1) $\Pi_1 = D^a \rho^b \Delta p^c Q$

2) $Q/b = f(g \cdot H)$ $\{L^3/T/L\} = \{L/T\}\{$ ... $\}$

solve for $a = -2, b = \frac{1}{2}, c = -\frac{1}{2}$

$$\therefore \Pi_1 = \frac{Q \rho^{1/2}}{D^2 \Delta p^{1/2}}$$

	Q/b	g	H
M	0	0	0
L	2	1	1
T	-1	-2	0

$\Pi_2 = D^a \rho^b \Delta p^c d$

rank $m = 2$ $n = 3$, $n - m = 1$

$a = -1$ $b = 0$ $c = 0$

$\Pi_1 = g^{x_1} H^{y_1} \frac{Q}{b}$

$$\therefore \Pi_2 = \frac{d}{D}$$

$\Pi_1 = (L^1 T^{-2})^{x_1} L^{y_1} (L^2 T^{-1}) = M^0 L^0 T^0$

$\Pi_3 = D^a \rho^b \Delta p^c \mu$

L: $x_1 + y_1 + 2 = 0$

T: $-2x_1$ $-1 = 0$

$a = -1$ $b = -1/2$ $c = -1/2$

$$\Pi_3 = \frac{\mu}{D \rho^{1/2} \Delta p^{1/2}}$$

$\therefore x_1 = \frac{-1}{2}$ $y_1 = \frac{-3}{2}$ $\therefore \Pi_1 = \frac{Q}{b g^{1/2} H^{3/2}}$

$$\Pi_1 = \frac{(600)(120)}{(32.2)^{1/2}(1.25)^{1.5}} = 0.6$$

$\therefore$ The orifice-flow

function is :

$$\frac{Q \rho^{1/2}}{D^2 \Delta p^{1/2}} = f\left(\frac{d}{D}, \frac{\mu}{D \rho^{1/2} \Delta p^{1/2}}\right)$$

$Q = 0.63 (120)(32.2)^{\frac{1}{2}}(3)^{1.5}$

$= 2229.1 \text{ ft}^3/s$

$\therefore$ The flow rate is

$2229.1 \text{ ft}^3/s$

3) $P = f(D, P, V, \Omega, h)$

$\{P\} = \{ML^2T^{-3}\}$

$\{D\} = \{L\}, \quad \{P\} = \{ML^{-3}\}$

$\{V\} = \{L/T\}, \quad \{\Omega\} = \{T^{-1}\}$

$\{h\} = \{1\}$

a) $\boxed{\therefore \dfrac{P}{PD^2V^3} = f\left(\dfrac{\Omega D}{V}, h\right)}$

$\dfrac{P}{PD^2V^3} = \dfrac{2700}{(1.2255)(0.5)^2(40)^3}$

$= 0.188 = \dfrac{P_{proto}}{1.0067 \times 5^2 \times 12^3}$

b) $\boxed{\therefore P_{proto} = 5980W \approx 6KW}$

$\left(\dfrac{\Omega D}{V}\right)_{model} = \dfrac{\frac{4800}{60} \times 0.5}{40} = 1$

$\left(\dfrac{\Omega D}{V}\right)_{proto} = \dfrac{\Omega_{proto} \times 5}{12} = 1$

c) $\boxed{\therefore \Omega_{proto} = 144 \, rev/min}$

4) $D = f(V, P, d)$

$\{D\} = \{F\}, \quad \{V\} = \{LT^{-1}\}$

$\{P\} = \{FL^{-4}T^2\}, \quad \{d\} = \{L\}, \quad 4-s = 1 \, W$

$\Pi = Dv^a p^b d^c$

$= (F)(LT^{-1})^a (FL^{-4}T^2)^b (L)^c$

$= F^0 L^0 T^0$

a) $\boxed{\therefore \Pi = \dfrac{D}{PV^2d^2}}$

$\dfrac{D}{PV^2d^2} = \dfrac{D_m}{P_m V_m^2 d^2_m}$

$D = \left(\dfrac{P}{P_m}\right)\left(\dfrac{V}{V_m}\right)^2\left(\dfrac{d}{d_m}\right)^2 D_m$

$= \left(\dfrac{2.38 \times 10^{-3}}{1.94}\right)\left(\dfrac{10}{4}\right)\left(\dfrac{30}{1}\right)(17)$

$= 117 \, lb$

b) $\boxed{\therefore \text{the similarity is} \\ \quad 117 \, lb}$