$$\ln[1]:= d[i_]:= \frac{\bar{l}}{dx^2} \left(psi[i+1] - 2 psi[i] + psi[i-1] \right) - \bar{l} v[i] \times psi[i]$$

In[2]:= **d[j**]

$$\text{Out[2]=} \quad \frac{\textit{i}\left(\texttt{psi[-1+j]}-2\;\texttt{psi[[j]}+\texttt{psi[[1+j]}\right)}{\texttt{dx}^2} - \textit{i}\;\texttt{psi[[j]]}\;\texttt{v[[j]]}$$

k1 = d[i]

$$\frac{i\left(\text{psi}[-1+i]\!]-2\;\text{psi}[\![i]\!]+\text{psi}[\![1+i]\!]\right)}{\text{d}x^2}-i\;\text{psi}[\![i]\!]\;\text{v}[\![i]\!]$$

k1

$$\frac{i\left(\text{psi}[-1+i]\!]-2\,\text{psi}[\![i]\!]+\text{psi}[\![1+i]\!]\right)}{\text{d}x^2}-i\,\text{psi}[\![i]\!]\,\text{v}[\![i]\!]$$

$$d[i] + \frac{dt}{2} k1$$

$$\frac{i\left(\text{psi}[-1+i]\!]-2\;\text{psi}[\![i]\!]+\text{psi}[\![1+i]\!]\right)}{\text{d}x^2}-i\;\text{psi}[\![i]\!]\;\text{v}[\![i]\!]+$$

$$\frac{1}{2} dt \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[1+i] \right)}{dx^2} - i psi[i] v[i] \right)$$

$$\frac{\bar{l}\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2} - \bar{l}\,\text{psi}[i]\,\text{v[i]} + \frac{1}{2}\,\text{dt}\left(\frac{\bar{l}\left(\text{d}[-1+i]-2\,\text{d}[i]+\text{d}[1+i]\right)}{\text{d}x^2} - \bar{l}\,\text{d}[i]\,\text{v[i]}\right)$$

$$k2 = \frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2} - i\,\text{psi}[i]\,\text{v[i]} + \\ \frac{1}{2}\,\text{dt}\left(-i\,\text{v[i]}\left(\frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2} - i\,\text{psi}[i]\,\text{v[i]}\right) + \\ \frac{1}{dx^2}\,i\left(\frac{i\left(\text{psi}[-2+i]-2\,\text{psi}[-1+i]+\text{psi}[i]\right)}{\text{d}x^2} + \\ \frac{i\left(\text{psi}[i]-2\,\text{psi}[1+i]+\text{psi}[2+i]\right)}{\text{d}x^2} - i\,\text{psi}[-1+i]\,\text{v[-1+i]} - \\ 2\left(\frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2} - i\,\text{psi}[i]\,\text{v[i]}\right) - i\,\text{psi}[i]\,\text{v[i]}\right) - i\,\text{psi}[1+i]\,\text{v[-1+i]}\right) \\ \frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2} - i\,\text{psi}[i]\,\text{v[i]}\right) + \\ \frac{1}{2}\,\text{dt}\left(-i\,\text{v[i]}\left(\frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[i]+\text{ii}\right)}{\text{d}x^2}\right) - i\,\text{psi}[i]\,\text{v[i]}\right) + \\ \frac{1}{2}\,\text{dt}\left(\frac{i\left(\text{psi}[-2+i]-2\,\text{psi}[-1+i]+\text{psi}[i]\right)}{\text{d}x^2} + \frac{i\left(\text{psi}[i]-2\,\text{psi}[1+i]+\text{psi}[2+i]\right)}{\text{d}x^2} - i\,\text{psi}[-1+i]\right) \\ \text{v[-1+i]}-2\left(\frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2}\right) - i\,\text{psi}[i]\,\text{v[i]}\right) - i\,\text{psi}[i]+i]\,\text{v[i]}\right) \\ d[i]+\frac{dt}{2}\,\text{k2}$$

$$\begin{split} \frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[1+i]\right)}{\text{d}x^2} - \\ \hat{t} \, \text{psi}[i] \, \text{v[i]} + \frac{1}{2} \, \text{dt} \left(\frac{i\left(\text{d}[-1+i]-2\,\text{d[i]}+\text{d[1+i]}\right)}{\text{d}x^2} - \hat{t} \, \text{d[i]} \, \text{v[i]} \right) + \\ \frac{1}{2} \, \text{dt} \left(-\hat{t} \, \text{v[i]} \left(\frac{i\left(\text{d}[-1+i]-2\,\text{d[i]}+\text{d[1+i]}\right)}{\text{d}x^2} - \hat{t} \, \text{d[i]} \, \text{v[i]} \right) + \\ \frac{1}{dx^2} \, i\left(\frac{i\left(\text{d}[-2+i]-2\,\text{d[i]}+\text{d[1+i]}\right)}{\text{d}x^2} - \hat{t} \, \text{d[i]} \, \text{v[i]} \right) + \\ 2 \left(\frac{i\left(\text{d}[-1+i]-2\,\text{d[i]}+\text{d[1+i]}\right)}{\text{d}x^2} - \hat{t} \, \text{d[i]} \, \text{v[i]} \right) - \hat{t} \, \text{d[i]} \, \text{v[i]} + i\right) \\ \frac{1}{dx^2} \, i\left(\frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[i]+\text{ii}\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} + i\right) \\ \frac{1}{dx^2} \, i\left(\frac{i\left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[i]+\text{ii}\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) + \\ \frac{1}{dx^2} \, i\left(\frac{i\left(\text{psi}[-2+i]-2\,\text{psi}[i]+\text{psi}[i]+\text{ii}\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) + \\ \frac{1}{2} \, dt\left(-\hat{t} \, \text{v[i]} \left(\frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{psi}[i]+\text{ii}\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) + \\ \frac{1}{2} \, dt\left(-\hat{t} \, \text{v[i]} \left(-\hat{t} \, \text{v[i]} \left(\frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{ii}\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) + \\ \frac{1}{dx^2} \, i\left(\frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[-1+i]+\text{psi}[2+i]\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) + \\ \frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[-1+i]+\text{psi}[2+i]\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) + \\ \frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[-1+i]+\text{psi}[2+i]\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] \, \text{v[i]} + i\right) - \hat{t} \, \text{psi}[i] + i\left(\text{v[i]} \, \text{v[i]} + i\right) + \hat{t} \, \text{v[i]} \right) + \\ \frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{ii} + \text{psi}[2+i]\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] + i\left(\text{v[i]} \, \text{v[i]} \right) + \\ \frac{\hat{t}\, \left(\text{psi}[-1+i]-2\,\text{psi}[i]+\text{ii} + \text{psi}[2+i]\right)}{\text{d}x^2} - \hat{t} \, \text{psi}[i] \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] + i\left(\text{v[i]} \, \text{v[i]} \right) - \hat{t} \, \text{psi}[i] + i\left(\text{v[i]} \, \text{v[i]} \right) + \\ \frac{\hat{t}\,$$

