```
\ln[2] = M[k_{,} \Phi_{]} = \frac{e^{-i\pi (k+\Phi)}}{2(-1+e^{2ik\pi})(1+e^{2i\pi\Phi})k} *
                                                                                                                   \left\{ \left\{ -\left(2\,e^{2\,i\,k\,\pi}\,k + 2\,e^{2\,i\,\pi\,\left(k + 2\,\Phi\right)}\,k - e^{2\,i\,\pi\,\left(k + \Phi\right)}\,i\,\alpha + e^{2\,i\,\pi\,\left(2\,k + \Phi\right)}\,\left(-4\,k + i\,\alpha\right) \right\}, \right. \right.
                                                                                                                                                               \left(-2\left(-1+e^{2\,\mathrm{i}\,\pi\,\bar{\Phi}}\right)\,\left(-1+e^{2\,\mathrm{i}\,\pi\,\left(k+\bar{\Phi}\right)}\right)\,k-e^{2\,\mathrm{i}\,\pi\,\bar{\Phi}}\,\left(-1+e^{2\,\mathrm{i}\,k\,\pi}\right)\,\mathrm{i}\,\alpha\right)\right\},
                                                                                                                                        \left\{ \; \left( 2\; e^{4\; i\; k\; \pi}\; k\; +\; 2\; e^{2\; i\; \pi\; \left( k\; +\; 2\; \bar{\Phi} \right)}\; k\; +\; e^{2\; i\; \pi\; \left( 2\; k\; +\; \bar{\Phi} \right)}\; \left( -\; 2\; k\; +\; i\; \alpha \right)\; -\; e^{2\; i\; \pi\; \left( k\; +\; \bar{\Phi} \right)}\; \left( 2\; k\; +\; i\; \alpha \right)\; \right)\; ,
                                                                                                                                                                 \left.\left(2\,\,e^{2\,\mathrm{i}\,k\,\pi}\,\,k\,+\,2\,\,e^{2\,\mathrm{i}\,\pi\,\,(k+2\,\Phi)}\,\,k\,+\,e^{2\,\mathrm{i}\,\pi\,\,(k+\Phi)}\,\,\mathrm{i}\,\alpha\,-\,e^{2\,\mathrm{i}\,\pi\,\Phi}\,\,(4\,\,k\,+\,\mathrm{i}\,\alpha)\,\right)\,\right\}\right\}
\text{Out[2]= } \left\{ \left\{ \begin{array}{c} e^{-\text{i}\,\pi\,\,(k+\Phi)} \,\, \left( -\,2\,\,e^{2\,\,\text{i}\,k\,\pi}\,\,k - 2\,\,e^{2\,\,\text{i}\,\pi\,\,(k+2\,\,\Phi)} \,\,k + e^{2\,\,\text{i}\,\pi\,\,(k+\Phi)} \,\,\text{i}\,\,\alpha - e^{2\,\,\text{i}\,\pi\,\,(2\,\,k+\Phi)} \,\,\left( -\,4\,\,k + \text{i}\,\,\alpha \right) \, \right) \\ \end{array} \right. \right. ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     2 \left(-1 + e^{2 \operatorname{i} k \pi}\right) \left(1 + e^{2 \operatorname{i} \pi \Phi}\right) k
                                                                                                                        \frac{e^{-\text{i}\,\pi\,\left(k+\Phi\right)}\,\left(-2\,\left(-1+e^{2\,\text{i}\,\pi\,\Phi}\right)\,\left(-1+e^{2\,\text{i}\,\pi\,\left(k+\Phi\right)}\right)\,k\,-\,e^{2\,\text{i}\,\pi\,\Phi}\,\left(-1+e^{2\,\text{i}\,k\,\pi}\right)\,\text{i}\,\alpha\right)}{2\,\left(-1+e^{2\,\text{i}\,k\,\pi}\right)\,\left(1+e^{2\,\text{i}\,\pi\,\Phi}\right)\,k}\Big\},
                                                                                                 \left\{ \frac{e^{-\text{i}\pi\;(k+\Phi)}\;\left(2\;e^{4\;\text{i}\;k\,\pi}\;k+2\;e^{2\;\text{i}\pi\;(k+2\;\Phi)}\;k+e^{2\;\text{i}\pi\;(2\;k+\Phi)}\;\left(-2\;k+\text{i}\;\alpha\right)\,-e^{2\;\text{i}\pi\;(k+\Phi)}\;\left(2\;k+\text{i}\;\alpha\right)\right)}{-e^{2\;\text{i}\pi\;(k+\Phi)}\;\left(2\;k+\text{i}\;\alpha\right)}\right\}.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     2(-1+e^{2ik\pi})(1+e^{2i\pi\Phi})k
                                                                                                                        \left. e^{-\text{i}\pi \, (k+\Phi)} \, \left( 2 \, e^{2\, \text{i} \, k\pi} \, k + 2 \, e^{2\, \text{i}\pi \, (k+2\, \Phi)} \, k + e^{2\, \text{i}\pi \, (k+\Phi)} \, \text{i} \, \alpha - e^{2\, \text{i}\pi \, \Phi} \, \left( 4 \, k + \text{i} \, \alpha \right) \right) \\ - \left. - \right. \right\} \right\}
