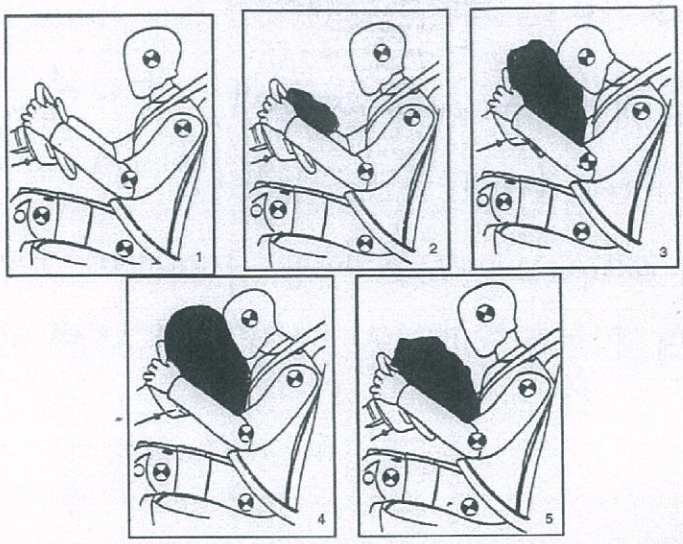
HOLY CROSS COLLEGE
Life to the Full

11 PHYSICS ATAR
EVALUATION 1: AIRBAGS

NAME: SOLUTIONS MARK: ___/18

5 Air Bags; Myths and facts.



The supplemental air-bag restraints system. In a serious frontal crash. the air-bag inflates in less than the blink of an eye. And begins to deflate very quickly. Yet in that brief time, it can help cushion you from forces that might otherwise cause severe injuries. Of course, whether your car is equipped with a supplemental air-bag system or not, you should always buckle your safety belt every time you go anywhere.

This sequence of drawings simulates how the Ford driver-side supplemental air-bag would help provide additional protection for the driver during moderate to severe frontal collisions. The nylon air-bag is stored in the centre of the steering wheel. The vehicle may also have a passenger side air-bag stored in the instrument panel above the glove box area.

The supplemental air-bag restraint system is activated in a frontal collision equivalent to hitting a solid barrier at about 23 kilometres per hour or more, or hitting a parked car of similar size at 47 kilometres per hour or more.

When activated, the nylon air-bag emerges very rapidly from its storage area as it fills with nitrogen, a harmless gas that is part of the air we breathe. This process takes place in approximately 55 milliseconds (1/20 of a second). Following inflation, the nitrogen gas is released almost immediately through vents in the back of the bag. The spent air-bag module can be removed and replaced relatively quickly by a qualified technician—it cannot be reused. However, significant vehicle damage will result in a crash severe enough to activate the air-bag and other parts of the supplemental air-bag restraint system also may have to be replaced or repaired.

When coupled with the use of safety belts, the supplemental air-bag, which helps provide additional face, head, neck and chest protection in certain higher energy frontal crashes, has been demonstrated to be an effective supplement to the safety belt.

The system consists of crash sensors, an air-bag module, the necessary wiring, and an electronic diagnostic device. The high technology sensors are designed to initiate inflation of the supplemental air-bag during moderate to severe frontal collisions while preventing accidental inflation during lower speed collisions and bumps, such as may occur in minor accidents or hitting 'potholes.' In these situations, the safety belts alone help provide protection.

In a moderate to severe frontal collision, the sensors, mounted in the front of the vehicle send an electrical signal which, almost instantly, causes inflation of the supplemental air-bag.

The system constantly monitors its own condition and state of readiness through an electronic diagnostic module. When the ignition switch is turned on, the module determines if the system is operating properly and is ready to function. If the diagnostic module detects a fault, it will provide a warning signal indicating that service is needed.

Ford has spent many years and millions of dollars developing and testing supplemental air-bags. Ford now has millions of kilometres of on-the-road experience with supplemental air-bags and the system has been demonstrated to be safe, reliable, and effective.

