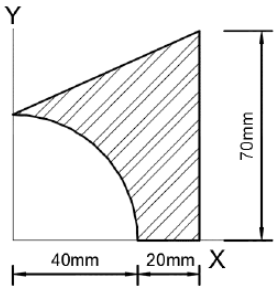
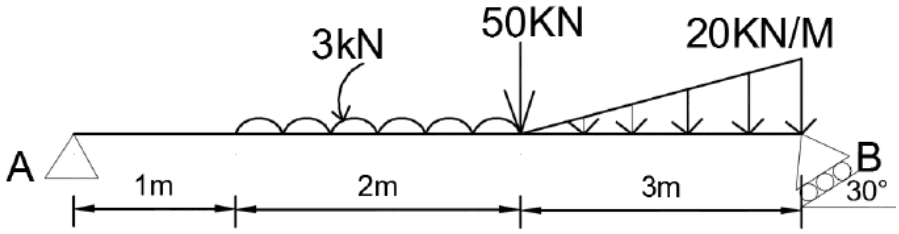
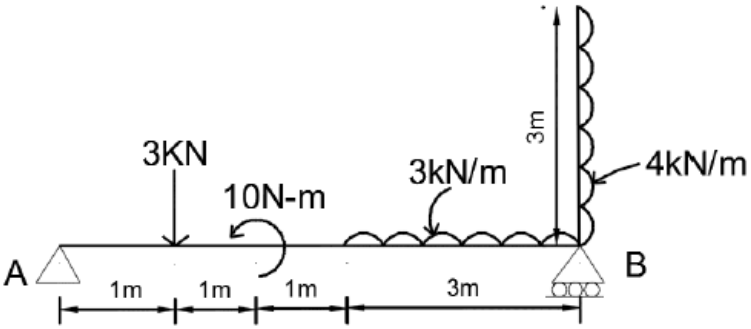
CMR INSTITUTE OF TECHNOLOGY	Roll NO				CMR

Improvementent Test

Sub:	Elements of Civil Engineering and Engineering Mechanics							CO104.de:	15CIV13
Date:	19 /11 / 2016	Duration:	90 mins	Max Marks:	50	Sem:	I	Branch:	All

Note: Q1and Q2 are compulsory, Attemp for 50m including Q1 and Q2 irrespective of sub questions

		Marks	OBE CO	OBE RBT
1(a)	Locate the position of centroid of the shaded area shown in Fig. 1b  Fig.1a	[07]	CO104.5	L2
(b)	A particle falling under gravity falls 30 meters in a certain second. Find the time required to cover next 30 meters. take g= 10 m/s^2	[03]	CO104.6	L2
2 (a)	Determine the reactions at the supports for the beam loaded as shown in Fig.2a  Fig. 2a	[07]	CO104.4	L2
(b)	Define the following terms (i) Position (ii) Distance (iii) kinematics	[03]	CO104.6	L1
3(a)	Derive the expression for centroid of a triangle of base ‘b’ and height ‘h’ with respect to base of the triangle.	[06]	CO104.5	L2
(b)	Determine the reactions at the supports for the beam loaded as shown in Fig.3b  Fig.3b	[08]	CO104.4	L3

4 (a)	A motorcyclist starts from a point with uniform acceleration of $2m/s^2$. After 10 s, a car starts from rest from the same point with a uniform acceleration of $6m/s^2$. Calculate when and where car overtakes the motorcycle.	[07]	CO104.6	L2
(b)	What is super elevation and why is it provided?	[03]	CO104.6	L1
5(a)	The velocity of a particle along a straight path is defined by a relation $v = 6t-3t^2$ m/s where t is in seconds. Knowing that x=0 when t=0. Determine (i) The particle's acceleration and position when t=4 sec. (ii) The distance travelled during this interval.	[07]	CO104.6	L2
(b)	Briefly explain (i) uniform velocity motion (ii) Projectile motion (iii) Horizontal range of the projectile.	[03]	CO104.6	L1
6(a)	A gunman fires a bullet with a velocity of 100m/s, 50° upwards from the top of a hill 300m high to hit a bird. The bullet misses its target and finally lands on the ground. Calculate (i) the maximum height reached by the bullet above the ground level (ii) Total time of flight (iii) horizontal range of the bullet to the point of landing (iv) velocity with which the bullet hits the ground.	[08]	CO104.6	L2

Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO104.1:	Explain the various infrastructural amenities of Civil Engineering like Roads, Bridges and Dams	1	2	1	1	1	1	1	1	1	1	2	3
CO104.2:	Solve simple problems related to action of forces on rigid bodies	2	2	1	1	2	1	1	1	1	1	2	2
CO104.3:	Solve simple problems on friction	2	3	2	3	3	1	1	1	1	3	1	2
CO104.4:	Solve problems related to support reactions of the beams	3	2	2	2	2	1	1		1	2	2	3
CO104.5:	Locate the Centroid, Compute Moment of Inertia of composite cross-sections.	3	2	3	3	2	1	1	2	1	2	3	2
CO104.6:	Solve problems related to motion of bodies performing rectilinear and curvilinear motion.	2	2	2	3	2	1	1	1	1	1	2	3

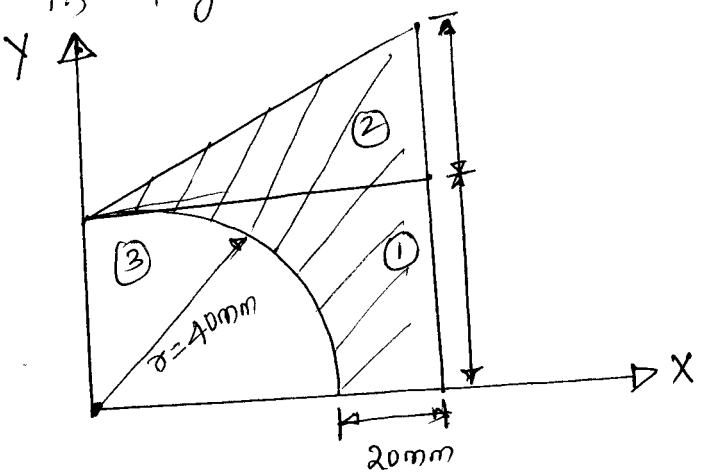
Cognitive level	KEYWORDS
L1	List, define, tell, describe, identify, show, label, Collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PO1 - *Engineering knowledge*; PO2 - *Problem analysis*; PO3 - *Design/development of solutions*; PO4 - *CO104nduct investigations of CO104mplex problems*; PO5 - *Modern tool usage*; PO6 - *The Engineer and society*; PO7- *Environment and sustainability*; PO8 – *Ethics*; PO9 - *Individual and team work*; PO10 - *CO104mmunication*; PO11 - *Project management and finance*; PO12 - *Life-long learning*

SOLUTION AND SCHEME OF EVALUATION : 1

Improvement test - Nov-2016 15CIV13/23

1 (a) Locate the position of centroid of the shaded area shown in fig.

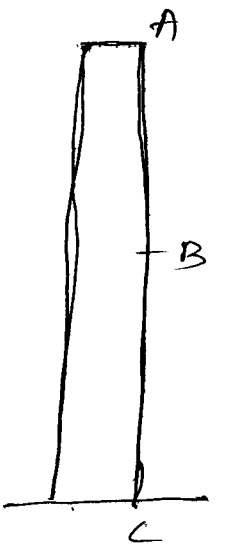


Component	Area (mm^2)	$\bar{x}$ (mm)	$\bar{y}$ mm	$a\bar{x}$	$a\bar{y}$
① Rectangle	$60 \times 40 = 2400$	$60/2 = 30$	$40/2 = 20$	~~48000~~ 72000	48000 (2)
② Triangle	$\frac{1}{2} \times 60 \times 30 = 900$	$\frac{2}{3} \times 60 = 40$	$40 + \frac{1}{3} \times 30 = 50$	36000	45000 (2)
③ Quarter circle	$-\frac{\pi \times 40^2}{4} = -1256.63$	$\frac{4 \times 40}{3\pi} = 16.97$	$\frac{4 \times 40}{3\pi} = 16.97$	-21333.21	-21333.21 (2)
	2043.37			86666.78	71666.79

