MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

SUMMER – 14 EXAMINATIONS

Subject Code: 17204 **Model Answer** **Total Pages: 41**

Important Instruction to Examiners:-

1) The answers should be examined by key words & not as word to word as given in the model answers scheme.

2) The model answers & answers written by the candidate may vary but the examiner may try to access the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance.

4) While assessing figures, examiners, may give credit for principle components indicated in the figure.

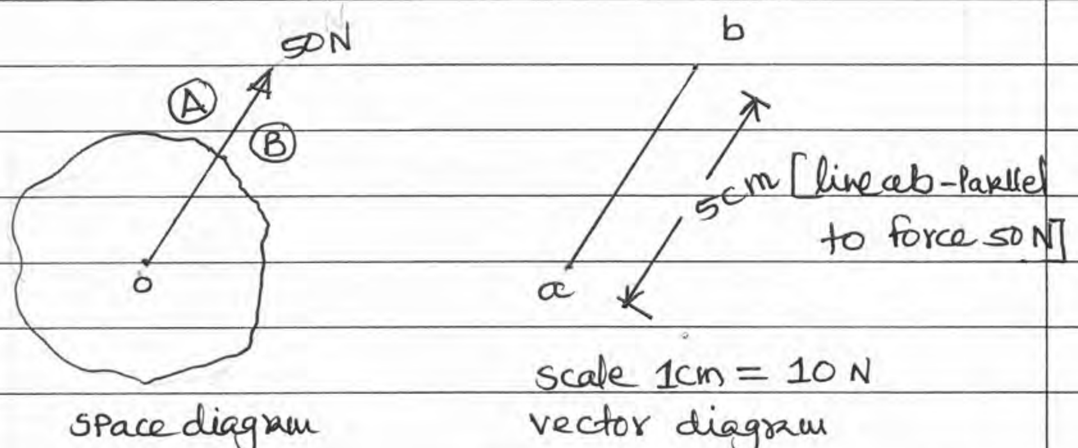
The figures drawn by candidate & model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credit may be given step wise for numerical problems. In some cases, the assumed contact 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 judgment on part of examiner of relevant answer based on candidates understanding.

7) For programming language papers, credit may be given to any other programme based on equivalent concept.

Q.NO	SOLUTION	MARKS
	Attempt any TEN.	
Q1 (a)	Compound Machine :- It is a device which consists of number of simple machines to do heavy work with less efforts and at greater speeds.	1
	Example :- crane, grinding machines, motorcycle, car, or the engine driven machines	1
(b)	Ideal Load :- Ideal load is the load that can be lifted by the given effort when there is no friction in the machine	1
	OR	OR
	Ideal load is the load that can be lifted by using given effort by the machine, assuming it to be ideal.	1
(c)	Self locking Machine :- A machine which is not capable of doing work in the reverse direction after the effort is removed, is called non-reversible or self locking machine.	2
(d)	Kinematics :- It is the branch of dynamics which deals with pure motion of the body without considering its mass and forces causing the motion.	2

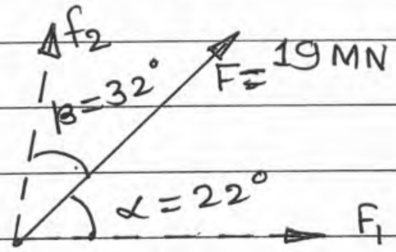
Q .NO	SOLUTION	MARKS
	OR	OR
(d)	It is the branch of dynamics which deals with the geometry of motion of bodies without reference to the agents or forces causing the motion.	2
(e)	Representation of force by Bow's Notations :-	
		2
	For given force Bow's notations A, & B is written on either side of force and a and b used in vector diagram	
(f)	Principle of transmissibility of force :-	
	"If a force acts at a point on a rigid body, it is assumed to act at any other point on the line of action of a force. within the same body"	2
(g)	Define funicular polygon :-	
	In Graphical solution of Non-concurrent forces, after drawing vector diagram	

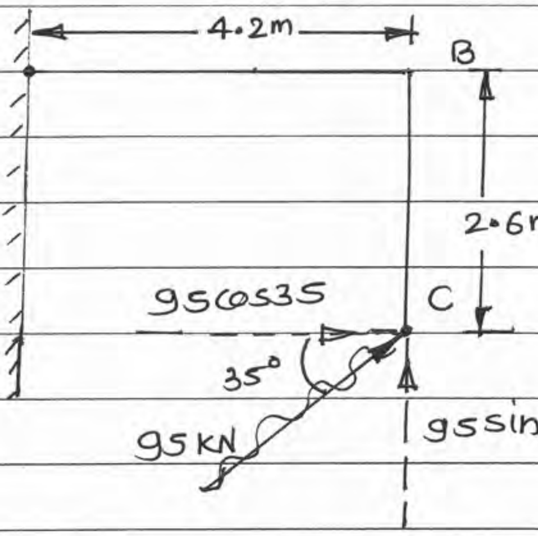
Q.NO	SOLUTION	MARKS
Q1 (g) cont..	and Polar diagram, all ray's in Polar diagram are drawn in their respective spaces in space diagram in proper order. Then the resulting Polygon is called funicular Polygon.	2
(h)	Defination of Equilibrant	
	It is a single force which brings the system of forces and the body in equilibrium.	2
	OR	OR
	It is a Singal force which is colinear with resultant force, equal in magnitude and acts in opposite direction and thus brings the body in equilibrium called as Equilibrant.	2
(i)	Graphical conditions of equilibrium for Non-concurrent forces	
	(1) vector diagram or force diagram must be a closed figure	1 M (for each condition)
	(2) Funicular Polygon must be a closed figure.	
(j)	Defination of Angle of Repose :-	
	"It is defined as the angle made by the	

Q .NO	SOLUTION	MARKS
Q1 (j) cont.	inclined plane with the horizontal plane at which the body placed on an inclined plane is just on the point of moving down the plane under the action of its own weight."	2
(K)	Given, dia of load drum $d = 300$ mm	
	Dia. of effort wheel $= D = 400$ mm	
	No of Teeth on wheel $= T = 78$	
	$\therefore$ Velocity Ratio $= \frac{DT}{nd}$	
	Assuming single threaded worm.	
	$\therefore n = 1$	
	$\therefore V.R. = \frac{DT}{d}$	1
	$= \frac{400 \times 78}{300}$	
	$\therefore V.R. = 104$	1
(l)	Advantages of friction :-	
	(1) one can easily walk on the ground surface due to friction	$\frac{1}{2}$ M (for any two)
	(2) vehicle moving on road can be stopped by applying brakes by producing sufficient frictional force	
	(3) one can easily hold writing material without slipping while writing on blackboard, slate or paper.	

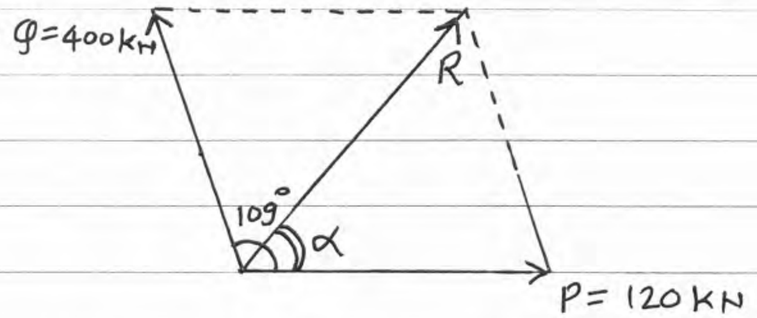
Q .NO	SOLUTION	MARKS
Q1 (l) cont--	(4) one can hammer the nail into wall due to friction	
	Disadvantages of friction	
	(1) Input work is always greater than output work due to friction in case of lifting machines	
	(2) friction between sliding parts of the machine generates heat in the machine parts.	$\frac{1}{2}$ M (for any two)
	(3) friction causes wear and tear in machine parts, tyres of vehicles etc.	
	(4) friction is responsible for more consumption of fuel in machines or engines.	
Q-2-(a)	Given Data. $\therefore W = 45 N$, $\therefore P = 9 N$, $\therefore V.R. = 25$	
	Effort lost due to friction (P_f)	
	$\therefore P_f = P - \frac{W}{V.R.}$	1
	$\therefore P_f = 9 - \frac{45}{25}$	
	$\therefore P_f = 7.2 N$	1
	Efficiency of the Machine (η)	
	$\therefore \eta = \frac{M.A.}{V.R.} \times 100$	1
	$\therefore \eta = \frac{W}{P \times V.R.} \times 100$	
	$\therefore \eta = \frac{45}{9 \times 25} \times 100$	
	$\therefore \eta = 20\%$	1

Q .NO	SOLUTION	MARKS
Q-2-(b)	Data: ∴ $D = 180$ mm, ∴ $d = 30$ mm, $\eta = 80\%$, ∴ $W = 100N$, ∴ $P = ?$	
	Velocity Ratio (V.R.)	
	∴ $V.R. = \frac{D}{d}$	1
	∴ $V.R. = \frac{180}{30}$	
	∴ $V.R = 6$	1
	∴ Effort required to lift a load of 100N.	
	∴ $\eta = \frac{M.A.}{V.R.} \times 100$	1
	∴ $\eta = \frac{W}{P \times V.R.} \times 100$	
	∴ $80 = \frac{100}{P \times 6} \times 100$	
	∴ $P = 20.833N$	1
(c)	Given Data: ∴ $N_1 = 100$, ∴ $N_2 = 25$, ∴ $L = 0.5m$, ∴ $d = 0.25m$, ∴ $W = 2500N$, ∴ $P = 200N$	
	Mechanical Advantage	
	∴ $M.A. = \frac{W}{P}$	
	∴ $M.A. = \frac{2500}{200}$	
	∴ $M.A. = 12.5$	1
	Velocity Ratio	
	∴ $V.R. = \frac{2L}{d} \times \frac{N_1}{N_2}$	1
	∴ $V.R. = \frac{2 \times 0.5}{0.25} \times \frac{100}{25}$	
	∴ $V.R. = 16$	1

