LAB 3 PROBLEM 3: FRICTIONAL FORCE

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Abstract

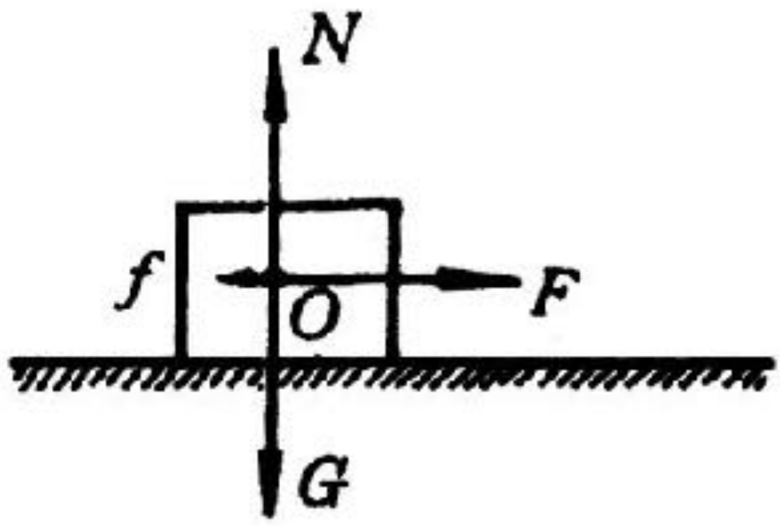
The use of video and analysis softwares to study the motions of object has a great importance. Trying to understand the more fundamental idea of the interaction between friction force and objects, we made an experiences of releasing a mass from a height, attached to a cart on a plane. Once the mass is released from rest, we record the motion and velocity of the cart with a camera equipment placed 133 cm in front of the spring. After the experiments, we learned that the friction force of the cart is constant when it is moving no matter accelerate or not.

Introduction

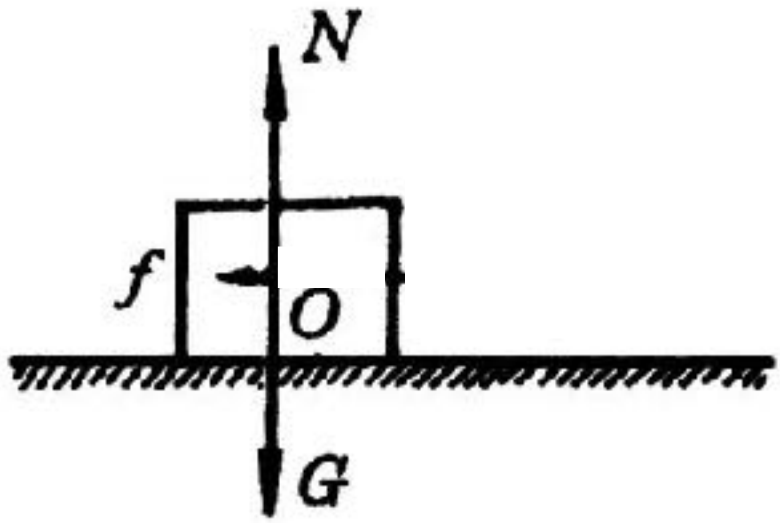
Trying to identify the relation of the **moving status** and **the friction force**, we want to use video analysis as a method of control to provide evidence of the acceleration and therefore the forces. I assume that there will be a constant friction force due to the **law of friction.** So, so we set up a cart with a friction accessory, which is 871.5 g in total, with a mass of 225 g attached at the end of it through a string. Then we released the mass and recorded the video.

Predictions

I assume that after being released, the mass will move straight down and causing the cart to accelerate. Then, after the mass hit the ground, the gravity force it acts on the cart through the string will be removed and then, the other force causing the cart to accelerate will be the friction the cart receives from the plane.



(Figure 1.1 This is the analysis of the forces acting on the cart before the mass hit the ground. There is a normal force and gravity force which cancels each other out. Also, there is a friction f and force F from the mass attached through a string. So, in this case, it will keep accelerating to the right)



(Figure 1.2 This is the analysis of the of forces acting on the cart after the mass hit the ground. There is a normal force and gravity force which cancels each other out. Also, there is a friction f alone the horizontal direction which will provide an acceleration to the left.)

The formula for computing the gravity force on the mass and the cart is:

$$G = mg$$

where m is the mass the weight, g is gravity constant, 9.8N/m^2

Also because

$$\text{Friction} = N*\mu$$

where N is the normal force and the μ is the friction constant

I also measured the time when the mass hit the ground, which was at 0.75 s after I release the mass. Therefore after 0.75s I release the mass, the horizontal forces on the cart has only one left, friction force, predictably. And this force should be the normal force times the constant of friction.

Also, we can assume that when the mass hit the ground, the original acceleration to the right will convert into a deceleration toward the left, because there is only friction left. So, when I use the motionlab's data, I can find this change point of acceleration and therefore do the analysis.

Procedure

We set up a 871.5 g cart and friction accessory, with a mass of 225 g attached at one end of it through a string. Then, we released the mass at the end of the spring and let it be pulled down the cart and accelerate. After a certain time period, when the mass hit the ground, the acceleration of the cart will change. At last, we then uploaded the video into a computer and did some analysis on it with motionLab.