$$\frac{1}{dx^{2}} i \left(-i \sqrt{[-1+i]} \left(\frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} \right) +$$

$$\frac{1}{dx^{2}} i \left(\frac{i \left(psi[-3+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} +$$

$$\frac{i \left(psi[-1+i] - 2 psi[i] + psi[1+i] \right)}{dx^{2}} - i psi[-2+i] \sqrt{[-2+i]} -$$

$$2 \left(\frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} \right) - i psi[i]$$

$$\sqrt{[i]} - i \sqrt{[i]} \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[1+i] + psi[2+i] \right)}{dx^{2}} - i psi[i] \sqrt{[i]} \right) + \frac{1}{dx^{2}}$$

$$i \left(\frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[i] \right)}{dx^{2}} +$$

$$\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^{2}} - i psi[-1+i] \sqrt{[-1+i]} -$$

$$4 psi[-1+i] \sqrt{$$

$$\frac{1}{2} \det \left(-i v \| i \| \frac{i \left(psi \| -1 + i \| -2 psi \| i \| + psi \| i \| + psi \| i \| -i psi \| i \| v \| i \| \right)}{dx^2} + \frac{i}{psi \| i \| v \| i \|} + \frac{1}{dx^2}$$

$$i \left(\frac{i \left(psi \| -2 + i \| -2 psi \| -1 + i \| + psi \| i \| \right)}{dx^2} + \frac{i \left(psi \| -1 + i \| -2 psi \| -1 + i \| + psi \| -1 + i \| \right)}{dx^2} - i psi \| -1 + i \| -1$$

$$i \operatorname{psi}[-1+i] \vee [-1+i] - 2 \left(\frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right)}{\operatorname{d} x^{2}} - \frac{i \operatorname{psi}[i] \vee [i] - i \operatorname{psi}[1+i] \vee [1+i] \right)}{\operatorname{d} x^{2}} + \frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[2+i] + \operatorname{psi}[3+i] \right)}{\operatorname{d} x^{2}} - \frac{i \left(\operatorname{psi}[i] \vee [i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right)}{\operatorname{d} x^{2}} + \frac{i \left(\operatorname{psi}[1+i] - 2 \operatorname{psi}[2+i] + \operatorname{psi}[3+i] \right)}{\operatorname{d} x^{2}} - \frac{i \operatorname{psi}[i] \vee [i] - 2 \left(\frac{i \left(\operatorname{psi}[i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[2+i] \right)}{\operatorname{d} x^{2}} - \frac{i \operatorname{psi}[1+i] \vee [1+i] - i \operatorname{psi}[2+i] \vee [2+i] \right)}{\operatorname{d} x^{2}} - \frac{i \operatorname{psi}[1+i] \vee [1+i] - i \operatorname{psi}[2+i] \vee [2+i] \right) \right)$$

d[i] + dt k3

$$\begin{split} &\frac{i}{d} \underbrace{\left(\text{psi} [-1+i] - 2 \, \text{psi} [i] + \text{psi} [1+i] \right)}_{\text{d} x^2} - i \, \text{psi} [i] \, \text{v[i]} + \text{dt} \left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[i] + d[1+i] \right)}_{\text{d} x^2} - \frac{i}{d} d[i] \, \text{v[i]} + \frac{1}{2} \, \text{dt} \left(-i \, \text{v[i]} \left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[i] + d[1+i] \right)}_{\text{d} x^2} - i \, d[i] \, \text{v[i]} \right) + \\ &\frac{1}{dx^2} \underbrace{i} \left(\frac{i}{d} \underbrace{\left(d[-2+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} + \frac{i}{d} \underbrace{\left(d[i] - 2 \, d[1+i] + d[2+i] \right)}_{\text{d} x^2} - i \, d[-1+i] \, \text{v[i-1+i]} - 2 \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[i] + d[1+i] \right)}_{\text{d} x^2} - i \, d[i] \, \text{v[i]} \right) + i}_{\text{d} x^2} - i \, d[i] \, \text{v[i]} \right) + \frac{1}{dx^2} \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-2+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} + \frac{i}{d} \underbrace{\left(d[i] - 2 \, d[1+i] + d[2+i] \right)}_{\text{d} x^2} - i \, d[-1+i] \right)}_{\text{d} x^2} - i \, d[i] \, \text{v[i]} \right) - i \, d[-1+i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[i] + d[1+i] \right)}_{\text{d} x^2} - i \, d[i] \, \text{v[i]} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[i] + d[1+i] \right)}_{\text{d} x^2} - i \, d[i] \, \text{v[i]} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[i] \right)}_{\text{d} x^2} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[-1+i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[-1+i] \right)}_{\text{d} x^2} \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[-1+i] \right)}_{\text{d} x^2} - i \, d[-1+i] \underbrace{\left(\frac{i}{d} \underbrace{\left(d[-1+i] - 2 \, d[-1+i] + d[-1+i] + d[-1+i] \right)}_{\text$$

