In[543]:=
```
MA = k * x / (2 * Sin[k * x / 2])
RA = Exp[I * k * x / 2] * k * x / (2 * Sin[k * x / 2])
GA = k * x/ ((H + H^3 / 3 * k^2) * Exp[-I * k * x / 2] * (2 * Sin[k * x / 2]))
FnnA = 0
FnGA = I * k/ (1 + H^2 * k^2 / 3)
FGnA = g * H * I * k
FGGA = 0
FmatA = {{FnnA, FnGA}, {FGnA, FGGA}}
wAp  =  Sqrt[g * H] * k * Sqrt[3 / (3 + H^2 * k^2)]
wAm  =  -Sqrt[g * H] * k * Sqrt[3 / (3 + H^2 * k^2)]
Eigenvalues[FmatA]
```

Out[543]= $\frac{1}{2} k x \operatorname{Csc}\left[\frac{k x}{2}\right]$

Out[544]= $\frac{1}{2} e^{\frac{i k x}{2}} k x \operatorname{Csc}\left[\frac{k x}{2}\right]$

Out[545]= $\frac{e^{\frac{i k x}{2}} k x \operatorname{Csc}\left[\frac{k x}{2}\right]}{2 \left(H + \frac{H^3 k^2}{3}\right)}$

Out[546]= 0

Out[547]= $\frac{i k}{1 + \frac{H^2 k^2}{3}}$

Out[548]= $i g H k$

Out[549]= 0

Out[550]= $\left\{\left\{0, \frac{i k}{1 + \frac{H^2 k^2}{3}}\right\}, \{i g H k, 0\}\right\}$

Out[551]= $\sqrt{3} \sqrt{g H} k \sqrt{\frac{1}{3 + H^2 k^2}}$

Out[552]= $-\sqrt{3} \sqrt{g H} k \sqrt{\frac{1}{3 + H^2 k^2}}$

Out[553]= $\left\{-\frac{i \sqrt{3} k \sqrt{3 g H + g H^3 k^2}}{3 + H^2 k^2}, \frac{i \sqrt{3} k \sqrt{3 g H + g H^3 k^2}}{3 + H^2 k^2}\right\}$

In[554]:=
```
M2 = 1
Series[M2 - MA, {x, 0, 10}]
```

Out[554]= 1

Out[555]= $-\frac{k^2 x^2}{24} - \frac{7 k^4 x^4}{5760} - \frac{31 k^6 x^6}{967\,680} - \frac{127 k^8 x^8}{154\,828\,800} - \frac{73 k^{10} x^{10}}{3\,503\,554\,560} + O[x]^{11}$

In[556]:=
```
Rm = (1 + I * Sin[k * x] / 2)
Series[Rm - RA, {x, 0, 10}]
Rp = Exp[I * k * x] * (1 - I * Sin[k * x] / 2)
Series[Rp - RA, {x, 0, 10}]
```

Out[556]= $1+\frac{1}{2}\,i\,\mathrm{Sin}[k\,x]$

Out[557]= $\frac{k^2 x^2}{12}-\frac{1}{12}\,i\,k^3 x^3+\frac{k^4 x^4}{720}+\frac{1}{240}\,i\,k^5 x^5+\frac{k^6 x^6}{30\,240}-\frac{i\,k^7 x^7}{10\,080}+\frac{k^8 x^8}{1\,209\,600}+\frac{i\,k^9 x^9}{725\,760}+\frac{k^{10} x^{10}}{47\,900\,160}+O[x]^{11}$

Out[558]= $e^{i\,k\,x}\left(1-\frac{1}{2}\,i\,\mathrm{Sin}[k\,x]\right)$

Out[559]= $\frac{k^2 x^2}{12}+\frac{1}{6}\,i\,k^3 x^3-\frac{89\,k^4 x^4}{720}-\frac{7}{120}\,i\,k^5 x^5+\frac{631\,k^6 x^6}{30\,240}+\frac{31\,i\,k^7 x^7}{5040}-\frac{1889\,k^8 x^8}{1\,209\,600}-\frac{127\,i\,k^9 x^9}{362\,880}+\frac{481\,k^{10} x^{10}}{6\,842\,880}+O[x]^{11}$

