1.2 (a) We know that O represents all rotational symmetry of the octoheadron. Additionally $O \cong S_4$, and S_4 is generated via (1234) and (12). Additionally the isomorphism between O and S_4 is via the group action of O on the diagonal pairs of faces. Therefore we need two matrices which rotate cycle all four diagonals and one which cycles just two. The 4 cycle is $R_{(1234)} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$, which is equvalent to a 90 degree rotation around e_3 in $\mathbb{R}^3$, and we assume that the octoheadron is the L^1 sphere in $\mathbb{R}^3$ with the vertices aligned with the standard basis vectors. For the 2-cycle we need to flip 2 faces, and this is achieved via rotating the octoheadron 45 degrees in the xy plane, flipping around e_2, then rotating 45 degrees back. This is represented via $R_{12} = \begin{bmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & -1 \end{bmatrix}$. Therefore, since we have the generators of O, then the group generated by $< R_{(1234)}, R_{(12)} >$ is the standard representation.

(b) For D_n, we know that we're operating on points in $\mathbb{R}^2$, therefore for generators x, y where $x^n = 1$ and $y^2 = 1$ we have that $R_x = \begin{bmatrix} \cos(\frac{2\pi}{n}) & -\sin(\frac{2\pi}{n}) \\ \sin(\frac{2\pi}{n}) & \cos(\frac{2\pi}{n}) \end{bmatrix}$, $R_y = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

2.1

2.2 For $n \geq 2$, the 2d representations of D_n are irreducible. Note that the only possible representations of D_n are the sign representation, trivial representation, and the standard representation. Therefore to represent D_n in a reducible way we need the matrices to only have $0, 1, -1$ as entries. Note that $\cos(\frac{2\pi}{n})$