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 NP NP-hard NP-complete 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 $\leq_p X$

Solution: We know LIS is in P. The reduction is saying that *X* is at least in P, which isn't saying much and *X* may or may not belong to any complexity class.

P

NP

NP-hard

NP-complete

ExpTime

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: $X \leq_p LIS$

Solution: We know LIS is in P. The reduction is saying that X is atmost in P, which makes it belong to P/NP/EXPTIME, but not NP-hard since $P \neq NP$.

P

NP

NP-hard

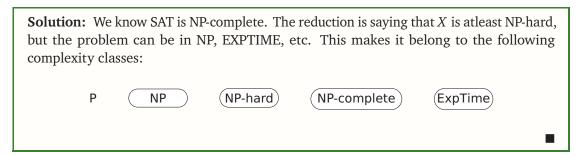
NP-complete

ExpTime

c. BYD

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

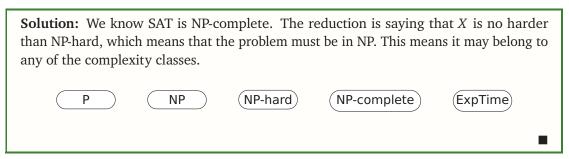
Reduction: SAT $\leq_P X$



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 NP NP-hard NP-complete 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 $\leq_p X$

Solution: We know LIS is in P. The reduction is saying that *X* is at least in P, which isn't saying much and *X* may or may not belong to any complexity class.

P NP NP-hard NP-complete ExpTime

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: $X \leq_p LIS$

Solution: We know LIS is in P. The reduction is saying that *X* is atmost in P, which makes it belong to everything else as well.

P

NP-hard

NP-complete

ExpTime

c. BYH

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

Reduction: SAT $\leq_P X$

Solution: We know SAT is NP-complete. The reduction is saying that X is at least NP-hard, the issue is that X may not even be decidable! That means all we know is that it belongs to the following complexity classes:

P NP

NP-hard

NP-complete

ExpTime

d. BYB

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

Reduction: $X \leq_p SAT$

Solution: We know SAT is NP-complete. The reduction is saying that X is no harder than NP-hard, which means that the problem must be in NP. This means it may belong to any of the complexity classes.

Р

NP

NP-hard

NP-complete

ExpTime