```mathematica
In[•]:= ρ := z1 + Z1 - z2 * Z2 - z3 * Z3 - g * z2^2 * Z3^2 - G * z3^2 * Z2^2
```

```mathematica
In[•]:= ρ
```

$$\text{Out[•]= } z1 + Z1 - z2\ Z2 - G\ Z2^2\ z3^2 - z3\ Z3 - g\ z2^2\ Z3^2$$

```mathematica
In[•]:= ρ2 := D[ρ, z2]
```

```mathematica
In[•]:= ρ20 := D[ρ, Z2]
```

```mathematica
In[•]:= ρ3 := D[ρ, z3]
```

```mathematica
In[•]:= ρ30 := D[ρ, Z3]
```

```mathematica
In[•]:= ρ22 := D[ρ, z2, Z2]
```

```mathematica
In[•]:= ρ22
```

$$\text{Out[•]= } -1$$

```mathematica
In[•]:= ρ23 := D[ρ, z2, Z3]
```

```mathematica
In[•]:= ρ23
```

$$\text{Out[•]= } -4\ g\ z2\ Z3$$

```mathematica
In[•]:= ρ33 := D[ρ, z3, Z3]
```

```mathematica
In[•]:= ρ32 := D[ρ, z3, Z2]
```

```mathematica
In[•]:= A := {{0, I, I*ρ20, I*ρ30}, {-I, 0, 0, 0},
        {-I*ρ2, 0, 4*ρ22, 4*ρ23}, {-I*ρ3, 0, 4*ρ32, 4*ρ33}}
```

```mathematica
In[•]:= MatrixForm[A]
```

Out[•]//MatrixForm=

$$\begin{pmatrix} 0 & i & i\left(-z2 - 2\ G\ Z2\ z3^2\right) & i\left(-z3 - 2\ g\ z2^2\ Z3\right) \\ -i & 0 & 0 & 0 \\ -i\left(-Z2 - 2\ g\ z2\ Z3^2\right) & 0 & -4 & -16\ g\ z2\ Z3 \\ -i\left(-2\ G\ Z2^2\ z3 - Z3\right) & 0 & -16\ G\ Z2\ z3 & -4 \end{pmatrix}$$

```mathematica
In[•]:= B := Inverse[A]
```

```mathematica
In[•]:= MatrixForm[B]
```

Out[•]//MatrixForm=

$$\begin{pmatrix} 0 & & \frac{-16\ i + 256\ i\ g\ G\ z2\ Z2\ z3\ Z3}{-16 + 256\ g\ G\ z2\ Z2\ z3\ Z3} \\ \frac{16\ i - 256\ i\ g\ G\ z2\ Z2\ z3\ Z3}{-16 + 256\ g\ G\ z2\ Z2\ z3\ Z3} & \frac{4\ z2\ Z2 + 4\ z3\ Z3 - 48\ g\ G\ z2^2\ Z2^2\ z3\ Z3 - 64\ g\ G^2\ z2\ Z2^3\ z3^3\ Z3 - 48\ g\ G\ z2\ Z2\ z3^2\ Z3^2 - 64\ g^2\ G\ z2^3\ Z2\ z3\ Z3^3}{-16 + 256\ g\ G\ z2\ Z2\ z3\ Z3} & 4\ z2 - \\ 0 & \frac{4\ Z2 - 32\ g\ G\ z2\ Z2^2\ z3\ Z3 - 8\ g\ z2\ Z3^2}{-16 + 256\ g\ G\ z2\ Z2\ z3\ Z3} \\ 0 & \frac{-8\ G\ Z2^2\ z3 + 4\ Z3 - 32\ g\ G\ z2\ Z2\ z3\ Z3^2}{-16 + 256\ g\ G\ z2\ Z2\ z3\ Z3} \end{pmatrix}$$

```mathematica
In[•]:= L := {{0, I, 0, 0},
        {-I, -(z2*Z2 + z3*Z3)/4, -(z2 - 2*G*Z2*z3^2)/4, -(z3 - 2*g*z2^2*Z3)/4},
        {0, -(Z2 - 2*g*z2*Z3^2)/4, -1/4, g*z2*Z3},
        {0, -(Z3 - 2*G*Z2^2*z3)/4, G*Z2*z3, -1/4}}
```

In[◦]:= `MatrixForm[L]`

Out[◦]//MatrixForm=

$$\begin{pmatrix} 0 & \mathbb{i} & 0 & 0 \\ -\mathbb{i} & \frac{1}{4}\left(-z2\ Z2 - z3\ Z3\right) & \frac{1}{4}\left(-z2 + 2\ G\ Z2\ z3^2\right) & \frac{1}{4}\left(-z3 + 2\ g\ z2^2\ Z3\right) \\ 0 & \frac{1}{4}\left(-Z2 + 2\ g\ z2\ Z3^2\right) & -\frac{1}{4} & g\ z2\ Z3 \\ 0 & \frac{1}{4}\left(2\ G\ Z2^2\ z3 - Z3\right) & G\ Z2\ z3 & -\frac{1}{4} \end{pmatrix}$$

In[◦]:= `q := {p0, I * p1, p2, p3}`

In[◦]:= `Q := {p0, -I * p1, P2, P3}`

In[◦]:= `q.L.Q`

Out[◦]= $p0\ p1 + P2\left(-\frac{p2}{4} + G\ p3\ Z2\ z3 + \frac{1}{4}\mathbb{i}\ p1\left(-z2 + 2\ G\ Z2\ z3^2\right)\right) +$

$P3\left(-\frac{p3}{4} + g\ p2\ z2\ Z3 + \frac{1}{4}\mathbb{i}\ p1\left(-z3 + 2\ g\ z2^2\ Z3\right)\right) -$

$\mathbb{i}\ p1\left(\mathbb{i}\ p0 + \frac{1}{4}\ p3\left(2\ G\ Z2^2\ z3 - Z3\right) + \frac{1}{4}\mathbb{i}\ p1\left(-z2\ Z2 - z3\ Z3\right) + \frac{1}{4}\ p2\left(-Z2 + 2\ g\ z2\ Z3^2\right)\right)$

In[◦]:= `Simplify[`$p0\ p1 + P2\left(-\frac{p2}{4} + G\ p3\ Z2\ z3 + \frac{1}{4}\mathbb{i}\ p1\left(-z2 + 2\ G\ Z2\ z3^2\right)\right) +$

$P3\left(-\frac{p3}{4} + g\ p2\ z2\ Z3 + \frac{1}{4}\mathbb{i}\ p1\left(-z3 + 2\ g\ z2^2\ Z3\right)\right) -$

$\mathbb{i}\ p1\left(\mathbb{i}\ p0 + \frac{1}{4}\ p3\left(2\ G\ Z2^2\ z3 - Z3\right) + \frac{1}{4}\mathbb{i}\ p1\left(-z2\ Z2 - z3\ Z3\right) + \frac{1}{4}\ p2\left(-Z2 + 2\ g\ z2\ Z3^2\right)\right)$`]`

Out[◦]= $2\ p0\ p1 - \frac{1}{4}\mathbb{i}\left(p3\left(-\mathbb{i}\ P3 + 2\ G\ Z2\left(2\ \mathbb{i}\ P2 + p1\ Z2\right)z3 - p1\ Z3\right) +\right.$

$p2\left(-\mathbb{i}\ P2 - p1\ Z2 + 4\ \mathbb{i}\ g\ P3\ z2\ Z3 + 2\ g\ p1\ z2\ Z3^2\right) +$

