```
> 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 $\sigma_{a\,b}$=0 =>ωΘ=0

Author: Peter Huf

eq72a - time differentiation 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(%);
```

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

proof of eq72a: We commence with SSSeq72:

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

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

```
> temp1 := expand(6·Ψ^4·`p'`·expand(rhs(temp) - lhs(temp) = 0)) : T(%);
```

$$-6\,PU\,\Psi^4\,\omega^2\,p''+12\,\Psi^4\,\omega^2\,p^2+2\,\Psi^4\,\omega^2\,p'+18\,\Psi^2\,\omega^2\,p^3+12\,\Psi^2\,\omega^2\,p^2-2\,\Psi^2\,p^2\,\theta^2 \qquad \textbf{(1.3)}$$
$$-18\,p^4\,\theta^2-3\,\Psi^2\,\mu\,p^2-9\,\Psi^2\,p\,p^2=0$$

taking the time derivative:

```
> temp2 := dotT(temp1) : T(%);
```

$$-6\,PU\,\Psi^4\,dotp''\,\omega^2-12\,PU\,\Psi^4\,\omega\,p''\,dotomega-24\,PU\,\Psi^3\,dotPsi\,\omega^2\,p'' \qquad \textbf{(1.4)}$$
$$-6\,\Psi^4\,dotPU\,\omega^2\,p''+24\,\Psi^4\,dotp'\,\omega^2\,p'+24\,\Psi^4\,\omega\,p^2\,dotomega+48\,\Psi^3\,dotPsi\,\omega^2\,p^2$$
$$+2\,\Psi^4\,dotp'\,\omega^2+4\,\Psi^4\,\omega\,p'\,dotomega+8\,\Psi^3\,dotPsi\,\omega^2\,p'+54\,\Psi^2\,dotp'\,\omega^2\,p^2$$
$$+36\,\Psi^2\,\omega\,p^3\,dotomega+36\,\Psi\,dotPsi\,\omega^2\,p^3+24\,\Psi^2\,dotp'\,\omega^2\,p'-4\,\Psi^2\,dotp'\,p'\,\theta^2$$
$$+24\,\Psi^2\,\omega\,p^2\,dotomega-4\,\Psi^2\,p^2\,\theta\,dottheta+24\,\Psi\,dotPsi\,\omega^2\,p^2-4\,\Psi\,dotPsi\,p^2\,\theta^2$$
$$-72\,dotp'\,p^3\,\theta^2-36\,p^4\,\theta\,dottheta-3\,\Psi^2\,dotmu\,p^2-9\,\Psi^2\,dotp\,p^2-6\,\Psi^2\,dotp'\,\mu\,p'$$
$$-18\,\Psi^2\,dotp'\,p\,p'-6\,\Psi\,dotPsi\,\mu\,p^2-18\,\Psi\,dotPsi\,p\,p^2=0$$

```
>
```

Now we use the following identities:

```
> temp3 := dotomega = θ·ω·`p'` - 2/3 · θ ·ω : T(%);
```

$$dotomega = \theta\,\omega\,p' - \frac{2}{3}\,\theta\,\omega \tag{1.5}$$

```
> temp4 := `dotp'` =- `p''`·θ ·PU : T(%);
```

$$dotp' = -p''\,\theta\,PU \tag{1.6}$$

```
> temp5 := eq[65] : T(%);
```

$$dotPsi = \left(-\frac{p''\,\mu}{p'} - \frac{p''\,p}{p'} + \frac{3\,p^2}{\Psi^2} + \frac{1}{3} \right) \Psi\,\theta \tag{1.7}$$

```
> temp6 := `dotp''` =- `p'''`·theta·PU : T(%);
```

$$dotp'' = -p'''\,\theta\,PU \tag{1.8}$$

```
> temp7 := dotPU =- (1 + `p'`)·PU·theta : T(%);
```

$$dotPU = -(1 + p')\,PU\,\theta \tag{1.9}$$

```
> #temp8:=isolate(eq[20], dottheta) : T(%);
> temp8 := subs(thetadot = dottheta, eq[69]) : T(%);
```

$$dottheta = \frac{3\,p^2\,\theta^2}{\Psi^2} \tag{1.10}$$

```
> temp9 := TEDS(mu + p = PU, isolate(eq[30], dotmu)) : T(%);
```

