Sheet 1

INTRODUCTION

1- The weight of a 20 kg body is 170 N at a location away from the earth.
What is the acceleration at this location?

2- The density of a fluid is 2.94 gm/cm^3.
Determine its specific gravity, specific weight, and specific volume?

3- When 7.3 m^3 of oil weighs 53 kN, find its density and its specific gravity?

4- A shear stress of 4 N/m^2 causes a fluid to have an angular deformation of 100 rad/sec.
What is its viscosity?

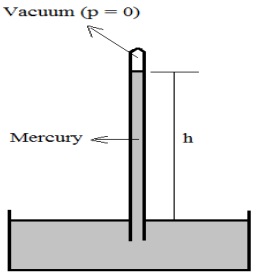
5- The velocity is 2.5 m/s at a distance of 130 mm from the boundary. The fluid has viscosity 0.048 Pa.s and a relative density 0.913.

a) For a linear velocity distribution, what are the velocity gradient & the shear stress?
b) Determine the kinematic viscosity?

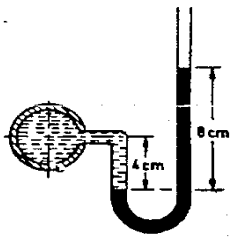
Sheet 2

STATICS OF FLUIDS

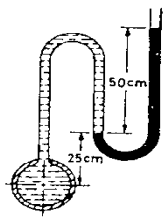
1- In the shown barometer tube, h is 760 mm. The specific gravity for mercury is 13.6 and ρ_w is 1,000 kg/m^3.
(a) Calculate the atmospheric pressure?
(b) Determine the atmospheric pressure (www.LMNOeng.com)?



2- The pressure of water in a pipe is measured by a mercury simple manometer, as shown in figure.
Determine the static pressure of water in the pipe as kg/m^2 and as head of water?

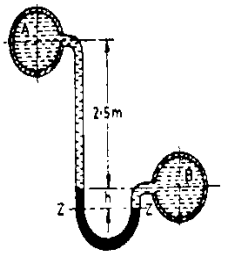


3- A mercury U-tube is used to measure the pressure of oil of specific gravity 0.8, as shown in figure.
Calculate the pressure of the oil?



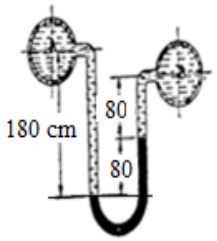
4- Two pipes A & B are connected by a mercury differential manometer, as shown in figure. Pipe A contains a liquid with specific gravity 1.594 under pressure of 1.2 kg/cm^2. Pipe B contains oil with specific gravity 0.8 under pressure of 2 kg/cm^2.

Determine the reading of manometer?



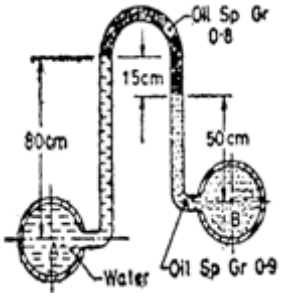
5- Two pipes containing water are connected by a mercury differential manometer, as shown in figure. The reading of manometer is 80 cm.

Determine the difference of pressure in the pipes?



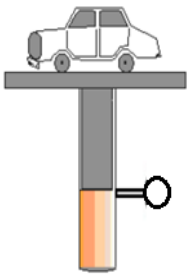
6- An inverted differential manometer is connected to two pipes A and B, as shown in figure. The pressure in pipe A is 1 kg/cm^2.

Determine the pressure in pipe B?



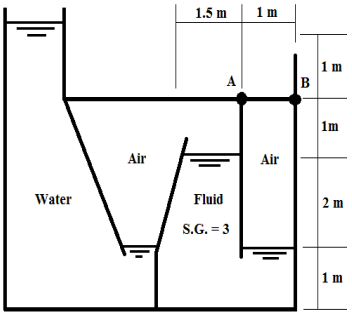
7- As shown in figure, a hydraulic jack supports a car. The jack has 0.4 m diameter cylinder, the piston weighs 1,000 N, and the gauge reading is 1.2 bar.

Determine the weight of the car?



8- A tank has 10 m length, as shown in figure.

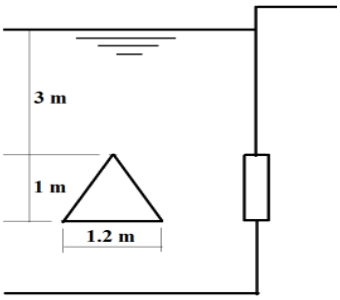
a) Where will the max pressure occur?
b) Find the force on the top part AB of the tank?



