

> restart;with(Riemann):with(TensorPack): with(Canon):CDF(0): CDS(index):

Chapter XX Tensor analysis using indices - Senovilla et al. - Shearfree for acceleration parallel to vorticity if $\sigma_{ab}=0 \Rightarrow \omega \Theta = 0$

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eq72b - omega[a]*cod(-a) contraction of SSSeq72

> read "EFE" : read "SFE" :read "fids" :read "Seneqs80" :

> SSSeq72 := ((3 * p'^2/Psi^2 + 1/3) * theta^2 - 2 * (Psi^2 + 1) * omega^2 + 1/2 * mu + 3

/2 * p) * p'/Psi^2 = (3 * (p'/Psi)^2 + 1/3 - PU * p''/p') * omega^2 : T(%);

$$\frac{\left(\left(\frac{3p^2}{\Psi^2} + \frac{1}{3} \right) \theta^2 - 2(\Psi^2 + 1)\omega^2 + \frac{1}{2}\mu + \frac{3}{2}p \right) p'}{\Psi^2} = \left(\frac{3p^2}{\Psi^2} + \frac{1}{3} - \frac{PU p''}{p'} \right) \omega^2 \quad (1.1)$$

proof of eq72b: We commence with SSSeq72:

> temp := eq[72] : T(%);

$$\frac{\left(\left(\frac{3p^2}{\Psi^2} + \frac{1}{3} \right) \theta^2 - 2(\Psi^2 + 1)\omega^2 + \frac{1}{2}\mu + \frac{3}{2}p \right) p'}{\Psi^2} = \left(\frac{3p^2}{\Psi^2} + \frac{1}{3} - \frac{PU p''}{p'} \right) \omega^2 \quad (1.2)$$

> temp1 := expand(6 * Psi^4 * p' * (expand(rhs(temp)) - lhs(temp)) : T(%);

$$\begin{aligned} & -6PU\Psi^4\omega^2 p'' + 12\Psi^4\omega^2 p^2 + 2\Psi^4\omega^2 p' + 18\Psi^2\omega^2 p^3 + 12\Psi^2\omega^2 p^2 - 2\Psi^2 p^2 \theta^2 \\ & - 18p^4 \theta^2 - 3\Psi^2 \mu p^2 - 9\Psi^2 p p^2 = 0 \end{aligned} \quad (1.3)$$

taking the covariant derivative:

> temp2 := cod(temp1, -a) : T(%);

$$\begin{aligned} & -3\Psi^2 p^2 \mu_{;a} - 72p^3 p'_{;a} \theta^2 - 9\Psi^2 p^2 p_{;a} - 36p^4 \theta \theta_{;a} + 2\Psi^4 p'_{;a} \omega^2 \\ & - 12\Psi^4 \omega \omega_{;a} PU p'' - 24\Psi^3 \Psi_{;a} \omega^2 PU p'' - 6\Psi^4 \omega^2 PU p''_{;a} + 24\Psi^4 p' p'_{;a} \omega^2 \\ & - 6\Psi^4 \omega^2 PU_{;a} p'' + 24\Psi^4 p^2 \omega \omega_{;a} + 48\Psi^3 \Psi_{;a} p^2 \omega^2 + 4\Psi^4 p' \omega \omega_{;a} \\ & + 8\Psi^3 \Psi_{;a} p' \omega^2 + 54\Psi^2 p^2 p'_{;a} \omega^2 + 36\Psi^2 p^3 \omega \omega_{;a} + 36\Psi \Psi_{;a} p^3 \omega^2 \\ & + 24\Psi^2 p' p'_{;a} \omega^2 + 24\Psi^2 p^2 \omega \omega_{;a} - 4\Psi^2 p^2 \theta \theta_{;a} - 4\Psi^2 p' p'_{;a} \theta^2 \\ & + 24\Psi \Psi_{;a} p^2 \omega^2 - 4\Psi \Psi_{;a} p^2 \theta^2 - 6\Psi^2 p' p'_{;a} \mu - 18\Psi^2 p' p'_{;a} p - 6\Psi \Psi_{;a} p^2 \mu \\ & - 18\Psi \Psi_{;a} p^2 p = 0 \end{aligned} \quad (1.4)$$

and contract by omega[a]

> temp3 := expand(omega[a] * temp2) : T(%);

$$\begin{aligned}
& -72 p^3 \theta^2 \omega^a p'_{;a} - 3 \Psi^2 p^2 \mu_{;a} \omega^a - 9 \Psi^2 p^2 \omega^a p'_{;a} + 2 \Psi^4 \omega^2 \omega^a p'_{;a} \\
& - 36 p^4 \theta \omega^a \theta_{;a} - 24 PU \Psi^3 \omega^2 p'' \Psi_{;a} \omega^a - 12 PU \Psi^4 \omega p'' \omega^a \omega_{;a} \\
& - 18 \Psi p p^2 \Psi_{;a} \omega^a - 6 PU \Psi^4 \omega^2 \omega^a p''_{;a} + 24 \Psi^4 \omega^2 p' \omega^a p'_{;a} \\
& - 6 \Psi^4 \omega^2 p'' PU_{;a} \omega^a + 24 \Psi^4 \omega p^2 \omega^a \omega_{;a} + 48 \Psi^3 \omega^2 p^2 \Psi_{;a} \omega^a \\
& + 4 \Psi^4 \omega p' \omega^a \omega_{;a} + 8 \Psi^3 \omega^2 p' \Psi_{;a} \omega^a + 54 \Psi^2 \omega^2 p^2 \omega^a p'_{;a} \\
& + 36 \Psi^2 \omega p^3 \omega^a \omega_{;a} + 36 \Psi \omega^2 p^3 \Psi_{;a} \omega^a + 24 \Psi^2 \omega^2 p' \omega^a p'_{;a} \\
& + 24 \Psi^2 \omega p^2 \omega^a \omega_{;a} - 4 \Psi^2 p^2 \theta \omega^a \theta_{;a} - 4 \Psi^2 p' \theta^2 \omega^a p'_{;a} + 24 \Psi \omega^2 p^2 \Psi_{;a} \omega^a \\
& - 4 \Psi p^2 \theta^2 \Psi_{;a} \omega^a - 6 \Psi^2 \mu p' \omega^a p'_{;a} - 18 \Psi^2 p p' \omega^a p'_{;a} - 6 \Psi \mu p^2 \Psi_{;a} \omega^a = 0
\end{aligned} \tag{1.5}$$

Now we use the following identities:

$$\begin{aligned}
& > \text{temp4} := p'[-A] = p''' \cdot PU \cdot u[-a] \cdot \theta - \frac{p'' \cdot PU \cdot du[-a]}{p'} : T(\%); \\
& \quad p'_{;a} = p'' PU u_a \theta - \frac{p'' PU du_a}{p'}
\end{aligned} \tag{1.6}$$

$$\begin{aligned}
& > \text{temp5} := \text{TEDS}(du[-a] \cdot \omega[a] = \Psi \cdot \omega^2, \text{TEDS}(\omega[a] \cdot u[-a] = 0, \text{expand}(\omega[a] \\
& \quad \cdot \text{temp4}))) : T(\%); \\
& \quad \omega^a p'_{;a} = - \frac{PU p'' \Psi \omega^2}{p'}
\end{aligned} \tag{1.7}$$

$$\begin{aligned}
& > \text{temp6} := \text{eq}[71] : T(\%); \\
& \quad \Psi_{;a} \omega^a = \left(\frac{3 p^2}{\Psi^2} + \frac{1}{3} \right) \theta^2 - 2 (\Psi^2 + 1) \omega^2 + \frac{1}{2} \mu + \frac{3}{2} p
\end{aligned} \tag{1.8}$$

