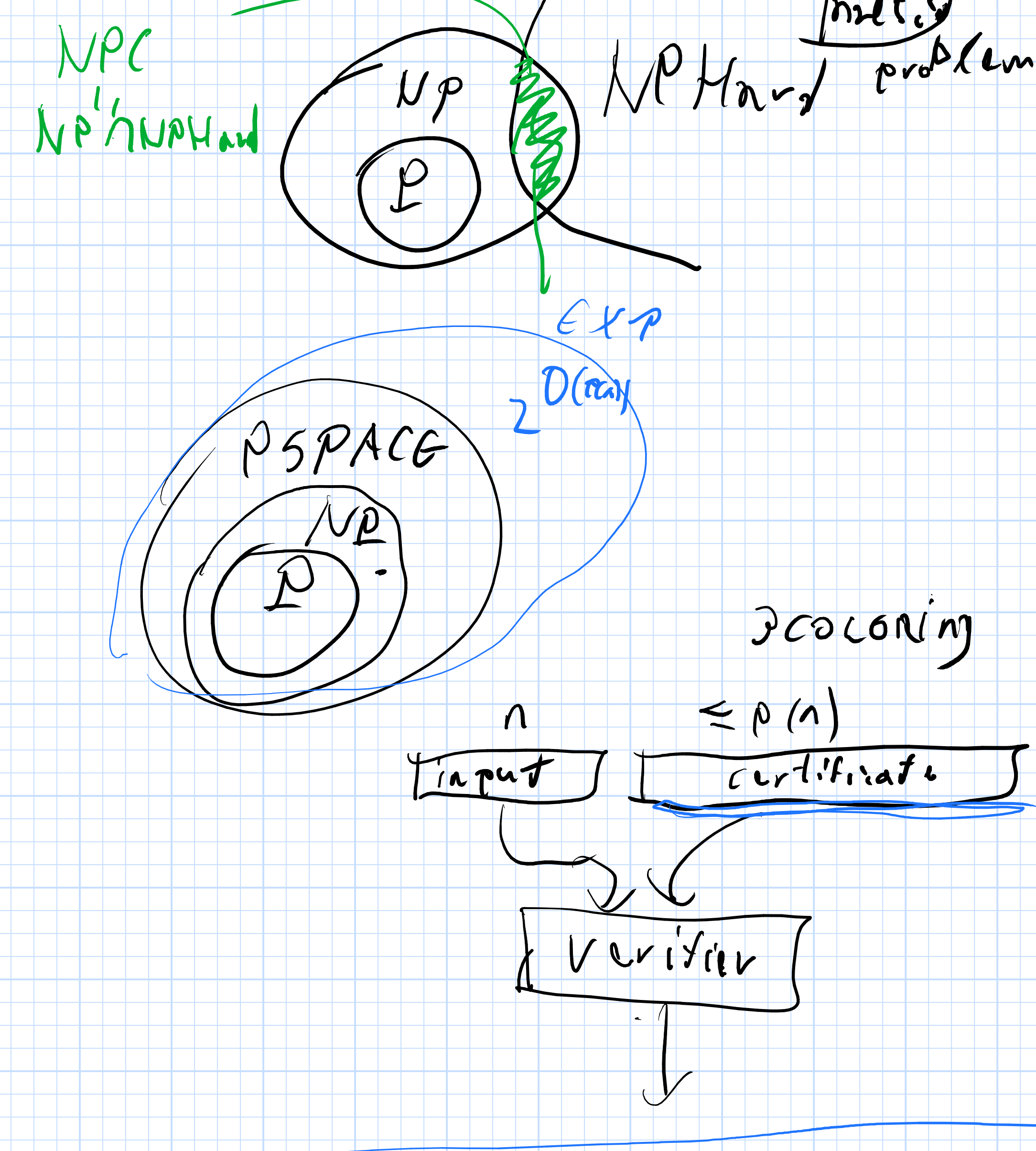


L24 NP II

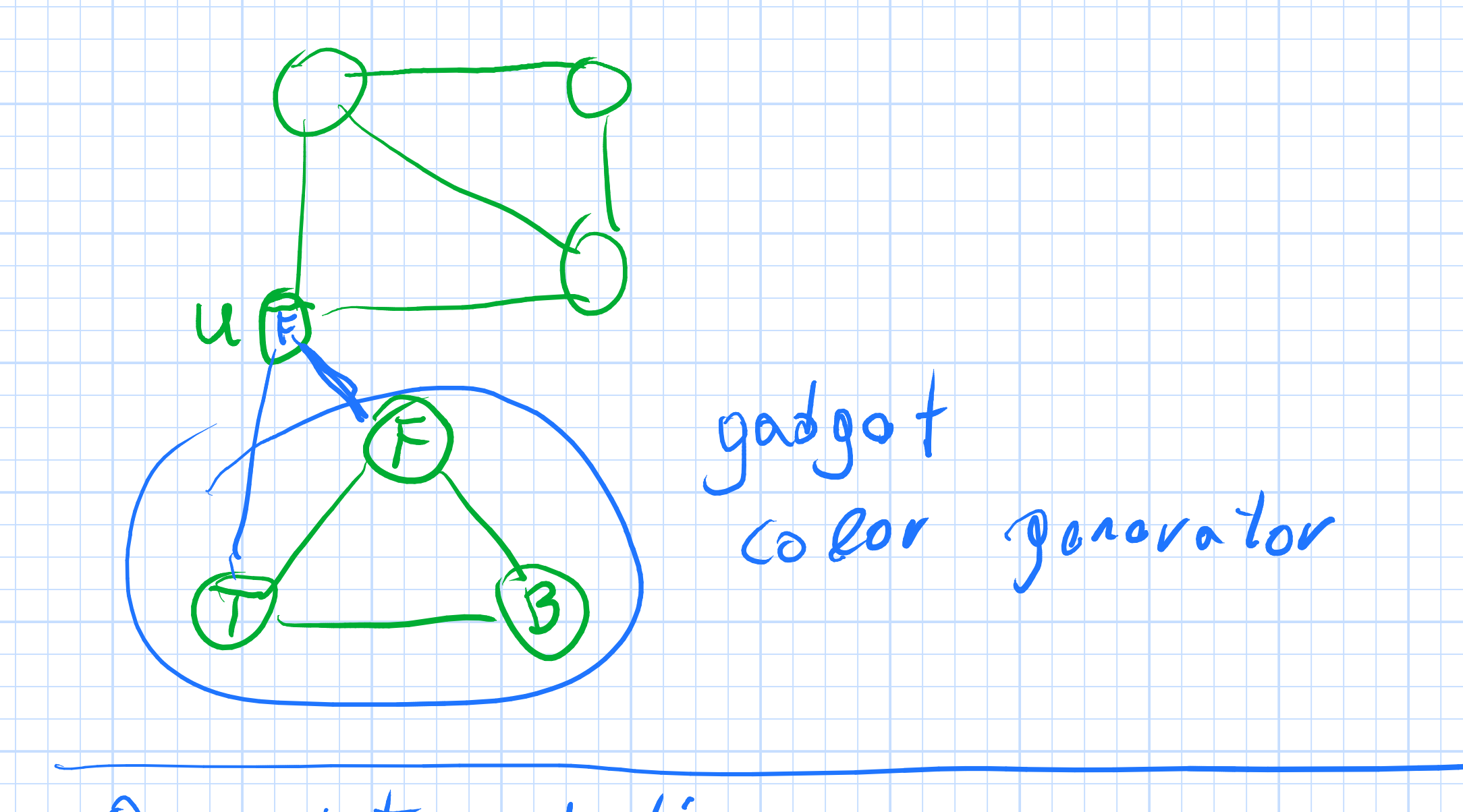
-NP Hard

A problem is NP-Hard if solving it in poly time implies $P=NP$.

