



Montana Teen Driver Education and Training

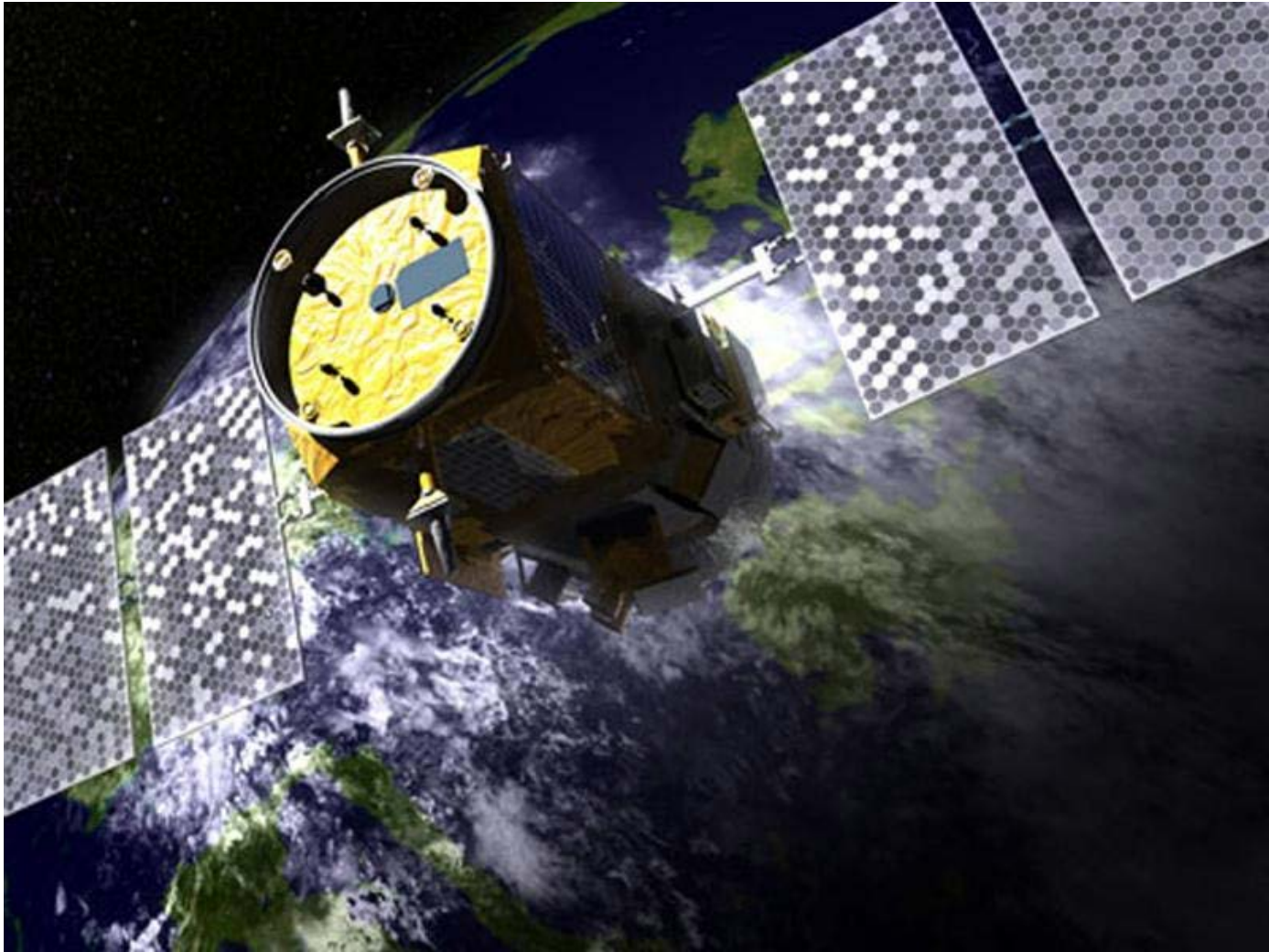
Module 4.1

Natural Laws



Natural Laws Objectives

- Understand the physical laws and concepts that govern driving.
- Understand and apply the concepts of Kinetic Energy.
- Understand the relationship between friction and traction.
- Calculate vehicle momentum and understand the relationship of vehicle mass, vehicle speed and their effects on vehicle crashes.
- Use your skills to manage natural laws.



Natural Laws
PHYSICS 101

Click on the image below to visit web page with videos. The IIHS in the Classroom link below takes you to all the classroom resources.

View: Classroom Videos and Video Segments

Join Dr. Griff Jones as he relates classroom physics and biology to the real world of cars and car crashes.



Understanding Car Crashes: It's Basic Physics

Watch Video Now! (3 viewing options)



Understanding Car Crashes: When Physics Meets Biology

Watch Video Now! (3 viewing options)

[IIHS in the Classroom](#)

Physics Concepts

- Gravity
- Kinetic Energy
- Momentum
- Force
- Inertia
- Friction
- Traction



Gravity

- The force that attracts a body toward the center of the earth
 - When I jump up I
 - When I throw a ball in the air it . . .
 - When I go off a cliff . . .

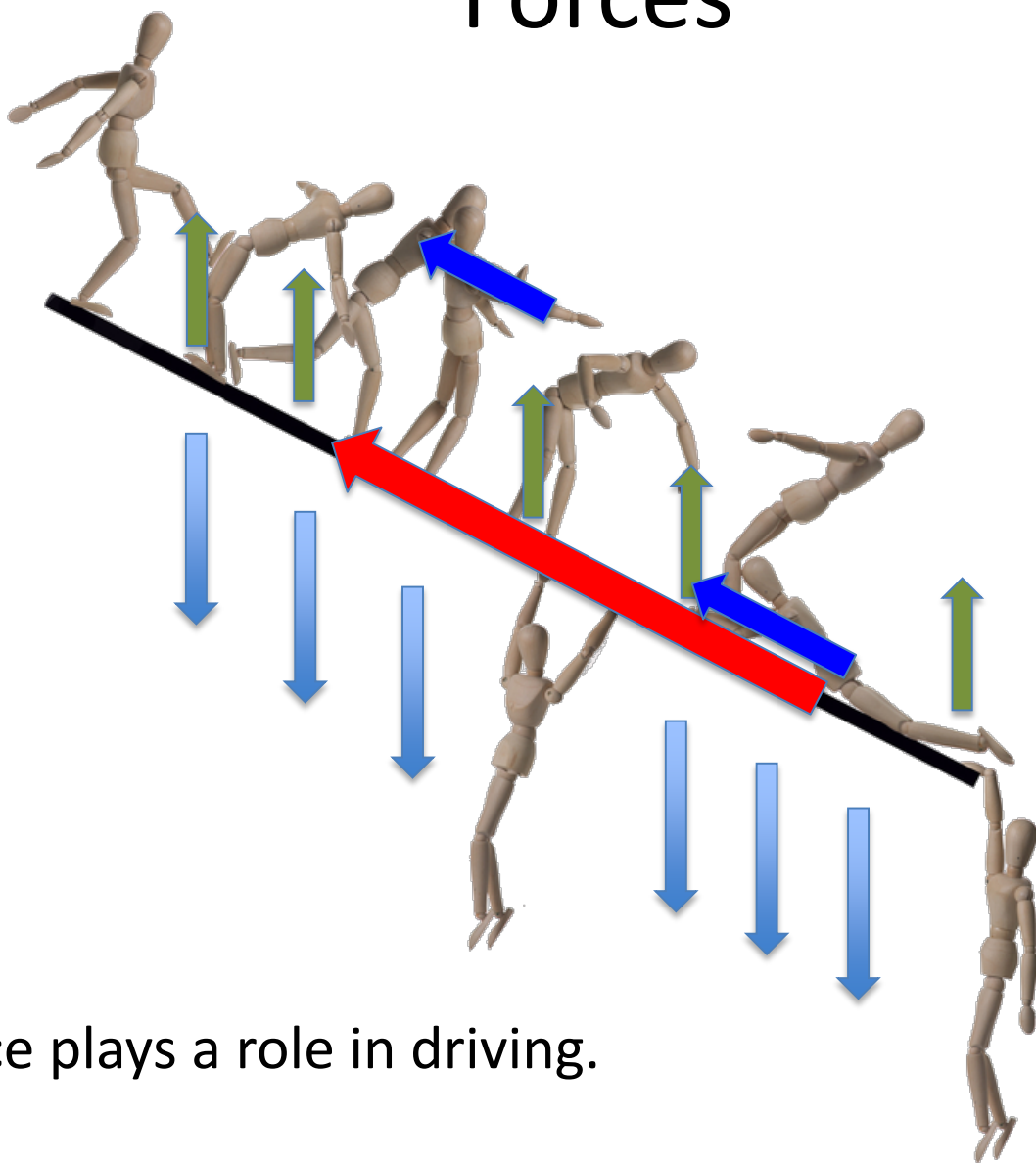
Gravity—It's not just a good idea. . .