$\left.p1\left(P2\left(z2 - 2\ G\ Z2\ z3^2\right) + P3\left(z3 - 2\ g\ z2^2\ Z3\right) - \mathbb{i}\ p1\left(z2\ Z2 + z3\ Z3\right)\right)\right)$

In[◦]:= `Expand[`$2\ p0\ p1 - \frac{1}{4}\mathbb{i}\left(p3\left(-\mathbb{i}\ P3 + 2\ G\ Z2\left(2\ \mathbb{i}\ P2 + p1\ Z2\right)z3 - p1\ Z3\right) +\right.$

$p2\left(-\mathbb{i}\ P2 - p1\ Z2 + 4\ \mathbb{i}\ g\ P3\ z2\ Z3 + 2\ g\ p1\ z2\ Z3^2\right) +$

$\left.p1\left(P2\left(z2 - 2\ G\ Z2\ z3^2\right) + P3\left(z3 - 2\ g\ z2^2\ Z3\right) - \mathbb{i}\ p1\left(z2\ Z2 + z3\ Z3\right)\right)\right)$`]`

Out[◦]= $2\ p0\ p1 - \frac{p2\ P2}{4} - \frac{p3\ P3}{4} - \frac{1}{4}\mathbb{i}\ p1\ P2\ z2 + \frac{1}{4}\mathbb{i}\ p1\ p2\ Z2 - \frac{1}{4}\ p1^2\ z2\ Z2 -$

$\frac{1}{4}\mathbb{i}\ p1\ P3\ z3 + G\ P2\ p3\ Z2\ z3 - \frac{1}{2}\mathbb{i}\ G\ p1\ p3\ Z2^2\ z3 + \frac{1}{2}\mathbb{i}\ G\ p1\ P2\ Z2\ z3^2 +$

$\frac{1}{4}\mathbb{i}\ p1\ p3\ Z3 + g\ p2\ P3\ z2\ Z3 + \frac{1}{2}\mathbb{i}\ g\ p1\ P3\ z2^2\ Z3 - \frac{1}{4}\ p1^2\ z3\ Z3 - \frac{1}{2}\mathbb{i}\ g\ p1\ p2\ z2\ Z3^2$

In[◦]:= `H := `$2\ p0\ p1 - \frac{p2\ P2}{4} - \frac{p3\ P3}{4} - \frac{1}{4}\mathbb{i}\ p1\ P2\ z2 + \frac{1}{4}\mathbb{i}\ p1\ p2\ Z2 - \frac{1}{4}\ p1^2\ z2\ Z2 -$

$\frac{1}{4}\mathbb{i}\ p1\ P3\ z3 + G\ P2\ p3\ Z2\ z3 - \frac{1}{2}\mathbb{i}\ G\ p1\ p3\ Z2^2\ z3 + \frac{1}{2}\mathbb{i}\ G\ p1\ P2\ Z2\ z3^2 +$

$\frac{1}{4}\mathbb{i}\ p1\ p3\ Z3 + g\ p2\ P3\ z2\ Z3 + \frac{1}{2}\mathbb{i}\ g\ p1\ P3\ z2^2\ Z3 - \frac{1}{4}\ p1^2\ z3\ Z3 - \frac{1}{2}\mathbb{i}\ g\ p1\ p2\ z2\ Z3^2$

In[ ]:= `Collect[H, p1 * P2]`

Out[ ]= $2\,p0\,p1 - \dfrac{p2\,P2}{4} - \dfrac{p3\,P3}{4} + \dfrac{1}{4}\,i\,p1\,p2\,Z2 - \dfrac{1}{4}\,p1^2\,z2\,Z2 - \dfrac{1}{4}\,i\,p1\,P3\,z3 +$

$G\,P2\,p3\,Z2\,z3 - \dfrac{1}{2}\,i\,G\,p1\,p3\,Z2^2\,z3 + p1\,P2\,\left(-\dfrac{i\,z2}{4} + \dfrac{1}{2}\,i\,G\,Z2\,z3^2\right) + \dfrac{1}{4}\,i\,p1\,p3\,Z3 +$

$g\,p2\,P3\,z2\,Z3 + \dfrac{1}{2}\,i\,g\,p1\,P3\,z2^2\,Z3 - \dfrac{1}{4}\,p1^2\,z3\,Z3 - \dfrac{1}{2}\,i\,g\,p1\,p2\,z2\,Z3^2$

In[ ]:= `H`

In[ ]:= `ClearAll[H]`

In[ ]:= $H := 2\,p0\,p1 - \dfrac{p2\,P2}{4} - \dfrac{p3\,P3}{4} - \dfrac{1}{4}\,i\,p1\,P2\,z2 + \dfrac{1}{4}\,i\,p1\,p2\,Z2 - \dfrac{1}{4}\,p1^2\,z2\,Z2 -$

$\dfrac{1}{4}\,i\,p1\,P3\,z3 + G\,P2\,p3\,Z2\,z3 - \dfrac{1}{2}\,i\,G\,p1\,p3\,Z2^2\,z3 + \dfrac{1}{2}\,i\,G\,p1\,P2\,Z2\,z3^2 +$

$\dfrac{1}{4}\,i\,p1\,p3\,Z3 + g\,p2\,P3\,z2\,Z3 + \dfrac{1}{2}\,i\,g\,p1\,P3\,z2^2\,Z3 - \dfrac{1}{4}\,p1^2\,z3\,Z3 - \dfrac{1}{2}\,i\,g\,p1\,p2\,z2\,Z3^2$

In[ ]:= `H`

Out[ ]= $2\,p0\,p1 - \dfrac{p2\,P2}{4} - \dfrac{p3\,P3}{4} - \dfrac{1}{4}\,i\,p1\,P2\,z2 + \dfrac{1}{4}\,i\,p1\,p2\,Z2 - \dfrac{1}{4}\,p1^2\,z2\,Z2 -$

$\dfrac{1}{4}\,i\,p1\,P3\,z3 + G\,P2\,p3\,Z2\,z3 - \dfrac{1}{2}\,i\,G\,p1\,p3\,Z2^2\,z3 + \dfrac{1}{2}\,i\,G\,p1\,P2\,Z2\,z3^2 +$

$\dfrac{1}{2}\,i\,G\,p1\,P3\,Z2\,z3^2 + \dfrac{1}{4}\,i\,p1\,p3\,Z3 + g\,p2\,P3\,z2\,Z3 - \dfrac{1}{4}\,p1^2\,z3\,Z3 - \dfrac{1}{2}\,i\,g\,p1\,p2\,z2\,Z3^2$

In[ ]:= `Collect[H, p1 * P2]`

Out[ ]= $2\,p0\,p1 - \dfrac{p2\,P2}{4} - \dfrac{p3\,P3}{4} + \dfrac{1}{4}\,i\,p1\,p2\,Z2 - \dfrac{1}{4}\,p1^2\,z2\,Z2 - \dfrac{1}{4}\,i\,p1\,P3\,z3 +$

$G\,P2\,p3\,Z2\,z3 - \dfrac{1}{2}\,i\,G\,p1\,p3\,Z2^2\,z3 + p1\,P2\,\left(-\dfrac{i\,z2}{4} + \dfrac{1}{2}\,i\,G\,Z2\,z3^2\right) + \dfrac{1}{4}\,i\,p1\,p3\,Z3 +$

$g\,p2\,P3\,z2\,Z3 + \dfrac{1}{2}\,i\,g\,p1\,P3\,z2^2\,Z3 - \dfrac{1}{4}\,p1^2\,z3\,Z3 - \dfrac{1}{2}\,i\,g\,p1\,p2\,z2\,Z3^2$

