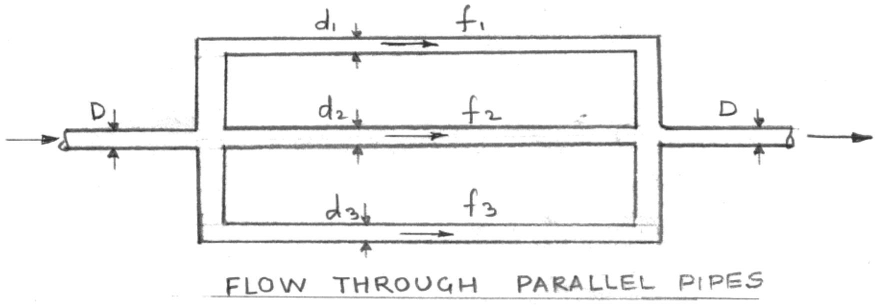
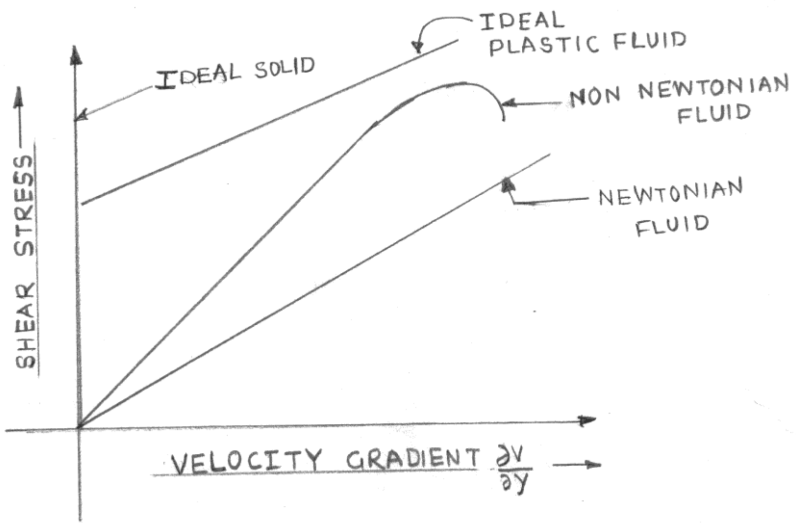
Subject: - Hydraulics **Subject Code: - 17421**

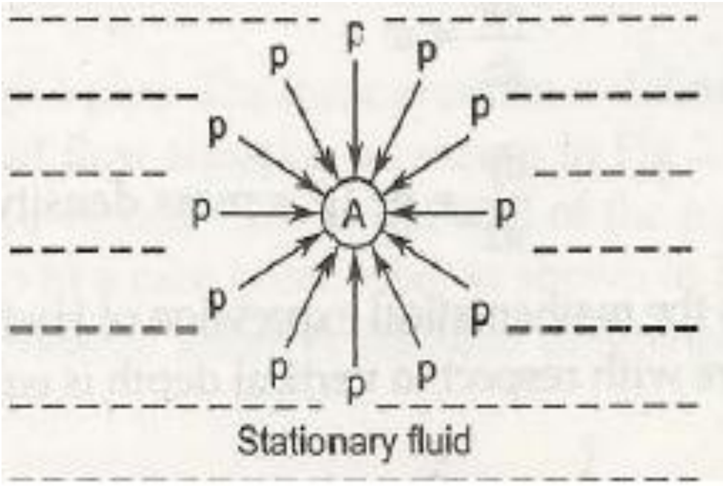
Important Instructions to examiners:

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 the candidate and those in the 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 the model answer.
6) In case of some questions credit may be given by judgment 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.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1.	**a)**	**Attempt any SIX of the following:**		**(12)**
	(i)	**Define capillarity.**		
	Ans.	It is defined as the phenomena of rise or fall of liquid surface in small tube relative to the adjacent general level of liquid when the tube is held vertically in the liquid.	**2**	**2**
	(ii)	**If 5 m^3 certain oil weight 40 kN. Calculate specific weight, mass density.**		
	Ans.	V=5m^3 W=40kN $\gamma = ?$ $\rho = ?$ Specific weight $\gamma_L = \frac{W}{V} = \frac{40}{5}$	**1**	
		=8 k N/m^3 = 8000N/m^3		**2**
		Mass density $\gamma_L = \rho_L \times g$ $\rho_L = \frac{\gamma_L}{g} = \frac{8000}{9.81} = 815.49 N/m^3$	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1.	**(iii)**	**What is the principle of manometer?**		
	Ans.	Manometer measure the pressure at a point in fluid by balancing the column of fluid by same or another column of fluid.	**02**	**02**
	(iv)	**Express a pressure intensity of 5 Kg (f)/cm^2 in meters of head of water and mercury.**		
	Ans.	P= 5 kgf/cm^2		
		1 kgf = 9.81 N		
		P=49.05 N/cm^2 P= 49.05 x 10^4 N/m^2		
		Head of water, $P = \gamma_w . h_w$ $49.05 \times 10^4 = 1 \times 9810 \times h_w$ $h_w = 50m$ of water	**01**	
		Head of mercury , $P = \gamma_w . h_w$ $49.05 \times 10^4 = 1 \times 9810 \times h_m$ $h_m = 3.67m$ of mercury	**01**	**02**
	(v)	**What is Moody's diagram? State its use.**		
	Ans.	**Moody's diagram.:-** it is the graphical representation of Friction factor verses Reynold's number (R_e) Curves for various values of relative roughness (R/K)	**01**	**02**
		Uses:- Moody's chart is used to find friction factor of a Commercial pipe.	**01**	
	(vi)	**Draw a neat sketch showing the flow through parallel pipes**		
	Ans.		**02**	**02**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1.	**(vii)**	**State the principle of venturimeter.**		
	Ans.	**Principle of venturimeter** : - It is based on Bernoulli's equation that is the velocity increases in an accelerated flow by reducing the cross section area of the flow passage.	**02**	**02**
	(viii)	**What is venna-contracta?**		
	Ans.	It is the section of jet of liquid in flow though orifice at which the cross sectional area is minimize and stream line are straight and parallel to each other	**02**	**02**
	b)	**Attempt any <u>TWO</u> of the following:**		**(08)**
	(i)	**Draw a neat sketch showing various types of fluids according to newton's low of viscosity.**		
	Ans.	 Fig. Type of fluid	**04**	**04**
	(ii)	**If 5mm dia. glass tube is immersed in water and contact angle is 5^0 find capillary rise take surface tension for water as 0.074 N/m.**		
	Ans.	d = 5mm= 5 x 10^{-3}		
		$\alpha = 5^0$ $\sigma = 0.074 N/m$	01	
		$\gamma_L = 9810 N/m^3$ $h = \frac{4\sigma\cos\alpha}{\gamma_L d}$	01	
		$h = \frac{4\times0.074\times\cos5^0}{9810\times5\times10^{-3}}$ $h = 6.01\times10^{-3} m$	01	**04**
		h= 0.60 cm	01	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	(iii)	**State Pascal's Law of fluid pressure. Enlist any four application of it.**		
	Ans.	Pascal's Law:- It states that the pressure intensity or pressure at a point in a static fluid is equal in all directions. 	**02**	**04**
		Applications of Pascal law:- It is applied in the construction of machines used for multiplying forces e.g. I. Hydraulic Jacks, II. Hydraulic Press, III. Hydraulic Lifts, IV. Hydraulic Crane V. Braking system of motor VI. Artesian well VII. Dam	**½ Marks each (Any four)**	
2.		**Attempt any FOUR of the following:**		**(16)**
	a)	**A rectangular plate is 2m wide and 3m deep. It lies in vertical plane in water. Find total pressure and position of C.P. on the plate when its upper edge is horizontal and** **i) Coincides with water and** **ii) 2.5 m below free water surface**		
	Ans.	**Case-1) Upper edge coincide water Surface** b = 2m , d = 3m A =2x3 = $6m^2$		

