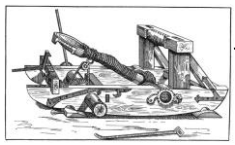


NAME: Meharamt Singh Roll No: 102003241 Group: 2CO10

This submission is original work and no part is plagiarized (signed)

(Date) 31st August, 2021

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

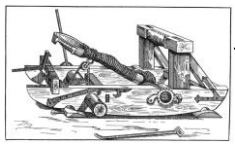
MECHANICAL ENGINEERING DEPARTMENT

Thapar Institute of Engineering and Technology, Patiala

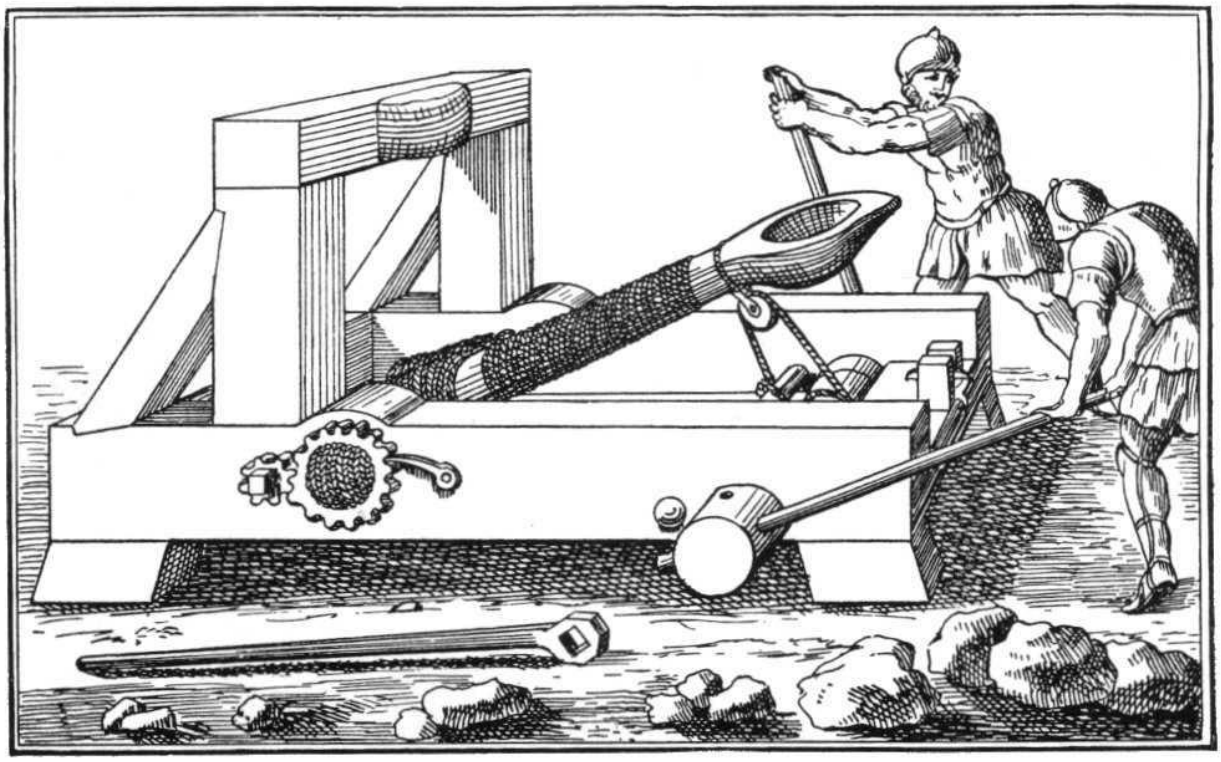
ASSIGNMENT - 2.
DYNAMICS FOR THE MANGONEL-WITH DRAG

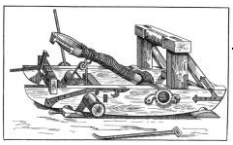
UTA016 Engineering Design Project-I

(Reference: TCD course 1E13



NAME: Meharamt Singh Roll No: 102003241 Group: 2CO10





NAME: Meharamt Singh Roll No: 102003241 Group: 2CO10

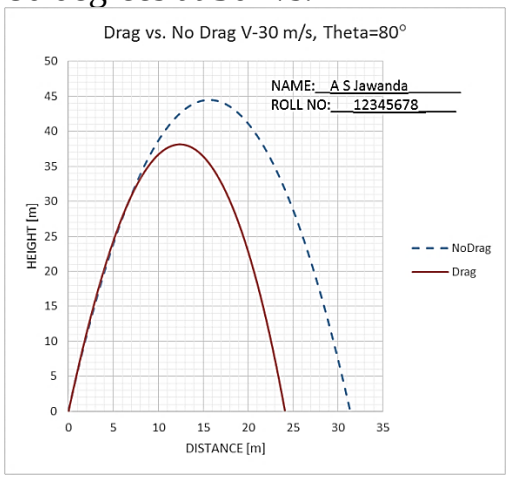
ASSIGNMENT - 2

DYNAMICS FOR THE MANGONEL-WITH DRAG

The following tasks have been based on the lecture on projectile dynamics for the Mangonel -**With Drag**.Complete the following **individually, copying will be dealt with severely.**

Notes:

1. Ensure the curves are visible and sufficient resolution is provided so that the height and distance is determinable. Keep scale of x-axis and y-axis roughly the same, e.g. 10m on x-axis and y-axis should be forming a square. The following chart is an example for 80 degrees at 30m/s.