Q .NO	SOLUTION	MARKS
Q 2 (c) cont---	efficiency (η)	
	$\therefore \eta = \frac{M.A.}{V.R.} \times 100$	
	$\therefore \eta = \frac{12.5}{16} \times 100$	
	$\therefore \eta = 78.125\ \%$	1
(d)		
	Let f_1 and f_2 be the components of the force F = 19 MN at $\alpha = 22^\circ$ and $\beta = 32^\circ$ respectively.	
	component along (f_1)	
	$\therefore f_1 = \frac{F \times \sin\beta}{\sin(\alpha+\beta)}$	1
	$\therefore f_1 = \frac{19 \times \sin 32}{\sin 54}$	
	$\therefore f_1 = 12.445$ MN	1
	component along (f_2)	
	$\therefore f_2 = \frac{F \times \sin\alpha}{\sin(\alpha+\beta)}$	1
	$\therefore f_2 = \frac{19 \times \sin 22}{\sin 54}$	
	$\therefore f_2 = 8.797$ MN	1

Q .NO	SOLUTION	MARKS
Q 2 (e)		1 Mark for sketch.
	Resolving force 95 KN and components are written as shown in above figure.	
	∴ Moment of 95KN @ A = Σ sum of moment of components of 95KN @ A	1
	∴ Moment of 95KN @ A = $-95\cos35 \times 2.6 - 95\sin35 \times 4.2$	
	∴ M = -431.188 KN-M.	2
(f)	Properties of couple :-	
	(1) The resultant of the forces forming couple is zero	
	(2) The moment of couple is equal to product of any one force and arm of couple	
	(3) Moment of couple about any point is constant.	4 Marks (any four)
	(4) A couple can be balanced only by another couple of equal & opposite moment	
	(5) Two or more couples are said to be equal when they have same sense.	
	(6) Any number of coplanar couples can be represented by a single couple, the moment of which is equal to the algebraic sum of the moment of all the couples.	

Q.NO	SOLUTION	MARKS
Q.3. a)		



Let
$P = 120\ kN$
$Q = 400\ kN$
$\theta = 109^\circ$

$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$ — 1

$= \sqrt{(120)^2 + (400)^2 + 2 \times 120 \times 400 \times \cos 109}$

$= 378.34\ kN$ — 1

Magnitude of Resultant = R = 378.34 kN

Let α be the direction of resultant, (R) with force P = 120 kN.

$\alpha = \tan^{-1}\left(\frac{Q\sin\theta}{P + Q\cos\theta}\right)$ — 1

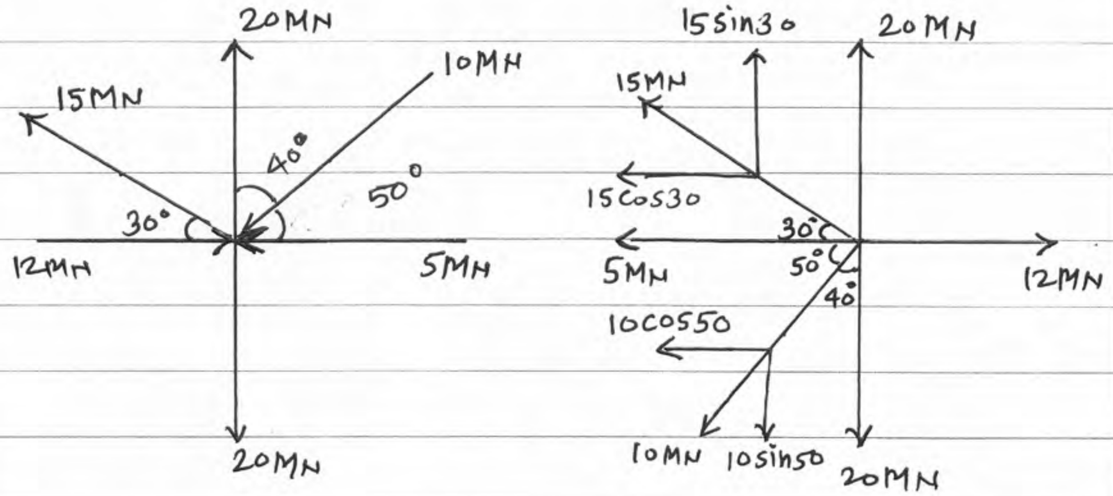
$= \tan^{-1}\left(\frac{400\sin 109}{120 + 400\cos 109}\right)$

$\alpha = -88.45^\circ$

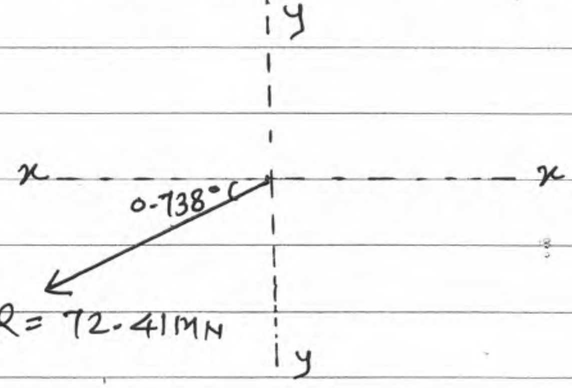
$\therefore \alpha = 180^\circ - 88.45^\circ = 91.55^\circ$

$= \alpha = 91.55^\circ$ w.r.t. 120 kN Force

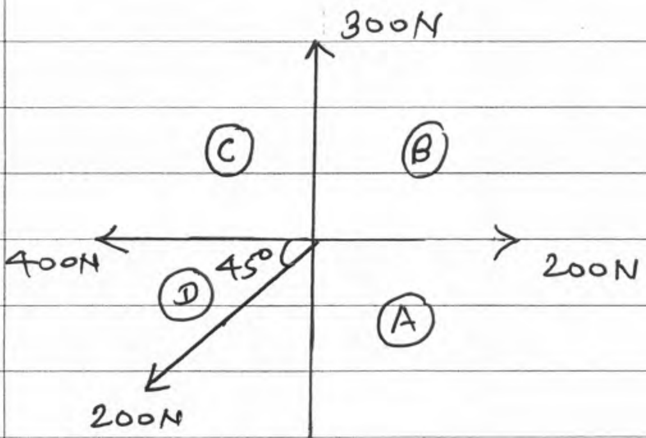
Resultant Makes an angle of 91.55° with 120 kN Force. — 1

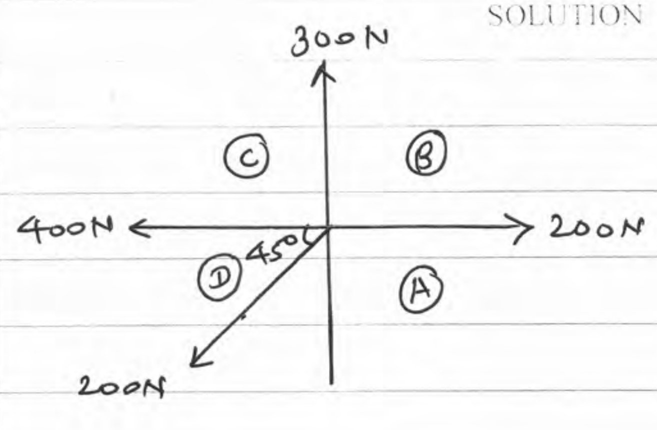
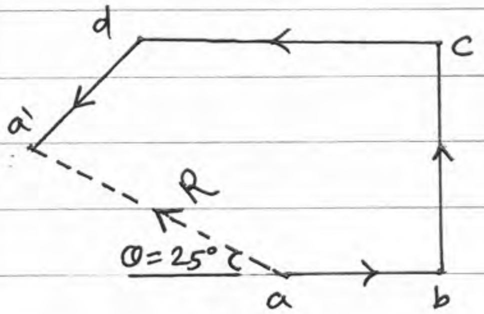
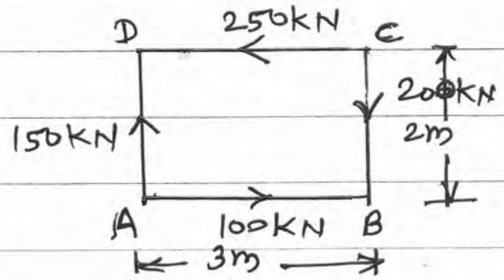
Q.NO	SOLUTION	MARKS
Q.3. b)		1
	1) Resolving Force System horizontally, $\Sigma Fx = 12 - 15\cos 30 - 5 - 10\cos 50$ $= -12.41\ MN$	$\frac{1}{2}$
	2) Resolving Force system Vertically, $\Sigma Fy = 20 + 15\sin 30 - 10\sin 50 - 20$ $= -0.160\ MN$	$\frac{1}{2}$
	3) Resultant $= R = \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2}$ $= \sqrt{(-12.41)^2 + (-0.16)^2}$ $R = 12.41\ MN$	1

Q .NO	SOLUTION	MARKS
3. b) Conti--	4) Angle of inclination of Resultant,	
	$\theta = \tan^{-1}\left(\frac{\Sigma fy}{\Sigma fx}\right)$	
	$= \tan^{-1}\left(\frac{0.16}{12.41}\right)$	
	$= 0.738^\circ$	1
	Since Σfx is -ve, and Σfy is -ve Resultant lie in the 3rd quadrant.	



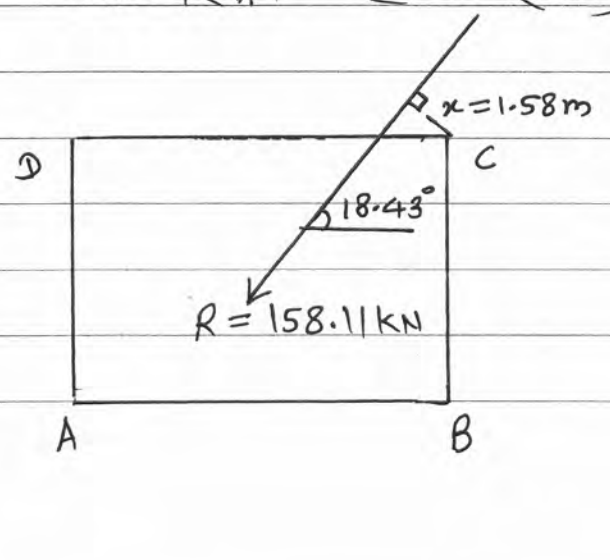
c)



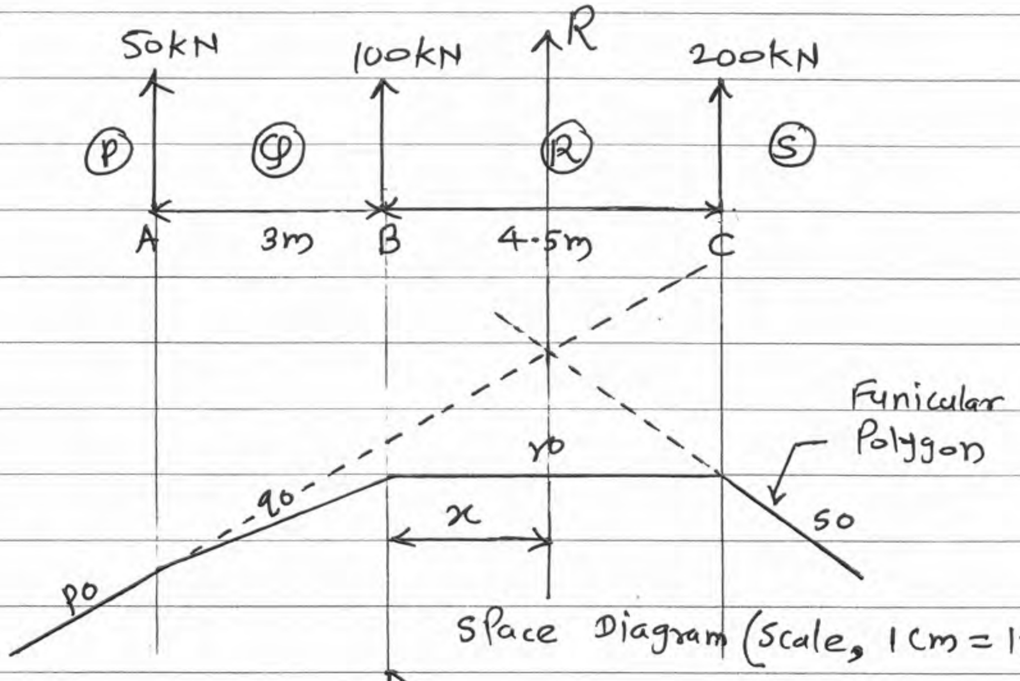
Q.NO	SOLUTION	MARKS
Q.3. c) Conti---	 Space Diagram	1
	 Vector Diagram, Scale, 1 cm = 100 N	1
	By Graphical Method	
	$R = l(aa') \times Scale$	
	$l(aa') = 3.75$ cm	
	$R = 3.75 \times 100 = 375$ N (Graphically)	1
	$\theta = 25°$ (Graphically)	1
d)	 1) Resolving Forces horizontally,	
	$\Sigma F_x = 100 - 250$	1 M for resolution & composition
	$= -150$ KN	
	2) Resolving Forces Vertically,	

$\Sigma F_y = 150 - 200$

$= -50$ KN

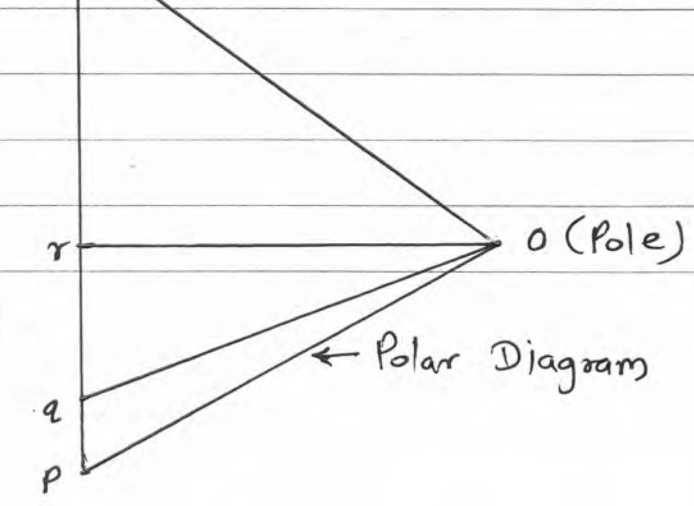
Q.NO	SOLUTION	MARKS
3. d) Conti--	3) Resultant.	
	$R = \sqrt{(\Sigma fx)^2 + (\Sigma fy)^2}$	
	$= \sqrt{(-150)^2 + (-50)^2}$	
	$= 158.11$ KN	
	Magnitude of Resultant = R = 158.11 KN	1
	4) Direction of resultant	
	$\theta = \tan^{-1}\left(\frac{\Sigma fy}{\Sigma fx}\right)$	
	$= \tan^{-1}\left(\frac{50}{150}\right)$	
	$= 18.43°$ with horizontally	1
	5) Position of Resultant w.r.t. - C -	
	Taking moment about point C -	
	$\Sigma M_C = (200 \times 0) + (250 \times 0) + (150 \times 3) - (100 \times 2)$	
	$= 250$ KN.m (Clockwise)	
		

Q .NO	SOLUTION	MARKS
3 d) conti--	Applying Varignon's theorem of moment,	
	$\Sigma MA = R \times x$	
	$250 = (158.11) \times x$	
	$\therefore x = \frac{250}{158.11}$	
	$\therefore x = 1.58\ m$	1
	Position of Resultant Lie at a perpendicular distance 1.58 m w.r.t. point C.	
e)		



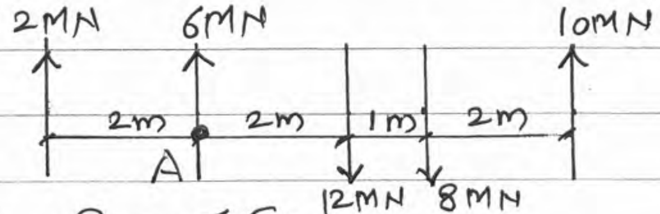
Marks: 1/2, 1 1/2

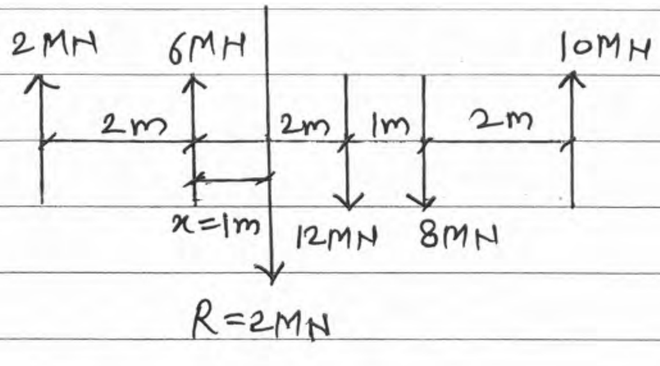
Space Diagram (Scale, 1cm = 1m)



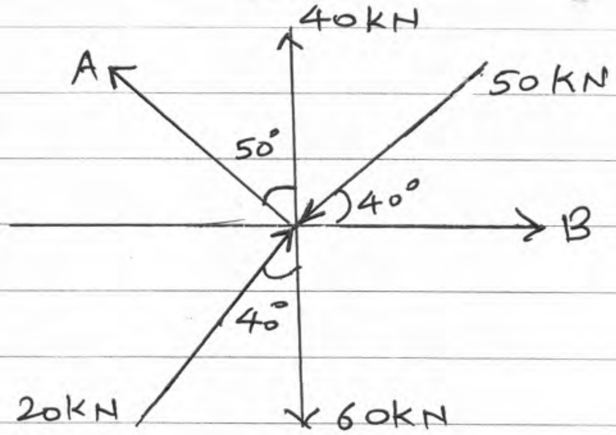
Marks: 1

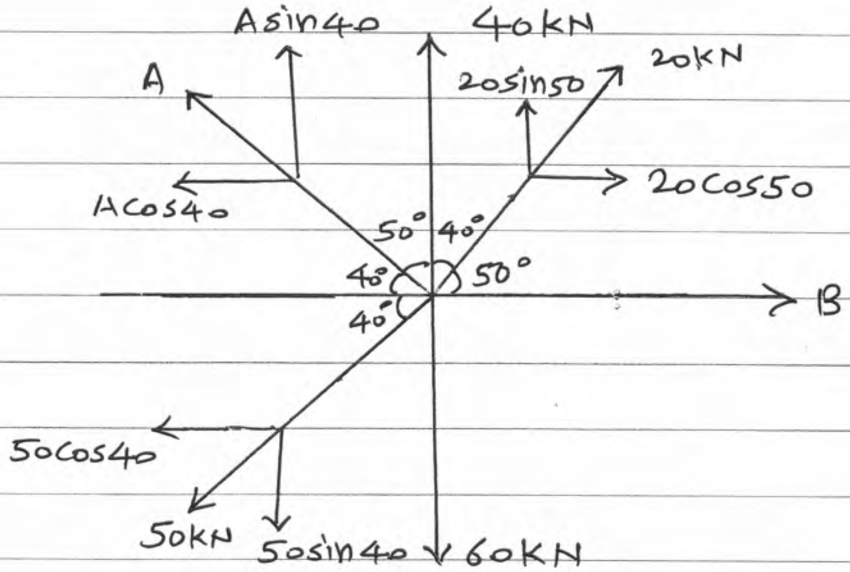
Vector Diagram
(Scale, 1cm=50KN)

Q.NO	SOLUTION	MARKS
Q.3. e) Conti---	$R = l(PS) \times Scale$	
	$= (7) \times (50)$	
	$= 350\,N$	$\frac{1}{2}$
	Let, x be peependicular distance between Resultant (R) and 100N force.	
	$x = 2.1\,m$	$\frac{1}{2}$
	∴ Position of Resultant w.r.t. 100N force is $x = 2.1\,m$	
f)		
	1) $R = \Sigma F_y$	
	$= 2+6-12-8+10$	
	$= -2\,MN$	1
	Magnitude of Resultant $= R = 2MN (\downarrow)$	
	2) Position of Resultant – Consider point A on a line of action of 6MN force as shown in figure.	

Q .NO	SOLUTION	MARKS
3. F) Conti---	∴ Taking moment of the forces about point A.	
	$\Sigma M_A = +(2\times2)+(6\times0)+(12\times2)+(8\times3)-(10\times5)$	
	$= 2\ MN\cdot m$ (clockwise).	1
	Applying Varignon's theorem of moment to find position of R. w.r.t. point A.	
	$\Sigma M_A = R\times x$	
	$2 = (2)\times x$	
	$x = \frac{2}{2}$	
	$x = 1m.$	1
	Resultant is acting at a distance 1m from 6 MN force.	
		1 for sketch

Q .NO	SOLUTION	MARKS
Q.4. a)		



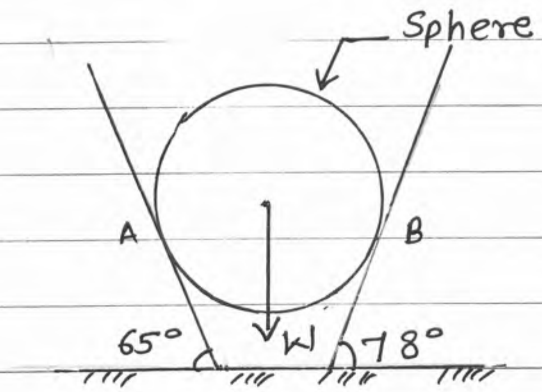


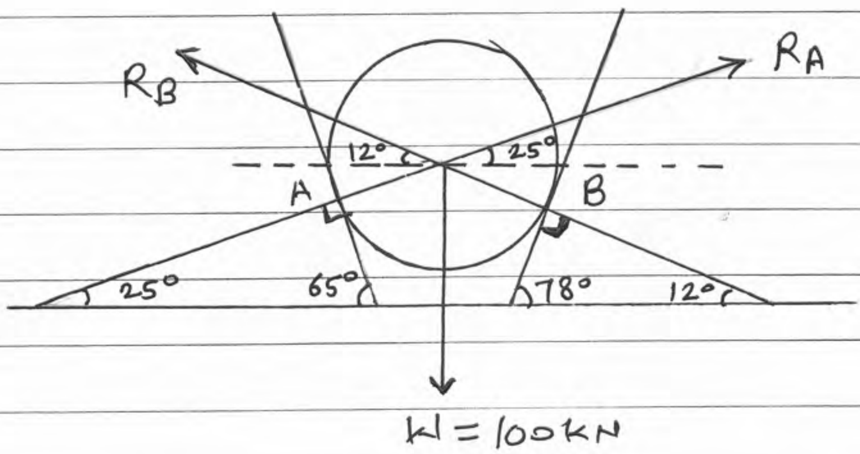
1 for sketch

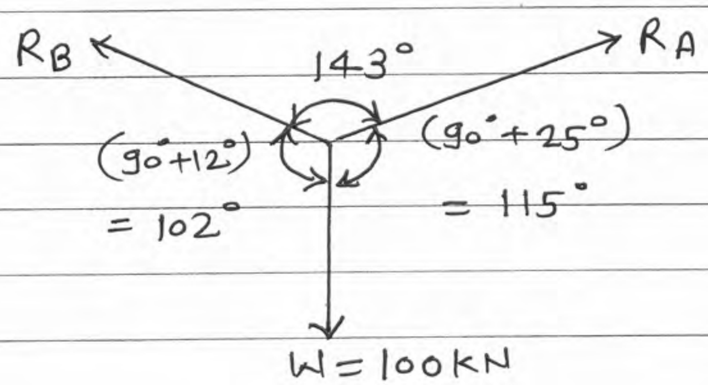
System is in equilibrium
i.e. it's components
Σf_x & Σf_y are Zero
$\therefore \Sigma f_x = 0$
$\therefore \Sigma f_y = 0$

Q .NO	SOLUTION	MARKS
4 a) conti--	1) Resolving the forces horizontally,	
	$\Sigma F_x = B + 20\cos 50 - A\cos 40 - 50\cos 40$	
	as, $\Sigma F_x = 0$	
	$\therefore B + 20\cos 50 - A\cos 40 - 50\cos 40 = 0$	
	$\therefore B - A\cos 40 = 25.44$ —— (1)	1
	2) Resolving the forces vertically,	
	$\Sigma F_y = 20\sin 50 + 40 + A\sin 40 - 50\sin 40 - 60$	
	as, $\Sigma F_y = 0$	
	$\therefore 20\sin 50 + 40 + A\sin 40 - 50\sin 40 - 60 = 0.$	
	$\therefore A\sin 40 = 36.81$	
	$\therefore A = -57.27$ kN	1
	From equation (1)	
	$B - (-57.27)\cos 40 = 25.44$	
	$\therefore B = -18.43$ kN	1
	Ans:-	
	$A = -57.27$ kN	
	$B = -18.43$ kN	

Q.NO	SOLUTION	MARKS
Q.4) b)		

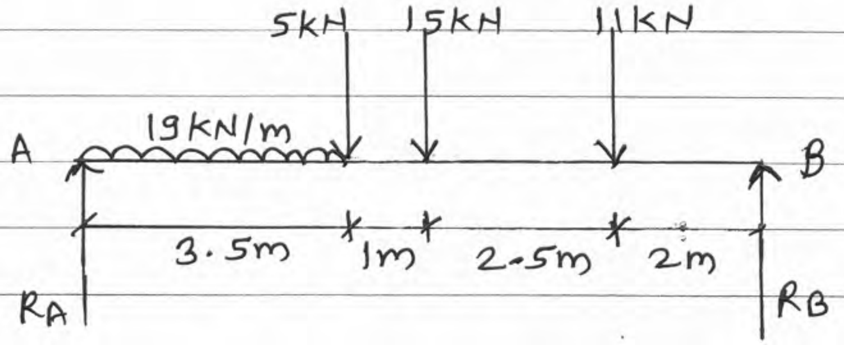
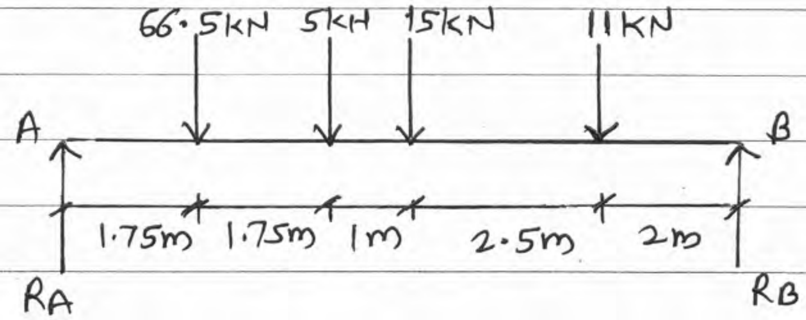


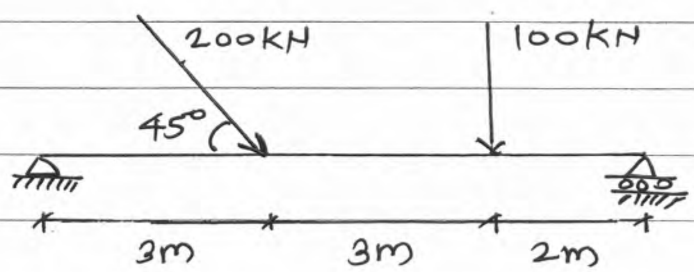




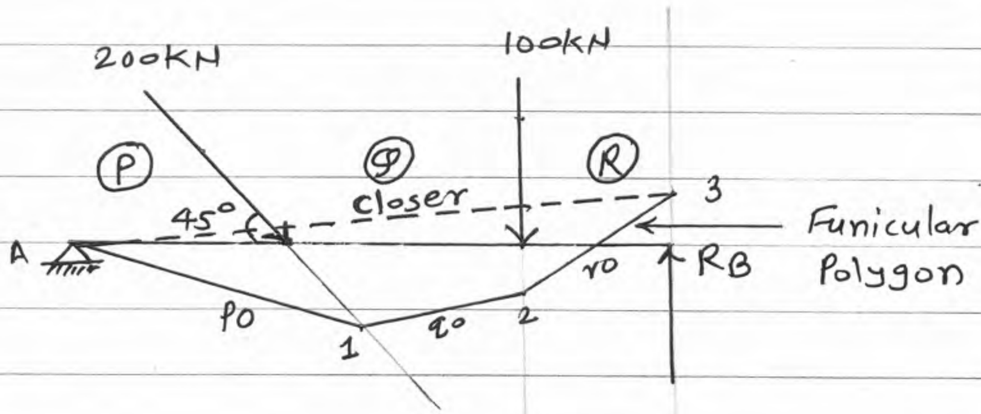
1 for sketch

F.B.D.

Q.NO	SOLUTION	MARKS
4. b) conti---	Applying Lami's Theorem.	
	$\frac{RA}{\sin 102} = \frac{RB}{\sin 115} = \frac{100}{\sin 143}$	1
	$\therefore RA = \frac{100}{\sin 143} \times \sin 102 = 162.53$ kN	1
	$RB = \frac{100}{\sin 143} \times \sin 115 = 150.59$ kN	1
c)		1 for sketch
		
	(1) Applying condition of equilibrium,	
	$\Sigma fy = 0$	
	$\therefore \Sigma fy = RA - 66.5 - 5 - 15 - 11 + RB = 0$	
	$\therefore RA + RB = 97.5$ kN —— (1)	1

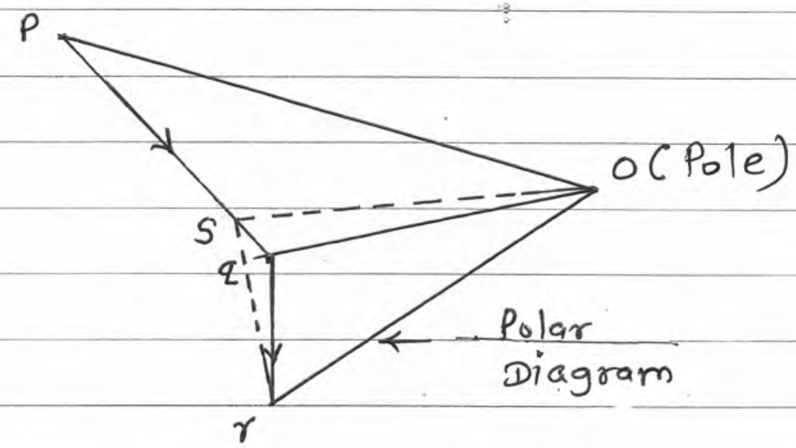
Q .NO	SOLUTION	MARKS
4: c) Contin---	2) Taking moment about point A,	
	$\Sigma M_A = (R_A \times 0) + (66.5 \times 1.75) + (5 \times 3.5) + (15 \times 4.5) + (11 \times 7) - (R_B \times 9)$	
	$\Sigma M_A = 278.375 - (R_B \times 9)$	
	Applying Condition of equilibrium,	
	$\Sigma M_A = 0$	
	$\therefore 278.375 - (R_B \times 9) = 0$	
	$\therefore R_B = 30.93$ kN.	1
	From equation (1)	
	$R_A + R_B = 97.5$	
	$\therefore R_A = 97.5 - 30.93$	
	$\therefore R_A = 66.57$ kN.	1
	Ans:- $\therefore R_A = 66.57$ kN, $R_B = 30.93$ kN	
d)		

Q .NO	SOLUTION	MARKS
Q.4) d) Conti---		



1

Space diagram (Scale, 1 cm = 1 m.)



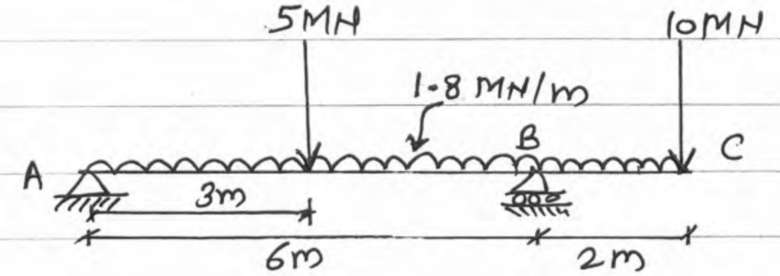
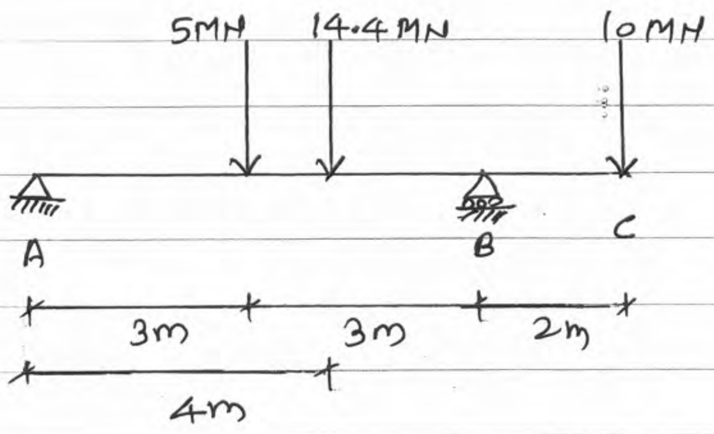
1

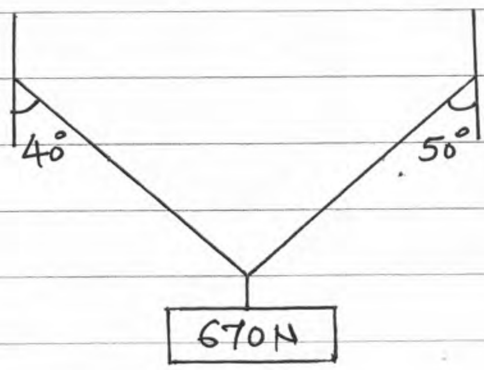
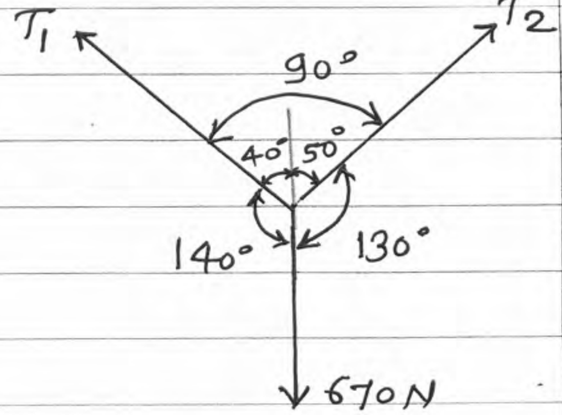
Vector diagram (Scale, 1 cm = 50 kN)

RA = l(ps) × Scale

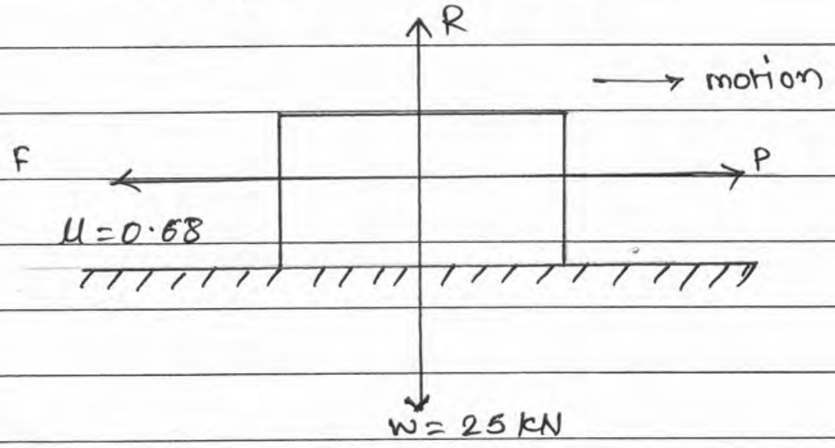
= 3.4 × 50

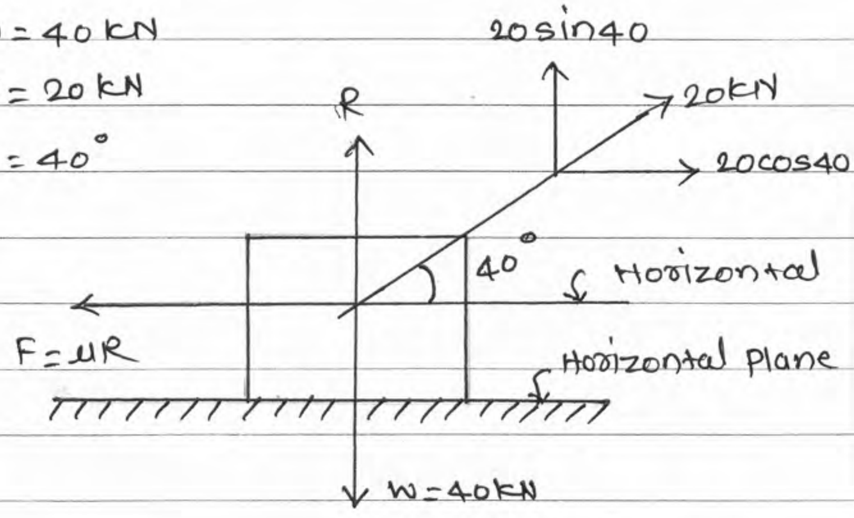
= 170 kN ↑ 1

Q.NO	SOLUTION	MARKS
4 : d) Conti---	RB = $\ell(rs) \times$ Scale = 2.4×50 = 120 kN ↑	1
e)		1
		
	Convert udl in to point load equivalent point load of $1.8 \times 8 = 14.4$ MN is acting at centre of u.d.l. 1) $\Sigma fy = 0$ $RA - 5 - 14.4 + RB - 10 = 0$ $\therefore RA + RB = 29.4$ — (1)	1

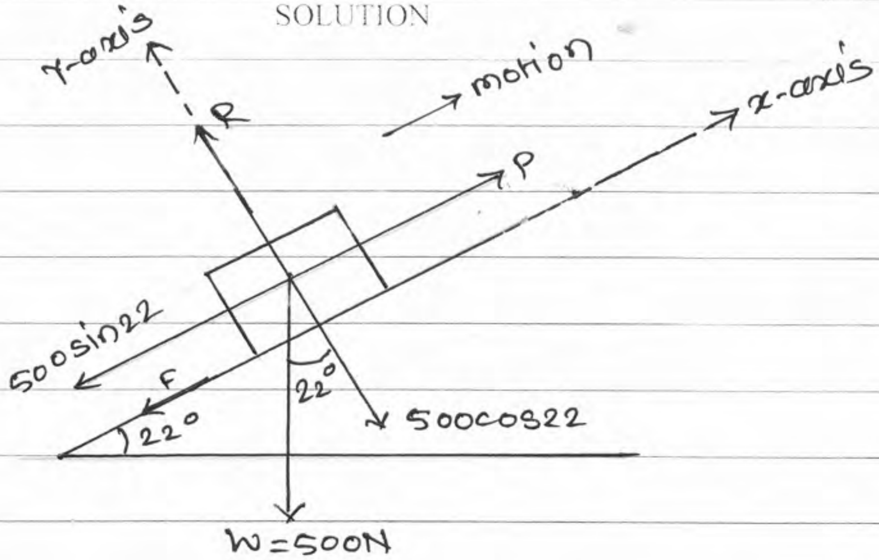
Q.NO	SOLUTION	MARKS
4.- e)	$\Sigma MA = 0$	
conti---	$\Sigma MA = (RA \times 0) + (5+3) + (14.4 \times 4) - RB(6) + (10 \times 8) = 0$	
	$\therefore (RB \times 6) = 152.6$	
	$RB = \frac{152.6}{6}$	
	$\therefore RB = 25.43$ MN.	1
	From equation – (1)	
	$RA + RB = 29.4$	
	$RA = 29.4 - 25.43$	
	$RA = 3.97$ MN	1
	Ans:–	
	$RA = 3.97$ mN	
	$RB = 25.43$ MN	
f)	  F.B.D.	1 for sketch
	Let T1 & T2 be the tension in the ropes.	

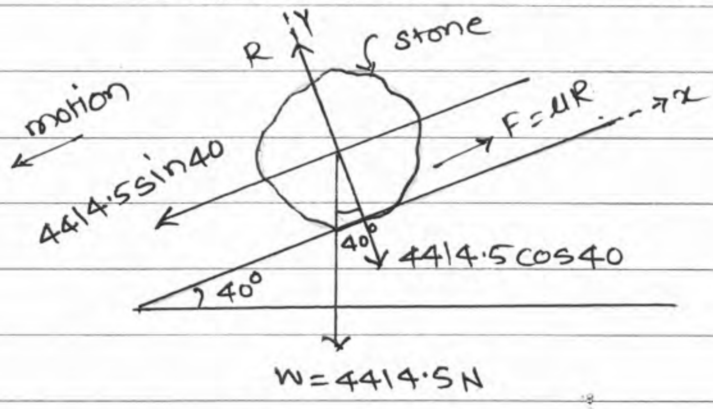
Q.NO	SOLUTION	MARKS
Q.4) f) Conti----	Applying Lami's Theoram -	
	$\frac{T_1}{\sin 130} = \frac{T_2}{\sin 140} = \frac{670}{\sin 90}$	1
	$\therefore T_1 = \frac{670}{\sin 90} \times \sin 130 = 513.25\ N$	1
	$T_2 = \frac{670}{\sin 90} \times \sin 140 = 430.66\ N$	1

Q.NO	SOLUTION	MARKS
Q 5	Attempt any four of the following:	
(a)	a) Given data:	
	w = weight of a body = 25 KN	
	$\mu = 0.68$	
	Find: i) Normal reaction (R),	
	ii) Limiting force of friction (F)	
	iii) horizontal force required (P)	
	iv) angle of friction (ϕ)	
		
	I) Resolving the forces horizontally, we get,	
	$\Sigma Fx = P - F$	
	$\Sigma Fx = P - \mu R \quad (\because F = \mu R)$	
	As the body in limiting equilibrium, $\Sigma Fx = 0$	
	$\therefore 0 = P - 0.68R$	1/2
	$\therefore P = 0.68R \longrightarrow$ (i)	
	II) Resolving the forces vertically, we get,	
	$\Sigma fy = 0$	
	$\Sigma fy = R - W$	
	$\Sigma fy = R - 25$	

Q.NO	SOLUTION	MARKS
Q.5 a: continue---	$R = 25 KN$ --- Normal Reaction	$\frac{1}{2}$
	put the value of 'R' in equation (i), we get,	
	$P = 0.68 (25)$	
	$P = 17 KN$ --- Horizontal Force	1
	III) To find limiting force of friction (F):	
	we know, $F = \mu R$	
	$\therefore F = 0.68 \times 25$	
	$\therefore F = 17 KN$	1
	IV) To find angle of friction (ϕ):	
	we know, $\tan\phi = \mu$	
	$\therefore \phi = \tan^{-1}(\mu)$	
	$= \tan^{-1}(0.68)$	
	$\phi = 34.215^\circ$	1
(b)	b) Given data:-	
	$W = 40 KN$	
	$P = 20 KN$	
	$\theta = 40^\circ$	
		1

Q .NO	SOLUTION	MARKS
Q.5 b. continue---	I) Resolving the forces horizontally, we get,	
	$\Sigma Fx = 20\cos 40 - F$	
	$\Sigma Fx = 20\cos 40 - \mu R$ $(\because F = \mu R)$	
	$\because$ As $\Sigma Fx = 0$ (condition of eq^{m}.)	
	$\therefore 0 = 15.32 - \mu R$	1
	$\mu R = 15.32$	
	$\therefore \mu = \frac{15.32}{R}$ $\longrightarrow$ (i)	
	II) Resolving the forces verically, we get.	
	$\Sigma Fy = R - 40 + 20\sin 40$	
	$\Sigma Fy = R - 27.14$	
	$\Sigma Fy = 0$	
	$0 = R - 27.14$	
	$R = 27.14\,kN$	1
	put the value of 'R' in equation (i), we get,	
	$\mu = \frac{15.32}{27.14}$	
	$\mu = 0.56$	1
(C)	c) Given data:	
	$w = 500N$, $\alpha = 22^{\circ}$	
	$\mu = 0.25$	
	$P = ?$	

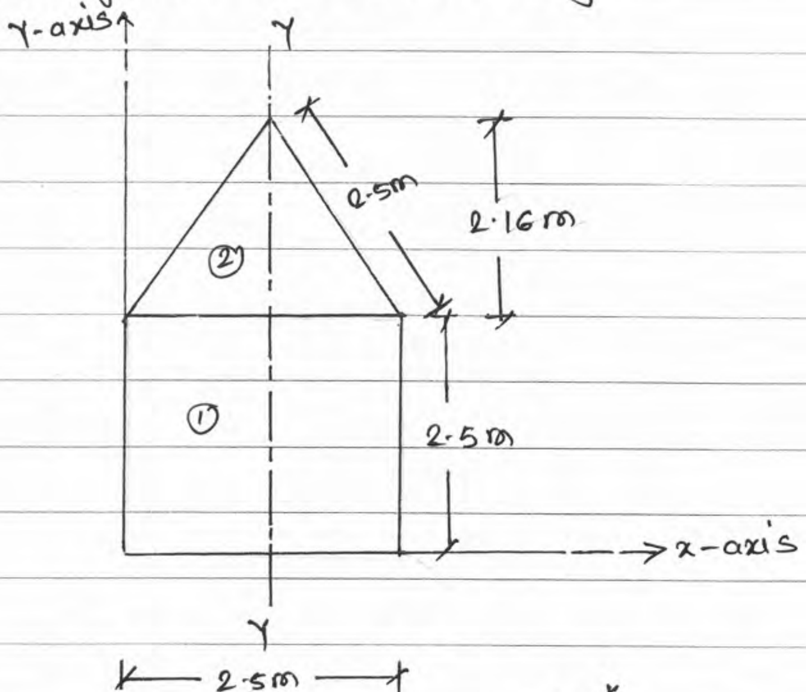
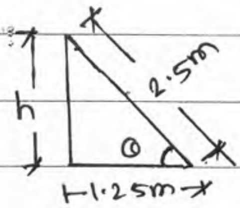
Q .NO	SOLUTION	MARKS
Q.5C. continue....		1 M for sketch
	I) Resolving the forces along x-axis, we get,	
	$\Sigma Fx = P - 500\sin 22 - F$	
	$\Sigma Fx = P - 187.30 - \mu R$ $(\because F = \mu R)$	
	$\Sigma Fx = 0$	
	$\therefore 0 = P - 187.30 - 0.25R$	
	$P = 187.30 + 0.25R \rightarrow (i)$	1
	II) Resolving the forces along Y-axis, we get,	
	$\Sigma Fy = R - 500\cos 22$	
	$\Sigma Fy = 0$	
	$0 = R - 500\cos 22$	
	$0 = R - 463.592$	
	$\therefore R = 463.592\ N$	1
	Put the value of 'R' in equation (i), we get,	
	$P = 187.30 + 0.25(463.592)$	
	$P = 303.198\ N$	1

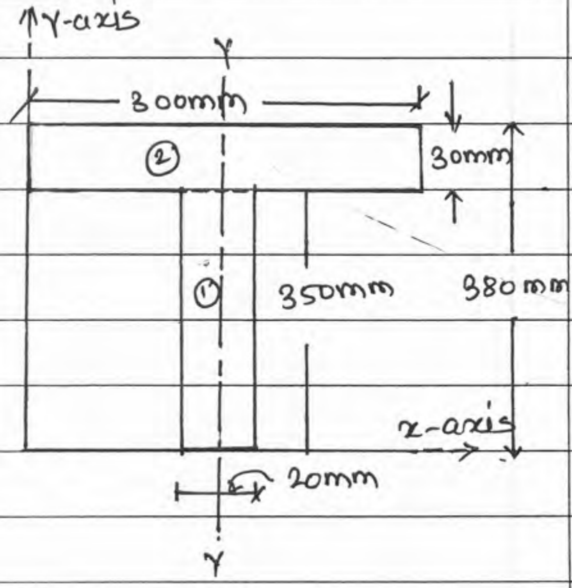
Q.NO	SOLUTION	MARKS
Q 5(d)	Given data:	
	$m = 450 kg$, $\alpha = 40^\circ$	
	we know, $W = mg$	
	$= 450 \times 9.81$	
	$= 4414.5 N$	1/2
	∴ weight of stone = 4414.5 N	
		1/2
	I) Resolving the forces perpendicular to the plane, we get,	
	$\Sigma F_y = R - 4414.5 \cos 40$	
	∴ use $\Sigma F_y = 0$	
	R = 3381.70 N	1
	II) consider the stone is just moving down the plane,	
	we know, $F = \mu R$	
	$= 0.65 \times 3381.70$	
	frictional force (F) = 2198.105 N	
	∴ F = 2198.105 N	1

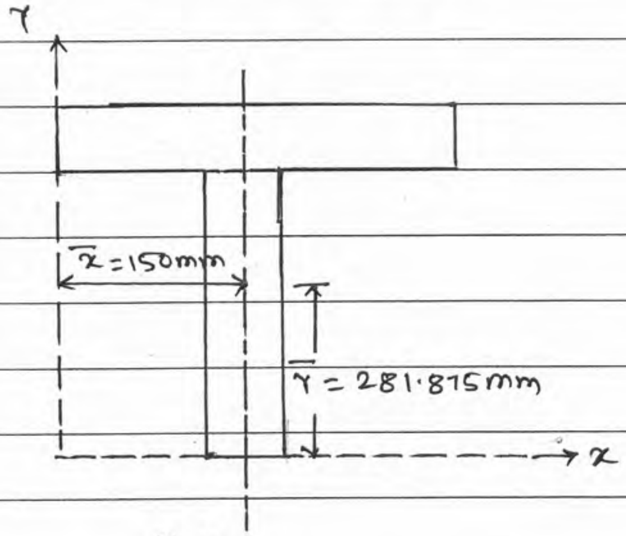
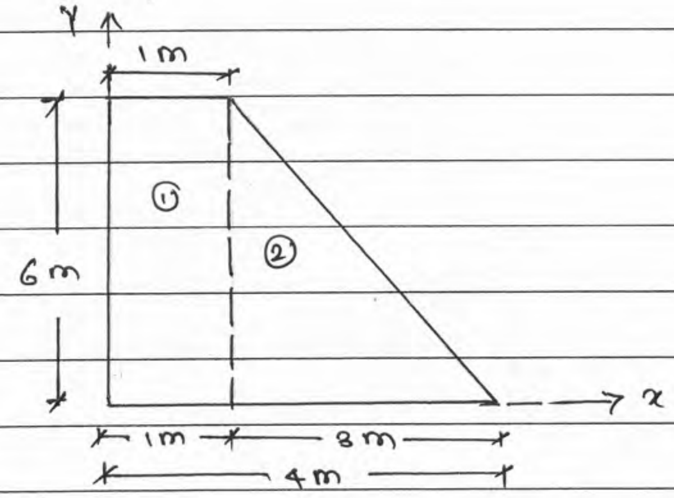
Q.NO	SOLUTION	MARKS
Q.5 d. continue---	Downward component of weight of stone	
	$= 4414.5 \sin 40$	
	$= 2837.58$ N	
	$\therefore$ 2837.58 N > 2198.105 N,	1
	$\therefore$ Stone will not be stable.	
(e)	e.) Given data:-	
	$W_1 = 25$ kN $= 25000$ N $W_2 = 10$ kN $= 10000$ N	
	$P_1 = 250$ N $P_2 = 125$ N	
	$\eta_1 = 80\%$	
	Find: I) velocity ratio, II) Law of machine	
	I) we know that,	
	$M.A. = W_1/P_1 = 25000/250$	
	$M.A. = 100$	1
	$\eta = \frac{M.A.}{V.R.} \times 100$	
	$80 = \frac{100}{V.R.} \times 100$	
	$V.R. \times 80 = 10{,}000$	
	$\therefore V.R. = \frac{10{,}000}{80}$	
	$V.R. = 125$	1

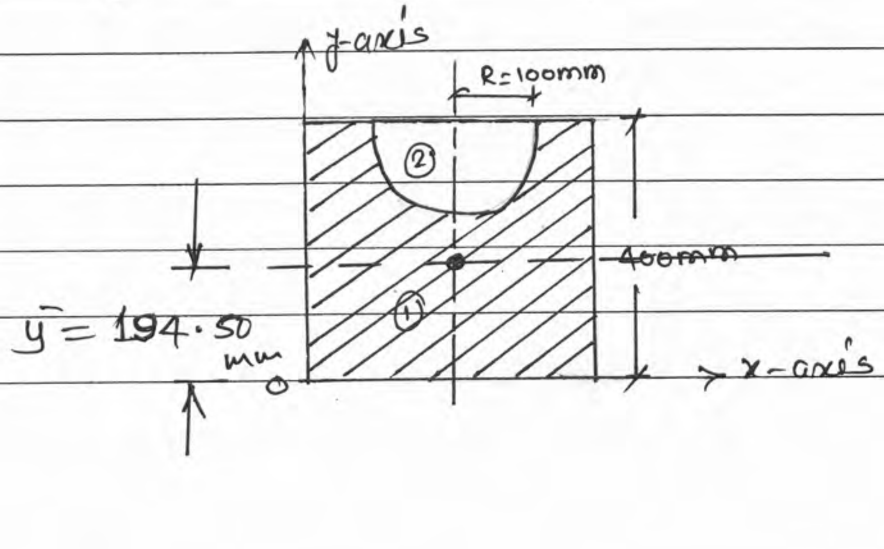
Q.NO	SOLUTION	MARKS
Q.5 e. continue---	II) To find law of machine:	
	$W_1 = 25000$, $P_1 = 250N$	
	$W_2 = 10,000$, $P_2 = 125N$	
	we know that,	
	$P = mW + C$ -- Law of machine eq^n.	
	substituting the values of W & P in the law of machine equation, we get	
	$250 = m(25000) + C \longrightarrow (i)$	
	$-125 = m(10,000) + C \longrightarrow (ii)$	
	$125 = 15000m$	
	$\therefore m = 0.0083$	$\frac{1}{2}$
	put the value of 'm' in equation (i), we get,	
	$250 = 25000 \times 0.0083 + C$	
	$250 = 207.5 + C$	
	$250 - 207.5 = C$	
	$\therefore C = 42.5N$	$\frac{1}{2}$
	$\therefore$ Law of machine is,	
	$P = 0.0083W + 42.5N$	1

Q .NO		SOLUTION	MARKS
Q5	f.)	Given data:	
		$W = 35\ KN = 35000\ N$	
		$P = 480\ N$	
		$L = 1\ m = 1000\ mm$	
		$p = 6\ mm$	
		Find: Efficiency $(\eta) = ?$	
		I) $V.R. = \frac{2\pi L}{p} = \frac{2\pi \times 1000}{6}$	$\frac{1}{2}$
		$\therefore$ $V.R. = 1047.197$	1
		II) $M.A. = \frac{W}{P} = \frac{35000}{480}$	
		$M.A. = 72.92\ N$	1
		III) $\eta = \frac{M.A.}{V.R.} \times 100$	$\frac{1}{2}$
		$= \frac{72.92}{1047.197} \times 100$	
		$\therefore$ $\eta = 6.96\%$	1

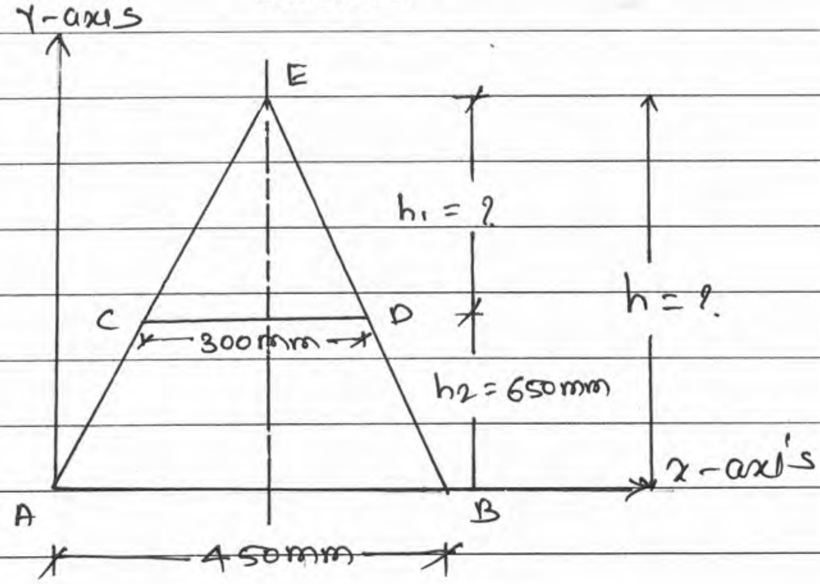
Q .NO	SOLUTION	MARKS
6.	Attempt any four of the following :	
(a)		$\frac{1}{2}$
	I) $\theta = 60^\circ$, equilateral Triangle, 	
	$\therefore \tan\theta = \frac{h}{1.25}$	
	$\tan 60 = \frac{h}{1.25}$	
	$\therefore$ $h = 2.16m$	$\frac{1}{2}$
	II) The Given Figure is symmetrical about Y-Y axis	
	$\therefore \bar{x} = \frac{2.5}{2}$	$\frac{1}{2}$
	$\bar{x} = 1.25m$	
	II) $a_1 = 2.5 \times 2.5 = 6.25m^2$	
	$a_2 = \frac{1}{2} \times 2.5 \times 2.16 = 2.7m^2$	$\frac{1}{2}$

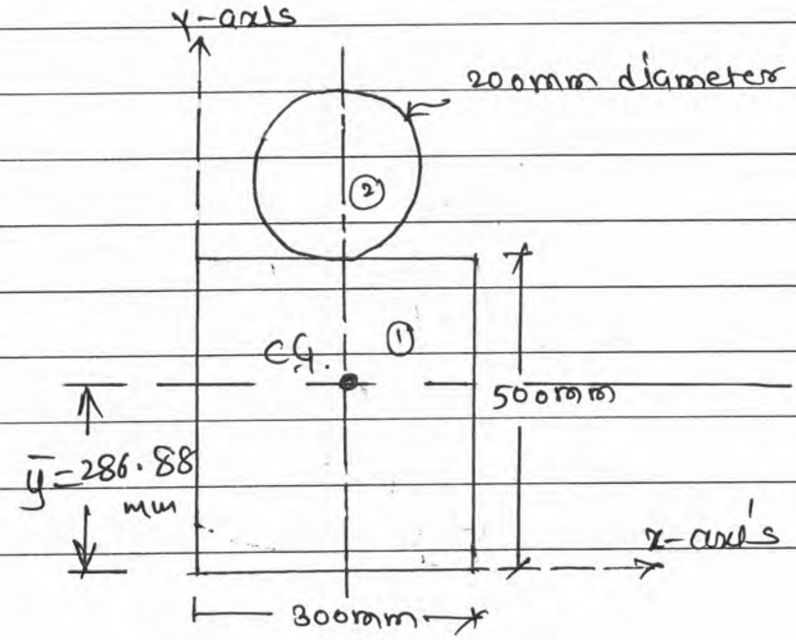
Q .NO	SOLUTION	MARKS
Q.6(a) continue----	$y_1 = \frac{2.5}{2} = 1.25\ m$	1
	$y_2 = 2.5 + \frac{2.16}{3} = 3.22$	
	$\bar{y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2} = \frac{(6.25 \times 1.25) + (2.7 \times 3.22)}{(6.25 + 2.7)}$	
	$\boxed{\bar{y} = 1.844\ m}$	1
(b)	b) $a_1 = 350 \times 20 = 7000\ mm^2$ $a_2 = 300 \times 30 = 9000\ mm^2$ The fig is symmetrical about Y-Y axis $\therefore \bar{x} = \frac{300}{2}$ 	$\frac{1}{2}$
	$\boxed{\bar{x} = 150\ mm}$	1
	$y_1 = \frac{350}{2} = 175\ mm,$	1/2
	$y_2 = 350 + \frac{30}{2} = 350 + 15 = 365\ mm$	1/2

Q.NO	SOLUTION	MARKS
Q.6b. continue----	$\bar{Y} = \dfrac{a_1 y_1 + a_2 y_2}{a_1 + a_2}$	
	$= \dfrac{(7000 \times 175) + (9000 \times 365)}{(7000 + 9000)}$	
	$\bar{Y} = 281.875mm$	1
		1/2
(C) a)		1/2
	Divide the section of retaining wall into reactangle say (1) & triangle say (2).	

Q .NO	SOLUTION	MARKS
Q.6 C. continue---	$a_1 = 6 \times 1 = 6 m^2$, $a_2 = \frac{1}{2} \times 3 \times 6 = 9 m^2$	$\frac{1}{2}$
	$x_1 = \frac{1}{2} = 0.5 m$	
	$x_2 = 1 + \frac{b}{3} = 1 + \frac{3}{3} = 2 m$	$\frac{1}{2}$
	$y_1 = \frac{6}{2} = 3 m$	
	$y_2 = \frac{h}{3} = \frac{6}{3} = 2 m$	$\frac{1}{2}$
	$\therefore \bar{x} = \frac{a_1 x_1 + a_2 x_2}{a_1 + a_2}$	
	$= \frac{(6 \times 0.5) + (9 \times 2)}{(6 + 9)}$	
	$\boxed{\bar{x} = 1.4 m}$	1
	$\bar{Y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2}$	
	$= \frac{(6 \times 3) + (9 \times 2)}{(6 + 9)}$	
	$\boxed{\bar{Y} = 2.4 m}$	1
(d)		$\frac{1}{2}$

Q .NO	SOLUTION	MARKS
Q. 6 d. continue---	Given data:	
	Side of a solid cube = 400mm	
	Diameter of hemispherical cut = 200mm	
	R = 100 mm	
	$V_1 = (400)^3 = 64 \times 10^6 \text{ mm}^3$	
	$V_2 = \frac{2}{3}\pi R^3 = \frac{2}{3}\pi (100)^3 = 2094.395 \times 10^3 \text{ mm}^3$	1
	The composite solid is symmetrical about Y-Y axis.	
	$\therefore \bar{x} = \frac{400}{2}$	
	$\boxed{\bar{x} = 200\text{mm}}$	$\frac{1}{2}$
	$y_1 = \frac{400}{2} = 200\text{mm}$.	
	$y_2 = 400 - \frac{3R}{8} = 400 - \frac{3(100)}{8}$	1
	$= 362.5 \text{ mm}$	
	$\therefore \bar{Y} = \frac{V_1 y_1 - V_2 y_2}{V_1 - V_2} =$	
	$= \frac{(64 \times 10^6 \times 200) - (2094.395 \times 10^3 \times 362.5)}{(64 \times 10^6) - (2094.395 \times 10^3)}$	
	$\therefore \boxed{\bar{Y} = 194.50\text{mm}}$	1

Q .NO	SOLUTION	MARKS
Q 6	e.) 	$\frac{1}{2}$
	I) From similar Triangles, AEB & ECD	
	$\frac{AB}{CD} = \frac{h}{h_1}$ $(h = h_1 + h_2)$	
	$\therefore \frac{450}{300} = \frac{h_1 + 650}{h_1}$ $\therefore (h = h_1 + 650)$	
	$450 h_1 = 300 (h_1 + 650)$	
	$450 h_1 = 300 h_1 + 195000$	
	$450 h_1 - 300 h_1 = 195000$	
	$150 h_1 = 195000$	
	$\therefore h_1 = 1300$ mm	
	$\therefore h = 1300 + 650 = 1950$ mm	1
	II)	
	$V_1 = \frac{1}{3} \pi R^2 h = \frac{1}{3} \pi (225)^2 \times 1950$	
	$= 103.378 \times 10^6 \text{ mm}^3$	1
	$V_2 = \frac{1}{3} \pi R^2 h_1 = \frac{1}{3} \pi (150)^2 \times 1300 = 30.63 \times 10^6 \text{ mm}^3$	

Q .NO	SOLUTION	MARKS
Q.5(e) continue----	The figure is symmetrical about Y-Y axis	
	$\bar{x} = \frac{450}{2} = 225\ mm$	
	$\boxed{\bar{x} = 225\ mm}$	$\frac{1}{2}$
	$y_1 = \frac{h}{4} = \frac{1950}{4} = 487.5\ mm$	
	$y_2 = h_2 + \frac{h_1}{4} = 650 + \frac{1300}{4} = 975\ mm$	
	$\bar{Y} = \frac{V_1 y_1 - V_2 y_2}{V_1 - V_2}$	
	$= \frac{(103.378 \times 10^6 \times 487.5) - (30.63 \times 10^6 \times 975)}{(103.378 \times 10^6) - (30.63 \times 10^6)}$	
	$\boxed{\bar{Y} = 282.20\ mm}$	1
(f)		$\frac{1}{2}$

Q .NO	SOLUTION	MARKS
Q.6(f) continue----	$V_1 = \pi R^2 h = \pi (150)^2 \times 500$	
	$= 35.34 \times 10^6\ mm^3$	
	$V_2 = \frac{4}{3} \pi R^3$	
	$= \frac{4}{3} \pi (100)^3$	1
	$= 4.188 \times 10^6\ mm^3$	
	The fig. is symmetrical about Y-Y axis	
	$\therefore \bar{x} = \frac{300}{2} = 150mm$	$\frac{1}{2}$
	$y_1 = \frac{500}{2} = 250mm$	
	$y_2 = 500 + \frac{200}{2} = 600mm$	1
	$\therefore \bar{Y} = \frac{V_1 y_1 + V_2 y_2}{V_1 + V_2}$	
	$= \frac{(35.34 \times 10^6 \times 250) + (4.188 \times 10^6 \times 600)}{(35.34 \times 10^6 + 4.188 \times 10^6)}$	
	$\bar{Y} = 286.88\ mm$	1