$$\frac{1}{dx^{2}} \int_{0}^{t} \frac{\left[d[-3+i]-2d[-2+i]+d[-1+i]\right]}{dx^{2}} + \frac{f(d[-1+i]-2d[i]+d[1+i])}{dx^{2}} - \frac{1}{t} d[-1+i] \sqrt{[-1+i]} - \frac{1}{t} dx^{2}$$

$$= \int_{0}^{t} d[-2+i] \sqrt{[-2+i]} - 2\left[\frac{f(d[-2+i]-2d[-1+i]+d[i])}{dx^{2}} - \int_{0}^{t} d[-1+i] \sqrt{[-1+i]}\right] - \frac{1}{t} d[-1+i] \sqrt{[-1+i]} -$$

$$\frac{1}{dx^{2}} t \left(\frac{t \left(psi[[-1+i]] - 2 psi[[-1+i]] + psi[[i]] \right)}{dx^{2}} + \frac{t \left(psi[[i]] - 2 psi[[+i]] + psi[[2+i]] \right)}{dx^{2}} - t psi[[-1+i]] \vee [[-1+i]] - 2 \right)$$

$$\frac{t \left(psi[[-1+i]] - 2 psi[[i]] + psi[[1+i]] \right)}{dx^{2}} - t psi[[i]] \vee [[i]] - t psi[[1+i]] \vee [[-1+i]] \right) + \frac{1}{dx^{2}} t \left(\frac{t \left(psi[[-2+i]] - 2 psi[[-1+i]] + psi[[i]] \right)}{dx^{2}} - t psi[[-1+i]] \vee [[-1+i]] \right) + \frac{1}{dx^{2}} t \left(\frac{t \left(psi[[-3+i]] - 2 psi[[-2+i]] + psi[[-1+i]] \right)}{dx^{2}} - t psi[[-2+i]] \vee [[-2+i]] - \frac{t}{dx^{2}} \right) \right)$$

$$\frac{t \left(psi[[-1+i]] - 2 psi[[i]] + psi[[i]] \right)}{dx^{2}} - t psi[[-1+i]] \vee [[-1+i]] - t psi[[i]] \right) - t psi[[i]] + \frac{1}{dx^{2}}$$

$$\frac{t \left(psi[[-2+i]] - 2 psi[[-1+i]] + psi[[i]] \right)}{dx^{2}} - t psi[[-1+i]] \vee [[-1+i]] - t psi[[i]] + \frac{1}{dx^{2}} \right)$$

$$\frac{t \left(psi[[-1+i]] - 2 psi[[-1+i]] + psi[[-1+i]] \right)}{dx^{2}} - t psi[[-1+i]] \vee [[-1+i]] - t psi[[-1+i]] -$$

$$2 \left(\frac{s \left(\text{psi}[1] - 2 \text{psi}[1 + i] + \text{psi}[2 + i] \right)}{\text{d}x^2} - t \text{psi}[1 + i] \text{v}[1 + i] \right) - t \text{psi}[2 + i] \text{v}[2 + i] \right) \right) +$$

$$\frac{1}{2} \text{dt} \left(-t \text{v}[i] \left(-t \text{v}[i] \left(\frac{t \left(\text{psi}[-1 + i] - 2 \text{psi}[i] + \text{psi}[1 + i] \right)}{\text{d}x^2} - t \text{psi}[i] \text{v}[i] \right) + \right)$$

$$\frac{1}{dx^2} t \left(\frac{t \left(\text{psi}[-2 + i] - 2 \text{psi}[-1 + i] + \text{psi}[i] \right)}{\text{d}x^2} + \frac{t \left(\text{psi}[-1 + i] - 2 \text{psi}[-1 + i] + \text{psi}[1 + i] \right)}{\text{d}x^2} - t \text{psi}[-1 + i] \text{v}[-1 + i] - 2 \right)$$

$$2 \left(\frac{t \left(\text{psi}[-1 + i] - 2 \text{psi}[-1 + i] + \text{psi}[1 + i] \right)}{\text{d}x^2} - t \text{psi}[-1 + i] \right) - t \text{psi}[-1 + i] \right) + \frac{1}{dx^2} t \left(-t \text{v}[-1 + i] \right)$$

$$\frac{1}{dx^2} t \left(\frac{t \left(\text{psi}[-2 + i] - 2 \text{psi}[-1 + i] + \text{psi}[-1 + i] \right)}{\text{d}x^2} - t \text{psi}[-1 + i] \right) + \frac{1}{dx^2} t \left(-t \text{psi}[-1 + i] \right) - t \text{psi}[-1 + i] \right) + \frac{1}{dx^2} t \left(-t \text{psi}[-1 + i] \right) - t \text{psi}[-1 + i] \right) - t \text{psi}[-1 + i] - 2 \text{psi}[-1 + i] + \text{psi}[-1 + i] \right) - t \text{psi}[-1 + i] + t \text{psi}[-1 + i] - t \text{p$$

$$\frac{i\left(\text{psi}[[-1]-2\,\text{psi}[[-1]+i]]+\text{psi}[[-1]+i]\right)}{\text{d}x^2} - i\,\text{psi}[[-1+i]] \vee [[-1+i]] - i\,\text{psi}[[-1+i]] - i\,\text{psi}[[-1$$