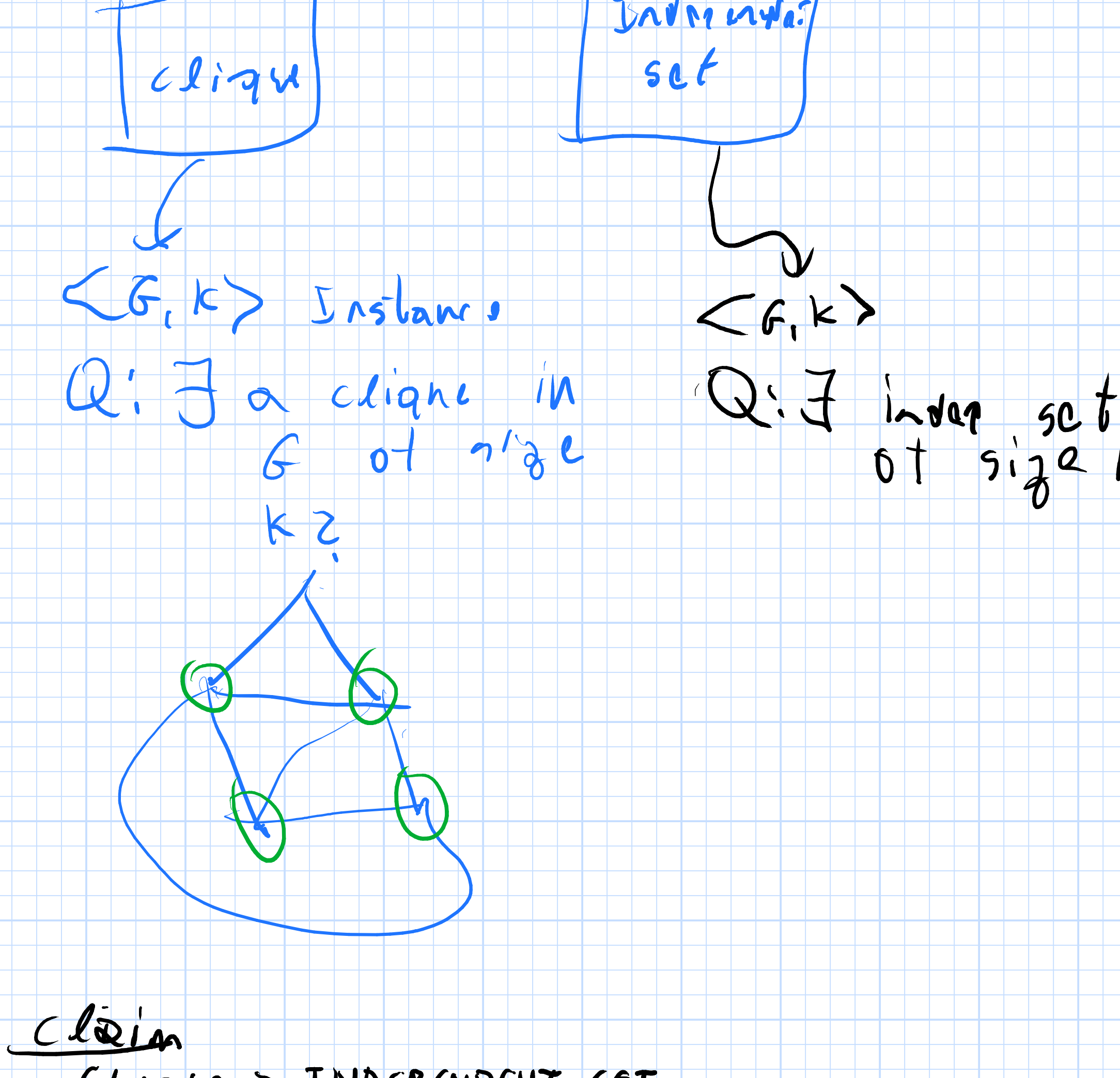


Reductions

UNIQUESS $\rightarrow$ SORTING
3COLOR 3COLOR-Decision

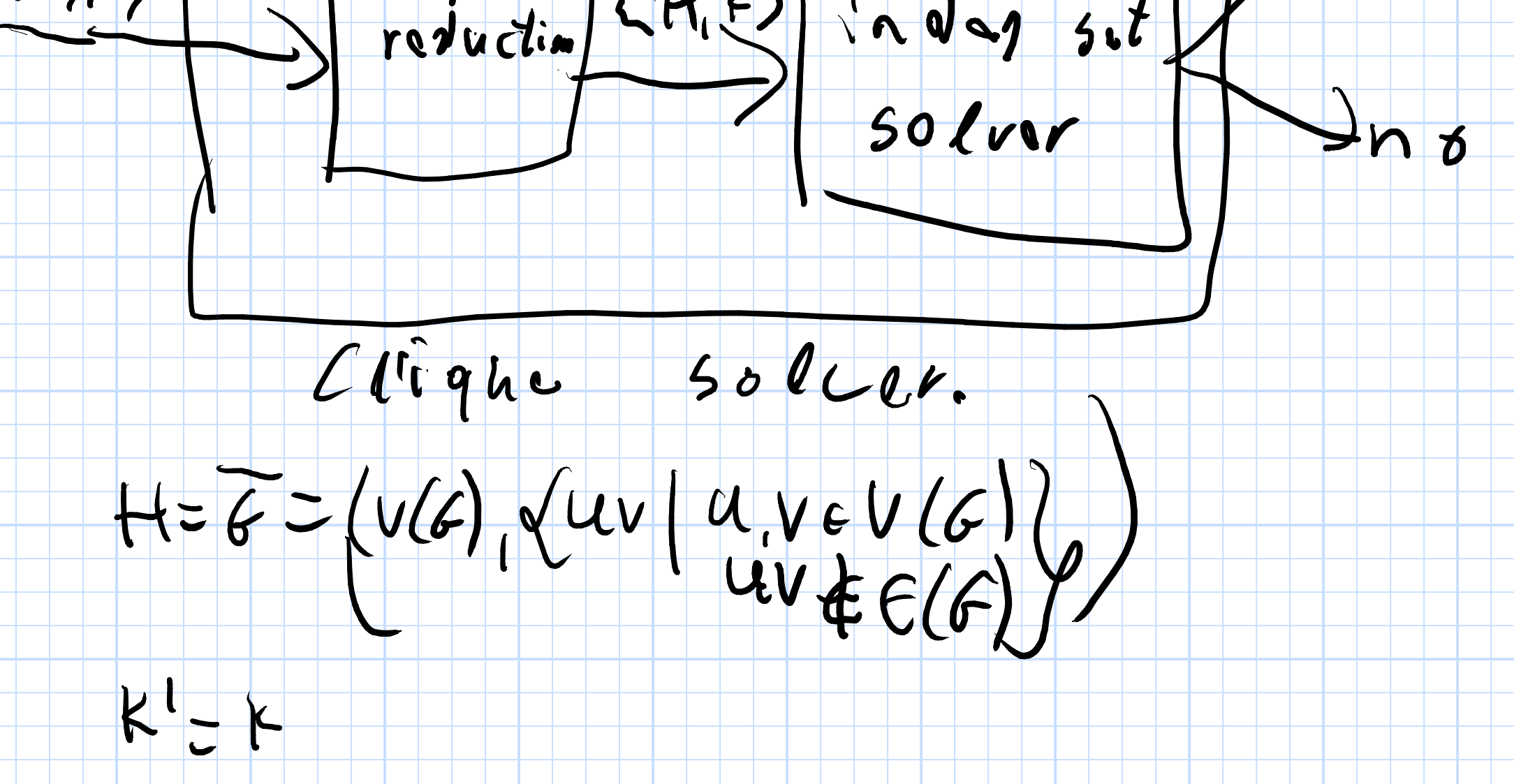


One shot reductions



Claim

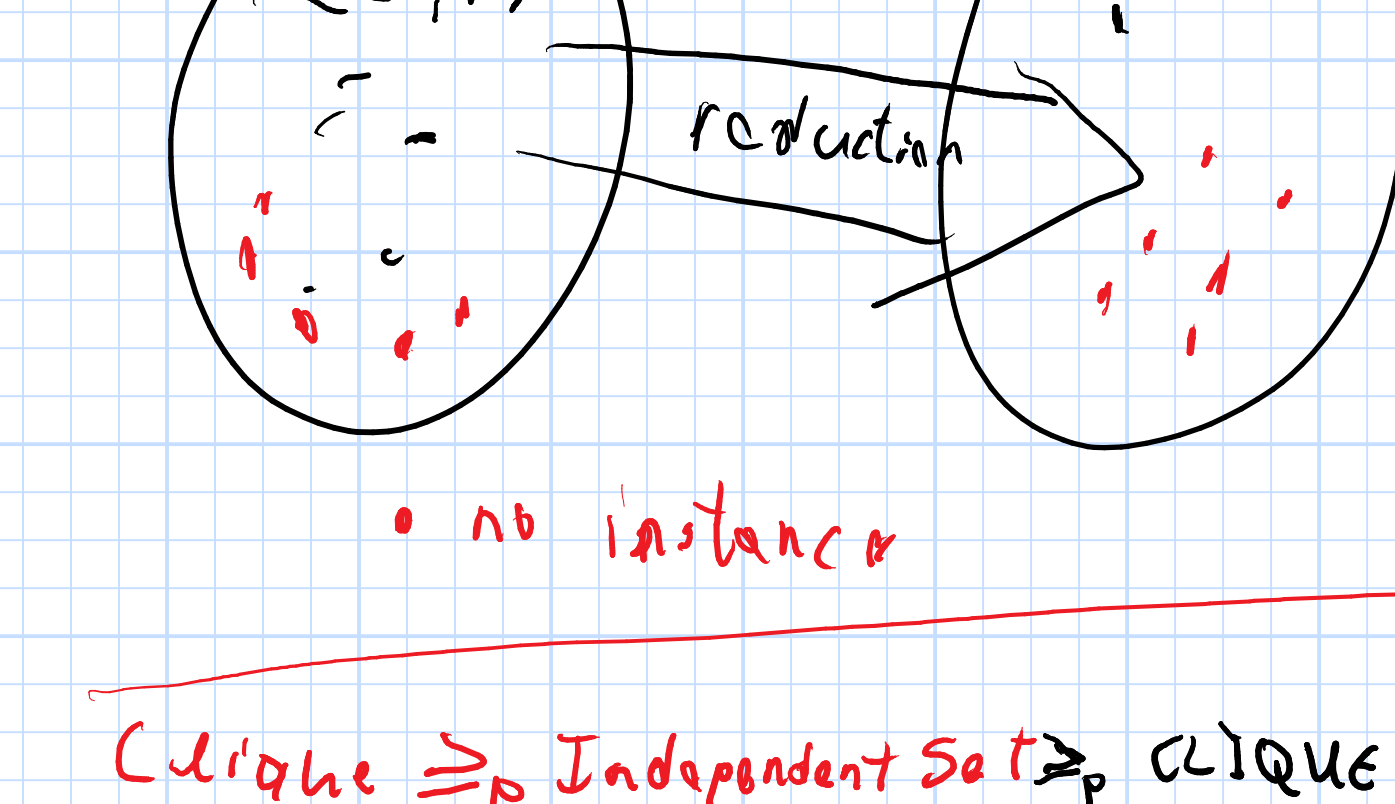
CLIQUE $\geq_p$ INDEPENDENT SET
One can reduce clique to indep set in polynomial time.



$$H = \bar{G} = (V(G), \{uv \mid u, v \in V(G), uv \notin E(G)\})$$

$$k' = k$$

Claim G has clique of size $k \iff \bar{G}$ has independent set of size k .



CLIQUE $\geq_p$ INDEPENDENT SET $\geq_p$ CLIQUE

can be reduced in polynomial time

INDEP SET $\equiv_p$ CLIQUE

Cook-Levin Theorem

$\forall \Pi \in NP, \Pi \geq_p CSAT$

SAT instance is a CNF formula ϕ

Q: ∃ satisfying assignment to ϕ ?

$SAT \geq_p CSAT$: Like to show!

