1. Show that a language $L$ is decidable iff there is some enumerator $E$ that prints the strings of $L$ in lexicographic order.

2. Let $A$ and $B$ be decidable languages. Show that the union $A \cup B$, the intersection $A \cap B$, the concatenation $AB = \{uv | u \in A, v \in B\}$, and the complement $\overline{A}$ are also decidable.
   
   Which of the above closure properties remain true when decidable is replaced by semi-decidable?

3. Show that $A$ is semi-decidable if and only if there is a mapping reduction $A \leq_m A_{TM}$. Recall that $A_{TM}$ is the language

   $$A_{TM} = \{ \langle M, w \rangle : M \text{ is a Turing machine that accepts } w \}.$$

   This exercise, combined with the fact that $A_{TM}$ is semidecidable, shows that $A_{TM}$ is complete for the class of semi-decidable problems.

4. Show that if $A$ is semi-decidable and there is a mapping reduction $A \leq_m \overline{A}$, then $A$ is decidable.