                                                                                                                                                                                                                                                                                                                                                                                                                                      2 \left(-1 + e^{2 \operatorname{i} k \pi}\right) \left(1 + e^{2 \operatorname{i} \pi \Phi}\right) k
           \ln[1]:=\text{ Eigenvalues}\left[\left\{\left\{-\left(2\,\,e^{2\,\mathrm{i}\,k\,\pi}\,k+2\,\,e^{2\,\mathrm{i}\,\pi\,\left(k+2\,\bar{\varpi}\right)}\,\,k\,-\,e^{2\,\mathrm{i}\,\pi\,\left(k+\bar{\varpi}\right)}\,\,\mathrm{i}\,\alpha\,+\,e^{2\,\mathrm{i}\,\pi\,\left(2\,k+\bar{\varpi}\right)}\,\,\left(-4\,\,k\,+\,\mathrm{i}\,\alpha\right)\right)\right\},
                                                                                                                                            \left(-2\left(-1+e^{2\,\mathrm{i}\,\pi\,\overline{\Phi}}\right)\,\left(-1+e^{2\,\mathrm{i}\,\pi\,\left(k+\overline{\Phi}\right)}\right)\,k-e^{2\,\mathrm{i}\,\pi\,\overline{\Phi}}\,\left(-1+e^{2\,\mathrm{i}\,k\,\pi}\right)\,\mathrm{i}\,\alpha\right)\right\},
                                                                                                                     \left\{ \; \left( 2\; e^{4\; i\; k\; \pi}\; k + 2\; e^{2\; i\; \pi\; (k+2\; \overline{\Phi})}\; k + e^{2\; i\; \pi\; (2\; k+\overline{\Phi})}\; \left( -2\; k + i\; \alpha \right) \; - \; e^{2\; i\; \pi\; (k+\overline{\Phi})}\; \left( 2\; k + i\; \alpha \right) \; \right) \; ,
                                                                                                                                          (2 e^{2 i k \pi} k + 2 e^{2 i \pi (k+2 \Phi)} k + e^{2 i \pi (k+\Phi)} i \alpha - e^{2 i \pi \Phi} (4 k + i \alpha)) \} 
  \text{Out} [1] = \left\{ \frac{1}{2} \left( -4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, \, \text{k} + 4 \, e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{k} - e^{2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, \alpha + 2 \, e^{2 \, \text{i} \, \pi} \, \frac{(\text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \, \text{i} \, \alpha - e^{2 \, \text{i} \, \pi} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \frac{(2 \, \text{k} + \Phi)}{4} \, \frac{(2 \,
                                                                                                                                                      \sqrt{\left(-\,4\,\left(4\,\,e^{2\,\mathrm{i}\,\pi\,\,(k+\Phi)}\,-\,16\,\,e^{4\,\mathrm{i}\,\pi\,\,(k+\Phi)}\,+\,4\,\,e^{6\,\mathrm{i}\,\pi\,\,(k+\Phi)}\,-\,8\,\,e^{2\,\mathrm{i}\,\pi\,\,(2\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,+\,4\,\,e^{2\,\mathrm{i}\,\pi\,\,(3\,\,k+\Phi)}\,
                                                                                                                                                                                                                                                                            8\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 8\; e^{2\; i\; \pi\; (3\; k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+3\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 8\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; \right)\; k^2\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; +\; 4\; e^{2\; i\; \pi\; (k+2\; \Phi)}\; -\; 6\; e^{2\; i\; \pi\; (2\; k+3\; \Phi)}\; +\; 6\; e^{2\; i\; \pi
