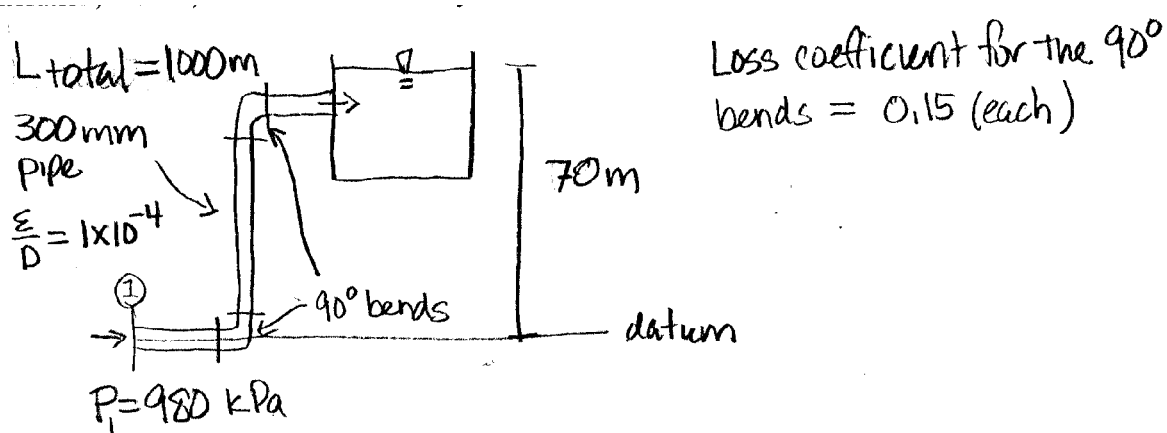


### Test Format and Instructions

- 3 problems on 2 pages (one problem with multiple parts)
- 20 - 30 points per problem
- 75 points total (25 additional points on take-home given later)
- open book, open notes
- initial all pages, staple solutions to test and hand in package
- start at 11:00, end at 12:25, Thursday, March 26, 1998

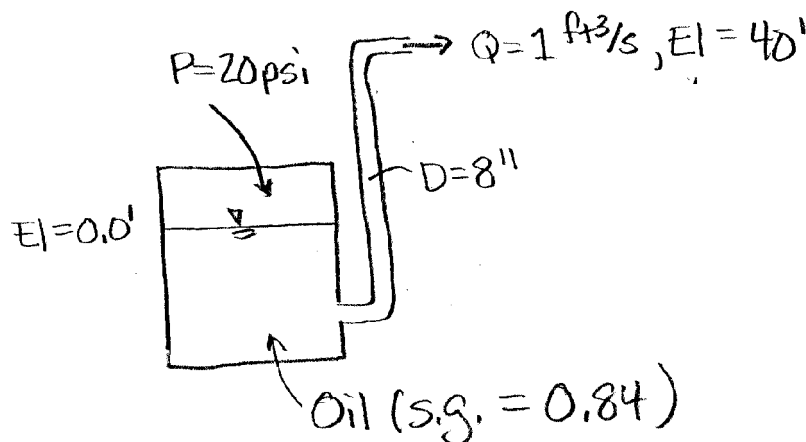
#### 1. Flow in Closed Conduits (25 points)

Water is being pumped up to a storage reservoir, as shown below. Estimate the flow rate, using the Darcy equation, including local losses. Do only one iteration, but indicate whether your second iteration, if done, would raise or lower your estimate of the flow.



#### 2. Bernoulli Equation (20 points)

Oil flows from a tank into the air, as shown below. What is the total head loss through the system?



**3. Short Answer/Multiple Choice (30 Points)**

- A. A viscous liquid is flowing through a 1-inch, cast-iron pipe. The Reynolds number is 1000. What is the friction factor,  $f$  ?
- B. What does it mean when it is said that the flow is “laminar.”
- C. The friction factor in turbulent, “fully rough” flow depends upon the following (circle one or more):
- a) the pipe diameter
  - b) the pipe roughness
  - c) the fluid velocity
  - d) the fluid viscosity
  - e) none of these
- D. Water flows through a nozzle, which reduces the pipe diameter by a factor of two. The velocity head has increased by a factor of how much?
- E. Water flows through a new 12-inch, cast-iron pipe at 3 ft/s. Using the Hazen-Williams equation, estimate the head loss due to friction per 1000 ft. of pipe.