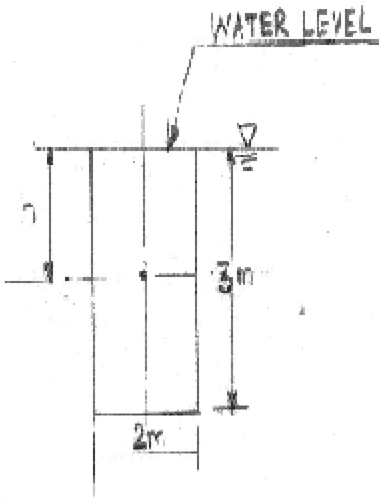
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.				

$p=\gamma_l A\bar{h}$

$p=9810\times 6\times\frac{3}{2}$

$p=88290N$

$\boxed{P=88.29\ \text{kN}}$ — **01**



$\bar{h}=\frac{I_G\times\sin^2\theta}{A\bar{Y}}+\bar{Y}$

$I_{xx}=\frac{2\times 3^3}{12}=4.5m^3$ — **01**

$\bar{h}=\frac{4.5\times 1}{6\times 1.5}+1.5$

$\boxed{\bar{h}=2m}$

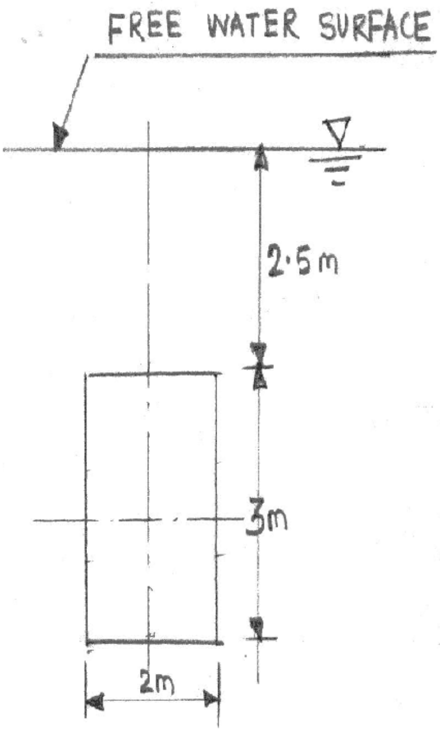
CASE-II) Upper Edge is 2.5 m below free water surface — Total Marks: **04**

$p=\gamma_l A\bar{h}$

$p=9810\times 6\times\left(2.5+\frac{3}{2}\right)$

$p=235440N$

$\boxed{P=235.44\ \text{kN}}$ — **01**



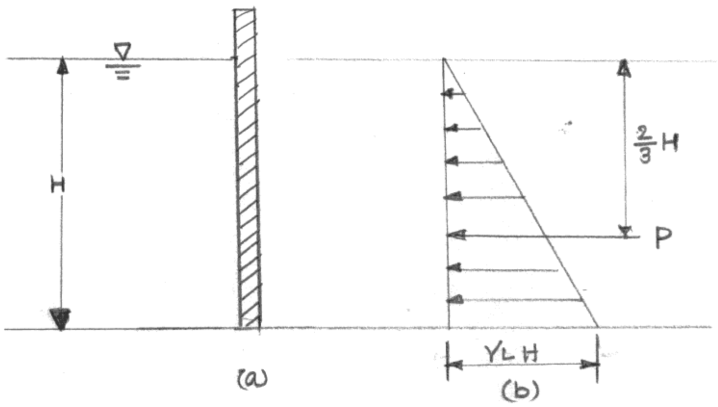
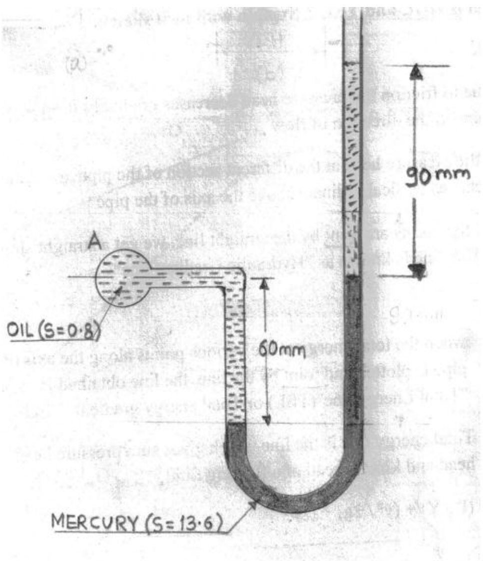
$\bar{Y}=2.5+3/2$

