In[692]:=
```
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[692]= $\frac{1}{2}\, k\, x\, \mathrm{Csc}\left[\frac{k\, x}{2}\right]$

Out[693]= $\frac{1}{2}\, e^{\frac{i k x}{2}}\, k\, x\, \mathrm{Csc}\left[\frac{k\, x}{2}\right]$

Out[694]= $\frac{e^{\frac{i k x}{2}}\, k\, x\, \mathrm{Csc}\left[\frac{k x}{2}\right]}{2\left(H + \frac{H^3 k^2}{3}\right)}$

Out[695]= 0

Out[696]= $\frac{i\, k}{1 + \frac{H^2 k^2}{3}}$

Out[697]= $i\, g\, H\, k$

Out[698]= 0

Out[699]= $\left\{\left\{0, \frac{i\, k}{1 + \frac{H^2 k^2}{3}}\right\}, \{i\, g\, H\, k, 0\}\right\}$

Out[700]= $\sqrt{3}\, \sqrt{g\, H}\, k\, \sqrt{\frac{1}{3 + H^2 k^2}}$

Out[701]= $-\sqrt{3}\, \sqrt{g\, H}\, k\, \sqrt{\frac{1}{3 + H^2 k^2}}$

Out[702]= $\left\{-\frac{i\, \sqrt{3}\, k\, \sqrt{3\, g\, H + g\, H^3\, k^2}}{3 + H^2\, k^2}, \frac{i\, \sqrt{3}\, k\, \sqrt{3\, g\, H + g\, H^3\, k^2}}{3 + H^2\, k^2}\right\}$

In[703]:=
```
M = 1
Series[M - MA, {x, 0, 10}]
```

Out[703]= 1

Out[704]= $-\frac{k^2\, x^2}{24} - \frac{7\, k^4\, x^4}{5760} - \frac{31\, k^6\, x^6}{967\,680} - \frac{127\, k^8\, x^8}{154\,828\,800} - \frac{73\, k^{10}\, x^{10}}{3\,503\,554\,560} + O[x]^{11}$

In[705]:=
```
Rm = 1
Series[Rm - RA, {x, 0, 10}]
Rp = Exp[I*k*x]
Series[Rp - RA, {x, 0, 10}]
Ru = (1 + Exp[I*k*x])/2
Series[Ru - Exp[I*k*x/2], {x, 0, 10}]
```

Out[705]= 1

Out[706]= $-\frac{1}{2}\, i\, k\, x + \frac{k^2 x^2}{12} + \frac{k^4 x^4}{720} + \frac{k^6 x^6}{30\,240} + \frac{k^8 x^8}{1\,209\,600} + \frac{k^{10} x^{10}}{47\,900\,160} + O[x]^{11}$

Out[707]= $e^{i k x}$

Out[708]= $\frac{i k x}{2} - \frac{5 k^2 x^2}{12} - \frac{1}{6}\, i\, k^3 x^3 + \frac{31 k^4 x^4}{720} + \frac{1}{120}\, i\, k^5 x^5 - \frac{41 k^6 x^6}{30\,240} - \frac{i k^7 x^7}{5040} + \frac{31 k^8 x^8}{1\,209\,600} + \frac{i k^9 x^9}{362\,880} - \frac{61 k^{10} x^{10}}{239\,500\,800} + O[x]^{11}$

Out[709]= $\frac{1}{2}\left(1 + e^{i k x}\right)$

Out[710]= $-\frac{k^2 x^2}{8} - \frac{1}{16}\, i\, k^3 x^3 + \frac{7 k^4 x^4}{384} + \frac{1}{256}\, i\, k^5 x^5 - \frac{31 k^6 x^6}{46\,080} - \frac{i k^7 x^7}{10\,240} + \frac{127 k^8 x^8}{10\,321\,920} + \frac{17\, i\, k^9 x^9}{12\,386\,304} - \frac{73 k^{10} x^{10}}{530\,841\,600} + O[x]^{11}$

