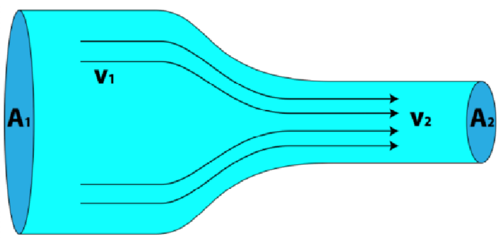
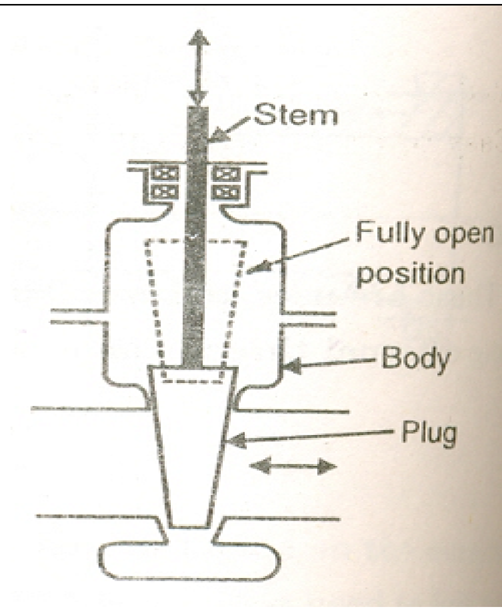
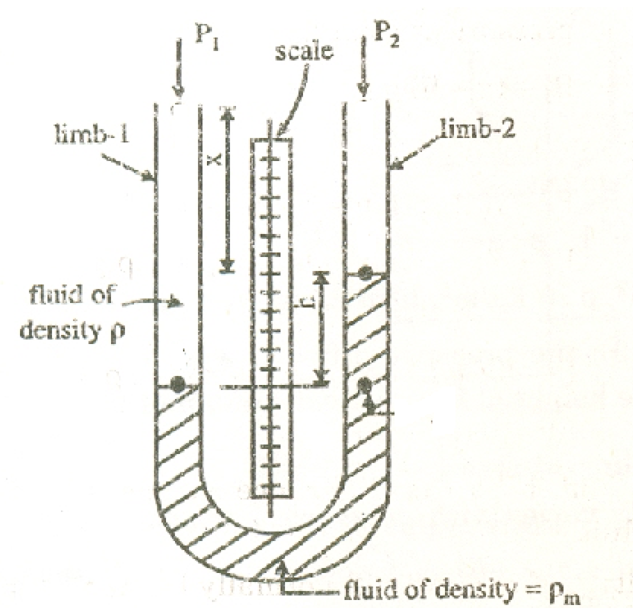
Important Instructions to examiners:

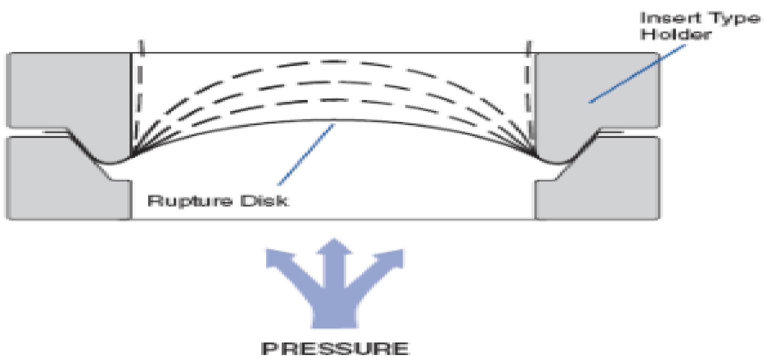
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

