Question: Will the coefficient of kinetic friction vary when the angle of the incline is changed?
Hypothesis: The coefficient of kinetic friction between the two surfaces will remain the same.
Strategy:

- A Modified Atwood's machine was created with a cart with a block dragging behind it to add friction set on a ramp and a weight of washers connected by a string to the cart, over a pulley. The acceleration of the block and cart was then measured by Vernier motion detection after they were released on the inclined ramp.
- The angle of the ramp of a modified atwood's machine was varied by elevating the ramp with textbooks and the different accelerations were measured.
- The weight of the masses of both m1 and m2 were kept constant.

Fig 1: Modified Atwoods's Machine
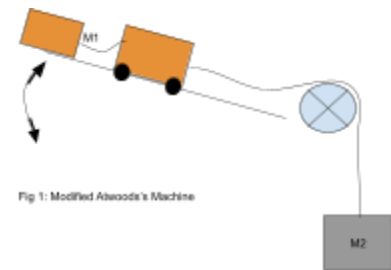
Data:
Weight of washers (M2): .0439 kg
Weight of cart and block (M1): .4231 kg

Angle of incline	Average Acceleration	Mu
0	0.1729	0.0842
2.23	0.4702	0.0897
4.23	0.6100	0.1090
6.91	0.8180	0.1328
8.49	1.2693	0.1095
10.63	1.615	0.1081

Analysis:
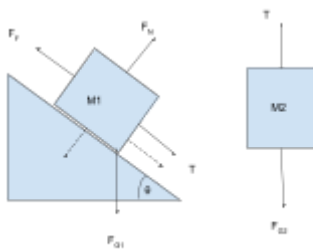   The free body diagrams in Figure 2 show the forces on the masses in the modified Atwood's machine.

Figure 2: Free Body Diagrams

    The following equations are based on the free body diagrams with positive motion being to the right and down for the sliding mass (M1) and down for the hanging mass (M2).

$$T+F_{G1}\sin\theta-\mu F_{G1}\cos\theta = m_1 a$$
$$F_{G2}-T=m_2 a$$

    These equations can be combined to form the equation:

$$F_{G2}+F_{G1}\sin\theta-\mu F_{G1}\cos\theta=(m_1+m_2)a$$

    Using this equation and the data of the acceleration and the angle of incline collected, the coefficient of friction (μ) between the cart with a block attached and the ramp can be solved for each angle. The coefficient of friction for each angle for which data was collected should be constant. The coefficients of friction calculated for each data point were found to vary on average 15% from the average value of 0.11, leading to the conclusion that our hypothesis was correct in that the coefficient of friction does remain constant for different angles.

    Possible sources of error include friction from the pulley that would vary from varying contact with the string based on the different angle that the string attaching the cart and the hanging weight, that it was pushed slightly forward, pulled back slightly, or if the cart's system of measuring its acceleration was slightly flawed.