In[711]:=
```
Gold = H - H^3/3*(2*Cos[k*x] - 2)/x^2
G = Ru / Gold
Series[G, {x, 0, 3} ]
Series[GA, {x, 0, 3} ]
Series[G - GA, {x, 0, 5}]
```

Out[711]= $H - \frac{H^3\,(-2 + 2\,\mathrm{Cos}[k\,x])}{3\,x^2}$

Out[712]= $\frac{1 + e^{i k x}}{2\left(H - \frac{H^3 (-2+2\,\mathrm{Cos}[k\,x])}{3 x^2}\right)}$

Out[713]= $\frac{1}{H + \frac{H^3 k^2}{3}} + \frac{i k x}{2\left(H + \frac{H^3 k^2}{3}\right)} + \frac{\left(-9 k^2 - 2 H^2 k^4\right) x^2}{4 H \left(3 + H^2 k^2\right)^2} - \frac{i \left(6 k^3 + H^2 k^5\right) x^3}{8 H \left(3 + H^2 k^2\right)^2} + O[x]^4$

Out[714]= $\frac{1}{H + \frac{H^3 k^2}{3}} + \frac{i k x}{2\left(H + \frac{H^3 k^2}{3}\right)} - \frac{k^2 x^2}{12\left(H + \frac{H^3 k^2}{3}\right)} + O[x]^4$

Out[715]= $\frac{\left(-6 k^2 - H^2 k^4\right) x^2}{4 H \left(3 + H^2 k^2\right)^2} - \frac{i \left(6 k^3 + H^2 k^5\right) x^3}{8 H \left(3 + H^2 k^2\right)^2} + \frac{\left(144 k^4 + 45 H^2 k^6 + 4 H^4 k^8\right) x^4}{240 H \left(3 + H^2 k^2\right)^3} - \frac{i \left(-54 k^5 + H^4 k^9\right) x^5}{480 H \left(3 + H^2 k^2\right)^3} + O[x]^6$

In[997]:=
```
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] / (I * t);
RKstepTay = Series[RKStep, {x, 0, 5}]
Simplify[RKstepTay, k * H > 0 ]
Simplify[RKstepTay - {wAp, wAm}, k * H > 0]
```

Out[1001]= $-\frac{1}{2x}\left(1-e^{-ikx}\right)\left(\frac{1}{6}\left(-5+e^{-ikx}-2e^{ikx}\right)+\frac{1}{6}e^{ikx}\left(5+2e^{-ikx}-e^{ikx}\right)\right)\sqrt{gH}$

Out[1002]= $\frac{1}{12}\sqrt{gH}\,k^4x^3-\frac{1}{72}\left(\sqrt{gH}\,k^6\right)x^5+O[x]^6$

Out[1003]= $\frac{\left(1-e^{-ikx}\right)\left(9-e^{-ikx}+9e^{ikx}-e^{2ikx}\right)H\,(26-2\,\mathrm{Cos}[k\,x])}{384\,x\left(H-\frac{H^3\,(-30+32\,\mathrm{Cos}[k\,x]-2\,\mathrm{Cos}[2\,k\,x])}{36\,x^2}\right)}$

Out[1004]= $-\frac{i\left(243\,k^5+49\,H^2k^7\right)x^4}{960\left(3+H^2k^2\right)^2}+O[x]^6$

Out[1005]= $-\frac{1}{2x}\left(1-e^{-ikx}\right)\left(\frac{1}{6}\left(-5+e^{-ikx}-2e^{ikx}\right)+\frac{1}{6}e^{ikx}\left(5+2e^{-ikx}-e^{ikx}\right)\right)\sqrt{gH}$