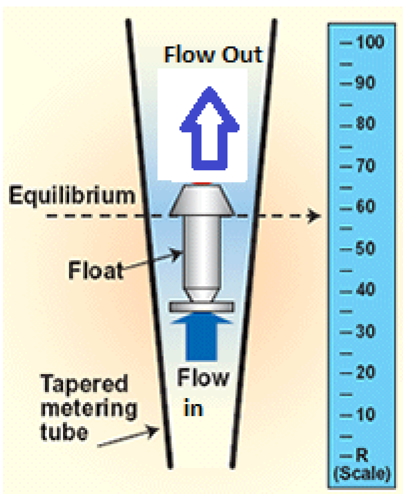
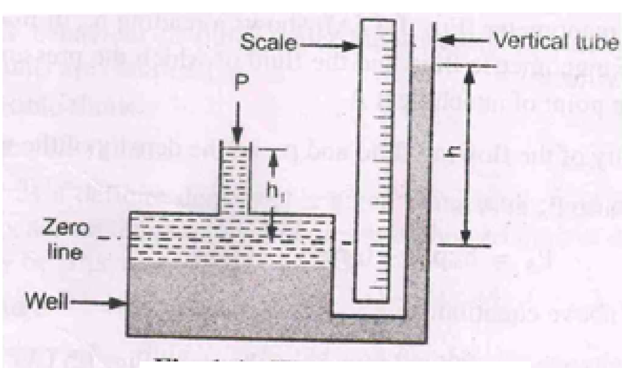
Q No.	Answer	marks	Total marks
1A	**Attempt any SIX of the following**		12
1A-a	**Dynamic Viscosity:** Dynamic Viscosity or absolute viscosity is the property of the fluid by virtue of which it offers resistance to the movement of one layer of fluid over an adjacent layer **Unit in CGS system** is poise or gm/cm S	1 1	2
1A-b	**Egs of Non-Newtonian fluids:** Toothpaste, Jellies, paints, sewage sludge, blood, solution of high molecular weight polymers, paper pulp, mud, suspension of starch in water, pulp in water	1 mark each for any two	2
1A-c	**Critical velocity**. It is the velocity at which the flow changes from laminar to transition. **Formula to calculate critical velocity:** $NR_e = \frac{\rho V d}{\mu}$ Critical Reynolds number = 2100 Therefore $2100 = \frac{\rho V d}{\mu}$	1 1	2
1A-d	**Fanning's friction factor:** Fanning's friction factor is defined as the ratio of shear stress at the wall to the product of velocity energy and density	2	2
1A-e	**Fitting used for** **(i)** **Changing the size of pipe line:** reducer, expander.(any one) **(ii)** **Branching of pipe line:** tee, cross.(any one)	1mark 1mark	2
1A-f	**Application of diaphragm pump:** They are used for pumping hazardous and toxic liquids.	2	2
1A-g	**Maximum pressure developed by**		2

	Reciprocating compressor: can deliver pressure as high as 240 MPa **Centrifugal compressor:** can deliver pressure up to 2 MPa	1 1	
1B	**Attempt any TWO of the following**		
1B-a	**Equation of continuity:** **Statement** Mass balance states that for a steady state flow system, the rate of mass entering the flow system is equal to that leaving the system provided accumulation is either constant or nil. **Derivation**  Let v_1 ,ρ_1& A_1 be the avg. velocity, density& area at entrance of tube & v_2 ρ_2& A_2 be the corresponding quantities at the exit of tube. Let be the mass flow rate Rate of mass entering the flow system = $v_1 \rho_1 A_1$ Rate of mass leaving the flow system = $v_2 \rho_2 A_2$ Under steady flow conditions $= \rho_1 v_1 A_1 = \rho_2 v_2 A_2$ $\rho v A$ = constant .... **Equation of continuity**	1 3	4
1B-b	**Diagram of gate valve**		4

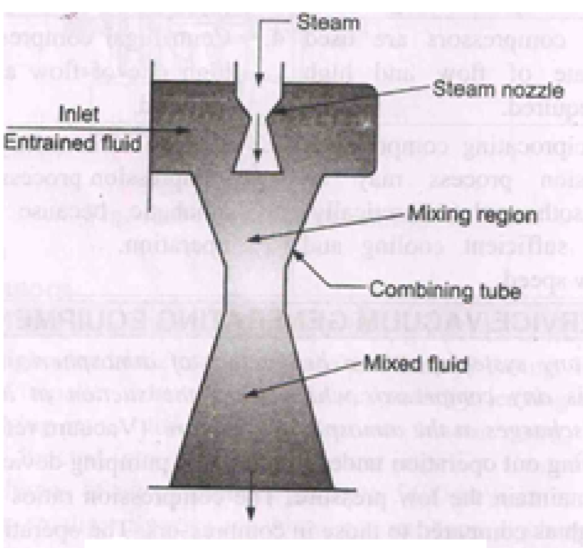
		4	
1B-c	**Working of centrifugal pump:** Once the trapped air in pump is removed (priming),the delivery valve is kept closed & power from electric motor is applied to the shaft. The delivery valve is kept closed to reduce the starting torque for motor. The impeller rotates within the casing , which produces the forced vortex & it imparts a centrifugal head to the liquid .The pressure throughout the liquid is increased. When delivery valve is opened, the liquid is made to flow in an outward radial direction thereby leaving the vanes of the impeller at the outer circumference of the impeller with high velocity & pressure. Due to centrifugal action, a partial vacuum is created at the eye of impeller. This causes the liquid from sump to rush through the suction pipe to the eye of impeller. From the eye, the liquid flow through the vanes and reach the tip pf the vanes. From the tip of the vanes, the liquid enters a casing where the kinetic energy of the fluid is converted to pressure energy. This pressure	4	4