9- A vertical triangular gate is subject to water on one side, as shown in figure.

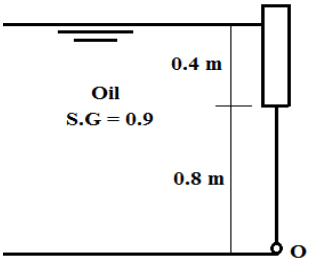
a) Calculate the total force on the gate?

b) Detect the centre of pressure?



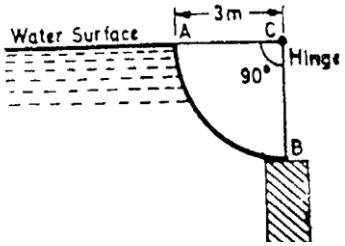
10- The gate holding oil is 80 cm high and 120 cm long, as shown in figure.

Calculate the necessary resisting moment at the bottom edge?



11- a) Calculate the resultant pressure of water per meter length, on the gate of radius 3 m, as shown in figure?

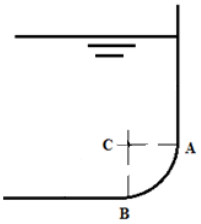
b) Detect its direction?



12- The lower part of a vertical side of a tank is a quarter of a circle 4 ft radius. The tank is 6 ft long and contains water of 12 ft height.

a) Determine the horizontal and vertical components of the total force on the curved part?

b) Detect also their locations?



13- Resolve the last problem when the water is on the other side of the curved part?

14- A block of wood 4 m long, 1 m wide, and 0.5 m deep is floating horizontally in water. Density of wood is 760 kg/m^3.

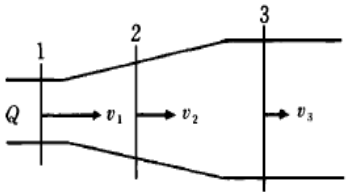
a) Determine volume of displaced water?

b) Discuss block's stability?

Sheet 3

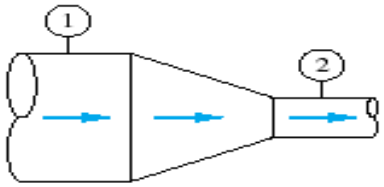
KINEMATICS OF FLUID FLOW

1- In the conduit shown in figure, the flow rate Q is 800 L/min and the diameters d_1, d_2, and d_3 at sections 1, 2 and 3 are 50, 60 and 100 mm respectively.
(a) Calculate the flow velocities v_1, v_2 and v_3?
(b) Determine the flow velocities v_1, v_2 and v_3 via (www.LMNOeng.com)?



2- As shown in figure, water flows at 0.1 m^3/s through a nozzle, where the diameters are D_1 = 18 cm and D_2 = 5 cm.

Compute the average velocity (m/s) at sections 1 and 2?



Sheet 4

DYNAMICS OF FLUID FLOW

1- Water is flowing in a tapered pipe with diameters 5 cm at the smaller end, and 15 cm at the larger end where the velocity of flow is 2.5 m/sec.

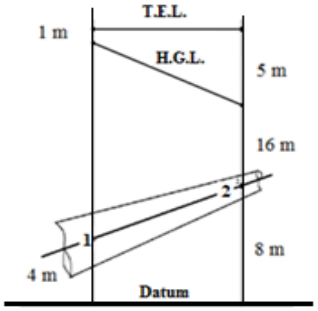
Determine the velocity head and the discharge at the smaller end?

2- A pipe 300 m long has a slope of 1/100, and tapers from 1 m diameter at the higher end to 0.5 m diameter at the lower end. The pressure at the higher end is 0.7 kg/cm^2, and the quantity of flowing water is 5400 liters per minute.

Determine the pressure at the lower end?

3- *In the shown figure,*

a) Is the flow is ideal or real? Why?
b) Determine v_2, P_1 (kg/cm^2), H_L, and the piezometric head at point (1)?
c) For H_L = 1 m, draw T.E.L.?
d) For H_L = 1 m, what will be the direction of flow?



4- A horizontal venturi meter 160 mm x 80 mm is used to measure the flow of oil of specific gravity 0.8. The discharge of the oil is 50 lit/sec.

