} s^7 z_{21} z_{23} + 2 i B p_1 p_{33} s^7 z_{21} z_{23} - 2 i a p_1 P_{21} s^5 Z_{21} z_{23} - \\
& 2 i b p_1 P_{31} s^5 Z_{21} z_{23} + i B p_1 P_{31} s^5 Z_{21} z_{23} - 2 i a p_1 P_{23} s^7 Z_{21} z_{23} - 2 i b p_1 P_{33} s^7 Z_{21} z_{23} + \\
& i B p_1 P_{33} s^7 Z_{21} z_{23} + i a p_1 p_{21} s^7 z_{23}^2 - \frac{1}{2} i b p_1 p_{31} s^7 z_{23}^2 + i B p_1 p_{31} s^7 z_{23}^2 + \\
& i a p_1 p_{23} s^9 z_{23}^2 - \frac{1}{2} i b p_1 p_{33} s^9 z_{23}^2 + i B p_1 p_{33} s^9 z_{23}^2 - 2 i a p_1 P_{21} s^5 z_{21} Z_{23} - \\
& 2 i b p_1 P_{31} s^5 z_{21} Z_{23} + i B p_1 P_{31} s^5 z_{21} Z_{23} - 2 i a p_1 P_{23} s^7 z_{21} Z_{23} - 2 i b p_1 P_{33} s^7 z_{21} Z_{23} + \\
& i B p_1 P_{33} s^7 z_{21} Z_{23} - 2 i a p_1 P_{21} s^7 z_{23} Z_{23} - 2 i b p_1 P_{31} s^7 z_{23} Z_{23} + i B p_1 P_{31} s^7 z_{23} Z_{23} - \\
& 2 i a p_1 P_{23} s^9 z_{23} Z_{23} - 2 i b p_1 P_{33} s^9 z_{23} Z_{23} + i B p_1 P_{33} s^9 z_{23} Z_{23} - B p_{21} P_{21} s^3 z_{31} - \\
& 2 G P_{21} p_{31} s^3 z_{31} + 2 a p_{21} P_{31} s^3 z_{31} + B p_{31} P_{31} s^3 z_{31} - B P_{21} p_{23} s^5 z_{31} - B p_{21} P_{23} s^5 z_{31} - \\
& 2 G P_{23} p_{31} s^5 z_{31} + 2 a p_{23} P_{31} s^5 z_{31} - 2 G P_{21} p_{33} s^5 z_{31} + B P_{31} p_{33} s^5 z_{31} + \\
& 2 a p_{21} P_{33} s^5 z_{31} + B p_{31} P_{33} s^5 z_{31} - B p_{23} P_{23} s^7 z_{31} - 2 G P_{23} p_{33} s^7 z_{31} + \\
& 2 a p_{23} P_{33} s^7 z_{31} + B p_{33} P_{33} s^7 z_{31} + i b p_1 p_{21} s^3 z_{21} z_{31} + 2 i G p_1 p_{31} s^3 z_{21} z_{31} + \\
& i b p_1 p_{23} s^5 z_{21} z_{31} + 2 i G p_1 p_{33} s^5 z_{21} z_{31} - i B p_1 P_{21} s^3 Z_{21} z_{31} + 4 i a p_1 P_{31} s^3 Z_{21} z_{31} + \\
& 2 i G p_1 P_{31} s^3 Z_{21} z_{31} - i B p_1 P_{23} s^5 Z_{21} z_{31} + 4 i a p_1 P_{33} s^5 Z_{21} z_{31} + 2 i G p_1 P_{33} s^5 Z_{21} z_{31} + \\
& i b p_1 p_{21} s^5 z_{23} z_{31} + 2 i G p_1 p_{31} s^5 z_{23} z_{31} + i b p_1 p_{23} s^7 z_{23} z_{31} + 2 i G p_1 p_{33} s^7 z_{23} z_{31} - \\
& i B p_1 P_{21} s^5 Z_{23} z_{31} + 4 i a p_1 P_{31} s^5 Z_{23} z_{31} + 2 i G p_1 P_{31} s^5 Z_{23} z_{31} - i B p_1 P_{23} s^7 Z_{23} z_{31} + \\
& 4 i a p_1 P_{33} s^7 Z_{23} z_{31} + 2 i G p_1 P_{33} s^7 Z_{23} z_{31} - 2 i a p_1 p_{21} s^3 z_{31}^2 - i G p_1 p_{21} s^3 z_{31}^2 - \\
& \frac{1}{2} i B p_1 p_{31} s^3 z_{31}^2 - 2 i a p_1 p_{23} s^5 z_{31}^2 - i G p_1 p_{23} s^5 z_{31}^2 - \frac{1}{2} i B p_1 p_{33} s^5 z_{31}^2 - \\
& \frac{1}{2} i B p_1 P_{21} s^3 z_{21} Z_{31} - 2 i g p_1 P_{31} s^3 z_{21} Z_{31} - \frac{1}{2} i B p_1 P_{23} s^5 z_{21} Z_{31} - \\
& 2 i g p_1 P_{33} s^5 z_{21} Z_{31} - \frac{1}{2} i B p_1 P_{21} s^5 z_{23} Z_{31} - 2 i g p_1 P_{31} s^5 z_{23} Z_{31} - \\
& \frac{1}{2} i B p_1 P_{23} s^7 z_{23} Z_{31} - 2 i g p_1 P_{33} s^7 z_{23} Z_{31} - 2 i G p_1 P_{21} s^3 z_{31} Z_{31} + i b p_1 P_{31} s^3 z_{31} Z_{31} - \\
& 2 i G p_1 P_{23} s^5 z_{31} Z_{31} + i b p_1 P_{33} s^5 z_{31} Z_{31} - B p_{21} P_{21} s^5 z_{33} - 2 G P_{21} p_{31} s^5 z_{33} + \\
& 2 a p_{21} P_{31} s^5 z_{33} + B p_{31} P_{31} s^5 z_{33} - B P_{21} p_{23} s^7 z_{33} - B p_{21} P_{23} s^7 z_{33} - 2 G P_{23} p_{31} s^7 z_{33} + \\
& 2 a p_{23} P_{31} s^7 z_{33} - 2 G P_{21} p_{33} s^7 z_{33} + B P_{31} p_{33} s^7 z_{33} + 2 a p_{21} P_{33} s^7 z_{33} + \\
& B p_{31} P_{33} s^7 z_{33} - B p_{23} P_{23} s^9 z_{33} - 2 G P_{23} p_{33} s^9 z_{33} + 2 a p_{23} P_{33} s^9 z_{33} + \\
& B p_{33} P_{33} s^9 z_{33} + i b p_1 p_{21} s^5 z_{21} z_{33} + 2 i G p_1 p_{31} s^5 z_{21} z_{33} + i b p_1 p_{23} s^7 z_{21} z_{33} + \\
& 2 i G p_1 p_{33} s^7 z_{21} z_{33} - i B p_1 P_{21} s^5 Z_{21} z_{33} + 4 i a p_1 P_{31} s^5 Z_{21} z_{33} + 2 i G p_1 P_{31} s^5 Z_{21} z_{33} - \\
& i B p_1 P_{23} s^7 Z_{21} z_{33} + 4 i a p_1 P_{33} s^7 Z_{21} z_{33} + 2 i G p_1 P_{33} s^7 Z_{21} z_{33} + i b p_1 p_{21} s^7 z_{23} z_{33} + \\
& 2 i G p_1 p_{31} s^7 z_{23} z_{33} + i b p_1 p_{23} s^9 z_{23} z_{33} + 2 i G p_1 p_{33} s^9 z_{23} z_{33} - i B p_1 P_{21} s^7 Z_{23} z_{33} + \\
& 4 i a p_1 P_{31} s^7 Z_{23} z_{33} + 2 i G p_1 P_{31} s^7 Z_{23} z_{33} - i B p_1 P_{23} s^9 Z_{23} z_{33} + 4 i a p_1 P_{33} s^9 Z_{23} z_{33} + \\
& 2 i G p_1 P_{33} s^9 Z_{23} z_{33} - 4 i a p_1 p_{21} s^5 z_{31} z_{33} - 2 i G p_1 p_{21} s^5 z_{31} z_{33} -
\end{aligned}$$

$$\begin{aligned}
& \frac{i}{2} B p_1 p_{31} s^5 z_{31} z_{33} - 4 \frac{i}{2} a p_1 p_{23} s^7 z_{31} z_{33} - 2 \frac{i}{2} G p_1 p_{23} s^7 z_{31} z_{33} - \frac{i}{2} B p_1 p_{33} s^7 z_{31} z_{33} - \\
& 2 \frac{i}{2} G p_1 P_{21} s^5 Z_{31} z_{33} + \frac{i}{2} b p_1 P_{31} s^5 Z_{31} z_{33} - 2 \frac{i}{2} G p_1 P_{23} s^7 Z_{31} z_{33} + \frac{i}{2} b p_1 P_{33} s^7 Z_{31} z_{33} - \\
& 2 \frac{i}{2} a p_1 p_{21} s^7 z_{33}^2 - \frac{i}{2} G p_1 p_{21} s^7 z_{33}^2 - \frac{1}{2} \frac{i}{2} B p_1 p_{31} s^7 z_{33}^2 - 2 \frac{i}{2} a p_1 p_{23} s^9 z_{33}^2 - \\
& \frac{i}{2} G p_1 p_{23} s^9 z_{33}^2 - \frac{1}{2} \frac{i}{2} B p_1 p_{33} s^9 z_{33}^2 - \frac{1}{2} \frac{i}{2} B p_1 P_{21} s^5 z_{21} Z_{33} - 2 \frac{i}{2} g p_1 P_{31} s^5 z_{21} Z_{33} - \\
& \frac{1}{2} \frac{i}{2} B p_1 P_{23} s^7 z_{21} Z_{33} - 2 \frac{i}{2} g p_1 P_{33} s^7 z_{21} Z_{33} - \frac{1}{2} \frac{i}{2} B p_1 P_{21} s^7 z_{23} Z_{33} - \\
& 2 \frac{i}{2} g p_1 P_{31} s^7 z_{23} Z_{33} - \frac{1}{2} \frac{i}{2} B p_1 P_{23} s^9 z_{23} Z_{33} - 2 \frac{i}{2} g p_1 P_{33} s^9 z_{23} Z_{33} - \\
& 2 \frac{i}{2} G p_1 P_{21} s^5 z_{31} Z_{33} + \frac{i}{2} b p_1 P_{31} s^5 z_{31} Z_{33} - 2 \frac{i}{2} G p_1 P_{23} s^7 z_{31} Z_{33} + \frac{i}{2} b p_1 P_{33} s^7 z_{31} Z_{33} - \\
& 2 \frac{i}{2} G p_1 P_{21} s^7 z_{33} Z_{33} + \frac{i}{2} b p_1 P_{31} s^7 z_{33} Z_{33} - 2 \frac{i}{2} G p_1 P_{23} s^9 z_{33} Z_{33} + \frac{i}{2} b p_1 P_{33} s^9 z_{33} Z_{33}
\end{aligned}$$

In[\*]:= Collect[%53, s]

$$\begin{aligned}
\text{Out[*]} = & s \left( \frac{\frac{i}{2} p_1 P_{21}}{2} + \frac{p_1^2 z_{21}}{2} \right) + \\
& s^3 \left( \frac{\frac{i}{2} p_1 P_{23}}{2} - 2 a p_{21} P_{21} z_{21} - B P_{21} p_{31} z_{21} - b p_{21} P_{31} z_{21} + 2 a p_{31} P_{31} z_{21} + \right. \\
& \frac{i}{2} a p_1 p_{21} z_{21}^2 - \frac{1}{2} \frac{i}{2} b p_1 p_{31} z_{21}^2 + \frac{i}{2} B p_1 p_{31} z_{21}^2 - 2 \frac{i}{2} a p_1 P_{21} z_{21} Z_{21} - \\
& 2 \frac{i}{2} b p_1 P_{31} z_{21} Z_{21} + \frac{i}{2} B p_1 P_{31} z_{21} Z_{21} + \frac{p_1^2 z_{23}}{2} - B p_{21} P_{21} z_{31} - \\
& 2 G P_{21} p_{31} z_{31} + 2 a p_{21} P_{31} z_{31} + B p_{31} P_{31} z_{31} + \frac{i}{2} b p_1 p_{21} z_{21} z_{31} + \\
& 2 \frac{i}{2} G p_1 p_{31} z_{21} z_{31} - \frac{i}{2} B p_1 P_{21} Z_{21} z_{31} + 4 \frac{i}{2} a p_1 P_{31} Z_{21} z_{31} + 2 \frac{i}{2} G p_1 P_{31} Z_{21} z_{31} - \\
& 2 \frac{i}{2} a p_1 p_{21} z_{31}^2 - \frac{i}{2} G p_1 p_{21} z_{31}^2 - \frac{1}{2} \frac{i}{2} B p_1 p_{31} z_{31}^2 - \frac{1}{2} \frac{i}{2} B p_1 P_{21} z_{21} Z_{31} - \\
& \left. 2 \frac{i}{2} g p_1 P_{31} z_{21} Z_{31} - 2 \frac{i}{2} G p_1 P_{21} z_{31} Z_{31} + \frac{i}{2} b p_1 P_{31} z_{31} Z_{31} \right) + \\
& s^5 \left( -2 a P_{21} p_{23} z_{21} - 2 a p_{21} P_{23} z_{21} - B P_{23} p_{31} z_{21} - b p_{23} P_{31} z_{21} - B P_{21} p_{33} z_{21} + \right. \\
& 2 a P_{31} p_{33} z_{21} - b p_{21} P_{33} z_{21} + 2 a p_{31} P_{33} z_{21} + \frac{i}{2} a p_1 p_{23} z_{21}^2 - \frac{1}{2} \frac{i}{2} b p_1 p_{33} z_{21}^2 + \\
& \frac{i}{2} B p_1 p_{33} z_{21}^2 - 2 \frac{i}{2} a p_1 P_{23} z_{21} Z_{21} - 2 \frac{i}{2} b p_1 P_{33} z_{21} Z_{21} + \frac{i}{2} B p_1 P_{33} z_{21} Z_{21} - \\
& 2 a p_{21} P_{21} z_{23} - B P_{21} p_{31} z_{23} - b p_{21} P_{31} z_{23} + 2 a p_{31} P_{31} z_{23} + 2 \frac{i}{2} a p_1 p_{21} z_{21} z_{23} - \\
& \frac{i}{2} b p_1 p_{31} z_{21} z_{23} + 2 \frac{i}{2} B p_1 p_{31} z_{21} z_{23} - 2 \frac{i}{2} a p_1 P_{21} Z_{21} z_{23} - 2 \frac{i}{2} b p_1 P_{31} Z_{21} z_{23} + \\
& \frac{i}{2} B p_1 P_{31} Z_{21} z_{23} - 2 \frac{i}{2} a p_1 P_{21} z_{21} Z_{23} - 2 \frac{i}{2} b p_1 P_{31} z_{21} Z_{23} + \frac{i}{2} B p_1 P_{31} z_{21} Z_{23} - \\
& B P_{21} p_{23} z_{31} - B p_{21} P_{23} z_{31} - 2 G P_{23} p_{31} z_{31} + 2 a p_{23} P_{31} z_{31} - 2 G P_{21} p_{33} z_{31} + \\
& B P_{31} p_{33} z_{31} + 2 a p_{21} P_{33} z_{31} + B p_{31} P_{33} z_{31} + \frac{i}{2} b p_1 p_{23} z_{21} z_{31} + \\
& 2 \frac{i}{2} G p_1 p_{33} z_{21} z_{31} - \frac{i}{2} B p_1 P_{23} Z_{21} z_{31} + 4 \frac{i}{2} a p_1 P_{33} Z_{21} z_{31} + 2 \frac{i}{2} G p_1 P_{33} Z_{21} z_{31} + \\
& \frac{i}{2} b p_1 p_{21} z_{23} z_{31} + 2 \frac{i}{2} G p_1 p_{31} z_{23} z_{31} - \frac{i}{2} B p_1 P_{21} Z_{23} z_{31} + 4 \frac{i}{2} a p_1 P_{31} Z_{23} z_{31} + \\
& 2 \frac{i}{2} G p_1 P_{31} Z_{23} z_{31} - 2 \frac{i}{2} a p_1 p_{23} z_{31}^2 - \frac{i}{2} G p_1 p_{23} z_{31}^2 - \frac{1}{2} \frac{i}{2} B p_1 p_{33} z_{31}^2 - \\
& \frac{1}{2} \frac{i}{2} B p_1 P_{23} z_{21} Z_{31} - 2 \frac{i}{2} g p_1 P_{33} z_{21} Z_{31} - \frac{1}{2} \frac{i}{2} B p_1 P_{21} z_{23} Z_{31} - 2 \frac{i}{2} g p_1 P_{31} z_{23} Z_{31} - \\
& 2 \frac{i}{2} G p_1 P_{23} z_{31} Z_{31} + \frac{i}{2} b p_1 P_{33} z_{31} Z_{31} - B p_{21} P_{21} z_{33} - 2 G P_{21} p_{31} z_{33} + \\
& 2 a p_{21} P_{31} z_{33} + B p_{31} P_{31} z_{33} + \frac{i}{2} b p_1 p_{21} z_{21} z_{33} + 2 \frac{i}{2} G p_1 p_{31} z_{21} z_{33} - \\
& \frac{i}{2} B p_1 P_{21} Z_{21} z_{33} + 4 \frac{i}{2} a p_1 P_{31} Z_{21} z_{33} + 2 \frac{i}{2} G p_1 P_{31} Z_{21} z_{33} - 4 \frac{i}{2} a p_1 p_{21} z_{31} z_{33} -
\end{aligned}$$