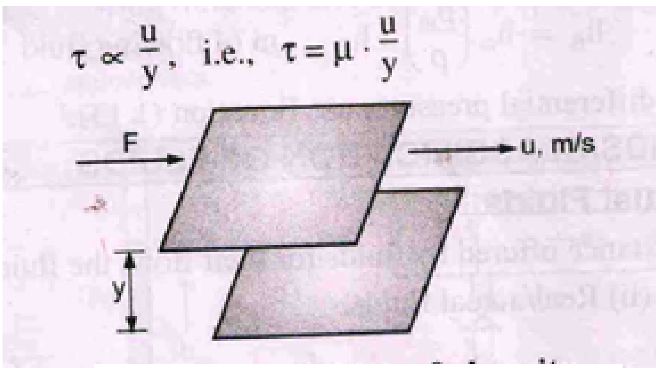
	energy is used to lift the liquid.		
2	**Attempt any FOUR of the following**		16
2-a	**U tube manometer:** **Diagram:**  	2	4
	Expression to calculate differential pressure : $P_1 - P_2 = \Delta P = h(\rho_m . \rho)g$ Where h=difference in level of manometric fluid in the two limbs of manometer. ρ = density of flowing fluid ρ_m = density of manometric fluid.	2	
2-b	**Types of friction:** Form friction and skin friction	1	4
	Form friction: Friction caused by eddies when an obstruction is present in the line of flow.	1.5	
	Skin friction: Friction between a moving fluid and wall of pipe. It is due to	1.5	

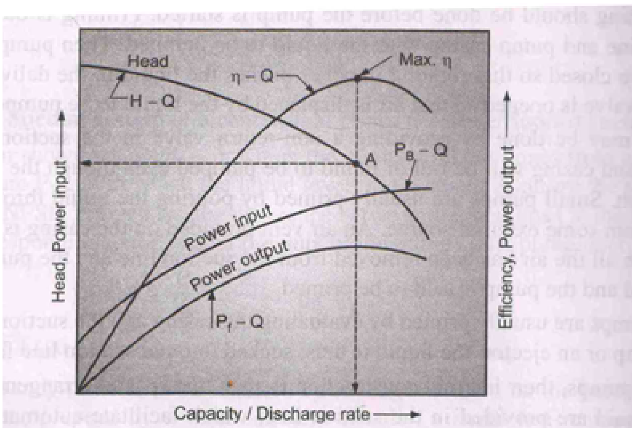
	the roughness of the pipe. When fluid is flowing through a straight pipe, only skin friction exists.		
2-c	**Rupture disc:**  Rupture disc, is a non-reclosing pressure relief device. A rupture disc is a one-time-use membrane. They can be used as single protection devices or as a backup device for a conventional safety valve; if the pressure increases and the safety valve fails to operate (or can't relieve enough pressure fast enough), the rupture disc will burst. Rupture discs are very often used in combination with safety relief valves, isolating the valves from the process, thereby saving on valve maintenance and creating a leak-tight pressure relief solution. The membrane is generally made up of metal. **Application:** It protects a pressure vessel, equipment or system from over -pressurization or potentially damaging vacuum conditions.	3 1	4
2-d	**Priming:** Removal of air from the suction line and pump casing and filling it with the liquid to be pumped is called priming. It is done by providing a non-return valve in the suction line so that suction line and pump casing will be filled with the liquid to be pumped when the pump is in shut down condition. If the non-return valve is not functioning,	4	4

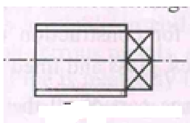
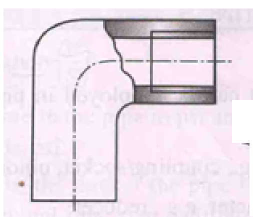
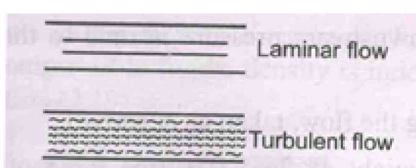
	priming has to be done from an external source.		
2-e	**Relation between friction factor and Reynold's number** **For laminar flow :** $f = \frac{16}{NRe}$ **for turbulent flow:** $f = 0.078/(N_{Re})^{0.25}$ or $1/\sqrt{f} = 4\log(N_{Re}\sqrt{f}) - 0.4$	2 2	4
2-f	**Diagram of rotameter** 	4	4
3	**Attempt any FOUR of the following**		16
3-a	Derivation for pressure drop using a well type manometer  A shallow reservoir having large cross sectional area as compared to the area		4

	of the tube is connected to one limb of the manometer. For any change in pressure, the change in liquid level in the reservoir will be so small that it may be neglected and the pressure is indicated by the height of liquid in the other limb. When pressure P is applied on the left limb, the level of heavy liquid in the reservoir falls below the zero line. As the area of the reservoir is very large, the fall of heavy liquid will be very small which can be neglected. This downward movement of the heavy liquid in the reservoir will cause a considerable rise of heavy liquid in the right limb. Pressure in the left limb above the zero line is $P + h1\rho g$ Pressure in the right limb above the zero line is $h\rho_m g$ $P + h1\rho g = h\rho_m g$ $P = h\rho mg - h1\rho g$	2 2	
3-b	**Uses of valves :** 1) Valves are used to control the flow. 2) Used for on-off service 3) Used when unidirectional flow is required Eg of valves 1. Gate valve 2. Globe valve 3. Ball valve 4. Plug valve 5. Diaphragm valve 6. Needle valve. 7. Non return valve	1/2 mark each for any 2 points 1/2 mark for any six	4
3-c	**Classification of pumps :**		4

