15210 RECORDING TIMER - AC
Teacher Instructions

CONTENTS

- *REQUIRED ACCESSORIES*
  - C-Clamps
  - Ruler or Meter Stick
  - Mass (200 g or larger)
- *OPTIONAL ACCESSORIES*
  - Ticker Tape Dispenser (#15225)
  - Constant Speed Vehicle (#10-103)

PURPOSE

To produce a position versus time record of moving objects using a mechanical striker and paper tape.

STANDARDS

- The student will show evidence of the following criteria from the National Science Education Standards (NSES) for grades 5-12:
  - Content Standard A (Science as Inquiry)
    - **Abilities necessary to do scientific inquiry.** (*Recording Timer allows students to conduct scientific inquiry about linear kinematics by creating a record of the motion of an object with respect to time. Addressed in Procedure A and B.*)
    - **Understandings about scientific inquiry.** (*Recording Timer allows students to conduct scientific inquiry about linear kinematics by creating a record of the motion of an object with respect to time. Addressed in Procedure A and B.*)

CONCEPTS

Timing events is an essential skill for many scientific investigations as well as other practical applications. While many events can be timed accurately by using a stopwatch, the recording timer provides capabilities that a stopwatch cannot achieve:

- The recording timer works in fixed time intervals (1/60 or 1/50 second).
- The recording timer creates a physical record of motion on a ticker tape.
- Analysis of recorded data does not depend on hastily recorded values; data from a ticker tape can be measured and analyzed after the completion of an investigation.

ASSEMBLY & SUGGESTIONS FOR USE

In order to record timed events successfully, practice using the recording timer. This recording timer records intervals of 1/60 of a second (1/50 of a second in countries which use 50 Hz AC electricity) and provides a record of positions on a paper tape. For many lab projects, the recording timer provides an easy-to-understand record of motion with far more detail than simple observations can provide.

Clamp the timer to a table top, ring stand, or other stable support. Place a carbon disc, *carbon side down*, over the post in the base of the timer. Slip the recording tape through the two guides and under the striker. Make sure that the paper tape rests *under* the carbon disc. The tape should move freely through the recording timer. The end of the paper tape can be attached to a variety of objects to record the position of that object as a function of time. Velocity and acceleration can be calculated from this recorded data.

Make sure the tape is drawn straight through the timer. Avoid situations where the tape will be pulled to the side; this may cause the tape to catch or bind. When the paper tape is properly loaded and a recording is about to be made, turn the recording timer on by using the slide switch on the back of the unit, then release the object that is to be timed.

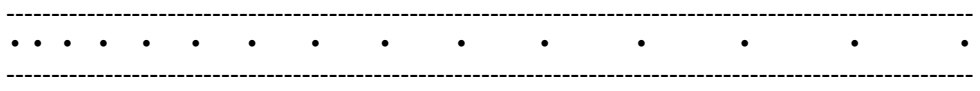
The timer needs no calibration, as it runs on 110V AC power. The striker will make a mark on the recording tape 60 times each second. (In countries that use 50 Hz AC electricity, this timer will make a mark on the recording tape 50 times a second. In

countries that use AC electricity at a voltage other than 110V, a voltage converter will be necessary. #15210A is a recording timer which runs on 220V AC electricity.)

The clarity of the dots on the recording tape can be controlled by adjusting the height of the striker. The clearest dots are obtained when the striker just touches the paper tape when in operation. To make this adjustment, place the plastic feeler gauge between the point of the striker and the base of the timer. Loosen the wingnuts on the striker and move them up or down until the striker just touches the gauge. Tighten the wingnuts after calibrating the height of the striker.

The position of the dots on the paper tape (from side to side) can be controlled by loosening the wingnuts and sliding the striker along the slot in the striker arm. When the desired location is reached, tighten the wingnuts. This adjustment will allow different portions of the carbon disk to be used.

After timing an experiment, the recording tape provides a direct measure of position as a function of time for a particular object. Below is an example of a recording tape taken from an object with constant acceleration.



In order to determine the successive positions of the object, pick a starting point on the recording tape to use as a reference. (This is usually a point near the beginning of the run. Often, this reference point is the first point that can be clearly distinguished from the smudge that the timer makes when it starts, but the starting point can be any arbitrary position.) Measure the distance from this reference point to each point marked on the tape by the recording timer. If you are measuring many data points, you may wish to measure sections of 5, 10, or 20 intervals between dots. (It is often helpful to circle the points on the tape that are actually used for measurement.)