$$\begin{aligned}
& 2 \, i \, G \, p1 \, p21 \, z31 \, z33 - i \, B \, p1 \, p31 \, z31 \, z33 - 2 \, i \, G \, p1 \, P21 \, Z31 \, z33 + i \, b \, p1 \, P31 \, Z31 \, z33 - \\
& \frac{1}{2} \, i \, B \, p1 \, P21 \, z21 \, Z33 - 2 \, i \, g \, p1 \, P31 \, z21 \, Z33 - 2 \, i \, G \, p1 \, P21 \, z31 \, Z33 + i \, b \, p1 \, P31 \, z31 \, Z33 \Big) + \\
s^7 \Big( & -2 \, a \, p23 \, P23 \, z21 - B \, P23 \, p33 \, z21 - b \, p23 \, P33 \, z21 + 2 \, a \, p33 \, P33 \, z21 - 2 \, a \, P21 \, p23 \, z23 - \\
& 2 \, a \, p21 \, P23 \, z23 - B \, P23 \, p31 \, z23 - b \, p23 \, P31 \, z23 - B \, P21 \, p33 \, z23 + 2 \, a \, P31 \, p33 \, z23 - \\
& b \, p21 \, P33 \, z23 + 2 \, a \, p31 \, P33 \, z23 + 2 \, i \, a \, p1 \, p23 \, z21 \, z23 - i \, b \, p1 \, p33 \, z21 \, z23 + \\
& 2 \, i \, B \, p1 \, p33 \, z21 \, z23 - 2 \, i \, a \, p1 \, P23 \, Z21 \, z23 - 2 \, i \, b \, p1 \, P33 \, Z21 \, z23 + i \, B \, p1 \, P33 \, Z21 \, z23 + \\
& i \, a \, p1 \, p21 \, z23^2 - \frac{1}{2} \, i \, b \, p1 \, p31 \, z23^2 + i \, B \, p1 \, p31 \, z23^2 - 2 \, i \, a \, p1 \, P23 \, z21 \, Z23 - \\
& 2 \, i \, b \, p1 \, P33 \, z21 \, Z23 + i \, B \, p1 \, P33 \, z21 \, Z23 - 2 \, i \, a \, p1 \, P21 \, z23 \, Z23 - 2 \, i \, b \, p1 \, P31 \, z23 \, Z23 + \\
& i \, B \, p1 \, P31 \, z23 \, Z23 - B \, p23 \, P23 \, z31 - 2 \, G \, P23 \, p33 \, z31 + 2 \, a \, p23 \, P33 \, z31 + B \, p33 \, P33 \, z31 + \\
& i \, b \, p1 \, p23 \, z23 \, z31 + 2 \, i \, G \, p1 \, p33 \, z23 \, z31 - i \, B \, p1 \, P23 \, Z23 \, z31 + 4 \, i \, a \, p1 \, P33 \, Z23 \, z31 + \\
& 2 \, i \, G \, p1 \, P33 \, Z23 \, z31 - \frac{1}{2} \, i \, B \, p1 \, P23 \, z23 \, Z31 - 2 \, i \, g \, p1 \, P33 \, z23 \, Z31 - B \, P21 \, p23 \, z33 - \\
& B \, p21 \, P23 \, z33 - 2 \, G \, P23 \, p31 \, z33 + 2 \, a \, p23 \, P31 \, z33 - 2 \, G \, P21 \, p33 \, z33 + B \, P31 \, p33 \, z33 + \\
& 2 \, a \, p21 \, P33 \, z33 + B \, p31 \, P33 \, z33 + i \, b \, p1 \, p23 \, z21 \, z33 + 2 \, i \, G \, p1 \, p33 \, z21 \, z33 - \\
& i \, B \, p1 \, P23 \, Z21 \, z33 + 4 \, i \, a \, p1 \, P33 \, Z21 \, z33 + 2 \, i \, G \, p1 \, P33 \, Z21 \, z33 + i \, b \, p1 \, p21 \, z23 \, z33 + \\
& 2 \, i \, G \, p1 \, p31 \, z23 \, z33 - i \, B \, p1 \, P21 \, Z23 \, z33 + 4 \, i \, a \, p1 \, P31 \, Z23 \, z33 + 2 \, i \, G \, p1 \, P31 \, Z23 \, z33 - \\
& 4 \, i \, a \, p1 \, p23 \, z31 \, z33 - 2 \, i \, G \, p1 \, p23 \, z31 \, z33 - i \, B \, p1 \, p33 \, z31 \, z33 - 2 \, i \, G \, p1 \, P23 \, Z31 \, z33 + \\
& i \, b \, p1 \, P33 \, Z31 \, z33 - 2 \, i \, a \, p1 \, p21 \, z33^2 - i \, G \, p1 \, p21 \, z33^2 - \frac{1}{2} \, i \, B \, p1 \, p31 \, z33^2 - \\
& \frac{1}{2} \, i \, B \, p1 \, P23 \, z21 \, Z33 - 2 \, i \, g \, p1 \, P33 \, z21 \, Z33 - \frac{1}{2} \, i \, B \, p1 \, P21 \, z23 \, Z33 - 2 \, i \, g \, p1 \, P31 \, z23 \, Z33 - \\
& 2 \, i \, G \, p1 \, P23 \, z31 \, Z33 + i \, b \, p1 \, P33 \, z31 \, Z33 - 2 \, i \, G \, p1 \, P21 \, z33 \, Z33 + i \, b \, p1 \, P31 \, z33 \, Z33 \Big) + \\
s^9 \Big( & -2 \, a \, p23 \, P23 \, z23 - B \, P23 \, p33 \, z23 - b \, p23 \, P33 \, z23 + 2 \, a \, p33 \, P33 \, z23 + i \, a \, p1 \, p23 \, z23^2 - \\
& \frac{1}{2} \, i \, b \, p1 \, p33 \, z23^2 + i \, B \, p1 \, p33 \, z23^2 - 2 \, i \, a \, p1 \, P23 \, z23 \, Z23 - 2 \, i \, b \, p1 \, P33 \, z23 \, Z23 + \\
& i \, B \, p1 \, P33 \, z23 \, Z23 - B \, p23 \, P23 \, z33 - 2 \, G \, P23 \, p33 \, z33 + 2 \, a \, p23 \, P33 \, z33 + B \, p33 \, P33 \, z33 + \\
& i \, b \, p1 \, p23 \, z23 \, z33 + 2 \, i \, G \, p1 \, p33 \, z23 \, z33 - i \, B \, p1 \, P23 \, Z23 \, z33 + 4 \, i \, a \, p1 \, P33 \, Z23 \, z33 + \\
& 2 \, i \, G \, p1 \, P33 \, Z23 \, z33 - 2 \, i \, a \, p1 \, p23 \, z33^2 - i \, G \, p1 \, p23 \, z33^2 - \frac{1}{2} \, i \, B \, p1 \, p33 \, z33^2 - \\
& \frac{1}{2} \, i \, B \, p1 \, P23 \, z23 \, Z33 - 2 \, i \, g \, p1 \, P33 \, z23 \, Z33 - 2 \, i \, G \, p1 \, P23 \, z33 \, Z33 + i \, b \, p1 \, P33 \, z33 \, Z33 \Big)
\end{aligned}$$

$ln[*]:=$  **p1 := 1**

$$ln[*]:= -\frac{p21}{2} - \frac{i \, p1 \, Z21}{2}$$

$$Out[*]:= -\frac{p21}{2} - \frac{i \, Z21}{2}$$

$$ln[*]:= \frac{i \, p1 \, P21}{2} + \frac{p1^2 \, z21}{2}$$

$$Out[*]:= \frac{i \, P21}{2} + \frac{z21}{2}$$

$$\text{DSolve}\left[\left\{\ell'[t] == -\frac{m[t]}{2} - \frac{i * \text{conj}(\ell[t])}{2}, m'[t] == \frac{i * m[t]}{2} + \frac{\ell[t]}{2}\right\}, \{\ell[t], m[t]\}, t\right]$$

$$\begin{aligned} \text{Out}[*]:= & \left\{ \left\{ \ell[t] \rightarrow -\frac{C[2] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[1] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] - i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right), \right. \right. \\ & \left. \left. m[t] \rightarrow \frac{C[1] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[2] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] + i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right) \right\} \right\} \end{aligned}$$

$$\text{In}[*]:= -\frac{C[2] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[1] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] - i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right)$$

$$\text{Out}[*]:= -\frac{C[2] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[1] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] - i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right)$$

$$\text{In}[*]:= \text{TrigReduce}\left[-\frac{C[2] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[1] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] - i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right)\right]$$

$$\text{Out}[*]:= \frac{1}{2} \left( 2 C[1] \cos\left[\frac{t}{\sqrt{2}}\right] - i \sqrt{2} C[1] \sin\left[\frac{t}{\sqrt{2}}\right] - \sqrt{2} C[2] \sin\left[\frac{t}{\sqrt{2}}\right] \right)$$

$$\text{In}[*]:= \frac{C[1] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[2] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] + i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right)$$

$$\text{Out}[*]:= \frac{C[1] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[2] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] + i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right)$$

$$\text{In}[*]:= \text{TrigReduce}\left[\frac{C[1] \sin\left[\frac{t}{\sqrt{2}}\right]}{\sqrt{2}} + \frac{1}{2} C[2] \left( 2 \cos\left[\frac{t}{\sqrt{2}}\right] + i \sqrt{2} \sin\left[\frac{t}{\sqrt{2}}\right] \right)\right]$$

$$\text{Out}[*]:= \frac{1}{2} \left( 2 C[2] \cos\left[\frac{t}{\sqrt{2}}\right] + \sqrt{2} C[1] \sin\left[\frac{t}{\sqrt{2}}\right] + i \sqrt{2} C[2] \sin\left[\frac{t}{\sqrt{2}}\right] \right)$$

$$\text{In}[*]:= \mathbf{H} /. \{a \rightarrow 0, b \rightarrow 0, g \rightarrow 0, B \rightarrow 0, G \rightarrow 0\}$$

$$\text{Out}[*]:= 2 p0 - \frac{p2 P2}{4} - \frac{p3 P3}{4} + \frac{i p2 z2}{4} - \frac{i P2 Z2}{4} - \frac{z2 Z2}{4} - \frac{z3 Z3}{4}$$

$$\text{In}[*]:= \mathbf{Ainv} /. \{a \rightarrow 0, b \rightarrow 0, g \rightarrow 0, B \rightarrow 0, G \rightarrow 0\}$$

$$\text{Out}[*]:= \left\{ \{0, i, 0, 0\}, \left\{ -i, \frac{1}{4} (-z2 Z2 - z3 Z3), -\frac{Z2}{4}, 0 \right\}, \left\{ 0, -\frac{z2}{4}, -\frac{1}{4}, 0 \right\}, \left\{ 0, 0, 0, -\frac{1}{4} \right\} \right\}$$

```
In[ ]:= MatrixForm[
  {{0, 1, 0, 0}, {-1, 1/4 (-z2 Z2 - z3 Z3), -Z2/4, 0}, {0, -Z2/4, -1/4, 0}, {0, 0, 0, -1/4}}]
```

Out[ ]//MatrixForm=

$$\begin{pmatrix} 0 & 1 & 0 & 0 \\ -1 & \frac{1}{4}(-z_2 Z_2 - z_3 Z_3) & -\frac{Z_2}{4} & 0 \\ 0 & -\frac{Z_2}{4} & -\frac{1}{4} & 0 \\ 0 & 0 & 0 & -\frac{1}{4} \end{pmatrix}$$

```
In[ ]:= A := {{0, I, I * f2, I * f3}, {-I, 0, 0, 0},
  {-I * f20, 0, 4 * f22, 4 * f23}, {-I * f30, 0, 4 * f32, 4 * f33}}
```

```
In[ ]:= A
```

```
Out[ ]:= {{0, 1, 1 f2, 1 f3}, {-1, 0, 0, 0}, {-1 f20, 0, 4 f22, 4 f23}, {-1 f30, 0, 4 f32, 4 f33}}
```

```
In[ ]:= MatrixForm[
  {{0, 1, 1 f2, 1 f3}, {-1, 0, 0, 0}, {-1 f20, 0, 4 f22, 4 f23}, {-1 f30, 0, 4 f32, 4 f33}}]
```

Out[ ]//MatrixForm=

$$\begin{pmatrix} 0 & 1 & 1 f2 & 1 f3 \\ -1 & 0 & 0 & 0 \\ -1 f20 & 0 & 4 f22 & 4 f23 \\ -1 f30 & 0 & 4 f32 & 4 f33 \end{pmatrix}$$

```
In[ ]:= ClearAll[A]
```

```
In[ ]:= A := {{0, I, I * f20, I * f30}, {-I, 0, 0, 0},
  {-I * f2, 0, 4 * f22, 4 * f23}, {-I * f3, 0, 4 * f32, 4 * f33}}
```

```
In[ ]:= A
```

```
Out[ ]:= {{0, 1, 1 f20, 1 f30}, {-1, 0, 0, 0}, {-1 f2, 0, 4 f22, 4 f23}, {-1 f3, 0, 4 f32, 4 f33}}
```

```
In[ ]:= MatrixForm[
  {{0, 1, 1 f20, 1 f30}, {-1, 0, 0, 0}, {-1 f2, 0, 4 f22, 4 f23}, {-1 f3, 0, 4 f32, 4 f33}}]
```

Out[ ]//MatrixForm=

$$\begin{pmatrix} 0 & 1 & 1 f20 & 1 f30 \\ -1 & 0 & 0 & 0 \\ -1 f2 & 0 & 4 f22 & 4 f23 \\ -1 f3 & 0 & 4 f32 & 4 f33 \end{pmatrix}$$

```
In[ ]:= W := Inverse[A]
```