Determine the reading of a differential mercury manometer?

5- A venturi meter of coefficient 0.95 is provided to a horizontal 10 cm diameter pipe line conveying water with discharge 20 lit/sec. The reading of a differential mercury manometer is 60 cm.

a) Determine the throat diameter of the venturi meter?
b) Determine the reading of the manometer when the pipe is vertical?

Sheet 5

FLOW THROUGH AN ORIFICE

1- Water of head 11 m is flowing through an orifice of 70 mm diameter. The coefficients of discharge and velocity are 0.62 and 0.9 respectively.

a. Calculate the actual discharge through the orifice?
b. Determine the actual velocity at vena contraction?

2- A tank of 1 m^2 cross sectional area contains water of 4 m deep. An orifice of 60 mm diameter and 0.6 coefficient of discharge is provided at the bottom of the tank.

a. Determine the fall of water level after 2 minutes?
b. Detect the time required to empty the rest of water?

Sheet 6

MOMENTUM EQUATION

1- A jet of water with a diameter of 60 mm and a velocity of 5 m/s hits a vertical fixed plate.

Calculate the force of the jet on the plate?

2- A nozzle is connected to a hose. At the entry section, the pressure is 300 kPa and the diameter is 30 mm. At the exit section, the diameter is 12 mm. The flow rate is 1.3 lit/s.

Determine the force required to hold the nozzle?

Sheet 7

FLOW THROUGH PIPES

1- The difference of heads between the two ends of a pipe, 250 m long and 200 mm diameter, is 1.5 m. The friction coefficient is 0.005.

a) Calculate the discharge neglecting the minor losses?
b) Find the discharge taking into account the minor losses?

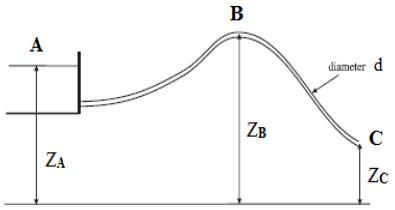
2- Horizontal pipe, 60 m long and 15 cm diameter, is connected to a water tank at one end and flows free in atmosphere at the other end. Height of water in the tank is 2.6 m above the centre of pipe. Friction coefficient is 0.006 and minor losses are neglected.

Determine the discharge?

3- Water flows in a steel pipe of 60 mm diameter and $k = 0.05 \times 10^{-3}$ m. The discharge is 1.6 lit/s and $\mu = 0.001$ k/ms.

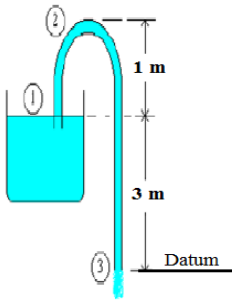
Determine the friction coefficient and the head loss due to friction per meter length of the pipe *using:* 1- Moody chart? 2- Smooth pipe formula?

4- A pipe transmits water from a tank A to point C that is lower than water level in the tank by 6 m. The pipe is 120 mm diameter and 27 m long.
The highest point on the pipe B is 1.7 m above water level in the tank and 9 m long from the tank. The friction coefficient is 0.08, with sharp inlet and outlet to the pipe.



a. Determine the velocity of water leaving the pipe at C?
b. Calculate the pressure in the pipe at the point B?

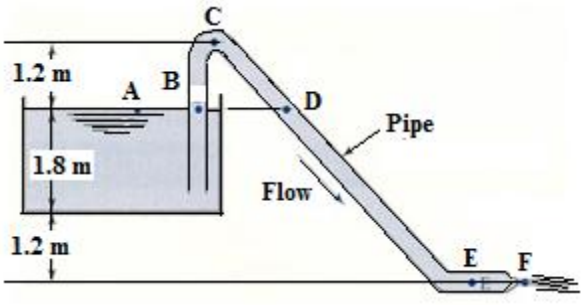
5- The pipe of a syphon has 90 mm diameter and discharges water to the atmosphere, as shown in figure.
Neglect all possible losses.



a. Determine the velocity of flow?
b. Find the discharge?
c. What is the absolute pressure at the point 2?