In[ ]:= `Collect[H, p1 * P3]`

Out[ ]= $2\,p0\,p1 - \dfrac{p2\,P2}{4} - \dfrac{p3\,P3}{4} - \dfrac{1}{4}\,i\,p1\,P2\,z2 + \dfrac{1}{4}\,i\,p1\,p2\,Z2 - \dfrac{1}{4}\,p1^2\,z2\,Z2 +$

$G\,P2\,p3\,Z2\,z3 - \dfrac{1}{2}\,i\,G\,p1\,p3\,Z2^2\,z3 + \dfrac{1}{2}\,i\,G\,p1\,P2\,Z2\,z3^2 + \dfrac{1}{4}\,i\,p1\,p3\,Z3 +$

$g\,p2\,P3\,z2\,Z3 - \dfrac{1}{4}\,p1^2\,z3\,Z3 - \dfrac{1}{2}\,i\,g\,p1\,p2\,z2\,Z3^2 + p1\,P3\,\left(-\dfrac{i\,z3}{4} + \dfrac{1}{2}\,i\,g\,z2^2\,Z3\right)$

In[•]:= `Collect[H, p2 * P2]`

Out[•]= $2 \, p0 \, p1 - \dfrac{p2 \, P2}{4} - \dfrac{p3 \, P3}{4} - \dfrac{1}{4} \, \mathbb{i} \, p1 \, P2 \, z2 + \dfrac{1}{4} \, \mathbb{i} \, p1 \, p2 \, Z2 - \dfrac{1}{4} \, p1^2 \, z2 \, Z2 -$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, P3 \, z3 + G \, P2 \, p3 \, Z2 \, z3 - \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, p3 \, Z2^2 \, z3 + \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, P2 \, Z2 \, z3^2 +$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, p3 \, Z3 + g \, p2 \, P3 \, z2 \, Z3 + \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, P3 \, z2^2 \, Z3 - \dfrac{1}{4} \, p1^2 \, z3 \, Z3 - \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, p2 \, z2 \, Z3^2$

In[•]:= `Collect[H, p2 * P3]`

Out[•]= $2 \, p0 \, p1 - \dfrac{p2 \, P2}{4} - \dfrac{p3 \, P3}{4} - \dfrac{1}{4} \, \mathbb{i} \, p1 \, P2 \, z2 + \dfrac{1}{4} \, \mathbb{i} \, p1 \, p2 \, Z2 - \dfrac{1}{4} \, p1^2 \, z2 \, Z2 -$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, P3 \, z3 + G \, P2 \, p3 \, Z2 \, z3 - \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, p3 \, Z2^2 \, z3 + \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, P2 \, Z2 \, z3^2 +$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, p3 \, Z3 + g \, p2 \, P3 \, z2 \, Z3 + \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, P3 \, z2^2 \, Z3 - \dfrac{1}{4} \, p1^2 \, z3 \, Z3 - \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, p2 \, z2 \, Z3^2$

In[•]:= `Collect[H, p1 * p2]`

Out[•]= $2 \, p0 \, p1 - \dfrac{p2 \, P2}{4} - \dfrac{p3 \, P3}{4} - \dfrac{1}{4} \, \mathbb{i} \, p1 \, P2 \, z2 - \dfrac{1}{4} \, p1^2 \, z2 \, Z2 - \dfrac{1}{4} \, \mathbb{i} \, p1 \, P3 \, z3 +$

$G \, P2 \, p3 \, Z2 \, z3 - \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, p3 \, Z2^2 \, z3 + \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, P2 \, Z2 \, z3^2 + \dfrac{1}{4} \, \mathbb{i} \, p1 \, p3 \, Z3 +$

$g \, p2 \, P3 \, z2 \, Z3 + \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, P3 \, z2^2 \, Z3 - \dfrac{1}{4} \, p1^2 \, z3 \, Z3 + p1 \, p2 \, \left(\dfrac{\mathbb{i} \, Z2}{4} - \dfrac{1}{2} \, \mathbb{i} \, g \, z2 \, Z3^2 \right)$

In[•]:= `Collect[H, p1 * p3]`

Out[•]= $2 \, p0 \, p1 - \dfrac{p2 \, P2}{4} - \dfrac{p3 \, P3}{4} - \dfrac{1}{4} \, \mathbb{i} \, p1 \, P2 \, z2 + \dfrac{1}{4} \, \mathbb{i} \, p1 \, p2 \, Z2 - \dfrac{1}{4} \, p1^2 \, z2 \, Z2 -$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, P3 \, z3 + G \, P2 \, p3 \, Z2 \, z3 + \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, P2 \, Z2 \, z3^2 + p1 \, p3 \, \left(-\dfrac{1}{2} \, \mathbb{i} \, G \, Z2^2 \, z3 + \dfrac{\mathbb{i} \, Z3}{4} \right) +$

$g \, p2 \, P3 \, z2 \, Z3 + \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, P3 \, z2^2 \, Z3 - \dfrac{1}{4} \, p1^2 \, z3 \, Z3 - \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, p2 \, z2 \, Z3^2$

In[•]:= `Collect[H, P2 * p3]`

Out[•]= $2 \, p0 \, p1 - \dfrac{p2 \, P2}{4} - \dfrac{p3 \, P3}{4} - \dfrac{1}{4} \, \mathbb{i} \, p1 \, P2 \, z2 + \dfrac{1}{4} \, \mathbb{i} \, p1 \, p2 \, Z2 - \dfrac{1}{4} \, p1^2 \, z2 \, Z2 -$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, P3 \, z3 + G \, P2 \, p3 \, Z2 \, z3 - \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, p3 \, Z2^2 \, z3 + \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, P2 \, Z2 \, z3^2 +$

$\dfrac{1}{4} \, \mathbb{i} \, p1 \, p3 \, Z3 + g \, p2 \, P3 \, z2 \, Z3 + \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, P3 \, z2^2 \, Z3 - \dfrac{1}{4} \, p1^2 \, z3 \, Z3 - \dfrac{1}{2} \, \mathbb{i} \, g \, p1 \, p2 \, z2 \, Z3^2$

In[•]:= `dz2 := 2 * D[H, P2]`

In[•]:= `dz2`

Out[•]= $2 \, \left(-\dfrac{p2}{4} - \dfrac{\mathbb{i} \, p1 \, z2}{4} + G \, p3 \, Z2 \, z3 + \dfrac{1}{2} \, \mathbb{i} \, G \, p1 \, Z2 \, z3^2 \right)$

In[•]:= `Expand[2 (-p2/4 - i p1 z2/4 + G p3 Z2 z3 + 1/2 i G p1 Z2 z3^2)]`

Out[•]= $-\dfrac{p2}{2} - \dfrac{i\, p1\, z2}{2} + 2\, G\, p3\, Z2\, z3 + i\, G\, p1\, Z2\, z3^2$

In[•]:= `Collect[%, p1]`

Out[•]= $-\dfrac{p2}{2} + 2\, G\, p3\, Z2\, z3 + p1 \left(-\dfrac{i\, z2}{2} + i\, G\, Z2\, z3^2\right)$

In[•]:= `dp2 := -2 * D[H, Z2]`

In[•]:= `dp2`

Out[•]= $-2 \left(\dfrac{i\, p1\, p2}{4} - \dfrac{p1^2\, z2}{4} + G\, P2\, p3\, z3 - i\, G\, p1\, p3\, Z2\, z3 + \dfrac{1}{2}\, i\, G\, p1\, P2\, z3^2\right)$

In[•]:= `Expand[-2 (i p1 p2/4 - p1^2 z2/4 + G P2 p3 z3 - i G p1 p3 Z2 z3 + 1/2 i G p1 P2 z3^2)]`