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$$\begin{aligned}
& > \text{temp7} := p'''[-A] = p'''' \cdot PU \cdot \theta \cdot u[-a] - p'''' \cdot PU / p' \cdot du[-a] : T(\%); \\
& \quad p''_{;a} = p'''' PU \theta u_a - \frac{p'''' PU du_a}{p'}
\end{aligned} \tag{1.9}$$

and so

$$\begin{aligned}
& > \text{temp8} := \text{TEDS}(du[-a] \cdot \omega[a] = \Psi \cdot \omega^2, \text{TEDS}(\omega[a] \cdot u[-a] = 0, \text{expand}(\omega[a] \\
& \quad \cdot \text{temp7}))) : T(\%); \\
& \quad \omega^a p''_{;a} = - \frac{p'''' PU \Psi \omega^2}{p'}
\end{aligned} \tag{1.10}$$

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also

> temp9 := subs(a=-a, A=-A, mu[A]=PU*theta*u[a]-PU*du[a]/p') : T(%);

$$\mu_{;a} = PU\theta u_a - \frac{PU du_a}{p'} \quad (1.11)$$

> temp10 := p'[-A] = p'·mu[-A] : T(%);

$$p_{;a} = p'\mu_{;a} \quad (1.12)$$

> temp11 := expand(TEDS(temp9, expand(MTELS([temp9, temp10], cod(PU=p + mu, -a)))) : T(%);

$$PU_{;a} = PU\theta u_a p' + PU\theta u_a - PU du_a - \frac{PU du_a}{p'} \quad (1.13)$$

hence

> temp12 := TEDS(omega[a]·u[-a]=0, expand(omega[a]·temp11)) : T(%);

$$\omega^a PU_{;a} = -\frac{PU du_a (p'+1) \omega^a}{p'} \quad (1.14)$$

>

and also

> temp13 := TEDS(omega[a]·u[-a]=0, expand(omega[a]·eq[66])) : T(%);

$$\omega^a \theta_{;a} = \frac{3 \omega^a p' \theta \omega_a}{\Psi} \quad (1.15)$$

> temp14 := TEDS(omega[a]·u[-a]=0, expand(omega[a]·temp9)) : T(%);

$$\omega^a \mu_{;a} = -\frac{\omega^a PU du_a}{p'} \quad (1.16)$$

and so we subs these (temps 5,6,8,9,10,12,13,14) all into the original equation, plus other identities:

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> temp15 := factor(expand(p'·Psi·expand(TEDS(PU=p + mu, TEDS(omega[a]·omega[-a] = ω², expand(TEDS(du[-a]·omega[a]=Psi·ω², expand(TEDS(omega[a]·u[-a]=0, expand(TEDS(temp14, expand(TEDS(temp13, expand(TEDS(temp12, expand(TEDS(temp10, expand(TEDS(temp9, expand(TEDS(temp8, expand(TEDS(temp6, expand(TEDS(temp5, temp3)))))))))))))))))))))) : T(%);

$$12 \Psi^6 \mu \omega^4 p p''' + 30 \Psi^6 \omega^4 p'' p' \mu + 30 \Psi^6 \omega^4 p'' p' p - 54 \Psi^4 p^2 \omega^4 p'' \mu \quad (1.17)$$

$$- 54 \Psi^4 p^2 \omega^4 p'' p + 24 \Psi^4 \omega^4 p'' p' \mu + 24 \Psi^4 \omega^4 p'' p' p - 6 \Psi^4 \mu^2 p'' \omega^2 p'$$

$$- 18 \Psi^4 p^2 p'' \omega^2 p' - 4 \Psi^4 \theta^2 p'' \omega^2 p' \mu - 4 \Psi^4 \theta^2 p'' \omega^2 p' p - 24 \Psi^4 \mu p'' \omega^2 p' p$$

$$+ 6 \Psi^6 \mu^2 \omega^4 p''' + 6 \Psi^6 \omega^4 p^2 p''' + 4 \Psi^6 \omega^4 p'' \mu + 4 \Psi^6 \omega^4 p'' p - 12 p^5 \theta^4$$

$$- \frac{4}{3} \Psi^2 p^3 \theta^4 - 18 \mu p^5 \theta^2 - 3 \Psi^2 \mu^2 p^3 - 54 p p^5 \theta^2 - 27 \Psi^2 p^2 p^3 - 96 \Psi^6 \omega^4 p^3$$

$$- 144 \Psi^4 \omega^4 p^3 - 16 \Psi^6 \omega^4 p^2 - 16 \Psi^4 \omega^4 p^2 - 72 \Psi^4 \omega^4 p^4 - 72 \Psi^2 \omega^4 p^4$$

$$\begin{aligned}
& -48 \Psi^2 \omega^4 p^3 + 72 \omega^2 p^5 \theta^2 - 4 \Psi^2 \mu p^3 \theta^2 - 12 \Psi^2 p p^3 \theta^2 + 45 \Psi^4 \mu \omega^2 p^3 \\
& + 24 \Psi^2 \mu \omega^2 p^3 - 18 \Psi^2 \mu p p^3 + 117 \Psi^4 \omega^2 p p^3 + 72 \Psi^2 \omega^2 p p^3 + 144 \Psi^2 \omega^2 p^5 \theta^2 \\
& + \frac{8}{3} \Psi^4 \omega^2 p^2 \theta^2 + 24 \Psi^2 \omega^2 p^4 \theta^2 + 7 \Psi^4 \mu \omega^2 p^2 + 15 \Psi^4 \omega^2 p p^2 + 18 \Psi^2 \mu \omega^2 p^4 \\
& + 54 \Psi^2 \omega^2 p p^4 + 24 \Psi^4 \omega^2 p^3 \theta^2 + 16 \Psi^2 \omega^2 p^3 \theta^2 + 24 \Psi^5 \omega p^3 \omega^a \omega_{;a} \\
& + 4 \Psi^5 \omega p^2 \omega^a \omega_{;a} + 36 \Psi^3 \omega p^4 \omega^a \omega_{;a} + 24 \Psi^3 \omega p^3 \omega^a \omega_{;a} \\
& - 12 p' \Psi^5 \mu \omega p'' \omega^a \omega_{;a} - 12 p' \Psi^5 \omega p p'' \omega^a \omega_{;a} = 0
\end{aligned}$$

