The exam is closed book and closed notes.

The volume flow rate per unit width, \( q \), over a certain dam is a function of gravity \( g \) and the upstream depth \( H \) above dam crest. (a) Find the dimensionless parameters. (b) The flow rate per unit width is 5 \( \text{ft}^2/\text{s} \) and \( H = 15 \text{ in.} \) for a model test. Using similarity find the flow rate if \( H = 3 \text{ ft} \)? (1 \( \text{ft} = 12 \text{ in.} \))
Solution: Format (+3)

a)

\[ q = f(g, h) \]
\[ q \equiv L^2T^{-1}, g \equiv LT^{-2}, h \equiv L \]
\[ k - r = 3 - 2 = 1 \]
\[ \Pi_1 = g^a h^b q = (LT^{-2})^a (L)^b (L^2T^{-1}) = M^0L^0T^0 \]
\[ L: a + b + 2 = 0 \]
\[ T: -2a - 1 = 0 \]
\[ \therefore a = -0.5, b = -1.5 \]
\[ \Pi_1 = \frac{q}{g^{0.5}H^{1.5}} \]  (4)

b)

\[ \frac{q_m}{g_m^{0.5}H_m^{1.5}} = \frac{q}{g^{0.5}H^{1.5}} \]
\[ q = q_m \left( \frac{g}{g_m} \right)^{0.5} \left( \frac{H}{H_m} \right)^{1.5} = 5 \frac{ft^2}{s} (1)^{0.5} \left( \frac{3 ft}{15/12 ft} \right)^{1.5} = 18.6 \frac{ft^2}{s} \]  (3)