Out[1006]= $\frac{1}{12}\sqrt{gH}\,k^4x^3-\frac{1}{72}\left(\sqrt{gH}\,k^6\right)x^5+O[x]^6$

Out[1007]= $\frac{1}{2x}\left(1-e^{-ikx}\right)\left(\frac{1}{6}e^{ikx}\left(5+2e^{-ikx}-e^{ikx}\right)+\frac{1}{6}\left(5-e^{-ikx}+2e^{ikx}\right)\right)gH$

Out[1008]= $-\frac{1}{30}\,i\,g\,H\,k^5x^4+O[x]^6$

Out[1009]=
$$\left\{\left\{-\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\left(-5+e^{-i\,k\,x}-2\,e^{i\,k\,x}\right)+\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)\right)\sqrt{g\,H},\right.\right.$$
$$\left.\frac{\left(1-e^{-i\,k\,x}\right)\left(9-e^{-i\,k\,x}+9\,e^{i\,k\,x}-e^{2\,i\,k\,x}\right)H\,(26-2\,\mathrm{Cos}[k\,x])}{384\,x\left(H-\frac{H^3\,(-30+32\,\mathrm{Cos}[k\,x]-2\,\mathrm{Cos}[2\,k\,x])}{36\,x^2}\right)}\right\},$$
$$\left\{\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)+\frac{1}{6}\left(5-e^{-i\,k\,x}+2\,e^{i\,k\,x}\right)\right)g\,H,\right.$$
$$\left.\left.-\frac{1}{2\,x}\left(1-e^{-i\,k\,x}\right)\left(\frac{1}{6}\left(-5+e^{-i\,k\,x}-2\,e^{i\,k\,x}\right)+\frac{1}{6}\,e^{i\,k\,x}\left(5+2\,e^{-i\,k\,x}-e^{i\,k\,x}\right)\right)\sqrt{g\,H}\right\}\right\}$$

Out[1011]=
$$\left\{-\frac{i\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\left(3+H^2\,k^2\right)}}+\frac{1}{12}\sqrt{g\,H}\,k^4\,x^3+\frac{i\,g^2\,H^2\,k^5\left(531+145\,H^2\,k^2\right)x^4}{1920\sqrt{3}\left(g\,H\left(3+H^2\,k^2\right)\right)^{3/2}}-\frac{1}{72}\left(\sqrt{g\,H}\,k^6\right)x^5+O[x]^6,\right.$$
$$\left.\frac{i\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\left(3+H^2\,k^2\right)}}+\frac{1}{12}\sqrt{g\,H}\,k^4\,x^3-\frac{i\,g^2\,H^2\,k^5\left(531+145\,H^2\,k^2\right)x^4}{1920\sqrt{3}\left(g\,H\left(3+H^2\,k^2\right)\right)^{3/2}}-\frac{1}{72}\left(\sqrt{g\,H}\,k^6\right)x^5+O[x]^6\right\}$$

Out[1012]=
$$\frac{x}{2\sqrt{g\,H}}$$

Out[1014]=
$$\left\{\frac{\sqrt{3}\,k\sqrt{g\,H\left(3+H^2\,k^2\right)}}{3+H^2\,k^2}-\frac{3\,i\sqrt{g\,H}\,k^2\,x}{4\left(3+H^2\,k^2\right)}-\frac{\left(\sqrt{3}\,k^3\sqrt{g\,H\left(3+H^2\,k^2\right)}\right)x^2}{4\left(3+H^2\,k^2\right)^2}-\right.$$
