1. For each of the languages below indicate whether it is (a) decidable (a.k.a. *recursive*), (b) recognizable (a.k.a. *recursively enumerable*) but not decidable, or (c) not recognizable.

   You may use the following facts:

   - the language $\overline{D} = \{w \mid M_w \text{ does not accept } w\}$ is not recognizable;
   - the language $ACCEPT = \{(z, w) \mid z, w \in \{0,1\}^* \text{ and } M_z \text{ accepts } w\}$ is recognizable but not decidable.

   - $L_1 = \{(z, w) \mid M_z \text{ does not halt on input } w\}$.
   - $L_2 = \{(z, w, n) \mid M_z \text{ accepts } w \text{ within } n \text{ steps}\}$.
   - $L_3 = \{w \mid M_w \text{ accepts } w\}$.

2. We saw in class that the language $ACCEPT = \{(z, w) \mid z, w \in \{0,1\}^* \text{ and } M_z \text{ accepts } w\}$ is undecidable. Use a reduction to argue that the language $L = \{(z_1, z_2, w) \mid \text{ exactly one of } M_{z_1} \text{ and } M_{z_2} \text{ accepts } w\}$ is undecidable.

3. Can you show that L from the previous problem is not recognizable?

   Hint: The previous problem shows $ACCEPT$ reduces to L. Show that $\overline{ACCEPT}$ reduces to L using a similar technique. Then prove and use the fact that $\overline{ACCEPT}$ is not recognizable to complete the proof.