$$dotmu = -\theta\,PU \tag{1.11}$$

```
> temp10 := `dotp` =- `p'`·θ ·PU : T(%);
```

$$dotp = -p'\,\theta\,PU \tag{1.12}$$

```
> temp11 := du[a,-A] = 2· Ψ^2·ω^2 + Psi[-A]·omega[a] : T(%);
```

$$du^{\,a}{}_{;a} = 2\,\Psi^2\,\omega^2 + \Psi_{;a}\,\omega^{\,a} \tag{1.13}$$

```
> temp12 := eq[71] : T(%);
```

$$\Psi_{;a}\,\omega^{\,a} = \left(\frac{3\,p^2}{\Psi^2} + \frac{1}{3} \right) \theta^2 - 2\left(\Psi^2 + 1\right)\omega^2 + \frac{1}{2}\,\mu + \frac{3}{2}\,p \tag{1.14}$$

Now substituting all of these:

```
> temp13 := expand( `p'`·Ψ^2·ω^2 / (theta·`p'`) TEDS(temp12, TEDS(PU = p + mu, TEDS(temp11,
      expand(TEDS(temp10, expand(TEDS(temp9, expand(TEDS(temp8,
      expand(TEDS(temp7, expand(TEDS(temp6, expand(TEDS(temp5, TEDS(temp4,
      expand(TEDS(temp3, temp2)))))))))))))))))))))))) : T(%)
```

$$12\,\omega^4\,\Psi^6\,\mu\,p\,p''' + \frac{48\,\omega^4\,\Psi^6\,\mu\,p''^2\,p}{p'} + 8\,\omega^2\,p'\,\Psi^4\,\mu\,p''\,\theta^2 + 8\,\omega^2\,p'\,\Psi^4\,p\,p''\,\theta^2 \tag{1.15}$$

$$+72\,\omega^2 p^3 \theta^2 p'' \Psi^2 \mu + 72\,\omega^2 p^3 \theta^2 p'' \Psi^2 p + 48\,\omega^2 p' \Psi^4 \mu p p'' + \frac{24\,\omega^4 \Psi^6 \mu^2 p''^2}{p'}$$

$$-78\,\omega^4 p' \Psi^6 \mu p'' + 6\,\omega^4 \Psi^6 p^2 p''' + \frac{24\,\omega^4 \Psi^6 p^2 p''^2}{p'} - 78\,\omega^4 p' \Psi^6 p p''$$

$$-4\,\omega^4 \Psi^6 \mu p'' - 4\,\omega^4 \Psi^6 p p'' - 162\,\omega^4 p^2 \Psi^4 \mu p'' - 162\,\omega^4 p^2 \Psi^4 p p''$$

$$-48\,\omega^4 p' \Psi^4 \mu p'' - 48\,\omega^4 p' \Psi^4 p p'' + 12\,\omega^2 p' \Psi^4 \mu^2 p'' + 36\,\omega^2 p' \Psi^4 p^2 p''$$

$$+6\,\omega^4 \Psi^6 \mu^2 p''' + 24\,\omega^4 p^3 \Psi^6 + 4\,\omega^4 p^2 \Psi^6 + 180\,\omega^4 p^4 \Psi^4 + 36\,\omega^4 p^3 \Psi^4$$

$$+108\,\omega^4 p^5 \Psi^2 - 8\,\omega^4 p^2 \Psi^4 + 72\,\omega^4 p^4 \Psi^2 - 108\,\omega^2 p^6 \theta^2 + 9\,\omega^2 p^3 \Psi^4 \mu$$

$$+9\,\omega^2 p^3 \Psi^4 p - \frac{4}{3}\,\omega^2 p^2 \Psi^4 \theta^2 - 24\,\omega^2 p^4 \theta^2 \Psi^2 + \omega^2 p^2 \Psi^4 \mu - 3\,\omega^2 p^2 \Psi^4 p$$

$$-18\,\omega^2 p^4 \mu \Psi^2 - 54\,\omega^2 p^4 p \Psi^2 = 0$$

```
> temp14 := isolate(temp13, `p'''`) : T(%);
```