In[\*]:= **W**

$$\text{Out[*]} = \left\{ \left\{ 0, \frac{16 \, i \, f_{23} \, f_{32} - 16 \, i \, f_{22} \, f_{33}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, 0, 0 \right\}, \left\{ \frac{-16 \, i \, f_{23} \, f_{32} + 16 \, i \, f_{22} \, f_{33}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, \right. \right. \\ \left. \left( 4 \, f_{20} \, f_{23} \, f_3 - 4 \, f_{22} \, f_3 \, f_{30} + 4 \, f_2 \, f_{30} \, f_{32} - 4 \, f_2 \, f_{20} \, f_{33} \right) / \left( 16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33} \right), \right. \\ \left. \frac{-4 \, f_{30} \, f_{32} + 4 \, f_{20} \, f_{33}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, \frac{-4 \, f_{20} \, f_{23} + 4 \, f_{22} \, f_{30}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}} \right\}, \\ \left\{ 0, \frac{-4 \, f_{23} \, f_3 + 4 \, f_2 \, f_{33}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, -\frac{4 \, f_{33}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, \frac{4 \, f_{23}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}} \right\}, \\ \left\{ 0, \frac{4 \, f_{22} \, f_3 - 4 \, f_2 \, f_{32}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, \frac{4 \, f_{32}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}}, -\frac{4 \, f_{22}}{16 \, f_{23} \, f_{32} - 16 \, f_{22} \, f_{33}} \right\} \right\}$$

In[\*]:= **F23 \* F32 - F22 \* F33**

$$\text{Out[*]} = \left( -b \, z^2 \, Z^2 + 4 \, a \, Z^2 \, z^3 - 4 \, g \, z^2 \, Z^3 + b \, z^3 \, Z^3 - b \, (z^2 \, Z^2 - z^3 \, Z^3) \right) \\ \left( -B \, z^2 \, Z^2 - 4 \, G \, Z^2 \, z^3 + 4 \, a \, z^2 \, Z^3 + B \, z^3 \, Z^3 - B \, (z^2 \, Z^2 - z^3 \, Z^3) \right) - \\ \left( -1 - 2 \, B \, Z^2 \, z^3 - 2 \, b \, z^2 \, Z^3 - a \, (4 \, z^2 \, Z^2 - 4 \, z^3 \, Z^3) \right) \\ \left( -1 + 2 \, B \, Z^2 \, z^3 + 2 \, b \, z^2 \, Z^3 - a \, (-4 \, z^2 \, Z^2 + 4 \, z^3 \, Z^3) \right)$$

In[\*]:= **Expand[%94]**

$$\text{Out[*]} = -1 + 16 \, a^2 \, z^2 \, Z^2 + 4 \, b \, B \, z^2 \, Z^2 + 8 \, a \, B \, z^2 \, Z^2 \, z^3 + 8 \, b \, G \, z^2 \, Z^2 \, z^3 + \\ 4 \, B^2 \, Z^2 \, z^3^2 - 16 \, a \, G \, Z^2 \, z^3^2 + 8 \, a \, b \, z^2 \, Z^2 \, Z^3 + 8 \, B \, g \, z^2 \, Z^2 \, Z^3 - 16 \, a^2 \, z^2 \, Z^2 \, z^3 \, Z^3 + \\ 16 \, g \, G \, z^2 \, Z^2 \, z^3 \, Z^3 - 8 \, a \, B \, Z^2 \, z^3^2 \, Z^3 - 8 \, b \, G \, Z^2 \, z^3^2 \, Z^3 + 4 \, b^2 \, z^2 \, Z^2 \, Z^3^2 - \\ 16 \, a \, g \, z^2 \, Z^2 \, Z^3^2 - 8 \, a \, b \, z^2 \, z^3 \, Z^3^2 - 8 \, B \, g \, z^2 \, z^3 \, Z^3^2 + 16 \, a^2 \, z^3^2 \, Z^3^2 + 4 \, b \, B \, z^3^2 \, Z^3^2$$

In[\*]:= **Ainvpre := {{0, -i f23 f32 + i f22 f33, 0, 0},**  
**{i f23 f32 - i f22 f33, (-f20 f23 f3 + f22 f3 f30 - f2 f30 f32 + f2 f20 f33)/4,**  
**(f30 f32 - f20 f33)/4, (f20 f23 - f22 f30)/4}, {0, (f23 f3 - f2 f33)/4,**  
**f33/4, -f23/4}, {0, (-f22 f3 + f2 f32)/4, -f32/4, f22/4}}**

In[\*]:= **-i f23 f32 + i f22 f33 /. {f2 -> F2, f22 -> F22,**  
**f23 -> F23, f20 -> F20, f3 -> F3, f30 -> F30, f32 -> F32, f33 -> F33}**

$$\text{Out[*]} = -i \left( -b \, z^2 \, Z^2 + 4 \, a \, Z^2 \, z^3 - 4 \, g \, z^2 \, Z^3 + b \, z^3 \, Z^3 - b \, (z^2 \, Z^2 - z^3 \, Z^3) \right) \\ \left( -B \, z^2 \, Z^2 - 4 \, G \, Z^2 \, z^3 + 4 \, a \, z^2 \, Z^3 + B \, z^3 \, Z^3 - B \, (z^2 \, Z^2 - z^3 \, Z^3) \right) + \\ i \left( -1 - 2 \, B \, Z^2 \, z^3 - 2 \, b \, z^2 \, Z^3 - a \, (4 \, z^2 \, Z^2 - 4 \, z^3 \, Z^3) \right) \\ \left( -1 + 2 \, B \, Z^2 \, z^3 + 2 \, b \, z^2 \, Z^3 - a \, (-4 \, z^2 \, Z^2 + 4 \, z^3 \, Z^3) \right)$$

In[\*]:= **Expand[%97]**

$$\text{Out[*]} = i - 16 \, i \, a^2 \, z^2 \, Z^2 - 4 \, i \, b \, B \, z^2 \, Z^2 - 8 \, i \, a \, B \, z^2 \, Z^2 \, z^3 - 8 \, i \, b \, G \, z^2 \, Z^2 \, z^3 - 4 \, i \, B^2 \, Z^2 \, z^3^2 + \\ 16 \, i \, a \, G \, Z^2 \, z^3^2 - 8 \, i \, a \, b \, z^2 \, Z^2 \, Z^3 - 8 \, i \, B \, g \, z^2 \, Z^2 \, Z^3 + 16 \, i \, a^2 \, z^2 \, Z^2 \, z^3 \, Z^3 - \\ 16 \, i \, g \, G \, z^2 \, Z^2 \, z^3 \, Z^3 + 8 \, i \, a \, B \, Z^2 \, z^3^2 \, Z^3 + 8 \, i \, b \, G \, Z^2 \, z^3^2 \, Z^3 - 4 \, i \, b^2 \, z^2 \, Z^2 \, Z^3^2 + \\ 16 \, i \, a \, g \, z^2 \, Z^2 \, Z^3^2 + 8 \, i \, a \, b \, z^2 \, z^3 \, Z^3^2 + 8 \, i \, B \, g \, z^2 \, z^3 \, Z^3^2 - 16 \, i \, a^2 \, z^3^2 \, Z^3^2 - 4 \, i \, b \, B \, z^3^2 \, Z^3^2$$

In[\*]:= **H11 := 0**

In[\*]:= **H12 := I**

In[\*]:= **H13 := 0**

In[ ]:= **H14 := 0**

In[ ]:= **i f23 f32 - i f22 f33 /. {f2 → F2, f22 → F22,  
f23 → F23, f20 → F20, f3 → F3, f30 → F30, f32 → F32, f33 → F33}**

Out[ ]:= **i ( - b z2 Z2 + 4 a Z2 z3 - 4 g z2 Z3 + b z3 Z3 - b ( z2 Z2 - z3 Z3 ) )  
( - B z2 Z2 - 4 G Z2 z3 + 4 a z2 Z3 + B z3 Z3 - B ( z2 Z2 - z3 Z3 ) ) -  
i ( - 1 - 2 B Z2 z3 - 2 b z2 Z3 - a ( 4 z2 Z2 - 4 z3 Z3 ) )  
( - 1 + 2 B Z2 z3 + 2 b z2 Z3 - a ( - 4 z2 Z2 + 4 z3 Z3 ) )**

In[ ]:= **Expand[%103]**

Out[ ]:= **- i + 16 i a<sup>2</sup> z2<sup>2</sup> Z2<sup>2</sup> + 4 i b B z2<sup>2</sup> Z2<sup>2</sup> + 8 i a B z2 Z2<sup>2</sup> z3 + 8 i b G z2 Z2<sup>2</sup> z3 + 4 i B<sup>2</sup> Z2<sup>2</sup> z3<sup>2</sup> -  
16 i a G Z2<sup>2</sup> z3<sup>2</sup> + 8 i a b z2<sup>2</sup> Z2 Z3 + 8 i B g z2<sup>2</sup> Z2 Z3 - 16 i a<sup>2</sup> z2 Z2 z3 Z3 +  
16 i g G z2 Z2 z3 Z3 - 8 i a B Z2 z3<sup>2</sup> Z3 - 8 i b G Z2 z3<sup>2</sup> Z3 + 4 i b<sup>2</sup> z2<sup>2</sup> Z3<sup>2</sup> -  
16 i a g z2<sup>2</sup> Z3<sup>2</sup> - 8 i a b z2 z3 Z3<sup>2</sup> - 8 i B g z2 z3 Z3<sup>2</sup> + 16 i a<sup>2</sup> z3<sup>2</sup> Z3<sup>2</sup> + 4 i b B z3<sup>2</sup> Z3<sup>2</sup>**

In[ ]:= **H21 := -I**

In[ ]:= **- f20 f23 f3 + f22 f3 f30 - f2 f30 f32 + f2 f20 f33 /. {f2 → F2, f22 → F22,  
f23 → F23, f20 → F20, f3 → F3, f30 → F30, f32 → F32, f33 → F33}**

Out[ ]:= **( - 1 + 2 B Z2 z3 + 2 b z2 Z3 - a ( - 4 z2 Z2 + 4 z3 Z3 ) )  
( - z2 - 2 G Z2 z3<sup>2</sup> - z2 ( B Z2 z3 + b z2 Z3 ) - B z3 ( z2 Z2 - z3 Z3 ) - a ( 2 z2<sup>2</sup> Z2 - 4 z2 z3 Z3 ) )  
( - Z2 - 2 g z2 Z3<sup>2</sup> - Z2 ( B Z2 z3 + b z2 Z3 ) - b Z3 ( z2 Z2 - z3 Z3 ) - a ( 2 z2 Z2<sup>2</sup> - 4 Z2 z3 Z3 ) ) -  
( - B z2 Z2 - 4 G Z2 z3 + 4 a z2 Z3 + B z3 Z3 - B ( z2 Z2 - z3 Z3 ) )  
( - Z2 - 2 g z2 Z3<sup>2</sup> - Z2 ( B Z2 z3 + b z2 Z3 ) - b Z3 ( z2 Z2 - z3 Z3 ) - a ( 2 z2 Z2<sup>2</sup> - 4 Z2 z3 Z3 ) )  
( - z3 - 2 g z2<sup>2</sup> Z3 + z3 ( B Z2 z3 + b z2 Z3 ) - b z2 ( z2 Z2 - z3 Z3 ) - a ( - 4 z2 Z2 z3 + 2 z3<sup>2</sup> Z3 ) ) -  
( - b z2 Z2 + 4 a Z2 z3 - 4 g z2 Z3 + b z3 Z3 - b ( z2 Z2 - z3 Z3 ) )  
( - z2 - 2 G Z2 z3<sup>2</sup> - z2 ( B Z2 z3 + b z2 Z3 ) - B z3 ( z2 Z2 - z3 Z3 ) - a ( 2 z2<sup>2</sup> Z2 - 4 z2 z3 Z3 ) )  
( - 2 G Z2<sup>2</sup> z3 - Z3 + Z3 ( B Z2 z3 + b z2 Z3 ) - B Z2 ( z2 Z2 - z3 Z3 ) - a ( - 4 z2 Z2 Z3 + 2 z3 Z3<sup>2</sup> ) ) +  
( - 1 - 2 B Z2 z3 - 2 b z2 Z3 - a ( 4 z2 Z2 - 4 z3 Z3 ) )  
( - z3 - 2 g z2<sup>2</sup> Z3 + z3 ( B Z2 z3 + b z2 Z3 ) - b z2 ( z2 Z2 - z3 Z3 ) - a ( - 4 z2 Z2 z3 + 2 z3<sup>2</sup> Z3 ) )  
( - 2 G Z2<sup>2</sup> z3 - Z3 + Z3 ( B Z2 z3 + b z2 Z3 ) - B Z2 ( z2 Z2 - z3 Z3 ) - a ( - 4 z2 Z2 Z3 + 2 z3 Z3<sup>2</sup> ) )**



In[ ]:= **Expand[%106]**

Out[ ]:= 
$$\begin{aligned} & -z^2 Z^2 + 12 a^2 z^2 Z^3 Z^3 + 3 b B z^2 Z^3 Z^3 + 16 a^3 z^2 Z^4 Z^4 + 4 a b B z^2 Z^4 Z^4 + 6 a B z^2 Z^3 Z^3 + \\ & 6 b G z^2 Z^3 Z^3 + 24 a^2 B z^2 Z^4 Z^4 + 4 b B^2 z^2 Z^4 Z^4 + 8 a b G z^2 Z^4 Z^4 + 3 B^2 z^2 Z^3 Z^3 - \\ & 12 a G z^2 Z^3 Z^3 + 12 a B^2 z^2 Z^4 Z^4 + 12 b B G z^2 Z^4 Z^4 + 4 B^3 z^2 Z^4 Z^4 - 8 a B G z^2 Z^4 Z^4 + \\ & 8 b G^2 z^2 Z^4 Z^4 + 4 B^2 G z^2 Z^4 Z^4 - 16 a G^2 Z^4 Z^4 + 6 a b z^2 Z^3 Z^3 + 6 B g z^2 Z^3 Z^3 + \\ & 24 a^2 b z^2 Z^4 Z^3 + 4 b^2 B z^2 Z^4 Z^3 + 8 a B g z^2 Z^4 Z^3 - z^3 Z^3 + 3 b B z^2 Z^2 z^3 Z^3 + \\ & 12 g G z^2 Z^2 z^3 Z^3 - 80 a^3 z^2 Z^3 Z^3 z^3 Z^3 + 8 B^2 g z^2 Z^3 Z^3 z^3 Z^3 + 8 b^2 G z^2 Z^3 Z^3 z^3 Z^3 + \\ & 16 a g G z^2 Z^3 Z^3 z^3 Z^3 - 72 a^2 B z^2 Z^2 Z^3 z^3 Z^3 - 48 a b G z^2 Z^2 Z^3 z^3 Z^3 + 24 B g G z^2 Z^2 Z^3 z^3 Z^3 + \\ & 3 B^2 Z^2 z^3 Z^3 Z^3 - 12 a G Z^2 z^3 Z^3 Z^3 - 32 a B^2 z^2 Z^3 z^3 Z^3 + 48 a^2 G z^2 Z^2 z^3 Z^3 Z^3 - \\ & 16 b B G z^2 Z^2 z^3 Z^3 Z^3 + 16 g G^2 z^2 Z^2 z^3 Z^3 Z^3 - 4 B^3 Z^2 z^3 Z^4 Z^3 + 8 a B G Z^2 z^3 Z^4 Z^3 - \\ & 8 b G^2 Z^2 z^3 Z^4 Z^3 + 3 b^2 Z^2 z^3 Z^2 Z^3 - 12 a g z^2 Z^2 Z^3 Z^2 + 12 a b^2 z^2 Z^4 Z^2 Z^3 + 12 b B g z^2 Z^4 Z^2 Z^3 - \\ & 72 a^2 b z^2 Z^3 Z^2 z^3 Z^3 - 48 a B g z^2 Z^3 Z^2 z^3 Z^3 + 24 b g G z^2 Z^3 Z^2 z^3 Z^3 + 3 b B z^2 Z^2 z^3 Z^3 Z^2 + \\ & 12 g G z^2 Z^2 z^3 Z^3 Z^2 + 96 a^3 z^2 Z^2 Z^2 z^3 Z^3 Z^2 - 24 a b B z^2 Z^2 Z^3 Z^3 Z^2 - 12 B^2 g z^2 Z^2 Z^2 z^3 Z^3 Z^2 - \\ & 12 b^2 G z^2 Z^2 Z^2 z^3 Z^3 Z^2 - 96 a g G z^2 Z^2 Z^2 z^3 Z^3 Z^2 - 6 a B Z^2 z^3 Z^3 Z^3 - 6 b G Z^2 z^3 Z^3 Z^2 + \\ & 72 a^2 B z^2 Z^2 z^3 Z^3 Z^2 + 48 a b G z^2 Z^2 z^3 Z^3 Z^2 - 24 B g G z^2 Z^2 z^3 Z^3 Z^2 + 12 a B^2 Z^2 z^3 Z^4 Z^2 + \\ & 12 b B G Z^2 z^3 Z^4 Z^2 + 4 b^3 z^2 Z^4 Z^2 Z^3 - 8 a b g z^2 Z^4 Z^2 Z^3 + 8 B g^2 z^2 Z^4 Z^2 Z^3 + 3 b^2 z^2 Z^2 z^3 Z^3 - \\ & 12 a g z^2 Z^2 z^3 Z^3 - 32 a b^2 z^2 Z^2 z^3 Z^3 + 48 a^2 g z^2 Z^2 z^3 Z^3 - 16 b B g z^2 Z^2 z^3 Z^3 + \\ & 16 g^2 G z^2 Z^2 z^3 Z^3 - 6 a b z^2 Z^2 z^3 Z^3 - 6 B g z^2 Z^2 z^3 Z^3 + 72 a^2 b z^2 Z^2 z^3 Z^3 + \\ & 48 a B g z^2 Z^2 z^3 Z^3 - 24 b g G z^2 Z^2 z^3 Z^3 + 12 a^2 z^3 Z^3 Z^3 + 3 b B z^3 Z^3 Z^3 - \\ & 80 a^3 z^2 Z^2 z^3 Z^3 Z^3 + 8 B^2 g z^2 Z^2 z^3 Z^3 Z^3 + 8 b^2 G z^2 Z^2 z^3 Z^3 Z^3 + 16 a g G z^2 Z^2 z^3 Z^3 Z^3 - \\ & 24 a^2 B Z^2 z^3 Z^4 Z^3 - 4 b B^2 Z^2 z^3 Z^4 Z^3 - 8 a b G Z^2 z^3 Z^4 Z^3 + 4 b^2 g z^2 Z^4 Z^3 - 16 a g^2 z^2 Z^4 Z^3 - \\ & 4 b^3 z^2 Z^3 z^3 Z^4 + 8 a b g z^2 Z^3 z^3 Z^4 - 8 B g^2 z^2 Z^3 z^3 Z^4 + 12 a b^2 z^2 Z^2 z^3 Z^4 + 12 b B g z^2 Z^2 z^3 Z^4 - \\ & 24 a^2 b z^2 Z^3 Z^4 - 4 b^2 B z^2 Z^3 Z^4 - 8 a B g z^2 Z^3 Z^4 + 16 a^3 z^3 Z^4 Z^4 + 4 a b B z^3 Z^4 Z^4 \end{aligned}$$

In[ ]:= **H22 :=  $(-z^2 * Z^2 - z^3 Z^3) / 4$**

In[ ]:= **f30 f32 - f20 f33 /. {f2 → F2, f22 → F22, f23 → F23, f20 → F20, f3 → F3, f30 → F30, f32 → F32, f33 → F33}**

Out[ ]:= 
$$\begin{aligned} & -(-1 + 2 B Z^2 z^3 + 2 b z^2 Z^3 - a(-4 z^2 Z^2 + 4 z^3 Z^3)) \\ & (-z^2 - 2 G Z^2 z^3 - z^2 (B Z^2 z^3 + b z^2 Z^3) - B z^3 (z^2 Z^2 - z^3 Z^3) - a(2 z^2 Z^2 - 4 z^2 z^3 Z^3)) + \\ & (-B z^2 Z^2 - 4 G Z^2 z^3 + 4 a z^2 Z^3 + B z^3 Z^3 - B(z^2 Z^2 - z^3 Z^3)) \\ & (-z^3 - 2 g z^2 Z^3 + z^3 (B Z^2 z^3 + b z^2 Z^3) - b z^2 (z^2 Z^2 - z^3 Z^3) - a(-4 z^2 Z^2 z^3 + 2 z^3 Z^3)) \end{aligned}$$

In[ ]:= **Expand[%109]**

Out[ ]:= 
$$\begin{aligned} & -z^2 + 2 a z^2 Z^2 + 8 a^2 z^2 Z^3 Z^2 + 2 b B z^2 Z^3 Z^2 + 2 B z^2 Z^2 z^3 + \\ & 4 a B z^2 Z^2 z^3 + 4 b G z^2 Z^2 z^3 + 2 G Z^2 z^3 Z^2 + 2 B^2 z^2 Z^2 z^3 - 8 a G z^2 Z^2 z^3 + \\ & b z^2 Z^3 + 4 a b z^2 Z^3 Z^3 + 4 B g z^2 Z^3 Z^3 - 4 a z^2 z^3 Z^3 - 8 a^2 z^2 Z^2 z^3 Z^3 + \\ & 8 g G z^2 Z^2 z^3 Z^3 - B z^3 Z^3 Z^3 - 4 a B z^2 Z^2 z^3 Z^3 - 4 b G z^2 Z^2 z^3 Z^3 + 2 b^2 z^2 Z^3 Z^3 - \\ & 8 a g z^2 Z^3 Z^3 - 4 a b z^2 Z^3 Z^3 - 4 B g z^2 Z^3 Z^3 + 8 a^2 z^2 Z^3 Z^3 + 2 b B z^2 Z^3 Z^3 \end{aligned}$$

In[ ]:= **H23 :=  $(-z^2 + 2 a z^2 Z^2 + 2 B z^2 Z^2 z^3 + 2 G Z^2 z^3 Z^2 + b z^2 Z^3 - 4 a z^2 z^3 Z^3 - B z^3 Z^3) / 4$**

$\text{In}[\#] := \mathbf{f20\ f23 - f22\ f30\ /. \{f2 \rightarrow F2, f22 \rightarrow F22, f23 \rightarrow F23, f20 \rightarrow F20, f3 \rightarrow F3, f30 \rightarrow F30, f32 \rightarrow F32, f33 \rightarrow F33\}}$

$\text{Out}[\#] = (-b\ z2\ Z2 + 4\ a\ Z2\ z3 - 4\ g\ z2\ Z3 + b\ z3\ Z3 - b\ (z2\ Z2 - z3\ Z3))$   
 $(-z2 - 2\ G\ Z2\ z3^2 - z2\ (B\ Z2\ z3 + b\ z2\ Z3) - B\ z3\ (z2\ Z2 - z3\ Z3) - a\ (2\ z2^2\ Z2 - 4\ z2\ z3\ Z3)) -$   
 $(-1 - 2\ B\ Z2\ z3 - 2\ b\ z2\ Z3 - a\ (4\ z2\ Z2 - 4\ z3\ Z3))$   
 $(-z3 - 2\ g\ z2^2\ Z3 + z3\ (B\ Z2\ z3 + b\ z2\ Z3) - b\ z2\ (z2\ Z2 - z3\ Z3) - a\ (-4\ z2\ Z2\ z3 + 2\ z3^2\ Z3))$

$\text{In}[\#] := \mathbf{Expand[\%112]}$

$\text{Out}[\#] = b\ z2^2\ Z2 - z3 - 4\ a\ z2\ Z2\ z3 + 8\ a^2\ z2^2\ Z2^2\ z3 + 2\ b\ B\ z2^2\ Z2^2\ z3 - B\ Z2\ z3^2 +$   
 $4\ a\ B\ z2\ Z2^2\ z3^2 + 4\ b\ G\ z2\ Z2^2\ z3^2 + 2\ B^2\ Z2^2\ z3^3 - 8\ a\ G\ Z2^2\ z3^3 + 2\ g\ z2^2\ Z3 -$   
 $2\ b\ z2\ z3\ Z3 + 4\ a\ b\ z2^2\ Z2\ z3\ Z3 + 4\ B\ g\ z2^2\ Z2\ z3\ Z3 + 2\ a\ z3^2\ Z3 - 8\ a^2\ z2\ Z2\ z3^2\ Z3 +$   
 $8\ g\ G\ z2\ Z2\ z3^2\ Z3 - 4\ a\ B\ Z2\ z3^3\ Z3 - 4\ b\ G\ Z2\ z3^3\ Z3 + 2\ b^2\ z2^2\ z3\ Z3^2 -$   
 $8\ a\ g\ z2^2\ z3\ Z3^2 - 4\ a\ b\ z2\ z3^2\ Z3^2 - 4\ B\ g\ z2\ z3^2\ Z3^2 + 8\ a^2\ z3^3\ Z3^2 + 2\ b\ B\ z3^3\ Z3^2$

$\text{In}[\#] := \mathbf{H24 := (b\ z2^2\ Z2 - z3 - 4\ a\ z2\ Z2\ z3 - B\ Z2\ z3^2 + 2\ g\ z2^2\ Z3 - 2\ b\ z2\ z3\ Z3 + 2\ a\ z3^2\ Z3) / 4}$

$\text{In}[\#] := \mathbf{H31 := 0}$

$\text{In}[\#] := \mathbf{f23\ f3 - f2\ f33\ /. \{f2 \rightarrow F2, f22 \rightarrow F22, f23 \rightarrow F23, f20 \rightarrow F20, f3 \rightarrow F3, f30 \rightarrow F30, f32 \rightarrow F32, f33 \rightarrow F33\}}$

$\text{Out}[\#] = (-1 + 2\ B\ Z2\ z3 + 2\ b\ z2\ Z3 - a\ (-4\ z2\ Z2 + 4\ z3\ Z3))$   
 $(-Z2 - 2\ g\ z2\ Z3^2 - Z2\ (B\ Z2\ z3 + b\ z2\ Z3) - b\ z3\ (z2\ Z2 - z3\ Z3) - a\ (2\ z2\ Z2^2 - 4\ Z2\ z3\ Z3)) +$   
 $(-b\ z2\ Z2 + 4\ a\ Z2\ z3 - 4\ g\ z2\ Z3 + b\ z3\ Z3 - b\ (z2\ Z2 - z3\ Z3))$   
 $(-2\ G\ Z2^2\ z3 - Z3 + Z3\ (B\ Z2\ z3 + b\ z2\ Z3) - B\ Z2\ (z2\ Z2 - z3\ Z3) - a\ (-4\ z2\ Z2\ Z3 + 2\ z3\ Z3^2))$

$\text{In}[\#] := \mathbf{Expand[\%116]}$

$\text{Out}[\#] = -Z2 + 2\ a\ z2\ Z2^2 + 8\ a^2\ z2^2\ Z2^3 + 2\ b\ B\ z2^2\ Z2^3 + B\ Z2^2\ z3 + 4\ a\ B\ z2\ Z2^3\ z3 +$   
 $4\ b\ G\ z2\ Z2^3\ z3 + 2\ B^2\ Z2^3\ z3^2 - 8\ a\ G\ Z2^3\ z3^2 + 2\ b\ z2\ Z2\ Z3 + 4\ a\ b\ z2^2\ Z2^2\ Z3 +$   
 $4\ B\ g\ z2^2\ Z2^2\ Z3 - 4\ a\ Z2\ z3\ Z3 - 8\ a^2\ z2\ Z2^2\ z3\ Z3 + 8\ g\ G\ z2\ Z2^2\ z3\ Z3 -$   
 $4\ a\ B\ Z2^2\ z3^2\ Z3 - 4\ b\ G\ Z2^2\ z3^2\ Z3 + 2\ g\ z2\ Z3^2 + 2\ b^2\ z2^2\ Z2\ Z3^2 - 8\ a\ g\ z2^2\ Z2\ Z3^2 -$   
 $b\ z3\ Z3^2 - 4\ a\ b\ z2\ Z2\ z3\ Z3^2 - 4\ B\ g\ z2\ Z2\ z3\ Z3^2 + 8\ a^2\ Z2\ z3^2\ Z3^2 + 2\ b\ B\ Z2\ z3^2\ Z3^2$

$\text{In}[\#] := \mathbf{H32 := (-Z2 + 2\ a\ z2\ Z2^2 + B\ Z2^2\ z3 + 2\ b\ z2\ Z2\ Z3 - 4\ a\ Z2\ z3\ Z3 + 2\ g\ z2\ Z3^2 - b\ z3\ Z3^2) / 4}$

$\text{In}[\#] := \mathbf{H32}$

$\text{Out}[\#] = \frac{1}{4} (-Z2 + 2\ a\ z2\ Z2^2 + B\ Z2^2\ z3 + 2\ b\ z2\ Z2\ Z3 - 4\ a\ Z2\ z3\ Z3 + 2\ g\ z2\ Z3^2 - b\ z3\ Z3^2)$

$\text{In}[\#] := \mathbf{H23}$

$\text{Out}[\#] = \frac{1}{4} (-Z2 + 2\ a\ z2^2\ Z2 + 2\ B\ z2\ Z2\ z3 + 2\ G\ Z2\ z3^2 + b\ z2^2\ Z3 - 4\ a\ z2\ z3\ Z3 - B\ z3^2\ Z3)$