> temp15a := collect(temp15, [p''', Psi, omega]) : T(%);

$$\begin{aligned}
& (6 \mu^2 + 12 \mu p + 6 p^2) \omega^4 \Psi^6 p''' + (30 \mu p' p'' + 30 p p' p'' - 96 p^3 + 4 \mu p'' + 4 p p'' \\
& - 16 p^2) \omega^4 \Psi^6 + (-12 \mu p' p'' \omega^a \omega_{;a} - 12 p p' p'' \omega^a \omega_{;a} + 24 p^3 \omega^a \omega_{;a} \\
& + 4 p^2 \omega^a \omega_{;a}) \omega \Psi^5 + \left((-54 \mu p^2 p'' - 54 p p^2 p'' - 72 p^4 + 24 \mu p' p'' + 24 p p' p'' \right. \\
& \left. - 144 p^3 - 16 p^2) \omega^4 + \left(-6 \mu^2 p'' p' - 18 p^2 p'' p' - 4 \theta^2 p'' p' \mu - 4 \theta^2 p'' p' p \right. \right. \\
& \left. \left. - 24 \mu p'' p' p + 45 \mu p^3 + 117 p p^3 + \frac{8}{3} p^2 \theta^2 + 7 \mu p^2 + 15 p p^2 + 24 p^3 \theta^2 \right) \omega^2 \right) \\
& \Psi^4 + (36 p^4 \omega^a \omega_{;a} + 24 p^3 \omega^a \omega_{;a}) \omega \Psi^3 + \left((-72 p^4 - 48 p^3) \omega^4 + (144 p^5 \theta^2 \right. \\
& \left. + 24 p^4 \theta^2 + 18 \mu p^4 + 54 p p^4 + 16 p^3 \theta^2 + 24 \mu p^3 + 72 p p^3) \omega^2 - \frac{4}{3} p^3 \theta^4 \right. \\
& \left. - 3 \mu^2 p^3 - 27 p^2 p^3 - 4 \mu p^3 \theta^2 - 12 p p^3 \theta^2 - 18 \mu p p^3 \right) \Psi^2 + 72 \omega^2 p^5 \theta^2 \\
& - 12 p^5 \theta^4 - 18 \mu p^5 \theta^2 - 54 p p^5 \theta^2 = 0
\end{aligned} \tag{1.18}$$

from eq72a

> temp72a := (6 * mu^2 + 12 * mu * p + 6 * p^2) * omega^4 * Psi^6 * p''' = - (-78 * mu * p' * p''' - 78 * p * p' * p''' + 24 / p' * mu^2 * p'''^2 + 24 / p' * p^2 * p'''^2 - 4 * p''' * mu - 4 * p''' * p + 4 * p''^2 + 48 / p' * mu * p'''^2 * p + 24 * p''^3) * omega^4 * Psi^6 - ((-162 * mu * p''^2 * p''' - 162 * p * p''^2 * p''' + 180 * p''^4 - 48 * mu * p' * p''' - 48 * p * p' * p''' + 36 * p''^3 - 8 * p''^2) * omega^4 + (9 * mu * p''^3 + 9 * p * p''^3 + 12 * p' * mu^2 * p'' + 36 * p' * p^2 * p'' - 4/3 * p''^2 * theta^2 + p''^2 * mu - 3 * p''^2 * p + 8 * p' * mu * p'' * theta^2 + 8 * p' * p * p'' * theta^2 + 48 * p' * mu * p * p'')) * omega^2 * Psi^4 - ((108 * p''^5 + 72 * p''^4) * omega^4 + (72 * mu * p''^3 * p''' * theta^2 + 72 * p * p''^3 * p''' * theta^2 - 24 * p''^4 * theta^2 - 18 * mu * p''^4 - 54 * p * p''^4) * omega^2) * Psi^2 + 108 * omega^2 * p''^6 * theta^2 : T(%);

$$(6 \mu^2 + 12 \mu p + 6 p^2) \omega^4 \Psi^6 p''' = - \left(-78 \mu p' p'' - 78 p p' p'' + \frac{24 \mu^2 p'^2}{p'} + \frac{24 p^2 p'^2}{p'} \right) \tag{1.19}$$

$$\begin{aligned}
& -4 p'' \mu - 4 p'' p + 4 p^2 + \frac{48 \mu p'^2 p}{p'} + 24 p^3 \Big) \omega^4 \Psi^6 - \left((-162 \mu p^2 p'' \right. \\
& - 162 p p^2 p'' + 180 p^4 - 48 \mu p' p'' - 48 p p' p'' + 36 p^3 - 8 p^2) \omega^4 + \left(9 \mu p^3 \right. \\
& + 9 p p^3 + 12 \mu^2 p'' p' + 36 p^2 p'' p' - \frac{4}{3} p^2 \theta^2 + \mu p^2 - 3 p p^2 + 8 \theta^2 p'' p' \mu \\
& + 8 \theta^2 p'' p' p + 48 \mu p'' p' p \Big) \omega^2 \Big) \Psi^4 - \left((108 p^5 + 72 p^4) \omega^4 + (72 \mu p^3 p'' \theta^2 \right. \\
& + 72 p p^3 p'' \theta^2 - 24 p^4 \theta^2 - 18 \mu p^4 - 54 p p^4) \omega^2 \Big) \Psi^2 + 108 \omega^2 p^6 \theta^2
\end{aligned}$$

eliminating 'p''':

> temp15b := collect(expand('p'·subs(temp72a, temp15a)), [omega]) : T(%);

$$\begin{aligned}
& (-24 \Psi^6 \mu^2 p'^2 - 48 \Psi^6 \mu p p'^2 + 108 \Psi^6 \mu p^2 p'' - 24 \Psi^6 p^2 p'^2 + 108 \Psi^6 p p^2 p'' \\
& - 120 \Psi^6 p^4 + 8 \Psi^6 \mu p' p'' + 8 \Psi^6 p p' p'' - 20 \Psi^6 p^3 + 108 \Psi^4 \mu p^3 p'' \\
& + 108 \Psi^4 p p^3 p'' - 252 \Psi^4 p^5 + 72 \Psi^4 \mu p^2 p'' + 72 \Psi^4 p p^2 p'' - 180 \Psi^4 p^4 \\
& - 108 \Psi^2 p^6 - 8 \Psi^4 p^3 - 144 \Psi^2 p^5 - 48 \Psi^2 p^4) \omega^4 + (-12 \Psi^4 \mu p^2 p'' \theta^2 \\
& - 12 \Psi^4 p p^2 p'' \theta^2 + 24 \Psi^4 p^4 \theta^2 - 72 \Psi^2 \mu p^4 p'' \theta^2 - 72 \Psi^2 p p^4 p'' \theta^2 + 144 \Psi^2 p^6 \theta^2 \\
& - 18 \Psi^4 \mu^2 p^2 p'' - 72 \Psi^4 \mu p p^2 p'' + 36 \Psi^4 \mu p^4 - 54 \Psi^4 p^2 p^2 p'' + 108 \Psi^4 p p^4 \\
& + 4 \Psi^4 p^3 \theta^2 + 48 \Psi^2 p^5 \theta^2 + 108 p^7 \theta^2 + 6 \Psi^4 \mu p^3 + 18 \Psi^4 p p^3 + 36 \Psi^2 \mu p^5 \\
& + 108 \Psi^2 p p^5 + 16 \Psi^2 p^4 \theta^2 + 72 p^6 \theta^2 + 24 \Psi^2 \mu p^4 + 72 \Psi^2 p p^4) \omega^2 + (\\
& -12 p^2 \Psi^5 \mu p'' \omega^a \omega_{;a} - 12 p^2 \Psi^5 p p'' \omega^a \omega_{;a} + 24 \Psi^5 p^4 \omega^a \omega_{;a} \\
& + 4 \Psi^5 p^3 \omega^a \omega_{;a} + 36 \Psi^3 p^5 \omega^a \omega_{;a} + 24 \Psi^3 p^4 \omega^a \omega_{;a}) \omega - 54 p p^6 \theta^2 \\
& - \frac{4}{3} \Psi^2 p^4 \theta^4 - 3 \Psi^2 \mu^2 p^4 - 18 \mu p^6 \theta^2 - 27 \Psi^2 p^2 p^4 - 4 \Psi^2 \mu p^4 \theta^2 - 12 \Psi^2 p p^4 \theta^2 \\
& - 18 \Psi^2 \mu p p^4 - 12 p^6 \theta^4 = 0
\end{aligned} \tag{1.20}$$

