1) We showed that \((x, y)\) is a rational solution to \(X^2 + Y^2 = 1\) if and only if \((x, y) = (-1, 0)\) or there is \(\lambda \in \mathbb{Q}\) such that
\[
(x, y) = \left( \frac{1 - \lambda^2}{1 + \lambda^2}, \frac{2\lambda}{1 + \lambda^2} \right).
\]

a) Suppose \(\lambda = \frac{m}{n}\), where \(m, n \in \mathbb{N}\). Show that \((n^2 - m^2, 2mn, n^2 + m^2)\) is an integral solution to \(X^2 + Y^2 = Z^2\).

b) Under what conditions on \(m\) and \(n\) is \((n^2 - m^2, 2mn, n^2 + m^2)\) a primitive solution in \(\mathbb{N}\)
[Recall that it is enough to have \(\gcd(n^2 - m^2, 2mn) = 1\).]

2) Find a formula as in 1) for all rational points on the hyperbola \(X^2 - Y^2 = 1\).

3) Solve the following congruences. Give the general solution.

a) \(616x \equiv 144 \pmod{780}\)

b) \(x \equiv 3 \pmod{5}\) and \(x \equiv 4 \pmod{8}\) and \(x \equiv 2 \pmod{3}\).