In[602]:=
```
GLHS = x / 6 * (Rp + Rm)
GRHSp1 = -Exp[-I * k * x / 2] + 2 + 4 * Exp[I * k * x / 2] +
  Exp[I * k * x] * (4 * Exp[-I * k * x / 2] + 2 - Exp[I * k * x / 2])
GRHSp1 = GRHSp1 / Exp[I * k * x / 2]
GRHSp1 = Expand[GRHSp1]
GRHSp1 = ExpToTrig[GRHSp1]
GRHSp2 = Exp[-I * k * x / 2] - 8 + 7 * Exp[I * k * x / 2] +
  Exp[I * k * x] * (7 * Exp[-I * k * x / 2] - 8 + Exp[I * k * x / 2])
GRHSp2 = GRHSp2 / Exp[I * k * x / 2]
GRHSp2 = Expand[GRHSp2]
GRHSp2 = ExpToTrig[GRHSp2]
G = GLHS / (H * x / 30 * (GRHSp1 ) + H^3 / (9 * x) * GRHSp2)
Series[G, {x, 0, 3} ]
Series[GA, {x, 0, 3} ]
Series[G - GA, {x, 0, 5}]
```

Out[602]= $\frac{1}{6}\,x\left(1+e^{i\,k\,x}\left(1-\frac{1}{2}\,i\,\mathrm{Sin}[k\,x]\right)+\frac{1}{2}\,i\,\mathrm{Sin}[k\,x]\right)$

Out[603]= $2-e^{-\frac{1}{2}i\,k\,x}+4\,e^{\frac{i\,k\,x}{2}}+e^{i\,k\,x}\left(2+4\,e^{-\frac{1}{2}i\,k\,x}-e^{\frac{i\,k\,x}{2}}\right)$

Out[604]= $e^{-\frac{1}{2}i\,k\,x}\left(2-e^{-\frac{1}{2}i\,k\,x}+4\,e^{\frac{i\,k\,x}{2}}+e^{i\,k\,x}\left(2+4\,e^{-\frac{1}{2}i\,k\,x}-e^{\frac{i\,k\,x}{2}}\right)\right)$

Out[605]= $8+2\,e^{-\frac{1}{2}i\,k\,x}+2\,e^{\frac{i\,k\,x}{2}}-e^{-i\,k\,x}-e^{i\,k\,x}$

Out[606]= $8+4\,\mathrm{Cos}\left[\frac{k\,x}{2}\right]-2\,\mathrm{Cos}[k\,x]$

Out[607]= $-8+e^{-\frac{1}{2}\,i\,k\,x}+7\,e^{\frac{i\,k\,x}{2}}+e^{i\,k\,x}\left(-8+7\,e^{-\frac{1}{2}\,i\,k\,x}+e^{\frac{i\,k\,x}{2}}\right)$

Out[608]= $e^{-\frac{1}{2}\,i\,k\,x}\left(-8+e^{-\frac{1}{2}\,i\,k\,x}+7\,e^{\frac{i\,k\,x}{2}}+e^{i\,k\,x}\left(-8+7\,e^{-\frac{1}{2}\,i\,k\,x}+e^{\frac{i\,k\,x}{2}}\right)\right)$

Out[609]= $14-8\,e^{-\frac{1}{2}\,i\,k\,x}-8\,e^{\frac{i\,k\,x}{2}}+e^{-i\,k\,x}+e^{i\,k\,x}$

Out[610]= $14-16\,\mathrm{Cos}\left[\frac{k\,x}{2}\right]+2\,\mathrm{Cos}[k\,x]$

Out[611]= $$\left(x\left(1+e^{i\,k\,x}\left(1-\frac{1}{2}\,i\,\mathrm{Sin}[k\,x]\right)+\frac{1}{2}\,i\,\mathrm{Sin}[k\,x]\right)\right)\Big/\left(6\left(\frac{1}{30}\,H\,x\left(8+4\,\mathrm{Cos}\left[\frac{k\,x}{2}\right]-2\,\mathrm{Cos}[k\,x]\right)+\frac{H^3\left(14-16\,\mathrm{Cos}\left[\frac{k\,x}{2}\right]+2\,\mathrm{Cos}[k\,x]\right)}{9\,x}\right)\right)$$

Out[612]= $$\frac{3}{3\,H+H^3\,k^2}+\frac{3\,i\,k\,x}{2\left(3\,H+H^3\,k^2\right)}+\frac{\left(-18\,k^2-5\,H^2\,k^4\right)x^2}{40\,H\left(3+H^2\,k^2\right)^2}+\frac{i\left(12\,k^3+5\,H^2\,k^5\right)x^3}{80\,H\left(3+H^2\,k^2\right)^2}+O[x]^4$$

