To Find the Downward Force, Along an Inclined Plane, Acting on a Roller due to Gravitational Pull of the Earth and Study its Relationship with the Angle of Inclination θ by Plotting Graph Between Force and sin θ.

Aim

To find the downward force, along an inclined plane, acting on a roller due to gravitational pull of the earth and study its relationship with the angle of inclination θ by plotting graph between force and sin θ.

Apparatus

An inclined plane, A trolley or roller, pan, weight box, spring balance, spirit level, strong thread, half metre scale.

Theory

If total weight $W_1 - M_1$ g moves the body up and total weight $W_2 - M_2$ g makes the body move down, then downward force acting on the body along the inclined plane,

$$W = \frac{W_1 + W_2}{2} = \frac{(M_1 + M_2)\, g}{2}$$

This force must equal $mg \sin \theta$.

For same body, m = constant

Hence, $W \propto \sin \theta$.

A graph between sin θ along X-axis and W along Y-axis must be a straight line.

Procedure

1. Test the pulley of the inclined plane and see that it is free from friction. Oil it, if necessary.
2. Keep the apparatus on table with the slot portion of the base beyond the edge of the table.
3. Make the base of inclined plane horizontal (test by spirit level) and make it stable (by putting paper pieces if necessary).
4. Bring the inclined plane to horizontal position (touching the base). The angle of inclination is now zero (as indicated by protractor).
5. Find the weight of the roller by a spring balance and place it on the inclined plane in the middle.
6. Tie one end of a thread to the roller placed on the inclined plane and pass it over the pulley.
7. Pass the thread through the slot in base.

8. Find the weight of the pan by spring balance and tie it to free end of thread, keeping the thread free from board.
9. Raise the inclined plane and fix it at an angle of 30°. The roller may start rolling down with acceleration.
10. Put weights on the pan and increase them till the roller just starts moving upward with uniform velocity only on tapping. Note the total weights in pan.
11. Remove some small weights from weights in the pan till the roller just starts moving downward with uniform speed only on tapping. Note the total weights in pan.
12. Increase the angle of inclination in steps of 5° each, making it 35°, 40°, 45°, 50°, 55° and 60° and repeat steps 10 and 11.
13. Record your observations in table as given below.

Observations

Least count of spring balance = ……..g wt.
Zero error of spring balance (e) = ……g wt.
Zero correction of spring balance (c) = (- e) = …….g wt.
Observed weight of the roller (w_0) = ……g wt.
Corrected weight of the roller (w = mg) = (w_0 + c)
= …….g wt.
Observed weight of the pan (p_0) = ……..g wt.
Corrected weight of the pan (p) = (p_0 + c) = …….g wt.
Table for angle of inclination and weights in pan

Serial No. of Obs.	Angle of inclination (θ)	$\sin\theta$	$w \sin\theta = mg \sin\theta$	Weight in pan when roller moves		Total weight when roller moves		Force acting on roller downward	Error $W - mg \sin\theta$
				Upward w_1(g wt)	Downward w_2(g wt)	Upward $W_1 = w_1 + p$ (g wt)	Downward $W_2 = w_2 + p$ (g wt)	$W = \frac{W_1 + W_2}{2}$ (g wt)	
1.	30°	0.50000							
2.	35°	0.57358							
3.	40°	0.64279							
4.	45°	0.70711							
5.	50°	0.76604							
6.	55°	0.81915							
7.	60°	0.86603							

