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 m^3/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.

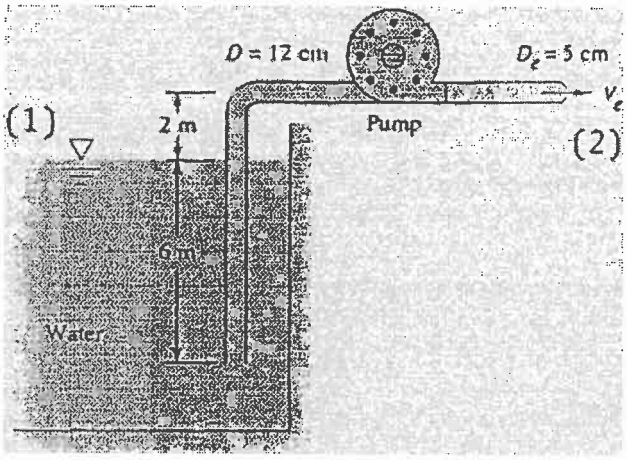

Figure for Question 1a.

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?

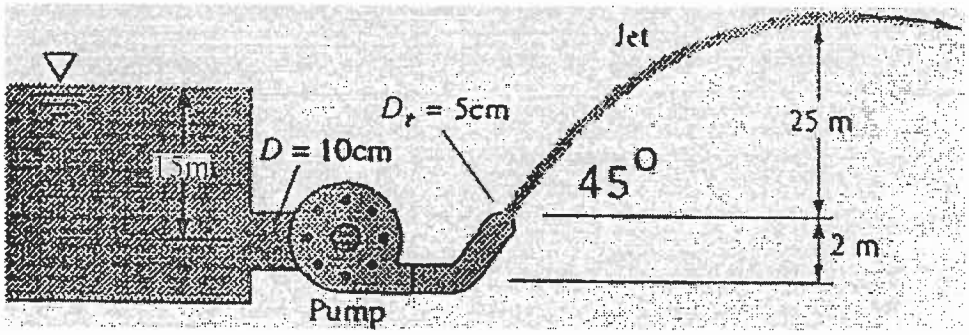

Figure for Question 1b.

2. The three arm lawn sprinkler shown below receives water at 20°C through the center at a volume of 2.7 m^3/hr. If collar friction is negligible, what is the steady rotation rate in rev/min for:

a) $\theta=0°$
b) $\theta=40°$

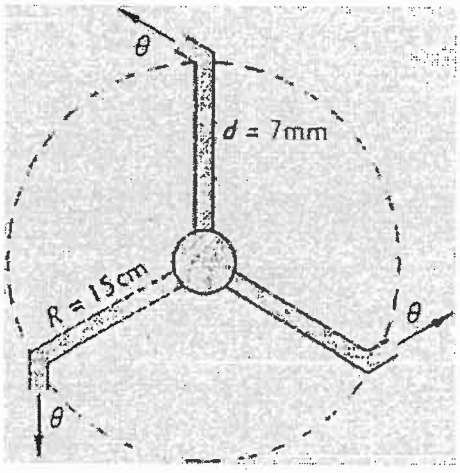

Figure for Question 2.

3. A certain water flows at 20°C has a critical cavitation number, where bubbles form, $Ca \approx 0.25$ where $Ca=2(p_a-p_{vap})/\rho V^2$. If $p_a=1$ 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 m^3/hr

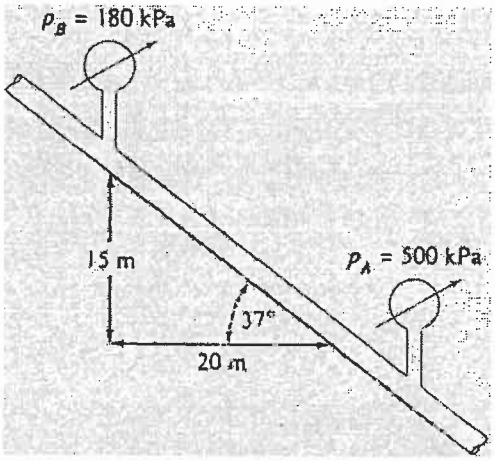

Figure for Question 4a.

4b.A blower delivers air at 3000 m^3/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.

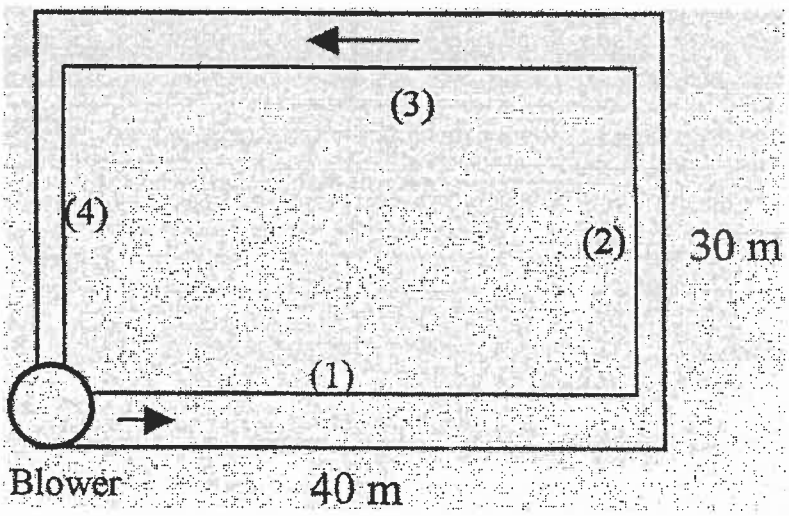

Figure for Question 4b.