$$\frac{i\sqrt{g\,H}\left(-99\,k^4-48\,H^2\,k^6-8\,H^4\,k^8\right)x^3}{96\left(3+H^2\,k^2\right)^2}+\frac{g\,H\left(1215\sqrt{3}\,k^5+474\sqrt{3}\,H^2\,k^7+95\sqrt{3}\,H^4\,k^9\right)x^4}{5760\left(3+H^2\,k^2\right)^2\sqrt{g\,H\left(3+H^2\,k^2\right)}}-$$
$$\frac{i\sqrt{g\,H}\left(7641\,k^6+5742\,H^2\,k^8+1725\,H^4\,k^{10}+160\,H^6\,k^{12}\right)x^5}{11\,520\left(3+H^2\,k^2\right)^3}+O[x]^6,$$
$$-\frac{\sqrt{3}\,k\sqrt{g\,H\left(3+H^2\,k^2\right)}}{3+H^2\,k^2}-\frac{3\,i\sqrt{g\,H}\,k^2\,x}{4\left(3+H^2\,k^2\right)}+\frac{\sqrt{3}\,k^3\sqrt{g\,H\left(3+H^2\,k^2\right)}\,x^2}{4\left(3+H^2\,k^2\right)^2}-$$
$$\frac{i\sqrt{g\,H}\left(-99\,k^4-48\,H^2\,k^6-8\,H^4\,k^8\right)x^3}{96\left(3+H^2\,k^2\right)^2}-\frac{\left(g\,H\left(1215\sqrt{3}\,k^5+474\sqrt{3}\,H^2\,k^7+95\sqrt{3}\,H^4\,k^9\right)\right)x^4}{5760\left(\left(3+H^2\,k^2\right)^2\sqrt{g\,H\left(3+H^2\,k^2\right)}\right)}-$$
$$\left.\frac{i\sqrt{g\,H}\left(7641\,k^6+5742\,H^2\,k^8+1725\,H^4\,k^{10}+160\,H^6\,k^{12}\right)x^5}{11\,520\left(3+H^2\,k^2\right)^3}+O[x]^6\right\}$$

Out[1015]=

$$\left\{\frac{\sqrt{3}\, g\, H\, k}{\sqrt{g\, H\, (3+H^2 k^2)}} - \frac{3\, i \sqrt{g\, H}\, k^2\, x}{4\, (3+H^2 k^2)} - \frac{\left(\sqrt{3}\, \sqrt{g\, H}\, k^3\right) x^2}{4\, (3+H^2 k^2)^{3/2}} + \frac{i \sqrt{g\, H}\, k^4\, (99+48\, H^2 k^2+8\, H^4 k^4)\, x^3}{96\, (3+H^2 k^2)^2} + \frac{\sqrt{g\, H}\, k^5\, (1215+474\, H^2 k^2+95\, H^4 k^4)\, x^4}{1920\, \sqrt{3}\, (3+H^2 k^2)^{5/2}} - \frac{i \sqrt{g\, H}\, k^6\, (7641+5742\, H^2 k^2+1725\, H^4 k^4+160\, H^6 k^6)\, x^5}{11\,520\, (3+H^2 k^2)^3} + O[x]^6,\right.$$

$$\left. -\frac{\sqrt{3}\, g\, H\, k}{\sqrt{g\, H\, (3+H^2 k^2)}} - \frac{3\, i \sqrt{g\, H}\, k^2\, x}{4\, (3+H^2 k^2)} + \frac{\sqrt{3}\, \sqrt{g\, H}\, k^3\, x^2}{4\, (3+H^2 k^2)^{3/2}} + \frac{i \sqrt{g\, H}\, k^4\, (99+48\, H^2 k^2+8\, H^4 k^4)\, x^3}{96\, (3+H^2 k^2)^2} - \frac{\left(\sqrt{g\, H}\, k^5\, (1215+474\, H^2 k^2+95\, H^4 k^4)\right) x^4}{1920\, \left(\sqrt{3}\, (3+H^2 k^2)^{5/2}\right)} - \frac{i \sqrt{g\, H}\, k^6\, (7641+5742\, H^2 k^2+1725\, H^4 k^4+160\, H^6 k^6)\, x^5}{11\,520\, (3+H^2 k^2)^3} + O[x]^6\right\}$$

