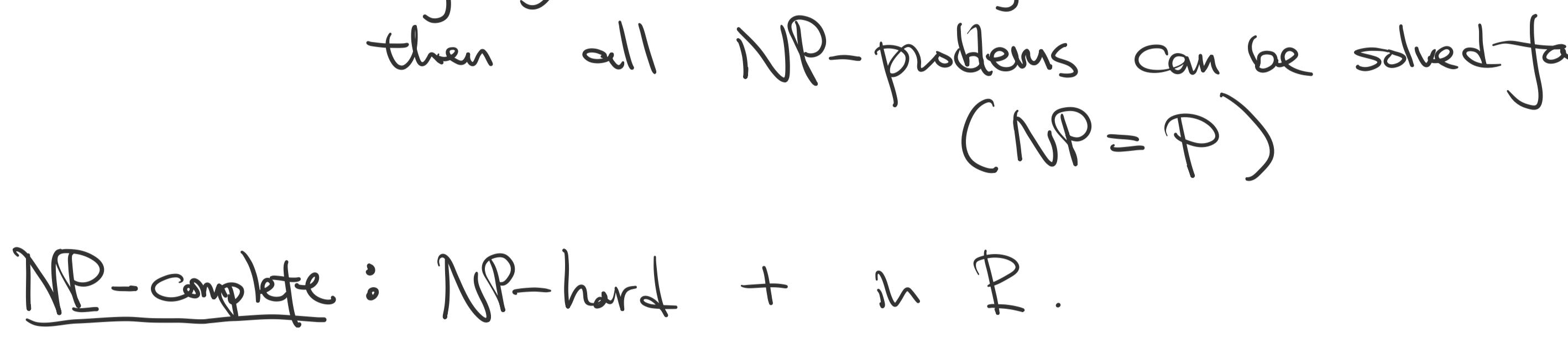


Administrivia.

- Midterm 1 is graded. 34 ± 10 pts.
28 ± 6 pts remain outliers.
- Schedule oral exam w/ me!
- Hw4 due 7/5 (Mon)



Last time in complexity land: $P = NP?$



Could it be that there's a hardest problem in NP ?

NP-hard: If you solve X fast ($X \in P$)
then all NP -problems can be solved fast.
($NP = P$)

NP-complete: $NP\text{-hard} + \in P$.

CIRCUIT SAT

Input: A circuit consists of AND, OR, NOT gates,

some input wires, one output wire

Output: Is there an input to the circuit such that
the output wire is 1?



Cook-Levin Thm. CIRCUIT SAT is NP -complete.

CIRCUIT SAT in P !