$$2 \left(\frac{i \left(\text{psi}[-3+i] - 2 \text{ psi}[-2+i] + \text{psi}[-1+i] \right)}{\text{d}x^2} - \frac{i}{t} \text{ psi}[-2+i] \text{ v}[-2+i] \right) - i \text{ psi}[-1+i] \text{ v}[-1+i] \right) - \frac{i}{t} \text{ psi}[-1+i] \text{ v}[-1+i] - \frac{i}{t} \text{ psi}[-1+i] - 2 \text{ psi}[i] + \text{psi}[1+i] \right) - \frac{i}{t} \text{ psi}[i] \text{ v}[i] \right) - \frac{i}{t} \text{ vsi}[-1+i] \left(\frac{i}{t} \left(\text{psi}[-2+i] - 2 \text{ psi}[-1+i] + \text{psi}[i] \right) - \frac{i}{t} \text{ psi}[-1+i] \right) - \frac{i}{t} \text{ psi}[-1+i] \right) + \frac{1}{t} \frac{i}{t} \frac{i}{t} \frac{i}{t} \frac{i}{t} \frac{i \text{ psi}[-3+i] - 2 \text{ psi}[-2+i] + \text{psi}[-1+i] \right)}{\text{d}x^2} + \frac{i}{t} \frac{i}{t} \frac{i \text{ psi}[-1+i] - 2 \text{ psi}[i] + \text{psi}[i] \right) - \frac{i}{t} \text{ psi}[-2+i] - 2 \text{ psi}[-1+i] + \text{psi}[i] \right) - \frac{i}{t} \text{ psi}[-1+i] - 2 \text{ psi}[-1+i] + \text{psi}[i] \right) + \frac{1}{t} \frac{i}{t} \frac{i}{t} \frac{i}{t} \frac{i \text{ (psi}[-2+i] - 2 \text{ psi}[-1+i] + \text{psi}[i] \right)}{\text{d}x^2} + \frac{i}{t} \frac{i}{$$

$$\frac{\delta\left(\text{psi}[1+i]-2\,\text{psi}[2+i]+\text{psi}[3+i]\right)}{\text{d}x^{2}} - \delta\,\text{psi}[i]\,\text{v[i]} - \frac{1}{\delta}\,\text{psi}[i]\,\text{v[i]} - \frac{1}{\delta}\,\text{psi}[i]\,\text{v[i]} - \frac{1}{\delta}\,\text{psi}[i]\,\text{v[i]} - \frac{1}{\delta}\,\text{psi}[i]\,\text{v[i]} + \frac{1}{\delta}\,\text{v[i]} + \frac{1}{\delta}\,\text{v[i$$

$$2 \left(-i \vee [i] \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[1+i] \right)}{dx^2} - i psi[i] \vee [i] \right) + \frac{1}{dx^2} i \left(\frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[i] \right)}{dx^2} + \frac{i \left(psi[i] - 2 psi[1+i] + psi[2+i] \right)}{dx^2} - i psi[-1+i] \frac{i}{dx^2} \right)$$

$$-i psi[i] \vee [i] - i psi[i] + psi[i] + psi[i] + psi[i] + psi[i] + i] \right) - \frac{i}{dx^2} i \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[i] + i] \right)}{dx^2} + \frac{i \left(psi[-1+i] - 2 psi[i] + psi[i] + i] \right)}{dx^2} - i psi[i] \vee [i] - \frac{i}{dx^2} \right) - i psi[i] \vee [i] - \frac{i}{dx^2}$$

$$i \left(\frac{i \left(psi[i] - 2 psi[i] + i] + psi[i] + psi[i] + i] \right)}{dx^2} - i psi[i] \vee [i] + \frac{i}{dx^2} \right) - i psi[i] \vee [i] \right) + \frac{1}{dx^2}$$

$$i \left(-i \vee [i] \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[i] + psi[i] \right)}{dx^2} + \frac{i \left(psi[-1+i] - 2 psi[i] + i] + psi[i] \right)}{dx^2} \right) - i psi[i] \vee [i] \right) - \frac{i}{dx^2}$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[i] + psi[i] \right)}{dx^2} - i psi[i] \vee [i] \right) - \frac{i}{dx^2} \right) - i psi[i] \vee [i] \right) - \frac{i}{dx^2}$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[i] + psi[i] + i] \right)}{dx^2} - i psi[i] \vee [i] \right) - \frac{i}{dx^2} \right) - i psi[i] \vee [i] \right) - \frac{i}{dx^2}$$

$$2 \left(\frac{i \left(psi[-1+i] - 2 psi[i] + psi[i] + psi[i] + i] \right)}{dx^2} - i psi[i] \vee [i] \right) - \frac{i}{dx^2} \right) - i psi[i] \vee [i] \right) - \frac{i}{dx^2}$$

$$\frac{\left[i\left(\text{psi}[1+i]-2\,\text{psi}[2+i]+\text{psi}[3+i]\right)}{\text{d}x^2} - i\,\text{psi}[2+i]\right] - i\,\text{psi}[2+i]}{\text{d}x^2} - i\,\text{psi}[1+i] \times [1+i] - 2\,\text{psi}[1+i] \times [1+i]} - i\,\text{psi}[1+i] \times [1+i] \times [1+i] + i\,\text{psi}[2+i] \times [1+i] \times [1+$$

$$\frac{1}{dx^2} dt \left(-i v [i] \left[-i v [i] \left[\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[i] \right)}{dx^2} + i \frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[i] \right)}{dx^2} + i \frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^2} + i \frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^2} - i psi[-1+i] v [-1+i] - 2 \left(\frac{i \left(psi[-1+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^2} - i psi[-1+i] v [-1+i] - i psi[-1+i] v [-1+i] \right) + i \frac{1}{dx^2} i \left(-i v [-1+i] \left(\frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^2} - i psi[-1+i] v [-1+i] \right) + i \frac{1}{dx^2} i \left(\frac{i \left(psi[-3+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^2} - i psi[-1+i] v [-2+i] - 2 \right) - i \frac{i \left(psi[-2+i] - 2 psi[-1+i] + psi[-1+i] \right)}{dx^2} - i psi[-1+i] v [-1+i] - i psi[-1+i] - i psi[-$$

