The thick mattress on the ground provides a protective cushion for the stunt person when he lands.

Why do you think the hardness of a surface affects the type injury upon impact?

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
Read the text below:

Carts collide in Physics labs all the time with little damage. But when cars collide on a freeway, the resulting rapid change in speed can cause injury or death to the drivers and any passengers.

Many types of collisions are dangerous, but head-on collisions involve the greatest accelerations and thus the greatest forces. When two cars going 100km/hr collide head-on, each car dissipates the same amount of kinetic energy that it would dissipate if it hit the ground after being dropped from the roof of a 12-storey building.

The key to many automobile-safety features is the concept of impulse. Impulse is measured as the product of force and time in which that force acts on an object.

**Momentum** is a measure of how difficult an object is to change direction or speed. The higher its speed and the greater its mass the greater its momentum. The faster an object is moving—whether it be a baseball, an automobile, or a particle of matter—the harder it is to stop. The impulse-momentum relationship is extremely important for understanding how to protect yourself and your occupants from personal injury in a car collision.

A 2000-kg car moving at 50 km/h has a tremendous amount of momentum. In order to stop the car, the car’s momentum must be reduced to zero. The only way to do this is to apply an impulse opposite to the car’s motion. To safely brake the vehicle, we apply an impulse by exerting a force on the wheels for a long period of time. In cases where the car stops rapidly, as in a collision, the impulse is applied over a short duration of time, resulting in very large, destructive forces acting on the car and its occupants. In order to cushion the blow, manufacturers have invented several devices that use the impulse-momentum relationship by increasing the amount of time for the impulse and, consequently, decreasing the applied force. It’s kind of like an egg toss. If you catch the egg without allowing your hands to “give”, then the force is usually too large for the egg and the egg breaks.

Technology has allowed scientists to work with airbags to prevent injury in collisions with reference to impulse. There is another way that cars were improved using the idea of impulse called Crumple Zones.
Cushioning devices - Crumple Zones

One way today’s cars make use of the concept of impulse is by crumpling during impact. The front and back ends of the car have now been made into crumple zones. A crumple zone is a part of a car that is designed to compress during an accident to absorb the impulse from an impact. A crumple zone increases the amount of time it takes the car to stop, and therefore decreases the amount of force in the impulse. Crumple zones mean that the impulse is reduced before it is passed on to the occupant compartment.

Pliable sheet metal and frame structures absorb energy until the force reaches the passenger compartment. Because the crumpling slows the car gradually, it is an important factor in keeping the driver alive.

Seat Belts and Air Bags

According to the law of inertia, if a car stops abruptly, the occupants and all other objects in the car maintain their forward momentum.

Seat belts are necessary to protect a body from forces of such larger magnitudes. They stretch and extend the time it takes a passenger's body to stop, thereby reducing the force on the person. Air bags further extend the time over which the momentum of a passenger changes, decreasing the force even more. Air bags cushion the blow by increasing the amount of time during which the force is applied hence reducing the amount of force of the impulse.

As of 1998, all new cars have air bags on both the driver and passenger sides. Research shows that air bags can save lives by reducing the risk of fatality in frontal impacts by about 30 per cent. Seat belts also prevent passengers from hitting the inside frame of the car. During a collision, a person not wearing a seat belt is likely to hit the windshield, the steering wheel, or the dashboard—often with traumatic results. Car crash researchers estimate that seat belts reduce the risk of fatal injury to front-seat occupants by up to 45 per cent and the risk of serious injury by 50 per cent.
**ACTIVITY-1**

1. Listed below are the new words from the reading passage, Write the meaning for the following using the Dictionary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinetic Energy</td>
<td></td>
</tr>
<tr>
<td>Momentum</td>
<td></td>
</tr>
<tr>
<td>Impulse</td>
<td></td>
</tr>
<tr>
<td>Inertia</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td></td>
</tr>
</tbody>
</table>

2. As you read about momentum and impulse in this section, complete the concept map to organize what you learn

- **Momentum**
  - Is measured
  - Is calculated by multiplying

- **Impulse**
  - depends on

3. Circle the letter of each factor that affects the momentum of a moving object.
   a. mass  
   b. volume  
   c. shape  
   d. velocity

4. If two identical objects are moving at different velocities, the object that is moving faster will have ____________(more/less) momentum.

