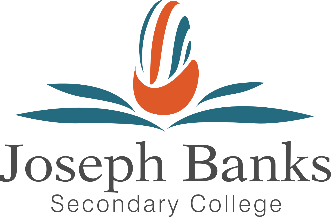
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**Year 12 Integrated Science General 2020**

**TASK 4: Comparison of Vehicle Safety Devices (Extended response)**

**Introduction: ANSWERS**

As the number of vehicles on Western Australian roads increases, with over 5 million registered vehicles (Australian Bureau of statistics, 2015), the need for safety is more important than ever. The number of road deaths per 100, 000 population in WA has dropped over the past four decades, from 28.9 in 1970 to 4.1 in 2014 (Transport for NSW, 2014), heavily contributed to by the introduction of safety features. These safety features, specifically seatbelts, low speed zones, airbags, and crumple zones, are heavily involved in the reduction of the likelihood or impacts of hospitalisations and fatalities in accidents. The main aim of many car safety features is to absorb the kinetic energy from the crash in the car. These help in reducing the acceleration and force on the person, decreasing the intensity of injuries.

Car Safety is divided into two sections: active and passive. An active safety feature diminishes the chance of an accident or failure before they arise. Active safety features include pressure monitoring systems, brake assist, and parking assist. These features are always working in the background with computer technology. Passive safety features are for cars to reduce the disaster and the risk of injuries and deaths if an event does go wrong. Airbags, head rests, seat belt lock engagement are examples of passive safety.

**Topic:**

The extended response questions will be based around a comparison of vehicle safety devices, how they function to prevent passenger injury, how these devices have improved over time and how Newton’s Laws of Motion have aided in the design of these devices.

**Unit Content Covered:**

* SIS - use appropriate representations, to communicate conceptual understanding, solve problems and make predictions
* SIS- communicate scientific ideas and information for a particular purpose, using appropriate scientific language, conventions and representations
* SIS- interpret a range of scientific and media texts and evaluate the conclusions by considering the quality of available evidence
* SHE- the use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences
* SHE- scientific knowledge can enable scientists to offer [valid](http://www.australiancurriculum.edu.au/Glossary?a=SSCSCH&t=Validity) explanations and make [reliable](http://www.australiancurriculum.edu.au/Glossary?a=SSCSCH&t=Reliability) predictions
* SU - the Laws of Motion can assist in predicting the motion of objects
* SU- multiple forces can act on objects by direct contact, or from a distance, when the object is in motion
* SU- motion of an object is directional and is a vector quantity that can be determined mathematically

**Useful Websites:**

* <https://www.consumerreports.org/cro/2012/04/guide-to-safety-features/index.htm>
* <https://www.ancap.com.au/understanding-safety-features>
* <https://www.science.org.au/curious/technology-future/death-defying-designs-car-safety>
* <https://www.buyautoinsurance.com/car-physics-and-newtons-laws-of-motion/>

**Task Date Details:**

Research Assignment Questions: Friday 15th, Monday 18th -Wednesday 20th May 2020

Weighting: 10%

**SECTION 1: Research:** Complete the following table- first 3 have been completed for you. **[10 marks]**

**Table 1: Safety Features Designed to Prevent Collisions.**

|  |  |  |  |
| --- | --- | --- | --- |
| Feature | Function | Prevents injury | Newton’s Law |
| Tyre Tread | Increases friction and makes steering and braking more reliable, especially in wet weather.  The tread even pushes water out from beneath the tyre when the road is wet. | Allows tyres to grip the road, allows car to brake and turn, and prevents sliding of the car. | 1st Law- travel in same direction unless acted upon by an unbalanced force. |
| Windscreen Wipers | Keep the windscreen clear. | Ensures good visibility for the driver. | None |
| Speed Alarm | The driver selects a maximum speed. If the speed is exceeded an alarm sounds. | Warns the driver to slow down. | 2nd Law-acceleration, F=ma |
| Anti-Lock Brake Systems (ABS) |  |  |  |
| Electronic Stability Control (ESC) |  |  |  |
| Seatbelts |  |  |  |
| Head Restraints |  |  |  |
| Front Airbags |  |  |  |
| Side Airbags |  |  |  |
| Collapsible Steering Wheels |  |  |  |
| Padded Dashboards |  |  |  |
| Crumple Zones |  |  |  |
| Indicators |  |  |  |
| Head lights |  |  |  |

**10 lines completed with function, prevent injury and newton’s law that applies.**

**SECTION 2: Extended Response Questions [53 Marks]**

Please answer all questions, taking note of how many marks each question is worth (1 mark = 1 piece of information)

**Question 1**

1. Identify two (2) vehicle safety devices that have been designed because of Newton’s First Law of Motion and explain how they are linked to Newton’s First Law of Motion. **(6 marks)**

Any 2 of the following:

-Seatbelts (1) – If the car stop suddenly the seatbelt will stop you (1), if you didn’t have a seat belt, you would continue to move forward at the same speed as the car was originally travelling at (1)

-Headrest (1) – When you take off suddenly, your head wants to stay where it is, the head rest prevents your neck from flinging backwards (1), Headrests do not work for braking, as your head would move the other way (1)

-Brakes (1) – If the brakes are not applied, the car will continue to move forward (1), braking applies the unequal force required to stop the car (1)

-Any other correct answers, e.g. Airbags.

