

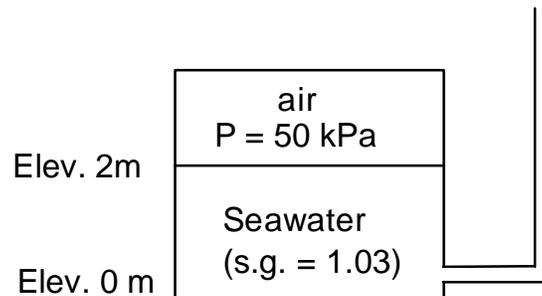
Test Format and Instructions

- 6 problems on 5 pages
 - 20 - 55 points per problem
 - 200 points total (100 points in each section)
 - open book, open notes
 - initial all pages, staple solutions to test and hand in package
 - start at 12:00, end at 3:00 PM, Tuesday, May 5, 1998
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II.1 Pressure in a Closed Vessel (25 points)

A vessel containing seawater under pressure is shown below. Assume all pressures are gauge pressures. Find:

- a) the pressure at the bottom of the vessel
- b) the elevation of the water surface in the attached piezometer
- c) the air pressure in the vessel if the elevation of the water surface in the piezometer were 2 m.



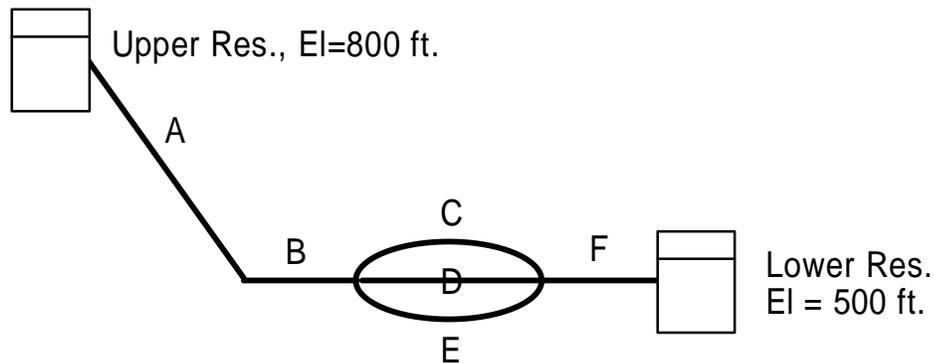
- a) $P(\text{gage}) = 70.2 \text{ kPa}$
- b) $h = 6.96 \text{ m}$
- c) $P = P_{\text{atm}} = 0.0 \text{ kPa}$

II.2 Flow in Water Distribution Networks (45 points total)

Consider the pipe network below. Find the following:

1. Find the flow distribution between pipes C, D, and E, in percent (e.g. C=30%, D=40%, E=40%). Justify your answer with an explanation or a calculation. (20 points)
2. Find the flow in each pipe. Assume that local losses are relatively small. (25 points)

Pipe	Length(ft)	H-W "C"	Diameter (ft)
A	5000	90	2.0
B	1000	90	2.0
C	1500	120	1.0
D	1500	120	1.0
E	1500	120	1.0
F	1000	90	2.0



1. Percentage of total flow for pipes C, D, and E: C=33.3%, D=33.3%, E=33.3%.

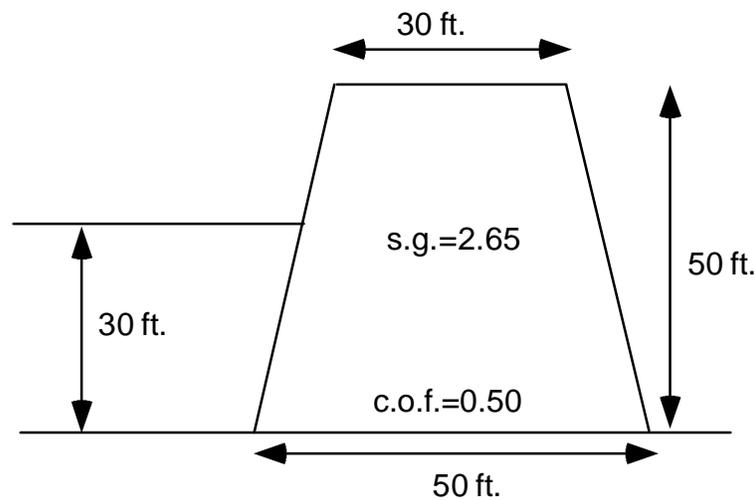
2.