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$$\begin{aligned}
& -72 \Psi p^6 \omega^2 \theta^2 + 4 \Psi^3 p^A \mu \theta^2 + 12 \Psi^3 p^A p \theta^2 - 45 \Psi^5 p^A \mu \omega^2 - 24 \Psi^3 p^A \mu \omega^2 \\
& + 18 \Psi^3 p^A \mu p - 117 \Psi^5 p^A \omega^2 p - 72 \Psi^3 p^A \omega^2 p - 144 \Psi^3 p^6 \omega^2 \theta^2 - \frac{8}{3} \Psi^5 p^3 \omega^2 \theta^2 \\
& - 24 \Psi^3 p^5 \omega^2 \theta^2 - 7 \Psi^5 p^3 \mu \omega^2 - 15 \Psi^5 p^3 \omega^2 p - 18 \Psi^3 p^5 \mu \omega^2 - 54 \Psi^3 p^5 \omega^2 p \\
& - 24 \Psi^5 p^A \omega^2 \theta^2 - 16 \Psi^3 p^A \omega^2 \theta^2 - 36 \Psi^4 p^5 \omega \omega^a \omega_{;a} - 24 \Psi^4 p^A \omega \omega^a \omega_{;a} \\
& - 24 \Psi^6 p^A \omega \omega^a \omega_{;a} - 4 \Psi^6 p^3 \omega \omega^a \omega_{;a} - 30 \Psi^7 p^2 \omega^4 p'' \mu - 30 \Psi^7 p^2 \omega^4 p'' p \\
& + 54 \Psi^5 p^3 \omega^4 p'' \mu + 54 \Psi^5 p^3 \omega^4 p'' p - 24 \Psi^5 p^2 \omega^4 p'' \mu - 24 \Psi^5 p^2 \omega^4 p'' p \\
& + 6 \Psi^5 p^2 \mu^2 p'' \omega^2 + 18 \Psi^5 p^2 p^2 p'' \omega^2 - 4 \Psi^7 p' \omega^4 p'' \mu - 4 \Psi^7 p' \omega^4 p'' p \\
& + 72 \Psi^3 p^5 \omega^4 + 48 \Psi^3 p^A \omega^4 + 72 \Psi^5 p^5 \omega^4 + 96 \Psi^7 p^A \omega^4 + 3 \Psi^3 p^A \mu^2 + 16 \Psi^5 p^3 \omega^4 \\
& + 144 \Psi^5 p^A \omega^4 + 27 \Psi^3 p^A p^2 + \frac{4}{3} \Psi^3 p^A \theta^4 + 16 \Psi^7 p^3 \omega^4 + 12 \Psi p^6 \theta^4 \\
& + 12 \Psi^6 p^2 \mu \omega p'' \omega^a \omega_{;a} + 12 \Psi^6 p^2 \omega p p'' \omega^a \omega_{;a}
\end{aligned}$$

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from eq72a:

$$\begin{aligned}
> \text{temp17} := p''' = & (-72 * \text{Psi}^6 * \mu^2 * \omega^2 * p''^2 - 144 * \text{Psi}^6 * \mu * \omega^2 * p \\
& * p''^2 + 234 * \text{Psi}^6 * \mu * \omega^2 * p''^2 * p''' - 72 * \text{Psi}^6 * \omega^2 * p^2 * p''^2 \\
& + 234 * \text{Psi}^6 * \omega^2 * p * p''^2 * p''' - 72 * \text{Psi}^6 * \omega^2 * p'^4 + 12 * \text{Psi}^6 \\
& * \mu * \omega^2 * p' * p''' + 12 * \text{Psi}^6 * \omega^2 * p * p' * p''' - 12 * \text{Psi}^6 * \omega^2 \\
& * p'^3 + 486 * \text{Psi}^4 * \mu * \omega^2 * p'^3 * p''' + 486 * \text{Psi}^4 * \omega^2 * p * p'^3 \\
& * p''' - 540 * \text{Psi}^4 * \omega^2 * p'^5 + 144 * \text{Psi}^4 * \mu * \omega^2 * p'^2 * p''' - 24 \\
& * \text{Psi}^4 * \mu * p'^2 * p''' * \theta^2 + 144 * \text{Psi}^4 * \omega^2 * p * p'^2 * p''' - 108 * \text{Psi} \\
& ^4 * \omega^2 * p'^4 - 24 * \text{Psi}^4 * p * p'^2 * p''' * \theta^2 - 216 * \text{Psi}^2 * \mu * p'^4 \\
& * p''' * \theta^2 - 324 * \text{Psi}^2 * \omega^2 * p'^6 - 216 * \text{Psi}^2 * p * p'^4 * p''' * \theta^2 \\
& - 36 * \text{Psi}^4 * \mu^2 * p'^2 * p''' - 144 * \text{Psi}^4 * \mu * p * p'^2 * p''' - 27 * \text{Psi}^4 * \mu \\
& * p'^4 + 24 * \text{Psi}^4 * \omega^2 * p'^3 - 108 * \text{Psi}^4 * p^2 * p'^2 * p''' - 27 * \text{Psi}^4 * p \\
& * p'^4 + 4 * \text{Psi}^4 * p'^3 * \theta^2 - 216 * \text{Psi}^2 * \omega^2 * p'^5 + 72 * \text{Psi}^2 * p'^5 \\
& * \theta^2 + 324 * p'^7 * \theta^2 - 3 * \text{Psi}^4 * \mu * p'^3 + 9 * \text{Psi}^4 * p * p'^3 + 54 \\
& * \text{Psi}^2 * \mu * p'^5 + 162 * \text{Psi}^2 * p * p'^5) / (18 * \text{Psi}^6 * \mu^2 * \omega^2 * p' + 36 \\
& * \text{Psi}^6 * \mu * \omega^2 * p * p' + 18 * \text{Psi}^6 * \omega^2 * p^2 * p');
\end{aligned}$$

$$\text{temp17} := p''' = (-72 \Psi^6 \mu^2 \omega^2 p'^2 - 144 \Psi^6 \mu \omega^2 p p'^2 + 234 \Psi^6 \mu \omega^2 p^2 p'' \quad (1.22)$$

$$\begin{aligned}
& - 72 \Psi^6 \omega^2 p^2 p'^2 + 234 \Psi^6 \omega^2 p p^2 p'' - 72 \Psi^6 \omega^2 p^A + 12 \Psi^6 \mu \omega^2 p' p'' \\
& + 12 \Psi^6 \omega^2 p p' p'' - 12 \Psi^6 \omega^2 p^3 + 486 \Psi^4 \mu \omega^2 p^3 p'' + 486 \Psi^4 \omega^2 p p^3 p'' \\
& - 540 \Psi^4 \omega^2 p^5 + 144 \Psi^4 \mu \omega^2 p^2 p'' - 24 \Psi^4 \mu p^2 p'' \theta^2 + 144 \Psi^4 \omega^2 p p^2 p''
\end{aligned}$$

$$\begin{aligned}
& -108 \Psi^4 \omega^2 p^A - 24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^A p'' \theta^2 - 324 \Psi^2 \omega^2 p^6 \\
& - 216 \Psi^2 p p^A p'' \theta^2 - 36 \Psi^4 \mu^2 p^2 p'' - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^A + 24 \Psi^4 \omega^2 p^3 \\
& - 108 \Psi^4 p^2 p^2 p'' - 27 \Psi^4 p p^A + 4 \Psi^4 p^3 \theta^2 - 216 \Psi^2 \omega^2 p^5 + 72 \Psi^2 p^5 \theta^2 \\
& + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5) / (18 \Psi^6 \mu^2 \omega^2 p' \\
& + 36 \Psi^6 \mu \omega^2 p p' + 18 \Psi^6 \omega^2 p^2 p')
\end{aligned}$$

subs in temp15:

> temp18 := subs(temp17, temp15) : T(%);

$$\begin{aligned}
& 30 \Psi^6 \omega^4 p'' p' \mu + 30 \Psi^6 \omega^4 p'' p' p - 54 \Psi^4 p^2 \omega^4 p'' \mu - 54 \Psi^4 p^2 \omega^4 p'' p \\
& + 24 \Psi^4 \omega^4 p'' p' \mu + 24 \Psi^4 \omega^4 p'' p' p - 6 \Psi^4 \mu^2 p'' \omega^2 p' - 18 \Psi^4 p^2 p'' \omega^2 p' \\
& + (6 \Psi^6 \mu^2 \omega^4 (-72 \Psi^6 \mu^2 \omega^2 p'^2 - 144 \Psi^6 \mu \omega^2 p p'^2 + 234 \Psi^6 \mu \omega^2 p^2 p'' - 72 \Psi^6 \omega^2 p^2 p'^2 + 234 \Psi^6 \omega^2 p^2 p'' \\
& + 144 \Psi^4 \mu \omega^2 p^2 p'' - 24 \Psi^4 \mu p^2 p'' \theta^2 + 144 \Psi^4 \omega^2 p p^2 p'' - 108 \Psi^4 \omega^2 p^A \\
& - 24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^A p'' \theta^2 - 324 \Psi^2 \omega^2 p^6 - 216 \Psi^2 p p^A p'' \theta^2 \\
& - 36 \Psi^4 \mu^2 p^2 p'' - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^A + 24 \Psi^4 \omega^2 p^3 - 108 \Psi^4 p^2 p^2 p'' \\
& - 27 \Psi^4 p p^A + 4 \Psi^4 p^3 \theta^2 - 216 \Psi^2 \omega^2 p^5 + 72 \Psi^2 p^5 \theta^2 + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 \\
& + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5)) / (18 \Psi^6 \mu^2 \omega^2 p' + 36 \Psi^6 \mu \omega^2 p p' \\
& + 18 \Psi^6 \omega^2 p^2 p') + (6 \Psi^6 \omega^4 p^2 (-72 \Psi^6 \mu^2 \omega^2 p'^2 - 144 \Psi^6 \mu \omega^2 p p'^2 \\
& + 234 \Psi^6 \mu \omega^2 p^2 p'' - 72 \Psi^6 \omega^2 p^2 p'^2 + 234 \Psi^6 \omega^2 p p^2 p'' - 72 \Psi^6 \omega^2 p^A \\
& + 12 \Psi^6 \mu \omega^2 p' p'' + 12 \Psi^6 \omega^2 p p' p'' - 12 \Psi^6 \omega^2 p^3 + 486 \Psi^4 \mu \omega^2 p^3 p'' \\
& + 486 \Psi^4 \omega^2 p p^3 p'' - 540 \Psi^4 \omega^2 p^5 + 144 \Psi^4 \mu \omega^2 p^2 p'' - 24 \Psi^4 \mu p^2 p'' \theta^2 \\
& + 144 \Psi^4 \omega^2 p p^2 p'' - 108 \Psi^4 \omega^2 p^A - 24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^A p'' \theta^2 \\
& - 324 \Psi^2 \omega^2 p^6 - 216 \Psi^2 p p^A p'' \theta^2 - 36 \Psi^4 \mu^2 p^2 p'' - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^A \\
& + 24 \Psi^4 \omega^2 p^3 - 108 \Psi^4 p^2 p^2 p'' - 27 \Psi^4 p p^A + 4 \Psi^4 p^3 \theta^2 - 216 \Psi^2 \omega^2 p^5 \\
& + 72 \Psi^2 p^5 \theta^2 + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5)) / \\
& (18 \Psi^6 \mu^2 \omega^2 p' + 36 \Psi^6 \mu \omega^2 p p' + 18 \Psi^6 \omega^2 p^2 p') - 4 \Psi^4 \theta^2 p'' \omega^2 p' \mu \\
& - 4 \Psi^4 \theta^2 p'' \omega^2 p' p - 24 \Psi^4 \mu p'' \omega^2 p' p + 4 \Psi^6 \omega^4 p'' \mu + 4 \Psi^6 \omega^4 p'' p \\
& + (12 \Psi^6 \mu \omega^4 p (-72 \Psi^6 \mu^2 \omega^2 p'^2 - 144 \Psi^6 \mu \omega^2 p p'^2 + 234 \Psi^6 \mu \omega^2 p^2 p'' - 72 \Psi^6 \omega^2 p^2 p'^2 + 234 \Psi^6 \omega^2 p^2 p'' \\
& - 24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^A p'' \theta^2 - 324 \Psi^2 \omega^2 p^6 - 216 \Psi^2 p p^A p'' \theta^2 \\
& - 36 \Psi^4 \mu^2 p^2 p'' - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^A + 24 \Psi^4 \omega^2 p^3 - 108 \Psi^4 p^2 p^2 p''
\end{aligned}$$

$$\begin{aligned}
& -27 \Psi^4 p p^A + 4 \Psi^4 p^3 \theta^2 - 216 \Psi^2 \omega^2 p^5 + 72 \Psi^2 p^5 \theta^2 + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 \\
& + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5) / (18 \Psi^6 \mu^2 \omega^2 p' + 36 \Psi^6 \mu \omega^2 p p' \\
& + 18 \Psi^6 \omega^2 p^2 p') - 12 p^5 \theta^4 - \frac{4}{3} \Psi^2 p^3 \theta^4 - 18 \mu p^5 \theta^2 - 3 \Psi^2 \mu^2 p^3 - 54 p p^5 \theta^2 \\
& - 27 \Psi^2 p^2 p^3 - 96 \Psi^6 \omega^4 p^3 - 144 \Psi^4 \omega^4 p^3 - 16 \Psi^6 \omega^4 p^2 - 16 \Psi^4 \omega^4 p^2 \\
& - 72 \Psi^4 \omega^4 p^A - 72 \Psi^2 \omega^4 p^A - 48 \Psi^2 \omega^4 p^3 + 72 \omega^2 p^5 \theta^2 - 4 \Psi^2 \mu p^3 \theta^2 \\
& - 12 \Psi^2 p p^3 \theta^2 + 45 \Psi^4 \mu \omega^2 p^3 + 24 \Psi^2 \mu \omega^2 p^3 - 18 \Psi^2 \mu p p^3 + 117 \Psi^4 \omega^2 p p^3 \\
& + 72 \Psi^2 \omega^2 p p^3 + 144 \Psi^2 \omega^2 p^5 \theta^2 + \frac{8}{3} \Psi^4 \omega^2 p^2 \theta^2 + 24 \Psi^2 \omega^2 p^A \theta^2 + 7 \Psi^4 \mu \omega^2 p^2 \\
& + 15 \Psi^4 \omega^2 p p^2 + 18 \Psi^2 \mu \omega^2 p^A + 54 \Psi^2 \omega^2 p p^A + 24 \Psi^4 \omega^2 p^3 \theta^2 + 16 \Psi^2 \omega^2 p^3 \theta^2 \\
& + 24 \Psi^5 \omega p^3 \omega^a \omega_{;a} + 4 \Psi^5 \omega p^2 \omega^a \omega_{;a} + 36 \Psi^3 \omega p^A \omega^a \omega_{;a} \\
& + 24 \Psi^3 \omega p^3 \omega^a \omega_{;a} - 12 p' \Psi^5 \mu \omega p'' \omega^a \omega_{;a} - 12 p' \Psi^5 \omega p p'' \omega^a \omega_{;a} = 0
\end{aligned}$$

