

4. $D_m = 50 \text{ cm.}$

$N = 10000 \text{ rpm.}$

$V_{w1} = 380 \text{ m/s, } \alpha_1 = 25^\circ$

$\beta_2 = 35^\circ$

$U = \frac{\pi D_m 10000}{60 \times 1000} = 261.8 \text{ m/s.}$

$V_{w1} = V_1 \cos \alpha_1 = 380 \times \cos 25^\circ = 344.4 \text{ m/s}$

$V_1 \sin \alpha_1 = V_{w2} \sin \beta_2$

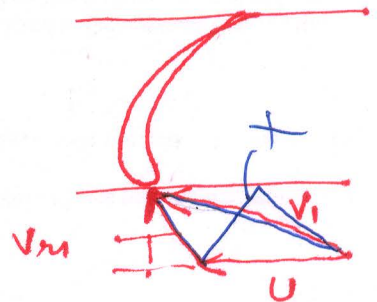
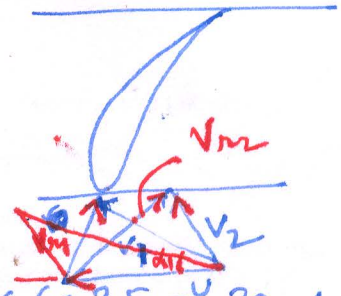
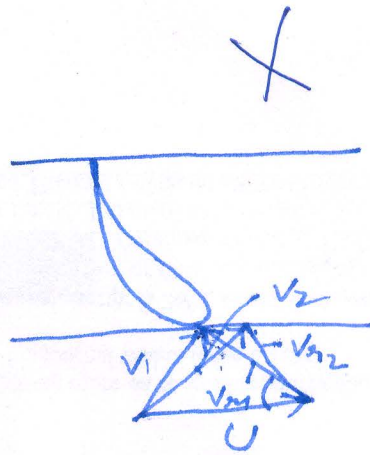
$V_{w2} = \frac{380 \times \sin 25^\circ}{\sin 35^\circ} = 280 \text{ m/s}$

$V_{u2} = U - V_{w2} \cos \beta_2 = 261.8 - 280 \times \cos 35^\circ = 32.4 \text{ m/s}$

$w = U(V_{w1} - V_{w2})$
 $= 261.8(344.4 - 280)$
 $= 81.7 \text{ kJ/kg}$

$R = \frac{w - \frac{V_1^2 - V_2^2}{2}}{w} =$

$\epsilon = \frac{w}{w + \frac{V_2^2}{2}} =$



$V_{w1} > U$

$V_1 > V_2$

$V_1 < V_2$

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Pai

$$V_1 = 60 \text{ m/s} \quad D_1 = 90 \text{ cm}, \quad \alpha_1 = 30^\circ$$

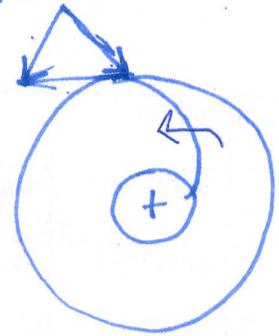
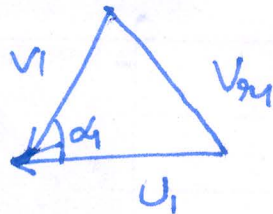
$$N = 1200 \text{ rpm}, \quad D_2 = 30 \text{ cm}.$$

$$U_1 = \frac{2\pi N}{60} \times \frac{D_1}{2} = \frac{2\pi \times 1200}{60} \times \frac{0.9}{2} = 18\pi \text{ m/s}$$

$$V_{2y}^2 = V_1^2 + U_1^2 - 2U_1 V_1 \cos \alpha_1$$

$$= 60^2 + (18\pi)^2$$

$$- 2 \times 60 \times 18\pi \times \cos 30$$



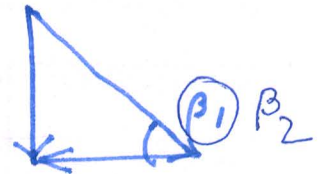
$$= 921 \text{ m}^2/\text{s}^2 \Rightarrow V_{2y} = 30.3 \text{ m/s}$$