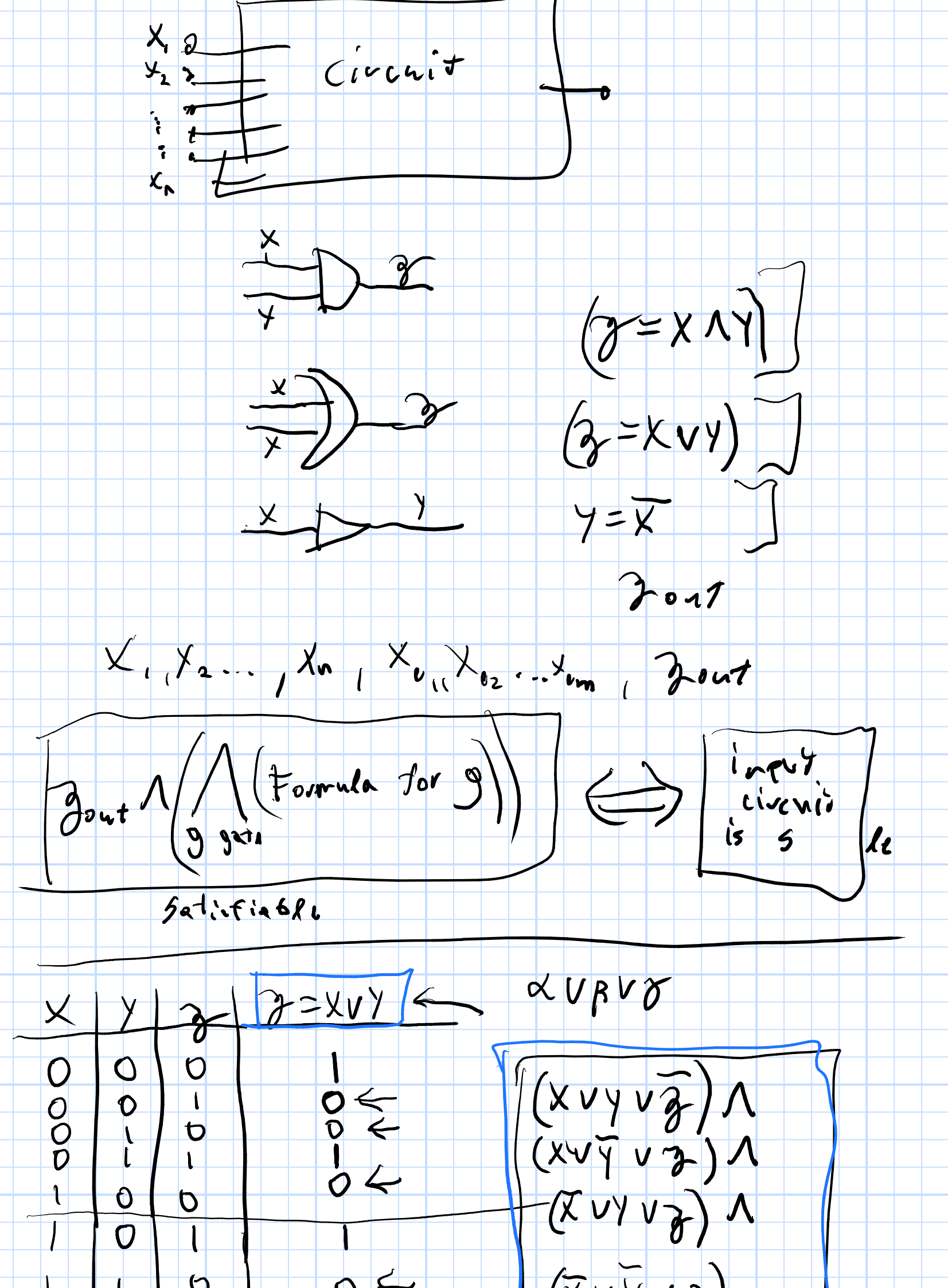
$A \geq_p B$ If can solve B in polynomial time, then we can solve A in poly time.

A can not be solved in polynomial time. $\Rightarrow$ B can not be solved in poly time!

To prove that NP is NPC one need to prove $CSAT \geq_p \Pi$.

$A \geq_p B \geq_p C \Rightarrow A \geq_p C$.

$CSAT \geq_p SAT$



$x_1, x_2, \dots, x_n, y_1, y_2, \dots, y_m, g_{out}$