Graph

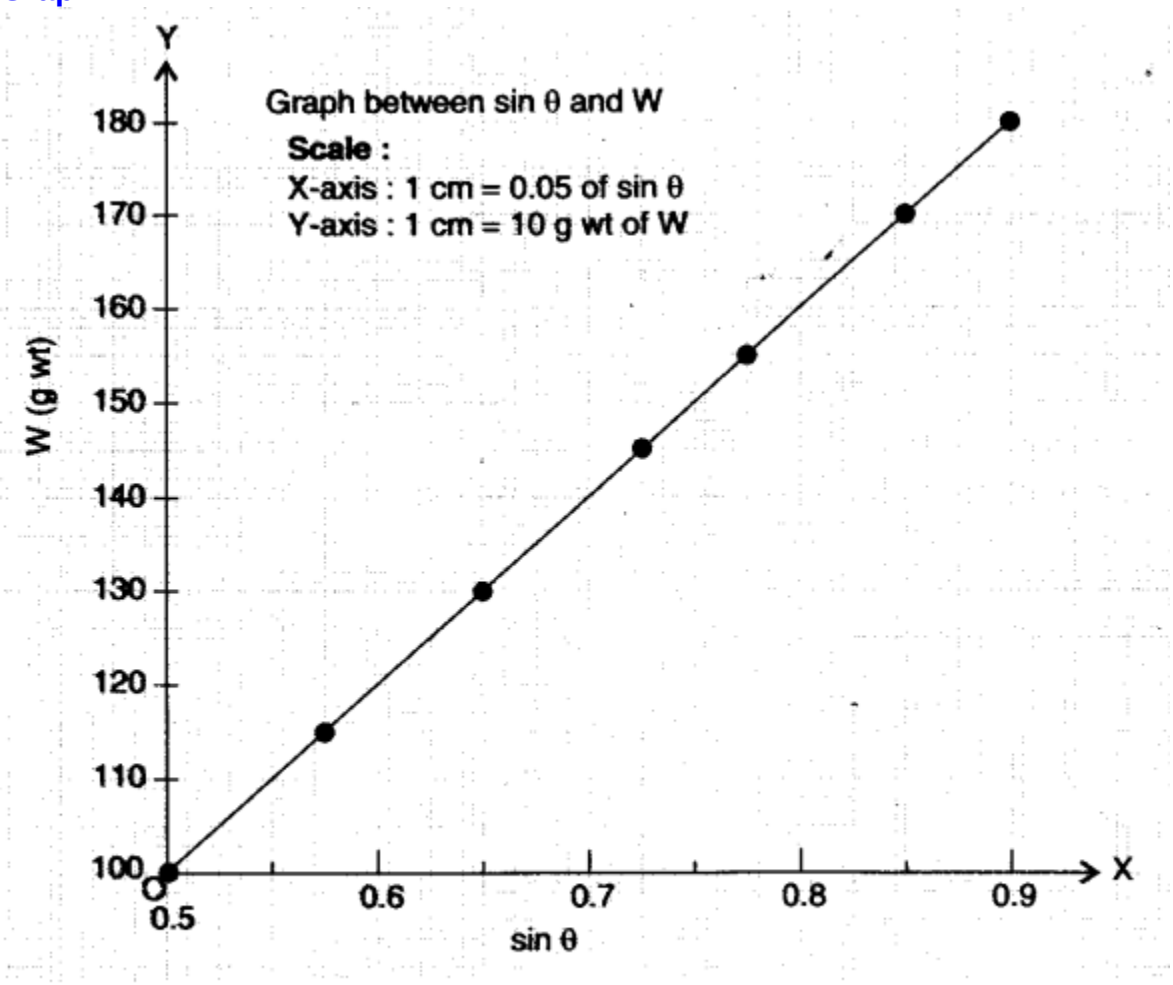

Fig. Graph between sin θ and *W*. It is a straight line.

Result

1. Downward force on the body of weight w = mg comes to be mg sin θ.
2. Graph between sin θ and W comes to be a straight line. Hence, W °c sin θ.

Precautions

1. Pulley should be friction less.
2. Base should be stable and horizontal.
3. Thread should not touch the board or table.
4. Inclined surface should be clean, dry and smooth (use glass top).
5. Weights in pan should be increased or decreased in small steps.

6. Weights should be noted only when the roller just starts moving up or moving down.

Sources of error

1. The pulley may not be friction less.
2. Spring balance may not be accurate.
3. Protractor graduations may not be correct.

Viva Voce

Question.1. What is an inclined plane ?
Answer. It is a wooden plane made smooth by putting a glass sheet over it and makes an angle with the horizontal ground.

Question.2.What is relation between downward force and angle of inclination of the plane ?
Answer. The relation is, W-mg sin θ, which is the component of the weight of the body down the inclined plane.

Question.3.What is the normal reaction on the inclined plane ?
Answer. The normal reaction is mg cos θ. There is no movement in this direction.

Question.4.Why is the glass plate fixed at the top of the inclined plane ?
Answer. To make the inclined plane smooth.

Question.5.Name the few application of an inclined plane.
Answer. Inclined plane is a simple machine which makes the work easier. The following are the applications in
(i) Ramp of house
(ii) Ladder
(iii) A plank put at the back of a truck or a railway wagon for loading and unloading heavy goods.