$\bar{Y}=4m$

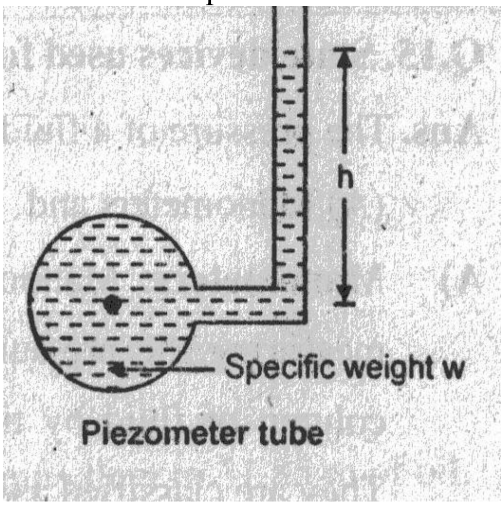
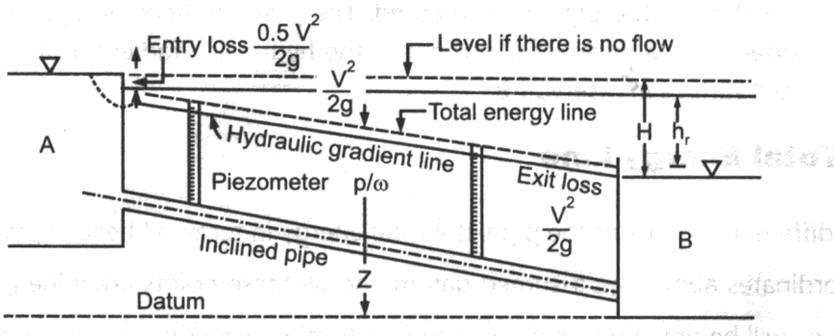
$\bar{h}=\frac{4.5\times 1}{6\times 4}+4$

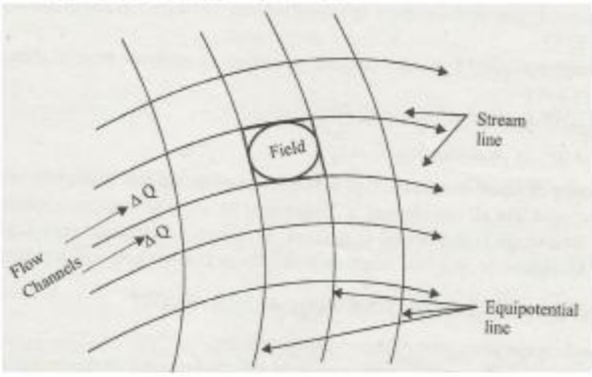
$\boxed{\bar{h}=4.18m}$ — **01**

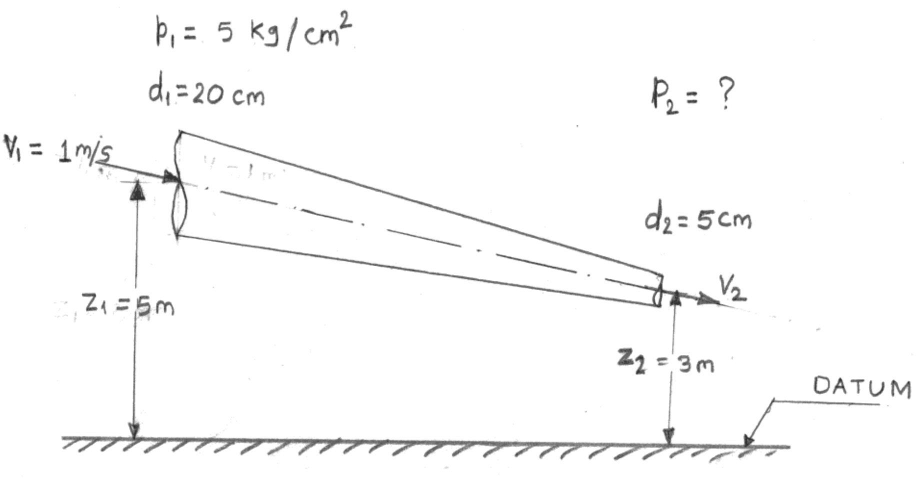
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**b)**	**A Triangular plate having 1m base and 1.8 m altitude is immersed in water. The plane of plate is inclined at 30^0 with free surface of water and base is parallel to and at depth of 2 m from water surface. Find pressure acting on the plate and its center of pressure.**		
	Ans.	**Case: -i)** Apex upward		
		A = 1/2×1×1.8 = 0.9 m^2	01	
		$\bar{y} = 0.6+1.1=1.7m$		
		$\bar{h} = \frac{bh^3/36\times\sin^2(30)}{A\times\bar{y}} + \bar{y}$	01	
		$\bar{h} = 1.726$ m	01	04
		$P = \gamma_L A\bar{Y}$ $=9810\times0.9\times1.7$ $P = 15009.3N$ $P = 15kN$	01	
		OR		
		Case:- ii Apex downward		
		$A = \frac{1}{2}\times b\times h = \frac{1}{2}\times1\times1.8 = 0.9m^2$	01	
		$\bar{Y} = 2+\left(\frac{1}{3}h\right)\times\sin30^0 = 2+\left(\frac{1}{3}\times1.8\right)\times\frac{1}{2} = 2.3m$		
		To calculate total pressure(P)		
		$P=\gamma_1\times A\times\bar{Y} = 9.81\times0.9\times2.3 = 20.31$ k N	01	04
		To calculate center of pressure ($\bar{h}$)		
		$I_G = \frac{bh^3}{36} = \frac{1\times1.8^3}{36} = 0.162m^3$	01	
		$\bar{h} = \frac{I_G\sin^2\theta}{A\bar{Y}} + \bar{Y} = \frac{0.162\times\sin^2 30}{0.9\times2.3} + 2.3$	01	
		$\bar{h} = 2.32m$ *From free water surface*		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**c)**	**Explain the concept and use of pressure diagram with neat sketches**		
	Ans.	Concept: - Consider a wall subjected to water pressure as shown in fig. (a), pressure at base is (γh) and at the water surface its zero. Hence the pressure diagram is a triangle.	**01**	
		The total pressure on the wall = Area of triangle $P = \frac{1}{2} \times (\gamma_L H) H$	**01**	
			**01**	**04**
		Use:- 1) To calculate pressure by liquid on the side of surface. 2) To Calculate of pressure of liquid on both side of the surface.	**01**	
	d)	**An oil of specific gravity = 0.8 is flowing through a pipe. A simple manometer is connected to the pipe containing mercury. The deflection of mercury level in left limb from center of pipe = 60mm where as in right limb (from center of pipe) it is 90mm. Calculate pressure in kPa.**		
	Ans.			
		$h_1 = 60mm = 0.06m$, $h_2 = 90+60 = 150mm$ $S_1 = 0.80$ $S_2 = 13.6$	**01**	
		$h_A + s_1 h_1 = s_2 h_2$	**01**	
		$h_A + 0.8 \times 0.06 = 13.6 \times 0.15$ $\therefore h_A = 1.99m$ of water	**01**	**04**
		$P_A = \gamma_w \times h_A = 9.81 \times 1.99 = 19.54 KN/m^2$ $P_A = 19.54$ kPa	**01**	

