1 ElGamal over another Group

Let $n$ be a positive integer. We consider the set of real angles $A = \{\frac{2k\pi}{n} ; k \in \mathbb{Z}\}$ and the set of $2 \times 2$-matrices

$$G = \left\{ \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix} ; \theta \in A \right\}$$

Q.1 Together with the matrix multiplication, prove that $G$ is a cyclic group and give its order and a generator.

Q.2 Fully specify the adaptation of the ElGamal cryptosystem over the group $G$. Carefully specify domains and algorithms, and carefully verify correctness.

Q.3 Make a complete analysis of the security of the proposed cryptosystem.