> op(40, op(1, temp18));

$$117 \Psi^4 \omega^2 p p^3 \quad (1.24)$$

> nops(op(1, temp18));

$$52 \quad (1.25)$$

>

>

> temp19 := collect(temp18, [omega[-A], omega]);

$$temp19 := (-12 \Psi^5 \mu p' p'' \omega_a - 12 \Psi^5 p p' p'' \omega_a + 24 \Psi^5 p^3 \omega_a + 4 \Psi^5 p^2 \omega_a + 36 \Psi^3 p^A \omega_a \quad (1.26)$$

$$+ 24 \Psi^3 p^3 \omega_a) \omega \omega_{-A} + \left(30 \Psi^6 p'' p' \mu + 30 \Psi^6 p'' p' p - 54 \Psi^4 \mu p^2 p''$$

$$- 54 \Psi^4 p p^2 p'' + 24 \Psi^4 \mu p' p'' + 24 \Psi^4 p p' p''$$

$$+ \frac{1}{18 \Psi^6 \mu^2 p' + 36 \Psi^6 \mu p p' + 18 \Psi^6 p^2 p'} (6 \Psi^6 \mu^2 (-72 \Psi^6 \mu^2 p'^2 - 144 \Psi^6 \mu p p'^2$$

$$+ 234 \Psi^6 \mu p^2 p'' - 72 \Psi^6 p^2 p'^2 + 234 \Psi^6 p p^2 p'' - 72 \Psi^6 p^A + 12 \Psi^6 \mu p' p''$$

$$+ 12 \Psi^6 p p' p'' - 12 \Psi^6 p^3 + 486 \Psi^4 \mu p^3 p'' + 486 \Psi^4 p p^3 p'' - 540 \Psi^4 p^5$$

$$\begin{aligned}
& + 144 \Psi^4 \mu p^2 p'' + 144 \Psi^4 p p^2 p'' - 108 \Psi^4 p^4 - 324 \Psi^2 p^6 + 24 \Psi^4 p^3 \\
& - 216 \Psi^2 p^5) + \frac{1}{18 \Psi^6 \mu^2 p' + 36 \Psi^6 \mu p p' + 18 \Psi^6 p^2 p'} (6 \Psi^6 p^2 (\\
& - 72 \Psi^6 \mu^2 p'^2 - 144 \Psi^6 \mu p p'^2 + 234 \Psi^6 \mu p^2 p'' - 72 \Psi^6 p^2 p'^2 + 234 \Psi^6 p p^2 p'' \\
& - 72 \Psi^6 p^4 + 12 \Psi^6 \mu p' p'' + 12 \Psi^6 p p' p'' - 12 \Psi^6 p^3 + 486 \Psi^4 \mu p^3 p'' \\
& + 486 \Psi^4 p p^3 p'' - 540 \Psi^4 p^5 + 144 \Psi^4 \mu p^2 p'' + 144 \Psi^4 p p^2 p'' - 108 \Psi^4 p^4 \\
& - 324 \Psi^2 p^6 + 24 \Psi^4 p^3 - 216 \Psi^2 p^5) + 4 \Psi^6 p'' \mu + 4 \Psi^6 p'' p \\
& + \frac{1}{18 \Psi^6 \mu^2 p' + 36 \Psi^6 \mu p p' + 18 \Psi^6 p^2 p'} (12 \Psi^6 \mu p (-72 \Psi^6 \mu^2 p'^2 - 144 \Psi^6 \mu p p'^2 \\
& + 234 \Psi^6 \mu p^2 p'' - 72 \Psi^6 p^2 p'^2 + 234 \Psi^6 p p^2 p'' - 72 \Psi^6 p^4 + 12 \Psi^6 \mu p' p'' \\
& + 12 \Psi^6 p p' p'' - 12 \Psi^6 p^3 + 486 \Psi^4 \mu p^3 p'' + 486 \Psi^4 p p^3 p'' - 540 \Psi^4 p^5 \\
& + 144 \Psi^4 \mu p^2 p'' + 144 \Psi^4 p p^2 p'' - 108 \Psi^4 p^4 - 324 \Psi^2 p^6 + 24 \Psi^4 p^3 \\
& - 216 \Psi^2 p^5) - 96 \Psi^6 p^3 - 144 \Psi^4 p^3 - 16 \Psi^6 p^2 - 16 \Psi^4 p^2 - 72 \Psi^4 p^4 \\
& - 72 \Psi^2 p^4 - 48 \Psi^2 p^3) \omega^4 + \left(-6 \Psi^4 \mu^2 p'' p' - 18 \Psi^4 p^2 p'' p' \right. \\
& + \frac{1}{18 \Psi^6 \mu^2 p' + 36 \Psi^6 \mu p p' + 18 \Psi^6 p^2 p'} (6 \Psi^6 \mu^2 (-24 \Psi^4 \mu p^2 p'' \theta^2 \\
& - 24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^4 p'' \theta^2 - 216 \Psi^2 p p^4 p'' \theta^2 - 36 \Psi^4 \mu^2 p^2 p'' \\
& - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^4 - 108 \Psi^4 p^2 p^2 p'' - 27 \Psi^4 p p^4 + 4 \Psi^4 p^3 \theta^2 \\
& + 72 \Psi^2 p^5 \theta^2 + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5) \\
& + \frac{1}{18 \Psi^6 \mu^2 p' + 36 \Psi^6 \mu p p' + 18 \Psi^6 p^2 p'} (6 \Psi^6 p^2 (-24 \Psi^4 \mu p^2 p'' \theta^2
\end{aligned}$$