$$V_1 \sin \alpha_1 = V_{2y} \sin \beta_1 \Rightarrow \sin \beta_1 = \frac{60 \times \sin 30}{30.3} = 0.99$$

$$\beta_1 = 81.89^\circ$$

$$\tan \beta_2 = \frac{V_1 \sin \alpha_1}{6\pi} = \frac{60 \times \sin 30}{6\pi} = 1.59$$

$$\beta_2 = 57.8^\circ$$



$$\begin{aligned} \omega &= U_1 V_{t1} - U_2 V_{t2} \\ &= 18\pi \times 60 \times \cos 30 \\ &= 2938 \text{ J/kg} \end{aligned}$$

$$\omega = \frac{V_1^2 - V_2^2}{2(1-R)} = 2938$$

$$2(1-R) = \frac{2938}{\frac{V_1^2 - V_2^2}{2(2938)}}$$

$$1-R = \frac{60^2 - (60 \times \sin 30)^2}{2 \times 2938}$$

$$= \frac{675}{1469}$$

$$E = \frac{V_1^2 - V_2^2}{V_1^2 - R V_2^2} = \frac{60^2 - 30^2}{60^2 - 0.54 \times 30^2} \quad R = 1 - \frac{675}{1469} = 0.54$$

$$= \frac{6}{7} = 0.86$$

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$$U = \frac{35\pi}{3} = 36.6 \text{ m/s}$$

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$$\begin{aligned} V_{u1} &= V_1 \cos \alpha_1 \\ &= 100 \times \cos 28 \\ &= 88.3 \text{ m/s} \end{aligned}$$

$$\beta_1' = \tan^{-1} \left(\frac{100 \times \sin 28}{88.3 - 36.6} \right)$$

$$= 42.2$$

$$\tan \beta = \tan^{-1} \left(\frac{100 \times \sin 28}{36.6 - 88.3} \right)$$

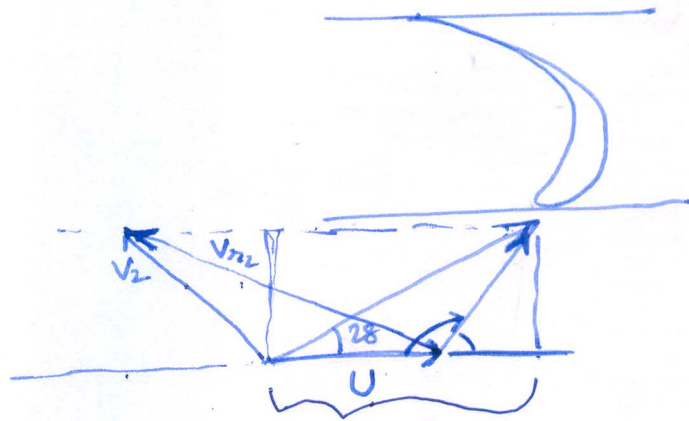
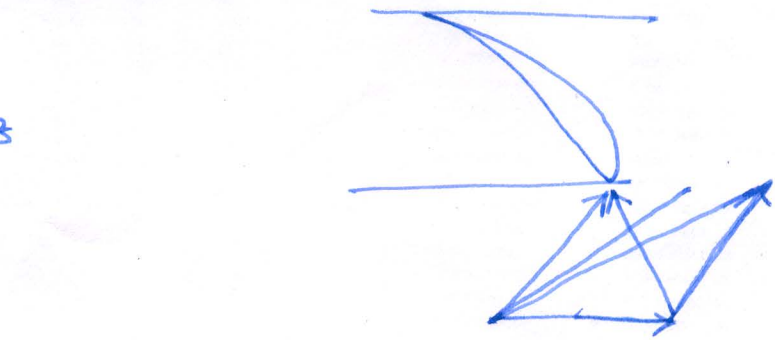
$$= -42.2$$