Data

The distance from the camera to the plane of motion was

133.0 ± 0.5 cm

The mass of the cart and friction accessory was :

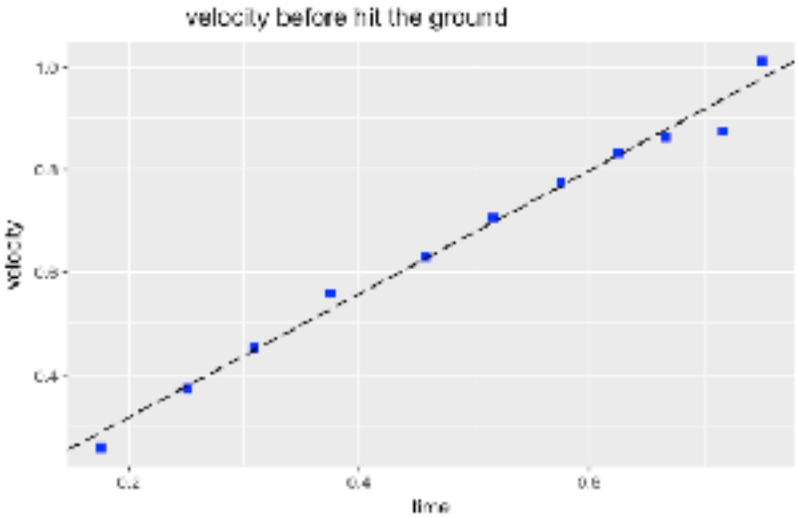
871.5 ± 1 g

The mass of the weight attached to the cart through string was :

225 g

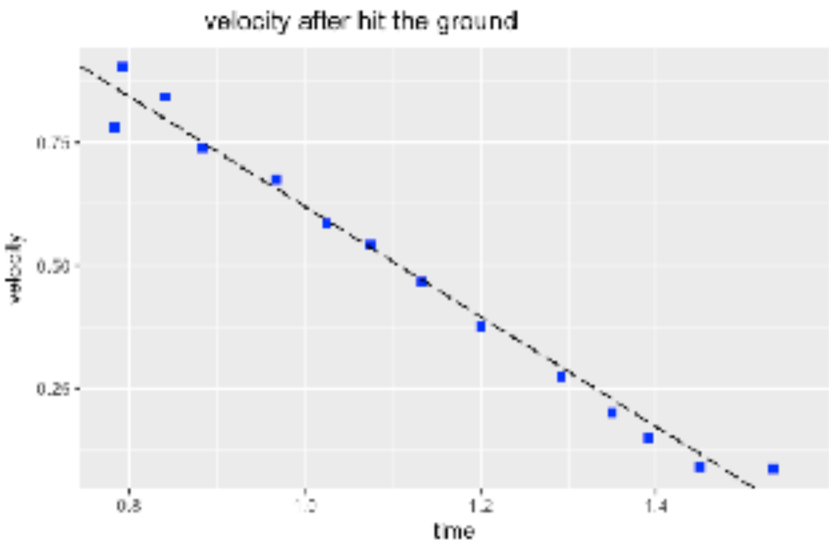
The force exerted by the mass to the cart is:

0.225 kg * 9.8 N/m^2 = 2.2 N



(Figure 1.3, This a graph of time versus the velocity of the cart before the mass hit the ground. In this graph we can clearly see that the cart's velocity goes up as the time passes)

f(t) = 0.08 + 1.2 t



(Figure 1.4 This is a graph of time versus the velocity of the cart after the mass hit the ground. In this graph we can clear see that the cart's velocity goes down as the time passes)

f(t) = 1.74 + -1.12 t

Analysis

According to the data I have collected above. The estimated acceleration of before the mass hit the ground should be the derivative of the velocity function:

$$f'(t) = 1.2 \text{ m/s}^2$$

The acceleration after the mass hit the ground should be the derivative of the velocity function after the mass hit the ground:

$$f'(t) = -1.12 \text{ m/s}^2$$

According to the formula of acceleration:

$$F = ma$$

The net force for the cart before the mass hit the ground should be:

$$F = (0.8715 \text{ kg} + 0.225 \text{ kg}) * 1.2 \text{ m/s^2} = 1.31 \text{ N}$$

So the friction of this situation is:

$$G - F = 1.31\text{N} - 2.2\text{N} = -0.89\text{N}$$

The net force for the cart after the mass hit the ground should be:

$$F = 0.8715 \text{ kg} * -1.12 \text{ m/s^2} = - 0.98 \text{ N}$$

And because in this case, the only force acting o the cart is friction, so the friction is 0.98 N. Based on my calculation, the friction force before the mass hit the ground is -0.89 newton and the friction force after the mass hit the ground is -0,98 N.

These last two graphs(figure 1.3, and figure 1.4) I received by graphing the data suggests that there is always a constant acceleration no matter the mass hit the ground or not. Also, because the gravity acceleration from the mass is a constant, and the total acceleration is a constant, the acceleration caused by the friction force is also a constant. Therefore, it is safe to say that the friction for in these 2 scenario are identical.

Conclusion

It was shown above that friction forces before the mass hit the ground and after the mass hit the ground are basically the same. This result coincides with my guess in the prediction part. The only thing that is unexpected variations of the points I received when I plot the graphs.

This is probably due to that the time interval of this experience is too short that the precision of the measurement is not concrete. However, since our ultimate goal is to analyze the friction, These slight variations is probably not an issue.

In conclusion, we can imply from our result that the **friction force of an object stays constant as long as it is moving no matter how it is accelerated**.