$$p''' = \frac{1}{6\,\Psi^6 \mu^2 \omega^4 + 12\,\Psi^6 \mu \omega^4 p + 6\,\Psi^6 \omega^4 p^2} \left(-\frac{48\,\omega^4 \Psi^6 \mu p'^2 p}{p'} - 8\,\omega^2 p' \Psi^4 \mu p'' \theta^2 \right. \tag{1.16}$$

$$-8\,\omega^2 p' \Psi^4 p p'' \theta^2 - 72\,\omega^2 p^3 \theta^2 p'' \Psi^2 \mu - 72\,\omega^2 p^3 \theta^2 p'' \Psi^2 p - 48\,\omega^2 p' \Psi^4 \mu p p''$$

$$-\frac{24\,\omega^4 \Psi^6 \mu^2 p''^2}{p'} + 78\,\omega^4 p' \Psi^6 \mu p'' - \frac{24\,\omega^4 \Psi^6 p^2 p''^2}{p'} + 78\,\omega^4 p' \Psi^6 p p''$$

$$+4\,\omega^4 \Psi^6 \mu p'' + 4\,\omega^4 \Psi^6 p p'' + 162\,\omega^4 p^2 \Psi^4 \mu p'' + 162\,\omega^4 p^2 \Psi^4 p p''$$

$$+48\,\omega^4 p' \Psi^4 \mu p'' + 48\,\omega^4 p' \Psi^4 p p'' - 12\,\omega^2 p' \Psi^4 \mu^2 p'' - 36\,\omega^2 p' \Psi^4 p^2 p''$$

$$-24\,\omega^4 p^3 \Psi^6 - 4\,\omega^4 p^2 \Psi^6 - 180\,\omega^4 p^4 \Psi^4 - 36\,\omega^4 p^3 \Psi^4 - 108\,\omega^4 p^5 \Psi^2$$

$$+8\,\omega^4 p^2 \Psi^4 - 72\,\omega^4 p^4 \Psi^2 + 108\,\omega^2 p^6 \theta^2 - 9\,\omega^2 p^3 \Psi^4 \mu - 9\,\omega^2 p^3 \Psi^4 p$$

$$+\frac{4}{3}\,\omega^2 p^2 \Psi^4 \theta^2 + 24\,\omega^2 p^4 \theta^2 \Psi^2 - \omega^2 p^2 \Psi^4 \mu + 3\,\omega^2 p^2 \Psi^4 p + 18\,\omega^2 p^4 \mu \Psi^2$$

$$\left. +54\,\omega^2 p^4 p \Psi^2 \right)$$

```
> convert(temp13, string);
```

```
"12*omega^4*Psi^6*mu*p*`p'''`+48*omega^4/`p'`*Psi^6*mu*`p'''`^2*p+8*omega^2*`p'`*
    Psi^4*mu*`p'''`*theta^2+8*omega^2*`p'`*Psi^4*p*`p'''`*theta^2+72*omega^2*`p'`^3*
```

```
theta^2*`p'`*Psi^2*mu+72*omega^2*`p'`^3*theta^2*`p'`*Psi^2*p+48*omega^2*`p'`*
Psi^4*mu*p*`p'`+24*omega^4/`p'`*Psi^6*mu^2*`p'`^2-78*omega^4*`p'`*Psi^6*mu*
`p'`+6*omega^4*Psi^6*p^2*`p'`+24*omega^4/`p'`*Psi^6*p^2*`p'`^2-78*omega^4*
`p'`*Psi^6*p*`p'`-4*omega^4*Psi^6*mu*`p'`-4*omega^4*Psi^6*p*`p'`-162*omega^4*
`p'`^2*Psi^4*mu*`p'`-162*omega^4*`p'`^2*Psi^4*p*`p'`-48*omega^4*`p'`*Psi^4*mu*
`p'`-48*omega^4*`p'`*Psi^4*p*`p'`+12*omega^2*`p'`*Psi^4*mu^2*`p'`+36*
omega^2*`p'`*Psi^4*p^2*`p'`+6*omega^4*Psi^6*mu^2*`p'`+24*omega^4*`p'`^3*
Psi^6+4*omega^4*`p'`^2*Psi^6+180*omega^4*`p'`^4*Psi^4+36*omega^4*`p'`^3*
Psi^4+108*omega^4*`p'`^5*Psi^2-8*omega^4*`p'`^2*Psi^4+72*omega^4*`p'`^4*
Psi^2-108*omega^2*`p'`^6*theta^2+9*omega^2*`p'`^3*Psi^4*mu+9*omega^2*
`p'`^3*Psi^4*p-4/3*omega^2*`p'`^2*Psi^4*theta^2-24*omega^2*`p'`^4*theta^2*
Psi^2+omega^2*`p'`^2*Psi^4*mu-3*omega^2*`p'`^2*Psi^4*p-18*omega^2*`p'`^4*
mu*Psi^2-54*omega^2*`p'`^4*p*Psi^2 = 0"
```

```
> temp4 := `dotp'`=-`p''`·θ·PU : T(%);
```