$$\begin{aligned}
& -24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^A p'' \theta^2 - 216 \Psi^2 p p^A p'' \theta^2 - 36 \Psi^4 \mu^2 p^2 p'' \\
& - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^A - 108 \Psi^4 p^2 p^2 p'' - 27 \Psi^4 p p^A + 4 \Psi^4 p^3 \theta^2 \\
& + 72 \Psi^2 p^5 \theta^2 + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5) \\
& - 4 \Psi^4 \theta^2 p'' p' \mu - 4 \Psi^4 \theta^2 p'' p' p - 24 \Psi^4 \mu p'' p' p \\
& + \frac{1}{18 \Psi^6 \mu^2 p' + 36 \Psi^6 \mu p p' + 18 \Psi^6 p^2 p'} \left(12 \Psi^6 \mu p \left(-24 \Psi^4 \mu p^2 p'' \theta^2 \right. \right. \\
& - 24 \Psi^4 p p^2 p'' \theta^2 - 216 \Psi^2 \mu p^A p'' \theta^2 - 216 \Psi^2 p p^A p'' \theta^2 - 36 \Psi^4 \mu^2 p^2 p'' \\
& - 144 \Psi^4 \mu p p^2 p'' - 27 \Psi^4 \mu p^A - 108 \Psi^4 p^2 p^2 p'' - 27 \Psi^4 p p^A + 4 \Psi^4 p^3 \theta^2 \\
& + 72 \Psi^2 p^5 \theta^2 + 324 p^7 \theta^2 - 3 \Psi^4 \mu p^3 + 9 \Psi^4 p p^3 + 54 \Psi^2 \mu p^5 + 162 \Psi^2 p p^5) \\
& + 72 p^5 \theta^2 + 45 \Psi^4 \mu p^3 + 24 \Psi^2 \mu p^3 + 117 \Psi^4 p p^3 + 72 \Psi^2 p p^3 + 144 \Psi^2 p^5 \theta^2 \\
& + \frac{8}{3} \Psi^4 p^2 \theta^2 + 24 \Psi^2 p^A \theta^2 + 7 \Psi^4 \mu p^2 + 15 \Psi^4 p p^2 + 18 \Psi^2 \mu p^A + 54 \Psi^2 p p^A \\
& \left. + 24 \Psi^4 p^3 \theta^2 + 16 \Psi^2 p^3 \theta^2 \right) \omega^2 - 12 p^5 \theta^4 - \frac{4}{3} \Psi^2 p^3 \theta^4 - 18 \mu p^5 \theta^2 - 3 \Psi^2 \mu^2 p^3 \\
& - 54 p p^5 \theta^2 - 27 \Psi^2 p^2 p^3 - 4 \Psi^2 \mu p^3 \theta^2 - 12 \Psi^2 p p^3 \theta^2 - 18 \Psi^2 \mu p p^3 = 0
\end{aligned}$$

>

> *convert(templ8, string);*

$$\begin{aligned}
& "30*\Psi^6*\omega^4*p''*p''*\mu+30*\Psi^6*\omega^4*p''*p''*p-54*\Psi^4*p''^2* \\
& \omega^4*p''*\mu-54*\Psi^4*p''^2*\omega^4*p''*p+24*\Psi^4*\omega^4*p''*p''* \\
& \mu+24*\Psi^4*\omega^4*p''*p''*p-6*\Psi^4*\mu^2*p''*\omega^2*p''-18*\Psi^4*p^2* \\
& p''*\omega^2*p''+6*\Psi^6*\mu^2*\omega^4*(-72*\Psi^6*\mu^2*\omega^2*p''^2-144* \\
& \Psi^6*\mu*\omega^2*p''*p''^2+234*\Psi^6*\mu*\omega^2*p''^2*p''-72*\Psi^6* \\
& \omega^2*p^2*p''^2+234*\Psi^6*\omega^2*p''*p''^2*p''-72*\Psi^6*\omega^2* \\
& p''^4+12*\Psi^6*\mu*\omega^2*p''*p''+12*\Psi^6*\omega^2*p''*p''*p''-12*\Psi^6* \\
& \omega^2*p''^3+486*\Psi^4*\mu*\omega^2*p''^3*p''+486*\Psi^4*\omega^2*p''*p''^3* \\
& p''-540*\Psi^4*\omega^2*p''^5+144*\Psi^4*\mu*\omega^2*p''^2*p''-24*\Psi^4*\mu* \\
& p''^2*p''*\theta^2+144*\Psi^4*\omega^2*p''*p''^2*p''-108*\Psi^4*\omega^2*p''^4
\end{aligned} \tag{1.27}$$