It's the LAW!

(The Law of Physics)



Forces



Each force plays a role in driving.



Hills and Gravity



PLAY VIDEO (:51)



Kinetic Energy

- Energy of Motion

$$KE = \frac{1}{2}mv^2$$

- KE is for Kinetic Energy
- M is for Mass
- V is for Velocity



Energy of Motion

20 MPH



40 MPH



Double the speed—quadruple the energy!



Stopping Distance



PLAY VIDEO (:31)



Stopping Distance





Momentum

- Mass in Motion
 - How much stuff and how fast the stuff is moving in one direction

Momentum = mass x velocity

Momentum



**Both the cyclist and SUV are traveling at the same speed—20 mph.
Which has the greater momentum?**



Energy in a Crash

Student Activity 1: Force of Impact

- Stand 1-2 inches from a wall with hands up facing wall and go as fast as possible into the wall protecting yourself with your hands. (Similar to sport coaches saying to run through the finish line.) Ask if there were any injuries.
- Step back one step and do the same, protecting self with the hands to prevent injury. Discuss whether or not injury could occur from this distance and why.
- Now step back five steps and ask what the results would be if you were to go through the finish line or wall from this distance. DO NOT actually run into the wall from this distance nor have a student attempt this.



Check out this road ...

Describe what you
see:

- Roadway design
- Road surface conditions
- Space for error

**As the driver, what decisions
should you make?**





QUESTION:

What would cause this 25-inch diameter high voltage power pole to break like this?



ANSWER:

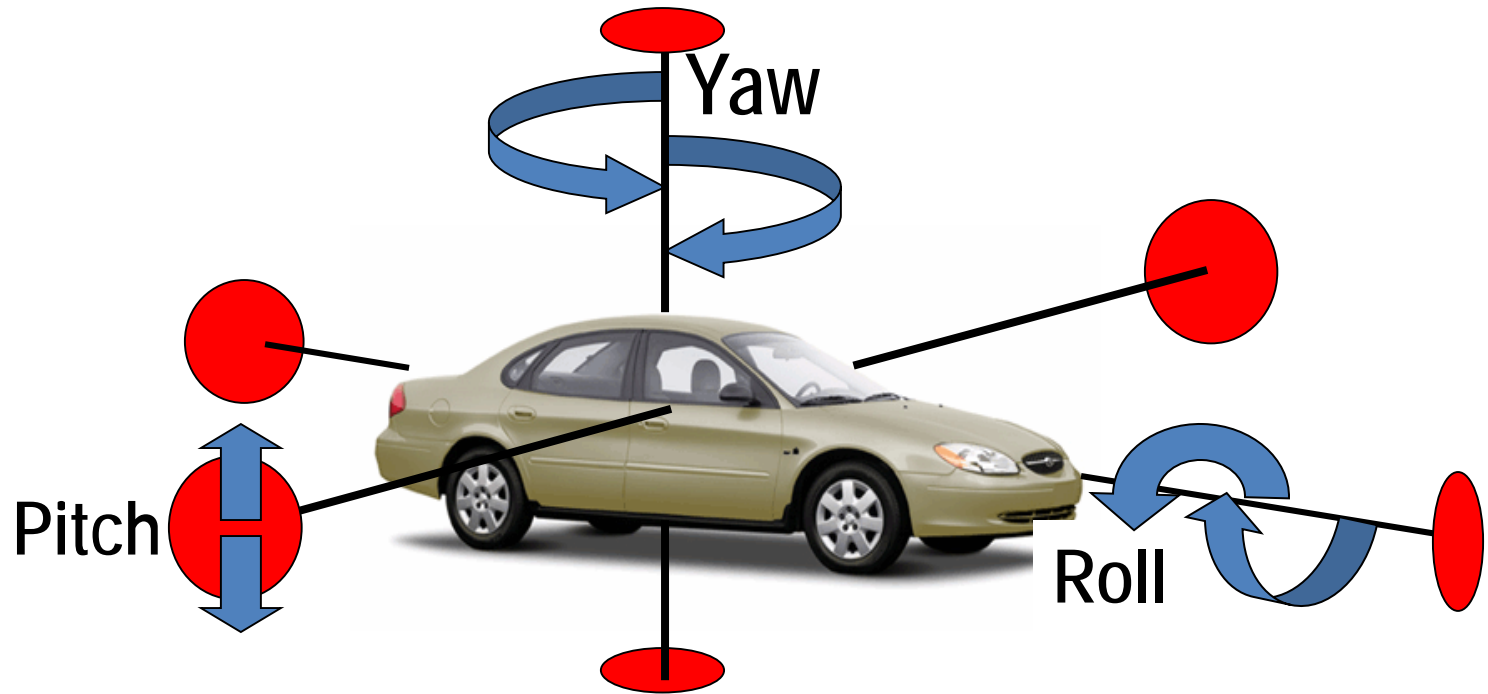
This Volvo traveling at 100mph when it lost control and struck the power pole!

That's why speed kills!



Remember Vehicle Balance

PITCH, ROLL, YAW?





Pitch





Student Activity 2: Pitch

- Stand up.
- Pretend that you are in a car moving at 35mph.
- The driver slams on the brakes.
- Demonstrate what your body does when the car suddenly stops.



Roll



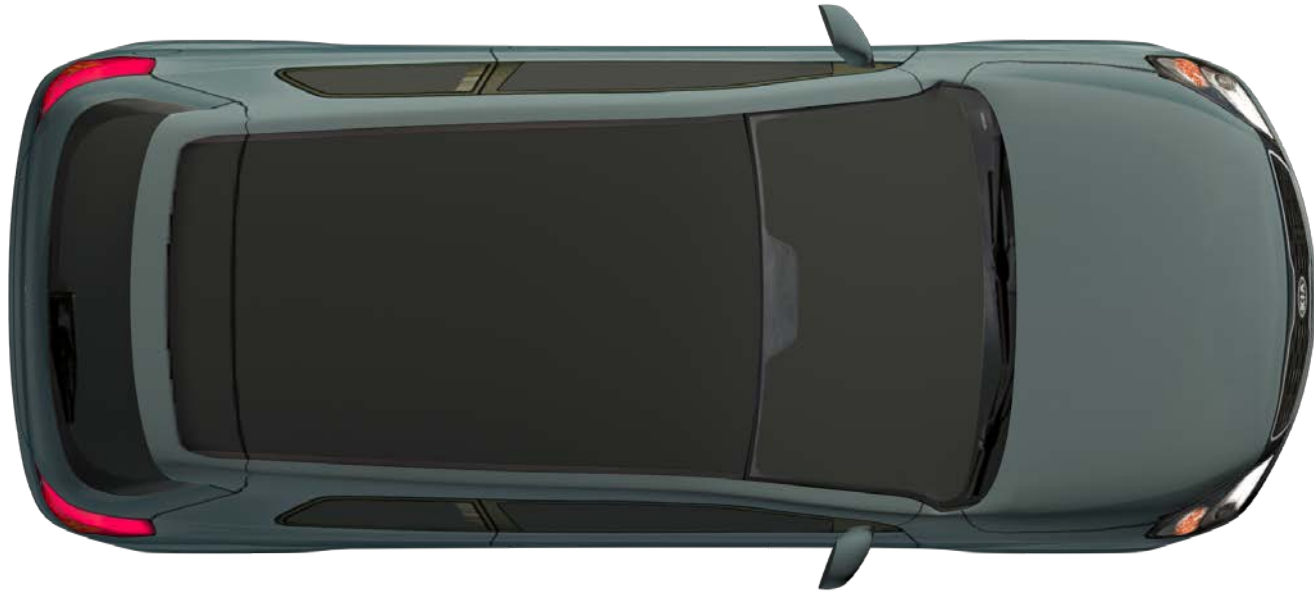


Student Activity 3: Roll

- Stand up.
- Pretend you are traveling in a car moving at 35mph.
- The driver turns sharply to the left.
- Demonstrate what your body does when the driver turns.



