Alternate CBL Instructions
Sticky Collisions

Safety Precautions

- Use caution when plugging in, using, or unplugging the CBL 2 unit's power supply.

Materials
air track
two gliders
balance
masking tape, 20 cm
two index cards
miscellaneous masses to alter mass of gliders
two CBL 2 units
two link cables
two TI graphing calculators
two motion detectors
DataMate program
small piece of clay or glider coupler

Procedure
The following is a procedure to investigate inelastic and elastic collisions along an air track. The air track will minimize friction during the motion of the gliders.

1. For each CBL 2 unit, plug a motion detector into the DIG/SONIC channel. Connect the CBL 2 units to the TI graphing calculators using link cables. Firmly press the ends of the link cable into each unit.

2. The index card will increase the reflective surface area on a glider for the ultrasonic sound waves. Using masking tape, mount an index card to each air track glider so that the flat side is facing the direction the glider moves. Mount or arrange a motion detector at each end of the air track so that the circular gold disk on the detector points toward the center of the track. Keep the motion detector about 30 cm from the end of each track because the detector will not operate properly for objects nearer than 40 cm. Level the air track.

3. Turn on the graphing calculators. Start the DataMate program. The CBL 2 units should auto ID the motion detectors. Press CLEAR to reset the application program.

4. On the TI graphing calculators, select SETUP from the Main screen. Use the arrow keys to scroll to MODE and press ENTER.

5. From the SELECT MODE menu, select TIME GRAPH. Select CHANGE TIME GRAPH SETTINGS from the TIME GRAPH menu. Enter 0.1 as the time between samples (in seconds). Enter 100 as the number of samples so that the data collection will last 10 s. Select OK to return to the setup screen. Select OK once more to return to the Main screen.

6. Use a balance to determine the mass of each glider. Small masses can be added to one of the gliders so that mass combinations can be adjusted in order to have collisions between gliders of one-half the mass or twice the mass (or some other combination of your choice). Record the mass of each glider in your data table.
7. Prepare the gliders to have an inelastic collision. This may be done using a piece of clay on one glider or by using the pair of coupling end pieces. Place one glider stationary position near the middle of the track. Place the other glider at the opposite end. Turn on the air track. Select START on one of the graphing calculators. The single motion detector can record the motion of the single glider and then the motion of the coupled gliders. The motion detectors should begin blinking and ticking, indicating that they are functioning. Gently push the glider at the end of the air track toward the stationary glider. After the gliders have coupled and slid toward the far end of the track, stop them before they bounce backward.
8. Examine the distance versus time graph for the gliders. Select a region near the beginning with a constant slope and calculate Δd and Δt for an interval along the line. Record these data in your data table by mass, m_1. Scroll along the graph to an area after the collision. A gentler slope should identify this. Select two additional points along this portion of the graph and calculate Δd and Δt for motion after the collision. Record these data in your data table.
9. Press ENTER to return to the Main screen. Repeat steps 6–8 for two additional mass combinations of gliders having inelastic collisions.
10. Prepare the gliders to have an elastic collision. Replace the clay or coupler device with a bumper device. Use a balance to determine the mass of each glider, and record their masses in your data table. Place one glider in a stationary position near the middle of the track. Place the other glider at the opposite end of the air track. Record the mass of each glider in your data table. Turn on the air track.
11. Both motion detectors will be needed to collect data on both moving gliders because they may move independently of each other after the collision. Select START on the graphing calculators. The motion detectors should begin blinking and ticking, indicating that they are functioning. Gently push the glider at the end of the air track toward the stationary glider. Stop the gliders when they reach the ends of the air track before bouncing backward.
12. On each calculator, examine the distance versus time graph for the gliders. Select a region near the beginning with a constant slope and calculate Δd and Δt for an interval along the line. Record these data in your data table by mass, m_1. Scroll along the graph to an area after the collision. This should be identified by a change of slope. Select two additional points along this portion of the graph and calculate Δd and Δt for motion after the collision. Record these data in your data table. Likewise, record data for the glider that was struck.
13. Press ENTER to return to the Main screen. Repeat steps 10–12 for two additional mass combinations of gliders having elastic collisions.

14. Compute the velocity, initial momentum, and final momentum values for the different trials. Note the direction of the gliders since the stationary glider will appear to have a negative velocity as it moves toward the motion detector. If a glider bounces off another, the velocity becomes negative.

15. Examine the data and make a graph of the final momentum versus initial momentum. How close to or far off is the slope from 1.0?