Note:Compulsory to Add Text box of Name and Roll No to every graph as shown.

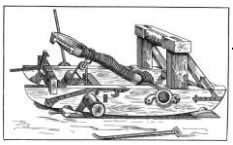
2. The excel graphs for Drag Vs No Drag Velocity=20m/s, Angle=50 degrees have to be shown for evaluation on the same day. While the remaining questions are to be submitted in next Tutorial class (if it is a holiday, then as instructed).
3. Do not leave this assignment until the last minute to find you have some IT issue.

Enjoy the assignment and try to think around the subject as much as possible and take from it any tips that you might use with your own Mangonel design.

Marking Scheme:

Tutorial 1 Total = 5 Marks
Evaluation at end of Tutorial class = 2.5
Home evaluation = 2.5

TUTORIAL CLASS EVALUATION



NAME: Meharamt Singh Roll No: 102003241 Group: 2CO10

Only Q1a below evaluated at the end of tutorial class on computer.

Point five Marks each for: **[2.5 Marks]**

1. Excel sheet formulation,
2. Layout,
3. Graph series,
4. Graph clarity and
5. Graph format, as given in note.

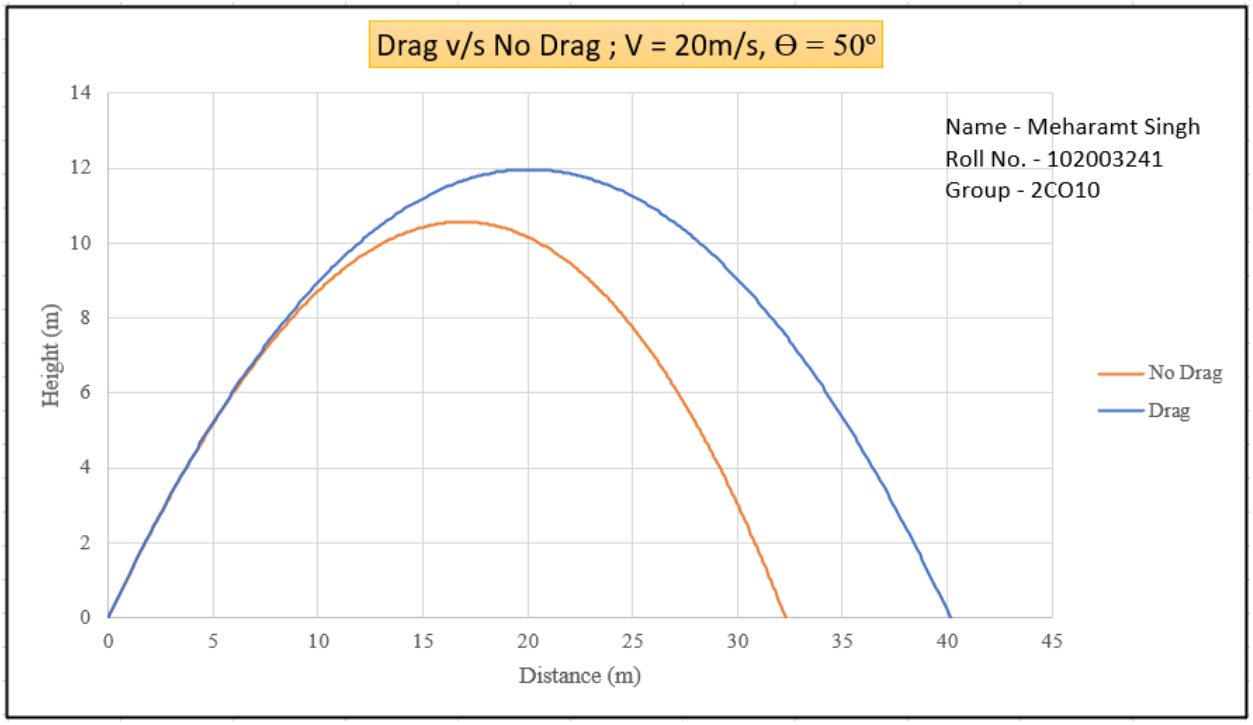
NOTE: ***Compulsory*** *to Add Text box of Name and Roll No to every graph as shown.*

