

# NEWTON'S 2<sup>ND</sup> LAW

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& New York Times Feb. 3 , 2016 by Hiroko Tabuchi

## Senators Call for a Much Broader Recall of Defective Takata Airbags After a Recent Death

How airbags work

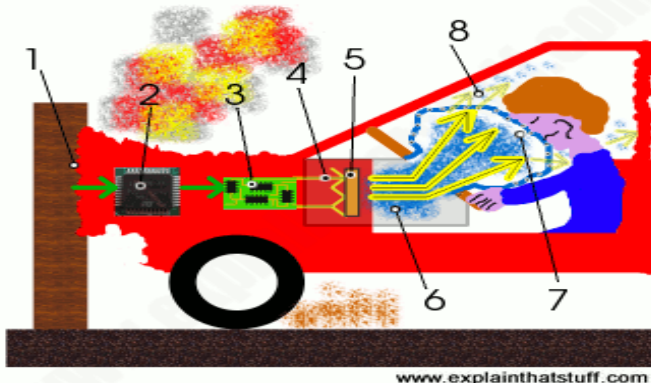
1. When a car hits something, it starts to decelerate (lose speed) very rapidly.
2. An [accelerometer](#) (electronic chip that measures acceleration or force) detects the change of speed.



The steering wheel in the 2006 Ford Ranger belonging to Joel Knight. He was killed in December when the vehicle's Takata airbag ruptured after he ran into a stray cow in South Carolina.

3. If the deceleration is great enough, the accelerometer triggers the **airbag circuit**. Normal [braking](#) doesn't generate enough force to do this.
4. The airbag circuit passes an electric current through a [heating element](#) (a bit like one of the wires in a [toaster](#)).
5. The heating element ignites a chemical **explosive**. Older airbags used sodium azide as their explosive; newer ones use different chemicals.
6. As the explosive burns, it generates a massive amount of harmless gas (typically either nitrogen or argon) that floods into a [nylon bag](#)packed behind the steering wheel.
7. As the bag expands, it blows the plastic cover off the steering wheel and inflates in front of the driver. The bag is coated with a chalky substance such as talcum powder to help it unwrap smoothly.
8. The driver (moving forward because of the impact) pushes against the bag. This makes the bag deflate as the gas it contains escapes through small holes around its edges. By the time the car

stops, the bag should have completely deflated.



**INTRODUCTION:** As you can see at left.... air bags cause the driver's head ( 16 lb.)to decelerate over about 2 ft.. Consider the car initially moving at 60 mph (88 ft./s.) prior to crashing to a stop. Also, consider the area of the face to be 50 in.<sup>2</sup>.

**QUESTIONS:** (a) Find this car's deceleration? (b) Find mass in slugs of this head? (c) Find force on head provided by the air bag? (d) Find pressure ( in lb./in.<sup>2</sup> ) on face while stopping? (e) If instead head being stopped by airbag the steering wheel stopped the head in 1 inch (1/12 ft.), find

With millions of cars containing potentially defective airbags made by Takata still on the road, two senators on Tuesday urged the Obama administration to significantly expand the airbag recalls.

Richard Blumenthal of Connecticut and Edward Markey of Massachusetts, both Democrats, called on the Obama administration [in a letter](#) to force the recall of every Takata airbag that uses a propellant that contains a compound called ammonium nitrate, which can degrade over time and become unstable. **The letter follows the death of Joel Knight, who was killed in December when the airbag in his 2006 Ford Ranger ruptured after hitting a stray cow in South Carolina, sending metal debris into his throat.** The airbag, on the driver's side, had not been recalled until last month. Ten deaths and more than 100 injuries have been linked to the defect.

To date, 14 automakers have recalled 28 million airbag inflators — the metal casing that contains the propellant — in about 24 million vehicles. But millions of cars with potentially defective inflators remain on the road. In total, Takata has shipped about 54 million inflators to automakers in the United States.

**QUESTIONS CONTINUED:** (e) deceleration while stopping in just 1/12 foot? (f) Find force on head now if stopped by steering wheel in 1/12 foot ( 1 inch )?, (g) How much larger is stopping force on face by steering wheel compared to air bag?

**HINTS:** Weight =  $m g$  ,  $F_{NET} = m a$  ,  $v^2 = v_0^2 + 2 a x$  ,  $P = F/A = \text{pressure}$  ,  $g = 32 \text{ ft./s}$

**ANSWERS:** (a)  $-1,936 \text{ ft./s.}^2$  , (b) 0.5 slugs , (c) 968 lb. , (d) 19.4 lb./in.<sup>2</sup> , (e)  $-46,464 \text{ ft./s.}^2$  , (f) 23,232 lb. , (g)  $\sim 24$