$$\begin{split} i \operatorname{psi}[i] \operatorname{v}[i] - 2 \left(\frac{i \left(\operatorname{psi}[i] - 2 \operatorname{psi}[1 + i] + \operatorname{psi}[2 + i] \right)}{\operatorname{d} x^2} - \\ i \operatorname{psi}[1 + i] \operatorname{v}[1 + i] \right) - i \operatorname{psi}[2 + i] \operatorname{v}[2 + i] \right) + \\ \frac{1}{2} \operatorname{dt} \left(-i \operatorname{v}[i] \left(-i \operatorname{v}[i] \left(\frac{i \left(\operatorname{psi}[-1 + i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1 + i] \right)}{\operatorname{d} x^2} - i \operatorname{psi}[1 + i] + \operatorname{psi}[1] \operatorname{v}[i] \right) + \frac{1}{\operatorname{d} x^2} \right) \\ - i \left(\frac{i \left(\operatorname{psi}[-2 + i] - 2 \operatorname{psi}[-1 + i] + \operatorname{psi}[i] \right)}{\operatorname{d} x^2} + \frac{i \left(\operatorname{psi}[i] - 2 \operatorname{psi}[1 + i] + \operatorname{psi}[1 + i] \right)}{\operatorname{d} x^2} - \\ i \operatorname{psi}[i] \operatorname{v}[i] \right) - i \operatorname{psi}[1 + i] \operatorname{v}[1 + i] \right) + \\ \frac{1}{\operatorname{d} x^2} i \left(-i \operatorname{v}[-1 + i] \left(\frac{i \left(\operatorname{psi}[-2 + i] - 2 \operatorname{psi}[-1 + i] + \operatorname{psi}[i] \right)}{\operatorname{d} x^2} - i \operatorname{psi}[-1 + i] \right) - i \operatorname{psi}[-1 + i] \right) \\ - i \operatorname{psi}[i] \operatorname{v}[i] \right) + \frac{1}{\operatorname{d} x^2} i \left(\frac{i \left(\operatorname{psi}[-3 + i] - 2 \operatorname{psi}[-2 + i] + \operatorname{psi}[-1 + i] \right)}{\operatorname{d} x^2} - i \operatorname{psi}[-1 + i] \operatorname{v}[-2 + i] - \\ 2 \left(\frac{i \left(\operatorname{psi}[-1 + i] - 2 \operatorname{psi}[i] + \operatorname{psi}[i] \right)}{\operatorname{d} x^2} - i \operatorname{psi}[-1 + i] \operatorname{v}[-1 + i] \right) - \\ i \operatorname{psi}[i] \operatorname{v}[i] \right) - i \operatorname{v}[1 + i] \left(\frac{i \left(\operatorname{psi}[-1 + i] - 2 \operatorname{psi}[-1 + i] + \operatorname{psi}[2 + i] \right)}{\operatorname{d} x^2} - \\ i \operatorname{psi}[1 + i] \operatorname{v}[1 + i] \right) - 2 \left(-i \operatorname{v}[i] \left(\frac{i \left(\operatorname{psi}[-1 + i] - 2 \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] \right)}{\operatorname{d} x^2} - \\ i \operatorname{psi}[i] \operatorname{v}[i] \right) + \frac{1}{\operatorname{d} x^2} i \left(\frac{i \left(\operatorname{psi}[-2 + i] - 2 \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] \right)}{\operatorname{d} x^2} + \\ \frac{i \left(\operatorname{psi}[i] - 2 \operatorname{psi}[1 + i] + \operatorname{psi}[2 + i] \right)}{\operatorname{d} x^2} - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] \right)} - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] \right) - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] - i \right) - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] - i \right) - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] - i \right) - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] - i \right) - i \operatorname{psi}[-1 + i] + \operatorname{psi}[-1 + i] - i \right) - i \operatorname{psi}[-1 + i] - i - \operatorname{psi}[-1 + i] - i - \operatorname{p$$

$$2 \left(\frac{i \left(psi [[-1+i]] - 2 psi [[i]] + psi [[1+i]] \right)}{dx^2} - i psi [[i]] \vee [[i]] \right) - i psi [[1+i]] \vee [[1+i]] \right) + \frac{1}{dx^2} i \left(\frac{i \left(psi [[-1+i]] - 2 psi [[i]] + psi [[1+i]] \right)}{dx^2} + \frac{i \left(psi [[1+i]] - 2 psi [[2+i]] + psi [[2+i]] \right)}{dx^2} - i psi [[i]] \vee [[i]] - \frac{1}{dx^2} i \left(\frac{i \left(psi [[i]] - 2 psi [[1+i]] + psi [[2+i]] \right)}{dx^2} - i psi [[1+i]] \vee [[1+i]] \right) - \frac{i}{i} psi [[2+i]] \vee [[-1+i]] \left(\frac{i \left(psi [[-2+i]] - 2 psi [[-1+i]] + psi [[i]] \right)}{dx^2} - i psi [[-2+i]] + psi [[-1+i]] \right) + \frac{1}{dx^2} i \left(\frac{i \left(psi [[-3+i]] - 2 psi [[-2+i]] + psi [[-1+i]] \right)}{dx^2} - i psi [[-2+i]] \vee [[-2+i]] - \frac{i}{i} psi [[-1+i]] \vee [[-1+i]] \right) - \frac{i}{i} psi [[i]] \vee [[i]] \right) + \frac{1}{dx^2} i \left(-i \vee [[-2+i]] - i psi [[-1+i]] \vee [[-2+i]] - i psi [[-2+i]] \vee [[-2+i]] \right) + \frac{1}{dx^2} i \left(\frac{i \left(psi [[-3+i]] - 2 psi [[-2+i]] + psi [[-1+i]] \right)}{dx^2} - i psi [[-2+i]] \vee [[-2+i]] \right) + \frac{1}{dx^2} i \left(\frac{i \left(psi [[-4+i]] - 2 psi [[-3+i]] + psi [[-1+i]] \right)}{dx^2} - i psi [[-3+i]] \vee [[-3+i]] - \frac{i}{i} psi [[-3+i]] -$$

$$\begin{split} i \operatorname{psi}[-2+i] \operatorname{v}[-2+i] &- i \operatorname{psi}[-1+i] \operatorname{v}[-1+i] - i \operatorname{psi}[-1+i] - i \operatorname{psi}[-1+i$$