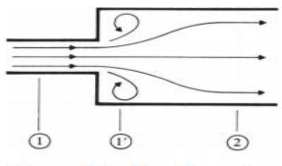
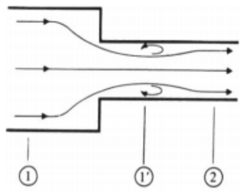
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**e)**	**State the Bernoulli's theorem. State any two application of it.**		
	Ans.	Statement - It states that in an incompressible frictionless fluid, when the flow is steady and continuous the energy of each particle of the fluid is the same. **OR** Statement - It states that in an incompressible fluid, when the flow is steady and continuous the sum of pressure energy, kinetic energy and potential energy (or datum) energy along a stream line.	**02**	
		Mathematically, $\frac{P}{\gamma}+\frac{V^2}{2g}+z=Cons\tan t$ Where, $\frac{P}{\gamma}=\text{Pressure energy}$ $\frac{V^2}{2g}=\text{Kinetic energy}$ $z=\text{Datum}$		**04**
		Application :- 1) To find the total energy at any section. 2) To find the head loss in the system. 3) To find the pressure difference at any given two points. 4) Practical applications to the following measuring devices a) Venturimeter b)Orifice meter, c) Pitot tube	**02** **(1 Mark each)**	
	f)	**Define -** **i.) Pressure head.** **ii.) Velocity head with neat sketches.**		
	Ans.	**i. Pressure head-** it is the head possessed by fluid due to having some pressure force by the flowing fluid**.** $h=\frac{P}{\gamma}$	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.		Where in fig. " **h**" indicate as pressure head 	**01**	**04**
		Velocity head- It is the head possessed by fluid due to having some velocity of the flow.	**01**	
		Velocity Head = $\frac{V^2}{2g}$ 	**01**	
3.		**Attempt any <u>FOUR</u> of the following:**		**(16)**
	a)	**What are streamlines and equipotential lines? State any two uses of flow net.**		
	Ans.	**Stream Line:** A stream line is defined as a continuous line in a fluid which shows the direction of velocity of fluid at each point along line.	**01**	
		Equipotential lines: It is an imaginary line in a fluid flow helping to better understand the flow. These are the lines running orthogonally (perpendicular) to the stream lines.	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.		 **Fig. Flow Net**		04
		Uses of flow net - 1) To check the problems of flow under hydrostatic structure like dams etc. 2) To determine of seepage pressure. 3) To find exit gradient. 4) A flow net analysis assists in the design of an efficient boundary shapes.	02 (1 mark each)	
	b)	**Water is flowing through tapering pipe who's Centre of upper end is 5 m above the datum and its diameter is 20 cm. The pressure at this upper end is 5 kg/ cm^2 .The lower end is situated 3 m above the datum with a diameter of 05 cm. Determine the pressure at lower end and if velocity at upper end is 1 m/s.**		
	Ans.	At the upper end :- d_1 = 20cm = 0.2m $a_1 = \pi (d_1^{2)}/4 = \pi\times(0.2)^2 /4 = 0.3141$ m^2 P_1 = 5 kg/cm^2 P_1 = 5 ×9.81 N/ cm^2 = 49.05 N/ cm^2 P_1 = 49.05/ 0.01^2 = 490.5 × 10^3 N/ m^2 V_1 = 1 m/s	01	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.		At the lower end :- $d_2 = 5cm = 0.05$ m $a_2 = \pi/4\ d_2^2$ $= \pi/4\ (0.05)^2$ $= 1.963 \times 10^{-3}\ m^2$		
		By Continuity equation : $a_1 v_1 = a_2 v_2$ $0.03141 \times 1 = 1.963 \times 10^{-3}\ v_2$ $V_2 = 16.00$ m/s	**01**	**04**
		By using Bernoulli's equation:-	**01**	
		$P_1/\gamma + v_1/2g + Z_1 = P_2/\gamma + v_2/2g + Z_2$ $(490.5 \times 10^{3)}/(9810) + (1)^2/(2 \times 9.81) + 5 = P_2/(9810) + (16)^2/(2 \times 9.81) + 3 + 0$ $P_2 / 9810 = 39.00 P_2 = 382.628 \times 10^3\ N/m^2 = 382.62\ kN/m^2$	**01**	
		 		
	c.	**Find head lost due to friction in pipe of ø = 300 mm and length = 50m through which water is flowing at a velocity = 3 m/m using** **1. Darcy's equation** **2. Chezys formula** **Take f = 0.0025 6 and C = 60**		
	Ans.	Given: - diameter of pipe , d = 300 mm = 0.3 m		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.		Length of pipe = 50m velocity of flow = 3 m/s f = 0.00256		
		i) Darcy equation :- If f is considered as friction factor.		
		$h_f = \dfrac{f\ L\ V^2}{2gd}$	**01**	
		$h_f = \dfrac{0.00256\times50\times3^2}{2\times9.81\times0.3}$		**04**
		$h_f = 0.1957\text{m}$	**01**	
		OR		
		i) Darcy equation: - If f is considered as coefficient.		
		$h_f = \dfrac{4f\ L\ V^2}{2gd}$	**01**	
		$h_f = \dfrac{4\times0.00256\times50\times3^2}{2\times9.81\times0.3}$		
		$h_f = 0.7828\text{m}$	**01**	
		ii) Chezy's formula		
		$C = 60,\ \text{m}=\dfrac{\text{d}}{4}=\dfrac{0.30}{4}=0.075m$		
		$V = C\sqrt{mi}$	**01**	
		$3=60\sqrt{0.075\times i}$		
		$\therefore\ \text{i} = 0.0333$		
		$\text{i} = \dfrac{h_f}{\text{L}}$		
		$\therefore\ h_f = \text{i}\times\text{L}$		
		$=0.0333\times50$		
		$=1.665\text{m}$	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	**d)**	**What is major and minor loss of head in flow through pipes? Write any two equations of minor loss.**		
	Ans.	**Major loss:** The major loss of head is caused due to friction when fluid flow through a pipe.	**01**	
		Minor loss: - The minor loss of head are caused due to change in velocity of flowing fluid either in magnitude or direction.	**01**	
		 $h_e = (V_1 - V_2)^2/2g$		**4**
		2. Loss of head due to sudden contraction -		
		 $h_c = 0.5\, V_2^2/2g$	**1 Mark each (any two)**	
		3. Loss of head at the entrance - $h_{entry} = 0.5\, V^2/2g$		
		4. Loss of head due to exit- $h_{exit} = V^2/2g$		
		5. Loss of head due to bend $H_L = KV_2^2/2g$		
		6. Loss of head due to gradual contraction and expansion $H_L = (V_1 - V_2)^2/2g$		
		7. Loss of head due to obstruction $h_L = ((A/c_c) \times a) - 1)^2 \times (V_2)^2/2g$		
		8. Loss of head due to top pipe fitting $h_L = (V_1 - V_2)^2/2g$		

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>3.</td><td>e)

Ans.</td><td>What is HGL and TEL? Explain with neat sketch.