Yaw





Describe what is happening to this vehicle in balance terms.

FRICTION

Friction

- The force when two surfaces move against each other and one surface resists the other.
- Described in terms of a coefficient of friction.
- Different surfaces have different coefficients of friction.



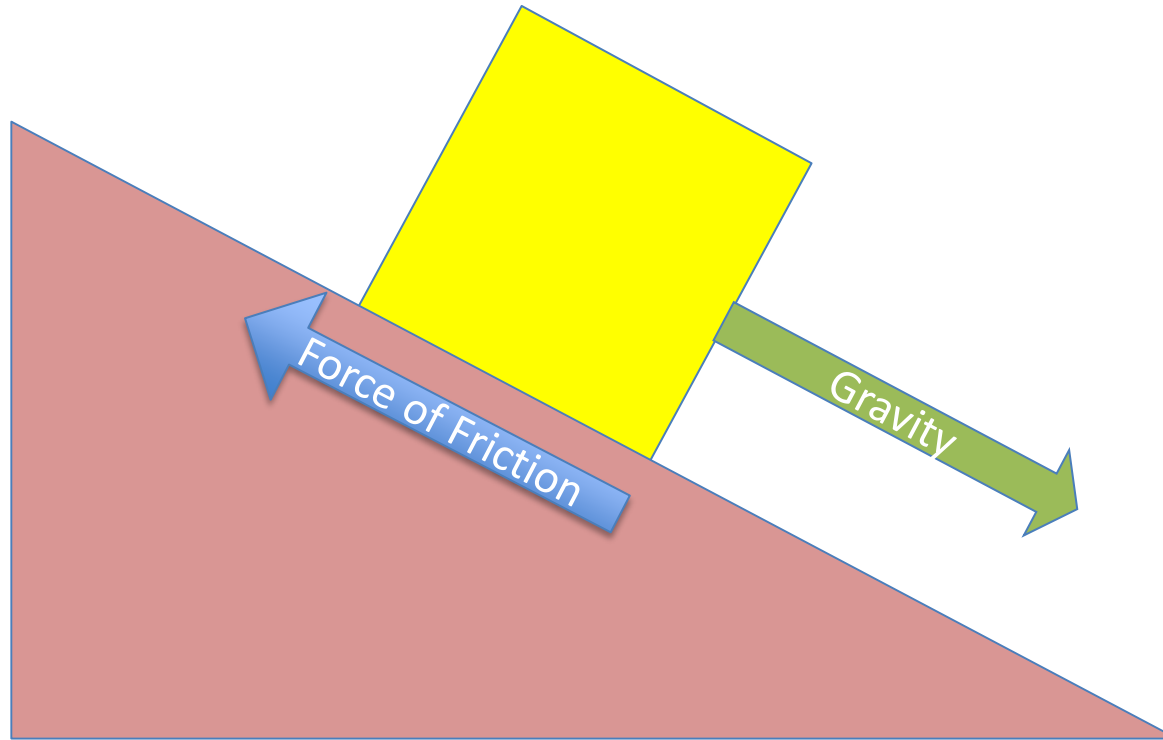
Student Activity 4: Friction

- Put your palms together and press them together firmly
- Rub them back and forth quickly for 30 seconds

What happened as you rubbed your hands together?



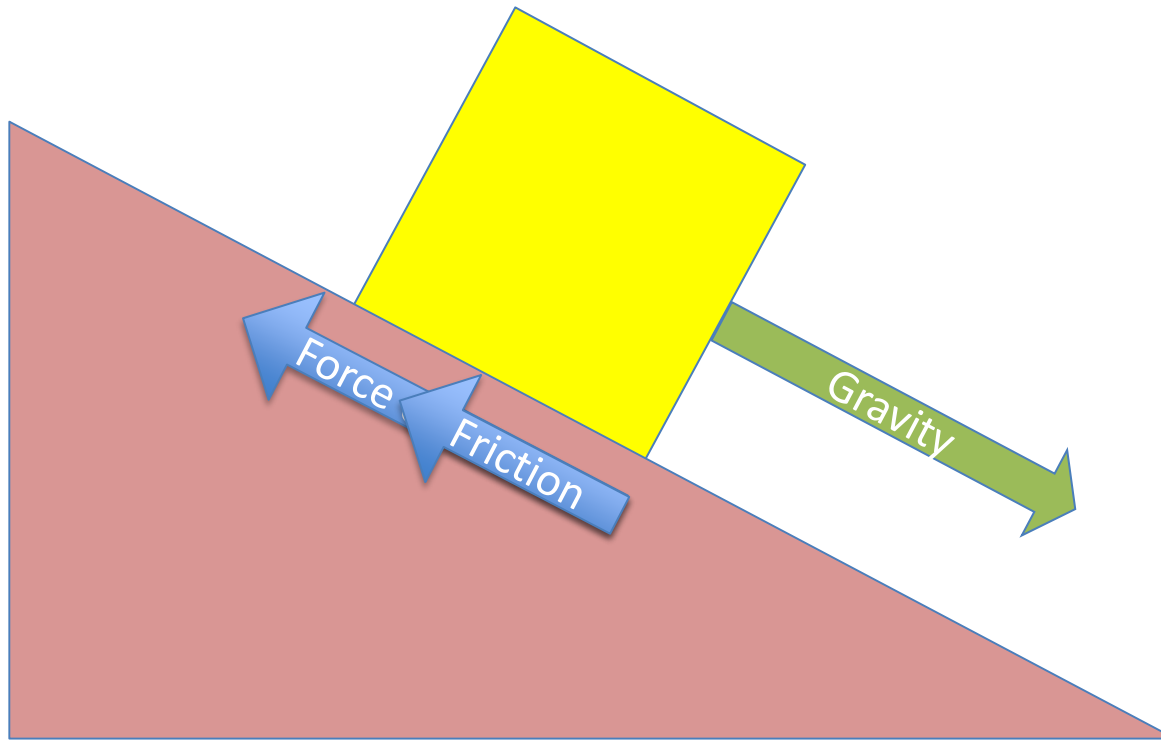
Static Friction



Force of friction is equal to or greater than the force of gravity
Object doesn't move or remains static

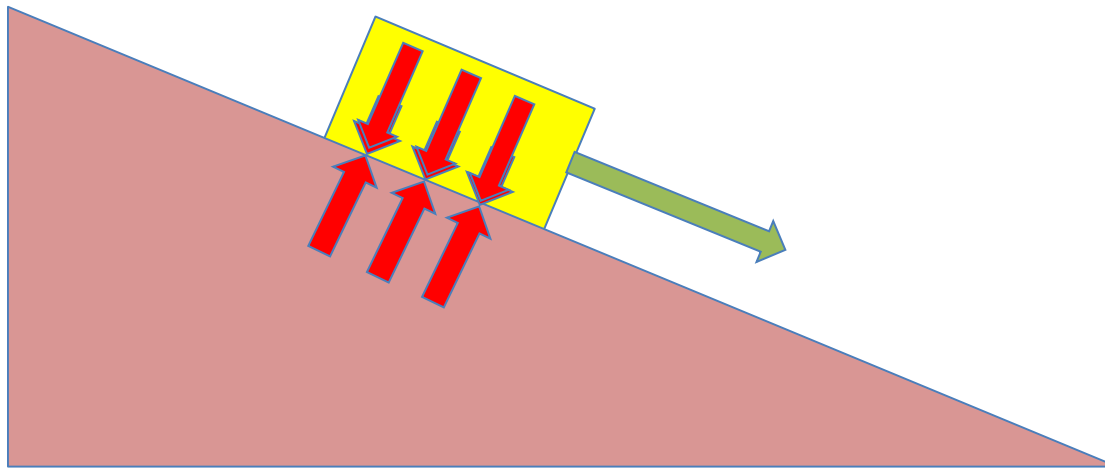


Sliding Friction



When the force of friction is less than the force of gravity
Object slides down the slope