Out[•]= $-\dfrac{1}{2}\, i\, p1\, p2 + \dfrac{p1^2\, z2}{2} - 2\, G\, P2\, p3\, z3 + 2\, i\, G\, p1\, p3\, Z2\, z3 - i\, G\, p1\, P2\, z3^2$

In[•]:= `dz3 := 2 * D[H, P3]`

In[•]:= `dz3`

Out[•]= $2 \left(-\dfrac{p3}{4} - \dfrac{i\, p1\, z3}{4} + g\, p2\, z2\, Z3 + \dfrac{1}{2}\, i\, g\, p1\, z2^2\, Z3\right)$

In[•]:= `Expand[2 (-p3/4 - i p1 z3/4 + g p2 z2 Z3 + 1/2 i g p1 z2^2 Z3)]`

Out[•]= $-\dfrac{p3}{2} - \dfrac{i\, p1\, z3}{2} + 2\, g\, p2\, z2\, Z3 + i\, g\, p1\, z2^2\, Z3$

In[•]:= `Collect[%, p1]`

Out[•]= $-\dfrac{p3}{2} + 2\, g\, p2\, z2\, Z3 + p1 \left(-\dfrac{i\, z3}{2} + i\, g\, z2^2\, Z3\right)$

In[•]:= `dp3 := -2 * D[H, Z3]`

In[•]:= `dp3`

Out[•]= $-2 \left(\dfrac{i\, p1\, p3}{4} + g\, p2\, P3\, z2 + \dfrac{1}{2}\, i\, g\, p1\, P3\, z2^2 - \dfrac{p1^2\, z3}{4} - i\, g\, p1\, p2\, z2\, Z3\right)$

In[•]:= `Expand[-2 (i p1 p3/4 + g p2 P3 z2 + 1/2 i g p1 P3 z2^2 - p1^2 z3/4 - i g p1 p2 z2 Z3)]`

Out[•]= $-\dfrac{1}{2}\, i\, p1\, p3 - 2\, g\, p2\, P3\, z2 - i\, g\, p1\, P3\, z2^2 + \dfrac{p1^2\, z3}{2} + 2\, i\, g\, p1\, p2\, z2\, Z3$

In[•]:= `z2st := s * Exp[I * t] + s^3 * v2`

In[ ]:= `z2st`

Out[ ]= $e^{i\,t}\,s + s^3\,v2$

In[ ]:= `p2st := s * w21 + s^3 * w23`

In[ ]:= `p2st`

Out[ ]= $s\,w21 + s^3\,w23$

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

In[ ]:= `H`

Out[ ]= $-2\,p0 - \dfrac{p2\,P2}{4} - \dfrac{p3\,P3}{4} + \dfrac{i\,P2\,z2}{4} - \dfrac{i\,p2\,Z2}{4} - \dfrac{z2\,Z2}{4} + \dfrac{i\,P3\,z3}{4} + G\,P2\,p3\,Z2\,z3 + \dfrac{1}{2}\,i\,G\,p3\,Z2^2\,z3 -$

$\dfrac{1}{2}\,i\,G\,P2\,Z2\,z3^2 - \dfrac{i\,p3\,Z3}{4} + g\,p2\,P3\,z2\,Z3 - \dfrac{1}{2}\,i\,g\,P3\,z2^2\,Z3 - \dfrac{z3\,Z3}{4} + \dfrac{1}{2}\,i\,g\,p2\,z2\,Z3^2$

In[ ]:= `dz2 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2, p2 → p2st, P2 → s * W21 + s^3 * W23}`

Out[ ]= $2\,\left(\dfrac{1}{4}\,i\,\left(e^{i\,t}\,s + s^3\,v2\right) + \dfrac{1}{4}\,\left(-s\,w21 - s^3\,w23\right) + G\,p3\,\left(e^{-i\,t}\,s + s^3\,V2\right)\,z3 - \dfrac{1}{2}\,i\,G\,\left(e^{-i\,t}\,s + s^3\,V2\right)\,z3^2\right)$

In[ ]:= $\text{Expand}\Big[2\,\Big(\dfrac{1}{4}\,i\,\left(e^{i\,t}\,s + s^3\,v2\right) +$

$\dfrac{1}{4}\,\left(-s\,w21 - s^3\,w23\right) + G\,p3\,\left(e^{-i\,t}\,s + s^3\,V2\right)\,z3 - \dfrac{1}{2}\,i\,G\,\left(e^{-i\,t}\,s + s^3\,V2\right)\,z3^2\Big)\Big]$

Out[ ]= $\dfrac{1}{2}\,i\,e^{i\,t}\,s + \dfrac{1}{2}\,i\,s^3\,v2 - \dfrac{s\,w21}{2} - \dfrac{s^3\,w23}{2} +$

$2\,e^{-i\,t}\,G\,p3\,s\,z3 + 2\,G\,p3\,s^3\,V2\,z3 - i\,e^{-i\,t}\,G\,s\,z3^2 - i\,G\,s^3\,V2\,z3^2$

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

Out[ ]= $s\,\left(\dfrac{1}{2}\,i\,e^{i\,t} - \dfrac{w21}{2} + 2\,e^{-i\,t}\,G\,p3\,z3 - i\,e^{-i\,t}\,G\,z3^2\right) + s^3\,\left(\dfrac{i\,v2}{2} - \dfrac{w23}{2} + 2\,G\,p3\,V2\,z3 - i\,G\,V2\,z3^2\right)$

In[ ]:= `z3st := c * s + s^3 * v3`

In[ ]:= `p3st := s * w31 + s^3 * w33`

In[ ]:= `dz2 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2,`
`p2 → p2st, P2 → s * W21 + s^3 * W23, z3 → z3st,`
`Z3 → k * s + s^3 * V3, p3 → p3st, P3 → s * W31 + s^3 * W33}`

Out[ ]= $2\,\Big(\dfrac{1}{4}\,i\,\left(e^{i\,t}\,s + s^3\,v2\right) - \dfrac{1}{2}\,i\,G\,\left(e^{-i\,t}\,s + s^3\,V2\right)\,\left(c\,s + s^3\,v3\right)^2 +$

$\dfrac{1}{4}\,\left(-s\,w21 - s^3\,w23\right) + G\,\left(e^{-i\,t}\,s + s^3\,V2\right)\,\left(c\,s + s^3\,v3\right)\,\left(s\,w31 + s^3\,w33\right)\Big)$

In[•]:= `Expand`$\left[2\left(\frac{1}{4}\,\mathrm{i}\,\left(e^{i\,t}\,s+s^3\,v2\right)-\frac{1}{2}\,\mathrm{i}\,G\,\left(e^{-i\,t}\,s+s^3\,V2\right)\left(c\,s+s^3\,v3\right)^2+\right.\right.$

$\left.\left.\frac{1}{4}\,\left(-s\,w21-s^3\,w23\right)+G\,\left(e^{-i\,t}\,s+s^3\,V2\right)\left(c\,s+s^3\,v3\right)\left(s\,w31+s^3\,w33\right)\right)\right]$

Out[•]= $\frac{1}{2}\,\mathrm{i}\,e^{i\,t}\,s-\mathrm{i}\,c^2\,e^{-i\,t}\,G\,s^3+\frac{1}{2}\,\mathrm{i}\,s^3\,v2-\mathrm{i}\,c^2\,G\,s^5\,V2-2\,\mathrm{i}\,c\,e^{-i\,t}\,G\,s^5\,v3-$