1. HGL -
Due to friction the pressure head decreases gradually from section of the pipe in the direction of flow.
2. If the pressure head at the different section of the pipe are plotted to the scale as vertical ordinate above the axis of the pipe.
3. All the points are joint by the straight line, we get a straight sloping line. This line is known as "Hydraulic Gradient line"
TEL -
1) when the total energy at the various points along the axis of the pipe is plotted and joint by the line, the line obtained is called as "Total Energy line"(TEL) or Total energy gradient (TEG)

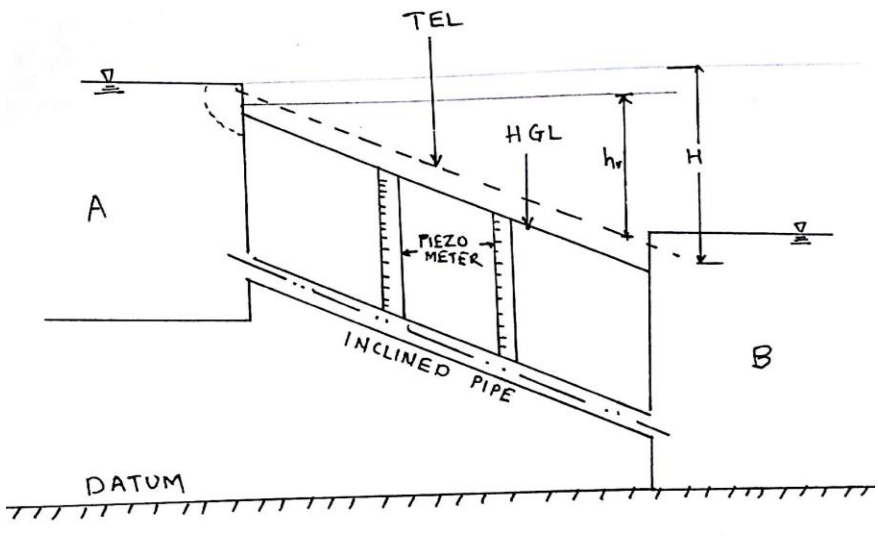
Total energy line is the line which gives sum pressure head, datum head and kinetic head of a flowing fluid
$$TEL = \frac{P}{\gamma} + \frac{V^2}{2g} + z$$


Fig. HGL and TEL</td><td>01

01

02</td><td>04</td></tr>
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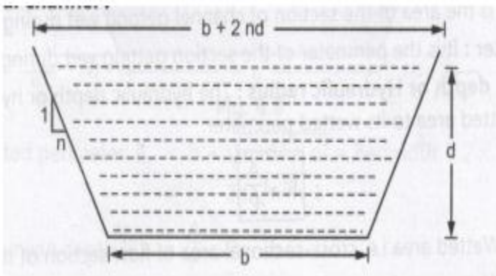
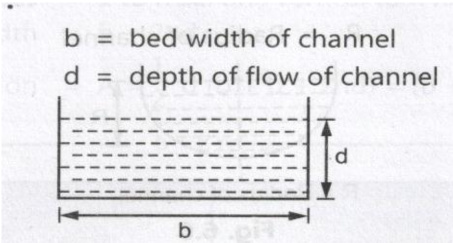
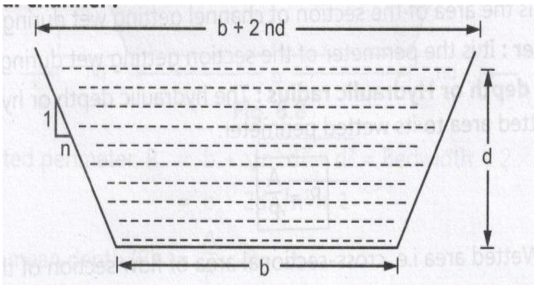
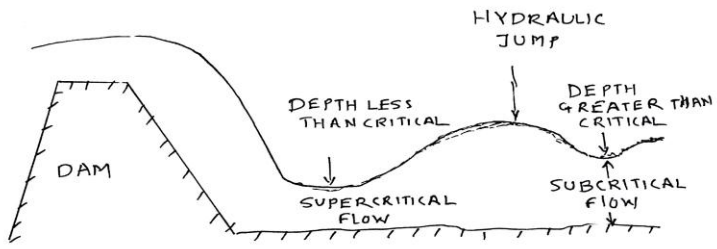
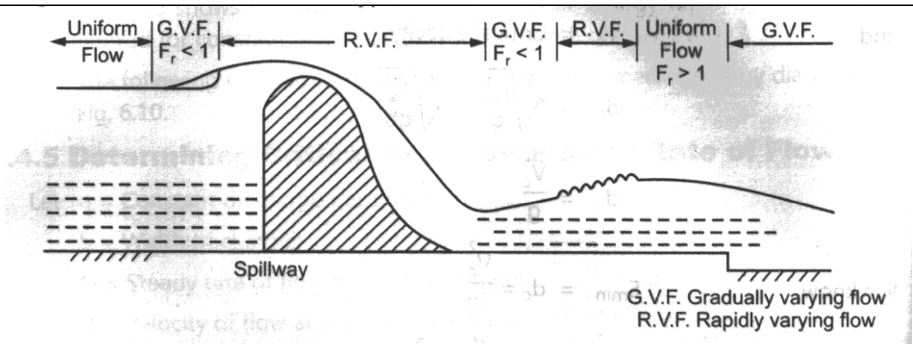
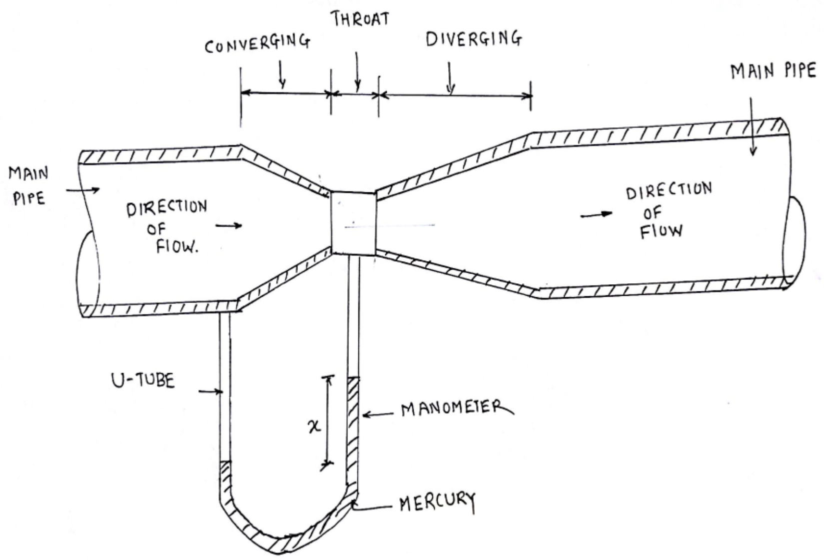
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	**f)**	**Define with a neat sketch for a trapezoidal channel-** **i) Hydraulic Depth ii) Hydraulic Radius**		
	Ans.	**i) Hydraulic Depth**: The depth of flow in a channel above bed surface is called as hydraulic depth (d).	**01**	
		ii) **Hydraulic Radius:** It is the ratio of the wetted area to wetted perimeter. It is also called as Hydraulic mean depth.	**01**	
		 Fig. Trapezoidal channel	**01**	**04**
		R= Wetted area / Wetted perimeter = A/P For Trapezoidal Channel. $A= bd + nd^2$ $P= b + 2d \sqrt{n^2+1}$ $R = A/P = (b+ nd)d/ (b + 2d \sqrt{n^2+1})$	**01**	
		Where, R = Hydraulic radius. B = width of the channel at bottom d= Hydraulic depth of the flow P = Wetted perimeter The side slope is given as 1 vertical to n horizontal		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.		**Attempt any <u>FOUR</u> of the following:**		**(16)**
	a)	**The daily record of rainfall over a catchment is 0.2 million cubic meter. Out of this 80 % rain water reaches the storage reservoir and passes over a rectangular weir. What should be its length if water level do not rise more than 400mm above the crest. Take Cd = 0.61**		
	Ans.	Given:- Daily rainfall over a catchment is 0.2 million cubic meter $=0.2 \times 10^6 m^3$		
		…. Daily discharge $Q_R = 0.2 \times 10^6/24 \times 60 \times 60$	**01**	
		$= 2.314 m^3/sec$		
		… Daily discharge reaches a reservoir over a rectangular weir $Q_1 = 80\% Q_R$ $Q_1 = 0.80 \times 2.314 = 1.85\ 12\ m^3/sec$	**01**	
		Head over rectangular weir h= 400mm = 0.4m		**04**
		$C_d=0.61$ For rectangular weir	**01**	
		$Q = 2/3\ C_d.L\sqrt{2g}\ \ h^{3/2}$		
		$1.8512 = 2/3 \times 0.61 \times L\sqrt{2 \times 9.81}\ (0.4)^{3/2}$		
		$1.8512 = 0.406\ L \times 4.429 \times 0.252$ $L = 1.8512/0.406 \times 4.429 \times 0.252$	**01**	
		$L = 4.085m$ Length of rectangular weir is 4.085m		
	b)	**What is meant by most economical channel section? Explain with an example and sketch.**		
	Ans.	**Most economical section:-** A channel section is said to be most economical when it gives maximum discharge for a given cross section area, bed slope and coefficient of resistance.	**02**	