Pipe	Flow (cfs)
A	35.53
B	35.53
C	11.84
D	11.84
E	11.84
F	35.53

II.3. Pressure Forces on Dams & Buoyancy, Short Answer (30 points total)

A dam, as shown below, is trapezoidal in cross-section, is 50 ft. high, has a base width of 50 ft., and a top width of 30 ft. The dam is made of concrete (s.g.=2.65). The depth of water behind the dam is 30 ft. Find the following:

1. The horizontal force exerted by the water on the dam, per unit length of dam. (5 pts.)
2. The vertical force exerted by the water on the dam, per unit length of dam (5 pts.)
3. The average pressure on the foundation, assuming no hydrostatic uplift (5 pts.)
4. The safety factor for sliding, assuming no hydrostatic uplift, and a coefficient of friction between the foundation and the dam of 0.50 (5 pts.)



1. $F_H = 28,080$ lbs.
2. $F_V = 5,616$ lbs.
3. $P = 6,726$ lb/ft²
4. $F_s(\text{sliding}) = 5.98$

5. The sinking titanic has filled with water so that its specific gravity is 0.9. The water surrounding the ship has a specific gravity of 1.03. What percentage of the ship's volume is under water? (10 pts.)

5. Percentage submerged = 87.4%

I.1. Open Channel Flow & Pumps, Short Answer (55 points total)

A circular storm sewer pipe has a diameter 6 ft, is laid on a slope of 0.1%, and is made of concrete ($n=0.013$). Find the following:

1. The uniform flow rate when the pipe is 50% and 100% full (10 pts.)
2. The average velocity when the pipe is 50% full (5 pts.)
3. The Froude Number when the pipe is 50% full (5 pts.)
4. The flow rate when the pipe is 30% full ($A/A_{full} = 0.3$) (10 pts.)
5. The mid-channel depth when the velocity is 70% of the velocity when the pipe is 100% full. (5 pts.)

1. $Q_{100\%} = 134$ cfs, $Q_{50\%} = 67$ cfs
2. $V = 4.74$ ft./s
3. $N_F = 0.54$
4. $Q = 33.5$ cfs
5. $d = 1.68$ ft.

A pump has a flow rate of 1780 gpm, supplies a head of 100 ft., and has a rotational speed of 1500 rpm. Find the following:

6. The specific speed of the pump. (5 pts.)
7. The type of centrifugal pump that gives the highest efficiency (use Fig. 11-5), and the efficiency for these conditions. (5 pts.)
8. The rotational speed that would give the highest efficiency. (5 pts.)
9. The electrical power requirement. (5 pts.)

6. $N_s = 2000$
7. radial, $E=92\%$
8. $N = 1,875$ rpm
9. $P = 48.9$ Hp

I.2 Open Channel Flow (25 pts.)

A rectangular channel, with a slope of 0.5% is to carry 15 cfs at a water depth of 2 ft. The channel is concrete ($n=0.013$). Find the following:

1. the width of the channel
2. the velocity in the channel
3. the Froude Number for this flow
4. the flow type (subcritical, critical, supercritical)

1. width = 1.42 ft.
2. velocity = 5.28 ft./s
3. $N_F = 0.66$
4. subcritical

I.3 Flow Measurement (20 pts.)

Water flows from a reservoir over a dam that is essentially a broad-crested weir. The length of the dam is 150 ft. and the depth of water over the weir is 1.5 ft. Compute the discharge of water over the dam.

$$Q = 851 \text{ cfs}$$