$2\,\mathrm{i}\,c\,G\,s^7\,V2\,v3-\mathrm{i}\,e^{-i\,t}\,G\,s^7\,v3^2-\mathrm{i}\,G\,s^9\,V2\,v3^2-\frac{s\,w21}{2}-\frac{s^3\,w23}{2}+$

$2\,c\,e^{-i\,t}\,G\,s^3\,w31+2\,c\,G\,s^5\,V2\,w31+2\,e^{-i\,t}\,G\,s^5\,v3\,w31+2\,G\,s^7\,V2\,v3\,w31+$

$2\,c\,e^{-i\,t}\,G\,s^5\,w33+2\,c\,G\,s^7\,V2\,w33+2\,e^{-i\,t}\,G\,s^7\,v3\,w33+2\,G\,s^9\,V2\,v3\,w33$

In[•]:= `Collect[%, s]`

Out[•]= $s\left(\frac{1}{2}\,\mathrm{i}\,e^{i\,t}-\frac{w21}{2}\right)+s^3\left(-\mathrm{i}\,c^2\,e^{-i\,t}\,G+\frac{\mathrm{i}\,v2}{2}-\frac{w23}{2}+2\,c\,e^{-i\,t}\,G\,w31\right)+$

$s^5\left(-\mathrm{i}\,c^2\,G\,V2-2\,\mathrm{i}\,c\,e^{-i\,t}\,G\,v3+2\,c\,G\,V2\,w31+2\,e^{-i\,t}\,G\,v3\,w31+2\,c\,e^{-i\,t}\,G\,w33\right)+$

$s^7\left(-2\,\mathrm{i}\,c\,G\,V2\,v3-\mathrm{i}\,e^{-i\,t}\,G\,v3^2+2\,G\,V2\,v3\,w31+2\,c\,G\,V2\,w33+2\,e^{-i\,t}\,G\,v3\,w33\right)+$

$s^9\left(-\mathrm{i}\,G\,V2\,v3^2+2\,G\,V2\,v3\,w33\right)$

In[•]:= `dp2 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2,`
`  p2 → p2st, P2 → s * W21 + s^3 * W23, z3 → z3st,`
`  Z3 → k * s + s^3 * V3, p3 → p3st, P3 → s * W31 + s^3 * W33}`

Out[•]= $-2\left(\frac{1}{4}\left(-e^{i\,t}\,s-s^3\,v2\right)-\frac{1}{4}\,\mathrm{i}\,\left(s\,w21+s^3\,w23\right)-\right.$

$\frac{1}{2}\,\mathrm{i}\,G\,\left(c\,s+s^3\,v3\right)^2\left(s\,W21+s^3\,W23\right)+\mathrm{i}\,G\,\left(e^{-i\,t}\,s+s^3\,V2\right)\left(c\,s+s^3\,v3\right)\left(s\,w31+s^3\,w33\right)+$

$\left.G\,\left(c\,s+s^3\,v3\right)\left(s\,W21+s^3\,W23\right)\left(s\,w31+s^3\,w33\right)\right)$

In[•]:= `Expand`$\left[-2\left(\frac{1}{4}\left(-e^{i\,t}\,s-s^3\,v2\right)-\frac{1}{4}\,\mathrm{i}\,\left(s\,w21+s^3\,w23\right)-\right.\right.$

$\frac{1}{2}\,\mathrm{i}\,G\,\left(c\,s+s^3\,v3\right)^2\left(s\,W21+s^3\,W23\right)+\mathrm{i}\,G\,\left(e^{-i\,t}\,s+s^3\,V2\right)\left(c\,s+s^3\,v3\right)\left(s\,w31+s^3\,w33\right)+$

$\left.\left.G\,\left(c\,s+s^3\,v3\right)\left(s\,W21+s^3\,W23\right)\left(s\,w31+s^3\,w33\right)\right)\right]$

Out[•]= $\frac{1}{2}\,e^{i\,t}\,s+\frac{s^3\,v2}{2}+\frac{\mathrm{i}\,s\,w21}{2}+\mathrm{i}\,c^2\,G\,s^3\,W21+2\,\mathrm{i}\,c\,G\,s^5\,v3\,W21+\mathrm{i}\,G\,s^7\,v3^2\,W21+\frac{1}{2}\,\mathrm{i}\,s^3\,w23+$

$\mathrm{i}\,c^2\,G\,s^5\,W23+2\,\mathrm{i}\,c\,G\,s^7\,v3\,W23+\mathrm{i}\,G\,s^9\,v3^2\,W23-2\,\mathrm{i}\,c\,e^{-i\,t}\,G\,s^3\,w31-2\,\mathrm{i}\,c\,G\,s^5\,V2\,w31-$

$2\,\mathrm{i}\,e^{-i\,t}\,G\,s^5\,v3\,w31-2\,\mathrm{i}\,G\,s^7\,V2\,v3\,w31-2\,c\,G\,s^3\,W21\,w31-2\,G\,s^5\,v3\,W21\,w31-2\,c\,G\,s^5\,W23\,w31-$

$2\,G\,s^7\,v3\,W23\,w31-2\,\mathrm{i}\,c\,e^{-i\,t}\,G\,s^5\,w33-2\,\mathrm{i}\,c\,G\,s^7\,V2\,w33-2\,\mathrm{i}\,e^{-i\,t}\,G\,s^7\,v3\,w33-$

$2\,\mathrm{i}\,G\,s^9\,V2\,v3\,w33-2\,c\,G\,s^5\,W21\,w33-2\,G\,s^7\,v3\,W21\,w33-2\,c\,G\,s^7\,W23\,w33-2\,G\,s^9\,v3\,W23\,w33$

In[●]:= `Collect[%, s]`

Out[●]= $s \left(\frac{e^{i\,t}}{2} + \frac{i\,w21}{2} \right) + s^3 \left(\frac{v2}{2} + i\,c^2\,G\,W21 + \frac{i\,w23}{2} - 2\,i\,c\,e^{-i\,t}\,G\,w31 - 2\,c\,G\,W21\,w31 \right) +$

$s^5 \left(2\,i\,c\,G\,v3\,W21 + i\,c^2\,G\,W23 - 2\,i\,c\,G\,V2\,w31 - 2\,i\,e^{-i\,t}\,G\,v3\,w31 - 2\,G\,v3\,W21\,w31 - 2\,c\,G\,W23\,w31 - 2\,i\,c\,e^{-i\,t}\,G\,w33 - 2\,c\,G\,W21\,w33 \right) +$

$s^7 \left(i\,G\,v3^2\,W21 + 2\,i\,c\,G\,v3\,W23 - 2\,i\,G\,V2\,v3\,w31 - 2\,G\,v3\,W23\,w31 - 2\,i\,c\,G\,V2\,w33 - 2\,i\,e^{-i\,t}\,G\,v3\,w33 - 2\,G\,v3\,W21\,w33 - 2\,c\,G\,W23\,w33 \right) +$

$s^9 \left(i\,G\,v3^2\,W23 - 2\,i\,G\,V2\,v3\,w33 - 2\,G\,v3\,W23\,w33 \right)$

In[●]:= `w21 := -I * Exp[I * t]`

In[●]:= `dz2`

Out[●]= $2 \left(-\frac{p2}{4} + \frac{i\,z2}{4} + G\,p3\,Z2\,z3 - \frac{1}{2}\,i\,G\,Z2\,z3^2 \right)$

In[●]:= $s \left(\frac{1}{2}\,i\,e^{i\,t} - \frac{w21}{2} \right) + s^3 \left(-i\,c^2\,e^{-i\,t}\,G + \frac{i\,v2}{2} - \frac{w23}{2} + 2\,c\,e^{-i\,t}\,G\,w31 \right)$