Out[613]= $$\frac{1}{H+\frac{H^3\,k^2}{3}}+\frac{i\,k\,x}{2\left(H+\frac{H^3\,k^2}{3}\right)}-\frac{k^2\,x^2}{12\left(H+\frac{H^3\,k^2}{3}\right)}+O[x]^4$$

Out[614]= $$\frac{\left(12\,k^2+5\,H^2\,k^4\right)x^2}{40\,H\left(3+H^2\,k^2\right)^2}+\frac{i\left(12\,k^3+5\,H^2\,k^5\right)x^3}{80\,H\left(3+H^2\,k^2\right)^2}+\frac{\left(-6651\,k^4-4680\,H^2\,k^6-820\,H^4\,k^8\right)x^4}{4800\,H\left(3+H^2\,k^2\right)^3}-\frac{i\left(6291\,k^5+4410\,H^2\,k^7+770\,H^4\,k^9\right)x^5}{9600\,H\left(3+H^2\,k^2\right)^3}+O[x]^6$$

```
In[931]:= fnn = - Sqrt[g * H] / 2 * (Rp - Rm);
fng = H * G;
fgg = - Sqrt[g * H] / 2 * (Rp - Rm);
fgn = g * H * (Rp + Rm) / 2;

Fnn = (1 - Exp[-I * k * x]) / x * fnn
Series[Fnn - FnnA, {x, 0, 5}]
Fng = (1 - Exp[-I * k * x]) / x * fng
Series[Fng - FnGA, {x, 0, 5}]
Fgg = (1 - Exp[-I * k * x]) / x * fgg
Series[Fgg - FGGA, {x, 0, 5}]
Fgn = (1 - Exp[-I * k * x]) / x * fgn
Series[Fgn - FGnA, {x, 0, 5}]

Fmat = {{Fnn , Fng}, {Fgn , Fgg}}
EigvFmat = Eigenvalues[Fmat];
 Simplify[Series[EigvFmat , {x, 0, 5}]]
t = x / (2 * Sqrt[g * H])
RKStep = Log[ 1 - t * EigvFmat + (t * EigvFmat) ^2 / 2] / (I * t);
RKstepTay = Series[RKStep, {x, 0, 5}]
Simplify[RKstepTay, k * H > 0 ]
Simplify[RKstepTay - {wAp, wAm}, k * H > 0]
```

Out[935]= $-\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\left(-5+e^{-i\,k\,x}-2\,e^{i\,k\,x}\right)+\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)\right)\sqrt{g\,H}$

Out[936]= $\frac{1}{12}\sqrt{g\,H}\;k^4\,x^3-\frac{1}{72}\left(\sqrt{g\,H}\;k^6\right)x^5+O[x]^6$

Out[937]= $\frac{\left(1-e^{-i\,k\,x}\right)\left(9-e^{-i\,k\,x}+9\,e^{i\,k\,x}-e^{2\,i\,k\,x}\right)H\,(26-2\,\mathrm{Cos}[k\,x])}{384\,x\left(H-\frac{H^3\,(-30+32\,\mathrm{Cos}[k\,x]-2\,\mathrm{Cos}[2\,k\,x])}{36\,x^2}\right)}$

Out[938]= $-\frac{i\left(243\,k^5+49\,H^2\,k^7\right)x^4}{960\left(3+H^2\,k^2\right)^2}+O[x]^6$

Out[939]= $-\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\left(-5+e^{-i\,k\,x}-2\,e^{i\,k\,x}\right)+\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)\right)\sqrt{g\,H}$

Out[940]= $\frac{1}{12}\sqrt{g\,H}\;k^4\,x^3-\frac{1}{72}\left(\sqrt{g\,H}\;k^6\right)x^5+O[x]^6$

Out[941]= $\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)+\frac{1}{6}\left(5-e^{-i\,k\,x}+2\,e^{i\,k\,x}\right)\right)g\,H$

Out[942]= $-\frac{1}{30}\,i\,g\,H\,k^5\,x^4+O[x]^6$

Out[943]=
$$\left\{\left\{-\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\left(-5+e^{-i\,k\,x}-2\,e^{i\,k\,x}\right)+\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)\right)\sqrt{g\,H},\ \frac{\left(1-e^{-i\,k\,x}\right)\left(9-e^{-i\,k\,x}+9\,e^{i\,k\,x}-e^{2\,i\,k\,x}\right)H\,(26-2\,\mathrm{Cos}[k\,x])}{384\,x\left(H-\frac{H^3\,(-30+32\,\mathrm{Cos}[k\,x]-2\,\mathrm{Cos}[2\,k\,x])}{36\,x^2}\right)}\right\},\right.$$
$$\left.\left\{\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)+\frac{1}{6}\left(5-e^{-i\,k\,x}+2\,e^{i\,k\,x}\right)\right)g\,H,\ -\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\left(-5+e^{-i\,k\,x}-2\,e^{i\,k\,x}\right)+\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)\right)\sqrt{g\,H}\right\}\right\}$$

