#1 Integral

$$\texttt{Integrate}\left[\frac{1}{2\,\pi\,\hbar}\,\texttt{Exp}\left[-\beta\left(\frac{1}{2\,\mathrm{m}}+\frac{\mathrm{k}^2\,\mathrm{x}^2}{\mathrm{m}}\right)\mathrm{p}^2\right],\ \{\mathrm{p},\,-\infty,\,\infty\}\right]$$

Out[4]= $$\texttt{ConditionalExpression}\left[\frac{1}{\sqrt{2\,\pi}\,\sqrt{\frac{\beta+2\,\mathrm{k}^2\,\mathrm{x}^2\,\beta}{\mathrm{m}}}\,\hbar},\ \mathrm{Re}\left[\frac{\beta+2\,\mathrm{k}^2\,\mathrm{x}^2\,\beta}{\mathrm{m}}\right]>0\right]$$

#2 Integral

In[2]:= $$\texttt{Integrate}\left[\frac{1}{\sqrt{2\,\pi}\,\sqrt{\frac{\beta+2\,\mathrm{k}^2\,\mathrm{x}^2\,\beta}{\mathrm{m}}}\,\hbar},\ \{\mathrm{x},\,-\mathrm{X}/2,\,\mathrm{X}/2\},\ \texttt{Assumptions}\to\{\beta\in\texttt{Reals},\ \mathrm{k}\in\texttt{Reals},\ \mathrm{X}\in\texttt{Reals}\}\right]$$

Out[2]= $$\texttt{ConditionalExpression}\left[\frac{\mathrm{Log}\left[1+\mathrm{k}\,\mathrm{X}\left(\mathrm{k}\,\mathrm{X}+\sqrt{2+\mathrm{k}^2\,\mathrm{X}^2}\right)\right]}{2\,\mathrm{k}\,\sqrt{\pi}\,\sqrt{\frac{\beta}{\mathrm{m}}}\,\hbar},\ \beta\geq 0\ \&\&\ \mathrm{k}\,\beta\geq 0\ \&\&\ \mathrm{X}>0\right]$$

#3 Derivative

In[8]:= $$-\texttt{D}\left[\texttt{Log}\left[\frac{1}{\mathrm{n}\,!}\left(\frac{\texttt{Log}\left[1+\mathrm{k}\,\mathrm{X}\left(\mathrm{k}\,\mathrm{X}+\sqrt{2+\mathrm{k}^2\,\mathrm{X}^2}\right)\right]}{2\,\mathrm{k}\,\sqrt{\pi}\,\sqrt{\frac{\beta}{\mathrm{m}}}\,\hbar}\right)^{\mathrm{n}}\right],\ \beta\right]$$

Out[8]= $$\frac{\mathrm{n}}{2\,\beta}$$

#4 Summation

In[9]:= $$\texttt{Sum}\left[\texttt{Exp}\left[-\frac{\beta\,\hbar\,\mathrm{p}\,\mathrm{k}}{\mathrm{m}}\,(\mathrm{i}+1)\right],\ \{\mathrm{i},\,0,\,\infty\}\right]$$

Out[9]= $$\frac{1}{-1+e^{\frac{\mathrm{k}\,\mathrm{p}\,\beta\,\hbar}{\mathrm{m}}}}$$

#5 Derivative

In[13]:= $$\texttt{FullSimplify}\left[-\texttt{D}\left[\texttt{Log}\left[\left(\frac{1}{-1+e^{\frac{\mathrm{k}\,\mathrm{p}\,\beta\,\hbar}{\mathrm{m}}}}\right)^{\mathrm{n}}\right],\ \beta\right]\right]$$

Out[13]= $$\frac{\left(1+\frac{1}{-1+e^{\frac{\mathrm{k}\,\mathrm{p}\,\beta\,\hbar}{\mathrm{m}}}}\right)\mathrm{k}\,\mathrm{n}\,\mathrm{p}\,\hbar}{\mathrm{m}}$$