Save this word document adding your name and roll number to the front page. Using the Excel spreadsheets that you have developed in class to model the dynamics of a "missile" cast by the Mangonel which is subject to aero-dynamic drag, cut and paste charts for the following parameters into the document below:

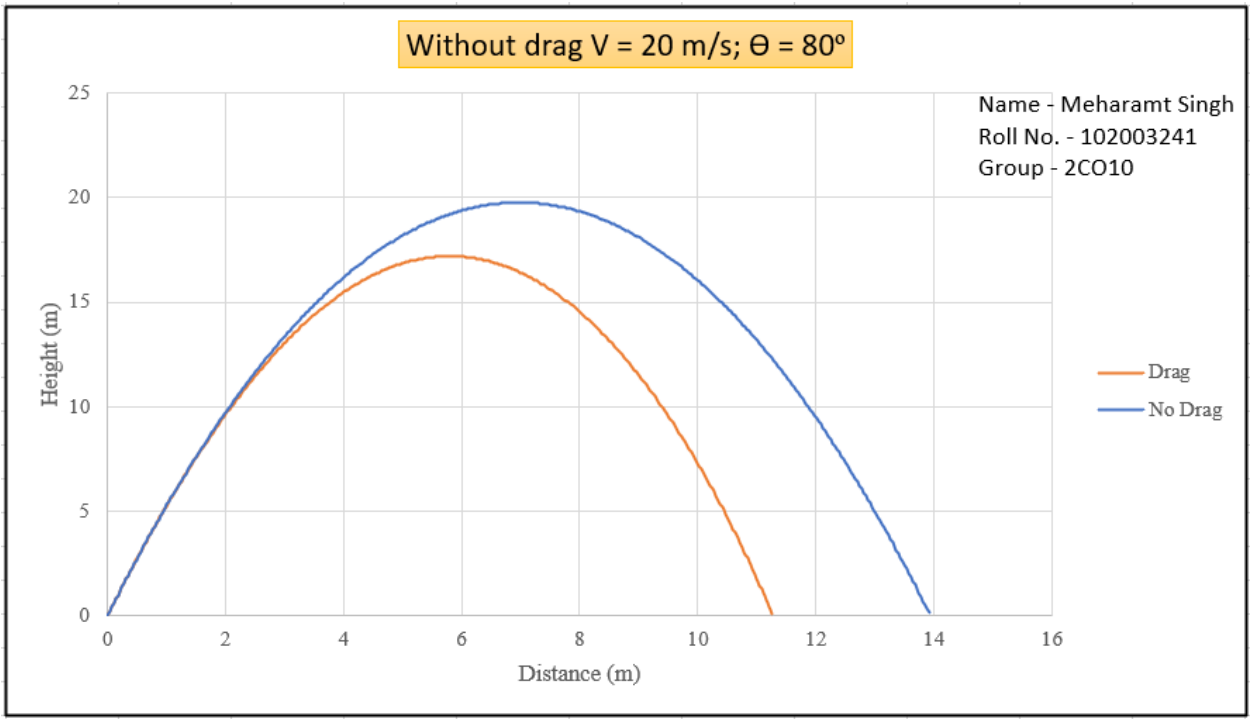
Q1. Use rho=1.2 kg/m^3, Cd=0.4, mass=0.05kg, D=0.045 m.