$$2 \left[-i \sqrt{\|i\|} \left(\frac{i \left(psi \| -1 + i \| -2 psi \| -1 + i \| + psi \| -1 \right)}{dx^2} - i psi \| -1 \right) \right] + \frac{1}{dx^2} i \left(\frac{i \left(psi \| -2 + i \| -2 psi \| -1 + i \| + psi \| -1 \right)}{dx^2} + \frac{i \left(psi \| -1 + i \| -2 psi \| -1 + i \| + psi \| -1 \right)}{dx^2} + \frac{i \left(psi \| -1 + i \| -2 psi \| -1 + i \| + psi \| -1 \right)}{dx^2} - i psi \| -1 + i \| \sqrt{\|-1 + i \|} - \frac{2}{dx^2} \left(\frac{i \left(psi \| -1 + i \| -2 psi \| -1 + i \| + psi \| -1 \right)}{dx^2} - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - \frac{i}{dx^2} i \left(\frac{i \left(psi \| -2 + i \| -2 psi \| -1 + i \| + psi \| -1 \right)}{dx^2} - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) + \frac{1}{dx^2} i \left(\frac{i \left(psi \| -3 + i \| -2 psi \| -1 + i \| + psi \| -1 + i \| \right)}{dx^2} - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - \frac{i}{dx^2} i \left(\frac{i \left(psi \| -2 + i \| -2 psi \| -1 + i \| + psi \| -1 + i \| \right)}{dx^2} - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - i psi \| -1 + i \| \sqrt{\|-1 + i \|} \right) - i psi \| -1 + i \| -2 psi \| -1 + i \| -2$$

$$\begin{split} i \operatorname{psi}[i] \operatorname{v}[i] &- i \operatorname{psi}[1+i] \operatorname{v}[1+i] \end{pmatrix} + \\ & \frac{1}{dx^2} i \left(\frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right)}{dx^2} + \\ & \frac{i \left(\operatorname{psi}[1+i] - 2 \operatorname{psi}[2+i] + \operatorname{psi}[3+i] \right)}{dx^2} - \\ & i \operatorname{psi}[i] \operatorname{v}[i] - 2 \left(\frac{i \left(\operatorname{psi}[i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[2+i] \right)}{dx^2} - \\ & i \operatorname{psi}[1+i] \operatorname{v}[1+i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right) - i \operatorname{psi}[1+i] \operatorname{v}[1+i] \right) + \\ & \frac{1}{dx^2} i \left(-i \operatorname{v}[i] \left(\frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right)}{dx^2} + i \operatorname{psi}[i] \operatorname{v}[i] \right) + \\ & \frac{1}{dx^2} i \left(\frac{i \left(\operatorname{psi}[-2+i] - 2 \operatorname{psi}[-1+i] + \operatorname{psi}[i] \right)}{dx^2} + i \operatorname{psi}[-1+i] \operatorname{v}[-1+i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right) - i \operatorname{psi}[-1+i] \operatorname{v}[-1+i] - \\ & 2 \left(\frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[i] + \operatorname{psi}[1+i] \right)}{dx^2} - i \operatorname{psi}[1+i] \operatorname{v}[i] \right) - \\ & i \operatorname{psi}[1+i] \operatorname{v}[1+i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[2+i] \right) - i \operatorname{psi}[1+i] \operatorname{v}[1+i] \right) - \\ & 2 \left(-i \operatorname{v}[1+i] \left(\frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[2+i] \right)}{dx^2} - i \operatorname{psi}[1+i] \operatorname{v}[1+i] \right) + \\ & \frac{1}{dx^2} i \left(\frac{i \left(\operatorname{psi}[-1+i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[1+i] \right)}{dx^2} - i \operatorname{psi}[1+i] \operatorname{v}[1+i] \right) - i \operatorname{psi}[1+i] \operatorname{v}[1+i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[1+i] \right) - i \operatorname{psi}[1+i] \operatorname{v}[1+i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[1+i] - 2 \operatorname{psi}[1+i] + \operatorname{psi}[1+i] - 2 \operatorname{psi}[1+$$

$$2 \left(\frac{i \left(psi[i] - 2 psi[1 + i] + psi[2 + i] \right)}{dx^{2}} - i psi[1 + i] v[1 + i] \right) - i psi[2 + i] v[2 + i] \right) + \frac{1}{dx^{2}} i \left(\frac{i \left(psi[i] - 2 psi[1 + i] + psi[2 + i] \right)}{dx^{2}} + \frac{i \left(psi[2 + i] - 2 psi[3 + i] + psi[4 + i] \right)}{dx^{2}} - i psi[1 + i] v[1 + i] - \frac{i}{dx^{2}} - i psi[2 + i] v[2 + i] - \frac{i}{dx^{2}} - i psi[2 + i] v[2 + i] - \frac{i}{dx^{2}} - i psi[3 + i] v[3 + i]$$

k1

$$\frac{i\left(\text{psi}[-1+i]]-2\,\text{psi}[i]]+\text{psi}[1+i]}{\text{dx}^2}-i\,\text{psi}[i]]\,\text{v[[i]]}$$

Simplify[k1]

$$(I*(psi[[-1 + i]] + psi[[1 + i]] - psi[[i]]*(2 + dx^2*v[[i]])))/dx^2$$

Simplify[k2]

```
-((1/(2*dx^4))*(dt*psi[-2 + i]) + 6*dt*psi[[i]] + 4*I*dx^2*psi[[i]] -
     4*dt*psi[[1 + i]] - 2*I*dx^2*psi[[1 + i]] + dt*psi[[2 + i]] +
    4*dt*dx^2*psi[[i]]*v[[i]] + 2*I*dx^4*psi[[i]]*v[[i]] -
    dt*dx^2*psi[[1 + i]]*v[[i]] + dt*dx^4*psi[[i]]*v[[i]]^2 -
    psi[[-1 + i]]*(4*dt + 2*I*dx^2 + dt*dx^2*v[[-1 + i]] + dt*dx^2*v[[i]]) -
     dt*dx^2*psi[[1 + i]]*v[[1 + i]]))
```