Out[1016]=

$$\left\{-\frac{3\, i \sqrt{g\, H}\, k^2\, x}{4\, (3+H^2 k^2)} - \frac{\left(\sqrt{3}\, \sqrt{g\, H}\, k^3\right) x^2}{4\, (3+H^2 k^2)^{3/2}} + \frac{i \sqrt{g\, H}\, k^4\, (99+48\, H^2 k^2+8\, H^4 k^4)\, x^3}{96\, (3+H^2 k^2)^2} + \frac{\sqrt{g\, H}\, k^5\, (1215+474\, H^2 k^2+95\, H^4 k^4)\, x^4}{1920\, \sqrt{3}\, (3+H^2 k^2)^{5/2}} - \frac{i \sqrt{g\, H}\, k^6\, (7641+5742\, H^2 k^2+1725\, H^4 k^4+160\, H^6 k^6)\, x^5}{11\,520\, (3+H^2 k^2)^3} + O[x]^6,\right.$$

$$\left. -\frac{3\, i \sqrt{g\, H}\, k^2\, x}{4\, (3+H^2 k^2)} + \frac{\sqrt{3}\, \sqrt{g\, H}\, k^3\, x^2}{4\, (3+H^2 k^2)^{3/2}} + \frac{i \sqrt{g\, H}\, k^4\, (99+48\, H^2 k^2+8\, H^4 k^4)\, x^3}{96\, (3+H^2 k^2)^2} - \frac{\left(\sqrt{g\, H}\, k^5\, (1215+474\, H^2 k^2+95\, H^4 k^4)\right) x^4}{1920\, \left(\sqrt{3}\, (3+H^2 k^2)^{5/2}\right)} - \frac{i \sqrt{g\, H}\, k^6\, (7641+5742\, H^2 k^2+1725\, H^4 k^4+160\, H^6 k^6)\, x^5}{11\,520\, (3+H^2 k^2)^3} + O[x]^6\right\}$$

In[915]:=

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

Out[915]=

$$\frac{x}{4\sqrt{g\, H}}$$

Out[917]=

$$\Big\{\frac{\sqrt{3}\,k\sqrt{g\,H\,(3+H^2\,k^2)}}{3+H^2\,k^2}-\frac{3\,i\sqrt{g\,H}\,k^2\,x}{8\,(3+H^2\,k^2)}-\frac{\left(\sqrt{3}\,k^3\sqrt{g\,H\,(3+H^2\,k^2)}\right)x^2}{16\,(3+H^2\,k^2)^2}-i\sqrt{g\,H}\left(-\frac{k^4}{12}-\frac{9\,k^4}{256\,(3+H^2\,k^2)^2}\right)x^3-\frac{\left(g\,H\left(945\sqrt{3}\,k^5+492\sqrt{3}\,H^2\,k^7+50\sqrt{3}\,H^4\,k^9\right)\right)x^4}{11\,520\left((3+H^2\,k^2)^2\sqrt{g\,H\,(3+H^2\,k^2)}\right)}-\frac{i\sqrt{g\,H}\,(28\,809\,k^6+31\,608\,H^2\,k^8+11\,220\,H^4\,k^{10}+1280\,H^6\,k^{12})\,x^5}{92\,160\,(3+H^2\,k^2)^3}+O[x]^6,$$

$$-\frac{\sqrt{3}\,k\sqrt{g\,H\,(3+H^2\,k^2)}}{3+H^2\,k^2}-\frac{3\,i\sqrt{g\,H}\,k^2\,x}{8\,(3+H^2\,k^2)}+\frac{\sqrt{3}\,k^3\sqrt{g\,H\,(3+H^2\,k^2)}\,x^2}{16\,(3+H^2\,k^2)^2}-i\sqrt{g\,H}\left(-\frac{k^4}{12}-\frac{9\,k^4}{256\,(3+H^2\,k^2)^2}\right)x^3+\frac{g\,H\left(945\sqrt{3}\,k^5+492\sqrt{3}\,H^2\,k^7+50\sqrt{3}\,H^4\,k^9\right)x^4}{11\,520\,(3+H^2\,k^2)^2\sqrt{g\,H\,(3+H^2\,k^2)}}-\frac{i\sqrt{g\,H}\,(28\,809\,k^6+31\,608\,H^2\,k^8+11\,220\,H^4\,k^{10}+1280\,H^6\,k^{12})\,x^5}{92\,160\,(3+H^2\,k^2)^3}+O[x]^6\Big\}$$