a. Drag Vs No Drag. Velocity=20m/s, Angle=50 degrees

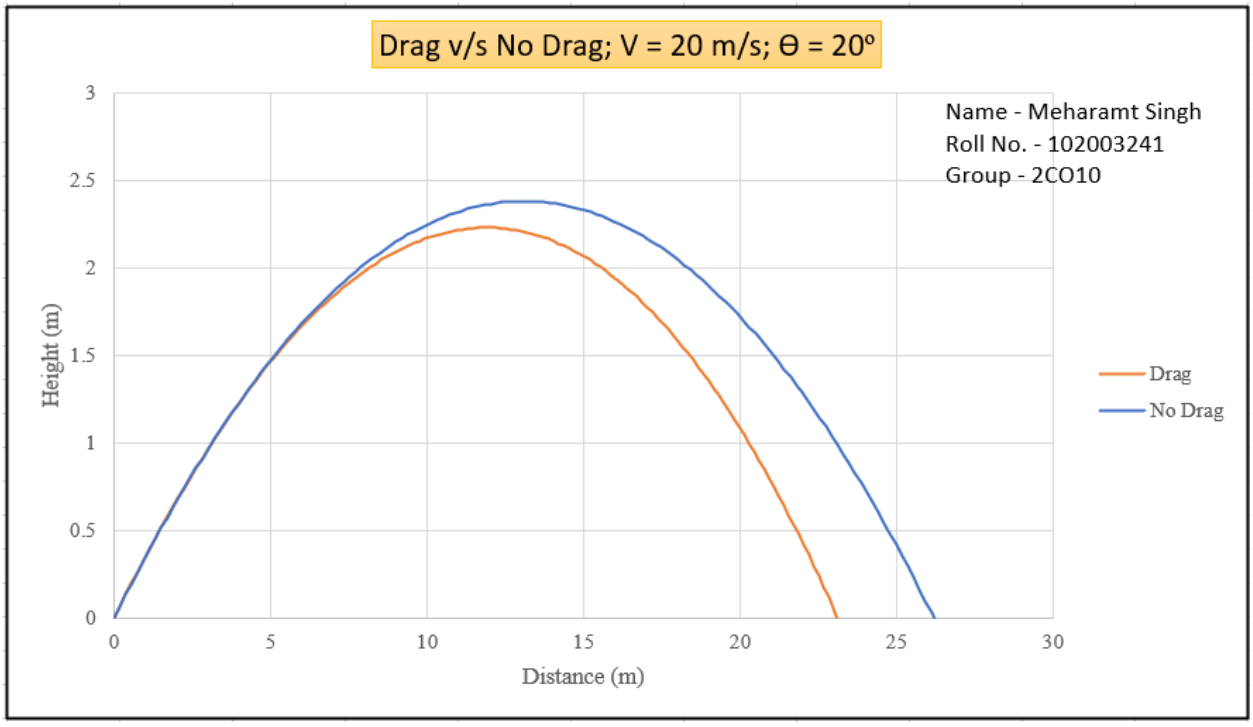
Soft copy evaluated at the end of 2 Hours of practical class on computer.



b. Drag Vs No Drag. Velocity=20m/s, Angle=80 degrees



c. Drag Vs No Drag. Velocity=20m/s, Angle=20 degrees



Q2. Read, from the figures determined in Q1 or directly from the results calculated using your spreadsheets, the predicted max. horizontal distances travelled (in the x-direction when y = 0 approx.) for the "drag" and "no-drag" cases. Complete the following table with **hand written values**. Round your results to nearest integer (no decimal places).