$$dotp' = -p''\,\theta\,PU \tag{1.18}$$

```
> temp5 := eq[65] : T(%);
```

$$dotPsi = \left(-\frac{p''\,\mu}{p'} - \frac{p''\,p}{p'} + \frac{3\,p^2}{\Psi^2} + \frac{1}{3} \right) \Psi\,\theta \tag{1.19}$$

```
> temp6 := `dotp''`=-`p'''`·theta·PU : T(%);
```

$$dotp'' = -p'''\,\theta\,PU \tag{1.20}$$

```
> temp7 := dotPU=-(1+`p'`)·PU·theta : T(%);
```

$$dotPU = -(1+p')\,PU\,\theta \tag{1.21}$$

```
> #temp8:=isolate(eq[20], dottheta) : T(%);
> temp8 := subs(thetadot=dottheta, eq[69]) : T(%);
```

$$dottheta = \frac{3\,p^2\,\theta^2}{\Psi^2} \tag{1.22}$$

```
> temp9 := TEDS(mu+p=PU, isolate(eq[30], dotmu)) : T(%);
```

$$dotmu = -\theta\,PU \tag{1.23}$$

```
> temp10 := `dotp`=-`p'`·θ·PU : T(%);
```

$$dotp = -p'\,\theta\,PU \tag{1.24}$$

```
> temp11 := du[a,-A]=2·Ψ^2·ω^2+Psi[-A]·omega[a] : T(%);
```

$$du^{\,a}{}_{;a} = 2\,\Psi^2\,\omega^2 + \Psi_{;a}\,\omega^{\,a} \tag{1.25}$$

```
> temp12 := eq[71] : T(%);
```

$$\Psi_{;a}\,\omega^{a} = \left(\frac{3p^2}{\Psi^2} + \frac{1}{3}\right)\theta^2 - 2\left(\Psi^2+1\right)\omega^2 + \frac{1}{2}\mu + \frac{3}{2}p \tag{1.26}$$

Now subsstituting all of these:

```
> temp13 := expand( `p'`·Ψ^2·ω^2 / theta·`p'` TEDS(temp12, TEDS(PU=p+mu, TEDS(temp11,
      expand(TEDS(temp10, expand(TEDS(temp9, expand(TEDS(temp8,
      expand(TEDS(temp7, expand(TEDS(temp6, expand(TEDS(temp5, TEDS(temp4,
      expand(TEDS(temp3, temp2)))))))))))))))))))) : T(%)
```

$$12\omega^4\Psi^6\mu p p''' + \frac{48\omega^4\Psi^6\mu p'^2 p}{p'} + 8\omega^2 p'\Psi^4\mu p''\theta^2 + 8\omega^2 p'\Psi^4 p p''\theta^2 \tag{1.27}$$
$$+ 72\omega^2 p^3\theta^2 p''\Psi^2\mu + 72\omega^2 p^3\theta^2 p''\Psi^2 p + 48\omega^2 p'\Psi^4\mu p p'' + \frac{24\omega^4\Psi^6\mu^2 p'^2}{p'}$$
$$- 78\omega^4 p'\Psi^6\mu p'' + 6\omega^4\Psi^6 p^2 p''' + \frac{24\omega^4\Psi^6 p^2 p'^2}{p'} - 78\omega^4 p'\Psi^6 p p''$$
$$- 4\omega^4\Psi^6\mu p'' - 4\omega^4\Psi^6 p p'' - 162\omega^4 p^2\Psi^4\mu p'' - 162\omega^4 p^2\Psi^4 p p''$$
$$- 48\omega^4 p'\Psi^4\mu p'' - 48\omega^4 p'\Psi^4 p p'' + 12\omega^2 p'\Psi^4\mu^2 p'' + 36\omega^2 p'\Psi^4 p^2 p''$$
$$+ 6\omega^4\Psi^6\mu^2 p''' + 24\omega^4 p^3\Psi^6 + 4\omega^4 p^2\Psi^6 + 180\omega^4 p^4\Psi^4 + 36\omega^4 p^3\Psi^4$$
$$+ 108\omega^4 p^5\Psi^2 - 8\omega^4 p^2\Psi^4 + 72\omega^4 p^4\Psi^2 - 108\omega^2 p^6\theta^2 + 9\omega^2 p^3\Psi^4\mu$$
$$+ 9\omega^2 p^3\Psi^4 p - \frac{4}{3}\omega^2 p^2\Psi^4\theta^2 - 24\omega^2 p^4\theta^2\Psi^2 + \omega^2 p^2\Psi^4\mu - 3\omega^2 p^2\Psi^4 p$$
$$- 18\omega^2 p^4\mu\Psi^2 - 54\omega^2 p^4 p\Psi^2 = 0$$

```
> temp14 := isolate(temp13, `p'''`) : T(%);
```

