Lab: Capturing Motion Data AP Physics

Background
A classic, time-honored strategy used in collecting position-time data for a moving object involves a "spark timer." The timer itself creates a small electrical spark between two electrical contacts at a fixed time rate—at 10 Hz, or maybe 60 Hz—while a piece of paper passes between the contacts. The distance between the electric burns on the paper can be measured to determine the average velocity of the paper during that time interval.

The piece of paper itself is attached to a moving object, which pulls the paper through the contacts. The kinematic behavior of the moving object is identical to that of the paper. By analyzing the sparks on the paper, we can understand the motion of the object.

See this YouTube video for further information on the process and analysis:
https://www.youtube.com/watch?v=yPLzMQnNBVI

While there's a certain old-school appeal to this kind of analysis, we can do better.

Some LED lights—keychains, headlamps, etc—have a "dim" setting, which is achieved by turning the LED on and off very quickly, thereby reducing the light output over time. If we know the flash rate for these dim LEDs, we can use them as a light-based equivalent to the old spark timer.

Objectives
Use a flashing-LED attached to a moving object to analyze the motion of a moving object of your choice.

Equipment
- Flashing-LED
- Solar cell
- An oscilloscope
- Digital camera with "bulb" setting
- Moving object of your choice
- Meter stick
- Computer

Procedure

In this experiment we'll be using a flashing LED (instead of a spark timer) to create a series of timed "marks"). By attaching the flashing LED to a moving object and recording those flashes on a digital image, we'll create a record of the motion of the object. Digital analysis will allow us to measure and calculate the object's motion.

Part A. Find the Frequency of your Flashing LED
1. Attach a solar cell to the oscilloscope so that light hitting the cell registers as a voltage increase on the 'scope.
2. Turn on your LED so that it is in flashing mode.
3. Aim the LED at the solar cell and adjust the oscilloscope as necessary to identify the periodic voltage spikes across the solar cell.
4. Start up Logger Pro on the computer. Force-time and motion-time graphs should display on the monitor.
5. Make calculations to determine the flashing rate of your LED.

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Part B. Use a digital camera to capture the motion of a moving object

1. Attach the flashing LED to a moving object of your choice. (An accelerating cart? A free-falling mass? A pendulum? A turntable? A mass-spring oscillator?)
2. Use a digital camera or your iPhone with a "bulb" setting or a sufficiently long exposure to capture the motion of your object in a semi-darkened room. An appropriate image will show the motion of the object with its varying position indicated by the flashes of the bulb.
3. Use a digital camera to take a picture of a meter stick or other suitable measuring device in the same location as your moving object.

Part C. Analyze your photo to determine the motion of the moving object

1. Based on the spacing of the LED flashes in your photo, make calculations to determine the motion of your object.