Q.3(1)

(1) Work done per second $= \rho a v_1 (v_{w_1} + v_{w_2}) u$

(2) KE of jet per second $= \frac{1}{2} m v_1^2 =$

$$\frac{1}{2} (\rho a v_1) v_1^2$$

(3)

$$\eta_K = \frac{\text{work done per second}}{\text{KE of jet per second}}.$$

$$\eta_K = \frac{\rho a v_1 (v_{w_1} + v_{w_2}) u}{\frac{1}{2} (\rho a v_1) v_1^2} \quad \text{--- (1)}$$

(4) for a Pelton wheel we have.

$$v_{w_1} = v_1 \; ; \; v_{r_1} = (v_1 - u_1) = v_1 - u$$

$$v_{r_2} = v_1 - u$$

$$v_{w_2} = v_{r_2} \cos\phi - u_2$$

$$= v_{r_2} \cos\phi - u = (v_1 - u) \cos\phi - u$$

(5) Substitute the value of v_{w_1} and v_{w_2} in eq^n (1) we get

$$\eta_K = \frac{2[v_1 + (v_1 - u)\cos\phi - u]u}{v_1^2}$$

$$= \frac{2(v_1 - u + (v_1 - u)\cos\phi)u}{v_1^2}$$

$$= \frac{2(v_1 - u)(1 + \cos\phi)u}{v_1^2}$$

(6.) for maximum efficiency,

$$\frac{d}{du}(\eta_h) = 0$$

$$\frac{d}{du}\left[\frac{2(v_1 - u)(1 + \cos\phi)u}{v_1^2}\right] = 0$$

$$\left(\frac{1 + \cos\phi}{v_1^2}\right)\frac{d}{du}\left(2(v_1 - u)u\right] = 0$$

$$\frac{d}{du}\left[2v_1 u - 2u^2\right] = 0$$

$$2v_1 - 4u = 0$$