$\text{In}[\#] := \mathbf{F33 / 4}$

$\text{Out}[\#] = \frac{1}{4} (-1 + 2\ B\ Z2\ z3 + 2\ b\ z2\ Z3 - a\ (-4\ z2\ Z2 + 4\ z3\ Z3))$

$$\text{In[*]:= Expand}\left[\frac{1}{4} \left(-1 + 2 B Z^2 z^3 + 2 b z^2 Z^3 - a \left(-4 z^2 Z^2 + 4 z^3 Z^3\right)\right)\right]$$

$$\text{Out[*]} = -\frac{1}{4} + a z^2 Z^2 + \frac{B Z^2 z^3}{2} + \frac{b z^2 Z^3}{2} - a z^3 Z^3$$

$$\text{In[*]:= H33 := } -\frac{1}{4} + a z^2 Z^2 + \frac{B Z^2 z^3}{2} + \frac{b z^2 Z^3}{2} - a z^3 Z^3$$

$$\text{In[*]:= H33}$$

$$\text{Out[*]} = -\frac{1}{4} + a z^2 Z^2 + \frac{B Z^2 z^3}{2} + \frac{b z^2 Z^3}{2} - a z^3 Z^3$$

$$\text{In[*]:= } -F23 / 4$$

$$\text{Out[*]} = \frac{1}{4} \left(b z^2 Z^2 - 4 a Z^2 z^3 + 4 g z^2 Z^3 - b z^3 Z^3 + b \left(z^2 Z^2 - z^3 Z^3\right)\right)$$

$$\text{In[*]:= Expand}\left[\frac{1}{4} \left(b z^2 Z^2 - 4 a Z^2 z^3 + 4 g z^2 Z^3 - b z^3 Z^3 + b \left(z^2 Z^2 - z^3 Z^3\right)\right)\right]$$

$$\text{Out[*]} = \frac{b z^2 Z^2}{2} - a Z^2 z^3 + g z^2 Z^3 - \frac{b z^3 Z^3}{2}$$

$$\text{In[*]:= H34 := } \frac{b z^2 Z^2}{2} - a Z^2 z^3 + g z^2 Z^3 - \frac{b z^3 Z^3}{2}$$

$$\text{In[*]:= H41 := 0}$$

$$\text{In[*]:= } -f22 f3 + f2 f32 /. \{f2 \rightarrow F2, f22 \rightarrow F22, f23 \rightarrow F23, \\ f20 \rightarrow F20, f3 \rightarrow F3, f30 \rightarrow F30, f32 \rightarrow F32, f33 \rightarrow F33\}$$

$$\begin{aligned} \text{Out[*]} = & \left(-B z^2 Z^2 - 4 G Z^2 z^3 + 4 a z^2 Z^3 + B z^3 Z^3 - B \left(z^2 Z^2 - z^3 Z^3\right)\right) \\ & \left(-Z^2 - 2 g z^2 Z^2 - Z^2 \left(B Z^2 z^3 + b z^2 Z^3\right) - b Z^3 \left(z^2 Z^2 - z^3 Z^3\right) - a \left(2 z^2 Z^2 - 4 Z^2 z^3 Z^3\right)\right) - \\ & \left(-1 - 2 B Z^2 z^3 - 2 b z^2 Z^3 - a \left(4 z^2 Z^2 - 4 z^3 Z^3\right)\right) \\ & \left(-2 G Z^2 z^3 - Z^3 + Z^3 \left(B Z^2 z^3 + b z^2 Z^3\right) - B Z^2 \left(z^2 Z^2 - z^3 Z^3\right) - a \left(-4 z^2 Z^2 Z^3 + 2 z^3 Z^3^2\right)\right) \end{aligned}$$

$$\text{In[*]:= Expand[ \%129 ]}$$

$$\begin{aligned} \text{Out[*]} = & B z^2 Z^2 + 2 G Z^2 z^3 - Z^3 - 4 a z^2 Z^2 Z^3 + 8 a^2 z^2 Z^2 Z^2 Z^3 + 2 b B z^2 Z^2 Z^2 Z^3 - \\ & 2 B Z^2 z^3 Z^3 + 4 a B z^2 Z^2 z^3 Z^3 + 4 b G z^2 Z^2 z^3 Z^3 + 2 B^2 Z^2 z^3 Z^2 Z^3 - \\ & 8 a G Z^2 z^3 Z^2 Z^3 - b z^2 Z^3 + 4 a b z^2 Z^2 Z^2 Z^3 + 4 B g z^2 Z^2 Z^2 Z^3 + 2 a z^3 Z^3 - \\ & 8 a^2 z^2 Z^2 z^3 Z^3 + 8 g G z^2 Z^2 z^3 Z^3 - 4 a B Z^2 z^3 Z^2 Z^3 - 4 b G Z^2 z^3 Z^2 Z^3 + 2 b^2 z^2 Z^2 Z^3 - \\ & 8 a g z^2 Z^3 - 4 a b z^2 z^3 Z^3 - 4 B g z^2 z^3 Z^3 + 8 a^2 z^3 Z^3 + 2 b B z^3 Z^3 \end{aligned}$$

$$\text{In[*]:= H42 := } \left(B z^2 Z^2 + 2 G Z^2 z^3 - Z^3 - 4 a z^2 Z^2 Z^3 - 2 B Z^2 z^3 Z^3 - b z^2 Z^3 + 2 a z^3 Z^3\right) / 4$$

$$\text{In[*]:= H42}$$

$$\text{Out[*]} = \frac{1}{4} \left(B z^2 Z^2 + 2 G Z^2 z^3 - Z^3 - 4 a z^2 Z^2 Z^3 - 2 B Z^2 z^3 Z^3 - b z^2 Z^3 + 2 a z^3 Z^3\right)$$

$$\text{In}[\#] := \text{Expand} \left[ \frac{1}{4} \left( B z^2 Z^2 + 2 G Z^2 z^3 - Z^3 - 4 a z^2 Z^2 Z^3 - 2 B Z^2 z^3 Z^3 - b z^2 Z^3 + 2 a z^3 Z^3 \right) \right]$$

$$\text{Out}[\#] = \frac{1}{4} B z^2 Z^2 + \frac{1}{2} G Z^2 z^3 - \frac{Z^3}{4} - a z^2 Z^2 Z^3 - \frac{1}{2} B Z^2 z^3 Z^3 - \frac{1}{4} b z^2 Z^3 + \frac{1}{2} a z^3 Z^3$$

$$\text{In}[\#] := \text{H24}$$

$$\text{Out}[\#] = \frac{1}{4} \left( b z^2 Z^2 - z^3 - 4 a z^2 Z^2 z^3 - B Z^2 z^3 + 2 g z^2 Z^3 - 2 b z^2 z^3 Z^3 + 2 a z^3 Z^3 \right)$$

$$\text{In}[\#] := \text{Expand} \left[ \frac{1}{4} \left( b z^2 Z^2 - z^3 - 4 a z^2 Z^2 z^3 - B Z^2 z^3 + 2 g z^2 Z^3 - 2 b z^2 z^3 Z^3 + 2 a z^3 Z^3 \right) \right]$$

$$\text{Out}[\#] = \frac{1}{4} b z^2 Z^2 - \frac{z^3}{4} - a z^2 Z^2 z^3 - \frac{1}{4} B Z^2 z^3 + \frac{1}{2} g z^2 Z^3 - \frac{1}{2} b z^2 z^3 Z^3 + \frac{1}{2} a z^3 Z^3$$

$$\text{In}[\#] := -\text{F32} / 4$$

$$\text{Out}[\#] = \frac{1}{4} \left( B z^2 Z^2 + 4 G Z^2 z^3 - 4 a z^2 Z^3 - B z^3 Z^3 + B \left( z^2 Z^2 - z^3 Z^3 \right) \right)$$

$$\text{In}[\#] := \text{Expand} \left[ \frac{1}{4} \left( B z^2 Z^2 + 4 G Z^2 z^3 - 4 a z^2 Z^3 - B z^3 Z^3 + B \left( z^2 Z^2 - z^3 Z^3 \right) \right) \right]$$

$$\text{Out}[\#] = \frac{B z^2 Z^2}{2} + G Z^2 z^3 - a z^2 Z^3 - \frac{B z^3 Z^3}{2}$$

$$\text{In}[\#] := \text{H43} := \frac{B z^2 Z^2}{2} + G Z^2 z^3 - a z^2 Z^3 - \frac{B z^3 Z^3}{2}$$

$$\text{In}[\#] := \text{H34}$$

$$\text{Out}[\#] = \frac{b z^2 Z^2}{2} - a z^2 Z^3 + g z^2 Z^3 - \frac{b z^3 Z^3}{2}$$

$$\text{In}[\#] := \text{F22} / 4$$

$$\text{Out}[\#] = \frac{1}{4} \left( -1 - 2 B Z^2 z^3 - 2 b z^2 Z^3 - a \left( 4 z^2 Z^2 - 4 z^3 Z^3 \right) \right)$$

$$\text{In}[\#] := \text{Expand} \left[ \frac{1}{4} \left( -1 - 2 B Z^2 z^3 - 2 b z^2 Z^3 - a \left( 4 z^2 Z^2 - 4 z^3 Z^3 \right) \right) \right]$$

$$\text{Out}[\#] = -\frac{1}{4} - a z^2 Z^2 - \frac{B Z^2 z^3}{2} - \frac{b z^2 Z^3}{2} + a z^3 Z^3$$

$$\text{In}[\#] := \text{H44} := -\frac{1}{4} - a z^2 Z^2 - \frac{B Z^2 z^3}{2} - \frac{b z^2 Z^3}{2} + a z^3 Z^3$$

$$\text{In}[\#] := \text{Ainultimate} := \{ \{ \text{H11}, \text{H12}, \text{H13}, \text{H14} \}, \{ \text{H21}, \text{H22}, \text{H23}, \text{H24} \}, \{ \text{H31}, \text{H32}, \text{H33}, \text{H34} \}, \{ \text{H41}, \text{H42}, \text{H43}, \text{H44} \} \}$$

In[ ]:= **Ainvultimate**

$$\text{Out[ ]} = \left\{ \{0, i, 0, 0\}, \left\{ -i, \frac{1}{4} (-z2 Z2 - z3 Z3), \right. \right. \\ \frac{1}{4} (-z2 + 2 a z2^2 Z2 + 2 B z2 Z2 z3 + 2 G Z2 z3^2 + b z2^2 Z3 - 4 a z2 z3 Z3 - B z3^2 Z3), \\ \frac{1}{4} (b z2^2 Z2 - z3 - 4 a z2 Z2 z3 - B Z2 z3^2 + 2 g z2^2 Z3 - 2 b z2 z3 Z3 + 2 a z3^2 Z3) \left. \right\}, \\ \left\{ 0, \frac{1}{4} (-Z2 + 2 a z2 Z2^2 + B Z2^2 z3 + 2 b z2 Z2 Z3 - 4 a Z2 z3 Z3 + 2 g z2 Z3^2 - b z3 Z3^2), \right. \\ -\frac{1}{4} + a z2 Z2 + \frac{B Z2 z3}{2} + \frac{b z2 Z3}{2} - a z3 Z3, \frac{b z2 Z2}{2} - a Z2 z3 + g z2 Z3 - \frac{b z3 Z3}{2} \left. \right\}, \\ \left\{ 0, \frac{1}{4} (B z2 Z2^2 + 2 G Z2^2 z3 - Z3 - 4 a z2 Z2 Z3 - 2 B Z2 z3 Z3 - b z2 Z3^2 + 2 a z3 Z3^2), \right. \\ \frac{B z2 Z2}{2} + G Z2 z3 - a z2 Z3 - \frac{B z3 Z3}{2}, -\frac{1}{4} - a z2 Z2 - \frac{B Z2 z3}{2} - \frac{b z2 Z3}{2} + a z3 Z3 \left. \right\} \}$$

In[ ]:= **MatrixForm[%144]**

$$\text{Out[ ]/MatrixForm} = \begin{pmatrix} 0 & i & \frac{1}{4} (-z2 Z2 - z3 Z3) & \frac{1}{4} (-z2 + 2 a z2^2 Z2 + 2 B z2 Z2 z3 + 2 G Z2 z3^2 + b z2^2 Z3 - 4 a z2 z3 Z3 - B z3^2 Z3) \\ -i & \frac{1}{4} (-Z2 + 2 a z2 Z2^2 + B Z2^2 z3 + 2 b z2 Z2 Z3 - 4 a Z2 z3 Z3 + 2 g z2 Z3^2 - b z3 Z3^2) & -\frac{1}{4} + a z2 Z2 + \frac{B Z2 z3}{2} + \frac{b z2 Z3}{2} - a z3 Z3 & \frac{b z2 Z2}{2} - a Z2 z3 + g z2 Z3 - \frac{b z3 Z3}{2} \\ 0 & \frac{1}{4} (B z2 Z2^2 + 2 G Z2^2 z3 - Z3 - 4 a z2 Z2 Z3 - 2 B Z2 z3 Z3 - b z2 Z3^2 + 2 a z3 Z3^2) & \frac{B z2 Z2}{2} + G Z2 z3 - a z2 Z3 - \frac{B z3 Z3}{2} & -\frac{1}{4} - a z2 Z2 - \frac{B Z2 z3}{2} - \frac{b z2 Z3}{2} + a z3 Z3 \end{pmatrix}$$

In[ ]:= **q**

$$\text{Out[ ]} = \{p0, i, p2, p3\}$$

In[ ]:= **Q**

$$\text{Out[ ]} = \{p0, -i, P2, P3\}$$

In[ ]:= **q.Ainvultimate.Q**

$$\text{Out[ ]} = p0 + \\ p3 \left( p3 \left( -\frac{1}{4} - a z2 Z2 - \frac{B Z2 z3}{2} - \frac{b z2 Z3}{2} + a z3 Z3 \right) + p2 \left( \frac{b z2 Z2}{2} - a Z2 z3 + g z2 Z3 - \frac{b z3 Z3}{2} \right) + \right. \\ \left. \frac{1}{4} i (b z2^2 Z2 - z3 - 4 a z2 Z2 z3 - B Z2 z3^2 + 2 g z2^2 Z3 - 2 b z2 z3 Z3 + 2 a z3^2 Z3) \right) + \\ p2 \left( p2 \left( -\frac{1}{4} + a z2 Z2 + \frac{B Z2 z3}{2} + \frac{b z2 Z3}{2} - a z3 Z3 \right) + p3 \left( \frac{B z2 Z2}{2} + G Z2 z3 - a z2 Z3 - \frac{B z3 Z3}{2} \right) + \right. \\ \left. \frac{1}{4} i (-z2 + 2 a z2^2 Z2 + 2 B z2 Z2 z3 + 2 G Z2 z3^2 + b z2^2 Z3 - 4 a z2 z3 Z3 - B z3^2 Z3) \right) - \\ i \left( i p0 + \frac{1}{4} i (-z2 Z2 - z3 Z3) + \right. \\ \left. \frac{1}{4} p3 (B z2 Z2^2 + 2 G Z2^2 z3 - Z3 - 4 a z2 Z2 Z3 - 2 B Z2 z3 Z3 - b z2 Z3^2 + 2 a z3 Z3^2) + \right. \\ \left. \frac{1}{4} p2 (-Z2 + 2 a z2 Z2^2 + B Z2^2 z3 + 2 b z2 Z2 Z3 - 4 a Z2 z3 Z3 + 2 g z2 Z3^2 - b z3 Z3^2) \right)$$

In[ ]:= **Expand[%148]**

$$\begin{aligned} \text{Out[ ]} = & 2 p_0 - \frac{p_2 P_2}{4} - \frac{p_3 P_3}{4} - \frac{i P_2 z_2}{4} + \frac{i p_2 Z_2}{4} - \frac{z_2 Z_2}{4} + a p_2 P_2 z_2 Z_2 + \frac{1}{2} B P_2 p_3 z_2 Z_2 + \\ & \frac{1}{2} b p_2 P_3 z_2 Z_2 - a p_3 P_3 z_2 Z_2 + \frac{1}{2} i a P_2 z_2^2 Z_2 + \frac{1}{4} i b P_3 z_2^2 Z_2 - \frac{1}{2} i a p_2 z_2 Z_2^2 - \\ & \frac{1}{4} i B p_3 z_2 Z_2^2 - \frac{i P_3 z_3}{4} + \frac{1}{2} B p_2 P_2 Z_2 z_3 + G P_2 p_3 Z_2 z_3 - a p_2 P_3 Z_2 z_3 - \\ & \frac{1}{2} B p_3 P_3 Z_2 z_3 + \frac{1}{2} i B P_2 z_2 Z_2 z_3 - i a P_3 z_2 Z_2 z_3 - \frac{1}{4} i B p_2 Z_2^2 z_3 - \frac{1}{2} i G p_3 Z_2^2 z_3 + \\ & \frac{1}{2} i G P_2 Z_2 z_3^2 - \frac{1}{4} i B P_3 Z_2 z_3^2 + \frac{i p_3 Z_3}{4} + \frac{1}{2} b p_2 P_2 z_2 Z_3 - a P_2 p_3 z_2 Z_3 + \\ & g p_2 P_3 z_2 Z_3 - \frac{1}{2} b p_3 P_3 z_2 Z_3 + \frac{1}{4} i b P_2 z_2^2 Z_3 + \frac{1}{2} i g P_3 z_2^2 Z_3 - \frac{1}{2} i b p_2 z_2 Z_2 Z_3 + \\ & i a p_3 z_2 Z_2 Z_3 - \frac{z_3 Z_3}{4} - a p_2 P_2 z_3 Z_3 - \frac{1}{2} B P_2 p_3 z_3 Z_3 - \frac{1}{2} b p_2 P_3 z_3 Z_3 + a p_3 P_3 z_3 Z_3 - \\ & i a P_2 z_2 z_3 Z_3 - \frac{1}{2} i b P_3 z_2 z_3 Z_3 + i a p_2 Z_2 z_3 Z_3 + \frac{1}{2} i B p_3 Z_2 z_3 Z_3 - \frac{1}{4} i B P_2 z_3^2 Z_3 + \\ & \frac{1}{2} i a P_3 z_3^2 Z_3 - \frac{1}{2} i g p_2 z_2 Z_3^2 + \frac{1}{4} i b p_3 z_2 Z_3^2 + \frac{1}{4} i b p_2 z_3 Z_3^2 - \frac{1}{2} i a p_3 z_3 Z_3^2 \end{aligned}$$