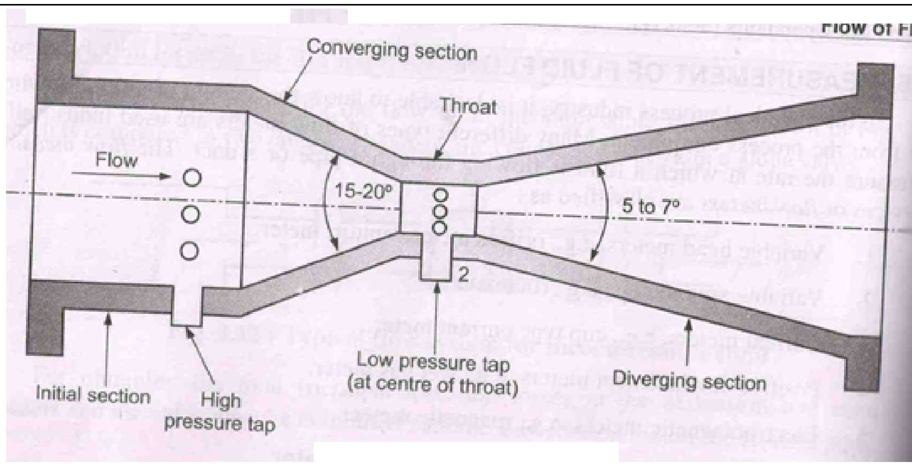
	Pumps Positive displacement pump non positive special pump Reciprocating rotary centrifugal Regenerative Single acting gear Double acting lobe Duplex screw Triplex diaphragm	01 01 01 01	
3-d	**Diagram of steam jet ejector**  	4	4
3-e	**Newton's law of viscosity :** **Statement**		4

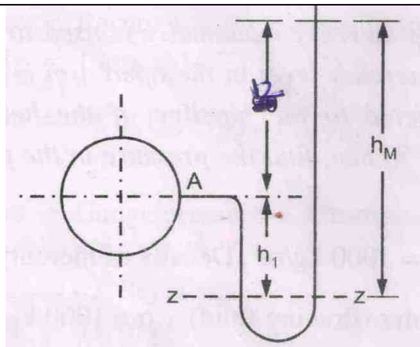
	It states that the shear stress on a layer of fluid is directly proportional to the rate of shear.	1	
	Derivation:		
			
	Consider two layer of fluid 'y' cm apart as shown in fig. let the area of each of these layer be A cm^2. Assume that top layer is moving parallel to the bottom layer at a velocity u cm/s relative to the bottom layer. To maintain this motion i.e. the velocity 'u' and to overcome the fluid friction between these layers, for any actual fluid, a force of 'F' dyne is required.		
	Experimentally it has been found that the force F is directly proportional to the velocity u and area A and inversely proportional to the distance y.		
	Therefore , mathematically it becomes		
	$F \propto u.A/y$		
	Introducing a proportionality constant μ ,		
	$F = \mu u A/y$		
	$F/A = \mu u/y$		
	Shear stress ,τ equal to F/A between any two layers of fluid may be expressed as	3	
	$\tau = F/A = \mu .u/y$		
	The above equation in a differential form becomes		

	$\tau = \mu.\frac{du}{dy}$ ……eq^n Newton's law of viscosity.		
3-f	**Characteristic curves of a centrifugal pump :**  The H-Q curve shows the relationship between head and capacity rate .it is clear from the curve that the head decreases continuously as the discharge rate is increased. The optimum conditions for operation are those at which the ordinate through the point of maximum efficiency cuts the head curve. The point A is called as duty point. The head corresponding to zero or no discharge is known as the shut off head of the pump. From H-Q curve, it is possible to determine whether the pump will handle the necessary quantity of liquid against a desired head or not and the effect of increase or decrease of head. The PB- Q curve gives us an idea regarding the size of motor required to operate the pump at the required conditions and whether or not motor will be overloaded under any other operating conditions. The η-Q curve shows the relationship between pump efficiency and capacity. It is clear from η-Q curve that efficiency rises rapidly with discharge at low discharge rate, reaches a maximum in the region of the rated capacity and then falls.	2 2	4
4	**Attempt any FOUR of the following**		16

4-a	**Plug :**  **Application:** termination of pipe line. **Bend :**  **Application:** changing direction of flow.	1 1 1 1	4
4-b	**Types of flow :** 1) laminar flow : the flow in which the streamlines remain distinct/separated from one another over their entire length of flow is known as laminar flow. NRe< 2100 2) Turbulent flow : the flow in which the fluid instead of flowing in an orderly manner, moves erratically in the form of cross currents and eddies is called turbulent flow. NRe > 4000  2100 < NRe<4000, flow is tansition	1.5 1.5 1	4
4-c	**Specific application** **Fans :**		4