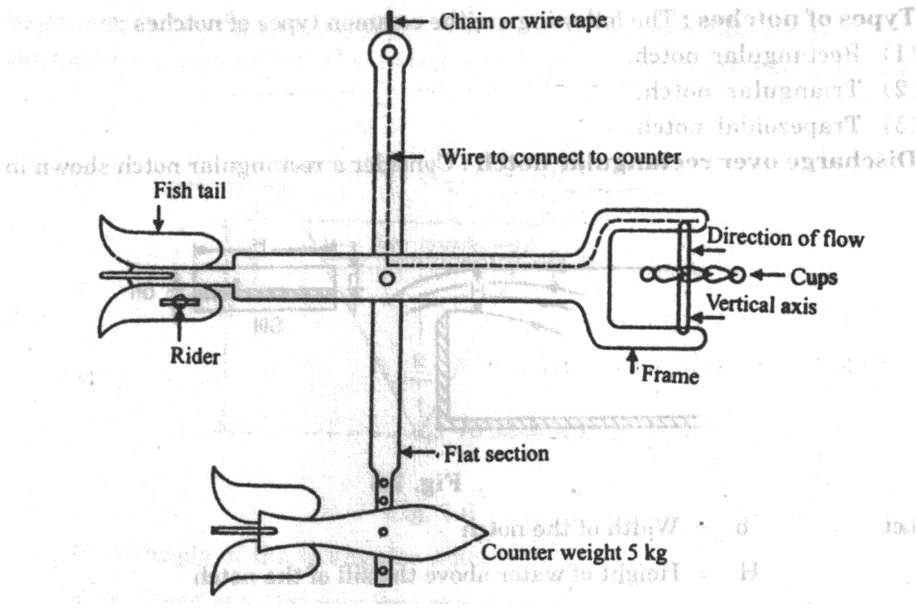
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.		**For rectangular section-** 	**01**	
		For rectangular section- b = 2d and R = d/2 For trapezoidal section- 	**01**	**04**
		Half of top width = sloping side $b+2nd / 2 = d\sqrt{1+n^2}$ And m or R = d/2 b = width at bottom of channel d = depth of flow 1: n = side slope m= hydraulic mean depth		
	c)	**Explain the phenomenon of hydraulics jump with a neat sketch. State any two uses of it.**		
	Ans.	1) It is the phenomenon occurring in an open channel when rapidly flowing stream abruptly change to slowly flowing stream causing a distance rise or jump in level of liquid surface 2) Hydraulic jump formed on a horizontal floor of canal and at the downstream side of spillway, at the downstream side of sluice gate, or at the downstream side of canal fall.	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.		 Q 4] c)- Fig - HYDRAULIC JUMP.	**02**	
		Uses of Hydraulic Jump: This phenomenon is used in hydraulic structures constructed for irrigation, water supply works such as: 1) Energy dissipation below the spillway of dam 2) Mixing of chemicals in water treatment plants 3) Retaining head in canal if head drops due to losses in long canals.	**½ Mark each (any two)**	
	d)	**What is Froude's experiment? Explain with a neat sketch**.		
	Ans.	The Froude's Number is defined as the square root of ratio of inertia force of flowing fluid to the gravity force. Mathematically it is expressed as,	**01**	
		$F_r = \sqrt{\frac{F_i}{F_g}}$ $F_r = \frac{V}{\sqrt{g D}}$	**01**	
		Where, V= Mean velocity of flow g= Acceleration due gravity D= Hydraulic mean depth of channel section When, a. Froude's Number (F_r) = 1 The flow is critical. b. Froude's Number (F_r) < 1 The flow is Sub-critical. c. Froude's Number (F_r) > 1 The flow is Super-critical.	**01**	**04**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.			**01**	
	e)	**Define hydraulic coefficients for orifice and State relationship among the hydraulic coefficients for an Orifice.**		
	Ans.	1. **Coefficient of discharge (C_d).** The ratio of the actual discharge to the theoretical discharge is called as the coefficient of discharge.	**01**	
		2. **Coefficient of contraction (C_c).** The ratio of the cross-sectional area of the jet at vena contracta to the cross-sectional area of the orifice is called coefficient of contraction.	**01**	
		3. **Coefficient of velocity (C_v).** The ratio of actual velocity of the jet at vena contracta to the theoretical velocity of the jet is called coefficient of velocity.	**01**	**04**
		Relation: - $Cd = C_v \times C_c$	**01**	
	f)	**Explain with neat sketch the working of Venturimeter.**		
	Ans.	**Working: -** The venturimeter is used to measure the rate of flow of a fluid flowing through the pipes. Let's understand how it does this measurement step by step. 1. Here we have considered two cross section, first at the inlet and the second one is at the throat. The difference in the pressure heads of these two sections is used to calculate the rate of flow through venturimeter.	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.		1. As the water enters at the inlet section i.e. in the converging part it converges and reaches to the throat. 2. The throat has the uniform cross section area and least cross section area in the venturimeter. As the water enters in the throat its velocity gets increases and due to increase in the velocity the pressure drops to the minimum. 3. Now there is a pressure difference of the fluid at the two sections. At the section 1(i.e. at the inlet) the pressure of the fluid is maximum and the velocity is minimum. And at the section 2 (at the throat) the velocity of the fluid is maximum and the pressure is minimum. 4. The pressure difference at the two section can be seen in the manometer attached at both the section. 5. This pressure difference is used to calculate the rate flow of a fluid flowing through a pipe.	**01**	**04**
		 **Fig. Venturimeter**	**02**	
5.		**Attempt any <u>FOUR</u> of the following:**		**(16)**
	a)	**Draw a neat sketch of cup type current meter and explain its working.** Current meter is used to find out velocity of water. Current meter consist of a wheel containing blades on cups. These cups are vertically immersed in stream of water. The thrust exerted by water on the cups. The number of revolutions of the wheel per unit time is proportional to the velocity of flow. The revolution counter operated by dry cell. The counter is calibrated or a calibration curve is provided to read velocity.	**02**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.				04