Out[●]= $i\,e^{i\,t}\,s + s^3 \left(-i\,c^2\,e^{-i\,t}\,G + \frac{i\,v2}{2} - \frac{w23}{2} + 2\,c\,e^{-i\,t}\,G\,w31 \right)$

In[●]:= $s \left(\frac{e^{i\,t}}{2} + \frac{i\,w21}{2} \right) + s^3 \left(\frac{v2}{2} + i\,c^2\,G\,W21 + \frac{i\,w23}{2} - 2\,i\,c\,e^{-i\,t}\,G\,w31 - 2\,c\,G\,W21\,w31 \right)$

Out[●]= $e^{i\,t}\,s + s^3 \left(\frac{v2}{2} + i\,c^2\,G\,W21 + \frac{i\,w23}{2} - 2\,i\,c\,e^{-i\,t}\,G\,w31 - 2\,c\,G\,W21\,w31 \right)$

In[●]:= `W21 := I * Exp[-I * t]`

In[●]:= `dz3 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2,`
`    p2 → p2st, P2 → s * W21 + s^3 * W23, z3 → z3st,`
`    Z3 → k * s + s^3 * V3, p3 → p3st, P3 → s * W31 + s^3 * W33}`

Out[●]= $2 \left(\frac{1}{4}\,i\,\left(c\,s + s^3\,v3 \right) - \frac{1}{2}\,i\,g\,\left(e^{i\,t}\,s + s^3\,v2 \right)^2 \left(k\,s + s^3\,V3 \right) + g\,\left(e^{i\,t}\,s + s^3\,v2 \right) \left(k\,s + s^3\,V3 \right) \left(-i\,e^{i\,t}\,s + s^3\,w23 \right) + \frac{1}{4}\,\left(-s\,w31 - s^3\,w33 \right) \right)$

In[●]:= $\text{Expand} \left[2 \left(\frac{1}{4}\,i\,\left(c\,s + s^3\,v3 \right) - \frac{1}{2}\,i\,g\,\left(e^{i\,t}\,s + s^3\,v2 \right)^2 \left(k\,s + s^3\,V3 \right) + g\,\left(e^{i\,t}\,s + s^3\,v2 \right) \left(k\,s + s^3\,V3 \right) \left(-i\,e^{i\,t}\,s + s^3\,w23 \right) + \frac{1}{4}\,\left(-s\,w31 - s^3\,w33 \right) \right) \right]$

Out[●]= $\frac{i\,c\,s}{2} - 3\,i\,e^{2\,i\,t}\,g\,k\,s^3 - 4\,i\,e^{i\,t}\,g\,k\,s^5\,v2 - i\,g\,k\,s^7\,v2^2 + \frac{1}{2}\,i\,s^3\,v3 - 3\,i\,e^{2\,i\,t}\,g\,s^5\,V3 - 4\,i\,e^{i\,t}\,g\,s^7\,v2\,V3 - i\,g\,s^9\,v2^2\,V3 + 2\,e^{i\,t}\,g\,k\,s^5\,w23 + 2\,g\,k\,s^7\,v2\,w23 + 2\,e^{i\,t}\,g\,s^7\,V3\,w23 + 2\,g\,s^9\,v2\,V3\,w23 - \frac{s\,w31}{2} - \frac{s^3\,w33}{2}$

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

Out[ ]= $s^5 \left(-4 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, k \, v2 - 3 \, \mathbb{i} \, e^{2 \, \mathbb{i} \, t} \, g \, V3 + 2 \, e^{\mathbb{i} \, t} \, g \, k \, w23\right) +$
$\quad s^7 \left(-\mathbb{i} \, g \, k \, v2^2 - 4 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, v2 \, V3 + 2 \, g \, k \, v2 \, w23 + 2 \, e^{\mathbb{i} \, t} \, g \, V3 \, w23\right) +$
$\quad s^9 \left(-\mathbb{i} \, g \, v2^2 \, V3 + 2 \, g \, v2 \, V3 \, w23\right) + s \left(\frac{\mathbb{i} \, c}{2} - \frac{w31}{2}\right) + s^3 \left(-3 \, \mathbb{i} \, e^{2 \, \mathbb{i} \, t} \, g \, k + \frac{\mathbb{i} \, v3}{2} - \frac{w33}{2}\right)$

In[ ]:= **dp3 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2,**
  p2 → p2st, P2 → s * W21 + s^3 * W23, z3 → z3st,
  Z3 → k * s + s^3 * V3, p3 → p3st, P3 → s * W31 + s^3 * W33}

Out[ ]= $-2 \left(\frac{1}{4} \left(-c \, s - s^3 \, v3\right) + \mathbb{i} \, g \left(e^{\mathbb{i} \, t} \, s + s^3 \, v2\right) \left(k \, s + s^3 \, V3\right) \left(-\mathbb{i} \, e^{\mathbb{i} \, t} \, s + s^3 \, w23\right) - \frac{1}{4} \, \mathbb{i} \left(s \, w31 + s^3 \, w33\right) -\right.$
$\quad \left. \frac{1}{2} \, \mathbb{i} \, g \left(e^{\mathbb{i} \, t} \, s + s^3 \, v2\right)^2 \left(s \, W31 + s^3 \, W33\right) + g \left(e^{\mathbb{i} \, t} \, s + s^3 \, v2\right) \left(-\mathbb{i} \, e^{\mathbb{i} \, t} \, s + s^3 \, w23\right) \left(s \, W31 + s^3 \, W33\right)\right)$

In[ ]:= **Expand[%99]**

Out[ ]= $\frac{c \, s}{2} - 2 \, e^{2 \, \mathbb{i} \, t} \, g \, k \, s^3 - 2 \, e^{\mathbb{i} \, t} \, g \, k \, s^5 \, v2 + \frac{s^3 \, v3}{2} - 2 \, e^{2 \, \mathbb{i} \, t} \, g \, s^5 \, V3 - 2 \, e^{\mathbb{i} \, t} \, g \, s^7 \, v2 \, V3 - 2 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, k \, s^5 \, w23 -$
$\quad 2 \, \mathbb{i} \, g \, k \, s^7 \, v2 \, w23 - 2 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, s^7 \, V3 \, w23 - 2 \, \mathbb{i} \, g \, s^9 \, v2 \, V3 \, w23 + \frac{\mathbb{i} \, s \, w31}{2} + 3 \, \mathbb{i} \, e^{2 \, \mathbb{i} \, t} \, g \, s^3 \, W31 +$
$\quad 4 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, s^5 \, v2 \, W31 + \mathbb{i} \, g \, s^7 \, v2^2 \, W31 - 2 \, e^{\mathbb{i} \, t} \, g \, s^5 \, w23 \, W31 - 2 \, g \, s^7 \, v2 \, w23 \, W31 + \frac{1}{2} \, \mathbb{i} \, s^3 \, w33 +$
$\quad 3 \, \mathbb{i} \, e^{2 \, \mathbb{i} \, t} \, g \, s^5 \, W33 + 4 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, s^7 \, v2 \, W33 + \mathbb{i} \, g \, s^9 \, v2^2 \, W33 - 2 \, e^{\mathbb{i} \, t} \, g \, s^7 \, w23 \, W33 - 2 \, g \, s^9 \, v2 \, w23 \, W33$