$$p''' = \frac{1}{6\Psi^6\mu^2\omega^4 + 12\Psi^6\mu\omega^4 p + 6\Psi^6\omega^4 p^2}\left(-\frac{48\omega^4\Psi^6\mu p'^2 p}{p'} - 8\omega^2 p'\Psi^4\mu p''\theta^2\right) \tag{1.28}$$
$$- 8\omega^2 p'\Psi^4 p p''\theta^2 - 72\omega^2 p^3\theta^2 p''\Psi^2\mu - 72\omega^2 p^3\theta^2 p''\Psi^2 p - 48\omega^2 p'\Psi^4\mu p p''$$
$$- \frac{24\omega^4\Psi^6\mu^2 p'^2}{p'} + 78\omega^4 p'\Psi^6\mu p'' - \frac{24\omega^4\Psi^6 p^2 p'^2}{p'} + 78\omega^4 p'\Psi^6 p p''$$
$$+ 4\omega^4\Psi^6\mu p'' + 4\omega^4\Psi^6 p p'' + 162\omega^4 p^2\Psi^4\mu p'' + 162\omega^4 p^2\Psi^4 p p''$$
$$+ 48\omega^4 p'\Psi^4\mu p'' + 48\omega^4 p'\Psi^4 p p'' - 12\omega^2 p'\Psi^4\mu^2 p'' - 36\omega^2 p'\Psi^4 p^2 p''$$
$$- 24\omega^4 p^3\Psi^6 - 4\omega^4 p^2\Psi^6 - 180\omega^4 p^4\Psi^4 - 36\omega^4 p^3\Psi^4 - 108\omega^4 p^5\Psi^2$$

$$+ 8\,\omega^4 p^2 \Psi^4 - 72\,\omega^4 p^4 \Psi^2 + 108\,\omega^2 p^6 \theta^2 - 9\,\omega^2 p^3 \Psi^4 \mu - 9\,\omega^2 p^3 \Psi^4 p$$

$$+ \frac{4}{3}\,\omega^2 p^2 \Psi^4 \theta^2 + 24\,\omega^2 p^4 \theta^2 \Psi^2 - \omega^2 p^2 \Psi^4 \mu + 3\,\omega^2 p^2 \Psi^4 p + 18\,\omega^2 p^4 \mu \Psi^2$$