Out[918]=

$$\Big\{\frac{\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\,(3+H^2\,k^2)}}-\frac{3\,i\sqrt{g\,H}\,k^2\,x}{8\,(3+H^2\,k^2)}-\frac{\left(\sqrt{3}\sqrt{g\,H}\,k^3\right)x^2}{16\,(3+H^2\,k^2)^{3/2}}-\frac{1}{768}\,i\sqrt{g\,H}\,k^4\left(-64-\frac{27}{(3+H^2\,k^2)^2}\right)x^3-\frac{\left(\sqrt{g\,H}\,k^5\,(945+492\,H^2\,k^2+50\,H^4\,k^4)\right)x^4}{3840\left(\sqrt{3}\,(3+H^2\,k^2)^{5/2}\right)}-\frac{i\sqrt{g\,H}\,k^6\,(28\,809+31\,608\,H^2\,k^2+11\,220\,H^4\,k^4+1280\,H^6\,k^6)\,x^5}{92\,160\,(3+H^2\,k^2)^3}+O[x]^6,$$

$$-\frac{\sqrt{3}\,g\,H\,k}{\sqrt{g\,H\,(3+H^2\,k^2)}}-\frac{3\,i\sqrt{g\,H}\,k^2\,x}{8\,(3+H^2\,k^2)}+\frac{\sqrt{3}\sqrt{g\,H}\,k^3\,x^2}{16\,(3+H^2\,k^2)^{3/2}}-\frac{1}{768}\,i\sqrt{g\,H}\,k^4\left(-64-\frac{27}{(3+H^2\,k^2)^2}\right)x^3+\frac{\sqrt{g\,H}\,k^5\,(945+492\,H^2\,k^2+50\,H^4\,k^4)\,x^4}{3840\sqrt{3}\,(3+H^2\,k^2)^{5/2}}-\frac{i\sqrt{g\,H}\,k^6\,(28\,809+31\,608\,H^2\,k^2+11\,220\,H^4\,k^4+1280\,H^6\,k^6)\,x^5}{92\,160\,(3+H^2\,k^2)^3}+O[x]^6\Big\}$$

Out[919]=

$$\left\{-\frac{3\,i\,\sqrt{g\,H}\,k^2\,x}{8\,(3+H^2\,k^2)}-\frac{\left(\sqrt{3}\,\sqrt{g\,H}\,k^3\right)x^2}{16\,(3+H^2\,k^2)^{3/2}}-\frac{1}{768}\,i\,\sqrt{g\,H}\,k^4\left(-64-\frac{27}{(3+H^2\,k^2)^2}\right)x^3-\frac{\left(\sqrt{g\,H}\,k^5\,(945+492\,H^2\,k^2+50\,H^4\,k^4)\right)x^4}{3840\left(\sqrt{3}\,(3+H^2\,k^2)^{5/2}\right)}-\frac{i\,\sqrt{g\,H}\,k^6\,(28\,809+31\,608\,H^2\,k^2+11\,220\,H^4\,k^4+1280\,H^6\,k^6)\,x^5}{92\,160\,(3+H^2\,k^2)^3}+O[x]^6,\right.$$

$$\left.-\frac{3\,i\,\sqrt{g\,H}\,k^2\,x}{8\,(3+H^2\,k^2)}+\frac{\sqrt{3}\,\sqrt{g\,H}\,k^3\,x^2}{16\,(3+H^2\,k^2)^{3/2}}-\frac{1}{768}\,i\,\sqrt{g\,H}\,k^4\left(-64-\frac{27}{(3+H^2\,k^2)^2}\right)x^3+\frac{\sqrt{g\,H}\,k^5\,(945+492\,H^2\,k^2+50\,H^4\,k^4)\,x^4}{3840\,\sqrt{3}\,(3+H^2\,k^2)^{5/2}}-\frac{i\,\sqrt{g\,H}\,k^6\,(28\,809+31\,608\,H^2\,k^2+11\,220\,H^4\,k^4+1280\,H^6\,k^6)\,x^5}{92\,160\,(3+H^2\,k^2)^3}+O[x]^6\right\}$$