                                                                                                                                                                                                                      \left(4\;e^{2\;i\;\pi\;\Phi}\;k\;-\;4\;e^{2\;i\;\pi\;\left(2\;k+\bar{\Phi}\right)}\;k\;+\;e^{2\;i\;\pi\;\Phi}\;i\;\alpha\;-\;2\;e^{2\;i\;\pi\;\left(k+\bar{\Phi}\right)}\;i\;\alpha\;+\;e^{2\;i\;\pi\;\left(2\;k+\bar{\Phi}\right)}\;i\;\alpha\right)^{\;2}\right)\right)\text{,}
                                                                                              \Box \quad \frac{1}{2} \left( -4 \, e^{2 \, \mathrm{i} \, \pi \, \bar{\Phi}} \, k + 4 \, e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, k - e^{2 \, \mathrm{i} \, \pi \, \bar{\Phi}} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha + 2 \, e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k + \bar{\Phi})} \, \mathrm{i} \, \alpha - e^{2 \, \mathrm{i} \, \pi \, (2 \, k 
                                                                                                                                                        \sqrt{\left(-4 \left(4 \ e^{2 \ \text{i} \, \pi \, \left(k+\Phi\right)} \ -16 \ e^{4 \ \text{i} \, \pi \, \left(k+\Phi\right)} \ +4 \ e^{6 \ \text{i} \, \pi \, \left(k+\Phi\right)} \ -8 \ e^{2 \ \text{i} \, \pi \, \left(2 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right)} \ +4 \ e^{2 \ \text{i} \, \pi \, \left(3 \ k+\Phi\right
                                                                                                                                                                                                                                                                              8 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 8 \, e^{2 \, \text{i} \, \pi \, (3 \, k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+3 \, \Phi)} \, - \, 8 \, e^{2 \, \text{i} \, \pi \, (2 \, k+3 \, \Phi)} \, \big) \, \, k^2 \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, - \, 8 \, e^{2 \, \text{i} \, \pi \, (2 \, k+3 \, \Phi)} \, \big) \, \, k^2 \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, - \, 8 \, e^{2 \, \text{i} \, \pi \, (2 \, k+3 \, \Phi)} \, \big) \, \, k^2 \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, - \, 8 \, e^{2 \, \text{i} \, \pi \, (2 \, k+3 \, \Phi)} \, \big) \, k^2 \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, + \, 4 \, e^{2 \, \text{i} \, \pi \, (k
                                                                                                                                                                                                                         \left(4 e^{2 i \pi \Phi} k - 4 e^{2 i \pi (2 k + \Phi)} k + e^{2 i \pi \Phi} i \alpha - 2 e^{2 i \pi (k + \Phi)} i \alpha + e^{2 i \pi (2 k + \Phi)} i \alpha\right)^{2}\right)\right)
```

```
2 | transfer_matrix_det.nb
                               In[5]:= Together
                                                                                          \text{Det} \left[ \left\{ \frac{e^{-\text{i}\pi \; (k+\bar{\Phi})} \; \left( -2 \, e^{2\,\text{i}\,k\,\pi} \, k \, -2 \, e^{2\,\text{i}\,\pi \; (k+2\,\bar{\Phi})} \; k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (2\,k+\bar{\Phi})} \; \left( -4\,\,k \, + \, \text{i} \; \alpha \right) \right)}{,} \right] = 0 + \left[ \left\{ \frac{e^{-\text{i}\,\pi \; (k+\bar{\Phi})} \; \left( -2\,\,e^{2\,\text{i}\,k\,\pi} \, k \, -2\,\,e^{2\,\text{i}\,\pi \; (k+2\,\bar{\Phi})} \, k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (2\,k+\bar{\Phi})} \; \left( -4\,\,k \, + \, \text{i} \; \alpha \right) \right)} \right] = 0 + \left[ \frac{e^{-\text{i}\,\pi \; (k+\bar{\Phi})} \; \left( -2\,\,e^{2\,\text{i}\,k\,\pi} \, k \, -2\,\,e^{2\,\text{i}\,\pi \; (k+2\,\bar{\Phi})} \, k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (2\,k+\bar{\Phi})} \; \left( -4\,\,k \, + \, \text{i} \; \alpha \right) \right)} \right] = 0 + \left[ \frac{e^{-\text{i}\,\pi \; (k+\bar{\Phi})} \; \left( -2\,\,e^{2\,\text{i}\,k\,\pi} \, k \, -2\,\,e^{2\,\text{i}\,\pi \; (k+2\,\bar{\Phi})} \, k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (2\,k+\bar{\Phi})} \; \left( -4\,\,k \, + \, \text{i} \; \alpha \right) \right)} \right] = 0 + \left[ \frac{e^{-\text{i}\,\pi \; (k+\bar{\Phi})} \; \left( -2\,\,e^{2\,\text{i}\,k\,\pi} \, k \, -2\,\,e^{2\,\text{i}\,\pi \; (k+2\,\bar{\Phi})} \, k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (2\,k+\bar{\Phi})} \; \left( -4\,\,k \, + \, \text{i} \; \alpha \right) \right]} \right] = 0 + \left[ \frac{e^{-\text{i}\,\pi \; (k+\bar{\Phi})} \; \left( -2\,\,e^{2\,\text{i}\,\kappa\,\pi} \, k \, -2\,\,e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \, k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (2\,k+\bar{\Phi})} \; \left( -4\,\,k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \, k \, + \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i} \; \alpha \, - \, e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \right]} \right]
                                                                                                                                       \frac{e^{-\text{i}\pi\;\left(k+\tilde{\Phi}\right)}\;\left(-2\;\left(-1+e^{2\;\text{i}\pi\;\tilde{\Phi}}\right)\;\left(-1+e^{2\;\text{i}\pi\;\left(k+\tilde{\Phi}\right)}\right)\;k-e^{2\;\text{i}\pi\;\tilde{\Phi}}\;\left(-1+e^{2\;\text{i}\;k\;\pi}\right)\;\text{i}\;\alpha\right)}{2\;\left(-1+e^{2\;\text{i}\;k\;\pi}\right)\;\left(1+e^{2\;\text{i}\;\pi\;\tilde{\Phi}}\right)\;k}\right\},
                                                                                                                         \left\{ \begin{array}{l} e^{-i\,\pi\,\,(k+\bar{\Phi})} \,\, \left( 2\,\,e^{4\,i\,k\,\pi}\,\,k + 2\,\,e^{2\,i\,\pi\,\,(k+2\,\bar{\Phi})}\,\,k + e^{2\,i\,\pi\,\,(2\,k+\bar{\Phi})} \,\,\left( -2\,k + i\,\alpha \right) \, - e^{2\,i\,\pi\,\,(k+\bar{\Phi})} \,\,\left( 2\,k + i\,\alpha \right) \right) \\ \end{array} \right. \,,
```

 $\frac{ e^{-\text{i}\pi \; (k+\bar{\Phi})} \; \left(2 \; e^{2\,\text{i}\,k\,\pi} \; k + 2 \; e^{2\,\text{i}\,\pi \; (k+2\,\bar{\Phi})} \; k + e^{2\,\text{i}\,\pi \; (k+\bar{\Phi})} \; \text{i}\; \alpha - e^{2\,\text{i}\,\pi\,\bar{\Phi}} \; (4\;k+\text{i}\;\alpha) \, \right) }{ 2 \; \left(-1 + e^{2\,\text{i}\,k\,\pi} \right) \; \left(1 + e^{2\,\text{i}\,\pi\,\bar{\Phi}} \right) \; k } \bigg\} \bigg\} \bigg] \bigg]$ $\text{Out} \text{[5]= } \left(1 \left/ \right. \left(4 \left(-1 + e^{2 \, \text{i} \, k \, \pi} \right)^{\, 2} \, \left(1 + e^{2 \, \text{i} \, \pi \, \Phi} \right)^{\, 2} \, k^{2} \right) \right) e^{-2 \, \text{i} \, \pi \, \left(k + \Phi \right)}$ $\left(-4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 + 4 \, e^{4 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 - 4 \, e^{2 \, \text{i} \, \pi \, (2 \, k+\Phi)} \, k^2 + 4 \, e^{2 \, \text{i} \, \pi \, (k+2 \, \Phi)} \, k^2 - 4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 + 4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 - 4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 + 4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 - 4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2 + 4 \, e^{2 \, \text{i} \, \pi \, (k+\Phi)} \, k^2$ $4 \, e^{4 \, \mathrm{i} \, \pi \, (k + 2 \, \Phi)} \, k^2 \, + \, 8 \, e^{2 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi + 2 \, \mathrm{i} \, \pi \, (k + \Phi)} \, k^2 \, + \, 4 \, e^{4 \, \mathrm{i} \, k \, \pi +$ $4 e^{2 i \pi \Phi + 