	Fans are used for moving gases when the pressure heads of less than 30 kpa are involved. Fans are employed industrially for ventilation works, supplying air to dryers , supplying draft to boilers , removal of fumes . **Blowers :** Blowers are used for supplying air to furnaces. For cooling and drying purposes, for transporting materials, for ventilation. **Compressors :** Compressors are widely used in petroleum refineries and chemical plants.	2 1 1	
4-d	**Venturimeter :** **Construction** A Venturimeter consist of an inlet section followed by a convergent section. The inlet section of the venture meter is of the same diameter as that of the pipe line in which it is installed which is followed by the short convergent section with a converging cone angle of 15-20° and length parallel to axis is approximately equal to 2.7 (D-DT) where, D is diameter of pipe and DT is the throat diameter. In converging section the fluid is accelerated. A cylindrical throat the section of constant cross section with its length equal to diameter the flow area is minimum at the throat .A long diverging section gradual divergent cone with a cone angle of about 5-7° wherein the fluid is retarded and a large portion of kinetic energy is converted back into the pressure energy. **Diagram**	2	4

		2	
4-e	L= 300m D =150mm = 0.15m Density ρ =1000 kg/m^3 Viscosity $\mu = 10^{-3}$ N-S/m^2 Volumetric flow rate Q = 0.05m^3 / S Area A= $\frac{\pi D^2}{4} = \frac{3.14*0.15^2}{4}$ = 0.0177m^2 Velocity V = $\frac{Q}{A}$ = 0.05 / 0.0177 = 2.825 m / S NRe = $\frac{DV\rho}{\mu}$ = 0.15 *2.825*1000 / 10^{-3} = 423750 Since NRe > 4000, flow is turbulent f =0.078 / NRe$^{0.25}$ = 0.078 / 423750$^{0.25}$ = 3.057 *10^{-3} h_{fs} = 4flV^2 / 2D = 4*3.057 *10^{-3} *300* 2.825^2 / (2*0.15) = 97.58 N /m^2 ΔP = h_{fs} *ρ = 97.58*1000 = 97580 Pa = **97.58 KPa**	1 1 1 1	4
4-f			4

	 Specific gravity = 0.9 Density of flowing fluid ρ = 0.9* 1000 = 900 kg/m3 Density of manometric fluid = ρm =13600kg/m3 hm= height of manometric fluid above the datum line z-z = 20 cm h 1 = height of liq. Above datum plane = 12 cm = 12 *10^{-2}m hm - h 1 = 20 – 12 = 8 cm = 8*10^{-2}m Pressure of oil in the pipeline or guage pressure at A is P_A = hmρmg –(hm - h 1)ρg = 20*10^{-2}*13600*9.81-8*10^{-2}*900*9.8 = [0.2*13600-0.08*900]*9.8 = 25950.4 N/m^2 = 25.950KN/m^2	2 2	
5	**Attempt any two of the following**		16
5a	**Derivation of Hagen Poiseuille's Equation :**		8

