Question: How does the angle of a surface affect the friction force of an object sliding on it?
Hypothesis: The friction of the object will not change.
Strategy:

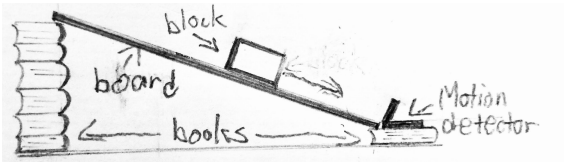

Figure 1: Experiment Setup

- The materials we use were:
  - A **wooden board**, which was used as the ramp
  - A **block** that would slide down the board
  - Many **textbooks** in order to change the angle of the ramp and keep it in place
  - A **Vernier motion detector** at the bottom of the ramp to track the acceleration of the block as it slides down the board
- The mass of the block stayed consistent throughout the experiment; the only thing that changed was the angle the board was set at

Data:

- For each angle of the board, we did 3 trials to measure its acceleration. We also found the mass of the block.

Height of board (cm)	Trial 1 (acc in m/s^2)	Trial 2 (acc in m/s^2)	Trial 3 (acc in m/s^2)
26.4	0.4115	0.4525	0.5779
29.3	1.006	1.041	1.025
33.4	1.647	1.63	1.667
37.3	2.179	2.186	2.217
41.5	2.889	3.051	2.929
44.9	3.474	3.437	3.261

Mass of block: 0.1317 kg

Length of board: 71.9 cm

Figure 2

Analysis:
Since we know the mass of the block, we can easily find what the weight of the block is in Newtons

$$F_g = mg = 0.1317\,kg \times 9.8\,m/s^2 = 1.29066\,N$$

Using the weight of the block and the angle of the board, we could find the gravitational force acting perpendicular to the ramp and parallel to the ramp, which is dependent on the angle the board is set at.

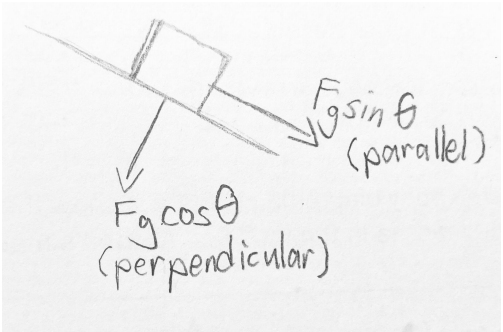

Figure 3: gravitational force acting perpendicular and parallel to the board

To find the angle of the board, we calculated sin(height of board / length of the board). We also took the average acceleration from each trial. This data is shown in Figure 4.

Possible Sources of Error:
Inaccuracies in the motion tracker
Imprecise mass reading
Inaccurate measurement of board height

Height of board (cm)	Angle of incline (deg)	Average acceleration (m/s^2):	Frictional Force (N):
26.4	21.54	0.4806	0.4106
29.3	24.05	1.0240	0.3911
33.4	27.68	1.6480	0.3825
37.3	31.25	2.1940	0.3806
41.5	35.25	2.9563	0.3556
44.9	38.64	3.3907	0.3594

Figure 4

To find the frictional force for each angle of incline, we used this equation:

$$F_N - F_{frict} = ma \qquad F_N = F_g sin\Theta$$

Since we know the mass, acceleration, and normal force (gravitational force parallel to the ramp) of the block for each case, we can easily find the frictional force for each angle of incline, which is listed in figure 3. Figure 5 shows that data graphed with a line of fit.

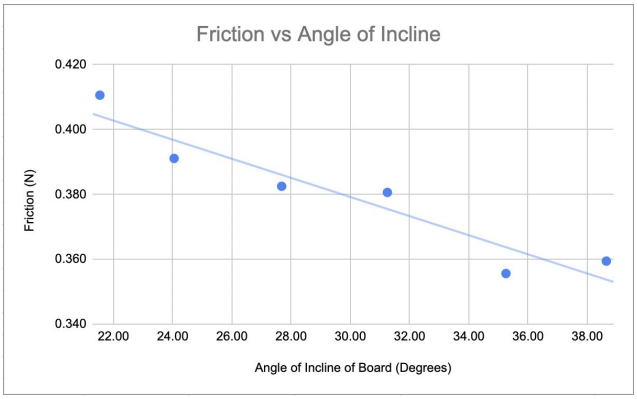

Figure 5

We found that the larger the angle of the board was, the less friction force there was. Though this was not our hypothesis, this result makes sense because the frictional force is directly proportional to our gravitational force perpendicular to the board. The larger the angle of the ramp, the lower the gravitational force perpendicular to the board will be, and the lower the frictional force will be as well

$$F_{frict} = \mu F_g cos\Theta$$