Physics of Driving and Occupant Restraints

Key Terms

- **Gravity** - The force that pulls all things to Earth
- **Center of Gravity** - The point around which an object's weight is evenly distributed
- **Inertia** - The amount of energy needed to propel a vehicle
- **Kinetic Energy** - An object in motion continues to move straight ahead until acted upon by some outside force
- **Traction** - The adhesion, friction or grip between the tires and the road surface
- **Balance Vehicle Suspension** - The distribution of the weight of the vehicle on the chassis

Gravity

You can feel the pull of gravity as you drive up and down hills.

- Driving uphill, you will lose speed unless you use extra power.
- Driving downhill, you will increase in speed.
- Do not ride your brakes downhill, instead use engine compression by shifting into a lower gear.

Center of Gravity

- The point around which an object's weight is evenly distributed.
- A vehicle's stability decreases as its center of gravity rises.

Natural Laws - Inertia

What is inertia?

An object in motion continues to move straight ahead until acted upon by some outside force.

These five factors can influence the effects of inertia:

1. Speed
2. Sharpness of the turn or curve
3. Size, height, weight and load of the vehicle
4. Roadway surface condition
5. Roadway slope

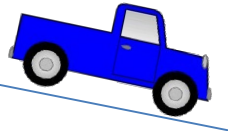
Kinetic Energy

Kinetic energy is the amount of energy needed to propel a vehicle.

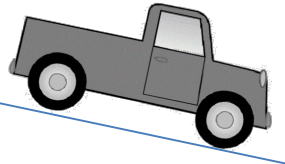
- What happens when a vehicle's speed doubles? Example: your speed increases from 20 mph to 40 mph. You will need four times the distance to stop the vehicle as the speed increases!

- If a vehicle's speed doubles, the forces involved in a collision will be quadrupled.

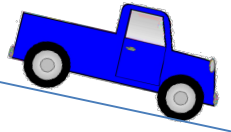
- Knowing this information traffic engineers study traffic patterns and identify where driving errors might occur and determine safe speed limits for these areas.



Empty truck going 25 MPH
will only travel 15 feet



Double the truck weight going
25 MPH will travel 30 feet



Empty truck going 50 MPH
will travel 60 feet

A vehicle's kinetic energy increases dramatically with increases in weight and speed.

Balance

- Balance of the vehicle is so important not only for vehicle control but also for the maintenance of the vehicle.
- How can you tell if a vehicle is accelerating? You should feel a backward motion as the weight of the vehicle is shifted to the rear.
- How about when a vehicle is decelerating? The weight of the vehicle is shifted forward so you should feel forward motion in your seat.
- What happens if you take a turn too fast? The weight of the vehicle shifts in the opposite direction of the turn.

What factors contribute to single-vehicle crashes?

- Statistics show that more than 50 percent of occupant fatalities occur as a result of single-vehicle crashes. Why do you think this is?

- Single-vehicle crashes involve too fast for conditions, improper steering or braking or a combination of all three.

- These factors can upset a vehicle’s balance and can lead to a loss of traction and loss of control in maintaining the intended path of travel.

Road Surface and Traction

- Traction is the adhesion, friction or grip between the tires and the road surface.
  - Without traction, a driver can not brake, steer, or accelerate their vehicle.
  - A loss of traction could cause loss of control resulting in skidding.
  - Traction varies with the vehicle's speed, tire condition, and roadway surface.

Drivers must learn to recognize conditions that may indicate a change in traction, which in turn will require a change in speed or direction.

Road Surfaces

Road surfaces produce different amounts of traction. The following are ranked in order, from the greatest traction to the least:

1. Concrete
2. Asphalt
3. Brick or polished concrete
4. Dirt
5. Gravel
6. Sand over hard surface

What's the best way to stay in control of the vehicles traction?

Conditions that Affect Traction: Substances on the Road

Any substance on a road surface can reduce traction

- Sewer covers
- Paint
- Vinyl strips
- Tar
- Wet leaves
- Sand
- Lose gravel or mud
- Oil, tar, radiator overflow and rubber left by frequent vehicle starts and stops at intersections

Conditions that Affect Traction: Surface Conditions

- Poor road conditions such as rippled surfaces or potholes can contribute to a loss of traction.
- At the beginning of a rainstorm, dirt and oil can rise and mix on the roadway surface, making the road extremely slippery.
- At speeds as low as 35 mph and a water depth of only 1/12 inch, “hydroplaning” can occur.
- It is the driver’s responsibility to prevent his or her vehicle from hydroplaning.

Conditions that Affect Traction: Temperature Changes

- As temperatures rise from below freezing to about 32 degrees, icy and snow-packed areas become more slippery.
- Wet ice is much more slippery than dry ice.
- Intersections are likely to be slicker because starting and stopping vehicles polish the ice.

