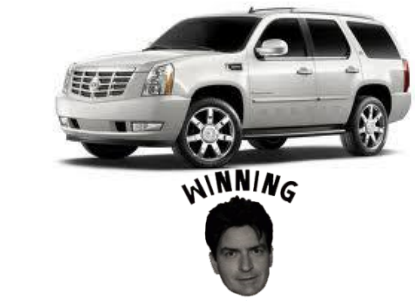
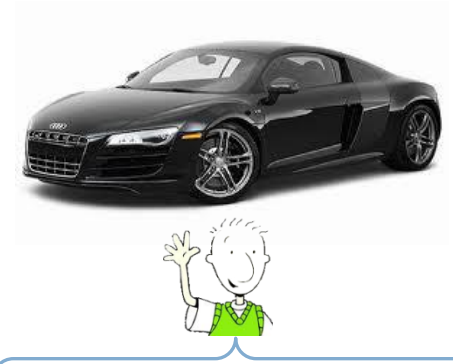
CAR CRASH RECONSTRUCTION

Name: _____ Due Date: _____



VERSUS



Vehicle #1 is a rear-wheel drive Cadillac Escalade driven by Charlie Sheen

Vehicle #2 is a Audi R8 driven by Dougie

DRIVER'S STATEMENTS

Prior to colliding, vehicle #1 is traveling east on Main Street and vehicle #2 is northbound on High Street. There are stop signs for north and southbound High Street traffic at Main Street.

Mr. Sheen states he was traveling 40 km/h as he approached the intersection. He also states that Dougie ran the stop sign at High Street, pulling out in front of him and causing the crash.

Dougie states he stopped at the stop sign and carefully looked both left and right before pulling out to cross Main Street. (From the stop sign, vehicle #2 traveled 9.1 m to the point of impact). He states that he did not see the other car until he felt the impact. Confident that he had carefully looked both ways before pulling out, her only explanation for the crash is that Mr. Sheen was speeding and was concealed by a hillcrest located on Main Street approximately 300 metres west of the intersection.

POST-CRASH DATA

Upon departure from the impact, vehicle #1 skidded 6.1 metres over an asphalt surface having a coefficient of friction of 0.72 and then skidded an additional 9.1 metres across grass having a coefficient of friction of 0.35 before coming to rest. Both front wheels were locked due to crush damage.

Upon departure from the impact, vehicle #2 traveled 5.5 metres over the same asphalt surface having a coefficient of friction of 0.72 and then traveled an additional 12.5 metres across grass having a coefficient of friction of 0.35 before coming to final rest. The left front tire of #2 was locked down due to crush damage. Vehicle #2 is a front-wheel drive vehicle.

ACCELERATION TEST DATA

Acceleration tests were conducted with a similar vehicle as #2. From these tests it was found that the maximum acceleration rate for vehicle #2 was approximately 1.96 m/s^2.

Summary of Crash Data

ITEM	VEHICLE #1	VEHICLE #2
Mass including load and occupants	1950 kg	1430 kg
Approach angle	[east]	[north]
Departure angle	E45°N	E35°N
Distance across asphalt	6.1 m	5.5 m
Asphalt coefficient of friction, μ_a	0.72	0.72
Distance across grass	9.1 m	12.5 m
Grass coefficient of friction, μ_g	0.35	0.35

CRASH ANALYSIS

Write in complete sentences and clearly show each step in your work.

Use subscripts to refer to velocities and cars. For example, v_{1xa} would be what you would call the velocity of vehicle #1 in the x direction on asphalt. v_{1ix} would be the initial velocity of vehicle #1 (or its impact speed) in the x direction. v_{1i} would be the impact velocity of vehicle #1. v_{1g} would be what you would call the velocity of vehicle #1 when it entered the grass. Each car comes to a stop on the grass.

Let the x-axis be in the east-west direction, and the y-axis be in the north-south direction. The point of impact will be the origin.

Acceleration due to gravity: $9.81\ m/s^2$

Sliding energy: $E_s = -F_f \Delta d = -\mu mg\Delta d$

1. Sketch a diagram of the crash scene, showing both vehicles before and after the impact. Label the vehicles, the streets and the different surfaces. Clearly show the angular direction of both vehicles after the impact. Indicate the locations of the stop signs and the point of impact. This diagram must be large, very well labeled, and clear.

Working from the End back to the Beginning

2. Use the work-energy formula to determine the speed with which vehicle #1 (v_{1g}) enters the grass. Use the work-energy formula to determine the speed with which vehicle #2 (v_{2g}) enters the grass.

3. Use the work-energy formula to determine the speed with which vehicle #1 (v_{1a}) enters the asphalt. Use the work-energy formula to determine the speed with which vehicle #2 (v_{2a}) enters the asphalt.

Momentum Conservation to Determine Impact Speeds

4. Use conservation of momentum expressions (Matrix/Component Method) to determine each vehicle's impact speed.

Assess the claims of Charlie Sheen and Dougie. Whose story is confirmed by the crash analysis?

5. Given vehicle #2's maximum acceleration, calculate its minimum speed at the stop sign, given that the crash site was 9.1 m north of the stop sign. Calculate the time it took for vehicle #2 to accelerate from this speed to the impact speed.

6. Calculate how far vehicle #1 would go during this time if it traveled at a constant speed equal to its impact speed.

Write a paragraph summarizing the crash analysis, including any recommendations for charges to be laid.

REFERENCES

1. David Larabee. "Car Collisions, Physics and the State Highway Patrol." *The Physics Teacher.* Vol. 38, No. 6 (September 2000): 334-336.

2. http://www.cyberclassrooms.net/~pschweiger

3. http://hypertextbook.com/physics.