```
Simplify@Module[{k = 3, q}, Series[e^(Sum[(1 - q)^j x^j/(j (1 - q^j)), {j, 2, k}]) /. q -> e^(γ e h), {e, 0, k}]]
```

$$1-\frac{1}{4}\left(h\,x^2\,\gamma\right)e+\frac{1}{288}h^2\,x^3\left(32+9\,x\right)\gamma^2\,e^2-\frac{\left(h^3\,x^2\left(-24+32\,x^3+3\,x^4\right)\gamma^3\right)e^3}{1152}+O[e]^4$$

```
Simplify@Module[{k = 3, q}, Series[e^(Sum[(1 - q)^j (h x)^j/(j (1 - q^j)), {j, 2, k}]) /. q -> e^(γ e h), {e, 0, k}]]
```

$$1-\frac{1}{4}\left(h^3\,x^2\,\gamma\right)e+\frac{1}{288}h^5\,x^3\left(32+9\,h\,x\right)\gamma^2\,e^2-\frac{\left(h^5\,x^2\left(-24+32\,h^3\,x^3+3\,h^4\,x^4\right)\gamma^3\right)e^3}{1152}+O[e]^4$$

```
t1 = Collect[Last@Λ_QU[{ξ, η, δ}, {x, y}], ϵ, Simplify]
```

$$\frac{\hbar}{\left(-1+T\right)\delta+\hbar}+\frac{1}{4\left(\left(-1+T\right)\delta+\hbar\right)^5}\epsilon\,\hbar^2\left(8\,a\,T\left(\left(-1+T\right)\delta+\hbar\right)^2\left(\eta\,\xi\,\hbar+\delta\left(1+y\,\eta+x\,\xi\right)\hbar+\delta^2\left(-1+T+x\,y\,\hbar\right)\right)+\gamma\left(\eta\,\xi\,\hbar^2\left(\left(-1+3\,T\right)\eta\left(\left(-1+T\right)\xi-2\,y\,\hbar\right)+2\,x\,\hbar\left(\xi-3\,T\,\xi+2\,y\,\hbar\right)\right)+\left(-1+T\right)\delta^4\left(-2+6\,T^3-x^2\,y^2\,\hbar^2-2\,T^2\left(7+4\,x\,y\,\hbar\right)+T\left(10+8\,x\,y\,\hbar-5\,x^2\,y^2\,\hbar^2\right)\right)-4\,\delta^3\,\hbar\left(1-3\,T^3+x^2\,y^2\,\hbar^2+T^2\left(7+2\,x\,y\left(3+y\,\eta\right)\hbar+2\,x^2\,y\,\xi\,\hbar\right)+T\left(-5-2\,x\,y\left(3+y\,\eta\right)\hbar+x^2\,y\,\hbar\left(-2\,\xi+y\,\hbar\right)\right)\right)+2\,\delta\,\hbar^2\left(\left(1-3\,T\right)y^2\,\eta^2\,\hbar+2\,\eta\left(\xi+3\,T^2\,\xi-4\,T\,\xi\left(1+x\,y\,\hbar\right)+y\,\hbar\left(1-3\,T+x\,y\,\hbar\right)\right)+x\,\hbar\left(\left(x-3\,T\,x\right)\xi^2+2\,y\,\hbar+\xi\left(2-6\,T+2\,x\,y\,\hbar\right)\right)\right)-\delta^2\,\hbar\left(\left(1-4\,T+3\,T^2\right)y^2\,\eta^2\,\hbar+\hbar\left(-2+3\,T^2\left(-2+4\,x\,\xi+x^2\,\xi^2\right)+4\,x\left(\xi+y\,\hbar\right)+x^2\left(\xi^2+2\,y\,\xi\,\hbar-4\,y^2\,\hbar^2\right)-2\,T\left(-4+x\left(8\,\xi-6\,y\,\hbar\right)+x^2\,\xi\left(2\,\xi-5\,y\,\hbar\right)\right)\right)+2\,\eta\left(-2\left(-1+T\right)\xi\left(1+3\,T^2-2\,T\left(2+x\,y\,\hbar\right)\right)+y\,\hbar\left(2+6\,T^2+x\,y\,\hbar+T\left(-8+5\,x\,y\,\hbar\right)\right)\right)\right)\right)\right)$$

```
t2 = Collect[Last@Λ_QU[ħ {ξ, η, δ}, {x, y}], ϵ, Simplify]
```

$$\frac{1}{1+\left(-1+T\right)\delta}+\frac{1}{4\left(1+\left(-1+T\right)\delta\right)^5}\epsilon\,\hbar\left(8\,a\,T\left(1+\left(-1+T\right)\delta\right)^2\left(\eta\,\xi\,\hbar+\delta^2\left(-1+T+x\,y\,\hbar\right)+\delta\left(1+y\,\eta\,\hbar+x\,\xi\,\hbar\right)\right)+\gamma\left(\eta\,\xi\left(\left(-1+3\,T\right)\eta\left(-2\,y+\left(-1+T\right)\xi\right)+2\,x\left(2\,y+\xi-3\,T\,\xi\right)\right)\hbar^2+2\,\delta\,\hbar\left(x^2\,\xi\left(2\,y+\xi-3\,T\,\xi\right)\hbar-\left(-1+3\,T\right)\eta\left(2\,y-2\left(-1+T\right)\xi+y^2\,\eta\,\hbar\right)+2\,x\left(y+\xi-3\,T\,\xi+y^2\,\eta\,\hbar-4\,T\,y\,\eta\,\xi\,\hbar\right)\right)+\left(-1+T\right)\delta^4\left(-2+6\,T^3-x^2\,y^2\,\hbar^2-2\,T^2\left(7+4\,x\,y\,\hbar\right)+T\left(10+8\,x\,y\,\hbar-5\,x^2\,y^2\,\hbar^2\right)\right)+4\,\delta^3\left(-1+3\,T^3-x^2\,y^2\,\hbar^2+T\left(5-x^2\,y\left(y-2\,\xi\right)\hbar^2+2\,x\,y\,\hbar\left(3+y\,\eta\,\hbar\right)\right)-T^2\left(7+2\,x^2\,y\,\xi\,\hbar^2+2\,x\,y\,\hbar\left(3+y\,\eta\,\hbar\right)\right)\right)+\delta^2\left(2-4\,y\,\eta\,\hbar-4\,\eta\,\xi\,\hbar+12\,T^3\,\eta\,\xi\,\hbar-y^2\,\eta^2\,\hbar^2+x^2\left(4\,y^2-2\,y\,\xi-\xi^2\right)\hbar^2-2\,x\,\hbar\left(2\,y+2\,\xi+y^2\,\eta\,\hbar\right)-T^2\left(-6+12\,x\,\xi\,\hbar+28\,\eta\,\xi\,\hbar+3\,y^2\,\eta^2\,\hbar^2+3\,x^2\,\xi^2\,\hbar^2+4\,y\,\eta\,\hbar\left(3+2\,x\,\xi\,\hbar\right)\right)-2\,T\left(x^2\left(5\,y-2\,\xi\right)\xi\,\hbar^2+x\,\hbar\left(6\,y-8\,\xi+5\,y^2\,\eta\,\hbar-4\,y\,\eta\,\xi\,\hbar\right)-2\left(-2+4\,y\,\eta\,\hbar+5\,\eta\,\xi\,\hbar+y^2\,\eta^2\,\hbar^2\right)\right)\right)\right)\right)$$

```
LeafCount /@ {t1, t2}
```

```
{478, 500}
```