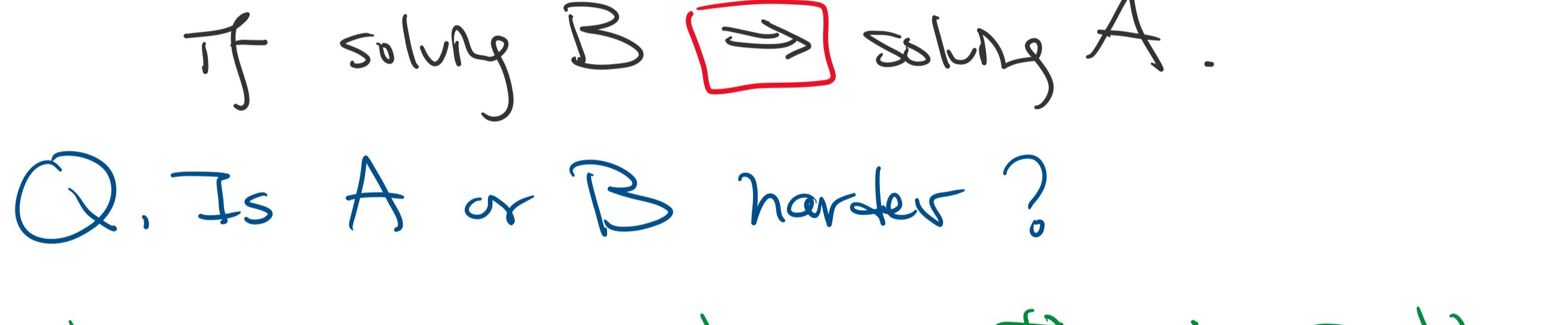
CIRCUIT VALUE

Input: A circuit consists of AND, OR, NOT gates,

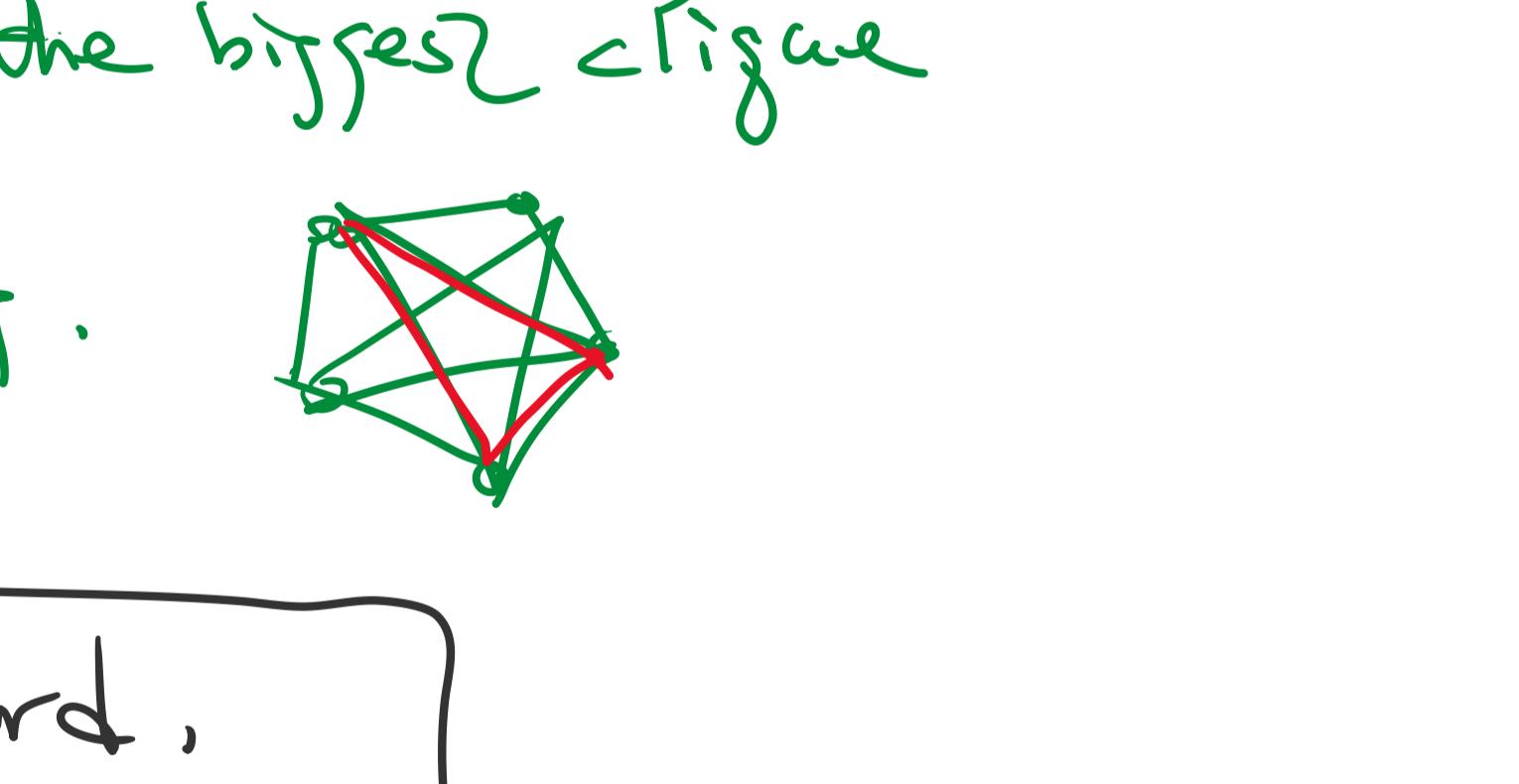
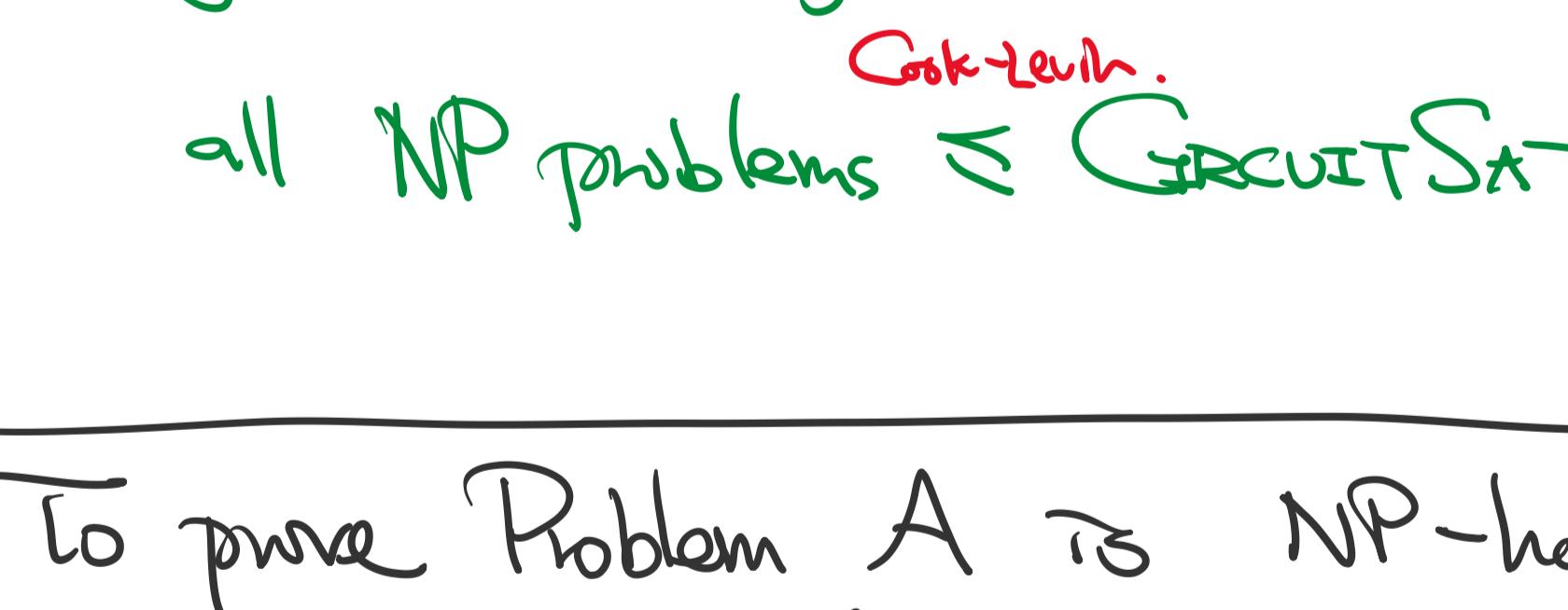
some input wires, one output wire $\xrightarrow{\text{input}}$ $\xrightarrow{\text{outputs to the circuit}}$