$\bar{X} = 42.41 mm$ $\bar{Y} = 35.07 mm$ (1)

1(b) A particle falling under gravity falls 30m in a certain second. Find the time required to cover next 30m take $g = 10\ m/s^2$

Soln:



$AB = 30m$, $BC = 30m$.

motion from A to B

$$s = ut + \frac{1}{2}gt^2$$

$$30 = 0 + \frac{1}{2} \times 10 \times t_{AB}^2$$

$$t_{AB} = 2.44s \quad (1)$$

$$v = u + gt$$

$$V_B = 0 + 10 \times 2.44$$

$$V_B = 24.4\ m/s. \quad (1)$$

Motion from B to C (b)

$$s = ut + \frac{1}{2}gt^2$$

$$30 = 24.4\,t + \frac{1}{2} \times 10\,t^2$$

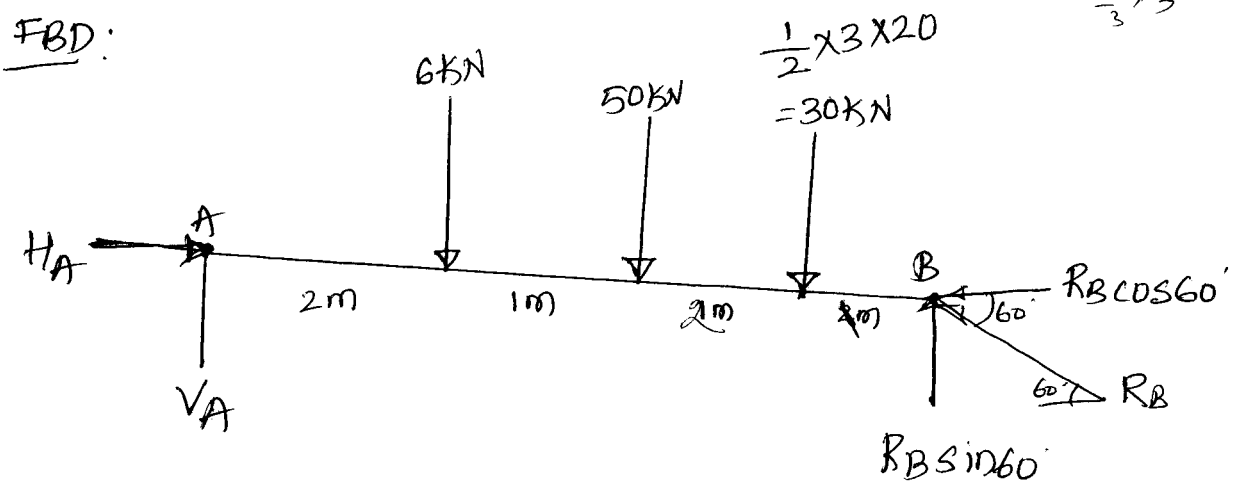
$$5t^2 + 24.4\,t - 30 = 0$$

$$t = 1.0173\ s. \quad (1)$$

2 (a) Determine the reactions at the supports for the beam loaded as shown in fig.

Soln.

FBD:



(2)

$\sum F_H = 0 \quad H_A - R_B\cos60 = 0 \longrightarrow (1)$ (1)

$\sum F_V = 0 \quad V_A + R_B\sin60 = 6+50+30 \longrightarrow (2)$ (2)

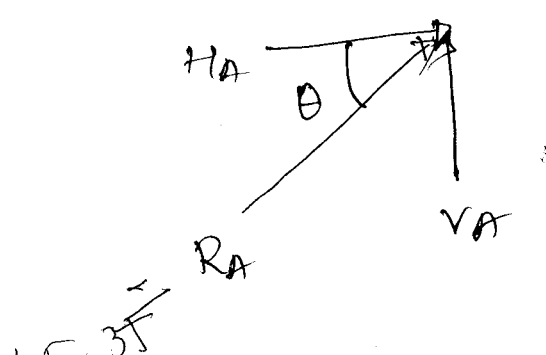
$\sum M_A = 0$

$6 \times 2 + 50 \times 3 + 30 \times 5 - R_B\sin60 \times 6 = 0$

$R_B = 60.04$ ~~54.27~~ KN.

$\therefore H_A = 30$ ~~27.135~~ KN (2)

$V_A =$ ~~39~~ KN 34



$R_A = \sqrt{H_A^2 + V_A^2}$

$R_A =$ ~~47.51 KN~~ 45.35 KN

$\theta = \tan^{-1}\left(\frac{V_A}{H_A}\right)$ (1)

$\theta = 55.17°$

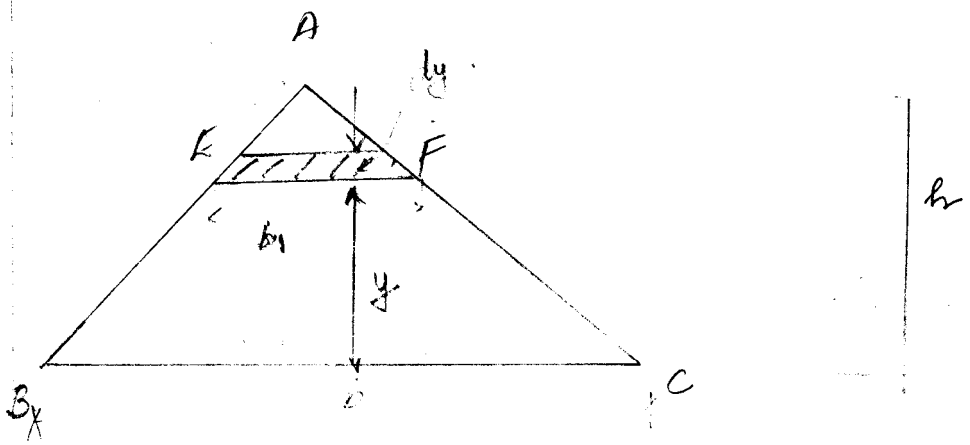
2(b) Define (i) Position (ii) Distance (iii) Kinematics.

Ans: (i) Position :- It is the location of the particle along the path with respect to a fixed reference point. (1)

(ii) Distance :- It is the length measured along the path of the particle during motion. (1)

(iii) Kinematics :- may be defined as the study of motion of a body without considering the force causing the motion of the body. (1)

3(a) CENTROID OF A TRIANGLE:



Consider a Δ^{le} ABC of base width - b, height - h

Centroid is located from base. (2)

Δ^{le} AEF & Δ^{le} ABC are similar.

$$\frac{b_1}{b} = \frac{h-y}{h}$$

$$b_1 = \left[\frac{h-y}{h}\right] b = \left[1 - \frac{y}{h}\right] b.$$

Area of element $= b_1 dy = dA$

$$dA = \left[1 - \frac{y}{h}\right] b\, dy.$$

$$\bar{y} = \frac{\int y\, dA}{A}$$

$$\int y\, dA = \int_0^h y \left[1 - \frac{y}{h}\right] b\, dy. \quad (2)$$

$$= \int_0^h \left[y - \frac{y^2}{h}\right] b\, dy.$$

$$= b\left[\frac{y^2}{2} - \frac{y^3}{3h}\right]_0^h.$$

$$= \left\{ b\left[\frac{h^2}{2} - \frac{h^3}{3h}\right] - [0] \right\}$$

$$= b\left[\frac{h^2}{2} - \frac{h^2}{3}\right] \qquad = b\left[\frac{3h^2 - 2h^2}{6}\right]$$

$$\int y\,dA = \frac{bh^2}{6} \qquad A = \frac{1}{2}bh.$$

$$\bar{y} = \frac{\int y\,dA}{A} = \frac{bh^2}{6} \times \frac{1}{\frac{1}{2}bh}$$

$$\boxed{\bar{y} = \frac{h}{3}}$$

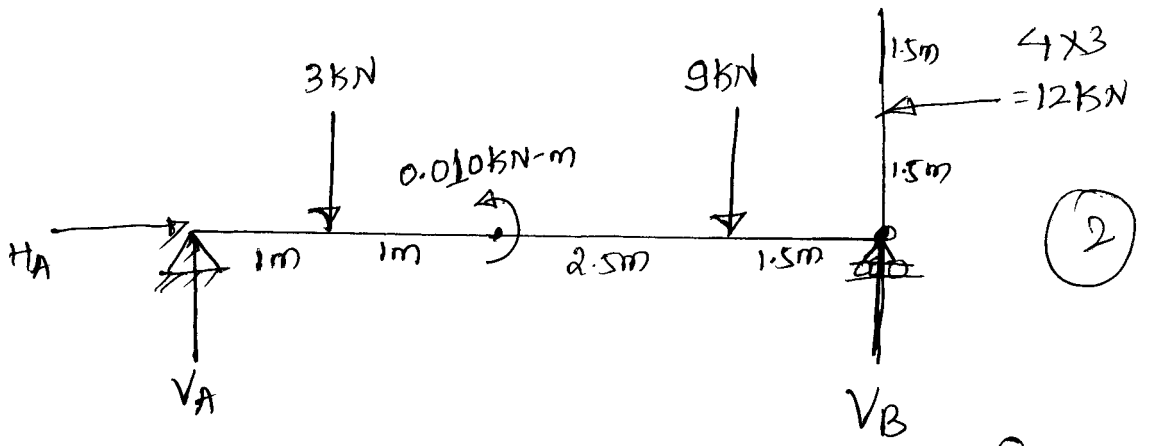
(2)

Thus the centroid of a triangle

$h/3$ from base

$2h/3$ from apex.

3(b) Determine the reactions at the supports for the beam shown in fig.



(2)

(1)

$\sum F_x = 0$

$H_A - 12 = 0 \quad H_A = 12KN$

(1)

$\sum F_y = 0$

$V_A + V_B = 3 + 9$

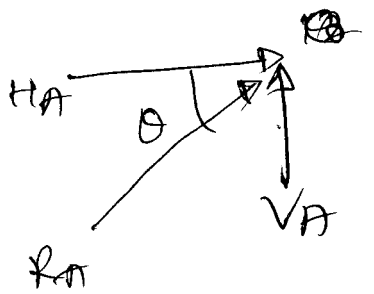
$V_A + V_B = 12\ KN \longrightarrow (1)$

$\sum M_A = 0$

$-V_B \times 6 + 3X1 - 0.01 + 9X4.5 - 12X1.5 = 0$

$V_B = 4.248\ KN$ (2)