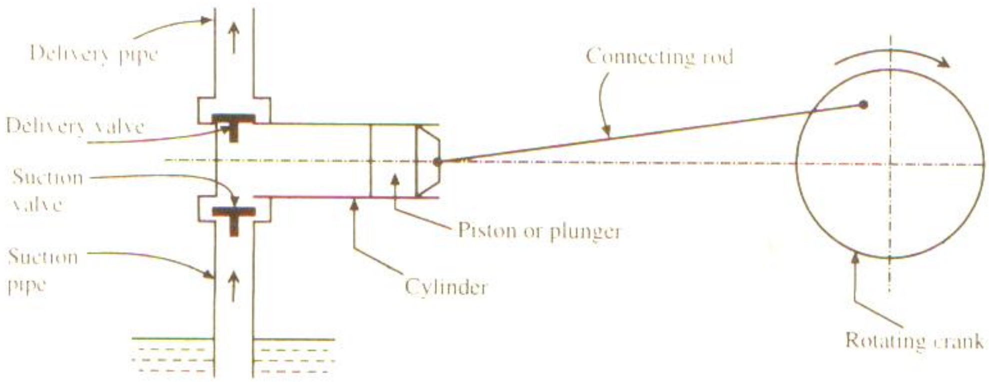
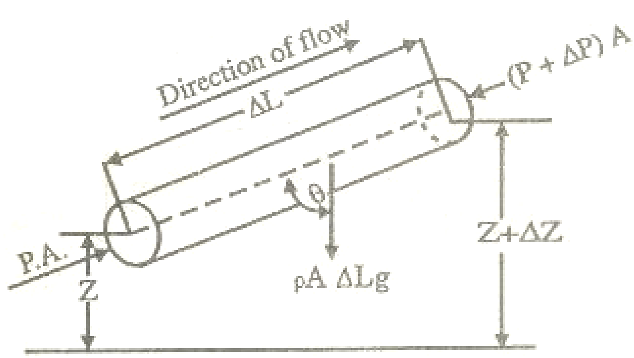
	As per Newton's law of viscosity ,viscosity is shear stress required to produce unit rate of shear deformation. $$\mu = -\frac{\tau}{\frac{du}{dr}} \qquad eq.1$$ The negative sign in the above equation is due to the fact that in a pipe velocity decreases with increase in radius. Rearranging the eq.1 $$\frac{du}{dr} = -\frac{\tau}{\mu} \qquad eq.2$$ As the linear relation between shear stress (τ) and radius (r) is $$\frac{\tau_w}{r_w} = \frac{\tau}{r}$$ Therefore $\tau = \frac{\tau_w}{r_w}.r \qquad eq.3$	2	
	Substituting value of τ $from\ eq.3\ in\ eq.2$, $$\frac{du}{dr} = \frac{\tau_w}{r_{w.}\mu}.r$$ $$du = \frac{\tau_w}{r_w.\mu}.r.dr \qquad eq.4$$ Integrating eq.4 with the boundary condition ,at r = $r_{w.}$: u = 0 we get $$\int_0^u d_u = -\frac{\tau_w}{r_w.\mu}\int_{r_w}^r r.dr$$ $$u = -\frac{\tau_w}{r_w.\mu}\left[\frac{r^2}{2}\right]_{r_w}^r$$ $$u = \frac{\tau_w}{2.r_w.\mu}[r_w^2 - r^2] \qquad eq.5$$ At the center of the pipe :r = 0 $.u = u_{max.}$ $$u_{max.} = \frac{\tau_w r_w}{2.\mu} \qquad eq.6$$	2	

	Substituting the value of shear stress as $\tau_w = \frac{\Delta P . r_w}{2 \Delta L}$ in eq.6 $$u_{max.} = \frac{\Delta P . r_w^2}{4 . \mu . \Delta L}$$ As D = r_w /2 $$u_{max.} = \frac{\Delta P . D^2}{16 . \mu . \Delta L}$$ From equations 5 and 6, $$u = u_{max.} \left[1 - \left(\frac{r}{r_w} \right)^2 \right]$$ The average velocity u f the entire stream flowing through any given cross-section (A) is defined as $u = \frac{1}{A} \int u . dA$ eq.7 As A = π r_w^2, dA = 2 πr.dr = area of elementary ring of radius r and width dr.Putting values of A,u and dA in eq.7 ,we get $$u = \frac{\tau}{r_w^3 . \mu} \int_0^{r_w} (r_w^2 - r^2) . rdr$$ $$u = \frac{\tau_w r_w}{4 \mu} \qquad eq.8$$ Therefore $\frac{u}{u_{max.}}$ = 0.5 Eliminating τ_w by replacing it by ΔP ,using $\tau_w = \frac{\Delta P . r_w}{2 \Delta L}$ and replacing r_w by by D/2 in eq ,we get $$u = \frac{\Delta P . D^2}{32 . \mu . \Delta L} \qquad eq.9$$	2	

	Above equation 9 can be rearranged as $$\Delta P = \frac{32\ \Delta L \mu u}{D^2}$$ ΔL *can be replaced as* L $$\Delta P = \frac{32\ L\ \mu\ u}{D^2} \qquad eq.10$$ Eq.9 is called as Hagen Poiseuille Equation which is used for determination of viscosity of a fluid by measuring the pressure drop and the volumetric flow rate of a tube of a given length and diameter. The equation is also useful in calculating the pressure drop due to friction in laminar flow if the viscosity is known.	2	
5-b	Data D1 = 30 cm = 0.3 m Area of pipe 1 = $A_1 = \pi/4\ D_1^2 = \pi/4*(0.3)^2 = 0.0706\ m^2$ D2 = 20 cm = 0.2 m Area of pipe 2 = $A_2 = \pi/4\ D_2^2 = \pi/4*(0.2)^2 = 0.0314\ m^2$ D3 = 15 cm = 0.15m Area of pipe 3 = $A_3 = \pi/4\ D_3^2 = \pi/4*(0.15)^2 = 0.0176\ m^2$ Volumetric flow rate of water in a pipe1(dia.30 cm) = $Q_1 = u_1A_1$ Q_1 = 2.5 * 0.0706 = **0.1765 m^3/s** Volumetric flow rate of water in a pipe2(dia.20 cm) = $Q_2 = u_2A_2$ = 2 * 0.0314 = 0.0628 m^3/s From continuity equation mass flow into the system = mass flow from the system mass flow in pipe 1 = mass flow in pipe2 + mass flow pipe flow in pipe 3 $$\dot{m}_1 = \dot{m}_2 + \dot{m}_3$$ $$\rho_1.u_1.A_1 = \rho_2.u_2.A_2 + \rho_3.u_3.A_3$$ But $\rho_1 = \rho_2 = \rho_3$	2 2 2	8