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

Out[ ]= $s \left(\frac{c}{2} + \frac{\mathbb{i} \, w31}{2}\right) + s^3 \left(-2 \, e^{2 \, \mathbb{i} \, t} \, g \, k + \frac{v3}{2} + 3 \, \mathbb{i} \, e^{2 \, \mathbb{i} \, t} \, g \, W31 + \frac{\mathbb{i} \, w33}{2}\right) +$
$\quad s^5 \left(-2 \, e^{\mathbb{i} \, t} \, g \, k \, v2 - 2 \, e^{2 \, \mathbb{i} \, t} \, g \, V3 - 2 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, k \, w23 +\right.$
$\quad\quad \left. 4 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, v2 \, W31 - 2 \, e^{\mathbb{i} \, t} \, g \, w23 \, W31 + 3 \, \mathbb{i} \, e^{2 \, \mathbb{i} \, t} \, g \, W33\right) +$
$\quad s^7 \left(-2 \, e^{\mathbb{i} \, t} \, g \, v2 \, V3 - 2 \, \mathbb{i} \, g \, k \, v2 \, w23 - 2 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, V3 \, w23 + \mathbb{i} \, g \, v2^2 \, W31 - 2 \, g \, v2 \, w23 \, W31 +\right.$
$\quad\quad \left. 4 \, \mathbb{i} \, e^{\mathbb{i} \, t} \, g \, v2 \, W33 - 2 \, e^{\mathbb{i} \, t} \, g \, w23 \, W33\right) + s^9 \left(-2 \, \mathbb{i} \, g \, v2 \, V3 \, w23 + \mathbb{i} \, g \, v2^2 \, W33 - 2 \, g \, v2 \, w23 \, W33\right)$

In[ ]:= **w31 := I * c**

In[ ]:= **W31 := -I * k**

In[ ]:= **dz3 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2,**
  p2 → p2st, P2 → s * W21 + s^3 * W23, z3 → z3st,
  Z3 → k * s + s^3 * V3, p3 → p3st, P3 → s * W31 + s^3 * W33}

Out[ ]= $2 \left(\frac{1}{4} \, \mathbb{i} \left(c \, s + s^3 \, v3\right) - \frac{1}{2} \, \mathbb{i} \, g \left(e^{\mathbb{i} \, t} \, s + s^3 \, v2\right)^2 \left(k \, s + s^3 \, V3\right) +\right.$
$\quad \left. g \left(e^{\mathbb{i} \, t} \, s + s^3 \, v2\right) \left(k \, s + s^3 \, V3\right) \left(-\mathbb{i} \, e^{\mathbb{i} \, t} \, s + s^3 \, w23\right) + \frac{1}{4} \left(-\mathbb{i} \, c \, s - s^3 \, w33\right)\right)$

In[•]:= `Expand[2 (`$\frac{1}{4}$` i (c s + s^3 v3) - `$\frac{1}{2}$` i g (e^{i t} s + s^3 v2)^2 (k s + s^3 V3) +`

   `g (e^{i t} s + s^3 v2) (k s + s^3 V3) (-i e^{i t} s + s^3 w23) + `$\frac{1}{4}$` (-i c s - s^3 w33))]`

Out[•]= $-3\,i\,e^{2 i t} g\,k\,s^3 - 4\,i\,e^{i t} g\,k\,s^5 v2 - i\,g\,k\,s^7 v2^2 + \frac{1}{2}\,i\,s^3 v3 - 3\,i\,e^{2 i t} g\,s^5 V3 - 4\,i\,e^{i t} g\,s^7 v2\,V3 -$

$i\,g\,s^9 v2^2 V3 + 2\,e^{i t} g\,k\,s^5 w23 + 2\,g\,k\,s^7 v2\,w23 + 2\,e^{i t} g\,s^7 V3\,w23 + 2\,g\,s^9 v2\,V3\,w23 - \frac{s^3 w33}{2}$

In[•]:= `Collect[%, s]`

Out[•]= $s^5 \left(-4\,i\,e^{i t} g\,k\,v2 - 3\,i\,e^{2 i t} g\,V3 + 2\,e^{i t} g\,k\,w23\right) +$

$s^7 \left(-i\,g\,k\,v2^2 - 4\,i\,e^{i t} g\,v2\,V3 + 2\,g\,k\,v2\,w23 + 2\,e^{i t} g\,V3\,w23\right) +$

$s^9 \left(-i\,g\,v2^2 V3 + 2\,g\,v2\,V3\,w23\right) + s^3 \left(-3\,i\,e^{2 i t} g\,k + \frac{i\,v3}{2} - \frac{w33}{2}\right)$

In[•]:= `dp3 /. {z2 → z2st, Z2 → s * Exp[-I * t] + s^3 * V2,`
   `p2 → p2st, P2 → s * W21 + s^3 * W23, z3 → z3st,`
   `Z3 → k * s + s^3 * V3, p3 → p3st, P3 → s * W31 + s^3 * W33}`

Out[•]= $-2 \left(\frac{1}{4} \left(-c\,s - s^3 v3\right) + i\,g \left(e^{i t} s + s^3 v2\right) \left(k\,s + s^3 V3\right) \left(-i\,e^{i t} s + s^3 w23\right) -\right.$

$\frac{1}{4}\,i \left(i\,c\,s + s^3 w33\right) - \frac{1}{2}\,i\,g \left(e^{i t} s + s^3 v2\right)^2 \left(-i\,k\,s + s^3 W33\right) +$

$\left. g \left(e^{i t} s + s^3 v2\right) \left(-i\,e^{i t} s + s^3 w23\right) \left(-i\,k\,s + s^3 W33\right)\right)$

In[•]:= `Expand[%107]`

Out[•]= $e^{2 i t} g\,k\,s^3 + 2\,e^{i t} g\,k\,s^5 v2 + g\,k\,s^7 v2^2 + \frac{s^3 v3}{2} - 2\,e^{2 i t} g\,s^5 V3 - 2\,e^{i t} g\,s^7 v2\,V3 -$

$2\,i\,e^{i t} g\,s^7 V3\,w23 - 2\,i\,g\,s^9 v2\,V3\,w23 + \frac{1}{2}\,i\,s^3 w33 + 3\,i\,e^{2 i t} g\,s^5 W33 +$

$4\,i\,e^{i t} g\,s^7 v2\,W33 + i\,g\,s^9 v2^2 W33 - 2\,e^{i t} g\,s^7 w23\,W33 - 2\,g\,s^9 v2\,w23\,W33$

In[•]:= `Collect[%, s]`

Out[•]= $s^3 \left(e^{2 i t} g\,k + \frac{v3}{2} + \frac{i\,w33}{2}\right) + s^5 \left(2\,e^{i t} g\,k\,v2 - 2\,e^{2 i t} g\,V3 + 3\,i\,e^{2 i t} g\,W33\right) +$

$s^7 \left(g\,k\,v2^2 - 2\,e^{i t} g\,v2\,V3 - 2\,i\,e^{i t} g\,V3\,w23 + 4\,i\,e^{i t} g\,v2\,W33 - 2\,e^{i t} g\,w23\,W33\right) +$

$s^9 \left(-2\,i\,g\,v2\,V3\,w23 + i\,g\,v2^2 W33 - 2\,g\,v2\,w23\,W33\right)$

In[•]:= `dz2trunc := s (`$\frac{1}{2}$` i e^{i t} - `$\frac{w21}{2}$`) + s^3 (-i c^2 e^{-i t} G + `$\frac{i\,v2}{2}$` - `$\frac{w23}{2}$` + 2 c e^{-i t} G w31)`

In[•]:= `dz2trunc`

Out[•]= $i\,e^{i t} s + s^3 \left(i\,c^2 e^{-i t} G + \frac{i\,v2}{2} - \frac{w23}{2}\right)$