In[ ]:= **ClearAll[H]**

$$\begin{aligned} \text{In[ ]} := H := & 2 p_0 - \frac{p_2 P_2}{4} - \frac{p_3 P_3}{4} - \frac{i P_2 z_2}{4} + \frac{i p_2 Z_2}{4} - \frac{z_2 Z_2}{4} + a p_2 P_2 z_2 Z_2 + \frac{1}{2} B P_2 p_3 z_2 Z_2 + \\ & \frac{1}{2} b p_2 P_3 z_2 Z_2 - a p_3 P_3 z_2 Z_2 + \frac{1}{2} i a P_2 z_2^2 Z_2 + \frac{1}{4} i b P_3 z_2^2 Z_2 - \frac{1}{2} i a p_2 z_2 Z_2^2 - \\ & \frac{1}{4} i B p_3 z_2 Z_2^2 - \frac{i P_3 z_3}{4} + \frac{1}{2} B p_2 P_2 Z_2 z_3 + G P_2 p_3 Z_2 z_3 - a p_2 P_3 Z_2 z_3 - \\ & \frac{1}{2} B p_3 P_3 Z_2 z_3 + \frac{1}{2} i B P_2 z_2 Z_2 z_3 - i a P_3 z_2 Z_2 z_3 - \frac{1}{4} i B p_2 Z_2^2 z_3 - \frac{1}{2} i G p_3 Z_2^2 z_3 + \\ & \frac{1}{2} i G P_2 Z_2 z_3^2 - \frac{1}{4} i B P_3 Z_2 z_3^2 + \frac{i p_3 Z_3}{4} + \frac{1}{2} b p_2 P_2 z_2 Z_3 - a P_2 p_3 z_2 Z_3 + \\ & g p_2 P_3 z_2 Z_3 - \frac{1}{2} b p_3 P_3 z_2 Z_3 + \frac{1}{4} i b P_2 z_2^2 Z_3 + \frac{1}{2} i g P_3 z_2^2 Z_3 - \frac{1}{2} i b p_2 z_2 Z_2 Z_3 + \\ & i a p_3 z_2 Z_2 Z_3 - \frac{z_3 Z_3}{4} - a p_2 P_2 z_3 Z_3 - \frac{1}{2} B P_2 p_3 z_3 Z_3 - \frac{1}{2} b p_2 P_3 z_3 Z_3 + a p_3 P_3 z_3 Z_3 - \\ & i a P_2 z_2 z_3 Z_3 - \frac{1}{2} i b P_3 z_2 z_3 Z_3 + i a p_2 Z_2 z_3 Z_3 + \frac{1}{2} i B p_3 Z_2 z_3 Z_3 - \frac{1}{4} i B P_2 z_3^2 Z_3 + \\ & \frac{1}{2} i a P_3 z_3^2 Z_3 - \frac{1}{2} i g p_2 z_2 Z_3^2 + \frac{1}{4} i b p_3 z_2 Z_3^2 + \frac{1}{4} i b p_2 z_3 Z_3^2 - \frac{1}{2} i a p_3 z_3 Z_3^2 \end{aligned}$$

In[ ]:= **H /. {a → 0, b → 0, B → 0, g → 0, G → 0}**

$$\text{Out[ ]} = 2 p_0 - \frac{p_2 P_2}{4} - \frac{p_3 P_3}{4} - \frac{i P_2 z_2}{4} + \frac{i p_2 Z_2}{4} - \frac{z_2 Z_2}{4} - \frac{i P_3 z_3}{4} + \frac{i p_3 Z_3}{4} - \frac{z_3 Z_3}{4}$$

In[ ]:= **ClearAll[dz2, dp2, dz3, dp3]**

In[ ]:= **dz2 := 2 \* D[H, P2]**

In[ ]:= **dp2 := -2 \* D[H, Z2]**

In[ ]:= **dz3 := 2 \* D[H, P3]**

In[ ]:= **dp3 := -2 \* D[H, Z3]**

In[ ]:= **dz2**

$$\text{Out[ ]}= 2 \left( -\frac{p2}{4} - \frac{i z2}{4} + a p2 z2 Z2 + \frac{1}{2} B p3 z2 Z2 + \frac{1}{2} i a z2^2 Z2 + \right. \\ \left. \frac{1}{2} B p2 Z2 z3 + G p3 Z2 z3 + \frac{1}{2} i B z2 Z2 z3 + \frac{1}{2} i G Z2 z3^2 + \frac{1}{2} b p2 z2 Z3 - \right. \\ \left. a p3 z2 Z3 + \frac{1}{4} i b z2^2 Z3 - a p2 z3 Z3 - \frac{1}{2} B p3 z3 Z3 - i a z2 z3 Z3 - \frac{1}{4} i B z3^2 Z3 \right)$$

In[ ]:= **Expand[%159]**

$$\text{Out[ ]}= -\frac{p2}{2} - \frac{i z2}{2} + 2 a p2 z2 Z2 + B p3 z2 Z2 + i a z2^2 Z2 + B p2 Z2 z3 + \\ 2 G p3 Z2 z3 + i B z2 Z2 z3 + i G Z2 z3^2 + b p2 z2 Z3 - 2 a p3 z2 Z3 + \\ \frac{1}{2} i b z2^2 Z3 - 2 a p2 z3 Z3 - B p3 z3 Z3 - 2 i a z2 z3 Z3 - \frac{1}{2} i B z3^2 Z3$$

In[ ]:= **1 /. {z2 → z2st, Z2 → Z2st, p2 → p2st, P2 → P2st, z3 → z3st, Z3 → Z3st, p3 → p3st, P3 → P3st}**

Out[ ]= 1

In[ ]:= **dz2 /. {a → 0, b → 0, B → 0, g → 0, G → 0}**

$$\text{Out[ ]}= 2 \left( -\frac{p2}{4} - \frac{i z2}{4} \right)$$

In[ ]:= **Expand[2 (- $\frac{p2}{4}$  -  $\frac{i z2}{4}$ )]**

$$\text{Out[ ]}= -\frac{p2}{2} - \frac{i z2}{2}$$

$\text{In}[*]:= \text{dz2} /. \{z2 \rightarrow z2\text{st}, Z2 \rightarrow Z2\text{st}, p2 \rightarrow p2\text{st},$

$P2 \rightarrow P2\text{st}, z3 \rightarrow z3\text{st}, Z3 \rightarrow Z3\text{st}, p3 \rightarrow p3\text{st}, P3 \rightarrow P3\text{st}\}$

$$\begin{aligned} \text{Out}[*]= & 2 \left( \frac{1}{4} (-p_{21} s - p_{23} s^3) - \frac{1}{4} i (s z_{21} + s^3 z_{23}) + \right. \\ & a (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \\ & \frac{1}{2} B (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \frac{1}{2} i a (s z_{21} + s^3 z_{23})^2 \\ & (s Z_{21} + s^3 Z_{23}) + \frac{1}{2} B (p_{21} s + p_{23} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \\ & G (p_{31} s + p_{33} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \frac{1}{2} i B (s z_{21} + s^3 z_{23}) \\ & (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \frac{1}{2} i G (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33})^2 + \\ & \frac{1}{2} b (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) - \\ & a (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) + \\ & \frac{1}{4} i b (s z_{21} + s^3 z_{23})^2 (s Z_{31} + s^3 Z_{33}) - a (p_{21} s + p_{23} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) - \\ & \frac{1}{2} B (p_{31} s + p_{33} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) - \\ & i a (s z_{21} + s^3 z_{23}) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) - \\ & \left. \frac{1}{4} i B (s z_{31} + s^3 z_{33})^2 (s Z_{31} + s^3 Z_{33}) \right) \end{aligned}$$



In[ ]:= **Expand[%164]**

$$\begin{aligned}
 \text{Out[ ]} = & -\frac{p_{21} s}{2} - \frac{p_{23} s^3}{2} - \frac{i s z_{21}}{2} + 2 a p_{21} s^3 z_{21} Z_{21} + B p_{31} s^3 z_{21} Z_{21} + 2 a p_{23} s^5 z_{21} Z_{21} + \\
 & B p_{33} s^5 z_{21} Z_{21} + i a s^3 z_{21}^2 Z_{21} - \frac{1}{2} i s^3 z_{23} + 2 a p_{21} s^5 Z_{21} z_{23} + B p_{31} s^5 Z_{21} z_{23} + \\
 & 2 a p_{23} s^7 Z_{21} z_{23} + B p_{33} s^7 Z_{21} z_{23} + 2 i a s^5 z_{21} Z_{21} z_{23} + i a s^7 Z_{21} z_{23}^2 + 2 a p_{21} s^5 z_{21} Z_{23} + \\
 & B p_{31} s^5 z_{21} Z_{23} + 2 a p_{23} s^7 z_{21} Z_{23} + B p_{33} s^7 z_{21} Z_{23} + i a s^5 z_{21}^2 Z_{23} + 2 a p_{21} s^7 z_{23} Z_{23} + \\
 & B p_{31} s^7 z_{23} Z_{23} + 2 a p_{23} s^9 z_{23} Z_{23} + B p_{33} s^9 z_{23} Z_{23} + 2 i a s^7 z_{21} z_{23} Z_{23} + \\
 & i a s^9 z_{23}^2 Z_{23} + B p_{21} s^3 Z_{21} z_{31} + 2 G p_{31} s^3 Z_{21} z_{31} + B p_{23} s^5 Z_{21} z_{31} + 2 G p_{33} s^5 Z_{21} z_{31} + \\
 & i B s^3 z_{21} Z_{21} z_{31} + i B s^5 Z_{21} z_{23} z_{31} + B p_{21} s^5 Z_{23} z_{31} + 2 G p_{31} s^5 Z_{23} z_{31} + \\
 & B p_{23} s^7 Z_{23} z_{31} + 2 G p_{33} s^7 Z_{23} z_{31} + i B s^5 z_{21} Z_{23} z_{31} + i B s^7 z_{23} Z_{23} z_{31} + i G s^3 Z_{21} z_{31}^2 + \\
 & i G s^5 Z_{23} z_{31}^2 + b p_{21} s^3 z_{21} Z_{31} - 2 a p_{31} s^3 z_{21} Z_{31} + b p_{23} s^5 z_{21} Z_{31} - 2 a p_{33} s^5 z_{21} Z_{31} + \\
 & \frac{1}{2} i b s^3 z_{21}^2 Z_{31} + b p_{21} s^5 z_{23} Z_{31} - 2 a p_{31} s^5 z_{23} Z_{31} + b p_{23} s^7 z_{23} Z_{31} - 2 a p_{33} s^7 z_{23} Z_{31} + \\
 & i b s^5 z_{21} z_{23} Z_{31} + \frac{1}{2} i b s^7 z_{23}^2 Z_{31} - 2 a p_{21} s^3 z_{31} Z_{31} - B p_{31} s^3 z_{31} Z_{31} - \\
 & 2 a p_{23} s^5 z_{31} Z_{31} - B p_{33} s^5 z_{31} Z_{31} - 2 i a s^3 z_{21} z_{31} Z_{31} - 2 i a s^5 z_{23} z_{31} Z_{31} - \\
 & \frac{1}{2} i B s^3 z_{31}^2 Z_{31} + B p_{21} s^5 Z_{21} z_{33} + 2 G p_{31} s^5 Z_{21} z_{33} + B p_{23} s^7 Z_{21} z_{33} + 2 G p_{33} s^7 Z_{21} z_{33} + \\
 & i B s^5 Z_{21} Z_{21} z_{33} + i B s^7 Z_{21} z_{23} z_{33} + B p_{21} s^7 Z_{23} z_{33} + 2 G p_{31} s^7 Z_{23} z_{33} + \\
 & B p_{23} s^9 Z_{23} z_{33} + 2 G p_{33} s^9 Z_{23} z_{33} + i B s^7 z_{21} Z_{23} z_{33} + i B s^9 z_{23} Z_{23} z_{33} + \\
 & 2 i G s^5 Z_{21} z_{31} z_{33} + 2 i G s^7 Z_{23} z_{31} z_{33} - 2 a p_{21} s^5 Z_{31} z_{33} - B p_{31} s^5 Z_{31} z_{33} - \\
 & 2 a p_{23} s^7 Z_{31} z_{33} - B p_{33} s^7 Z_{31} z_{33} - 2 i a s^5 z_{21} Z_{31} z_{33} - 2 i a s^7 z_{23} Z_{31} z_{33} - \\
 & i B s^5 z_{31} Z_{31} z_{33} + i G s^7 Z_{21} z_{33}^2 + i G s^9 Z_{23} z_{33}^2 - \frac{1}{2} i B s^7 Z_{31} z_{33}^2 + b p_{21} s^5 z_{21} Z_{33} - \\
 & 2 a p_{31} s^5 z_{21} Z_{33} + b p_{23} s^7 z_{21} Z_{33} - 2 a p_{33} s^7 z_{21} Z_{33} + \frac{1}{2} i b s^5 z_{21}^2 Z_{33} + b p_{21} s^7 z_{23} Z_{33} - \\
 & 2 a p_{31} s^7 z_{23} Z_{33} + b p_{23} s^9 z_{23} Z_{33} - 2 a p_{33} s^9 z_{23} Z_{33} + i b s^7 z_{21} z_{23} Z_{33} + \\
 & \frac{1}{2} i b s^9 z_{23}^2 Z_{33} - 2 a p_{21} s^5 z_{31} Z_{33} - B p_{31} s^5 z_{31} Z_{33} - 2 a p_{23} s^7 z_{31} Z_{33} - \\
 & B p_{33} s^7 z_{31} Z_{33} - 2 i a s^5 z_{21} z_{31} Z_{33} - 2 i a s^7 z_{23} z_{31} Z_{33} - \frac{1}{2} i B s^5 z_{31}^2 Z_{33} - \\
 & 2 a p_{21} s^7 z_{33} Z_{33} - B p_{31} s^7 z_{33} Z_{33} - 2 a p_{23} s^9 z_{33} Z_{33} - B p_{33} s^9 z_{33} Z_{33} - \\
 & 2 i a s^7 z_{21} z_{33} Z_{33} - 2 i a s^9 z_{23} z_{33} Z_{33} - i B s^7 z_{31} z_{33} Z_{33} - \frac{1}{2} i B s^9 z_{33}^2 Z_{33}
 \end{aligned}$$