	$0.1765 = 0.0628 + 0.0176U_3$ $u_3 = 0.1137/ 0.0176 =$ **6.46 m/s**	2	
5-c	Diameter of orifice: d_0 = 15 mm = 0.015 m Diameter of pipe: D= 78 mm = 0.078 m Density of water = 1000 kg/m^3 Density of mercury = 13000 kg/m^3 Volumetric flow rate Q = 719cm^3 /S = 719 x $10^{-6}m^3$ / S Area of orifice = $A_o = \pi/4\ d_0^2 = \pi/4\ (0.015)^2 = 1.767 \times 10^{-4} m^2$ β= Diameter of throat / Diameter of pipe = 15/78= 0.1923 Manometer reading = Δh = 18 cm= 0.18 m of mercury Let's find out the value of pressure drop in terms of process fluid(water)= ΔH $$\Delta H = \Delta h \left[\frac{\rho_{Hg-}\rho_{H_2O}}{\rho_{H_2O}}\right]$$ $$\Delta H = 0.18 \left[\frac{13600 - 1000}{1000}\right]$$ $\Delta H = 2.268$ m of water (i) The flow equation of orificemeter $$Q = \frac{C_o A_o}{(1-\beta^4)} \cdot \sqrt{2g\Delta H}$$ $$719 \times 10 - 6 = \frac{Cox1.767x10^{-4}}{(1 - 0.1923^4)} \cdot \sqrt{2x9.81x2.268}$$ C_o = **0.61** (ii) Pressure drop is reduced to 9cm of Hg. Δh = 9 cm= 0.9 m of mercury	1 1 1 2	8

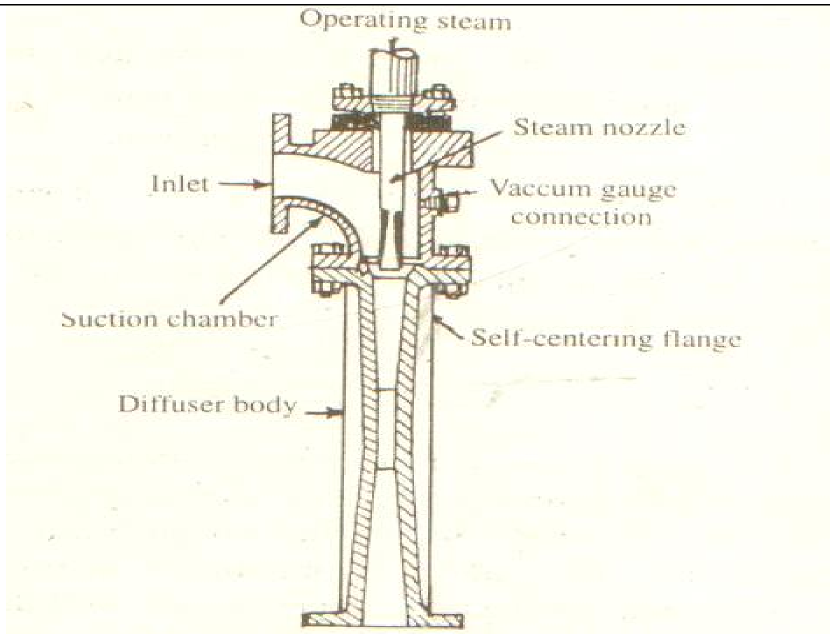
	$$\Delta H = \Delta h\left[\frac{\rho_{Hg-}\rho_{H_2O}}{\rho_{H_2O}}\right]$$ $$\Delta H = 0.09\left[\frac{13600-1000}{1000}\right]$$ $\Delta H = 1.134m$ m of water	1	
	$$Q = \frac{C_o A_o}{(1-\beta^4)}\cdot\sqrt{2g\Delta H}$$ Q = $\frac{0.61x1.767x10^{-4}}{(1-0.1923^4)}.\sqrt{2x9.81x.134}$ = **5.08 x 10^{-4} m^3 / S**	2	
6	**Attempt any two of the following**		16
6-a	**Single acting reciprocating Pump** Construction : Reciprocating pump consists of a piston or plunger which reciprocates in stationary cylinder. The cylinder is connected to suction and delivery pipes. Each of these pipes are provided with a non-return valve called as a suction & delivery valve respectively .The non-return valve permits unidirectional flow. The suction valve permits the liquid to enter into pipe only while the delivery valve allows the discharge of liquid from the cylinder. A piston or plunger is connected to a crank by means of a connecting rod. The crank is rotated by a driving engine or electric motor. When crank is rotated by the drive, the piston or plunger moves to and fro in the cylinder. Air vessels are provided at the discharge end to even out the discharge of liquid. Air vessels also reduce the frictional losses in pump. In case of single acting reciprocating pump, the liquid is in contact of with only one side of a piston or a plunger. Diagram	4	8