In[•]:= `dp2trunc := s (`$\frac{e^{i t}}{2}$` + `$\frac{i\,w21}{2}$`) + s^3 (`$\frac{v2}{2}$` + i c^2 G W21 + `$\frac{i\,w23}{2}$` - 2 i c e^{-i t} G w31 - 2 c G W21 w31)`

In[•]:= **dp2trunc**

Out[•]= $e^{i\,t}\,s + s^3\,\left(3\,c^2\,e^{-i\,t}\,G + \dfrac{v2}{2} + \dfrac{i\,w23}{2}\right)$

In[•]:= **dz3trunc := s $\left(\dfrac{i\,c}{2} - \dfrac{w31}{2}\right)$ + s^3 $\left(-3\,i\,e^{2\,i\,t}\,g\,k + \dfrac{i\,v3}{2} - \dfrac{w33}{2}\right)$**

In[•]:= **dz3trunc**

Out[•]= $s^3\,\left(-3\,i\,e^{2\,i\,t}\,g\,k + \dfrac{i\,v3}{2} - \dfrac{w33}{2}\right)$

In[•]:= **dp3trunc := s^3 $\left(e^{2\,i\,t}\,g\,k + \dfrac{v3}{2} + \dfrac{i\,w33}{2}\right)$**

In[•]:= **dp3trunc**

Out[•]= $s^3\,\left(e^{2\,i\,t}\,g\,k + \dfrac{v3}{2} + \dfrac{i\,w33}{2}\right)$

In[•]:= **DSolve$\left[\left\{l'[t] == i\,c^2\,e^{-i\,t}\,G + \dfrac{i\,l[t]}{2} - \dfrac{m[t]}{2},\right.\right.$**

   $\left.\left. m'[t] == 3\,c^2\,e^{-i\,t}\,G + \dfrac{l[t]}{2} + \dfrac{i\,m[t]}{2}\right\}, \{l[t], m[t]\}, t\right]$

Out[•]= $\left\{\left\{l[t] \to c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(-1 + e^{i\,t}\right)\,G\,\text{Cos}\!\left[\dfrac{t}{2}\right] + e^{\frac{i\,t}{2}}\,C[1]\,\text{Cos}\!\left[\dfrac{t}{2}\right] - \right.\right.$
$\left. i\,c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(1 + e^{i\,t}\right)\,G\,\text{Sin}\!\left[\dfrac{t}{2}\right] - e^{\frac{i\,t}{2}}\,C[2]\,\text{Sin}\!\left[\dfrac{t}{2}\right], m[t] \to i\,c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(1 + e^{i\,t}\right)\,G\,\text{Cos}\!\left[\dfrac{t}{2}\right] + \right.$
$\left.\left. e^{\frac{i\,t}{2}}\,C[2]\,\text{Cos}\!\left[\dfrac{t}{2}\right] + c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(-1 + e^{i\,t}\right)\,G\,\text{Sin}\!\left[\dfrac{t}{2}\right] + e^{\frac{i\,t}{2}}\,C[1]\,\text{Sin}\!\left[\dfrac{t}{2}\right]\right\}\right\}$

In[•]:= **c^2 e$^{-\frac{3\,i\,t}{2}}$ $\left(-1 + e^{i\,t}\right)$ G Cos$\left[\dfrac{t}{2}\right]$ - i c^2 e$^{-\frac{3\,i\,t}{2}}$ $\left(1 + e^{i\,t}\right)$ G Sin$\left[\dfrac{t}{2}\right]$**

Out[•]= $c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(-1 + e^{i\,t}\right)\,G\,\text{Cos}\!\left[\dfrac{t}{2}\right] - i\,c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(1 + e^{i\,t}\right)\,G\,\text{Sin}\!\left[\dfrac{t}{2}\right]$

In[•]:= **TrigReduce$\left[c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(-1 + e^{i\,t}\right)\,G\,\text{Cos}\!\left[\dfrac{t}{2}\right] - i\,c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(1 + e^{i\,t}\right)\,G\,\text{Sin}\!\left[\dfrac{t}{2}\right]\right]$**

Out[•]= 0

In[•]:= **c^2 e$^{-\frac{3\,i\,t}{2}}$ $\left(-1 + e^{i\,t}\right)$ G Cos$\left[\dfrac{t}{2}\right]$ + e$^{\frac{i\,t}{2}}$ C[1] Cos$\left[\dfrac{t}{2}\right]$ - i c^2 e$^{-\frac{3\,i\,t}{2}}$ $\left(1 + e^{i\,t}\right)$ G Sin$\left[\dfrac{t}{2}\right]$ - e$^{\frac{i\,t}{2}}$ C[2] Sin$\left[\dfrac{t}{2}\right]$**

Out[•]= $c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(-1 + e^{i\,t}\right)\,G\,\text{Cos}\!\left[\dfrac{t}{2}\right] + e^{\frac{i\,t}{2}}\,C[1]\,\text{Cos}\!\left[\dfrac{t}{2}\right] - i\,c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(1 + e^{i\,t}\right)\,G\,\text{Sin}\!\left[\dfrac{t}{2}\right] - e^{\frac{i\,t}{2}}\,C[2]\,\text{Sin}\!\left[\dfrac{t}{2}\right]$

In[•]:= **TrigReduce$\left[c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(-1 + e^{i\,t}\right)\,G\,\text{Cos}\!\left[\dfrac{t}{2}\right] + \right.$**

   $\left. e^{\frac{i\,t}{2}}\,C[1]\,\text{Cos}\!\left[\dfrac{t}{2}\right] - i\,c^2\,e^{-\frac{3\,i\,t}{2}}\,\left(1 + e^{i\,t}\right)\,G\,\text{Sin}\!\left[\dfrac{t}{2}\right] - e^{\frac{i\,t}{2}}\,C[2]\,\text{Sin}\!\left[\dfrac{t}{2}\right]\right]$

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

$\textit{In[\circ]:=}$ $\dot{\mathbb{i}}\, c^2\, e^{-\frac{3\,\dot{\mathbb{i}}\,t}{2}}\, \left(1 + e^{\dot{\mathbb{i}}\,t}\right) G \cos\left[\frac{t}{2}\right] + c^2\, e^{-\frac{3\,\dot{\mathbb{i}}\,t}{2}}\, \left(-1 + e^{\dot{\mathbb{i}}\,t}\right) G \sin\left[\frac{t}{2}\right]$

$\textit{Out[\circ]=}$ $\dot{\mathbb{i}}\, c^2\, e^{-\frac{3\,\dot{\mathbb{i}}\,t}{2}}\, \left(1 + e^{\dot{\mathbb{i}}\,t}\right) G \cos\left[\frac{t}{2}\right] + c^2\, e^{-\frac{3\,\dot{\mathbb{i}}\,t}{2}}\, \left(-1 + e^{\dot{\mathbb{i}}\,t}\right) G \sin\left[\frac{t}{2}\right]$

$\textit{In[\circ]:=}$ $\texttt{TrigReduce}\left[\dot{\mathbb{i}}\, c^2\, e^{-\frac{3\,\dot{\mathbb{i}}\,t}{2}}\, \left(1 + e^{\dot{\mathbb{i}}\,t}\right) G \cos\left[\frac{t}{2}\right] + c^2\, e^{-\frac{3\,\dot{\mathbb{i}}\,t}{2}}\, \left(-1 + e^{\dot{\mathbb{i}}\,t}\right) G \sin\left[\frac{t}{2}\right]\right]$

$\textit{Out[\circ]=}$ $2\,\dot{\mathbb{i}}\, c^2\, e^{-\dot{\mathbb{i}}\,t}\, G$