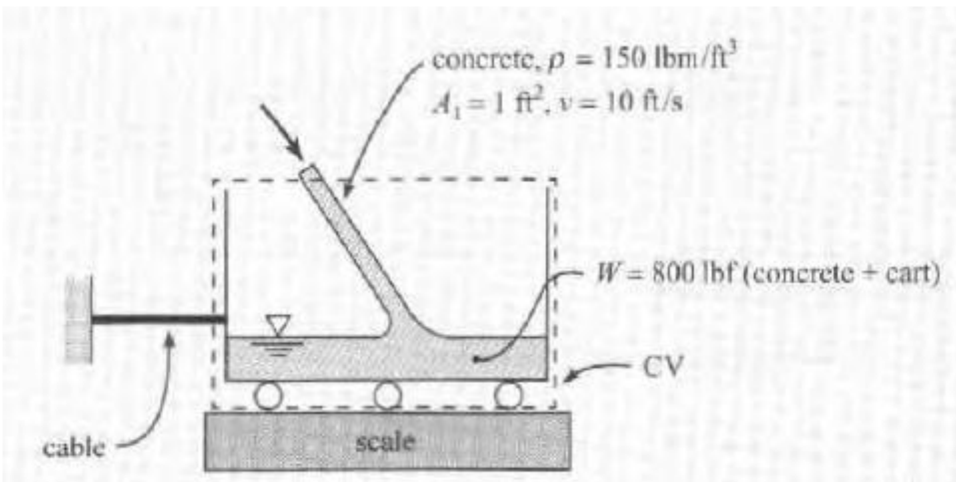
Project Models for Fluid Mechanics Part (M1112)

Each student will select one of the three following projects and write his name and section and number as follows:

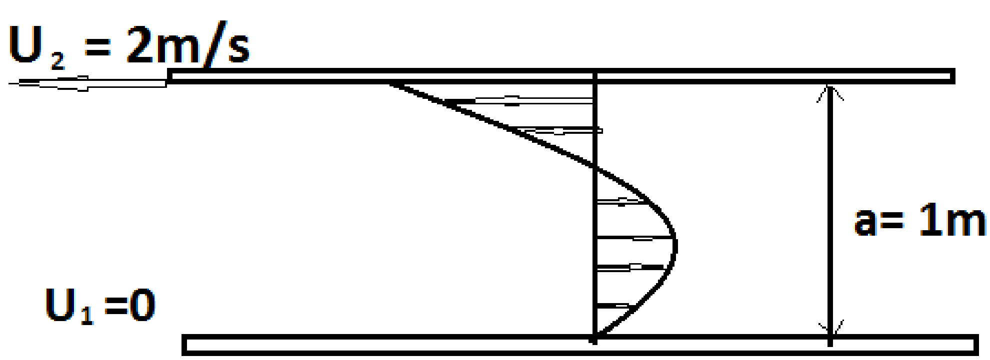
Student name: Sec.: No:

1-a Discuss the basic equations governing the flow in a system and apply RTT to deduce the steady flow energy equation .

1-b As shown in the sketch, concrete flows into a cart sitting on a scale. The stream of concrete has a density of ρ=150 lbm/f^3, an area of A = 1 ft^2 , and a speed of v = 10 ft/s. At the instant shown, the weight of the cart plus the concrete is 800 lbf. Determine the tension in the cable and the weight recorded by the scale. Assume steady flow.



2-a) The dimensionless velocity profile for fully laminar developed flow between infinite parallel plates with the upper plate moving at constant speed U to the left as shown in figure below. Find the pressure gradient dp/dx and the flow rate at which the lower plate experience zero shear and find the skin friction coefficient on the upper plate.

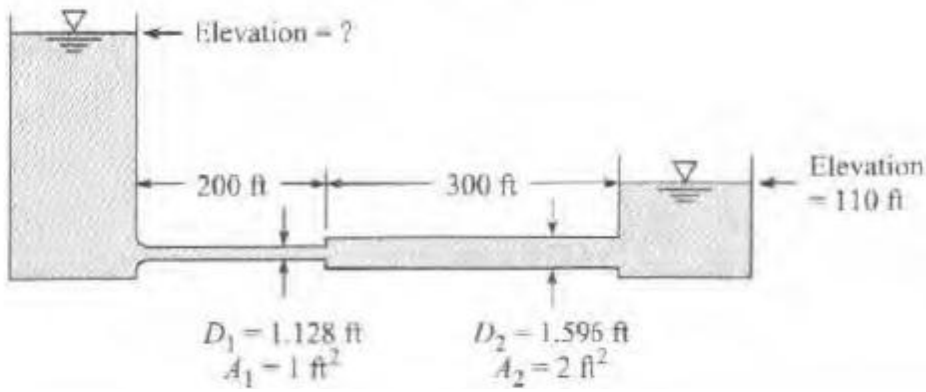


2-b) An approximate equation for the velocity distribution in a rectangular channel with turbulent flow is.

$$\frac{u}{U_{max}} = \left(\frac{y}{d}\right)^{1/7}$$

where U_{max} is the velocity at the surface, y is the distance from the floor of the channel, *d is* the depth of flow, and *n* is an exponent that varies from about 1/6 to 1/8 depending on the Reynolds number. Derive a formula for energy correction factor α as a function of *n*. What is the value of α for *n* = 1/7?