Marks: **02**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	b)	**A rectangular notch 2.5 m wide has a content head of 40cm. find discharge over it if C_d= 0.62**		
	Ans.	Given-length of weir (L) = 2.5m		
		Head of water (H)=40cm=0.4m Cd=0.62	**01**	
		For rectangular notch		
		$Q = 2/3 x Cd x L x (2xg)^{1/2} x H^{3/2}$	**01**	
		$Q = 2/3 x 0.62 x 2.5 x (2x9.81)^{1/2} x (0.4)^{3/2}$	**01**	**04**
		$= 2/3 x 0.62 x 2.5 x (2x9.81)^{1/2} x 0.253$ $= 0.2614 x 4.429$ $Q = 1.157\ m^3/s$	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	**c)**	**Write any four advantages of triangular notch over rectangular notch.**		
	Ans.	Advantages of triangular notch of rectangular notch: 1) Triangular notch gives more accurate results for low discharge. 2) Ventilation of triangular notch is not necessary. 3) In triangular notch only height is measure. 4) The expression for discharge for right angle V-notch is very simple. 5) In most of the cases of flow over triangular notch velocity approach may be neglected.	**1 Mark each (any four)**	**04**
	d)	**Define** **i)Static head** **ii) Manometric head of pump**		
	Ans.	**i) Static head-** The sum of suction head and delivery head is known as static head. $hs = h_s + h_d$	**02**	**04**
		ii) Manometric head- It is sum of suction head ,delivery head, major loss in suction and delivery pipes and minor losses in the system. $h_m = h_s + h_d + h_{fs} + h_{fd} + \text{minor losses}$	**02**	
	e)	**Differentiate between centrifugal pump and reciprocating pump (Any four points)**		
	Ans.	(table below)	**4 Marks (any four)**	**04**

Sr. No.	Centrifugal pump	Reciprocating pump
1	For Centrifugal pump discharge is continuous	For Reciprocating pump discharge is fluctuating
2	Suitable for large discharge and small heads	Suitable for less discharge and higher heads
3	nple in in construction because of less number of	Complicated in construction because of more number of parts
4	It has rotating elements so there is less wear and tear	It has reciprocating element , there is more wear and tear

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.				

Sr. No.	**Centrifugal pump**	**Reciprocating pump**
5	It can run at high speed	It cannot run at high speed
6	Air vessels are not required	Air vessels are required
7	Starting torque is more	Starting torque is less
8	It has less efficiency	It has more efficiency
9	Suction and delivery valve are not necessary	Suction and delivery valve are necessary
10	Requires less floor area and simple foundation	Requires more floor area and requires heavy foundation

f) **A centrifugal pump delivers water at 30 lit/sec to a height of 18m thro' a pipe 90 m long and 100 mm in diameter. If overall efficiency of pump is 75%. Find power required to drive the pump. Take f =0.012**

Ans.

Given:

$Q = 30\ \text{lit/sec} = 30 \times 10^{-3}\ \text{m}^3/\text{sec}$

$\eta = 0.75\ \ f = 0.012\ \ L = 90\ \text{m}\ \ d = 0.1\ \text{m}$

$$\text{Velocity at section} = \frac{Q}{A} = \frac{30 \times 10^{-3}}{\frac{\Pi}{4} \times (0.1)^2} = 3.819\ \text{m/sec}$$

01

Now, head loss due to friction

$$hf_d = \frac{f\,L\,V^2}{2g\,D} = \frac{0.012 \times 90 \times (3.819)^2}{2 \times 9.81 \times 0.1} = 8.028\ \text{m}$$

