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

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| **TOTAL MARKS:**  Section 1: **10**/10  Section 2:  **38**/53  Total: **48**/63  **76.2** % |

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

**10 [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) | Works by preventing the brakes from locking up during braking and maintaining tractive contact to the road surface. | Ensures the driver easy steering after period of hard braking. | 1st Law - Travel in same direction unless acted upon by an unbalanced force. |
| Electronic Stability Control (ESC) | Computerised technology that detects and reduces the loss of traction in tyres (skidding). Activates when the driver loses control of the vehicle. | Helps to avoid crashes by reducing the danger of skidding or losing control as a result of over-steering. | 1st Law - Travel in same direction unless acted upon by an unbalanced force. |
| Seatbelts | Secures driver or passenger from harmful movement when vehicle suddenly stops or when a collision occurs. | Reduces the likelihood of harm by securing the vehicle occupant in a position that blocks the individual from hitting interior hazards or other individuals. | 3rd Law -  For every action, there is an equal and opposite reaction. |
| Head Restraints | Attached to seats in order to stop rearward movement of individual’s heads during an accident and mitigates the severity of damage done to the cervical vertebrae. | Protects the head during a rear impacted collision and can minimise the effects of neck injury by 43%. | 1st Law - Travel in same direction unless acted upon by an unbalanced force. |
| Front Airbags | Works by deploying a frontal airbag in order to reduce the chance of injury during mild to moderate car accidents. | Frontal airbags reduce the chance that your upper body or head will strike the vehicle’s interior during a crash. | 3rd Law - For every action, there is an equal and opposite reaction. |
| Side Airbags | Can be deployed instantaneously during a side-impact collision and creates a cushion between the passenger and window and may stay in place if the car rolls over in order to prevent head injury. | Designed to inflate during side crashes and provides a cushion between the individual’s head or chest and any protruding, potentially dangerous vehicle parts, a striking vehicle, or harmful objects outside the vehicle (i.e., trees, poles). | 1st Law - Travel in same direction unless acted upon by an unbalanced force. |
| Collapsible Steering Wheels | Transfers energy from the steering wheel to gear box, which in turn transfers energy to turn the wheels of the vehicle. | When the vehicle comes into contact with another vehicle, resulting in a collision, the tube structure collapses and absorbs energy. Thus, reducing the risk of damage to the driver’s body by a considerable amount. | 3rd Law - For every action, there is an equal and opposite reaction. |
| Padded Dashboards | A control panel placed in front of the driver and passenger/s and are designed to reduce face and chest injuries during head-on collisions. | Increase the time of contact, which in turn reduces the force of the injury. Uses a padded material to act as an absorbent of impact. | 1st Law - Travel in same direction unless acted upon by an unbalanced force. |
| Crumple Zones | Areas of a vehicle which act to deform or crumple so the collision impact is absorbed and the absorbed energy being distributed is less likely to cause a stronger and more forceful impact to other occupants. | Work by managing crash energy and increasing the time over which the deceleration of the occupants of the vehicle occurs, while also preventing intrusion into or deformation of the passenger cabin. | 3rd Law - For every action, there is an equal and opposite reaction. |
| Indicators | A signalling device which is used by the driver to communicate where they intend on going. Used as a way of “reading the road”. | Reduce the risk or likelihood of accidents by signalling where the driver will go. If indicators weren’t used, the chance of rear collisions would increase drastically because you would be unaware of the actions of the person in front. | None |
| Head lights | Used to illuminate the perimeter of the vehicles surroundings and ensures fatigue-free and safe driving practices. | Prevents injury by brightening the road in front and providing a source of light which without, could result in an increased risk of accidents and head-on collisions due to being unable to see what’s in front of us (i.e., oncoming vehicles, trees, buildings). | None |

**SECTION 2: Extended Response Questions 38 [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) 4**

Airbags **(1)** and seatbelts **(1)** are two examples of vehicle safety devices within cars which have been designed based on Newton’s First Law of Motion. Newton’s First Law of Motion (can also be called Newton’s Law of Inertia), states that an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. This law is applied to both airbags and seatbelts because they both act as the unbalanced force which prevents the object from continuing movement, or in this case, the individual from flying forward and injuring themselves. **(2)**

**How do each of them work- explain both individually. Seatbelt prevents you moving out of the car, and airbag distributes force over a larger area.**

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

Seatbelts in vehicles apply to Newton’s First Law of Motion since this law states that every object will travel in the same direction unless an unbalanced force interferes and acts upon it and when an accident occurs, the passenger or driver of the vehicle may jolt forward slightly but is prevented from flying forward **(1)** and causing serious injury since the seatbelts role is to create an obstruction between the person and interior of the vehicle**-prevent person flying out of the vehicle** whereas airbags apply to Newton’s Third Law of Motion as well as Newton’s First Law of Motion but mainly the Third Law. **(1)** The role of seatbelts is to act as a force or barrier that keeps the passenger or driver in place when experiencing an abrupt stop or a dangerous accident; it keeps the individual from ejecting forward whereas the role of airbags is to serve as a cushion against the head or chest from preventing serious injury during an accident. **(1) -distribute force over a larger area** Seatbelts and airbags are both considered passive safety features since they both work to reduce the risk of injury**(1)**  or death when an accident or collision does take place (i.e., an airbag absorbs the impact of force by acting as a cushion to reduce the likelihood of injuries from occurring). Seatbelts are appropriate forms of vehicle safety features for all age groups **(1)** but airbags on the other hand are not because the force of impact being exerted onto a child (i.e., ages 2-4) may potentially result in injury or even death since the pressure is too strong for the child to handle. **(1)**

