Consider the following transformation from a set of canonical coordinates \((q, p)\) to a new set of coordinates \((Q, P)\):

\[
Q = \frac{1}{2}(q^2 + p^2), \quad P = -\arctan \frac{q}{p}.
\]

(a) Verify that this transformation is canonical by investigating its Jacobian determinant. (b) Determine the generating function \(F_4(p, P)\) by integration of the total differential \(dF_4\). (c) Determine the generating function \(F_1(q, Q)\) from \(F_4(p, P)\).

Solution: