(1a) (3 points) What is the image \( D' \) of the set \( D = \{ z \in \mathbb{C} : 0 \leq \text{Re}(z) \leq \pi \} \) under the mapping \( w = e^z \)? **Sketch the image and pre-image sets.** Write down a definition of \( D' \) in set notation.

![Image of a complex plane with a vertical line segment and a mapping diagram]

\[ z(t) = t + i \alpha, \quad -\infty < t < \infty \]
\[ \alpha \text{ is fixed but ranges from } 0 \text{ to } \pi \]
\[ D' = \{ w \in \mathbb{C} : |w| \leq e^{\pi} \} \]

(1b) (3 points) What is the image \( B' \) of the set \( B = \{ z \in \mathbb{C} : 0 \leq \text{Im}(z) \leq \pi \} \) under the mapping \( w = e^z \)? **Sketch the image and pre-image sets.** Write down a definition of \( B' \) in set notation.

![Image of a complex plane with a horizontal line segment and a mapping diagram]

\[ w = e^z \]
\[ \text{Image of } z \text{ is shaded} \]
\[ B' = \{ w \in \mathbb{C} : \text{Im}(w) \geq 0 \} \]

(1c) (4 points) Find all solutions of \( e^z = -4 \) where \( z \in \mathbb{C} \). Draw a picture indicating the location of the solution points in the complex plane.

\[ e^z = -4 = 4 \cdot (-1) = e^{\ln 4} \cdot e^{-\pi i + 2k\pi i} \]
\[ z = \ln 4 + \pi i + 2\pi i \cdot k \]

\[ \{ z \in \mathbb{C} : z = \ln 4 + (2k + 1)\pi i, \quad k \in \mathbb{Z} \} \]

\[ \text{Draw a line at point } \ln 4 \text{ with } k \text{ as a parameter} \]