Out[945]=
$$\left\{-\frac{i\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\left(3+H^2\,k^2\right)}}+\frac{1}{12}\sqrt{g\,H}\,k^4\,x^3+\frac{i\,g^2\,H^2\,k^5\left(531+145\,H^2\,k^2\right)x^4}{1920\sqrt{3}\left(g\,H\left(3+H^2\,k^2\right)\right)^{3/2}}-\frac{1}{72}\left(\sqrt{g\,H}\,k^6\right)x^5+O[x]^6,\right.$$
$$\left.\frac{i\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\left(3+H^2\,k^2\right)}}+\frac{1}{12}\sqrt{g\,H}\,k^4\,x^3-\frac{i\,g^2\,H^2\,k^5\left(531+145\,H^2\,k^2\right)x^4}{1920\sqrt{3}\left(g\,H\left(3+H^2\,k^2\right)\right)^{3/2}}-\frac{1}{72}\left(\sqrt{g\,H}\,k^6\right)x^5+O[x]^6\right\}$$

Out[946]=
$$\frac{x}{2\sqrt{g\,H}}$$

Out[948]=
$$\left\{\frac{\sqrt{3}\,k\sqrt{g\,H\left(3+H^2\,k^2\right)}}{3+H^2\,k^2}+\frac{\sqrt{3}\,k^3\sqrt{g\,H\left(3+H^2\,k^2\right)}\,x^2}{8\left(3+H^2\,k^2\right)^2}-\frac{i\sqrt{g\,H}\left(-117\,k^4-96\,H^2\,k^6-16\,H^4\,k^8\right)x^3}{192\left(3+H^2\,k^2\right)^2}-\right.$$
$$\frac{\left(g\,H\left(1755\sqrt{3}\,k^5+966\sqrt{3}\,H^2\,k^7+145\sqrt{3}\,H^4\,k^9\right)\right)x^4}{5760\left(\left(3+H^2\,k^2\right)^2\sqrt{g\,H\left(3+H^2\,k^2\right)}\right)}-\frac{i\sqrt{g\,H}\left(3\,k^6+4\,H^2\,k^8\right)x^5}{288\left(3+H^2\,k^2\right)}+O[x]^6,$$
$$-\frac{\sqrt{3}\,k\sqrt{g\,H\left(3+H^2\,k^2\right)}}{3+H^2\,k^2}-\frac{\left(\sqrt{3}\,k^3\sqrt{g\,H\left(3+H^2\,k^2\right)}\right)x^2}{8\left(3+H^2\,k^2\right)^2}-$$
$$\frac{i\sqrt{g\,H}\left(-117\,k^4-96\,H^2\,k^6-16\,H^4\,k^8\right)x^3}{192\left(3+H^2\,k^2\right)^2}+$$
$$\left.\frac{g\,H\left(1755\sqrt{3}\,k^5+966\sqrt{3}\,H^2\,k^7+145\sqrt{3}\,H^4\,k^9\right)x^4}{5760\left(3+H^2\,k^2\right)^2\sqrt{g\,H\left(3+H^2\,k^2\right)}}-\frac{i\sqrt{g\,H}\left(3\,k^6+4\,H^2\,k^8\right)x^5}{288\left(3+H^2\,k^2\right)}+O[x]^6\right\}$$

