Discovery Lab

Motion

SAFETY

- Tie back long hair, secure loose clothing, and remove loose jewelry to prevent their being caught in moving or rotating parts.
- Perform this experiment in a clear area. Moving masses can cause serious injury.

OBJECTIVES

- Observe objects moving at a constant speed and objects moving with changing speed.
- Graph the relationships between distance and time for moving objects.
- Interpret graphs relating distance and time for moving objects.

MATERIALS

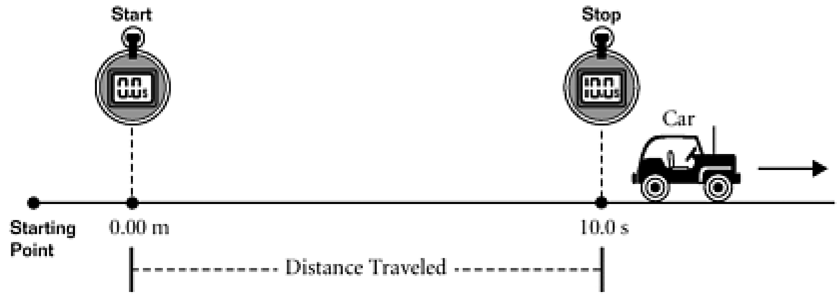
✔ battery-operated toy car
✔ block, book, or clay
✔ graph paper
✔ masking tape
✔ metal ball
✔ meterstick
✔ stopwatch
✔ track
✔ wooden block

Moving at a constant speed

Procedure

1. Find a clear, flat surface a few meters long to perform your experiment. Make sure the area is free of obstacles and traffic. Choose a starting point for your car. Mark this point with masking tape, and label it “starting point.”
2. Start the car, and place it on the starting point. Release the car (your lab partner should start the stopwatch at the same time). Let the car move in a straight line for 2.0 s. Notice where the car is after 2.0 s. Repeat for several trials, until you find the point that the car consistently crosses after 2.0 s. Mark this point with masking tape, and label it “0.00 m.” Throughout this lab, you will start the car at the original starting point, but you will begin to measure the distance and time of the car’s motion when the car crosses the 0.00 m mark.

3. Start the car, and place it on the floor at the starting point. Observe the car as it moves. Be sure to start the stopwatch as the car crosses the 0.00 m mark.



4. After 10.0 s, mark the position of the car with the masking tape. Label this mark "10.0 s."
5. Repeat steps 3 and 4 for 9.0 s, 8.0 s, 7.0 s, 6.0 s, 5.0 s, 4.0 s, 3.0 s, and 2.0 s. Be sure to label each point according to how much time it took for the car to get to that point from the 0.00 m mark.
6. Use the meterstick to measure the exact distance from the 0.00 m mark to each timed position mark. (Do not measure the distance from the starting point.)
7. For each position marked with tape, record the position and time in your notebook, using the appropriate SI units. Make sure to record all measured digits plus one estimated digit.
8. If your car has a multiple speed switch, set the car at a new speed and repeat steps 3–7.

Analysis

A. Did the car speed up or slow down as it traveled, or did it maintain the same speed? How can you tell?

B. Make a graph of your data with time on the *x*-axis and position on the *y*-axis. Label each axis with the appropriate SI units. This graph tells you the position of the car at any time. Describe the shape of the graph.

C. How far did the car travel in each 1.0 s time interval (2.0–3.0 s, 3.0–4.0 s, 4.0–5.0 s, etc.)? For example, to find the distance traveled in the 2.0–3.0 s time interval, subtract the car's position at 2.0 s from the car's position at 3.0 s, and record this value in your notebook. Repeat to find the change in position for each time interval.

D. Predict the position of the car at 12.0 s. Explain your prediction.

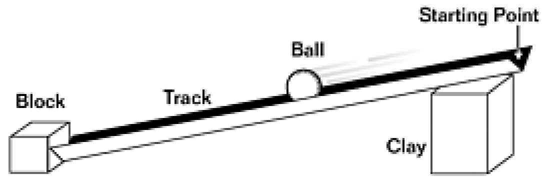
E. Use your answers from C to make a graph with time on the *x*-axis and change in position on the *y*-axis. Label each axis with the appropriate SI units. This graph tells you the distance traveled by the car in each time interval. Describe the shape of this graph.

F. Compare the graphs you made in parts B and E. What similarities are there between these two graphs?

Moving at an increasing speed

Procedure

9. Support one end of the track 2 cm–3 cm above the floor with clay as shown. Secure the track so that it does not move. The base of the track should rest on the floor. Place a block of wood on the floor against the base of the ramp. Mark a point near the top of the track with masking tape, and label it "starting point."
10. Place the ball at the starting point. Hold the ball in place with a ruler.



11. To release the ball, rapidly swing the ruler out of the way. Start the stopwatch the instant the ball is released. The ball will roll down the track.

12. Stop the stopwatch when the ball reaches the base of the track.

13. Repeat steps 10–12. Adjust the angle of the track for each trial until you find a position at which it takes the ball slightly longer than 5.0 s to travel from the starting point to the bottom of the track.

14. When the track is secured in position at the determined angle, place the ball at the starting point. Hold the ball in place with a ruler. To release the ball, rapidly swing the ruler out of the way. Start the stopwatch the instant the ball is released.

15. After 4.0 s, mark the position of the ball with masking tape. Label it “4.0 s.”

16. Repeat step 14, but mark the position of the ball after 3.0 s of travel. Label the tape “3.0 s.”

17. Repeat step 14, but mark the position of the ball after 2.0 s of travel. Label the tape “2.0 s.”

18. Measure the exact distance from the starting point to each position marked with tape.

19. For each position, record the distance and time in your notebook, using the appropriate SI units. Make sure to record all measured digits plus one estimated digit.

Analysis

G. Did the ball speed up or slow down as it traveled, or did it maintain the same speed? How can you tell?

H. Make a graph of your data with time on the *x*-axis and position on the *y*-axis. Label each axis with the appropriate SI units. This graph tells you the position of the ball at any time. What shape does the graph have?

I. How far did the ball travel in each 1.0 s time interval (2.0–3.0 s, 3.0–4.0 s, 4.0–5.0 s, etc.)? To answer this, find the distance that the ball traveled in each 1.0 s time interval. For example, to find the distance traveled in the 2.0–3.0 s time interval, subtract the ball’s position at 2.0 s from the ball’s position at 3.0 s, and record this value in your notebook. Repeat to find the change in position for each time interval.

J. Predict the position of the ball at 12.0 s. Explain your prediction.

K. Use your answers from I to make a graph with “time”on the *x*-axis and “change in position” on the *y*-axis. Label each axis with the appropriate SI units.

L. Compare the shape of the graphs you made in parts H and B. What differences are there between the graphs?