Conditions that Affect Traction: Other Factors

- Bridge surfaces, overpasses and shaded areas may freeze before other road surfaces.
- Wind gusts and strong crosswinds can make steering on a slick surface difficult.
- Large building or embankments may block the wind, cause a sudden change in wind direction or shade an icy area from the sun.
- Patches of ice or wet leaves can cause unequal traction.

Conditions That Affect Traction: Roadway Design

- Features such as banked or crowned roads, can have an effect on traction and control.
- Shoulders of most highways provide less traction than the road surface. Shoulders may be rough or soft; covered with loose materials such as dirt, cinders or sand; or littered with broken glass or other waste.

Tires and Traction

Tread – the grooved surface of a tire that grips the road.

When the road is wet, the tread allows water to flow through the grooves and away from the tire, allowing the tire to grip the road.

A worn, bald tire is dangerous!

- Will not grip a wet or icy road
- The tire may puncture causing a blowout

Tire Inflation

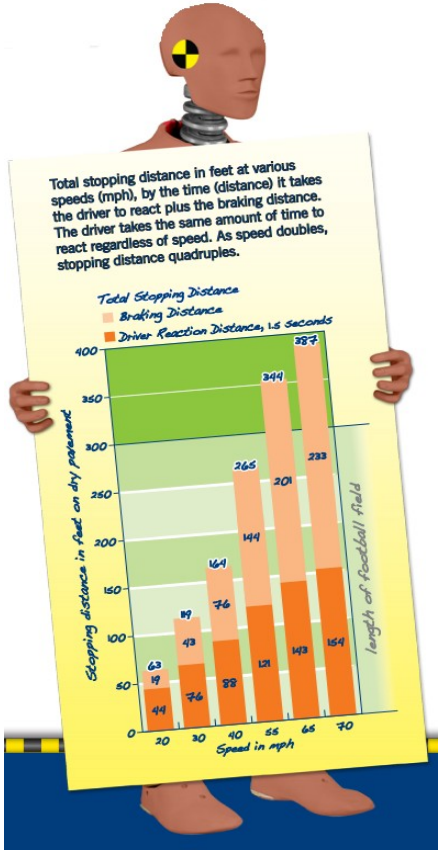
- How do you check for proper tread depth?

- How do you know how much air to put in your tire?

Factors That Affect Braking Distance

- Speed
- Vehicle Condition
- Roadway Surface
- Driver Ability
- Anti-Lock Braking System
- Hills
- Loads

Note: Brakes stop the wheels, not the vehicle



Force of Impact

Force of Impact – the force with which a moving object hits another object.

Three factors determining how hard something will hit another object:

- Speed
- Weight
- Distance Between Impact and Stopping

Three Collisions When a Crash Occurs

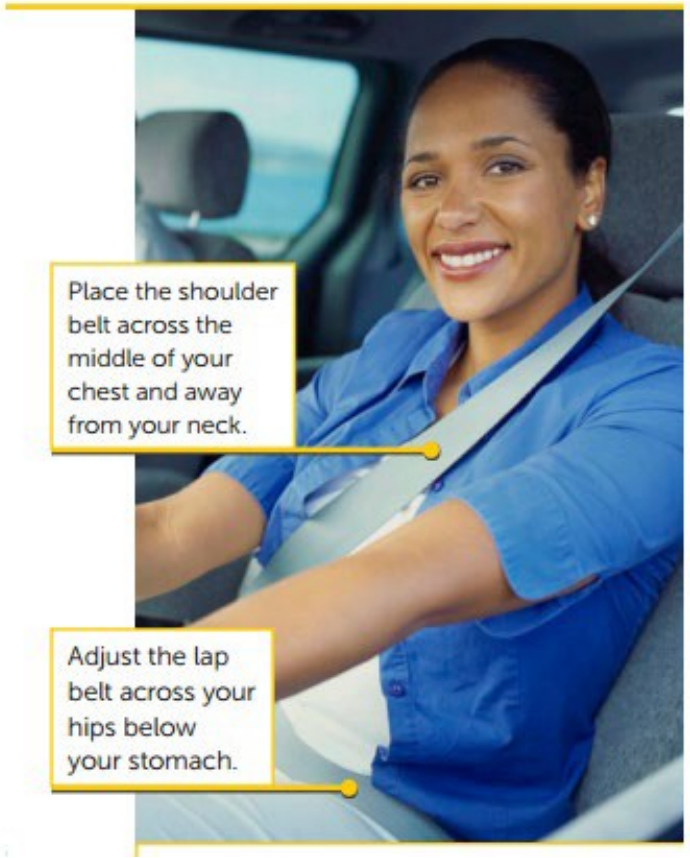
- **First-** the vehicle hits an object.
- **Second-** the occupant hits the interior parts of the vehicle, such as the steering wheel or dash board.
- **Third-** the occupants internal organs slam up against their skeletal structure, this usually results in the most injuries.