Alternate lab procedure, using a CBL unit

The following is a procedure to investigate inelastic and elastic collisions along an air track. The air track will minimize friction during the motion of the gliders.

1. For each CBL unit, connect a motion detector to the SONIC port. Connect a TI graphing calculator to each CBL with a link cable. Turn on the CBL units and the graphing calculators.

2. The index card will increase the reflective surface area on a glider for the ultrasonic sound waves. Using masking tape, mount an index card to each air track glider so that the flat side is facing the direction the glider moves. Mount or arrange a motion detector at each end of the air track so that the sensor side of it points toward the center of the track. Keep the motion detector about 30 cm from the end of each track because the sensor will not operate properly for objects nearer than 40 cm. Level the air track.

3. On both graphing calculators, start the PHYSICS program and go to the MAIN MENU.

4. Select SET UP PROBES from the MAIN MENU. Select ONE as the number of probes.

5. From the SELECT PROBE MENU, select MOTION. Return to the MAIN MENU.

6. Use a balance to determine the mass of each glider. Small masses can be added to one of the gliders so that mass combinations can be adjusted in order to have collisions between gliders of one-half the mass or twice the mass (or some other combination of your choice). Record the mass of each glider in your data table.

7. On both calculators, select COLLECT DATA. Select TIME GRAPH from the DATA COLLECTION menu. Enter "0.1" as the time between samples (in seconds). Enter "99" as the number of samples so the calculator will collect data for about 10 s. Press ENTER and then select USE TIME SETUP to continue. Select NON-LIVE DISPLAY.

8. Prepare the gliders to have an inelastic collision. This may be done using a piece of clay on one glider or by using the pair of coupling end pieces. Place one glider stationary position near the middle of the track. Place the other glider at the opposite end. Turn on the air track.

9. On <u>one</u> of the graphing calculators, press ENTER to begin data collection. The single motion detector can record the motion of the single glider and then the motion of the coupled gliders. The motion detectors should begin blinking and

ticking, indicating that they are functioning. Gently push the glider at the end of the air track toward the stationary glider. After the gliders have coupled and slid toward the far end of the track, stop them before they bounce backward.

10. After the CBL unit has stopped collecting data, press ENTER. On the SELECT GRAPH menu, select DISTANCE. Examine the distance versus time graph for the gliders. Select a region near the beginning with a constant slope and calculate Δd and Δt for an interval along the line. Record these data in your data table by mass, m_1. Scroll along the graph to an area after the collision. A gentler slope should identify this. Select two additional points along this portion of the graph and calculate Δd and Δt for motion after the collision. Record these data in your data table. When you are done, select NEXT. Select YES to prepare the program for another trial.
11. Repeat steps 8–10 for two additional mass combinations of gliders having inelastic collisions.
12. Prepare the gliders to have an elastic collision. Replace the clay or coupler device with a bumper device. Use a balance to determine the mass of each glider, and record their masses in your data table. Place one glider in a stationary position near the middle of the track. Place the other glider at the opposite end of the air track. Record the mass of each glider in your data table. Turn on the air track.
13. Both motion detectors will be needed to collect data on both moving gliders because they may move independently of each other after the collision. Press ENTER to begin data collection. The motion detectors should begin blinking and ticking, indicating that they are functioning. Gently push the glider at the end of the air track toward the stationary glider. Stop the gliders when they reach the ends of the air track before bouncing backward.
14. After the CBL units have stopped collecting data, press ENTER. On the SELECT GRAPH menu, select DISTANCE On each calculator, examine the distance versus time graph for the gliders. Select a region near the beginning with a constant slope and calculate Δd and Δt for an interval along the line. Record these data in your data table by mass, m_1. Scroll along the graph to an area after the collision. This should be identified by a change of slope. Select two additional points along this portion of the graph and calculate Δd and Δt for motion after the collision. Record these data in your data table. Likewise, record data for the glider that was struck. When you are done, select NEXT. Select YES to prepare the program for another trial.
15. Repeat steps 12–14 for two additional mass combinations of gliders having elastic collisions.
16. Compute the velocity, initial momentum, and final momentum values for the different trials. Note the direction of the gliders since the stationary glider will appear to have a negative velocity as it moves toward the motion detector. If a glider bounces off another, the velocity becomes negative.

17. Examine the data and make a graph of the final momentum versus initial momentum. How close to or far off is the slope from 1.0?