**Well done Ollie great answer- the only thing I would have added is that if seatbelts are not used or placed on incorrectly they will not function as designed, whereas airbags are automatic and can’t be influenced by passenger handling.**

1. Choose one of your above safety devices and discuss how and why it has changed over time. **8** **(8 marks)**

Seatbelts first originated in the mid-19th century by George Cayley and were initially used to restrain pilots in gliders. **(1)** During the 1930’s, many physicians in the U.S. began to test the effectiveness of seatbelts during accidents in cars and after seeing the impacts, urged car manufacturers to install seatbelts in all their vehicles. **(1)** Once the benefits of owning seatbelts were discovered, the sales reached a peak although back then the concept of using a seatbelt was an optional choice. **(1)**  By 1975, laws were established in most first-world countries that recognised the installation of seatbelts a requirement and in 1970, this law was introduced in Australia. **(1)**  Despite all this, the law for being required to wear a seatbelt for safety purposes wasn’t actually implemented until 1995 in the U.S. **(1)** In today’s society, the owning and wearing of seatbelts is a requirement in most countries and disobeying this law is considered an act punishable by law. **(1)**  Over time, the use of seatbelts have made a recognisable difference in countries across the world. For example, in the U.S. the car crash rate is half of what it is now than what it was in 1976. Seatbelts have received much recognition for their advantages and have been identified as acting as a passive safety feature as well as relating to Newton’s First Law of Motion since it is responsible for acting as an unbalanced force which stops the object (i.e., the passenger/driver) from the continuation of travel in the same direction. **(1)**  Another way seatbelts have gradually changed over time is that up until 1958, seatbelts only comprised of a two-point strap, meaning the belt strapped from one end and buckled to the other and was worn above the abdomen. Nils Bohlin, an engineer from Sweden, invented the safer three-point strap which is the design we are familiar with today which proved to be simpler and more effective by securing the upper and lower body and was estimated to have saved the lives of more than one million people from 1958-2002. **(1)**

**Should have added this from your question below to this question too**-a seatbelt locking mechanism has been introduced in recent years which works by locking the individual tightly in place when an accident takes place in order to secure the individual as best as possible and to avoid injury or death.

**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 (11 marks)**

**1.) Seatbelt**

I would rank seatbelts first because they are easily the most crucial vehicle safety devices and since they are one of the most widely used safety features in the world. If we didn’t have seatbelts then the fatality rate during car accidents and collisions would drastically climb and would become alarmingly dangerous. When seatbelts are applied, they act to prevent us from flying forward out of our seats and potentially fatal injuries by holding the individual in place and acting as a kind of barrier (the unbalanced force). It is a well known fact that the lack of wearing a seatbelt is recognised as being one of the leading factors of deaths in car accidents globally alongside other factors such as distractions. Another reason why I have placed this device where I have is because over time, seatbelts have evolved beneficially to accommodate for the implementations of seatbelt laws. For example, in recent years there have been many alterations that have been made such as the shift from a two-point strapped to three-point strapped seatbelt which better protects the individual from harm by fastening across the upper (i.e., torso) and lower body (i.e., abdomen). In addition to the three-point strap system, a seatbelt locking mechanism has been introduced in recent years which works by locking the individual tightly in place when an accident takes place in order to secure the individual as best as possible and to avoid injury or death. **(2)**

**2.) Airbags**

I’m placing airbags second because they are definitely an essential safety feature to include in any vehicle and are intended to inflate once a crash occurs to save a person’s life. Airbags work by suddenly inflating from either the steering wheel or from small compartments on the side of the interior (depending on whether the crash impacted the front or the side) and will immediately deflate thereafter, minimising the impact and harm that may have affected the passenger or driver. Airbags usually apply to Newton’s First and Third Law of Motion but rather the Third since it creates an action that exerts force onto the individual and an opposite reaction occurs with the same amount of force. **-distributes the force over a greater area** In 1952, John W. Hetrick, an American engineer, proposed the original concept of the modern airbag when he accidentally drove into a ditch while driving his family through a countryside. His idea was to create a safety cushion that would deploy whenever a vehicle endured a forceful accident and to soften the impact. Airbags only became a conventional feature within vehicles around 1971-73 when General Motors began to test their efficiency in cars, the 1973 Oldsmobile Toronado being the first car to include them. **(2)**