$$+ 54\,\omega^2 p^4 p \Psi^2 \Big)$$

```
> convert(temp13, string);
```

"12*omega^4*Psi^6*mu*p*`p'''`+48*omega^4/`p'`*Psi^6*mu*`p'''`^2*p+8*omega^2*`p'`* Psi^4*mu*`p'''`*theta^2+8*omega^2*`p'`*Psi^4*p*`p'''`*theta^2+72*omega^2*`p'`^3* theta^2*`p'''`*Psi^2*mu+72*omega^2*`p'`^3*theta^2*`p'''`*Psi^2*p+48*omega^2*`p'`* Psi^4*mu*p*`p'''`+24*omega^4/`p'`*Psi^6*mu^2*`p'''`^2-78*omega^4*`p'`*Psi^6*mu* `p'''`+6*omega^4*Psi^6*p^2*`p'''`+24*omega^4/`p'`*Psi^6*p^2*`p'''`^2-78*omega^4* `p'`*Psi^6*p*`p'''`-4*omega^4*Psi^6*mu*`p'''`-4*omega^4*Psi^6*p*`p'''`-162*omega^4* `p'`^2*Psi^4*mu*`p'''`-162*omega^4*`p'`^2*Psi^4*p*`p'''`-48*omega^4*`p'`*Psi^4*mu* `p'''`-48*omega^4*`p'`*Psi^4*p*`p'''`+12*omega^2*`p'`*Psi^4*mu^2*`p'''`+36* omega^2*`p'`*Psi^4*p^2*`p'''`+6*omega^4*Psi^6*mu^2*`p'''`+24*omega^4*`p'`^3* Psi^6+4*omega^4*`p'`^2*Psi^6+180*omega^4*`p'`^4*Psi^4+36*omega^4*`p'`^3* Psi^4+108*omega^4*`p'`^5*Psi^2-8*omega^4*`p'`^2*Psi^4+72*omega^4*`p'`^4* Psi^2-108*omega^2*`p'`^6*theta^2+9*omega^2*`p'`^3*Psi^4*mu+9*omega^2* `p'`^3*Psi^4*p-4/3*omega^2*`p'`^2*Psi^4*theta^2-24*omega^2*`p'`^4*theta^2* Psi^2+omega^2*`p'`^2*Psi^4*mu-3*omega^2*`p'`^2*Psi^4*p-18*omega^2*`p'`^4* mu*Psi^2-54*omega^2*`p'`^4*p*Psi^2 = 0" **(1.29)**

```
> convert(temp14, string);
```

"`p'''` = (-48*omega^4/`p'`*Psi^6*mu*`p'''`^2*p-8*omega^2*`p'`*Psi^4*mu*`p'''`*theta^2-8* omega^2*`p'`*Psi^4*p*`p'''`*theta^2-72*omega^2*`p'`^3*theta^2*`p'''`*Psi^2*mu-72* omega^2*`p'`^3*theta^2*`p'''`*Psi^2*p-48*omega^2*`p'`*Psi^4*mu*p*`p'''`-24* omega^4/`p'`*Psi^6*mu^2*`p'''`^2+78*omega^4*`p'`*Psi^6*mu*`p'''`-24*omega^4/`p'`* Psi^6*p^2*`p'''`^2+78*omega^4*`p'`*Psi^6*p*`p'''`+4*omega^4*Psi^6*mu*`p'''`+4* omega^4*Psi^6*p*`p'''`+162*omega^4*`p'`^2*Psi^4*mu*`p'''`+162*omega^4*`p'`^2* Psi^4*p*`p'''`+48*omega^4*`p'`*Psi^4*mu*`p'''`+48*omega^4*`p'`*Psi^4*p*`p'''`-12* omega^2*`p'`*Psi^4*mu^2*`p'''`-36*omega^2*`p'`*Psi^4*p^2*`p'''`-24*omega^4*`p'`^3* Psi^6-4*omega^4*`p'`^2*Psi^6-180*omega^4*`p'`^4*Psi^4-36*omega^4*`p'`^3*Psi^4 -108*omega^4*`p'`^5*Psi^2+8*omega^4*`p'`^2*Psi^4-72*omega^4*`p'`^4* Psi^2+108*omega^2*`p'`^6*theta^2-9*omega^2*`p'`^3*Psi^4*mu-9*omega^2*`p'`^3* Psi^4*p+4/3*omega^2*`p'`^2*Psi^4*theta^2+24*omega^2*`p'`^4*theta^2*Psi^2- **(1.30)**

```
omega^2*`p'`^2*Psi^4*mu+3*omega^2*`p'`^2*Psi^4*p+18*omega^2*`p'`^4*mu*
Psi^2+54*omega^2*`p'`^4*p*Psi^2)/(6*Psi^6*mu^2*omega^4+12*Psi^6*mu*
omega^4*p+6*Psi^6*omega^4*p^2)"
```

```
> temp15 := collect(temp13, [`p'''`, Psi, omega]) : T(%);
```

