1. Which of the following letters, when viewed as subsets of \( \mathbb{R}^2 \), are manifolds? Give a brief explanation for each one that is not a manifold.

\[ \text{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z} \]

2. How many non-homeomorphic 1-manifolds do you think there are? List as many as you can think of.

3. Is an open ball minus its center a manifold? More precisely, let \( x \in \mathbb{R}^n, r > 0 \). Is \( B_r(x) - \{x\} \) a manifold? Prove your answer.

4. (a) Is \( S^1 / \{(1,0) \sim (-1,0)\} \) a manifold? Explain.
   
   (b) Is \( S^1 / \{(x,y) \sim (-x,-y)\} \) a manifold? Explain.

5. State which of the following spaces are homeomorphic to each other. You do not need to prove your answers; but give brief explanation or draw pictures (or both) to support them.

   (a) \( X = \overline{B_1(0,0)} \subset \mathbb{R}^2 \) (i.e., \( X \) is the closed unit disk in the plane).
   (b) \( Y = X - B_{0.5}(0,0) \).
   (c) \( Y^\circ \) (the interior of \( Y \), where \( Y \) is viewed as a subspace of \( \mathbb{R}^2 \)).
   (d) \( X/\partial X \). (This means identify the whole boundary of \( X \) into one point – recall that \( \partial X = S^1 \).)
   (e) \( S^1 \times [0,1] \).
   (f) \( S^1 \times (0,1) \).
   (g) \( S^1 \times [0,1] \).
   (h) \( S^1 \times \mathbb{R} \).
   (i) \( \mathbb{R}^2 \)
   (j) \( S^2 = \{(x,y,z) \in \mathbb{R}^3 \mid x^2 + y^2 + z^2 = 1\} \).
   (k) \( S^2 - \{(1,0,0)\} \).
   (l) \( S^2 - \{(1,0,0),(-1,0,0)\} \).
   (m) \( S^2 - B_{0.5}(1,0,0) \).