Kinetic Friction

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Objective:

To investigate the properties of kinetic friction – to study how the coefficient of kinetic friction depends on the interface materials, the normal force between them, the contact area, and the relative surface speed.

Theory:

Consider the system of two masses, m and M, connected by a cord passing over a pulley. M is free to slide horizontally; if m is big enough, it will fall and cause M to slide and accelerate to the right. The tension in the cord is T (unimportant). A frictional force f resists the sliding; gravity acts downward on both masses; the horizontal surface reacts upward on mass M with a normal force N = Mg. Let the positive direction be M moving to the right and m moving down. Then f will act to the left. The net force acting on the system (the two connected masses acting as a unit) is mg-f.

Procedure:

First, we got the pulley system attached to the table, next we got the metal plate for object M to slide down put into place. Then, we got cut the string to the length that we thought would be appropriate for our experiment. Once we got it set up we weighed the block of wood and got 117.2g for the mass of the object. We then opened the DataStudio software on the computer and did a couple test runs to make sure that it is working correctly. For the first experiment we put 75g on the hanging weight and ran it three times with that weight and then we did three runs on both 100g and 125g to get our average acceleration. We did this same procedure multiple times for experiments 2,3, and 4; with the block of wood turned on each side and each end, one having felt on it and the other having just wood. For experiments 5 and 6 we tested the large surface of the wood and felt with additional weight on the object. Once as we got all the runs done we then did the calculations for the average acceleration and the coefficient of kinetic friction.

Data:

Exp. 1 Felt, Large Surface

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M,g | m,g | Vave, m/s | A, m/s^2 | µk |
| 117.2 | 75 | 1.0 | 1.98 | 0.308 |
| 117.2 | 100 | 1.25 | 2.85 | 0.314 |
| 117.2 | 125 | 1.5 | 3.48 | 0.333 |

Exp. 2 Wood, Large Surface

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M,g | m,g | Vave, m/s | A, m/s^2 | µk |
| 117.2 | 75 | 1.0 | 1.69 | 0.357 |
| 117.2 | 100 | 1.25 | 2.62 | 0.358 |
| 117.2 | 125 | 1.5 | 3.25 | 0.381 |

Exp. 3 Felt, Small Surface

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M,g | m,g | Vave, m/s | A, m/s^2 | µk |
| 117.2 | 75 | 1.0 | 2.06 | 0.295 |
| 117.2 | 100 | 1.25 | 2.95 | 0.295 |
| 117.2 | 125 | 1.5 | 3.62 | 0.303 |

Exp. 4 Wood, Small Surface

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M,g | m,g | Vave, m/s | A, m/s^2 | µk |
| 117.2 | 75 | 1.0 | 1.74 | 0.349 |
| 117.2 | 100 | 1.25 | 2.76 | 0.331 |
| 117.2 | 125 | 1.5 | 3.45 | 0.339 |

Exp. 5 Felt, Large Surface

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M,g | m,g | Vave, m/s | A, m/s^2 | µk |
| 117.2 | 75 | 1.0 | 2.03 | 0.300 |
| 167.2 | 100 | 1.0 | 1.93 | 0.233 |
| 217.2 | 125 | 1.0 | 1.85 | 0.185 |

Exp. 6 Wood, Large Surface

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M,g | m,g | Vave, m/s | A, m/s^2 | µk |
| 117.2 | 75 | 1.0 | 1.88 | 0.325 |
| 167.2 | 100 | 1.0 | 1.52 | 0.311 |
| 217.2 | 125 | 1.0 | 1.46 | 0.268 |

Formulas:  
ΣF = mg – f = (M+m)a  
f = µkN = µkMg  
µk = m/M – (1+m/M)a/g  
% difference = ((x1 – x2)/(x-x2/2))\*100

Results:

1. Is it a reasonable approximation that µk is independent of velocity over the range of tested velocities? Yes
2. Is it a reasonable approximation that µk is independent of area over the range of tested areas? Yes
3. Is it a reasonable approximation that µk is independent of normal force over the range of tested normal forces? Yes
4. What is the % difference between µk for the wood/Al interface and µk for the felt/Al interface? Wood,x1 = .335, Felt,x2 = .285 = 20%

Error Analysis:

Some of the errors we came up with were; the metal platform was not level on the table, the pulley was not lined up exactly how it should be, and the block could have been angled for some of the runs.

Conclusion:

In conclusion, I learned that the velocity and acceleration of the object greatly affect the coefficient of kinetic friction. The mass of the object also plays an important role in calculating the coefficient of kinetic friction. And I do think that that experiment did accomplish the object that it was designed to do.

References:

We just used each other for references.