Three Collisions in a Crash Video

Seat Belts Video

Occupant Protection- Seat Belts

- Wearing your seat belt is the single most effective thing you can do to protect yourself in crash.
- Air bags are designed to work with seat belts, not replace them.
- Seat belt fit matters- the shoulder belt should lay across the middle of the chest and way from neck; the lap belt should lay across your hips not your stomach.
- Everyone in the car should be properly restrained (in a car seat, booster or seat or seat belt, depending on their age and size).



Adjusting Your Head Restraints

- The top of the head restraint should be adjusted to a point slightly above your ears and, if possible, within 3 inches of the back of your head when you are seated in a normal, upright position.

- This can protect you from whiplash injury should you be involved in a rear end crash.

Don’t Forget to Buckle Up in the Back

Key Points from NYS Vehicle and Traffic Law

Child Passenger Safety (Car Seats and Booster Seats)

- Children under the age of eight must be in a federally approved child restraint system.
- A vehicle's seat belts are not defined as a child restraint system under the law, as they are not designed for children.
- Depending on child's size, the restraint system may be an infant-only, convertible, combination, all-in-one or booster seat used with a lap and shoulder belt.
- All children must use a rear-facing car seat until they are two years old or reach the highest weight or height limit allowed by the car seat manufacturer.

Key Points from NYS Vehicle and Traffic Law

Seat Belt Use for Drivers and Passengers

- All drivers must be restrained by a seat belt and all passengers must be properly restrained by a seat belt or child restraint system.

Can you name other protective devices in your car?

- Front and rear crash area zones
- Energy absorbing bumpers
- Side door beams
- Reinforced windshields
- Energy absorbing steering wheel and column
- Padded dash
- Seat belts
- Head restraints

Match These Key Terms

Gravity

Center of Gravity

Inertia

Traction

Kinetic Energy

Vehicle Suspension Balance

1. The adhesion, friction or grip between the tires and the road surface

2. The amount of energy needed to propel a vehicle

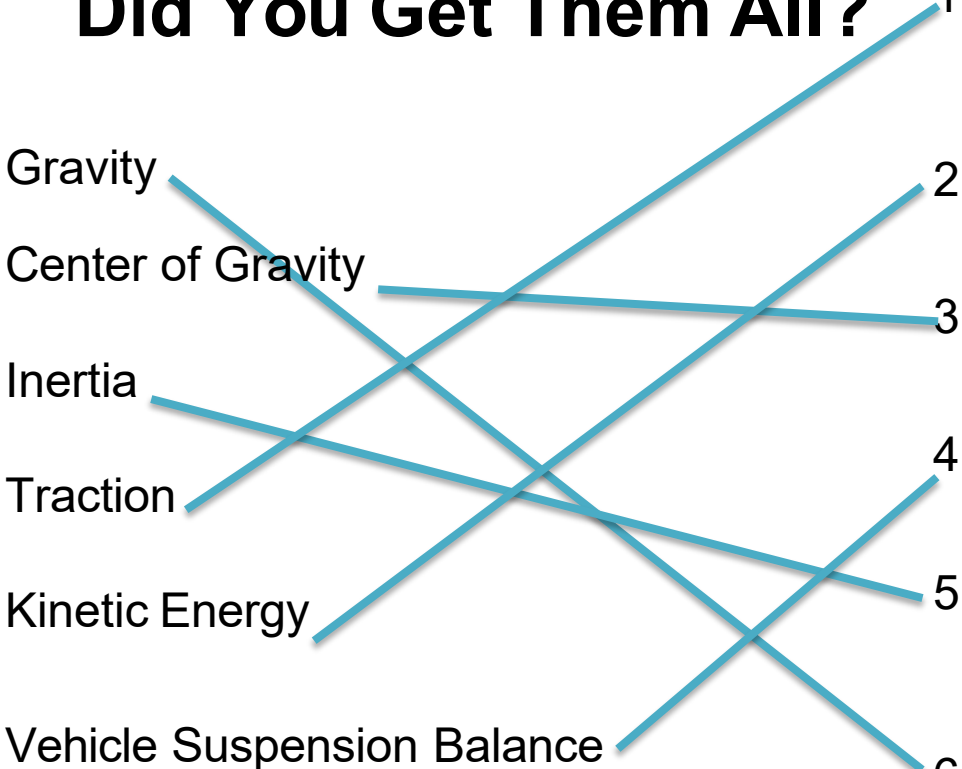
3. The point around which an object's weight is evenly distributed

4. The distribution of the weight of the vehicle on the chassis

5. An object in motion continues to move straight ahead until acted upon by some outside force

6. The force that pulls all things to Earth

Did You Get Them All?



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References

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