Crumple Zone Physics

Why do cars crumple when they are involved in a collision?

"**A Crumple Zone** is the zone of a car that **absorbs energy** upon impact. The purpose of a crumple zone is to increase the amount of time it takes the car to come to a complete stop in comparison to object the car hits. By increasing the time it takes for your car to come to a stop after you hit the object, the force is spread over a longer period of time."

For Example:

Consider a car travelling at 20 m/s. It strikes a solid wall that does not move at all during the collision. For each of the conditions below determine the acceleration and force of impact during impact. For the acceleration determine the number of *g*s it is equivalent to.

Calculating ***g***s

The number of *g*s is calculated by dividing the object's acceleration by the acceleration of gravity on Earth. This gives a **measure of the acceleration in multiples of *g***. *Sustained* accelerations over 10gs (or 10 times the acceleration of gravity) can be deadly to humans. Crashes are often over 50*g*s!!

Question

The 1000kg car is moving at 80 km/h and comes to a complete stop. *Compare the accelerations and impact forces* if the front of the car crumples by an amount of

a) 1.5m

b) 0.5 m.

Discussion

1. Why would you prefer a car that crumples compared to a car that does not?

2. What is so dangerous about a car that does not crumple at all and simply bounces backwards (similar to a bumper car)?

Making Connections

STUNT PERSON PHYSICS

Consider the following situation. BigBang the Stunt Beaver (20 kg) jumps from a 40 m high building. There is 4 m thick air bag (crash mat) at the bottom of the fall. If the beaver comes to rest 3.5 m after striking the bag.

Calculate the *a) acceleration b) time (duration) and c) force of impact.*

Repeat the calculation with a solid safety bag of the same thickness that stops the falling stunt person in just 0.5 m.

Which would you rather land in? Explain by referring to your calculations.

BUNGEE JUMPING PHYSICS

A 70 kg thrill seeker jumps from a 50 m high bridge attached to a bungee cord. The unstretched cord is 25 m long. Based on the mass of the person the cord is calculated to stretch to a length of 45 m where it reaches its lowest point before pulling the person back upward. *a) Determine the acceleration b) time of slow-down and c) average force acting on the person.*

Explain why you would want a cord that stretches over a long distance as opposed to one that only stretches by only a metre or two.

Repeat the calculation for an "ineffective" bungee cord that is attached to the same bridge that only stretches by 2.5 m. Comment on the results.

SOFT LANDING PHYSICS

When jumping from an object it is imperative that you bend your knees upon landing. Compare the *acceleration, time and force of impact* for a 75 kg person that jumps from a 1.5 m high desk on to the floor

a) and bends their knees by 30 cm

b) lands with their legs locked with an effective slow down distance of 1.5 cm.

Explain using Newton's laws why you want to do this and why you would not want to land with your legs and knees locked.