Myths	Facts
You don't need to wear seat belts if your car has air-bags.	Seat belts must still be worn. Air-bags inflate only in moderate to severe frontal crashes. Safety belts help restrain the occupant and help direct the occupant into the air-bag during a frontal collision. In addition safety belts help protect the occupant in other impacts such as side, rear, and rollover for which air-bags were not designed to inflate.
Air-bags cause high repair costs because the inflate in minor accidents.	Air-bags are designed to inflate only in certain frontal accidents more severe than hitting a car of similar size at approximately 47 kilometres per hour.
Air-bags can cause you to lose contrl of your car when they inflate inadvertently.	In actual consumer service since 1985 the supplemental air-bag system has been demonstrated to be safe, reliable and effective.

The first inflatable device for crash landings was created for an aeroplane during the Second World War. Airbags began to appear in cars in the 1980s.

1. Airbags work by increasing the time it takes to absorb the shock of an impact. Use Physics principles to explain why this is beneficial for the occupant of a car in a collision. (4 marks)

$I = Ft = m\Delta v = \Delta p$

$\Rightarrow F = \frac{\Delta p}{t}$ (1)

- Since Δp of the person is constant, $F \propto \frac{1}{t}$. (1)
- If t is made larger, F is smaller. (1)
- The bag collapses over a longer period of time, allowing the body to experience a lower force (and deceleration). (1)

2. How does the air bag assist in minimising injury to the driver? (3 marks)

- Provides additional face, head, neck and chest protection. (1)
- Prevents the body from striking the steering wheel, dashboard and/or side pillars. (1)
- Good supplement to the seat belt. (1)

3. Why is the airbag stored in the centre of the steering wheel? (2 marks)

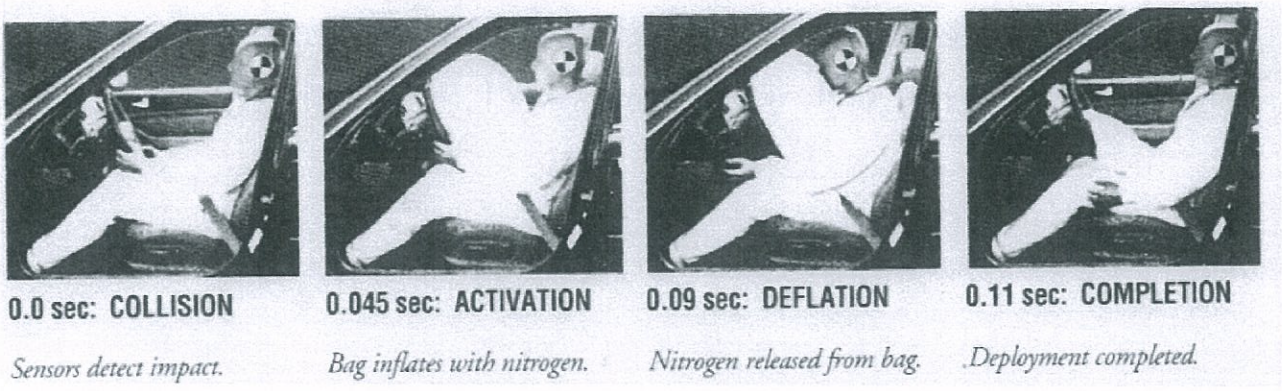
- It moves outwards to stop the forwards movement of the person. (1)
- Prevents contact with the steering wheel, windscreen, etc. (1)

4. With airbags now standard in motor vehicles, do you still need to wear a seat belt? In your answer, disregard the road rules in place. Explain using Physics principles whether it is necessary. (4 marks)

- Yes (1)
- Airbag expands at around 300 kmh^{-1}. (1)
- If the body moves forwards before the bag fully deploys, it will cause serious injuries to the person. (1)
- The seat belt holds the person in place while the bag expands. (1)

5. Air bags require sensors to deploy them. Where are these sensors located, and what do they measure? (2 marks)

- Mounted in the front of the vehicle. (1)
- Detect a sudden deceleration in the vehicle - usually above a minimum speed such as 23 kmh^{-1} (USA). (1)



6. In these photographs provided by the Honda Motor Company, it appears that the air bag is deflated just about the same time that the driver's head comes in contact with the bag. Why is this an important safety design? (3 marks)

- Gas is released "slowly" out the back of the bag. (1)
- This allows time for Δp of the body to occur over a longer time. (1)
- If it doesn't collapse, the force experienced by the body is much higher and could cause serious injuries. (1)