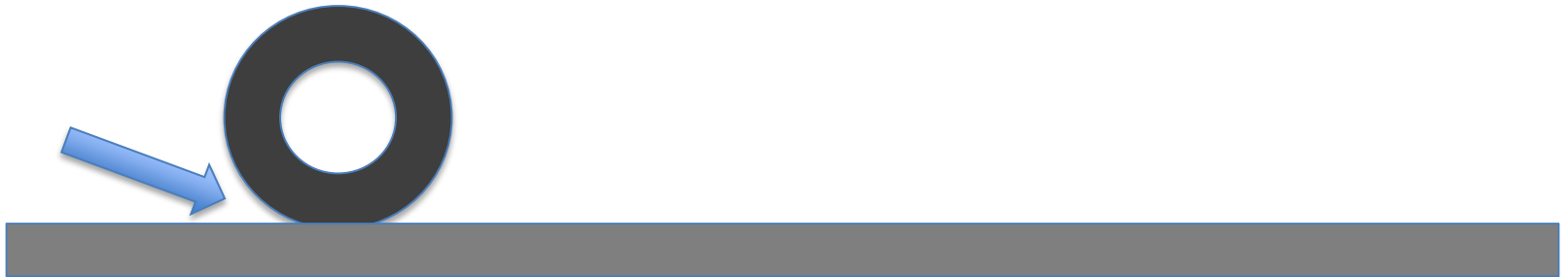
Sliding Friction and Mass





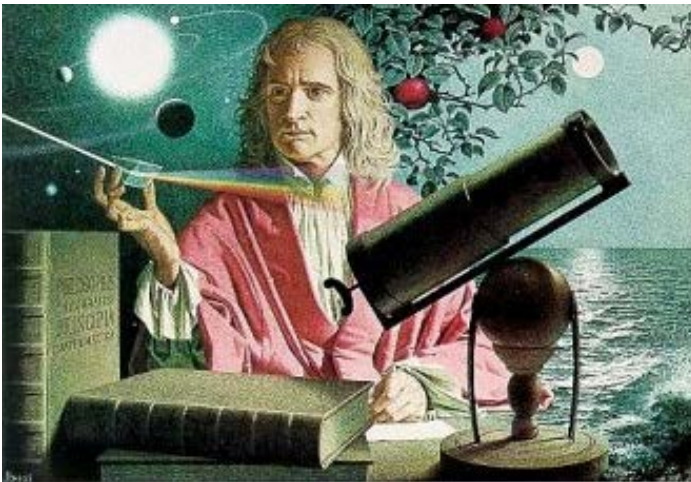
Rolling Friction

Friction between the ground and the tire



Inertia

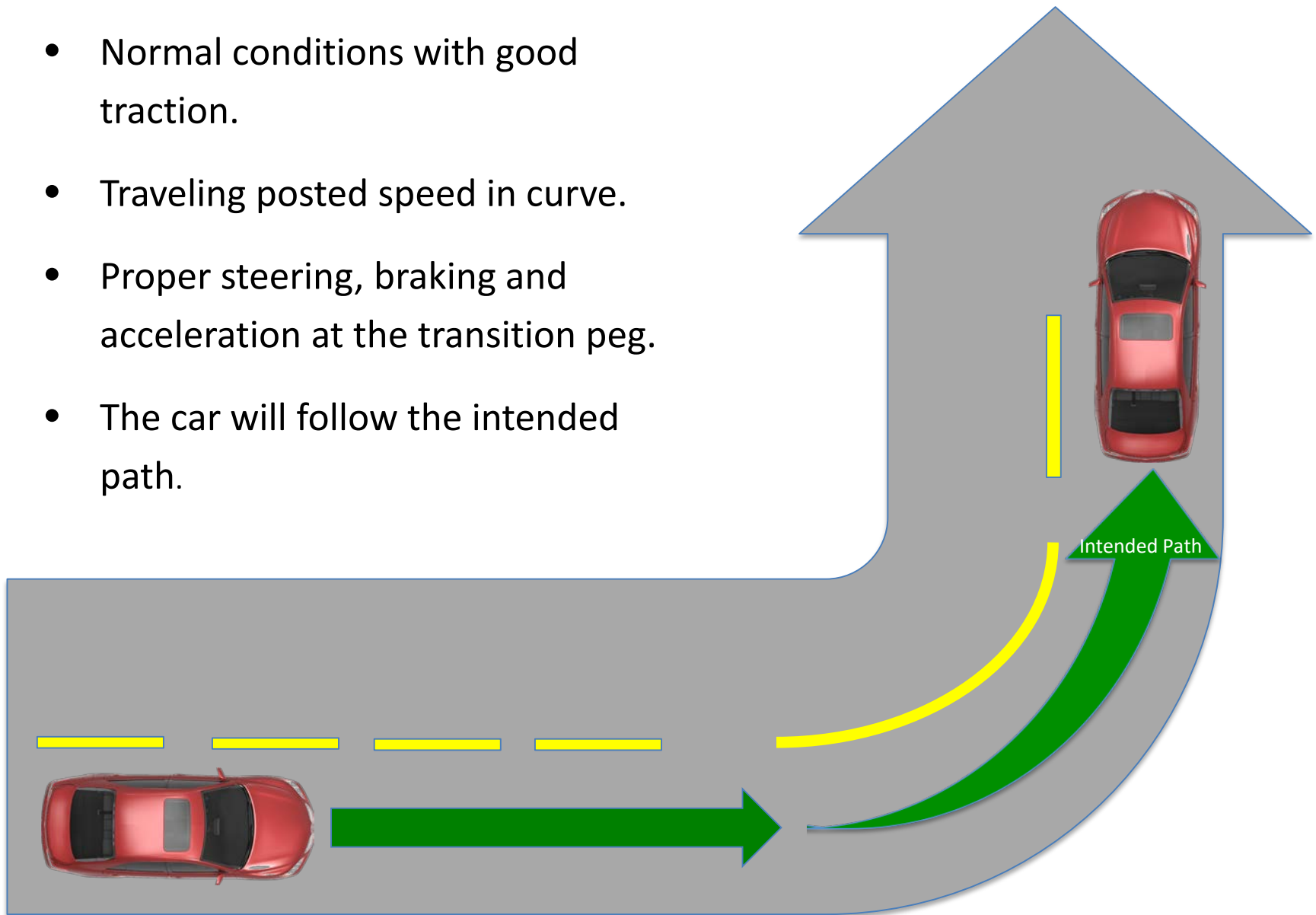
- An object at rest.
- An object in motion.



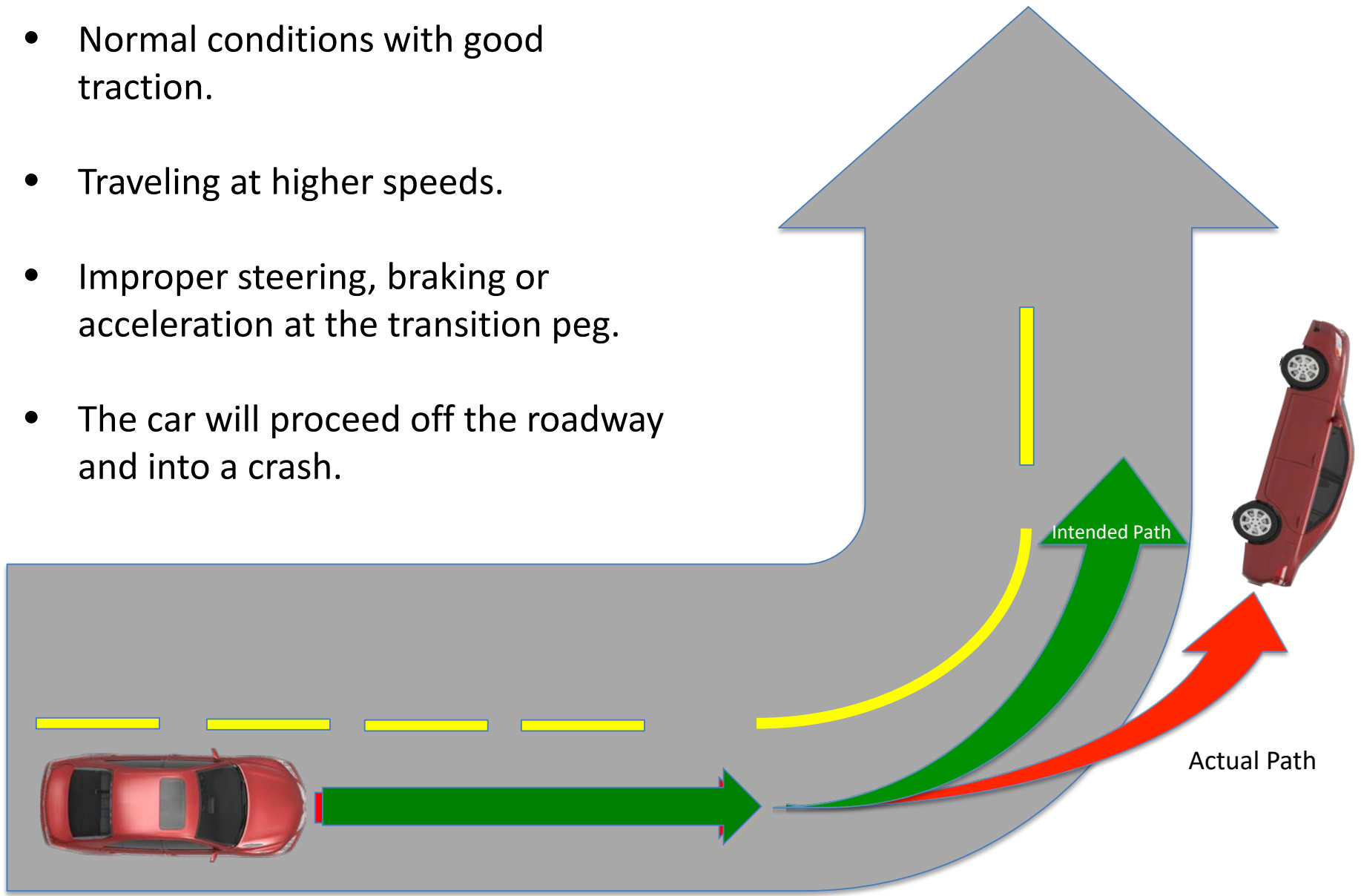
First published in 1666 by Sir Isaac Newton in
Principia Mathematica Philosophiae Naturalis.



