1. Show NP-completeness for each of the following problems. They are all simple, direct reductions from one of the problems we have shown to be NP-complete in class.

(a) **Minimum set cover.** You are given a set $S$, a collection of subsets $S_1, \ldots, S_n \subseteq S$, and an integer $k$. Does there exist a set of $k$ subsets $T \subseteq [n]$ such that $\bigcup_{i \in T} S_i = S$?

Hint (ROT-13): iregrk pbire.

(b) **Subgraph Isomorphism.** You are given two graphs, $G$ and $H$. Does $G = (V_G, E_G)$ contain a subgraph isomorphic to $H = (V_H, E_H)$?

That is, is there an injection $f : V_H \rightarrow V_G$ such that for every $u, v \in V_H$, $(u, v) \in E_H$ if, and only if, $(f(u), f(v)) \in E_G$?

Hint (ROT-13): Znk pyvdhr be vaqrcraqrag frg.

(c) **Partition.** You are given a set of $n$ positive integers $x_1, \ldots, x_n \in \mathbb{Z}^+$. Does there exist a subset $S \subseteq [n]$ such that

$$\sum_{i \in S} x_i = \sum_{i \in [n] \setminus S} x_i?$$


2. The problem ALLORNOTHINGSAT asks, given a 3CNF boolean formula, whether there is an assignment to the variables such that each clause either has three True literals or has three False literals.

Describe a polynomial time algorithm for ALLORNOTHINGSAT.