Simplify[k3]

```
(1/(4*dx^6))*(I*((-dt^2)*psi[[-3 + i]] - 15*dt^2*psi[[-1 + i]] -
            8*I*dt*dx^2*psi[[-1 + i]] + 4*dx^4*psi[[-1 + i]] + 20*dt^2*psi[[i]] +
            12*I*dt*dx^2*psi[[i]] - 8*dx^4*psi[[i]] - 15*dt^2*psi[[1 + i]] -
            8*I*dt*dx^2*psi[[1 + i]] + 4*dx^4*psi[[1 + i]] + 6*dt^2*psi[[2 + i]] +
            2*I*dt*dx^2*psi[[2 + i]] - dt^2*psi[[3 + i]] - 6*dt^2*dx^2*psi[[-1 + i]]*
               v[[-1 + i]] - 2*I*dt*dx^4*psi[[-1 + i]]*v[[-1 + i]] +
            dt^2*dx^2*psi[[i]]*v[[-1 + i]] - dt^2*dx^4*psi[[-1 + i]]*v[[-1 + i]]^2 -
            6*dt^2*dx^2*psi[[-1 + i]]*v[[i]] - 2*I*dt*dx^4*psi[[-1 + i]]*v[[i]] +
            16*dt^2*dx^2*psi[[i]]*v[[i]] + 8*I*dt*dx^4*psi[[i]]*v[[i]] -
            4*dx^6*psi[[i]]*v[[i]] - 6*dt^2*dx^2*psi[[1 + i]]*v[[i]] -
            2*I*dt*dx^4*psi[[1 + i]]*v[[i]] + dt^2*dx^2*psi[[2 + i]]*v[[i]] -
            dt^2*dx^4*psi[[-1 + i]]*v[[-1 + i]]*v[[i]] - dt^2*dx^4*psi[[-1 + i]]*v[[i]]^2 +
            6*dt^2*dx^4*psi[[i]]*v[[i]]^2 + 2*I*dt*dx^6*psi[[i]]*v[[i]]^2 -
            dt^2*dx^4*psi[[1 + i]]*v[[i]]^2 + dt^2*dx^6*psi[[i]]*v[[i]]^3 +
            dt*psi[-2 + i]]*(6*dt + 2*I*dx^2 + dt*dx^2*v[-2 + i]] + dt*dx^2*v[-1 + i]] +
                  dt*dx^2*v[[i]]) + dt^2*dx^2*psi[[i]]*v[[1 + i]] -
            6*dt^2*dx^2*psi[[1 + i]]*v[[1 + i]] - 2*I*dt*dx^4*psi[[1 + i]]*v[[1 + i]] +
            dt^2*dx^2*psi[[2 + i]]*v[[1 + i]] - dt^2*dx^4*psi[[1 + i]]*v[[i]]*v[[1 + i]] - dt^2*dx^4*psi[[1 + i]]*v[[i]]*v[[i]]*v[[i]]*v[i] + i]] - dt^2*dx^4*psi[[1 + i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[
            dt^2*dx^4*psi[[1 + i]]*v[[1 + i]]^2 + dt^2*dx^2*psi[[2 + i]]*v[[2 + i]])
```