6- *In the shown figure:*

$v_A = 0$	$P_A = 0$
$v_B = 3$ m/s	$P_B = -4.5$ kPa
$v_C = ?$	$P_C = -16.27$ kPa
$v_D = ?$	$P_D = ?$
$v_E = ?$	$P_E = 24.93$ kPa
$v_F = 7.67$ m/s	$P_F = ?$



a) Determine v_A, v_C, v_D, v_E, P_D and P_F?
b) Why P_A and P_B are not the same?
c) To what the decreased pressure energy at B is converted?
d) Why the pressure at C is the lowest?
e) Why the pressure at E is the highest?
f) Why P_B and P_D are the same?

7- A pipe line 1650 m long consists of pipes 45 cm diameter for 900 m, 37.5 cm for 450 m, and 30 cm for 300 m. It is required to fix a new pipe line with the same length and uniform diameter, instead of the first one.

Determine the diameter of the new pipe line?

8- A pipe line ABC, 180 m long, is laid on an upward slope of 1:50. The portion AB is 90 m long with 15 cm diameter. The diameter is suddenly enlarged at B to 30 cm, and remains so till C. Water of 55 lit/sec is pumped in the pipe at the lower end A, and is discharged in a closed tank at the upper end B. The pressure of water at A is 1.4 kg/cm^2, and friction coefficient is 0.005.

a) Determine the pressure at the end C?
b) Draw H.G.L. and T.E.L.?

9- A pipe line 1200 m long is conveying water from a tank to another, where the difference of water levels is 30 m. The diameter of the pipe is 400 mm for the first half and is 250 mm for the second half. Friction coefficient is 0.005.

a) Determine the discharge considering friction losses only?
b) Calculate the discharge considering all losses?

10- Two water reservoirs are connected by three paralleled pipes that have a length of L m and friction coefficient f. The diameters of pipes are d, 2d and 3d m. The smallest pipe is discharging 1 m^3/sec.

Determine the discharge in each of the other two pipes?

11- Two water reservoirs A & B, 30 m difference of water levels, are connected by a pipe line, that has a length of 6 km, a diameter of 70 cm and a friction coefficient of 0.006. In the middle of the pipe line, there is a tap through which water can be discharged to a third reservoir C.

a) Find the discharge from A to B when no water is discharged to C?
b) Determine the discharge from A to B when 150 lit/sec of water is discharged to C?

12- Three water tanks A, B and C are connected to a joint J by three pipes AJ, BJ and CJ such that the water level in tank A is 40 m higher than tank B and 55 m higher than tank C. Each pipe is 1500 m long, 0.3 m diameter and f = 0.01.

Calculate the discharges and directions of flow?

13- a) Deduce the relation between the maximum power transmitted through a pipe and the head loss due to friction in the pipe (neglect minor losses)?

b) If the pressure at a power station is 60 kg/cm^2, find the maximum power transmitted through a pipe line 3 km long, 20 cm diameter, and friction coefficient 0.0075?

Sheet 8

DIMENSIONAL ANALYSIS

1- What are the dimensions in MLT and FLT systems for:

a) Angular velocity? b) Energy? c) Pressure? d) Power?

2- Which combination is dimensionless:

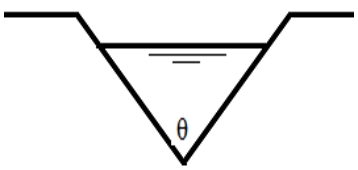
a) v y ν? b) v y / ν? c) v / y ν?

3- Prove that the following terms are dimensionless:

a) $P / \rho v^2$? b) $\rho v L / \mu$? c) $v / (g L)^{1/2}$?

4- The discharge Q over a V – notch is a function of ρ, μ, σ, g. h. and θ.

Employing π–theorem, derive an expression for it?



Sheet 9

MODEL ANALYSIS

1- Experiments with water on 90º V-notch showed that $Q = 2.48\ h^{2.48}$.

Neglecting surface tension, estimate the percentage error when this formula is used with a liquid whose viscosity is 10 times that of water?

(Note: *Refer to the solution of problem No. 4 Sheet 8.*)

2- A model for a spillway has to be built in a laboratory where the maximum capacity of the pump is 0.26 m^3/s. The prototype has 8.4 m^3/s maximum discharge with 1.5 m head on the crest.

a) Determine a suitable scale for the model?
b) Calculate the head on the crest of the model?
c) What is the time in model corresponding to 38 hours in prototype?
d) Find the loss of power in prototype corresponding to 0.05 HP in model?

3- The flow in a river is 1500 m^3/s. A distorted model with horizontal scale 1/60 and vertical scale 1/16 is built for laboratory testing.

What is the flow rate in the model?