

National Exams December 2008

04-Agric-A4, Fluid Flow

3 hours duration

NOTES

- 1 If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made
- 2 This is an OPEN BOOK EXAM
Any non-communicating calculator is permitted
- 3 Four (4) questions constitute a complete exam paper
The first four questions as they appear in the answer book will be marked
- 4 Each question is of equal value
- 5 All questions require calculation

Choose either 1a or 1b

1a When the pump shown below draws $220 \text{ m}^3/\text{hr}$ of water at 20°C from the reservoir, the total friction head loss is 5 m . The flow discharges through a nozzle to the atmosphere. Estimate the pump power in kW delivered to the water.

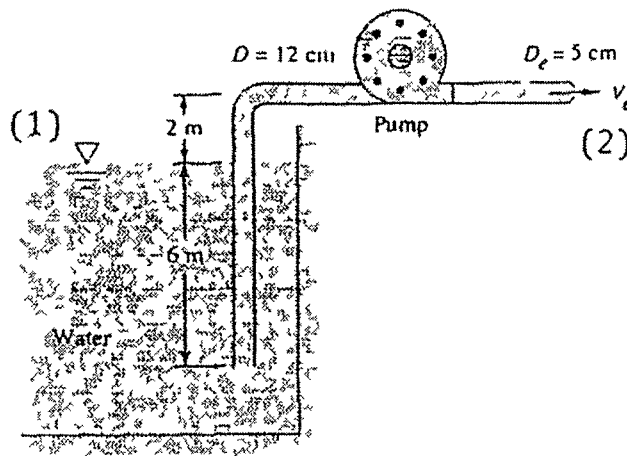


Figure for Question 1a

1b The pump shown below creates a 20°C water jet oriented to travel a maximum horizontal distance. System friction head losses are 6.5 m . The jet may be approximated by the trajectory of frictionless particles. What power must be delivered by the pump?

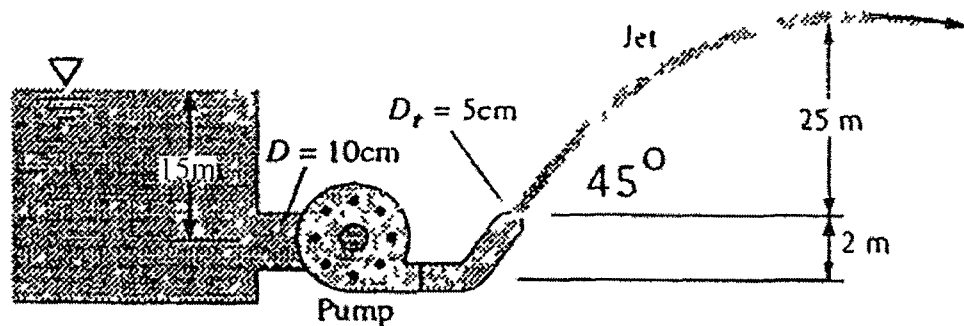


Figure for Question 1b

2 The three arm lawn sprinkler shown below receives water at 20°C through the center at a volume of 2.7 m³/hr. If collar friction is negligible, what is the steady rotation rate in rev/min for

- a) $\theta=0^\circ$
- b) $\theta=40^\circ$

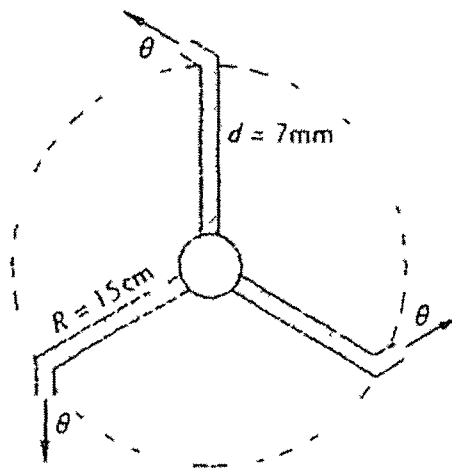


Figure for Question 2

3 A certain water flows at 20°C has a critical cavitation number, where bubbles form, $Ca \approx 0.25$ where $Ca = 2(p_a - p_{\text{vap}}) / \rho V^2$. If $p_a = 1 \text{ atm}$ and the vapor pressure is 0.34 pounds per square inch absolute (psia), for what water velocity will bubbles form?

Choose either 4a or 4b

4a SAE 30 oil at 20°C flows in the 3-cm diameter pipe as shown below, which slopes at 37°. For the pressure measurements shown, determine

- a) Whether the flow is up or down
- b) The flow rate in m³/hr

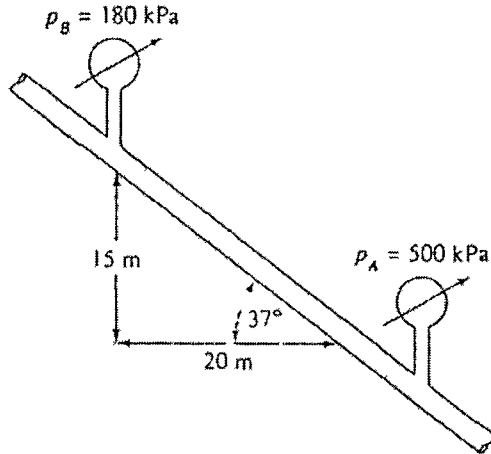


Figure for Question 4a

4b A blower delivers air at 3000 m³/hr to the duct circuit in below figure. Each duct is commercial steel and of square cross section, with side lengths $a_1=a_3=20$ cm and $a_2=a_4=12$ cm. Assuming sea level air conditions, estimate the power required if the blower has an efficiency of 75 percent. Neglect minor losses.

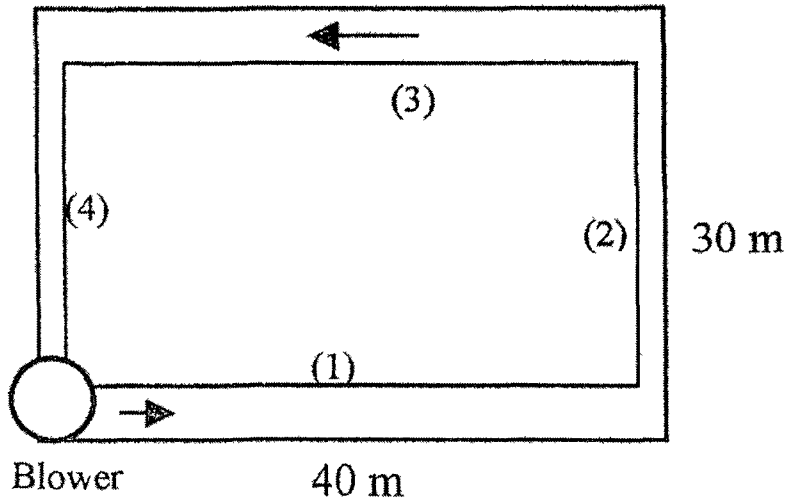


Figure for Question 4b