$$\begin{aligned}
& -24*\Psi^4*p*\rho'^2*\rho''*\theta^2-216*\Psi^2*\mu*\rho'^4*\rho''*\theta^2-324*\Psi^2* \\
& \omega^2*\rho'^6-216*\Psi^2*p*\rho'^4*\rho''*\theta^2-36*\Psi^4*\mu^2*\rho'^2*\rho''-144* \\
& \Psi^4*\mu*p*\rho'^2*\rho''-27*\Psi^4*\mu*\rho'^4+24*\Psi^4*\omega^2*\rho'^3-108*\Psi^4* \\
& \rho'^2*\rho'^2*\rho''-27*\Psi^4*p*\rho'^4+4*\Psi^4*\rho'^3*\theta^2-216*\Psi^2*\omega^2* \\
& \rho'^5+72*\Psi^2*\rho'^5*\theta^2+324*\rho'^7*\theta^2-3*\Psi^4*\mu*\rho'^3+9*\Psi^4*p* \\
& \rho'^3+54*\Psi^2*\mu*\rho'^5+162*\Psi^2*p*\rho'^5)/(18*\Psi^6*\mu^2*\omega^2* \\
& \rho'+36*\Psi^6*\mu*\omega^2*p*\rho'+18*\Psi^6*\omega^2*p^2*\rho')+6*\Psi^6* \\
& \omega^4*p^2*(-72*\Psi^6*\mu^2*\omega^2*\rho''^2-144*\Psi^6*\mu*\omega^2*p* \\
& \rho''^2+234*\Psi^6*\mu*\omega^2*\rho'^2*\rho''-72*\Psi^6*\omega^2*p^2*\rho''^2+234* \\
& \Psi^6*\omega^2*p*\rho'^2*\rho''-72*\Psi^6*\omega^2*\rho'^4+12*\Psi^6*\mu*\omega^2* \\
& \rho''*\rho''+12*\Psi^6*\omega^2*p*\rho''*\rho''-12*\Psi^6*\omega^2*\rho'^3+486*\Psi^4*\mu* \\
& \omega^2*\rho'^3*\rho''+486*\Psi^4*\omega^2*p*\rho'^3*\rho''-540*\Psi^4*\omega^2* \\
& \rho'^5+144*\Psi^4*\mu*\omega^2*\rho'^2*\rho''-24*\Psi^4*\mu*\rho'^2*\rho''*\theta^2+144* \\
& \Psi^4*\omega^2*p*\rho'^2*\rho''-108*\Psi^4*\omega^2*\rho'^4-24*\Psi^4*p*\rho'^2*\rho''* \\
& \theta^2-216*\Psi^2*\mu*\rho'^4*\rho''*\theta^2-324*\Psi^2*\omega^2*\rho'^6-216*\Psi^2*p* \\
& \rho'^4*\rho''*\theta^2-36*\Psi^4*\mu^2*\rho'^2*\rho''-144*\Psi^4*\mu*p*\rho'^2*\rho''-27* \\
& \Psi^4*\mu*\rho'^4+24*\Psi^4*\omega^2*\rho'^3-108*\Psi^4*p^2*\rho'^2*\rho''-27*\Psi^4*p* \\
& \rho'^4+4*\Psi^4*\rho'^3*\theta^2-216*\Psi^2*\omega^2*\rho'^5+72*\Psi^2*\rho'^5* \\
& \theta^2+324*\rho'^7*\theta^2-3*\Psi^4*\mu*\rho'^3+9*\Psi^4*p*\rho'^3+54*\Psi^2*\mu* \\
& \rho'^5+162*\Psi^2*p*\rho'^5)/(18*\Psi^6*\mu^2*\omega^2*\rho'+36*\Psi^6*\mu*\omega^2* \\
& p*\rho'+18*\Psi^6*\omega^2*p^2*\rho')-4*\Psi^4*\theta^2*\rho''*\omega^2*\rho''*\mu-4* \\
& \Psi^4*\theta^2*\rho''*\omega^2*\rho''*p-24*\Psi^4*\mu*\rho''*\omega^2*\rho''*p+4*\Psi^6* \\
& \omega^4*\rho''*\mu+4*\Psi^6*\omega^4*\rho''*p+24*\Psi^5*\omega*\rho'^3*\omega[a]* \\
& \omega[-A]+4*\Psi^5*\omega*\rho'^2*\omega[a]*\omega[-A]+36*\Psi^3*\omega*\rho'^4* \\
& \omega[a]*\omega[-A]+24*\Psi^3*\omega*\rho'^3*\omega[a]*\omega[-A]+12*\Psi^6*\mu* \\
& \omega^4*p*(-72*\Psi^6*\mu^2*\omega^2*\rho''^2-144*\Psi^6*\mu*\omega^2*p* \\
& \rho''^2+234*\Psi^6*\mu*\omega^2*\rho'^2*\rho''-72*\Psi^6*\omega^2*p^2*\rho''^2+234* \\
& \Psi^6*\omega^2*p*\rho'^2*\rho''-72*\Psi^6*\omega^2*\rho'^4+12*\Psi^6*\mu*\omega^2* \\
& \rho''*\rho''+12*\Psi^6*\omega^2*p*\rho''*\rho''-12*\Psi^6*\omega^2*\rho'^3+486*\Psi^4*\mu* \\
& \omega^2*\rho'^3*\rho''+486*\Psi^4*\omega^2*p*\rho'^3*\rho''-540*\Psi^4*\omega^2* \\
& \rho'^5+144*\Psi^4*\mu*\omega^2*\rho'^2*\rho''-24*\Psi^4*\mu*\rho'^2*\rho''*\theta^2+144* \\
& \Psi^4*\omega^2*p*\rho'^2*\rho''-108*\Psi^4*\omega^2*\rho'^4-24*\Psi^4*p*\rho'^2*\rho''* \\
& \theta^2-216*\Psi^2*\mu*\rho'^4*\rho''*\theta^2-324*\Psi^2*\omega^2*\rho'^6-216*\Psi^2*p* \\
& \rho'^4*\rho''*\theta^2-36*\Psi^4*\mu^2*\rho'^2*\rho''-144*\Psi^4*\mu*p*\rho'^2*\rho''-27* \\
& \Psi^4*\mu*\rho'^4+24*\Psi^4*\omega^2*\rho'^3-108*\Psi^4*p^2*\rho'^2*\rho''-27*\Psi^4*p* \\
& \rho'^4+4*\Psi^4*\rho'^3*\theta^2-216*\Psi^2*\omega^2*\rho'^5+72*\Psi^2*\rho'^5*
\end{aligned}$$

$$\begin{aligned}
& \theta^2 + 324 \cdot p'^7 \cdot \theta^2 - 3 \cdot \Psi^4 \cdot \mu \cdot p'^3 + 9 \cdot \Psi^4 \cdot p \cdot p'^3 + 54 \cdot \Psi^2 \cdot \mu \cdot \\
& p'^5 + 162 \cdot \Psi^2 \cdot p \cdot p'^5 / (18 \cdot \Psi^6 \cdot \mu^2 \cdot \omega^2 \cdot p' + 36 \cdot \Psi^6 \cdot \mu \cdot \omega^2 \cdot \\
& p \cdot p' + 18 \cdot \Psi^6 \cdot \omega^2 \cdot p^2 \cdot p') - 12 \cdot p'^5 \cdot \theta^4 - 4/3 \cdot \Psi^2 \cdot p'^3 \cdot \theta^4 - 18 \cdot \\
& \mu \cdot p'^5 \cdot \theta^2 - 3 \cdot \Psi^2 \cdot \mu^2 \cdot p'^3 - 54 \cdot p \cdot p'^5 \cdot \theta^2 - 27 \cdot \Psi^2 \cdot p^2 \cdot p'^3 - 96 \cdot \\
& \Psi^6 \cdot \omega^4 \cdot p'^3 - 144 \cdot \Psi^4 \cdot \omega^4 \cdot p'^3 - 16 \cdot \Psi^6 \cdot \omega^4 \cdot p'^2 - 16 \cdot \\
& \Psi^4 \cdot \omega^4 \cdot p'^2 - 72 \cdot \Psi^4 \cdot \omega^4 \cdot p'^4 - 72 \cdot \Psi^2 \cdot \omega^4 \cdot p'^4 - 48 \cdot \Psi^2 \cdot \\
& \omega^4 \cdot p'^3 + 72 \cdot \omega^2 \cdot p'^5 \cdot \theta^2 - 4 \cdot \Psi^2 \cdot \mu \cdot p'^3 \cdot \theta^2 - 12 \cdot \Psi^2 \cdot p \cdot \\
& p'^3 \cdot \theta^2 + 45 \cdot \Psi^4 \cdot \mu \cdot \omega^2 \cdot p'^3 + 24 \cdot \Psi^2 \cdot \mu \cdot \omega^2 \cdot p'^3 - 18 \cdot \\
& \Psi^2 \cdot \mu \cdot p \cdot p'^3 + 117 \cdot \Psi^4 \cdot \omega^2 \cdot p \cdot p'^3 + 72 \cdot \Psi^2 \cdot \omega^2 \cdot p \cdot \\
& p'^3 + 144 \cdot \Psi^2 \cdot \omega^2 \cdot p'^5 \cdot \theta^2 + 8/3 \cdot \Psi^4 \cdot \omega^2 \cdot p'^2 \cdot \theta^2 + 24 \cdot \\
& \Psi^2 \cdot \omega^2 \cdot p'^4 \cdot \theta^2 + 7 \cdot \Psi^4 \cdot \mu \cdot \omega^2 \cdot p'^2 + 15 \cdot \Psi^4 \cdot \omega^2 \cdot p \cdot \\
& p'^2 + 18 \cdot \Psi^2 \cdot \mu \cdot \omega^2 \cdot p'^4 + 54 \cdot \Psi^2 \cdot \omega^2 \cdot p \cdot p'^4 + 24 \cdot \Psi^4 \cdot \\
& \omega^2 \cdot p'^3 \cdot \theta^2 + 16 \cdot \Psi^2 \cdot \omega^2 \cdot p'^3 \cdot \theta^2 - 12 \cdot p' \cdot \Psi^5 \cdot \mu \cdot \\
& \omega \cdot p'' \cdot \omega[a] \cdot \omega[-A] - 12 \cdot p' \cdot \Psi^5 \cdot \omega \cdot p \cdot p'' \cdot \omega[a] \cdot \omega[-A] = \\
& 0
\end{aligned}$$

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