- Normal conditions with good traction.
- Traveling posted speed in curve.
- Proper steering, braking and acceleration at the transition peg.
- The car will follow the intended path.



- Normal conditions with good traction.
- Traveling at higher speeds.
- Improper steering, braking or acceleration at the transition peg.
- The car will proceed off the roadway and into a crash.





Gravity demands obedience.



PLAY VIDEO (:09)

What is traction?

The ability of the tires to grip the surface of the road.

What limits the amount of traction?

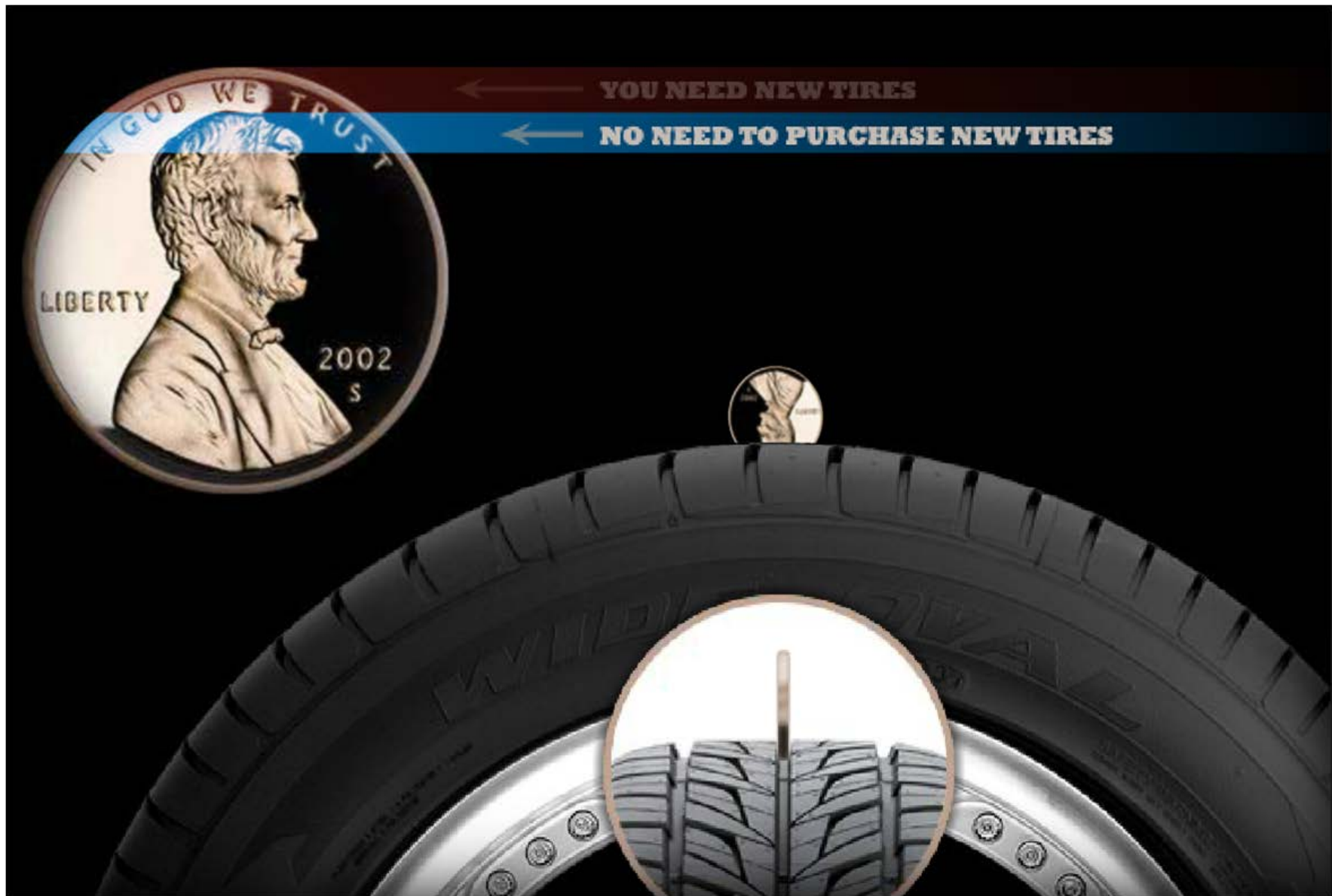
- Conditions of tires
- Conditions of the roadway
- Vehicle speed, pitch, and roll forces

