Problem type 1:

You are given a known problem and unknown problem X. You can show the reduction listed below.

> *(See variants below)*

Out of the following complexity classes:

$$P \quad\quad NP \quad\quad NP\text{-hard} \quad\quad NP\text{-complete} \quad\quad ExpTime$$

what classes **may** X belong to? In 1-2 sentences, explain why you made your particular selection(s). Assume $P \neq NP$.

a. **BYF**

   LIS: Given a sequence A and an integer k, return TRUE if the longest increasing subsequence is more than k in length. FALSE otherwise.

   Reduction: LIS $\leq_P$ X

b. **BYA**

   LIS: Given a sequence A and an integer k, return TRUE if the longest increasing subsequence is more than k in length. FALSE otherwise.

   Reduction: X $\leq_P$ LIS

c. **BYD**

   SAT: Given a conjunctive normal formula, determine if there is a truth assignment that makes the formula evaluate to true.

   Reduction: SAT $\leq_P$ X

d. **BYC**

   SAT: Given a conjunctive normal formula, determine if there is a truth assignment that makes the formula evaluate to true.

   Reduction: X $\leq_P$ SAT

Problem type 2:

You are given a known problem and unknown problem X. You can show the reduction listed below.

> *(See variants below)*

Out of the following complexity classes:

$$P \quad\quad NP \quad\quad NP\text{-hard} \quad\quad NP\text{-complete} \quad\quad ExpTime$$

what classes **must** X belong to? In 1-2 sentences, explain why you made your particular selection(s). Assume $P \neq NP$.

a. **BYE**

   LIS: Given a sequence A and an integer k, return TRUE if the longest increasing subsequence is more than k in length. FALSE otherwise.

   Reduction: LIS $\leq_P$ X

b. **BYG**

   LIS: Given a sequence A and an integer k, return TRUE if the longest increasing subsequence is more than k in length. FALSE otherwise.

   Reduction: X $\leq_P$ LIS

c. **BYH**

   SAT: Given a conjunctive normal formula, determine if there is a truth assignment that makes the formula evaluate to true.

   Reduction: SAT $\leq_P$ X

d. **BYB**

   SAT: Given a conjunctive normal formula, determine if there is a truth assignment that makes the formula evaluate to true.

   Reduction: X $\leq_P$ SAT