(2)	25 Degrees	45 Degrees	75 Degrees
x (with drag) [m]	27	33	16.5
x (no drag) [m]	31	41	20.5

Q3. Complete the following table by **hand written values** for the maximum distance travelled in x. Use values rho=1.2 kg/m^3, mass=0.05kg, D=0.045m, theta=45degrees in this question.

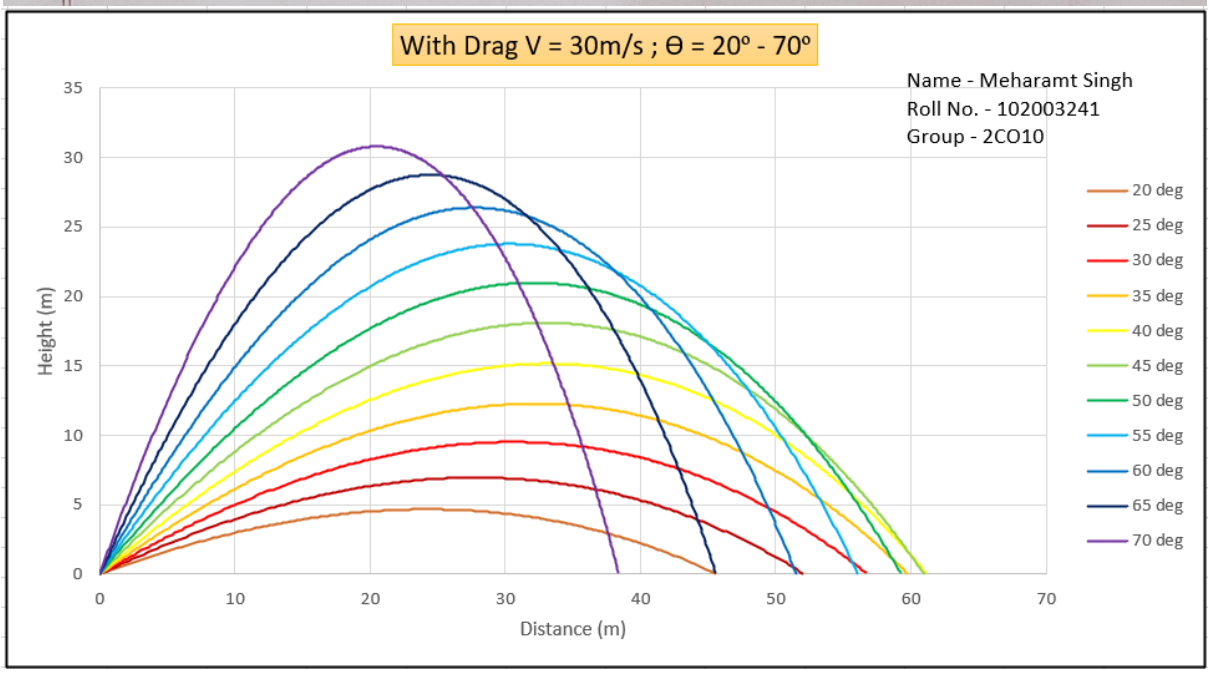
(3) Cd / Velocity	10 m/s	30 m/s	40 m/s
0	10.18	91.64	162.92
0.5	9.46	56.53	79.64
1.0	8.83	42.34	55.49

Q4. Complete the following table by **hand written values** for the maximum distance travelled in x. Use values rho=1.2 kg/m^3, Cd=0.4, D=0.045m, Theta=45degrees in this question.

(4) mass / velocity	10m/s	30m/s	40m/s
0.020 [kg]	9	42.4	55.9
0.040 [kg]	9.5	66.5	79.8
0.080 [kg]	9.8	69.1	109.8

Q5. For a 30m/s launch velocity, taking the values rho=1.2 kg/m^3, Cd=0.4, mass=0.05kg, D=0.045 m find the maximum horizontal distance of travel for launch angle varying from 20 to 70 degrees and record **hand written values** in table below. Plot the graph and use it to find the angle of launch which would give maximum horizontal distance of travel.

