7. [15 points] Nat is sailing a boat in a lake, with the path given by the following polar graph.
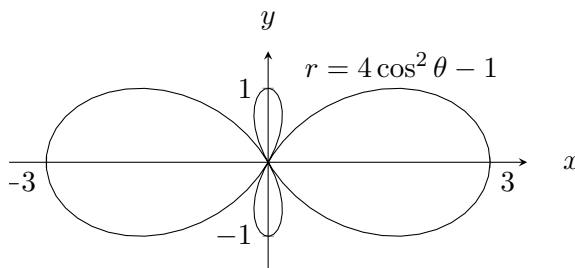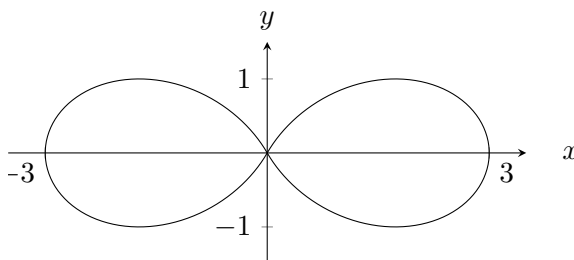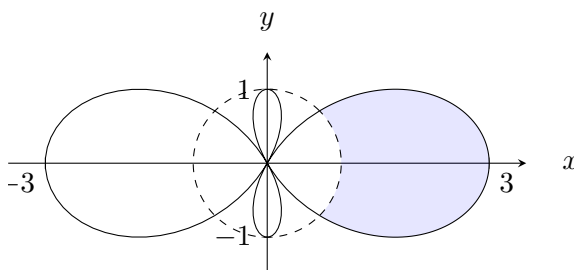

a. [4 points] What are all the angles θ, with $0 \le \theta \le 2\pi$, for which the graph passes through the origin?

b. [4 points] Write down, but do **not** evaluate, one or more integral(s) that gives the arc length of the larger horizontal figure 8 from the path above, as given in the following graph.

c. [5 points] Another boat is travelling around the unit circle $r = 1$, given by the dashed curve in the graph below. Write down, but do **not** evaluate, one or more integral(s) that gives the area of the shaded region, as shown below.

d. [2 points] Give an interval of θ-values for which the polar equation $r = 4\cos^2\theta - 1$ traces out the upper loop of the smaller figure 8 as shown below.