Answer the following questions:
## Question one (12 marks)

a) Define: Kinematic viscosity – Vapour pressure of liquids.
b) Mention Newton's law of viscosity, with declaring its parameters.
c) Let two layers of fluid be dragged along the motion of an upper plate as shown. The bottom plate is stationary. The top fluid puts a shear on the upper plate, and the lower fluid puts a shear on the bottom plate. Determine the ratio of these two shear stresses.
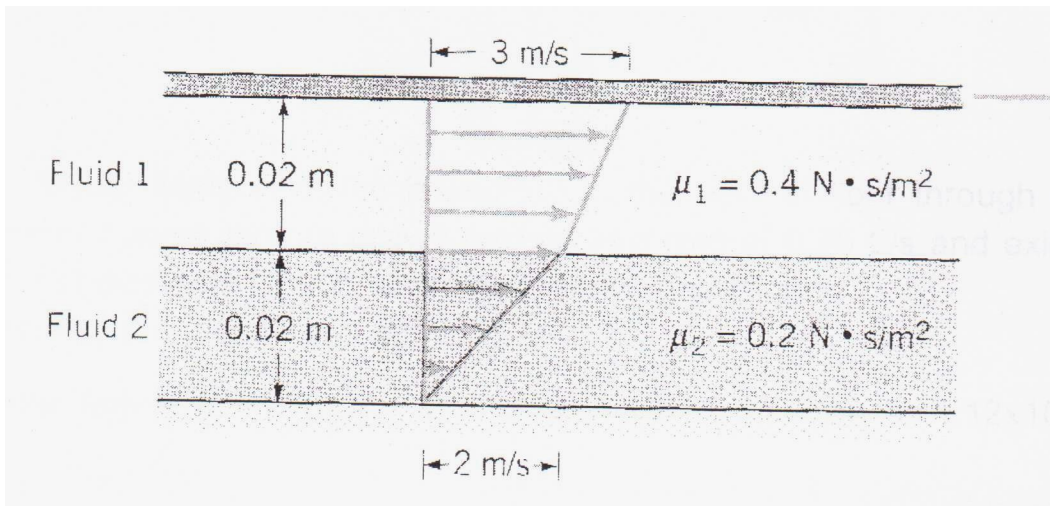
Question two (12 marks)

a) Prove that the pressure changes in the vertical direction.

b) For the inclined tube manometer shown in figure, the pressure in pipe A is 10 kPa. The fluid in both pipes A and B is water. The manometer fluid is mercury ($\gamma = 13.6$). What is the pressure in pipe B.
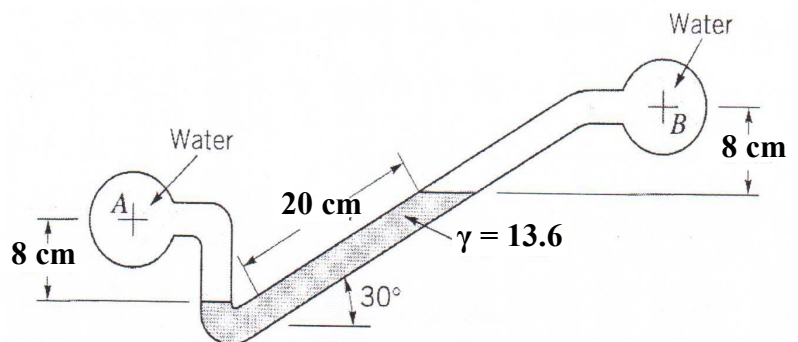
c) Water from a large reservoir is discharged to atmosphere through a 100 mm diameter cast iron pipe 450 m long. The entry from the reservoir to the pipe is sharp and the outlet is 12 m below the surface level in the reservoir. Calculate the discharge.

Question three (12 marks)

a) Compare between Positive displacement pumps and Dynamic head pumps. Also, name and sketch example for each type.

b) Calculate the weight of the oil leaks from a 3 cylinder piston pump has the following specifications:
   i. Rotating at 120 rpm.
   ii. The piston has a diameter of 4 cm.
   iii. Stroke 6 cm.
   iv. The shaft power is 2.75 hp.
   v. Mechanical efficiency 89 %.
   vi. Specific gravity of oil 0.81.
   vii. Delivery pressure 49.6 bar.
   viii. Suction pressure 0.4 bar.

Question Four (12 marks)

a) Explain how to avoid cavitation in the installed pumps.

b) A centrifugal pump has the following performance:

Q (m^3/hr)	0	15	30	45	60	75
hm (m)	75	72	65	53	38	19
η (%)	0	43	69	73	65	49

When this pump is used in a system where the difference between delivery and suction levels (h$_{st}$) is 42 m, it gives a discharge of 47 m^3/hr.
Calculate the discharge and shaft power of the pump when (h$_{st}$) decreases to 35 m.

Question Five (12 marks)

a) What are the components of the hydraulic systems?

b) Draw a complete hydraulic circuit used to rotate a hydraulic motor with a controllable velocity. This circuit contains:-
   i. Vented reservoir.   ii. Variable speed Hydraulic pump.
   iii. Electric motor.   iv. Filter.   v. Check valve
   vi. Relief valve.   vii. Flow control valve.   viii. Hydraulic motor.
   ix. Directional control valve two chambers four ports using solenoid control.