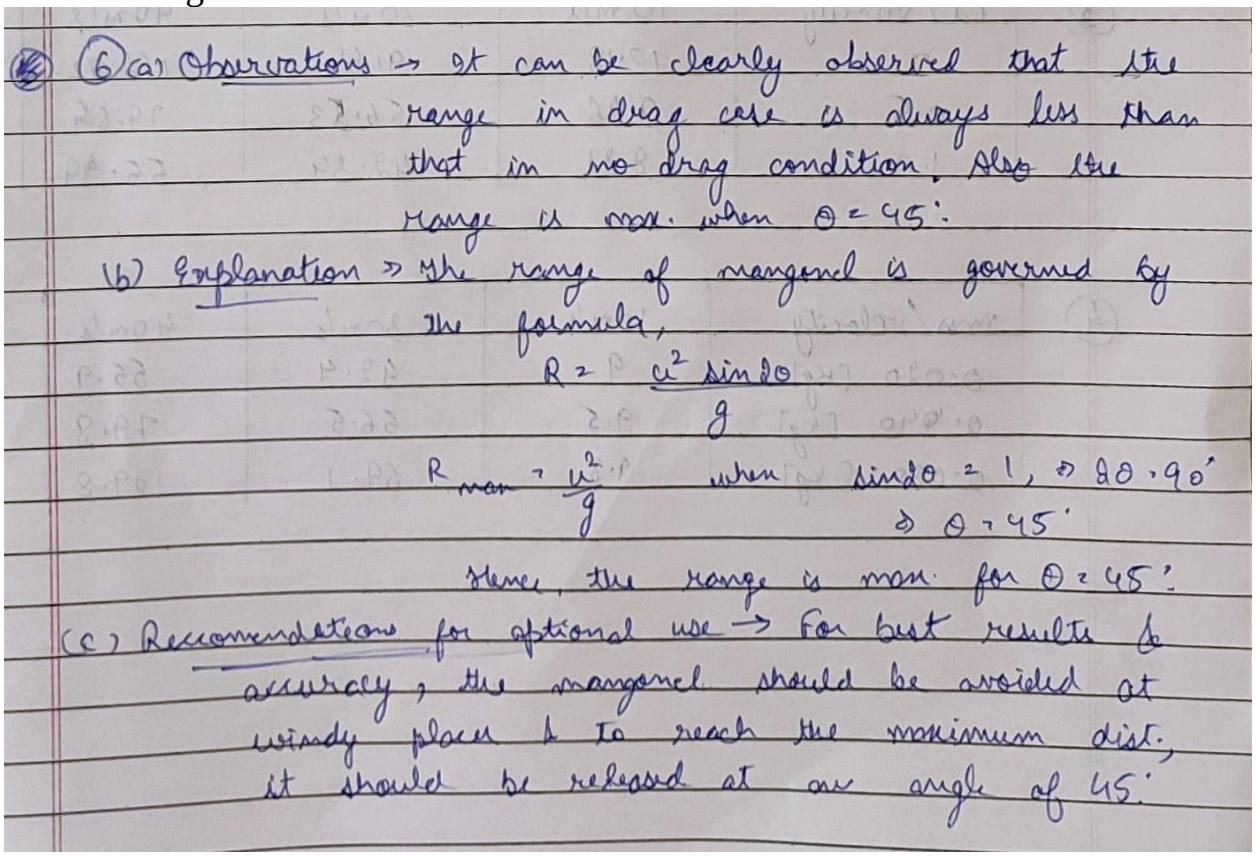
(5) Angle	Max. Distance in x
20°	45.51
25°	52.02
30°	57.67
35°	59.72
40°	61.1
45°	60.99
50°	59.21
55°	56.08
60°	51.52
65°	45.55
70°	88.35



NOTE: Answers to Q6,Q7, Q8, Q9 and Q10 to be **hand written only**

[5 Marks]

Q6. From the results of question 2, write one or two sentences to address each of the following:



(6) (a) Observations → It can be clearly observed that the range in drag case is always less than that in no drag condition. Also the range is max. when $\theta = 45°$.