		4	
6-b	**Derivation of Bernoulli's equation:** Statement:" For steady, irrotational flow of an incompressible fluid ,the sum of pressure energy, kinetic energy & potential energy at any point is constant". Bernoulli theorem is derived on the basis of Newton's Second law of motion.(Force = Rate of change of momentum.)  Force balance for potential flow Let us consider an element of length ΔL of a stream tube of constant c/s area as shown above.		8

	Let us assume that cross-sectional area of element be A & the density of the fluid be ρ. Let u & P be the velocity & pressure at the entrance & $(u + \Delta u)$,$(P + \Delta P)$ are the corresponding quantities at the exit. The forces acting on the element are 1) The force from upstream pressure = P.A (acting in the direction of flow) 2) The force from downstream pressure normal to the cross-section of the tube = $(P + \Delta P).A$(in opposite direction of flow) 3) The force from the weight of fluid (gravitational force acting downward) = $\rho.A.\Delta L.g$ The component of this force acting opposite to direction of flow = $\rho.A.\Delta L.g\cos\theta$ The rate of change of momentum of the fluid along the fluid element = $\dot{m}\,[u + \Delta u - u] = \dot{m}\Delta u$ As mass flow rate= $\dot{m} = \rho.\ uA\ .\ \Delta u$	2	
	According to Newton's Second law of motion {sum of forces acting in the direction of flow} = {rate of change of momentum of a fluid} $P.A - (P + \Delta P).A - \rho.A.\Delta L.g\cos\theta = \rho.\ uA\ .\ \Delta u$ $-\Delta P.A - \rho.A.\Delta L.g\cos\theta = \rho.\ uA\ .\ \Delta u$ $\Delta P.A + \rho.A.\Delta L.g\cos\theta + \rho.\ uA\ .\ \Delta u = 0$ Eq.I Dividing each term of eq.I by $A.\Delta L.\ \rho$ we get —— —— $\cos\theta =$ — ,we can write	2	

	$\frac{1}{\rho}\frac{\Delta P}{\Delta L} + g\frac{\Delta Z}{\Delta L} + u\frac{\Delta u}{\Delta L} = 0$ $\qquad Eq.II$ If we express the changes in the pressure, velocity , height etc. in the differential form ,eq .II becomes $\frac{1}{\rho}\frac{dP}{dL} + g\frac{dZ}{dL} + \frac{d\left(\frac{u^2}{2}\right)}{dL}$ Which can be written as $\frac{dP}{\rho} + g\,.dZ + d\left(\frac{u^2}{2}\right) = 0$ $\qquad Eq.III$ Eq.III is called as Bernoulli Equation. It is differential form of the Bernoulli Equation. For incompressible fluid, density is independent of pressure & hence ,the integrated form of eq.III is $\frac{P}{\rho} + gZ + \frac{u^2}{2} = constant$ The Bernoulli Equation relates the pressure at a point in the fluid to its position & velocity. **Explanation of the terms.** $\frac{P}{\rho}$ is the pressure energy. gZ is the potential energy. $\frac{u^2}{2}$ is the kinetic energy.	2 2	
6-c	**Vacuum pump:** A vacuum pump is any compressor which takes the suction at a pressure below the atmospheric and discharges at atmospheric pressure. Example of vacuum pump: Steam Jet Ejector **Construction and working:** An ejector is a pumping device. It has no moving parts. Instead, it uses a fluid		8

	or gas as a motive force. Very often, the motive fluid is steam and the device is called a "steam jet ejector." Basic ejector components are the steam chest, nozzle, suction, throat, diffuser and they discharge. An ejector has two inlets: one to admit the motive fluid, usually steam (inlet 1), and the other to admit the gas/vapor mixture to be evacuated or pumped (inlet 2). Motive steam, at high pressure and low velocity, enters the inlet 1 and exits the steam nozzle at design suction pressure and supersonic velocity, entraining the vapor to be evacuated into the suction chamber through inlet 2. The nozzle throat diameter controls the amount of steam to pass through the nozzle at a given pressure and temperature. The entrained gas/vapor flow and the motive fluid (steam) flow mix while they move through the converging section of the diffuser, increasing pressure and reducing velocity. The velocity of this mixture is supersonic and the decreasing cross sectional area creates an overall increase in pressure and a decrease in velocity. The steam slows down and the inlet gas stream picks up speed and, at some point in the throat of the diffuser, their combined flow reaches the exact speed of sound. A stationary, sonic-speed shock wave forms there and produces a sharp rise in absolute pressure. Then, in the diverging section of the diffuser, the velocity of the mixture is sub-sonic and the increasing cross sectional area increases the pressure but further decreases the velocity. **Diagram**	5	

	 Operating steam Steam nozzle Inlet Vaccum gauge connection Suction chamber Self-centering flange Diffuser body	3	