Out[949]=
$$\left\{\frac{\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\left(3+H^2\,k^2\right)}}+\frac{\sqrt{3}\sqrt{g\,H}\,k^3\,x^2}{8\left(3+H^2\,k^2\right)^{3/2}}+\frac{i\sqrt{g\,H}\,k^4\left(117+96\,H^2\,k^2+16\,H^4\,k^4\right)x^3}{192\left(3+H^2\,k^2\right)^2}-\right.$$
$$\frac{\left(\sqrt{g\,H}\,k^5\left(1755+966\,H^2\,k^2+145\,H^4\,k^4\right)\right)x^4}{1920\left(\sqrt{3}\left(3+H^2\,k^2\right)^{5/2}\right)}-\frac{i\sqrt{g\,H}\,k^6\left(3+4\,H^2\,k^2\right)x^5}{288\left(3+H^2\,k^2\right)}+O[x]^6,$$
$$-\frac{\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\left(3+H^2\,k^2\right)}}-\frac{\left(\sqrt{3}\sqrt{g\,H}\,k^3\right)x^2}{8\left(3+H^2\,k^2\right)^{3/2}}+\frac{i\sqrt{g\,H}\,k^4\left(117+96\,H^2\,k^2+16\,H^4\,k^4\right)x^3}{192\left(3+H^2\,k^2\right)^2}+$$
$$\left.\frac{\sqrt{g\,H}\,k^5\left(1755+966\,H^2\,k^2+145\,H^4\,k^4\right)x^4}{1920\sqrt{3}\left(3+H^2\,k^2\right)^{5/2}}-\frac{i\sqrt{g\,H}\,k^6\left(3+4\,H^2\,k^2\right)x^5}{288\left(3+H^2\,k^2\right)}+O[x]^6\right\}$$

Out[950]=
$$\left\{\frac{\sqrt{3}\ \sqrt{g\,H}\ k^3\, x^2}{8\left(3+H^2 k^2\right)^{3/2}}+\frac{i\sqrt{g\,H}\ k^4\left(117+96\,H^2 k^2+16\,H^4 k^4\right) x^3}{192\left(3+H^2 k^2\right)^2}-\frac{\left(\sqrt{g\,H}\ k^5\left(1755+966\,H^2 k^2+145\,H^4 k^4\right)\right) x^4}{1920\left(\sqrt{3}\ \left(3+H^2 k^2\right)^{5/2}\right)}-\frac{i\sqrt{g\,H}\ k^6\left(3+4\,H^2 k^2\right) x^5}{288\left(3+H^2 k^2\right)}+O[x]^6,\right.$$
$$\left.-\frac{\left(\sqrt{3}\ \sqrt{g\,H}\ k^3\right) x^2}{8\left(3+H^2 k^2\right)^{3/2}}+\frac{i\sqrt{g\,H}\ k^4\left(117+96\,H^2 k^2+16\,H^4 k^4\right) x^3}{192\left(3+H^2 k^2\right)^2}+\frac{\sqrt{g\,H}\ k^5\left(1755+966\,H^2 k^2+145\,H^4 k^4\right) x^4}{1920\sqrt{3}\ \left(3+H^2 k^2\right)^{5/2}}-\frac{i\sqrt{g\,H}\ k^6\left(3+4\,H^2 k^2\right) x^5}{288\left(3+H^2 k^2\right)}+O[x]^6\right\}$$

In[1022]:=
```
t =  x / (4 * Sqrt[g * H])
RKStep = Log[1 - t * EigvFmat + (t * EigvFmat)^2/2] / (I * t);
RKstepTay = Series[RKStep, {x, 0, 5}]
Simplify[RKstepTay, k * H > 0 ]
Simplify[RKstepTay - {wAp, wAm}, k * H > 0]
```

Out[1022]=
$$\frac{x}{4\sqrt{g\,H}}$$

Out[1024]=
$$\left\{\frac{\sqrt{3}\ k\sqrt{g\,H\left(3+H^2 k^2\right)}}{3+H^2 k^2}+\frac{\sqrt{3}\ k^3\sqrt{g\,H\left(3+H^2 k^2\right)}\ x^2}{32\left(3+H^2 k^2\right)^2}-i\sqrt{g\,H}\left(-\frac{k^4}{12}+\frac{9\,k^4}{512\left(3+H^2 k^2\right)^2}\right)x^3-\frac{\left(g\,H\left(12\,825\sqrt{3}\ k^5+7728\sqrt{3}\ H^2 k^7+1160\sqrt{3}\ H^4 k^9\right)\right)x^4}{46\,080\left(\left(3+H^2 k^2\right)^2\sqrt{g\,H\left(3+H^2 k^2\right)}\right)}-\frac{i\sqrt{g\,H}\ \left(39\,k^6+16\,H^2 k^8\right)x^5}{1152\left(3+H^2 k^2\right)}+O[x]^6,\right.$$
$$\left.-\frac{\sqrt{3}\ k\sqrt{g\,H\left(3+H^2 k^2\right)}}{3+H^2 k^2}-\frac{\left(\sqrt{3}\ k^3\sqrt{g\,H\left(3+H^2 k^2\right)}\right)x^2}{32\left(3+H^2 k^2\right)^2}-i\sqrt{g\,H}\left(-\frac{k^4}{12}+\frac{9\,k^4}{512\left(3+H^2 k^2\right)^2}\right)x^3+\frac{g\,H\left(12\,825\sqrt{3}\ k^5+7728\sqrt{3}\ H^2 k^7+1160\sqrt{3}\ H^4 k^9\right)x^4}{46\,080\left(3+H^2 k^2\right)^2\sqrt{g\,H\left(3+H^2 k^2\right)}}-\frac{i\sqrt{g\,H}\ \left(39\,k^6+16\,H^2 k^8\right)x^5}{1152\left(3+H^2 k^2\right)}+O[x]^6\right\}$$