(b) Explanation → The range of mangonel is governed by the formula,

$$R = \frac{u^2 \sin 2\theta}{g}$$

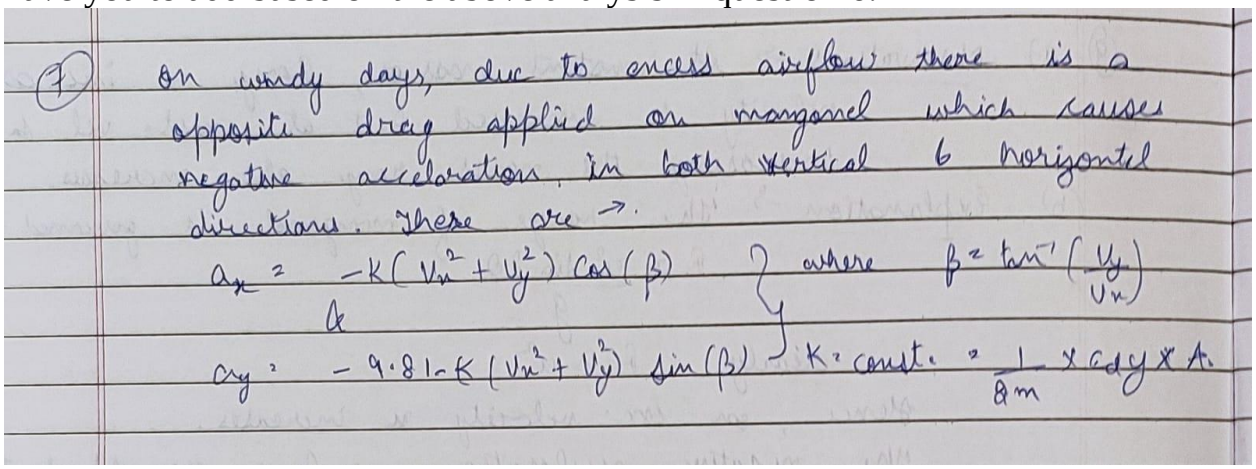
$R_{max} = \frac{u^2}{g}$ when $\sin 2\theta = 1$, $\Rightarrow 2\theta = 90°$

$\Rightarrow \theta = 45°$

Hence, the range is max. for $\theta = 45°$.

(c) Recommendations for optional use → For best results & accuracy, the mangonel should be avoided at windy places & To reach the maximum dist., it should be released at an angle of 45°.

Q7. If we were to test the mangonel outside in windy conditions, what comments have you to add based on the above analysis in question 6.



(7) On windy days, due to excess airflow there is a opposite drag applied on mangonel which causes negative acceleration in both vertical & horizontal directions. These are →