$$W = U [V_{u1} - V_{u2}]$$

$$= U [88.3 - (36.6 - 88.3)]$$

$$= 5124 \text{ J/kg}$$

$$\frac{V_1^2 - V_2^2}{2} =$$



$$W = \frac{(V_1^2 - V_2^2) + (V_{u2}^2 - V_{u1}^2)}{2}$$

$$= \frac{(V_1^2 - V_2^2) + (V_{u2}^2 - V_{u1}^2)}{2}$$

By
symmetry

$$R = 0.5$$

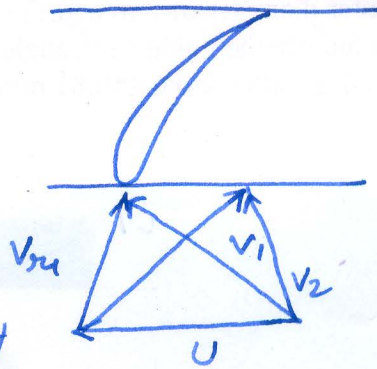
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Pai

$U = 125 \text{ m/s}$

$\beta_1 = 40^\circ, \beta_2 = 25^\circ$

$V_1 = 225 \text{ m/s}$

$V_{r2} = 1.5 V_{r1}$



$V_{r1} \cos \beta_1 + V_1 \cos \alpha_1 = V_{r2} \cos \beta_2 + V_2 \cos \alpha_2$

$V_{r1} \sin \beta_1 = V_1 \sin \alpha_1$

$V_{r1} \cos \beta_1 \cdot \frac{\sin \beta_1}{\cos \beta_1} = V_1 \sin \alpha_1$

$V_{r1} \tan \beta_1 \cdot V_{r1} \cos \beta_1 = V_1 \sin \alpha_1 \cdot \cot \beta_1$

$V_1 \sin \alpha_1 \cot \beta_1 + V_1 \cos \alpha_1 = U$

$225 \times \cot 40^\circ \times \sin \alpha_1 + 225 \cos \alpha_1 = 125$

$\sin \alpha_1 + \frac{225}{225 \times \cot 40^\circ} \cos \alpha_1 = \frac{125}{225 \times \cot 40^\circ}$

$\sin \alpha_1 + 0.84 \cos \alpha_1 = 0.47$

$\alpha_1 = 75^\circ$

$\alpha_2 = 50^\circ$

$\tan \alpha_1 = \frac{109 \sin 40^\circ}{125 + 109 \cos 40^\circ} = \frac{70.1}{208.5} \Rightarrow \alpha_1 = 18.6^\circ$

$V_{r2} = 1.5 \times 109 = 163.5 \text{ m/s}$

$V_{u2} = V_{r2} \cos \beta_2 = 163.5 \times \cos 25^\circ - U = 148.2 \text{ m/s} - 125 = 23.2$

$W = U(V_{u1} - V_{u2}) = 125 \times (208.5 + 23.2) = 28962.5 \text{ J/kg} = 44.4 \text{ m/s} - 109 \text{ m/s}$

$V_2^2 = 125^2 + 163.5^2 - 2 \times 125 \times 163.5 \times \cos 25^\circ$

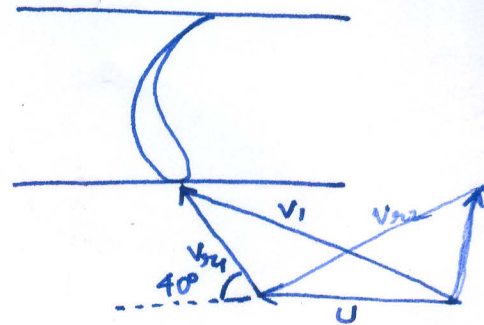
$V_2 = 72.9 \text{ m/s}$

$\frac{V_1^2 - V_2^2}{2} = \frac{225^2 - 72.9^2}{2} = 21542.8 \text{ m/s}$

$R = \frac{28962.5 - 21542.8}{28962.5} = 0.26$

$G = \frac{28962.5}{28962.5 + \frac{72.9^2}{2}} = 0.82$

$\text{Thrust} = 200 \sin 18.6^\circ - 163.5 \sin 25^\circ = 1.07 \text{ N/(kg/s)}$



