1. How many binary relations are there from a set with \( m \) elements to a set with \( n \) elements?

2. Determine whether each of the following relations are reflexive, symmetric, transitive, antisymmetric or none of these. Justify each answer with a proof or counterexample.
   
   (a) \( D \) is the “divides” relation on \( \mathbb{Z} \): for all integers \( m \) and \( n \), \( m \mid n \).
   
   (b) Let \( X = \{a, b, c\} \) and \( P(X) \) be the power set of \( X \). A binary relation \( \# \) is defined on \( P(X) \) as follows: for all \( A, B \in P(X) \), \( A \# B \leftrightarrow n(A) = n(B) \).
   
   (c) Let \( X = \{a, b, c\} \) and \( P(X) \) be the power set of \( X \). A binary relation \( R \) is defined on \( P(X) \) as follows: for all \( A, B \in P(X) \), \( A R B \leftrightarrow n(A) < n(B) \).
   
   (d) Let \( X = \{a, b, c\} \) and \( P(X) \) be the power set of \( X \). A binary relation \( T \) is defined on \( P(X) \) as follows: for all \( A, B \in P(X) \), \( A T B \leftrightarrow n(A) \neq n(B) \).
   
   (e) Let \( C \) be the set of all boolean formulas in three variables \( p, q \) and \( r \). Define \( I \) to be the “implies” relation on \( C \): for all boolean statements \( a \) and \( b \) in \( C \), \((a I b) \leftrightarrow (a \rightarrow b \) is true).