**3.) Head Restraints**

I’ll be placing head restraints third because they are still an incredibly significant and reliable vehicle safety feature however, I wouldn’t identify them as being as essential in comparison with seatbelts and airbags. Head restraints are attached to the top of each car seat and can be removable. The purpose of the head restraint is to stop the severity of damage inflicted on the head and neck during a crash which, when detached from the seat, can cause whiplash and even result in death since the impact forces the head backwards if a collision occurs at the rear of the vehicle therefore, much like the seatbelt, acts as a barrier. The head restraint is applied to Newton’s First Law because any object travelling in the same direction or if stationary (i.e., the individual) will stay the same unless acted upon by the unbalanced force (i.e., the head restraint). Introduced as an optional feature in the mid-late 1960’s, the head restraint was soon mandated by law in the U.S. and appeared in almost all cars after January of 1969. **(2)-if you impact after you hit your head will whip back and it acts to prevent neck injury.**

**4.) Tyre Tread**

I’m placing tyre tread fourth since it is still quite a fundamental component of many vehicles but in my personal opinion, I believe there is still a way you can gain control of the vehicle if you get in the situation where you begin to skid or lose traction of the road although it is likely a difficult task and the tyre tread system consequently becomes very beneficial. The tyre tread system involves maintaining consistent grip to the road in windy or wet environments and allows the driver to brake and turn more easily by increasing the level of friction from beneath the tyres. It prevents the likelihood of injury and danger by allowing the ability to grip the road and prevent sliding or skidding of the vehicle. The system also belongs to the First Law of Motion since it travels in the same direction (tyres) but can be acted upon by an unbalanced force **(brakes)** (road or surface). Tyre treads have been present ever since rubber tyres were first used and will eventually wear off after prolonged use, hence the reason why traction becomes less effective and reliable depending on how long they have been used for. **(2)**

**5.) Headlights**

I’m placing headlights last because even though they are a mandatory and standardised safety feature, they are only really used when driving in darker environments such as at night or through a tunnel. Headlights act as a source of light when travelling in dark environments which work to illuminate our surroundings in front and prevent the likelihood of injury by brightening our view in front which without, could cause head-on collisions with other vehicles or objects since we cannot properly see our surroundings. Headlights don’t apply to any Law of Motion. Similar to tyre tread, headlights have been present on cars ever since their creation but have received a few updates and improvements over time, one of which being the high beam which can be easily switched on and is used when driving on a deserted stretch of road to maintain clearer visibility but cannot be turned on when approaching a vehicle from the opposite lane since it can be potentially blinding. **(2) also important to see on-coming vehicles in the dark.**

**(1)-value line**

**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.  **3** **(12 marks)**

The car that travels at a speed of approximately 60km/hr collides with a stationary object. The Law that is applied to this situation is Newton’s Third Law since the stationary object exerts an equal amount of force onto the car which is initially distributed by the collision from the car. **(1)** Since the driver travels at a constant speed and suddenly hits the stationary object, it would mean that the driver would continue moving forward once the car stops since they were travelling at 60km/hr. **(1)** As a result, the driver may strike the front interior like the steering wheel and suffer harsh injuries such as damage to areas of the upper body. Such injuries may include fractures, concussion, whiplash, brain injury, internal bleeding, and permanent scars or cuts. Once the car stops, it is possible the tyres may lose traction to the road and be unable to grip properly. By which time, the Electronic Stability Control system (if installed) will activate to restore tractive contact with the road. **(1)**

**You need to explain braking, crumple zones, seatbelts, airbagas and headrests in how they work during a collision and which laws apply.**

**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.  **6 (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.

Children under the age of seven must remain in a booster seat and must be suspended high enough in order to adequately fasten and secure the child in a safe position. **(1)** Children must be properly restrained in a car to ensure maximum safety because if an accident occurs, the child may be more at risk of injury or even death in comparison with the other passengers because they are more vulnerable to a strong impact since they are not fully developed and might not retain the ability to handle such harsh experiences. **(1)** Additionally, the booster seat they are required to use must be strapped and fastened by an adult in a very specific way in order to meet the expectations of the law and overall safety of the child occupying it. **(1)** If a restraint is not secured correctly, **(1)** it can become loose and only increase the risk of fatal consequences if an accident were to take place. Some booster seats include cushions on either side of the head rest to provide better security during lateral impact. To properly secure a child in their booster seat, the adult must remember to:

* Place upper part of seatbelt across the child’s torso and shoulder but should avoid placing it too close to the neck.
* Place the lower part of the seatbelt across the hips but should avoid placing it on the stomach.
* Make sure the child is seated in a position that provides a range of movement in the knees or else it can become uncomfortable and the child may end up sliding forward.
* Make sure the child’s head is positioned at the same height parallel to the head restraint.
* **(1)** **Why for each of these?**

If the adult responsible for the child’s safety does not comply with these laws, the child will be more prone to the dangers of being in an accident and may face life-threatening consequences. For example, if a child is not seated in the correct position or the seatbelt wasn’t locked into place, the child may possibly end up slipping out of the seat and hitting the object in front (i.e., the head restraint). Also, if the adult in charge of the child’s safety does not obey these laws, they will be punished by being charged a $500 fine as well as a loss of four demerit points on their license. **(1)**

**You need to also explain how the harness works, rear facing booster seats, and why children shouldn’t be in the front seat for certain ages.**

**End of Assessment**