Simplify[k4]

```
(1/(4*dx^8))*(dt^3*psi[[-4 + i]] + 28*dt^3*psi[[-2 + i]] +
                       12*I*dt^2*dx^2*psi[[-2 + i]] - 4*dt*dx^4*psi[[-2 + i]] - 56*dt^3*psi[[-1 + i
                       30*I*dt^2*dx^2*psi[[-1 + i]] + 16*dt*dx^4*psi[[-1 + i]] +
                       4*I*dx^6*psi[[-1 + i]] + 70*dt^3*psi[[i]] + 40*I*dt^2*dx^2*psi[[i]] -
                       24*dt*dx^4*psi[[i]] - 8*I*dx^6*psi[[i]] - 56*dt^3*psi[[1 + i]] -
                       30*I*dt^2*dx^2*psi[[1 + i]] + 16*dt*dx^4*psi[[1 + i]] + 4*I*dx^6*psi[[1 + i]] +
                       28*dt^3*psi[[2 + i]] + 12*I*dt^2*dx^2*psi[[2 + i]] - 4*dt*dx^4*psi[[2 + i]] - 4*dt*dx^4*psi[[2
                       8*dt^3*psi[[3 + i]] - 2*I*dt^2*dx^2*psi[[3 + i]] + dt^3*psi[[4 + i]] +
                       8*dt^3*dx^2*psi[[-2 + i]]*v[[-2 + i]] + 2*I*dt^2*dx^4*psi[[-2 + i]]*v[[-2 + i]] -
                       dt^3*dx^2*psi[[-1 + i]]*v[[-2 + i]] + dt^3*dx^4*psi[[-2 + i]]*v[[-2 + i]]^2 +
                       8*dt^3*dx^2*psi[[-2 + i]]*v[[-1 + i]] + 2*I*dt^2*dx^4*psi[[-2 + i]]*v[[-1 + i]] -
                       29*dt^3*dx^2*psi[[-1 + i]]*v[[-1 + i]] - 12*I*dt^2*dx^4*psi[[-1 + i]]*
                             v[[-1 + i]] + 4*dt*dx^6*psi[[-1 + i]]*v[[-1 + i]] +
                       8*dt^3*dx^2*psi[[i]]*v[[-1 + i]] + 2*I*dt^2*dx^4*psi[[i]]*v[[-1 + i]] -
                       dt^3*dx^2*psi[[1 + i]]*v[[-1 + i]] + dt^3*dx^4*psi[[-2 + i]]*v[[-2 + i]]*v[[
                             v[[-1 + i]] + dt^3*dx^4*psi[[-2 + i]]*v[[-1 + i]]^2 -
                       8*dt^3*dx^4*psi[[-1 + i]]*v[[-1 + i]]^2 - 2*I*dt^2*dx^6*psi[[-1 + i]]*
                              v[[-1 + i]]^2 + dt^3*dx^4*psi[[i]]*v[[-1 + i]]^2 -
                       dt^3*dx^6*psi[[-1 + i]]*v[[-1 + i]]^3 + 8*dt^3*dx^2*psi[[-2 + i]]*v[[i]] +
                       2*I*dt^2*dx^4*psi[[-2 + i]]*v[[i]] - 29*dt^3*dx^2*psi[[-1 + i]]*
                       12*I*dt^2*dx^4*psi[[-1 + i]]*v[[i]] + 4*dt*dx^6*psi[[-1 + i]]*v[[i]] +
                       64*dt^3*dx^2*psi[[i]]*v[[i]] + 32*I*dt^2*dx^4*psi[[i]]*v[[i]] -
                       16*dt*dx^6*psi[[i]]*v[[i]] - 4*I*dx^8*psi[[i]]*v[[i]] -
                       29*dt^3*dx^2*psi[[1 + i]]*v[[i]] - 12*I*dt^2*dx^4*psi[[1 + i]]*v[[i]] +
                       4*dt*dx^6*psi[[1 + i]]*v[[i]] + 8*dt^3*dx^2*psi[[2 + i]]*v[[i]] +
                       2*I*dt^2*dx^4*psi[[2 + i]]*v[[i]] - dt^3*dx^2*psi[[3 + i]]*v[[i]] +
                       dt^3*dx^4*psi[[-2 + i]]*v[[-2 + i]]*v[[i]] + dt^3*dx^4*psi[[-2 + i]]*v[[-1 +
```

```
v[[i]] - 8*dt^3*dx^4*psi[[-1 + i]]*v[[-1 + i]]*v[[i]] -
2*I*dt^2*dx^6*psi[[-1 + i]]*v[[-1 + i]]*v[[i]] + 2*dt^3*dx^4*psi[[i]]*v[[-1 + i]]*
   v[[i]] - dt^3*dx^6*psi[[-1 + i]]*v[[-1 + i]]^2*v[[i]] +
dt^3*dx^4*psi[[-2 + i]]*v[[i]]^2 - 8*dt^3*dx^4*psi[[-1 + i]]*v[[i]]^2 -
2*I*dt^2*dx^6*psi[[-1 + i]]*v[[i]]^2 + 30*dt^3*dx^4*psi[[i]]*v[[i]]^2 +
12*I*dt^2*dx^6*psi[[i]]*v[[i]]^2 - 4*dt*dx^8*psi[[i]]*v[[i]]^2 -
8*dt^3*dx^4*psi[[1 + i]]*v[[i]]^2 - 2*I*dt^2*dx^6*psi[[1 + i]]*v[[i]]^2 +
dt^3*dx^4*psi[[2 + i]]*v[[i]]^2 - dt^3*dx^6*psi[[-1 + i]]*v[[-1 + i]
dt^3*dx^6*psi[[-1 + i]]*v[[i]]^3 + 8*dt^3*dx^6*psi[[i]]*v[[i]]^3 +
2*I*dt^2*dx^8*psi[[i]]*v[[i]]^3 - dt^3*dx^6*psi[[1 + i]]*v[[i]]^3 +
dt^3*dx^8*psi[[i]]*v[[i]]^4 - dt^2*psi[[-3 + i]]*
   (8*dt + 2*I*dx^2 + dt*dx^2*v[[-3 + i]] + dt*dx^2*v[[-2 + i]] +
         dt*dx^2*v[[-1 + i]] + dt*dx^2*v[[i]]) - dt^3*dx^2*psi[[-1 + i]]*v[[1 + i]] +
8*dt^3*dx^2*psi[[i]]*v[[1 + i]] + 2*I*dt^2*dx^4*psi[[i]]*v[[1 + i]] -
29*dt^3*dx^2*psi[[1 + i]]*v[[1 + i]] - 12*I*dt^2*dx^4*psi[[1 + i]]*v[[1 + i]] +
4*dt*dx^6*psi[[1 + i]]*v[[1 + i]] + 8*dt^3*dx^2*psi[[2 + i]]*v[[1 + i]] +
2*I*dt^2*dx^4*psi[[2 + i]]*v[[1 + i]] - dt^3*dx^2*psi[[3 + i]]*v[[1 + i]] +
2*dt^3*dx^4*psi[[i]]*v[[i]]*v[[1 + i]] - 8*dt^3*dx^4*psi[[1 + i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i]]*v[[i
   v[[1 + i]] - 2*I*dt^2*dx^6*psi[[1 + i]]*v[[i]]*v[[1 + i]] +
dt^3*dx^4*psi[[2 + i]]*v[[i]]*v[[1 + i]] - dt^3*dx^6*psi[[1 + i]]*v[[i]]^2*
   v[[1 + i]] + dt^3*dx^4*psi[[i]]*v[[1 + i]]^2 - 8*dt^3*dx^4*psi[[1 + i]]*
   v[[1 + i]]^2 - 2*I*dt^2*dx^6*psi[[1 + i]]*v[[1 + i]]^2 +
dt^3*dx^4*psi[[2 + i]]*v[[1 + i]]^2 - dt^3*dx^6*psi[[1 + i]]*v[[i]]*
   v[[1 + i]]^2 - dt^3*dx^6*psi[[1 + i]]*v[[1 + i]]^3 -
dt^3*dx^2*psi[[1 + i]]*v[[2 + i]] + 8*dt^3*dx^2*psi[[2 + i]]*v[[2 + i]] +
2*I*dt^2*dx^4*psi[2 + i]]*v[2 + i] - dt^3*dx^2*psi[3 + i]]*v[2 + i] + i
dt^3*dx^4*psi[[2 + i]]*v[[i]]*v[[2 + i]] + dt^3*dx^4*psi[[2 + i]]*v[[1 + i]
   v[[2 + i]] + dt^3*dx^4*psi[[2 + i]]*v[[2 + i]]^2 -
dt^3*dx^2*psi[[3 + i]]*v[[3 + i]])
```