Output: Is there an input to the circuit such that

Is the output wire $\rightarrow 1$?



Thus, CIRCUIT VALUE is $\xrightarrow{\text{SAT}} \xrightarrow{\text{NP-hard/NP-complete}} \xrightarrow{\text{P}} P$. (actually P -complete)



Question. Now what?

Reductions.

Problem A reduces \Rightarrow B ($A \leq B$)

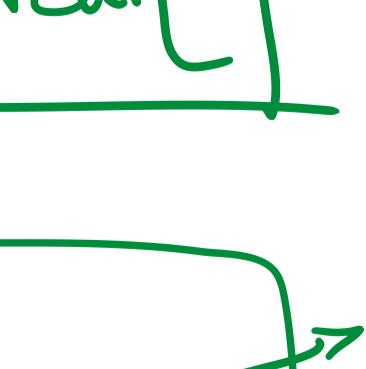
If solving B \Rightarrow solving A.

Q. Is A or B harder?

example. searching \Rightarrow sorting \Rightarrow searching
find a triangle, \leq find the biggest clique

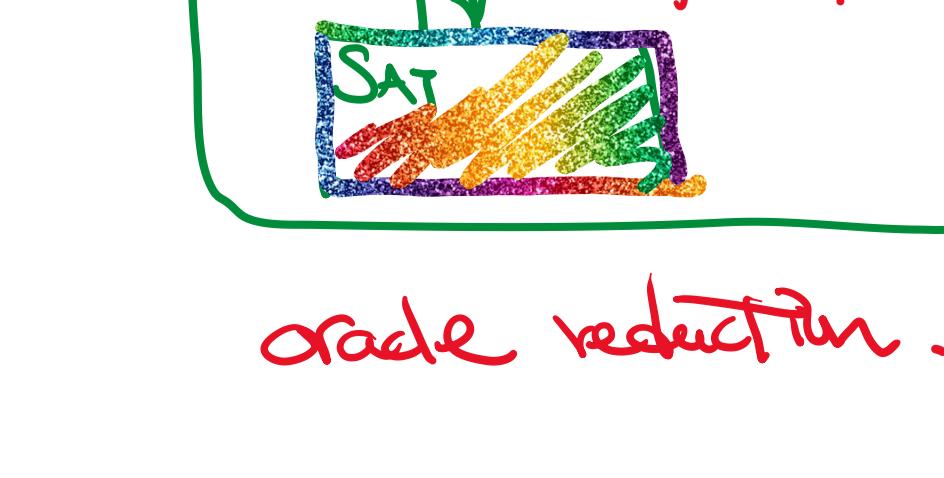
Cook-Levin.

all NP problems \leq CIRCUIT SAT.



$\text{SAT} \leq \text{CIRCUIT SAT}$:

$\text{CIRCUIT SAT} \leq \text{SAT}$



oracle reduction.