2 i \pi (k + \Phi)} k^2 + 4 e^{4 i k \pi + 2 i \pi \Phi + 2 i \pi (k + \Phi)} k^2 - 4 e^{2 i \pi \Phi + 4 i \pi (k + \Phi)} k^2 +$ $8 e^{2 i k \pi + 2 i \pi (2 k + \Phi)} k^2 - 12 e^{2 i \pi \Phi + 2 i \pi (2 k + \Phi)} k^2 + 4 e^{2 i \pi (k + \Phi) + 2 i \pi (2 k + \Phi)} k^2 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + \Phi) \, + 2 \, \text{i} \, \pi \, (2 \, k + \Phi)} \, \, k^2 \, - \, 8 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, + \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, (k + 2 \, \Phi)} \, \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi + 2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \, - \, 4 \, e^{2 \, \text{i} \, \pi \, \Phi} \, k^2 \,$ $4 \; e^{2 \, \mathrm{i} \, \pi \; (k + \Phi) \; + 2 \, \mathrm{i} \, \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 4 \; e^{2 \, \mathrm{i} \, \pi \; \Phi + 2 \; \mathrm{i} \; \pi \; (k + \Phi) \; + 2 \; \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 8 \; e^{2 \, \mathrm{i} \; \pi \; (2 \; k + \Phi) \; + 2 \; \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; - \; 4 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{i} \; \pi \; (k + 2 \; \Phi)} \; k^2 \; + \; 6 \; e^{2 \, \mathrm{$ $2 \, e^{2 \, \text{i} \, \pi \, (k + \Phi)} \, \, \text{i} \, k \, \alpha + 2 \, e^{4 \, \text{i} \, \pi \, (k + \Phi)} \, \, \text{i} \, k \, \alpha + 2 \, e^{2 \, \text{i} \, \pi \, (2 \, k + \Phi)} \, \, \text{i} \, k \, \alpha + 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \text{i} \, \pi \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, k \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i} \, \alpha - 2 \, e^{2 \, \text{i} \, k \, \pi + 2 \, \Phi} \, \, \text{i}$ $2 e^{4 i k \pi + 2 i \pi \Phi} i k \alpha + 2 e^{6 i k \pi + 2 i \pi \Phi} i k \alpha - 2 e^{2 i k \pi + 2 i \pi \Phi + 2 i \pi (k + \Phi)} i k \alpha - 2 e^{2 i k \pi + 2 i \pi \Phi} i k \alpha - 2 e^{2 i k \pi$ $2 \, e^{2 \, i \, \pi \, \Phi + 4 \, i \, \pi \, (k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha + 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, \Phi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi \, (2 \, k + \Phi)} \, \, i \, k \, \alpha - 2 \, e^{2 \, i \, k \, \pi + 2 \, i \, \pi$ $2 e^{2 i \pi (k+\Phi) + 2 i \pi (2 k+\Phi)} i k \alpha + 2 e^{2 i \pi \Phi + 2 i \pi (k+\Phi) + 2 i \pi (2 k+\Phi)} i k \alpha +$ $2 e^{2 i k \pi + 2 i \pi \Phi + 2 i \pi (k + 2 \Phi)} i k \alpha - 2 e^{2 i \pi (2 k + \Phi) + 2 i \pi (k + 2 \Phi)} i k \alpha + e^{4 i \pi (k + \Phi)} i^2 \alpha^2 - 2 e^{2 i \pi (2 k + \Phi) + 2 i \pi (k + \Phi)} i^2 \alpha^2 - 2 e^{2 i \pi (2 k + \Phi)} i^2 \alpha^2$ $e^{2ik\pi+2i\pi\Phi+2i\pi(k+\Phi)}i^{2}\alpha^{2}+e^{2ik\pi+2i\pi\Phi+2i\pi(2k+\Phi)}i^{2}\alpha^{2}-e^{2i\pi(k+\Phi)+2i\pi(2k+\Phi)}i^{2}\alpha^{2}$

 $2\left(-1+e^{2ik\pi}\right)\left(1+e^{2i\pi\Phi}\right)k$

 $2\left(-1+e^{2ik\pi}\right)\left(\overline{1+e^{2i\pi\Phi}}\right)k$

In[6]:=

$$\begin{split} &\text{FullSimplify} \bigg[\left(1 \middle/ \left(4 \left(-1 + e^{2\,\mathrm{i}\,k\,\pi} \right)^2 \left(1 + e^{2\,\mathrm{i}\,\pi\,\Phi} \right)^2 \, k^2 \right) \right) \, e^{-2\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{4\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, + \, 4 \, e^{4\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{4\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, + \, 4 \, e^{4\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{4\,\mathrm{i}\,k\,\pi+2\,\mathrm{i}\,\pi\,\Phi} \, k^2 \, + \, 4 \, e^{2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,(k+\Phi)} \, k^2 \, - \, 4 \, e^{2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi\,\Phi+2\,\mathrm{i}\,\pi$$

Out[6]= 1