**CTE Test Protocol**

Testing at Glenvar High School is conducted in the primary atrium, where the second floor hallway is open to the ground floor. This allows for plenty of space and controlled climate conditions.

**Materials**

Laptop computer with Vernier Graphical Analysis and LoggerPro

Vernier GoDirect Accelerometer Student-designed football helmets

Gym mat Video camera (optional)

**Area Set-up**

A gym mat should be used in the drop area to prevent damage to the floor. The drop zone should be far enough from the stairs to provide a clear vertical drop with no obstacles. The computer operator should be a safe distance from the drop zone.

Students will drop / throw the helmets downward from the second floor landing. At least one student should be below the landing, out of the vertical drop path, in order to collect the helmet after rebound.

Note: For video recording, an operator and a camera should also be positioned a safe distance from the drop zone. It is recommended that the camera is positioned to improve contrast between the helmet and the surroundings, or that a plain backdrop is used for the same purpose.

**Sensor Set-up (Vernier GoDirect Acceleration Sensor and Graphical Analysis)**

1. Open Graphical Analysis and select Sensor Data Collection.
2. Turn on the accelerometer and connect via the Bluetooth function.
3. Click Sensor Channels. Make sure these channels are checked:

|  |  |  |
| --- | --- | --- |
| x-axis HR acceleration | y-axis HR acceleration | z-axis HR acceleration |
| x-axis gyro | y-axis gyro | z-axis gyro |

 (HR stands for high-range)

1. Set Graphical Analysis to display two graphs.
	1. One graph will show Acceleration vs. Time (acceleration readings)
	2. One graph will show Rotation vs. Time (gyro readings)
2. On the Acceleration vs. Time graph, click a y-axis label, then click the three dots following any of the column names.
3. Select Add Calculated Column.
4. Click Insert Expression and select $\sqrt{X^{2}+Y^{2}+Z^{2}}$. Select the appropriate acceleration column for each of the variables (x-axis acceleration for x, for example).
5. Set the Acceleration vs. Time graph to show the resultant acceleration vs. time.

**Procedure – Dropping**

1. Measure the vertical distance from the second floor landing’s railing to the first floor. This will be the standard drop height.
2. Ensure that the helmet will fall in a straight path downward onto a gym mat.
3. Open the CTE Data Collection file and connect to the accelerometer.
4. The computer operator will click “Collect” and signal for a drop.
5. Drop the helmet.
6. The computer operator will save the trial in a secure file location.
7. Repeat until the desired number of trials have been conducted.
8. Calculate the impact velocity by applying $∆y=v\_{0}t+\frac{1}{2}at^{2}$.

**Procedure – Throwing**

1. Measure the vertical distance from the second floor landing to the first floor. This will be the drop height of interest for video analysis.
2. Ensure that the helmet will fall in a straight path downward onto a gym mat.
3. Open the CTE Data Collection file and connect to the accelerometer.
4. The video operator will start recording and signal to the computer operator.
5. The computer operator will click “Collect” and signal for a drop.
6. Drop the helmet.
7. The computer operator will save the trial in a secure file location.
8. The video operator will save the clip in a secure file location.
9. Repeated until the desired number of trials have been conducted.
10. Edit the video clips so they show only the testing actions.
11. Open LoggerPro and click “Insert” and “Movie” to insert a clip.
12. Use the video analysis features to track the falling motion of the helmet.
13. Apply a Model to the tracked motion. The measured height and average gravitational acceleration can be used to help determine coefficients.
14. From the model, determine the impact velocity of the helmet.

**Procedure – Analysis**

Analysis continues in the CTE Data Analysis Document. Data can be obtained from the Vernier Graphical Analysis files, even after the probes are disconnected.