Out[1025]= $\left\{\frac{\sqrt{3}\ g\ H\ k}{\sqrt{g\ H\ \left(3+H^2\ k^2\right)}}+\frac{\sqrt{3}\ \sqrt{g\ H}\ k^3\ x^2}{32\ \left(3+H^2\ k^2\right)^{3/2}}-\frac{i\ \sqrt{g\ H}\ k^4\ \left(-128+\frac{27}{\left(3+H^2\ k^2\right)^2}\right)\ x^3}{1536}-\frac{\left(\sqrt{g\ H}\ k^5\ \left(12\,825+7728\ H^2\ k^2+1160\ H^4\ k^4\right)\right)\ x^4}{15\,360\ \left(\sqrt{3}\ \left(3+H^2\ k^2\right)^{5/2}\right)}-\frac{i\ \sqrt{g\ H}\ k^6\ \left(39+16\ H^2\ k^2\right)\ x^5}{1152\ \left(3+H^2\ k^2\right)}+O[x]^6,\right.$
$\left.-\frac{\sqrt{3}\ g\ H\ k}{\sqrt{g\ H\ \left(3+H^2\ k^2\right)}}-\frac{\left(\sqrt{3}\ \sqrt{g\ H}\ k^3\right)\ x^2}{32\ \left(3+H^2\ k^2\right)^{3/2}}-\frac{i\ \sqrt{g\ H}\ k^4\ \left(-128+\frac{27}{\left(3+H^2\ k^2\right)^2}\right)\ x^3}{1536}+\frac{\sqrt{g\ H}\ k^5\ \left(12\,825+7728\ H^2\ k^2+1160\ H^4\ k^4\right)\ x^4}{15\,360\ \sqrt{3}\ \left(3+H^2\ k^2\right)^{5/2}}-\frac{i\ \sqrt{g\ H}\ k^6\ \left(39+16\ H^2\ k^2\right)\ x^5}{1152\ \left(3+H^2\ k^2\right)}+O[x]^6\right\}$

Out[1026]= $\left\{\frac{\sqrt{3}\ \sqrt{g\ H}\ k^3\ x^2}{32\ \left(3+H^2\ k^2\right)^{3/2}}-\frac{i\ \sqrt{g\ H}\ k^4\ \left(-128+\frac{27}{\left(3+H^2\ k^2\right)^2}\right)\ x^3}{1536}-\frac{\left(\sqrt{g\ H}\ k^5\ \left(12\,825+7728\ H^2\ k^2+1160\ H^4\ k^4\right)\right)\ x^4}{15\,360\ \left(\sqrt{3}\ \left(3+H^2\ k^2\right)^{5/2}\right)}-\frac{i\ \sqrt{g\ H}\ k^6\ \left(39+16\ H^2\ k^2\right)\ x^5}{1152\ \left(3+H^2\ k^2\right)}+O[x]^6,\right.$
$\left.-\frac{\left(\sqrt{3}\ \sqrt{g\ H}\ k^3\right)\ x^2}{32\ \left(3+H^2\ k^2\right)^{3/2}}-\frac{i\ \sqrt{g\ H}\ k^4\ \left(-128+\frac{27}{\left(3+H^2\ k^2\right)^2}\right)\ x^3}{1536}+\frac{\sqrt{g\ H}\ k^5\ \left(12\,825+7728\ H^2\ k^2+1160\ H^4\ k^4\right)\ x^4}{15\,360\ \sqrt{3}\ \left(3+H^2\ k^2\right)^{5/2}}-\frac{i\ \sqrt{g\ H}\ k^6\ \left(39+16\ H^2\ k^2\right)\ x^5}{1152\ \left(3+H^2\ k^2\right)}+O[x]^6\right\}$