3-a) Water flows from the reservoir on the left to the reservoir on the right at a rate of 16 cfs. the formula for the head losses in the pipes is $h_L = 0.02(L/D)(V^2/2g)$. What elevation in the left reservoir is required to produce this flow? Also carefully sketch the HGT. and the EGL for the system. *Note:* Assume the head-loss formula can be used for the smaller pipe as well as for the larger pipe. (include all minor losses assuming the inlet from the left tank to the pipe is rounded)



3-b) From the momentum equation of the boundary layer and assuming similar velocity profile given by:

$u/U = 3\eta - 3\eta^2 + \eta^3$, Where $\eta = y/\delta$ drive the formula for boundary layer thickness δ(x), displacement thickness momentum local skin friction coefficient, average skin friction coefficient , displacement thickness $\delta^*(x)$, momentum thickness θ(x), local and average skin friction coefficients, and shape factor.

4-a) The discharge of a centrifugal pump is a function of the rotational speed of the pump *N*, the diameter of the impeller *D*, the head across the pump *hp*, the viscosity of the fluid μ, the density of the fluid ρ, and the acceleration due to gravity *g*. The functional relationship is

Q = *f(N, D, hp*,μ,ρ,g)

By dimensional analysis, find the dimensionless parameters.

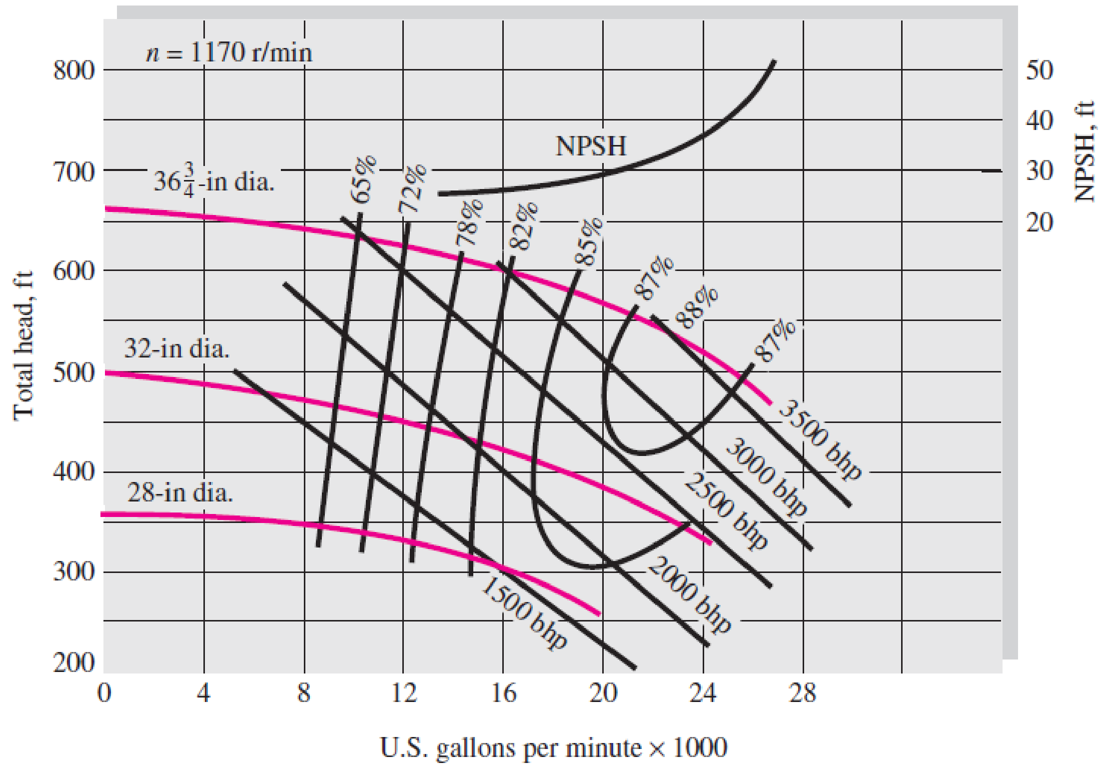
Express your answer in the form

$\frac{Q}{ND^3}$ = = f(π1, π2, π3)

4-b) A prototype ship is 35 m long and designed to cruise at 11 m/s (about 21 kn). Its drag is to be simulated by a 1-m-long model pulled in a tow tank. For Froude scaling find (a) the tow speed, (b) the ratio of prototype to model drag, and (c) the ratio of prototype to model power.

5-a) The 32-in pump of Figure below is to pump 24,000 gal/min of water at 1170 r/min from a reservoir whose surface is at 14.7 lbf/in^2 absolute. If head loss from reservoir to pump inlet is 6 ft, where should the pump inlet be placed to avoid cavitation for water at

(a) 60°F, p_v = 0.26 lbf/in^2 absolute, SG = 1.0 and (*b*) 200°F, p_v =11.52 lbf/in^2 absolute, SG=0.9635?



5-b) ii) Redraw the characteristic curve of the three pumps shown below when connected in:

i- parallel.

ii- series