$V_1^2 = U^2 + V_{r2}^2 - 2UV_{r2} \cos \beta_1$
 $225^2 = 125^2 + x^2 - 2 \times 125 \times x \times \cos 40^\circ$

$35000 = x^2 + 191.5x$

$x^2 + 191.5x - 35000 = 0$

$x = \frac{-191.5 \pm \sqrt{191.5^2 + 4 \times 35000}}{2} = \frac{-191.5 \pm 420.3}{2}$

$220^2 = 125^2 + x^2 - 2 \times 125 \times x \times \cos 140^\circ$

$x^2 + 191.5x - 32775 = 0$

$x = \frac{-191.5 \pm \sqrt{191.5^2 + 4 \times 32775}}{2}$

$x = \frac{-191.5 \pm 409.6}{2}$

$= 109 \text{ m/s}$

$\frac{9}{\text{Pa}}$

No whirl, $\alpha_1 = 90^\circ$

$$V_1 = 12 \text{ m/s}$$

$$D_1 = 10 \text{ cm}, D_2 = 20 \text{ cm}, N = 2000 \text{ rpm}$$

$$U_1 = \frac{2\pi N}{60} \times \frac{D_1}{2}$$

$$U_2 = 21 \text{ m/s. } \checkmark$$

$$= \frac{2\pi \times 2000}{60} \times \frac{0.1}{2}$$

$$= 10.5 \checkmark$$

$$\tan \beta_1 = \frac{V_1}{U} = \frac{12}{10.5}$$

$$\beta_1 = \tan^{-1} \left(\frac{12}{10.5} \right) = 48.8^\circ \checkmark$$

$$V_{r1} = \sqrt{U^2 + V_1^2}$$

$$= \sqrt{10.5^2 + 12^2}$$

$$= 15.9 \text{ m/s. } \checkmark$$

$$V_{r2} = 0.75 V_{r1}$$

$$= 0.75 \times 15.9$$

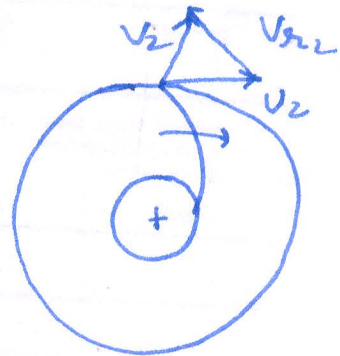
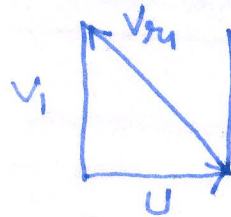
$$= 12 \text{ m/s } \checkmark$$

$$\beta_2 = 80^\circ$$

$$V_{u2} = U_2 - V_{r2} \cos \beta_2$$

$$= 21 - 12 \times \cos 80^\circ$$

$$= 18.9 \text{ m/s}$$



$$W = U_2 V_{u2}$$

$$= 21 \times 18.9 \text{ J/kg}$$

$$= 396.9 \checkmark$$

$$\tan \alpha_2 = \frac{V_{r2} \sin \beta_2}{V_{u2}}$$

$$= \frac{12 \sin 80^\circ}{18.9}$$

$$= 0.625$$

$$\alpha_2 = 32^\circ$$

$$V_2 = \sqrt{\left(\frac{V_{r2} \sin \beta_2}{\sin \alpha_2} \right)^2 + (V_{u2})^2}$$

$$= 22.3$$

$$R = \frac{396.9 - (22.3^2 - 12^2)/2}{396.9}$$

$$= 0.52$$

~~Answer not matching~~