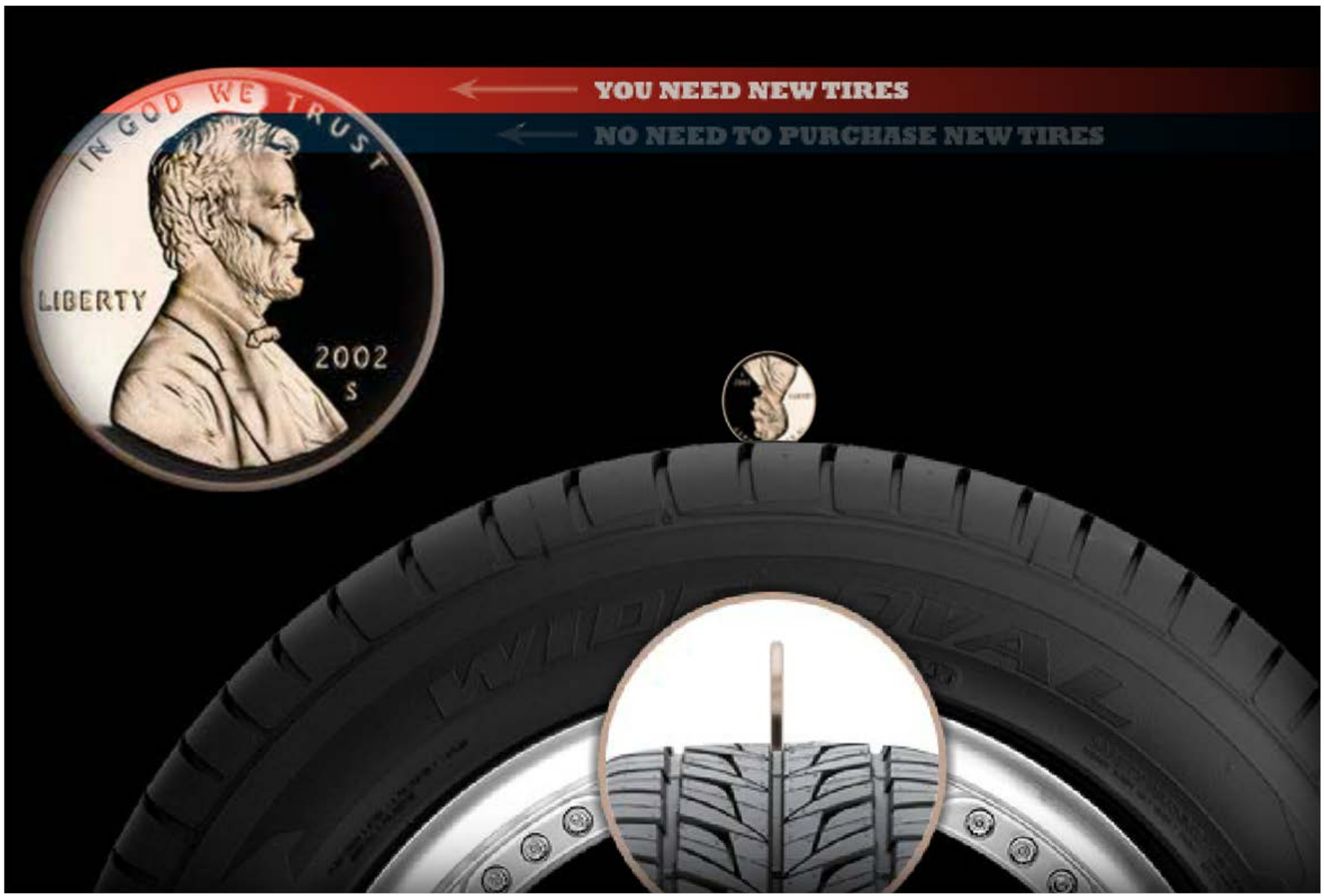


Which tire has better tread?

How can you tell?

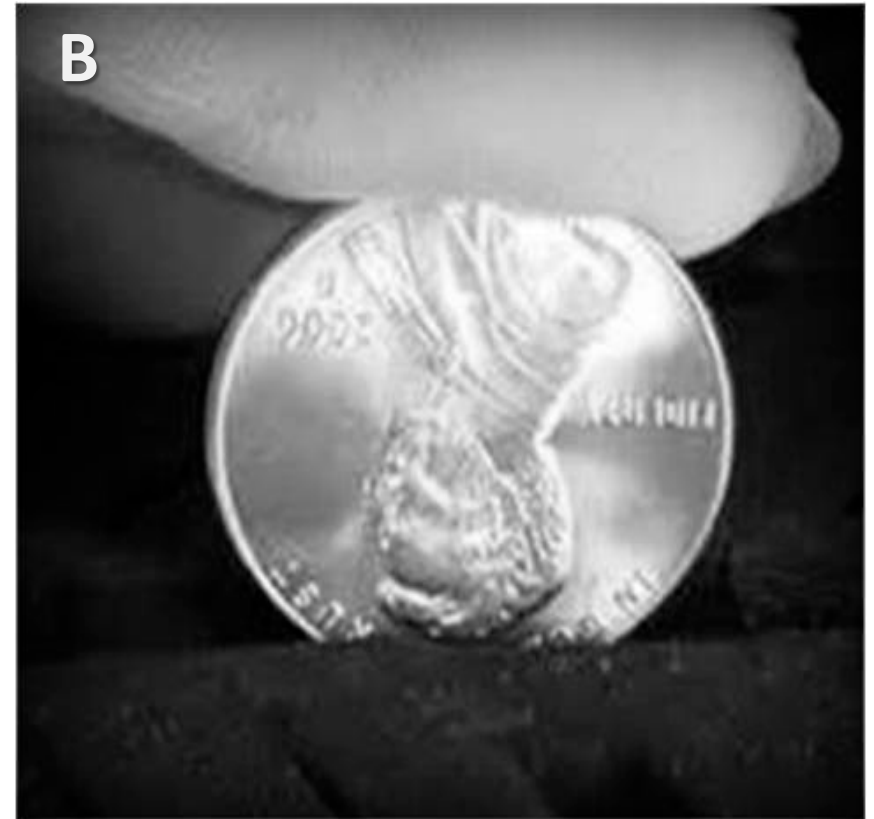
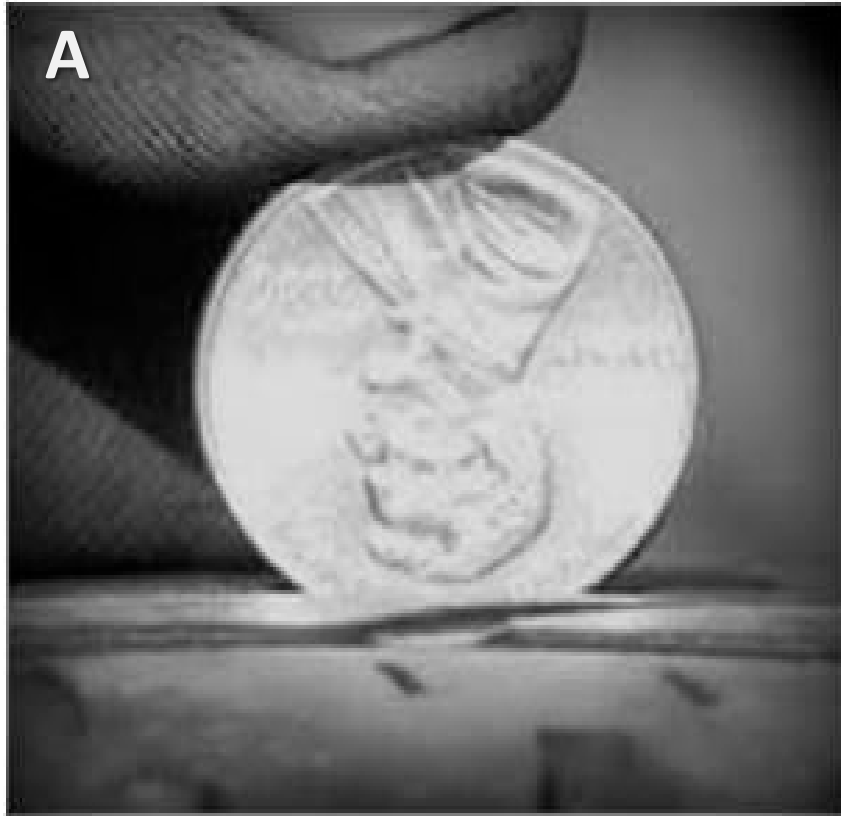








Which tire needs to be replaced? Can you tell?