1. Compare and contrast the vehicle safety devices you identified above, Identifying similarities and differences between them. (6 marks)

-Seatbelts work when the car breaks suddenly (1), compared to headrests that work when a car starts suddenly (1)

-Seatbelts need to be put on correctly for them to work (1), compared to headrests that are a fixed item in the car (1)

-Both seatbelts and headrests do their job when there is a sudden change in the velocity of the car (1)

-Brakes are a reactive approach, you need to apply them for them to work (1), however, seatbelts prevent the occupant from moving forward automatically if there is a sudden jerk (1)

Any other valid and correct responses.

1. Choose one of your above safety devices and discuss how and why it has changed over time.

**(8 marks)**

-Seatbelts were first designed as lap belts (1), this progressed to a 3-point design designed to protect both the upper and lower body (1).

-These initial seatbelts were fixed (not retractable), so occupants had to modify the length of them manually (1), if this wasn’t done correctly, then they were not protected as well as they could be (1)

-Retractable seatbelts were designed so that they would automatically fit to the occupant (1). They use an inertia locking retractor, which locks the seatbelt in place when a sharp tug occurs, like during a crash, or sudden stop (1). This holds the occupant more firmly in their position during a crash, preventing the occupant from moving uncontrollably (1)

-Seat sensors are now installed in most cars to alert the occupants if they do not have their seat belt on, minimising the likelihood of people traveling without a seatbelt (1)

Any other relevant and correct information

**Question 2**

Create a value line that places 5 different safety devices from most important to least important. Explain the reason why you place each device where you do. **(11 marks)**

-Creates a value line of 5 different safety devices stating which is most and least important (1)

-Provides a basic response for the positioning of each devices (1) (for each explanation) **or**

-Provides a detailed response for the positioning of each device using some scientific explanation (2) (for each explanation)

**Question 3**

Explain what happens to a car and its driver during a collision where the driver needs to brake, but still hits a stationary object at approximately 60km/hr. Include what parts of the car are involved and how Newton’s Laws of Motion are linked to each individual step. **(12 marks)**

-Brakes applied, causing the car to slow down (1), An unequal force is applied to slow down the car (1), the amount of force required to slow down the car is dependent on the mass of the car and how fast it is moving (1) according to f=ma (newton’s 2nd law of motion) (1)

-The car hits the stationary object, causing the front end of the car to crumple (1), for every action, there is an equal and opposite reaction (newtons 3rd law) (1), the crumple zone of the car absorbs a lot of the energy (1)

-Due to the sudden stopping of the car, the seatbelt tightens to protect the occupant more (1), to prevent the occupant from continuing forward at the same speed (inertia-newton’s 1st law) (1).

-The airbag is released (1), this is to distribute the force of the driver being flung forward (1), Newton’s 1st Law and Newtons 3rd law as otherwise the driver would hit the steering wheel. (1)

Any other valid and correct response

**Question 4**

In Australia, the following child restraint laws apply.

Explain why you think it is important that children need to be properly restrained in a car using the appropriate level of restraint and discuss what you think would happen if these laws were not followed and the car was in a collision, or the restraint was not fitted correctly. **(10 marks)**

*National child restraint laws*

* Children up to the age of six months must be secured in an approved rearward facing restraint
* Children aged from six months old but under four years old must be secured in either a rear or forward-facing approved child restraint with an inbuilt harness
* Children under four years old cannot travel in the front seat of a vehicle with two or more rows
* Children aged from four years old but under seven years old must be secured in a forward-facing approved child restraint with an inbuilt harness or an approved booster seat
* Children aged from four years old but under seven years old cannot travel in the front seat of a vehicle with two or more rows, unless all other back seats are occupied by children younger than seven years in an approved child restraint or booster seat
* Children aged from seven years old but under 16 years old who are too small to be restrained by a seatbelt properly adjusted and fastened are strongly recommended to use an approved booster seat
* Children in booster seats must be restrained by a suitable lap and sash type approved seatbelt that is properly adjusted and fastened, or by a suitable approved child safety harness that is properly adjusted and fastened.

-If a child uses a seatbelt that is too big for them, then they could get injured as the seatbelt will not be sitting in the correct position (1)

-Babies under the age of 6 months do not have the strength in their necks to be placed in an upright sitting position (1), and during a crash, they would not be able to support their own neck, resulting in serious injury (1). Babies still have a soft bone structure, so cannot withstand the forces of a crash (1)

-Children cannot sit in the front seat of a car until they are at least 4 years old, as the force of the airbag releasing in a crash will be too great for them, causing increased injury (1)

-Children under the age of 4 years are required to use a 5-point harness as it holds the child in position more, reducing the amount of movement and potential for injury (1) this is because children are more flexible and are more likely to slip out of a 3-point harness. (1)

-Child restraints also provide lateral protection for the child, preventing them from moving from side to side, particularly during a side-on collision (1)

-If restraints are not installed correctly, then they may move during a collision, increasing the likelihood of injuries (1)

-If the harnesses are not fitted snuggly, then the child could slip out of the restrain (1)

Any other valid and correct response.

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| --- |
| **TOTAL MARKS:**  Section 1: /10  Section 2: /53  Total: /63 % |