$\therefore V_A = 7.75\ KN$

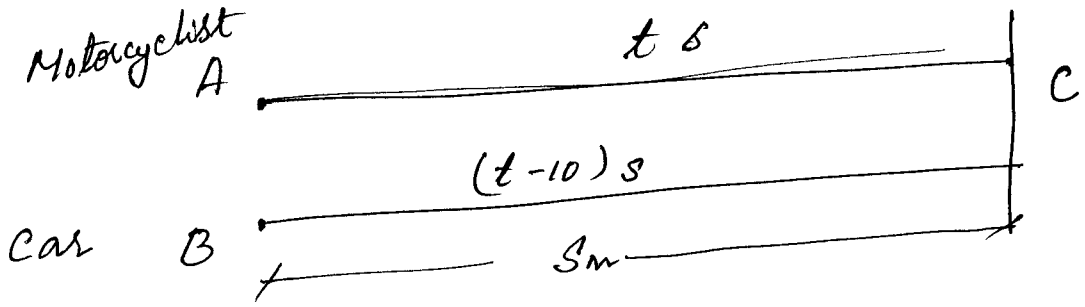


$R_A = 8.83\ KN$

$\theta = 32.855^\circ$ (2)

4 (a)

Soln



Motion of Motorcycle

$A \to C \quad u = 0 \quad t = t\,s$

$a = 2\,m/s^2$

$S = ut + \frac{1}{2}at^2$

$S = 0 + \frac{1}{2}(2)t^2$ (2)

$S = t^2$ — (1)

Motion of Car.

$B \to C \quad u = 0 \quad t = (t-10)s$

$a = 6\,m/s^2$

$S = ut + \frac{1}{2}at^2$

$S = 0 + \frac{1}{2}(6)(t-10)^2$ (2)

$S = 3(t-10)^2$ — (2)

Equating eqn (1) & (2)

$t^2 = 3(t-10)^2$

$\sqrt{\frac{1}{3}}\,t = (t-10)$ (3)

$t = 23.6\,s$

$S = 556.96\,m$

4(b).

Super Elevation:

It is the inward transverse slope provided throughout the length of the horizontal curves to counteract the centrifugal force and therefore to check the tendency of the vehicles to overturn or skid. (3)

It is provided to prevent lateral slipping of the vehicle due to the centrifugal force.

$$\tan\theta = \frac{V^2}{gr}$$

where θ is the banking angle.

5 (a) $v = 6t - 3t^2$

$a = \frac{dv}{dt} \Rightarrow a = 6 - 6t \quad m/s^2$.

(i) $t = 4s, \quad a = -18\ m/s^2$.

$v = \frac{dx}{dt} = 6t - 3t^2$ (2)

$\therefore \int_0^x dx = \int_0^t (6t - 3t^2)\, dt$

$x = 3t^2 - t^3$.

(ii) $t = 4s. \quad x = 3 \times (4)^2 - (4)^3$ (2)

$x = -16m$.

$v = 0 \qquad 0 = 6t - 3t^2$

$3t = 6$

$t = 2s$

$\therefore \quad d = |x_4 - x_2| + |x_2 - x_0|$

$= |-16 - 4| + |4 - 0|$ (3)

$d = 24m$

$x_2 = 3 \times 4 - (2)^3$

$x_2 = 4,$

5 (b)

(i) Uniform Velocity Motion:

For a particle whose velocity remains the same throughout the motion is said to undergo a uniform velocity motion. (1)

eg: Packages moving on a conveyor belt.

$V = \frac{S}{t}$ — uniform velocity Equation.

(ii) Projectile Motion:

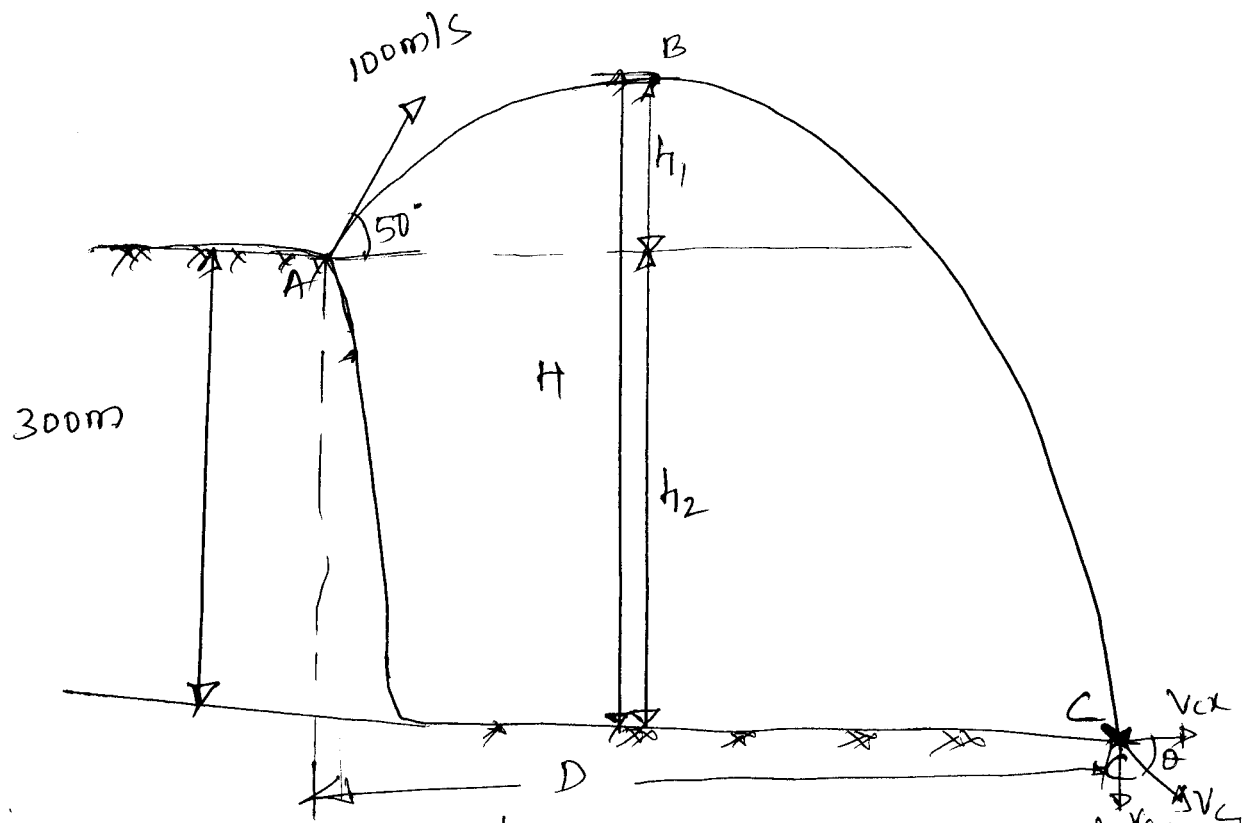
A particle freely projected in the air in any direction other than vertical, follows curved path and this motion is reffered to as a projectile motion. (1)

(iii) Horizontal Range of projectile:

It is the horizontal distance between the point of projection and target point (1)

$R = \{$Horizontal component of velocity of projection$\}$ × Time of flight

6 (a)



Motion from A → B

Vertical (↑)

$v^2 = u^2 - 2gxs$

$0 = (100\sin 50)^2 - 2\times 10\times h_1$

$h_1 = 293.41\text{m}$ (1)

$v = u - gt$

$0 = 100\sin 50 - 10\times t_{AB}$

$t_{AB} = 7.66\ s$

Motion B → DC vertical

$H = h_1 + h_2$

$= 293.41 + 300$

$H = 593.41$ (1)

$s = ut + \frac{1}{2}gt^2$

$593.41 = \frac{1}{2}\times 10\times t_{BC}$

$t_{BC} = 10.89\ s$

$T = t_{AB} + t_{BC}$

$= 18.55\ s$ (2)

Motion from A → C H.M

$s = v \times T$

$D = (100\cos 50)\times 18.55$

$D = 1192.37\text{m}$ (2)

$V_{cx} = 100\cos 50 = 64.278$

motion B → DC V.M

$v = u + gt_{BC}$ (2)

$v_{cy} = 10\times 10.89$ $\theta = 59.44$

$v_{cy} = 108.9$

$V_c = 126.455\text{m/s}$