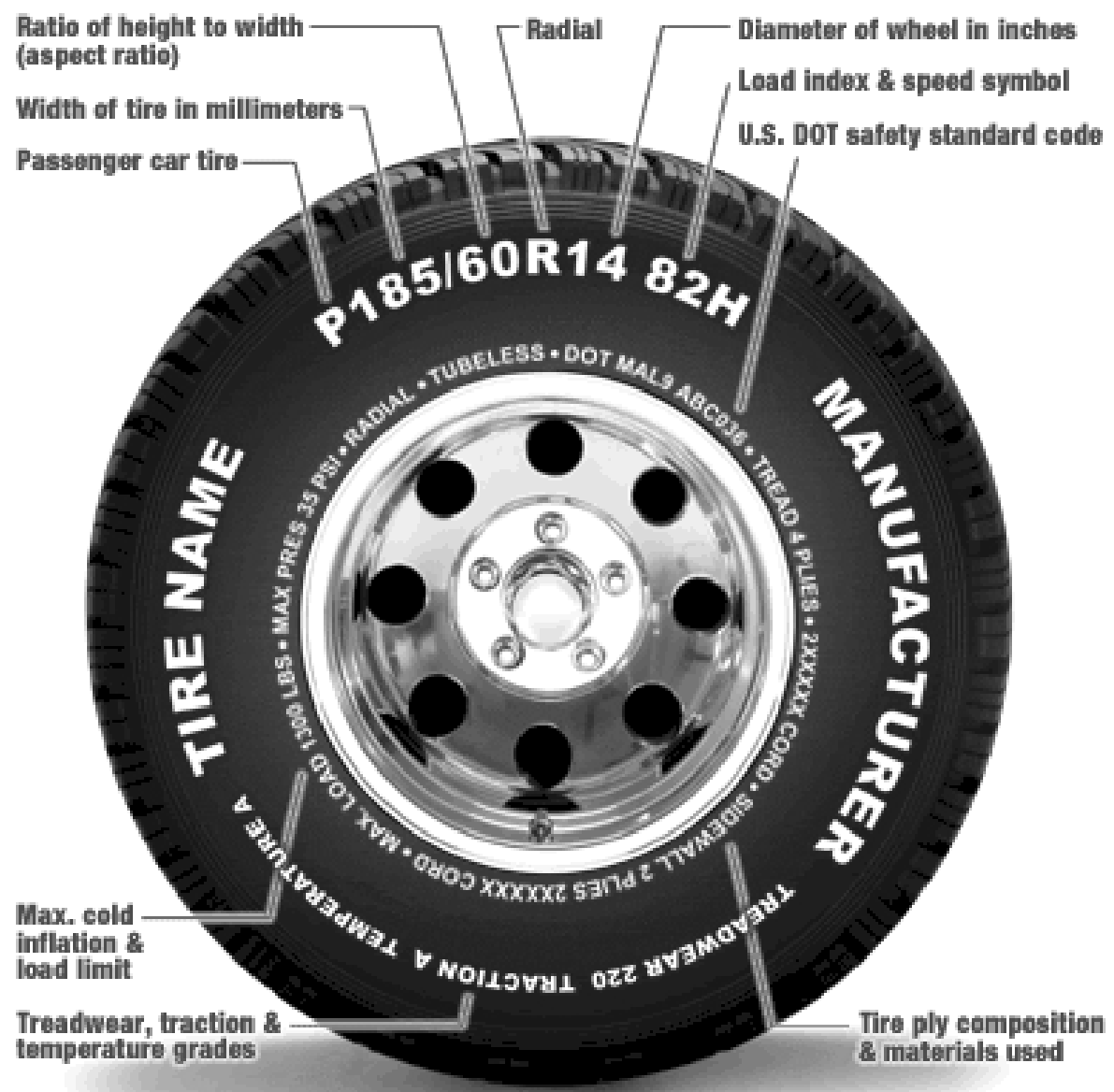


Both tires need to be replaced.



Tire Markings and Information

Routinely check your tire pressure!

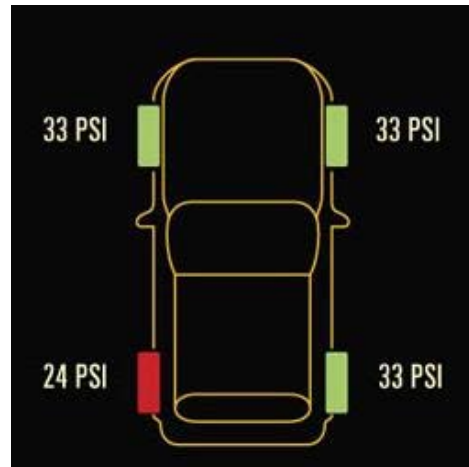




WHAT'S YOUR PSI?



Tire at 32 psi
100% recommended pressure



Tire at 16 psi
50% recommended pressure



Student Activity 5a: Traction

Partners face each other, place your palms together and push against each other. One partner is the tire patch, the other is the roadway.

The one being the tire will move their hands about and the roadway follows. Have them move their hands slowly at first and see how the roadway responds. Then move their hands around quickly. What happens to the tire's ability to "hold the road"?

This demonstrates that traction is a function of friction and pressure.



Student Activity 5b: Loss of Traction

- Put your palms together and hold them together firmly.
- This time add hand lotion or baby oil or water.
- Rub them back and forth quickly for 30 seconds.

What happened this time as you rubbed your hands together?



Momentum in Winter



MAXIMUM VEHICLE LOAD



Vehicle Load Considerations

- Vehicle type and design
- Tires
- Suspension
- Height
- Width
- Number of passengers
- Amount of gear



EXCEEDING MAXIMUM LOAD





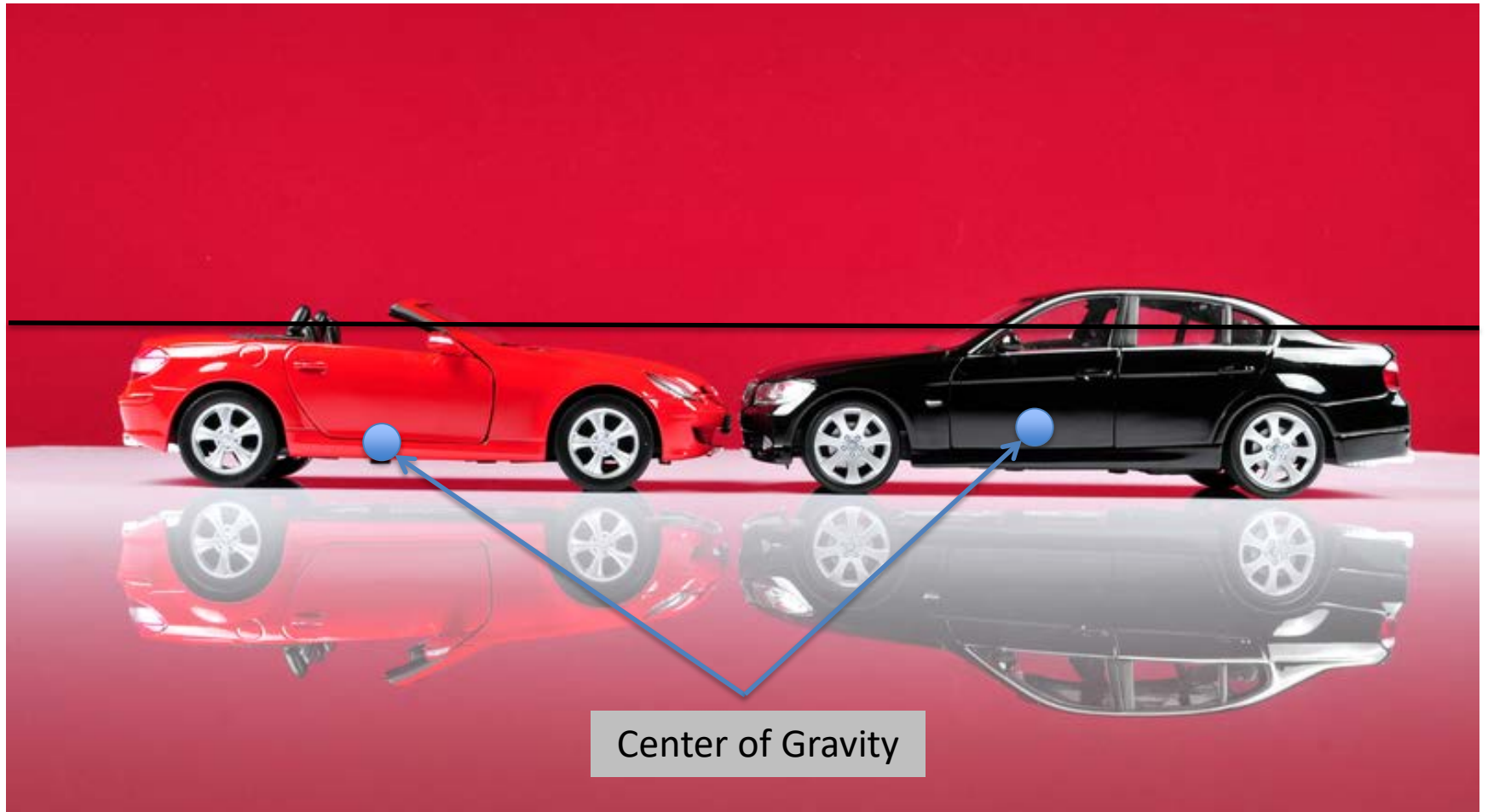




LOAD AND BALANCE

“Center of Gravity”

Height of the Vehicle



Which one is more likely to roll over?





What about this vehicle's center of gravity?



PUTTING IT ALL TOGETHER

What can I do to work within natural laws to manage risk and drive more safely?

