When solving for roots of higher degree polynomials in complex numbers, it is essential to convert $e^{i\theta}$ into its equivalent form $e^{i(2k\pi+\theta)}$ so that all roots can be discovered as the value of the **integer** k changes.

So how is $e^{i(2k\pi+\theta)} = e^{i\theta}$?

I will provide the mathematical proof below, which is actually rather simple:

$$e^{i(2k\pi+\theta)} = \cos(2k\pi+\theta) + i\sin(2k\pi+\theta)$$

$$= \cos(2k\pi)\cos\theta - \sin(2k\pi)\sin\theta + i\left[\sin(2k\pi)\cos\theta + \cos(2k\pi)\sin\theta\right] -------- (1)$$

For all $k \in \mathrm{Z}$, $\cos(2k\pi) = 1$ and $\sin(2k\pi) = 0$;

Hence (1) reduces to $\cos\theta + i\sin\theta = e^{i\theta}$ (shown)

(Note: the trigonometric expansions $\underline{\cos(A+B) = \cos A\cos B - \sin A\sin B}$ and

$\underline{\sin(A+B) = \sin A\cos B + \cos A\sin B}$ were employed in the above workings.)