In[ ]:= **Collect**[% , s]

$$\begin{aligned}
 \text{Out[ ]} = & \text{ s } \left( -\frac{\text{p21}}{2} - \frac{\text{i z21}}{2} \right) + \\
 & \text{s}^3 \left( -\frac{\text{p23}}{2} + 2 \text{ a p21 z21 Z21} + \text{B p31 z21 Z21} + \text{i a z21}^2 \text{ Z21} - \frac{\text{i z23}}{2} + \text{B p21 Z21 z31} + \right. \\
 & \quad 2 \text{ G p31 Z21 z31} + \text{i B z21 Z21 z31} + \text{i G Z21 z31}^2 + \text{b p21 z21 Z31} - 2 \text{ a p31 z21 Z31} + \\
 & \quad \left. \frac{1}{2} \text{i b z21}^2 \text{ Z31} - 2 \text{ a p21 z31 Z31} - \text{B p31 z31 Z31} - 2 \text{i a z21 z31 Z31} - \frac{1}{2} \text{i B z31}^2 \text{ Z31} \right) + \\
 & \text{s}^5 \left( 2 \text{ a p23 z21 Z21} + \text{B p33 z21 Z21} + 2 \text{ a p21 Z21 z23} + \text{B p31 Z21 z23} + 2 \text{i a z21 Z21 z23} + \right. \\
 & \quad 2 \text{ a p21 z21 Z23} + \text{B p31 z21 Z23} + \text{i a z21}^2 \text{ Z23} + \text{B p23 Z21 z31} + 2 \text{ G p33 Z21 z31} + \\
 & \quad \text{i B Z21 z23 z31} + \text{B p21 Z23 z31} + 2 \text{ G p31 Z23 z31} + \text{i B z21 Z23 z31} + \text{i G Z23 z31}^2 + \\
 & \quad \text{b p23 z21 Z31} - 2 \text{ a p33 z21 Z31} + \text{b p21 z23 Z31} - 2 \text{ a p31 z23 Z31} + \text{i b z21 z23 Z31} - \\
 & \quad 2 \text{ a p23 z31 Z31} - \text{B p33 z31 Z31} - 2 \text{i a z23 z31 Z31} + \text{B p21 Z21 z33} + 2 \text{ G p31 Z21 z33} + \\
 & \quad \text{i B z21 Z21 z33} + 2 \text{i G Z21 z31 z33} - 2 \text{ a p21 Z31 z33} - \text{B p31 Z31 z33} - \\
 & \quad 2 \text{i a z21 Z31 z33} - \text{i B z31 Z31 z33} + \text{b p21 z21 Z33} - 2 \text{ a p31 z21 Z33} + \frac{1}{2} \text{i b z21}^2 \text{ Z33} - \\
 & \quad \left. 2 \text{ a p21 z31 Z33} - \text{B p31 z31 Z33} - 2 \text{i a z21 z31 Z33} - \frac{1}{2} \text{i B z31}^2 \text{ Z33} \right) + \\
 & \text{s}^7 \left( 2 \text{ a p23 Z21 z23} + \text{B p33 Z21 z23} + \text{i a Z21 z23}^2 + 2 \text{ a p23 z21 Z23} + \text{B p33 z21 Z23} + \right. \\
 & \quad 2 \text{ a p21 z23 Z23} + \text{B p31 z23 Z23} + 2 \text{i a z21 z23 Z23} + \text{B p23 Z23 z31} + 2 \text{ G p33 Z23 z31} + \\
 & \quad \text{i B z23 Z23 z31} + \text{b p23 z23 Z31} - 2 \text{ a p33 z23 Z31} + \frac{1}{2} \text{i b z23}^2 \text{ Z31} + \text{B p23 Z21 z33} + \\
 & \quad 2 \text{ G p33 Z21 z33} + \text{i B Z21 z23 z33} + \text{B p21 Z23 z33} + 2 \text{ G p31 Z23 z33} + \text{i B z21 Z23 z33} + \\
 & \quad 2 \text{i G Z23 z31 z33} - 2 \text{ a p23 Z31 z33} - \text{B p33 Z31 z33} - 2 \text{i a z23 Z31 z33} + \\
 & \quad \text{i G Z21 z33}^2 - \frac{1}{2} \text{i B Z31 z33}^2 + \text{b p23 z21 Z33} - 2 \text{ a p33 z21 Z33} + \text{b p21 z23 Z33} - \\
 & \quad 2 \text{ a p31 z23 Z33} + \text{i b z21 z23 Z33} - 2 \text{ a p23 z31 Z33} - \text{B p33 z31 Z33} - 2 \text{i a z23 z31 Z33} - \\
 & \quad \left. 2 \text{ a p21 z33 Z33} - \text{B p31 z33 Z33} - 2 \text{i a z21 z33 Z33} - \text{i B z31 z33 Z33} \right) + \\
 & \text{s}^9 \left( 2 \text{ a p23 z23 Z23} + \text{B p33 z23 Z23} + \text{i a z23}^2 \text{ Z23} + \text{B p23 Z23 z33} + 2 \text{ G p33 Z23 z33} + \right. \\
 & \quad \text{i B z23 Z23 z33} + \text{i G Z23 z33}^2 + \text{b p23 z23 Z33} - 2 \text{ a p33 z23 Z33} + \frac{1}{2} \text{i b z23}^2 \text{ Z33} - \\
 & \quad \left. 2 \text{ a p23 z33 Z33} - \text{B p33 z33 Z33} - 2 \text{i a z23 z33 Z33} - \frac{1}{2} \text{i B z33}^2 \text{ Z33} \right)
 \end{aligned}$$

In[\*]:= **dp2 /. {z2 → z2st, Z2 → Z2st, p2 → p2st,  
P2 → P2st, z3 → z3st, Z3 → Z3st, p3 → p3st, P3 → P3st}**

$$\begin{aligned}
 \text{Out[*]} = & -2 \left( \frac{1}{4} i (p_{21} s + p_{23} s^3) + \frac{1}{4} (-s z_{21} - s^3 z_{23}) + \right. \\
 & a (p_{21} s + p_{23} s^3) (P_{21} s + P_{23} s^3) (s z_{21} + s^3 z_{23}) + \\
 & \frac{1}{2} B (P_{21} s + P_{23} s^3) (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) + \frac{1}{2} b (p_{21} s + p_{23} s^3) \\
 & (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) - a (p_{31} s + p_{33} s^3) (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) + \\
 & \frac{1}{2} i a (P_{21} s + P_{23} s^3) (s z_{21} + s^3 z_{23})^2 + \frac{1}{4} i b (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23})^2 - \\
 & i a (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) - \\
 & \frac{1}{2} i B (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{21} + s^3 Z_{23}) + \\
 & \frac{1}{2} B (p_{21} s + p_{23} s^3) (P_{21} s + P_{23} s^3) (s z_{31} + s^3 z_{33}) + \\
 & G (P_{21} s + P_{23} s^3) (p_{31} s + p_{33} s^3) (s z_{31} + s^3 z_{33}) - \\
 & a (p_{21} s + p_{23} s^3) (P_{31} s + P_{33} s^3) (s z_{31} + s^3 z_{33}) - \\
 & \frac{1}{2} B (p_{31} s + p_{33} s^3) (P_{31} s + P_{33} s^3) (s z_{31} + s^3 z_{33}) + \\
 & \frac{1}{2} i B (P_{21} s + P_{23} s^3) (s z_{21} + s^3 z_{23}) (s z_{31} + s^3 z_{33}) - \\
 & i a (P_{31} s + P_{33} s^3) (s z_{21} + s^3 z_{23}) (s z_{31} + s^3 z_{33}) - \\
 & \frac{1}{2} i B (p_{21} s + p_{23} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) - \\
 & i G (p_{31} s + p_{33} s^3) (s Z_{21} + s^3 Z_{23}) (s z_{31} + s^3 z_{33}) + \\
 & \frac{1}{2} i G (P_{21} s + P_{23} s^3) (s z_{31} + s^3 z_{33})^2 - \frac{1}{4} i B (P_{31} s + P_{33} s^3) (s z_{31} + s^3 z_{33})^2 - \\
 & \frac{1}{2} i b (p_{21} s + p_{23} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) + \\
 & i a (p_{31} s + p_{33} s^3) (s z_{21} + s^3 z_{23}) (s Z_{31} + s^3 Z_{33}) + \\
 & i a (p_{21} s + p_{23} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) + \\
 & \left. \frac{1}{2} i B (p_{31} s + p_{33} s^3) (s z_{31} + s^3 z_{33}) (s Z_{31} + s^3 Z_{33}) \right)
 \end{aligned}$$

In[\*]:= **Expand[%167]**

$$\begin{aligned}
\text{Out}[*]= & -\frac{1}{2} \imath p_{21} s - \frac{1}{2} \imath p_{23} s^3 + \frac{s z_{21}}{2} - 2 a p_{21} P_{21} s^3 z_{21} - B P_{21} p_{31} s^3 z_{21} - b p_{21} P_{31} s^3 z_{21} + \\
& 2 a p_{31} P_{31} s^3 z_{21} - 2 a P_{21} p_{23} s^5 z_{21} - 2 a p_{21} P_{23} s^5 z_{21} - B P_{23} p_{31} s^5 z_{21} - \\
& b p_{23} P_{31} s^5 z_{21} - B P_{21} p_{33} s^5 z_{21} + 2 a P_{31} p_{33} s^5 z_{21} - b p_{21} P_{33} s^5 z_{21} + 2 a p_{31} P_{33} s^5 z_{21} - \\
& 2 a p_{23} P_{23} s^7 z_{21} - B P_{23} p_{33} s^7 z_{21} - b p_{23} P_{33} s^7 z_{21} + 2 a p_{33} P_{33} s^7 z_{21} - \imath a P_{21} s^3 z_{21}^2 - \\
& \frac{1}{2} \imath b P_{31} s^3 z_{21}^2 - \imath a P_{23} s^5 z_{21}^2 - \frac{1}{2} \imath b P_{33} s^5 z_{21}^2 + 2 \imath a p_{21} s^3 z_{21} Z_{21} + \imath B p_{31} s^3 z_{21} Z_{21} + \\
& 2 \imath a p_{23} s^5 z_{21} Z_{21} + \imath B p_{33} s^5 z_{21} Z_{21} + \frac{s^3 z_{23}}{2} - 2 a p_{21} P_{21} s^5 z_{23} - B P_{21} p_{31} s^5 z_{23} - \\
& b p_{21} P_{31} s^5 z_{23} + 2 a p_{31} P_{31} s^5 z_{23} - 2 a P_{21} p_{23} s^7 z_{23} - 2 a p_{21} P_{23} s^7 z_{23} - \\
& B P_{23} p_{31} s^7 z_{23} - b p_{23} P_{31} s^7 z_{23} - B P_{21} p_{33} s^7 z_{23} + 2 a P_{31} p_{33} s^7 z_{23} - b p_{21} P_{33} s^7 z_{23} + \\
& 2 a p_{31} P_{33} s^7 z_{23} - 2 a p_{23} P_{23} s^9 z_{23} - B P_{23} p_{33} s^9 z_{23} - b p_{23} P_{33} s^9 z_{23} + \\
& 2 a p_{33} P_{33} s^9 z_{23} - 2 \imath a P_{21} s^5 z_{21} z_{23} - \imath b P_{31} s^5 z_{21} z_{23} - 2 \imath a P_{23} s^7 z_{21} z_{23} - \\
& \imath b P_{33} s^7 z_{21} z_{23} + 2 \imath a p_{21} s^5 z_{21} z_{23} + \imath B p_{31} s^5 z_{21} z_{23} + 2 \imath a p_{23} s^7 z_{21} z_{23} + \\
& \imath B p_{33} s^7 z_{21} z_{23} - \imath a P_{21} s^7 z_{23}^2 - \frac{1}{2} \imath b P_{31} s^7 z_{23}^2 - \imath a P_{23} s^9 z_{23}^2 - \frac{1}{2} \imath b P_{33} s^9 z_{23}^2 + \\
& 2 \imath a p_{21} s^5 z_{21} z_{23} + \imath B p_{31} s^5 z_{21} z_{23} + 2 \imath a p_{23} s^7 z_{21} z_{23} + \imath B p_{33} s^7 z_{21} z_{23} + \\
& 2 \imath a p_{21} s^7 z_{23} z_{23} + \imath B p_{31} s^7 z_{23} z_{23} + 2 \imath a p_{23} s^9 z_{23} z_{23} + \imath B p_{33} s^9 z_{23} z_{23} - \\
& B p_{21} P_{21} s^3 z_{31} - 2 G P_{21} p_{31} s^3 z_{31} + 2 a p_{21} P_{31} s^3 z_{31} + B p_{31} P_{31} s^3 z_{31} - B P_{21} p_{23} s^5 z_{31} - \\
& B p_{21} P_{23} s^5 z_{31} - 2 G P_{23} p_{31} s^5 z_{31} + 2 a p_{23} P_{31} s^5 z_{31} - 2 G P_{21} p_{33} s^5 z_{31} + B P_{31} p_{33} s^5 z_{31} + \\
& 2 a p_{21} P_{33} s^5 z_{31} + B p_{31} P_{33} s^5 z_{31} - B p_{23} P_{23} s^7 z_{31} - 2 G P_{23} p_{33} s^7 z_{31} + 2 a p_{23} P_{33} s^7 z_{31} + \\
& B p_{33} P_{33} s^7 z_{31} - \imath B P_{21} s^3 z_{21} z_{31} + 2 \imath a P_{31} s^3 z_{21} z_{31} - \imath B P_{23} s^5 z_{21} z_{31} + \\
& 2 \imath a P_{33} s^5 z_{21} z_{31} + \imath B p_{21} s^3 z_{21} z_{31} + 2 \imath G p_{31} s^3 z_{21} z_{31} + \imath B p_{23} s^5 z_{21} z_{31} + \\
& 2 \imath G p_{33} s^5 z_{21} z_{31} - \imath B P_{21} s^5 z_{23} z_{31} + 2 \imath a P_{31} s^5 z_{23} z_{31} - \imath B P_{23} s^7 z_{23} z_{31} + \\
& 2 \imath a P_{33} s^7 z_{23} z_{31} + \imath B p_{21} s^5 z_{23} z_{31} + 2 \imath G p_{31} s^5 z_{23} z_{31} + \imath B p_{23} s^7 z_{23} z_{31} + \\
& 2 \imath G p_{33} s^7 z_{23} z_{31} - \imath G P_{21} s^3 z_{31}^2 + \frac{1}{2} \imath B P_{31} s^3 z_{31}^2 - \imath G P_{23} s^5 z_{31}^2 + \frac{1}{2} \imath B P_{33} s^5 z_{31}^2 + \\
& \imath b p_{21} s^3 z_{21} z_{31} - 2 \imath a p_{31} s^3 z_{21} z_{31} + \imath b p_{23} s^5 z_{21} z_{31} - 2 \imath a p_{33} s^5 z_{21} z_{31} + \\
& \imath b p_{21} s^5 z_{23} z_{31} - 2 \imath a p_{31} s^5 z_{23} z_{31} + \imath b p_{23} s^7 z_{23} z_{31} - 2 \imath a p_{33} s^7 z_{23} z_{31} - \\
& 2 \imath a p_{21} s^3 z_{31} z_{31} - \imath B p_{31} s^3 z_{31} z_{31} - 2 \imath a p_{23} s^5 z_{31} z_{31} - \imath B p_{33} s^5 z_{31} z_{31} - \\
& B p_{21} P_{21} s^5 z_{33} - 2 G P_{21} p_{31} s^5 z_{33} + 2 a p_{21} P_{31} s^5 z_{33} + B p_{31} P_{31} s^5 z_{33} - B P_{21} p_{23} s^7 z_{33} - \\
& B p_{21} P_{23} s^7 z_{33} - 2 G P_{23} p_{31} s^7 z_{33} + 2 a p_{23} P_{31} s^7 z_{33} - 2 G P_{21} p_{33} s^7 z_{33} + B P_{31} p_{33} s^7 z_{33} + \\
& 2 a p_{21} P_{33} s^7 z_{33} + B p_{31} P_{33} s^7 z_{33} - B p_{23} P_{23} s^9 z_{33} - 2 G P_{23} p_{33} s^9 z_{33} + 2 a p_{23} P_{33} s^9 z_{33} + \\
& B p_{33} P_{33} s^9 z_{33} - \imath B P_{21} s^5 z_{21} z_{33} + 2 \imath a P_{31} s^5 z_{21} z_{33} - \imath B P_{23} s^7 z_{21} z_{33} + \\
& 2 \imath a P_{33} s^7 z_{21} z_{33} + \imath B p_{21} s^5 z_{21} z_{33} + 2 \imath G p_{31} s^5 z_{21} z_{33} + \imath B p_{23} s^7 z_{21} z_{33} + \\
& 2 \imath G p_{33} s^7 z_{21} z_{33} - \imath B P_{21} s^7 z_{23} z_{33} + 2 \imath a P_{31} s^7 z_{23} z_{33} - \imath B P_{23} s^9 z_{23} z_{33} + \\
& 2 \imath a P_{33} s^9 z_{23} z_{33} + \imath B p_{21} s^7 z_{23} z_{33} + 2 \imath G p_{31} s^7 z_{23} z_{33} + \imath B p_{23} s^9 z_{23} z_{33} + \\
& 2 \imath G p_{33} s^9 z_{23} z_{33} - 2 \imath G P_{21} s^5 z_{31} z_{33} + \imath B P_{31} s^5 z_{31} z_{33} - 2 \imath G P_{23} s^7 z_{31} z_{33} + \\
& \imath B P_{33} s^7 z_{31} z_{33} - 2 \imath a p_{21} s^5 z_{31} z_{33} - \imath B p_{31} s^5 z_{31} z_{33} - 2 \imath a p_{23} s^7 z_{31} z_{33} - \\
& \imath B p_{33} s^7 z_{31} z_{33} - \imath G P_{21} s^7 z_{33}^2 + \frac{1}{2} \imath B P_{31} s^7 z_{33}^2 - \imath G P_{23} s^9 z_{33}^2 + \frac{1}{2} \imath B P_{33} s^9 z_{33}^2 + \\
& \imath b p_{21} s^5 z_{21} z_{33} - 2 \imath a p_{31} s^5 z_{21} z_{33} + \imath b p_{23} s^7 z_{21} z_{33} - 2 \imath a p_{33} s^7 z_{21} z_{33} + \\
& \imath b p_{21} s^7 z_{23} z_{33} - 2 \imath a p_{31} s^7 z_{23} z_{33} + \imath b p_{23} s^9 z_{23} z_{33} - 2 \imath a p_{33} s^9 z_{23} z_{33} - \\
& 2 \imath a p_{21} s^5 z_{31} z_{33} - \imath B p_{31} s^5 z_{31} z_{33} - 2 \imath a p_{23} s^7 z_{31} z_{33} - \imath B p_{33} s^7 z_{31} z_{33} - \\
& 2 \imath a p_{21} s^7 z_{33} z_{33} - \imath B p_{31} s^7 z_{33} z_{33} - 2 \imath a p_{23} s^9 z_{33} z_{33} - \imath B p_{33} s^9 z_{33} z_{33}
\end{aligned}$$