$$a_x = -K(V_w^2 + V_y^2)\cos(\beta)$$

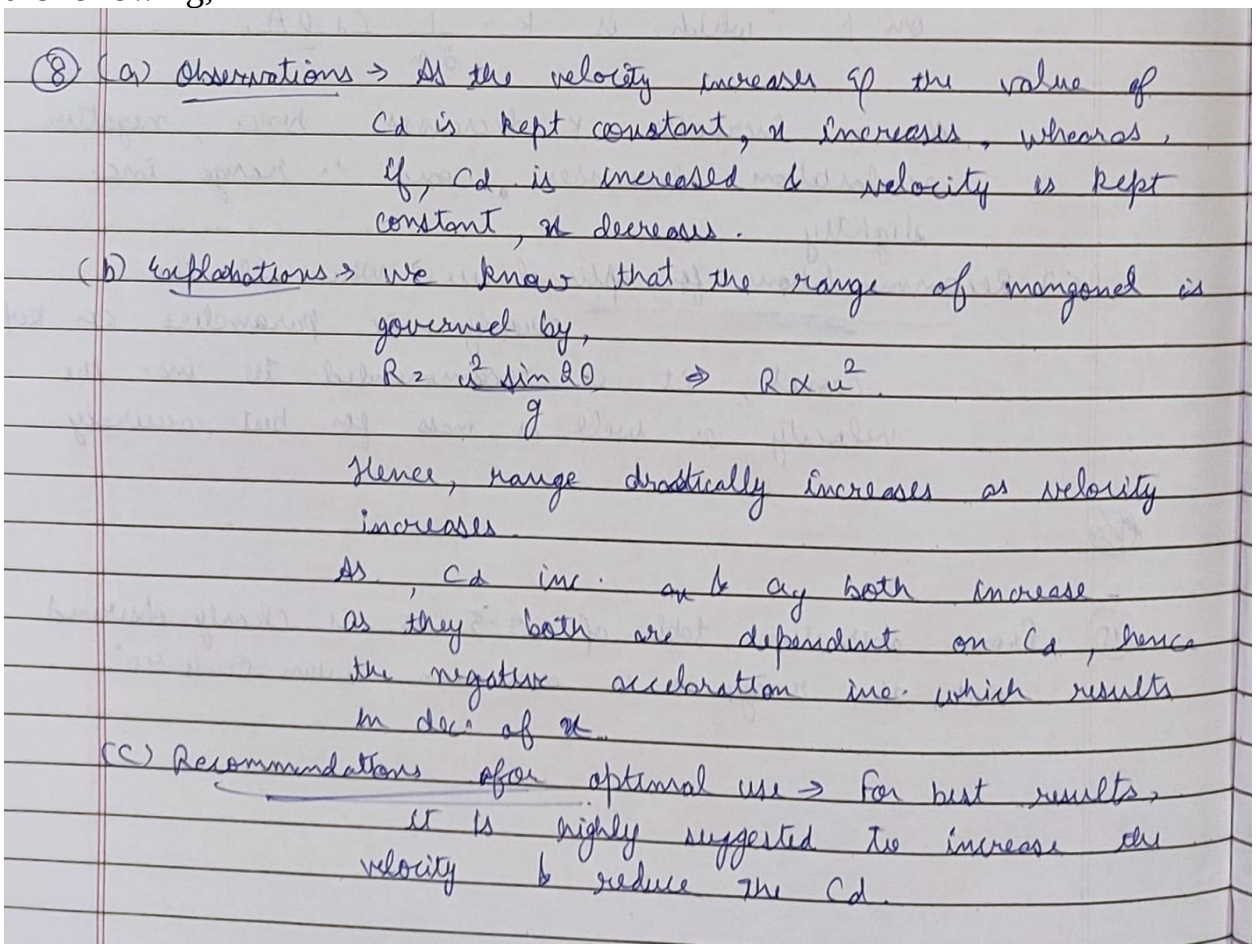
&

$$a_y = -9.81 - K(V_w^2 + V_y^2)\sin(\beta)$$

where $\beta = \tan^{-1}\left(\frac{V_y}{V_w}\right)$

K = const. $= \frac{1}{2m} \times C_d \rho \times A$.

Q8. From the results of question 3, write one or two sentences to address each of the following;



(8) (a) Observations → As the velocity increases & the value of C_d is kept constant, x increases, whereas, if C_d is increased & velocity is kept constant, x decreases.

(b) Explanations → We know that the range of mangonel is governed by,

$$R = \frac{u^2 \sin 2\theta}{g} \Rightarrow R \propto u^2.$$

Hence, range drastically increases as velocity increases.

As, C_d inc. & by both increase as they both are dependent on C_d, hence the negative acceleration inc. which results in dec. of x.

(c) Recommendations for optimal use → For best results, it is highly suggested to increase the velocity & reduce the C_d.

Q9. From the results of question 4, write one or two sentences to address each of the following;

(9) (a) Observations → At constant mass as, Range x inc. as velocity is increased. But at const. vel. by increasing the mass, range also increases.

(b) Explanation → The range of mangonel is governed by

$$R = \frac{u^2 \sin 2\theta}{g}$$

clearly $R \propto u^2$.

Hence, on inc. velocity x increases.

The negative acceleration, on & ay are dependent on K which is $K = \frac{1}{2m} C_d \rho A$.

As m increases, K decreases, hence, negative acceleration decreases, and ∴ range inc. slightly

(c) Recommendations for optimal use → When all the aerodynamic parameters are kept const., it is recommended to inc. the velocity as well as mass for best accuracy.

Q10. From question 5 angle of launch which would give maximum horizontal distance of travel is:

(10). From observation table of Q-5 it is clearly observed that the range x is maximum when θ is 40°.