$$\left(6\,\mu^2+12\,\mu p+6\,p^2\right)\omega^4\,\Psi^6\,p'''+\left(\frac{48\,\mu\,p'^2\,p}{p'}+\frac{24\,\mu^2\,p'^2}{p'}-78\,p'\,\mu\,p''+\frac{24\,p^2\,p'^2}{p'}\right.$$
$$\left.-78\,p'\,p\,p''-4\,p''\,\mu-4\,p''\,p+24\,p^3+4\,p^2\right)\omega^4\,\Psi^6+\left(\left(-162\,\mu\,p^2\,p''\right.\right.$$
$$\left.-162\,p\,p^2\,p''+180\,p^4-48\,\mu\,p'\,p''-48\,p\,p'\,p''+36\,p^3-8\,p^2\right)\omega^4+\left(8\,p'\,\mu\,p''\,\theta^2\right.$$
$$+8\,p'\,p\,p''\,\theta^2+48\,p'\,\mu\,p\,p''+12\,p'\,\mu^2\,p''+36\,p'\,p^2\,p''+9\,p^3\,\mu+9\,p^3\,p-\frac{4}{3}\,p^2\,\theta^2$$
$$\left.\left.+p^2\,\mu-3\,p^2\,p\right)\omega^2\right)\Psi^4+\left(\left(108\,p^5+72\,p^4\right)\omega^4+\left(72\,\mu\,p^3\,p''\,\theta^2+72\,p\,p^3\,p''\,\theta^2\right.\right.$$
$$\left.\left.-24\,p^4\,\theta^2-18\,\mu\,p^4-54\,p\,p^4\right)\omega^2\right)\Psi^2-108\,\omega^2\,p^6\,\theta^2=0 \qquad (1.31)$$

```
> temp16 := isolate(temp15, op(1, op(1, temp15))) : T(%);
```

$$\left(6\,\mu^2+12\,\mu p+6\,p^2\right)\omega^4\,\Psi^6\,p'''=-\left(\frac{48\,\mu\,p'^2\,p}{p'}+\frac{24\,\mu^2\,p'^2}{p'}-78\,p'\,\mu\,p''+\frac{24\,p^2\,p'^2}{p'}\right.$$
$$\left.-78\,p'\,p\,p''-4\,p''\,\mu-4\,p''\,p+24\,p^3+4\,p^2\right)\omega^4\,\Psi^6-\left(\left(-162\,\mu\,p^2\,p''\right.\right.$$
$$\left.-162\,p\,p^2\,p''+180\,p^4-48\,\mu\,p'\,p''-48\,p\,p'\,p''+36\,p^3-8\,p^2\right)\omega^4+\left(8\,p'\,\mu\,p''\,\theta^2\right.$$
$$+8\,p'\,p\,p''\,\theta^2+48\,p'\,\mu\,p\,p''+12\,p'\,\mu^2\,p''+36\,p'\,p^2\,p''+9\,p^3\,\mu+9\,p^3\,p-\frac{4}{3}\,p^2\,\theta^2$$
$$\left.\left.+p^2\,\mu-3\,p^2\,p\right)\omega^2\right)\Psi^4-\left(\left(108\,p^5+72\,p^4\right)\omega^4+\left(72\,\mu\,p^3\,p''\,\theta^2+72\,p\,p^3\,p''\,\theta^2\right.\right.$$
$$\left.\left.-24\,p^4\,\theta^2-18\,\mu\,p^4-54\,p\,p^4\right)\omega^2\right)\Psi^2+108\,\omega^2\,p^6\,\theta^2 \qquad (1.32)$$

```
> convert(temp16, string);
```

```
"(6*mu^2+12*mu*p+6*p^2)*omega^4*Psi^6*`p'''` = -(48/`p'`*mu*`p'`^2*p+24/`p'`*
mu^2*`p'`^2-78*`p'`*mu*`p'`+24/`p'`*p^2*`p'`^2-78*`p'`*p*`p'`-4*`p'`*mu-4*`p'`*
p+24*`p'`^3+4*`p'`^2)*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+(8*
`p'`*mu*`p'`*theta^2+8*`p'`*p*`p'`*theta^2+48*`p'`*mu*p*`p'`+12*`p'`*mu^2*
`p'`+36*`p'`*p^2*`p'`+9*`p'`^3*mu+9*`p'`^3*p-4/3*`p'`^2*theta^2+`p'`^2*mu-3*
`p'`^2*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"
>
```