In[ ]:= **Collect[%, s]**

$$\begin{aligned}
 \text{Out[ ]} = & \, s \left( -\frac{i p_{21}}{2} + \frac{z_{21}}{2} \right) + \\
 & s^3 \left( -\frac{i p_{23}}{2} - 2 a p_{21} P_{21} z_{21} - B P_{21} p_{31} z_{21} - b p_{21} P_{31} z_{21} + 2 a p_{31} P_{31} z_{21} - \right. \\
 & \quad i a P_{21} z_{21}^2 - \frac{1}{2} i b P_{31} z_{21}^2 + 2 i a p_{21} z_{21} Z_{21} + i B p_{31} z_{21} Z_{21} + \frac{z_{23}}{2} - \\
 & \quad B p_{21} P_{21} z_{31} - 2 G P_{21} p_{31} z_{31} + 2 a p_{21} P_{31} z_{31} + B p_{31} P_{31} z_{31} - i B P_{21} z_{21} z_{31} + \\
 & \quad 2 i a P_{31} z_{21} z_{31} + i B p_{21} Z_{21} z_{31} + 2 i G p_{31} Z_{21} z_{31} - i G P_{21} z_{31}^2 + \frac{1}{2} i B P_{31} z_{31}^2 + \\
 & \quad \left. i b p_{21} z_{21} Z_{31} - 2 i a p_{31} z_{21} Z_{31} - 2 i a p_{21} z_{31} Z_{31} - i B p_{31} z_{31} Z_{31} \right) + \\
 & s^5 \left( -2 a P_{21} p_{23} z_{21} - 2 a p_{21} P_{23} z_{21} - B P_{23} p_{31} z_{21} - b p_{23} P_{31} z_{21} - B P_{21} p_{33} z_{21} + \right. \\
 & \quad 2 a P_{31} p_{33} z_{21} - b p_{21} P_{33} z_{21} + 2 a p_{31} P_{33} z_{21} - i a P_{23} z_{21}^2 - \frac{1}{2} i b P_{33} z_{21}^2 + \\
 & \quad 2 i a p_{23} z_{21} Z_{21} + i B p_{33} z_{21} Z_{21} - 2 a p_{21} P_{21} z_{23} - B P_{21} p_{31} z_{23} - b p_{21} P_{31} z_{23} + \\
 & \quad 2 a p_{31} P_{31} z_{23} - 2 i a P_{21} z_{21} z_{23} - i b P_{31} z_{21} z_{23} + 2 i a p_{21} Z_{21} z_{23} + \\
 & \quad i B p_{31} Z_{21} z_{23} + 2 i a p_{21} z_{21} Z_{23} + i B p_{31} z_{21} Z_{23} - B P_{21} p_{23} z_{31} - B p_{21} P_{23} z_{31} - \\
 & \quad 2 G P_{23} p_{31} z_{31} + 2 a p_{23} P_{31} z_{31} - 2 G P_{21} p_{33} z_{31} + B P_{31} p_{33} z_{31} + 2 a p_{21} P_{33} z_{31} + \\
 & \quad B p_{31} P_{33} z_{31} - i B P_{23} z_{21} z_{31} + 2 i a P_{33} z_{21} z_{31} + i B p_{23} Z_{21} z_{31} + 2 i G p_{33} Z_{21} z_{31} - \\
 & \quad i B P_{21} z_{23} z_{31} + 2 i a P_{31} z_{23} z_{31} + i B p_{21} Z_{23} z_{31} + 2 i G p_{31} Z_{23} z_{31} - i G P_{23} z_{31}^2 + \\
 & \quad \frac{1}{2} i B P_{33} z_{31}^2 + i b p_{23} z_{21} Z_{31} - 2 i a p_{33} z_{21} Z_{31} + i b p_{21} z_{23} Z_{31} - 2 i a p_{31} z_{23} Z_{31} - \\
 & \quad 2 i a p_{23} z_{31} Z_{31} - i B p_{33} z_{31} Z_{31} - B p_{21} P_{21} z_{33} - 2 G P_{21} p_{31} z_{33} + 2 a p_{21} P_{31} z_{33} + \\
 & \quad B p_{31} P_{31} z_{33} - i B P_{21} z_{21} z_{33} + 2 i a P_{31} z_{21} z_{33} + i B p_{21} Z_{21} z_{33} + 2 i G p_{31} Z_{21} z_{33} - \\
 & \quad 2 i G P_{21} z_{31} z_{33} + i B P_{31} z_{31} z_{33} - 2 i a p_{21} Z_{31} z_{33} - i B p_{31} Z_{31} z_{33} + \\
 & \quad \left. i b p_{21} z_{21} Z_{33} - 2 i a p_{31} z_{21} Z_{33} - 2 i a p_{21} z_{31} Z_{33} - i B p_{31} z_{31} Z_{33} \right) + \\
 & s^7 \left( -2 a p_{23} P_{23} z_{21} - B P_{23} p_{33} z_{21} - b p_{23} P_{33} z_{21} + 2 a p_{33} P_{33} z_{21} - 2 a P_{21} p_{23} z_{23} - \right. \\
 & \quad 2 a p_{21} P_{23} z_{23} - B P_{23} p_{31} z_{23} - b p_{23} P_{31} z_{23} - B P_{21} p_{33} z_{23} + 2 a P_{31} p_{33} z_{23} - \\
 & \quad b p_{21} P_{33} z_{23} + 2 a p_{31} P_{33} z_{23} - 2 i a P_{23} z_{21} z_{23} - i b P_{33} z_{21} z_{23} + 2 i a p_{23} Z_{21} z_{23} + \\
 & \quad i B p_{33} Z_{21} z_{23} - i a P_{21} z_{23}^2 - \frac{1}{2} i b P_{31} z_{23}^2 + 2 i a p_{23} z_{21} Z_{23} + i B p_{33} z_{21} Z_{23} + \\
 & \quad 2 i a p_{21} z_{23} Z_{23} + i B p_{31} z_{23} Z_{23} - B p_{23} P_{23} z_{31} - 2 G P_{23} p_{33} z_{31} + 2 a p_{23} P_{33} z_{31} + \\
 & \quad B p_{33} P_{33} z_{31} - i B P_{23} z_{23} z_{31} + 2 i a P_{33} z_{23} z_{31} + i B p_{23} Z_{23} z_{31} + 2 i G p_{33} Z_{23} z_{31} + \\
 & \quad i b p_{23} z_{23} Z_{31} - 2 i a p_{33} z_{23} Z_{31} - B P_{21} p_{23} z_{33} - B p_{21} P_{23} z_{33} - 2 G P_{23} p_{31} z_{33} + \\
 & \quad 2 a p_{23} P_{31} z_{33} - 2 G P_{21} p_{33} z_{33} + B P_{31} p_{33} z_{33} + 2 a p_{21} P_{33} z_{33} + B p_{31} P_{33} z_{33} - \\
 & \quad i B P_{23} z_{21} z_{33} + 2 i a P_{33} z_{21} z_{33} + i B p_{23} Z_{21} z_{33} + 2 i G p_{33} Z_{21} z_{33} - i B P_{21} z_{23} z_{33} + \\
 & \quad 2 i a P_{31} z_{23} z_{33} + i B p_{21} Z_{23} z_{33} + 2 i G p_{31} Z_{23} z_{33} - 2 i G P_{23} z_{31} z_{33} + \\
 & \quad i B P_{33} z_{31} z_{33} - 2 i a p_{23} Z_{31} z_{33} - i B p_{33} Z_{31} z_{33} - i G P_{21} z_{33}^2 + \frac{1}{2} i B P_{31} z_{33}^2 + \\
 & \quad i b p_{23} z_{21} Z_{33} - 2 i a p_{33} z_{21} Z_{33} + i b p_{21} z_{23} Z_{33} - 2 i a p_{31} z_{23} Z_{33} - \\
 & \quad 2 i a p_{23} z_{31} Z_{33} - i B p_{33} z_{31} Z_{33} - 2 i a p_{21} z_{33} Z_{33} - i B p_{31} z_{33} Z_{33} \right) + \\
 & s^9 \left( -2 a p_{23} P_{23} z_{23} - B P_{23} p_{33} z_{23} - b p_{23} P_{33} z_{23} + 2 a p_{33} P_{33} z_{23} - i a P_{23} z_{23}^2 - \right.
 \end{aligned}$$

$$\begin{aligned} & \frac{1}{2} \, i \, b \, P_{33} \, z^2 z^2 + 2 \, i \, a \, p_{23} \, z^2 z^2 Z^2 + i \, B \, p_{33} \, z^2 z^2 Z^2 - B \, p_{23} \, P_{23} \, z^2 z^2 - 2 \, G \, P_{23} \, p_{33} \, z^2 z^2 + \\ & 2 \, a \, p_{23} \, P_{33} \, z^2 z^2 + B \, p_{33} \, P_{33} \, z^2 z^2 - i \, B \, P_{23} \, z^2 z^2 z^2 + 2 \, i \, a \, P_{33} \, z^2 z^2 z^2 + \\ & i \, B \, p_{23} \, Z^2 z^2 z^2 + 2 \, i \, G \, p_{33} \, Z^2 z^2 z^2 - i \, G \, P_{23} \, z^2 z^2 + \frac{1}{2} \, i \, B \, P_{33} \, z^2 z^2 + \\ & i \, b \, p_{23} \, z^2 z^2 Z^2 - 2 \, i \, a \, p_{33} \, z^2 z^2 Z^2 - 2 \, i \, a \, p_{23} \, z^2 z^2 Z^2 - i \, B \, p_{33} \, z^2 z^2 Z^2 \Big) \end{aligned}$$

$$In[ ] := \text{DSolve}\left[\left\{l'[t] = -\frac{m[t]}{2} - \frac{i * l[t]}{2}, m'[t] = -\frac{i * m[t]}{2} + \frac{l[t]}{2}\right\}, \{m[t], l[t]\}, t\right]$$

$$Out[ ] := \left\{ \left\{ l[t] \rightarrow e^{-\frac{i t}{2}} C[1] \cos\left[\frac{t}{2}\right] - e^{-\frac{i t}{2}} C[2] \sin\left[\frac{t}{2}\right], m[t] \rightarrow e^{-\frac{i t}{2}} C[2] \cos\left[\frac{t}{2}\right] + e^{-\frac{i t}{2}} C[1] \sin\left[\frac{t}{2}\right] \right\} \right\}$$

$$In[ ] := e^{-\frac{i t}{2}} C[1] \cos\left[\frac{t}{2}\right] - e^{-\frac{i t}{2}} C[2] \sin\left[\frac{t}{2}\right]$$

$$Out[ ] := e^{-\frac{i t}{2}} C[1] \cos\left[\frac{t}{2}\right] - e^{-\frac{i t}{2}} C[2] \sin\left[\frac{t}{2}\right]$$

$$In[ ] := \text{TrigReduce}\left[e^{-\frac{i t}{2}} C[1] \cos\left[\frac{t}{2}\right] - e^{-\frac{i t}{2}} C[2] \sin\left[\frac{t}{2}\right]\right]$$

$$Out[ ] := \frac{1}{2} e^{-i t} \left( C[1] + e^{i t} C[1] - i C[2] + i e^{i t} C[2] \right)$$

$$In[ ] := \text{Expand}\left[\frac{1}{2} e^{-i t} \left( C[1] + e^{i t} C[1] - i C[2] + i e^{i t} C[2] \right)\right]$$

$$Out[ ] := \frac{C[1]}{2} + \frac{1}{2} e^{-i t} C[1] + \frac{1}{2} i C[2] - \frac{1}{2} i e^{-i t} C[2]$$

$$In[ ] := \text{Collect}[\%, \text{Exp}[-I * t]]$$

$$Out[ ] := \frac{C[1]}{2} + e^{-i t} \left( \frac{C[1]}{2} - \frac{1}{2} i C[2] \right) + \frac{1}{2} i C[2]$$

$$In[ ] := \text{ClearAll}[p1]$$

$$In[ ] := p1 := -1$$

$$In[ ] := \text{ClearAll}[p1]$$

$$In[ ] := p1 := 1$$