After you have measured the distance from the reference point to each selected point on the tape, record your position values (x_1, x_2, etc.) in a data table, such as the table shown on the next page.

The time for the starting point is $t_0 = 0$. The time for each successive recorded point is the number of spaces (n) between that point and the starting point divided by the frequency of your AC electricity (since the recording timer strikes the ticker tape at the same frequency as your AC electricity).

The velocity of the object can be determined by measuring the displacement between two adjacent points and dividing this displacement by the time interval between the two points (use the same time interval for all calculations). Record these values in the table in a column to the right of the positions.

The acceleration of the object can be determined by calculating the change in velocity between two adjacent table values and dividing this by the time interval between the two points. Record this new value in a column to the right of the velocities. With this table you now have a record of the position, velocity, and acceleration of the object as a function of time. Notice that each calculated quantity has one less entry than the column before it.

SUGGESTIONS FOR EFFECTIVE USE

- Clamp the recording timer securely to a table or bench. If not secure, the recording timer could budge, and this could cause your tape to snag or tear.
- Make sure that any vehicles or falling objects move without moving the tape from side to side.

When investigating the acceleration due to gravity, use a mass of 250 grams or more in your investigation. Masses that are smaller will yield a slower value for the acceleration of gravity, because the striker in the recording timer imparts drag on the ticker tape. Larger mass will be able to overcome this drag factor, and will yield better results.

PROCEDURE A (BRIEF DESCRIPTION)

In this procedure, students will study a visual representation of an object moving with a constant velocity. From that visual representation, students will make a calculation of the velocity of the object.

Suggested Grade Level: Grades 5-12

Content Area Focus: Velocity and Acceleration (Linear Kinematics)

ANSWERS (PROCEDURE A)

Q1. Does the paper tape indicate uniform speed for the vehicle? Explain.

The paper tape should consist of a number of dots evenly spaced if the apparatus is moving at a truly constant velocity.

Q2. What time interval does this length (six segments, or seven dots) represent?

If the first dot in the segment is called t = 0 s, then the six subsequent dots occurred after 1/60 of a second. Seven dots would have been created in 6/60 of a second, so this length would represent 1/10 of a second.

Q3. What is the speed of the vehicle?

Allow your students to perform this calculation. Make this calculation yourself to determine the answer that is correct for your apparatus.

Q4. Does the paper tape show uniform speed for the vehicle? What is that speed?

See Q1 and Q3.

Q5. How can you account for the difference in speed?

If using the CSV, the difference in speed is a result of a change in power supply (i.e. an increase or decrease in the number of batteries powering the unit). If you used another apparatus to demonstrate a constant speed, provide the correct answer according to the operating instructions for that apparatus.

PROCEDURE B (BRIEF DESCRIPTION)

Students will observe and measure the acceleration of a falling body due to Earth's gravity using a recording timer. Use a 250 gram (or more) mass for the falling body.
Suggested Grade Level: Grades 5-12
Content Area Focus: Velocity and Acceleration (Linear Kinematics)

ANSWERS (PROCEDURE B)

Q1. Does the object appear to fall with constant speed or with acceleration? How can you tell?

The object will fall with a constant acceleration. The dots on the paper tape should separate further as the object falls, which indicates a constantly increasing velocity, or a constant acceleration.

Q2. If the object accelerated as it fell to the ground, what is the value of that acceleration? If the object fell with constant speed, what is that speed?

Students should calculate that the object fell with an acceleration of 9.8 m/s^2, to a reasonable degree of accuracy.

SAFETY/STORAGE
Inform your students of the following safety concerns:

- This device runs on 110V AC electricity from standard household outlets. Observe normal safety precautions for any electrical appliance. To avoid electrical shock, do not use near water. Do not use this device if it is damaged in any way.
- Use appropriate eye protection, as this device has rapidly vibrating parts that can propel debris at high speeds.
- When investigating the acceleration due to gravity, stand clear of the area directly under the recording timer where masses are being dropped. Also, pick up masses after they have been dropped, so that they do not present a tripping hazard.

Store this piece of equipment away from water sources. Do not allow students to use a recording timer with any damage that exposes wiring or internal components.