5. Your in-line skates are sitting in a box on a shelf in the closet. What is their momentum? ______________

6. Is the following sentence true or false?
   An object with a small mass can have a large momentum if the object is traveling at a high speed. ______________

7. Circle the letter of the object that has the greatest momentum.
   a. a 700-gram bird flying at a velocity of 2.5 m/s
   b. a 1000-kilogram car traveling at 5 m/s
c. a 40-kilogram shopping cart rolling along at 0.5 m/s
d. a 300-kilogram roller coaster car traveling at 25 m/s

**ACTIVITY-2**

A-Answer the following questions based on the reading passage

1. The purpose of an airbag in an automobile is
   - [ ] to prolong the time of impact for a given change in momentum thereby reducing the force of impact
   - [ ] to deliver a greater force to the car occupant upon impact
   - [ ] to shorten the time of impact
   - [ ] to reduce the momentum of the vehicle

2. Forces can be reduced when stopping (eg use of crumple zones, crash barriers, seatbelts and airbags) by:
   - [ ] increasing stopping or collision time
   - [ ] increasing stopping or collision distance
   - [ ] decreasing acceleration

3. Which of the following is the purpose of seatbelts, crumple zones and airbags
   - [ ] change shape
   - [ ] absorb energy
   - [ ] reduce injuries

4. The amount of momentum that any object has is dependent on which of the following quantities? Check all that apply.
   - [ ] Velocity
   - [ ] Weight
   - [ ] Mass
   - [ ] Distance

5. Impulse is calculated as
   - [ ] the product of force and velocity
   - [ ] the product of mass times velocity
   - [ ] the product of the force and the time interval

6. State the names of typical safety features of modern cars that require energy to be absorbed when vehicles stop

_______________________________________________________________________
7. What will be the effect of spreading the change in momentum over a longer time

________________________________________________________________________
________________________________________________________________________

2-Write True(T) if the sentence is true. Write False(F) if the sentence is false.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum is a measure of the motion of a body equal to the product of its mass and acceleration due to gravity.</td>
<td></td>
</tr>
<tr>
<td>Impulse is defined as the force times the time interval.</td>
<td></td>
</tr>
<tr>
<td>The tendency of an object to resist a change in motion is called Force</td>
<td></td>
</tr>
<tr>
<td>If the speed of an object is doubled, its momentum is multiplied by 2</td>
<td></td>
</tr>
<tr>
<td>Sudden change in momentum in a collision, results in a large force that can cause injury.</td>
<td></td>
</tr>
<tr>
<td>Safety features of modern cars ensures that energy is not absorbed when vehicles stop:</td>
<td></td>
</tr>
<tr>
<td>Crumple zones are built into cars to increase the duration of crashes.</td>
<td></td>
</tr>
</tbody>
</table>

**ACTIVITY-3**

1-Answer the following questions giving reason for the answer

1. Which has greater momentum: a train at rest or a moving skateboard?

________________________________________________________________________
________________________________________________________________________

2. Cars were previously manufactured to be as sturdy as possible, whereas today's cars are designed to crumple upon impact. Why?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

3. When jumping from a significant height, why is it advantageous to bend your knees when landing?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
4. Provide one example of situation in which (a) velocity is the dominant factor affecting the momentum of an object
________________________________________________________________________
________________________________________________________________________
(b) mass is the dominant factor affecting momentum of object
________________________________________________________________________
________________________________________________________________________

2-Rank the objects (A – E) in order of increasing momentum.

2

A

$A$: $m_A = 30 \text{ g}$
$\vec{v}_A = 3 \text{ m/s}$

B

$B$: $m_B = 40 \text{ g}$
$\vec{v}_B = 5 \text{ m/s}$

C

$C$: $m_C = 300 \text{ g}$
$\vec{v}_C = 2 \text{ m/s}$

D

$D$: $m_D = 10 \text{ g}$
$\vec{v}_D = 5 \text{ m/s}$

E

$E$: $m_E = 20 \text{ g}$
$\vec{v}_E = 7 \text{ m/s}$

Least 1 _______ 2 _______ 3 _______ 4 _______ 5 _______ Greatest

POST-READING TASK

Explain why they are wearing helmets and pads for cushioning, what is the purpose? Why are the pads on specific parts of the body?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________