Atwood's Machine Lab

Objective

Use an Atwood's machine to determine the mass of a key by measuring the motion of a slightly unbalanced 1-kg pulley system.

Equipment

- 1 key
- Pulley
- String
- Ring stand
- 2 × 100 g (0.1 kg) hooked masses
- Meter stick
- Timer
- Mass balance

1. Build your Atwood's Machine

- Attach the pulley securely to the ring stand.
- Hang **100 g** on **both** sides of the string.
- Add the **key** to *one* of the 0.1 kg masses so that side is slightly heavier.
- Ensure both masses hang freely and do not hit the stand.

Draw your apparatus.

Include the pulley, both 0.1 kg masses, the key, and the direction of motion.

2. Measure the distance of descent

- Choose a starting point for the key.
- Measure this vertical distance **in meters** using the meter stick.
- Record this distance.

3. Time the motion

Because the system is only slightly unbalanced, it will move **slow-ish** and be easier to time accurately.

- Pull the key side up to the starting mark.
- Release the key **from rest** and start the timer.
- Stop the timer when it reaches the bottom.
- Repeat for **10 trials** to reduce random error.
- Record all 10 times in a data table.

Compute your average time.

4. Calculate the acceleration of the system

Use the kinematics relationship for motion starting from rest:

5. Draw a free-body diagram

Draw and label all forces acting on:

- the heavier side (0.1 kg + key)
- the lighter side (0.1 kg)

Include:

- gravitational forces mg
- tension in the string
- direction of acceleration

6. Determine the mass of the key

Where:

- $m_1 = 0.1\ \text{kg} + m_{\text{key}}$
- $m_2 = 0.1\ \text{kg}$
- a is from your calculation
- $g = 9.81\ \text{m/s}^2$

Solve for the unknown m_{key}

7. Measure the actual mass of the key

- Use a balance to determine the real mass of the key.
- Record this value.

8. Percent error

Compute:

$$\text{Percent Error} = \frac{\text{Experimental Mass} - \text{Actual Mass}}{\text{Actual Mass}} \times 100\%$$

9. Identify sources of error

List at least **two** sources of error in this experiment.