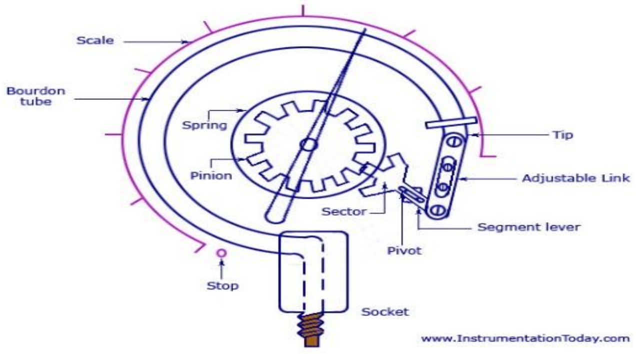
01 **04**

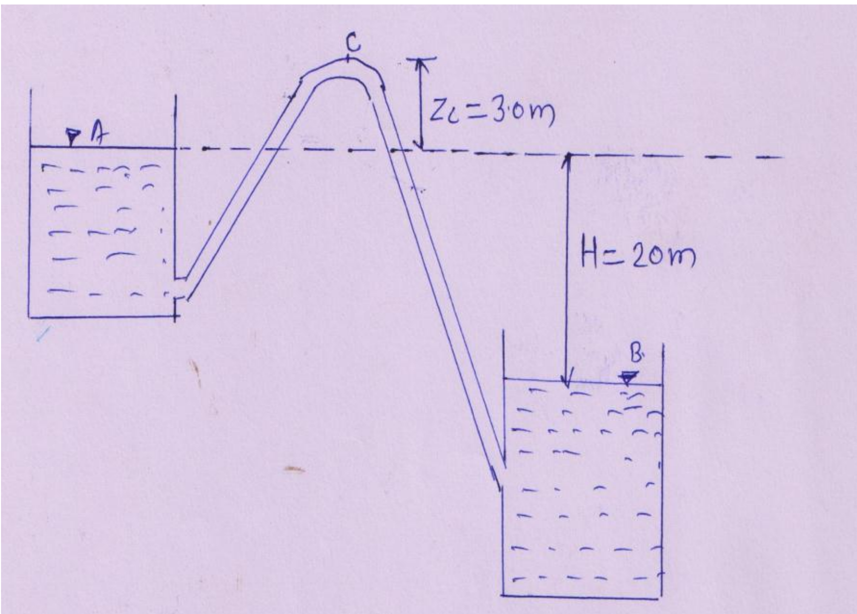
Total Manomentric Head

$$h_m = 18 + 8.028 = 26.028\ \text{m}$$

01

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.		$P = \frac{\gamma_w Q H_m}{\eta}$ $P = \frac{9810 \times 30 \times 10^{-3} \times 26.028}{0.75}$ $= 10213.39$ W $= 10.213$ kW	**01**	
		OR		
		$\frac{V^2}{2g}$	**01**	
		If suction head is considered Then, $h = \frac{V^2}{2g}$	**01**	
		$= \frac{3.819^2}{2 \times 9.81}$ $= 0.743$ m		**04**
		$h_m = 18 + 8.028 + 0.743$ $= 26.771$ m	**01**	
		$P = \frac{9810 \times 30 \times 10^{-3} \times (26.771)}{0.75}$ $P = 10504.94$ W $= 10.504$ kW	**01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.		**Attempt any <u>TWO</u> of the following:**		**(16)**
	a)	**Explain with neat sketch the working of Bourdons pressure gauge.**		
	Ans.	 Bourdon Tube Pressure Gauge	**04**	**08**
		Working : The pressure to be measured is connected to the fixed open end of the bourdon tube. The applied pressure acts on the inner walls of the bourdon tube. Due to the applied pressure, the bourdon tube tends to change in cross – section from elliptical to circular. This tends to straighten the bourdon tube causing a displacement of the free end of the bourdon tube. This displacement of the free closed end of the bourdon tube is proportional to the applied pressure. As the free end of the bourdon tube is connected to a link – section – pinion arrangement, the displacement is amplified and converted to a rotary motion of the pinion. As the pinion rotates, it makes the pointer to assume a new position on a pressure calibrated scale to indicate the applied pressure directly. As the pressure in the case containing the bourdon tube is usually atmospheric, the pointer indicates gauge pressure.	**04**	
	b.	**A Syphon ø= 200mm connects two reservoir having difference of elevation 20m total length of pipe is 500m and summits of syphon is 3.0 m above water level of upper reservoir the length of pipe from upper reservoir to summit is 100m find the discharge at the summit . Neglect minor losses . Take f = 0.005.**		
	Ans.	Given, d= 0.2 m H = 20m		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.		L = 500m $Z_c = 3$ m L (Upper reservoir to summit) = 100m, Coefficient of friction = f = 0.005 Q =? P =? **Diagram-** 		
		$h_f = \frac{(4f)\ L V^2}{2gd}$	**01**	
		$20 = \frac{(4 \times 0.005)\ 500\ V^2}{2 \times 9.81 \times 0.2}$ $20 = 0.637 \times 4V^2$ $V^2 = 7.848$ **V = 2.801 m/s**	**01**	
		Discharge $Q = a\ V$ $Q = \frac{\pi}{4} \times 0.2^2 \times 2.8014$	**01**	
		Q = 0.0879 m^3/s	**01**	**08**
		Pressure at summit - Applying Bernoulli's equation between A and C $\frac{P_A}{\gamma_c} + \frac{V_A^2}{2g} + Z_A = \frac{P_C}{\gamma_c} + \frac{V_C^2}{2g} + Z_C + Losses$	**02**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.		$0 = \frac{P_C}{\gamma_C} + \frac{2.801^2}{2 \times 9.81} + 3 + (\frac{4 \times 0..005 \times 100 \times 2.801^2}{2 \times 9.81 \times 0.2})$ $0 = \frac{P_C}{\gamma_C} + 3.39 + 4$ $0 = \frac{P_C}{9810} + 7.39$ P_C = -72.49 KN/m^2 **P_C = 72.49 KN/m^2 (Vacuum)**	**01** **01**	
	c)	**A trapezoidal most economical channel section has side slopes 1.5 (H): 1 (V). It is required to discharge 20 m^3/sec with a bed slope of 1m in 6 km. Design section using Manning's formula. Take N=0.015.**		
	Ans.	Given side slopes=1.5/1=1.5 Bed slope=s=1/6000 m Discharge = 20 m^3/s N=0.015 For trapezoidal section most economical condition the formula is Sloping side=1/2 (Top width) $d\sqrt{1+n^2} = \frac{b+2nd}{2}$ $d\sqrt{1.5^2+1} = \frac{b+2\times1.5d}{2}$ 1.8d = b+3d/2 3.6d = b+3d 0.6d = b Area of trapezoidal section A=bd+nd^2 =(0.6)d+1.5d^2 A=2.1d^2	**01** **01** **01** **01**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.		Manning's formula, $Q = \frac{A}{N} R^{2/3} S^{1/2}$	**01**	**08**
		$20 = \frac{2.1d^2}{0.015}\left(\frac{d}{2}\right)^{2/3}\left(\frac{1}{6000}\right)^{1/2}$ $= 140d^2 \frac{d^{2/3}}{(2)^{2/3}} \times 0.0129$	**01**	
		$20 = \frac{1.807}{1.587} \times d^{8/3}$ $20 = 1.1386 \times d^{8/3}$ $d^{8/3} = 17.565$ $d = (17.565)^{3/8}$ $d = 2.929 m.$	**01**	
		$b = 0.6 \times 2.929 = 1.757 m$	**01**	