Manage Natural Laws by:

- Controlling vision
- Controlling motion
- Controlling steering
- Protecting occupants
- Maintaining your vehicle

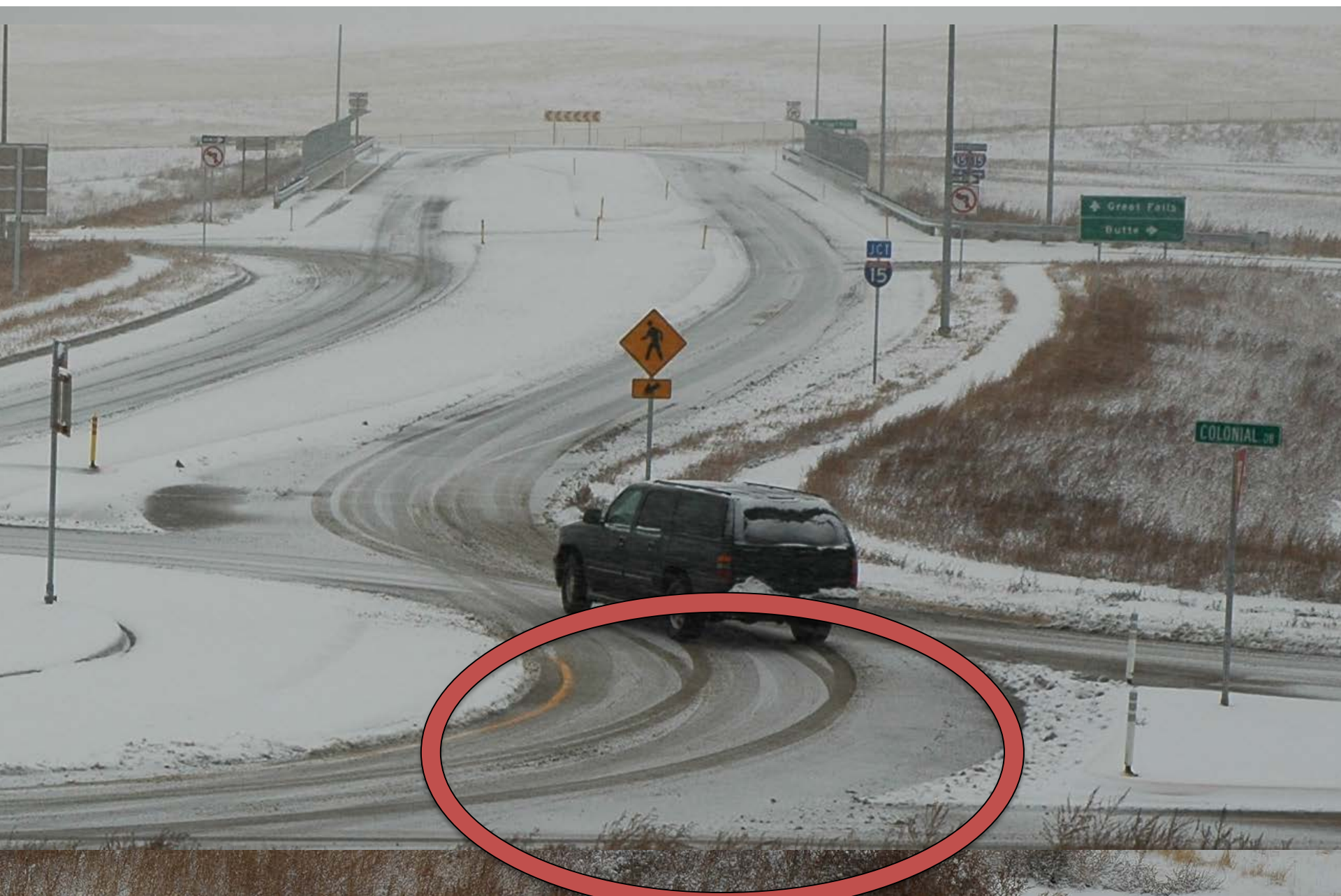




Look at the following slides ...

- Using Vision Control, determine how you would manage the natural laws with
 - Speed (motion) control
 - Steering control







Vehicle Maintenance

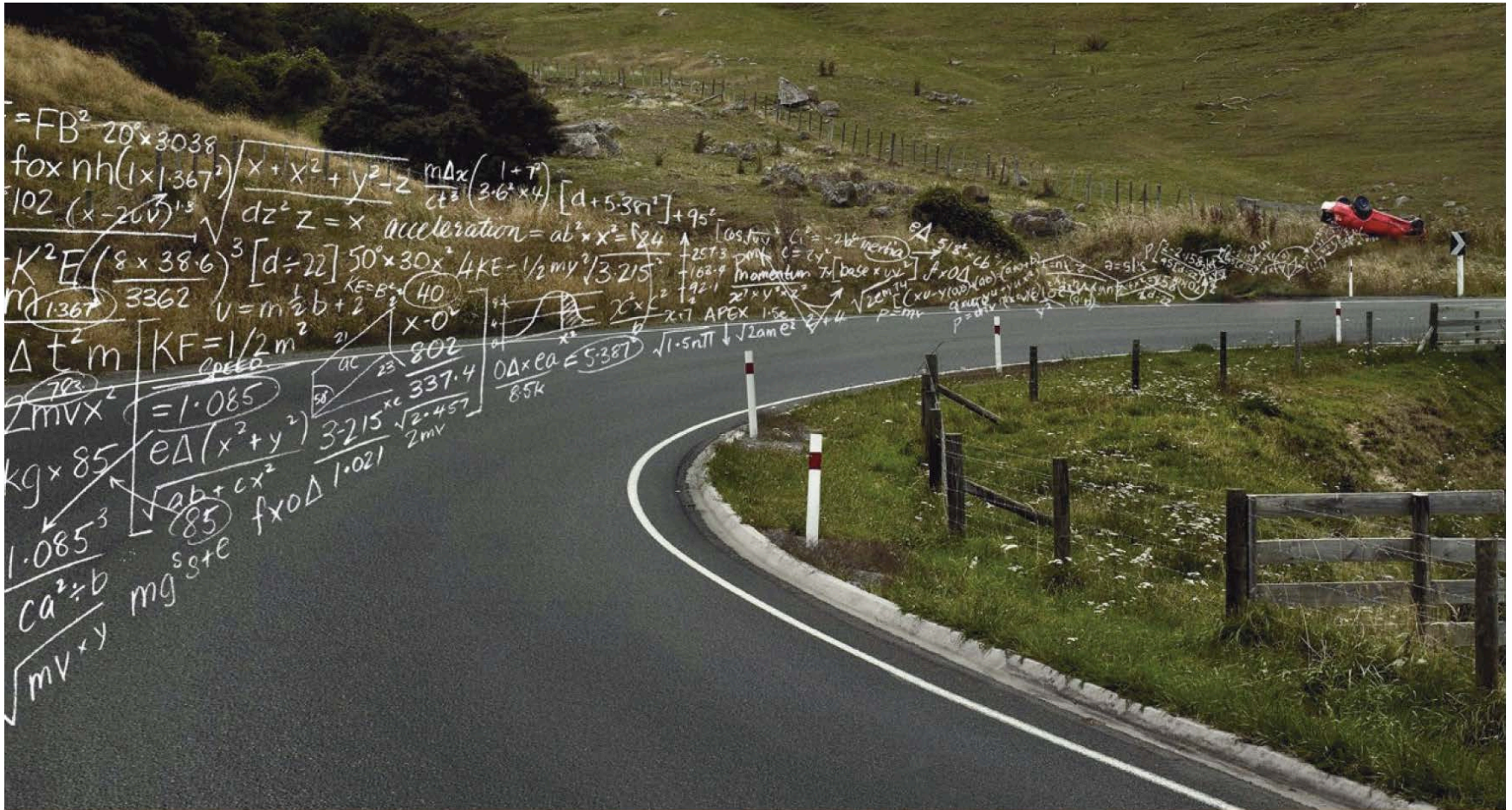
- Tires
- Brakes
- Fluid levels
- Routine maintenance



Occupant Protection

- Vehicle Design and Natural Laws
- Safety Belts and Safety Seats
- Air Bags

You can't beat physics—SLOW DOWN!



ARRIVE ALIVE



Montana Driver Education and Training Standards and Benchmarks

1. Laws and Highway System

- 1.1. know the laws outlined in the Montana Driver's manual;
- 1.2. understand the laws outlined in the Montana Driver's Manual; and
- 1.3. consistently demonstrate knowledge and understanding by responsible adherence to highway transportation system traffic laws and control devices.

2. Responsibility

- 2.1. recognize the importance of making safe and responsible decisions for owning and operating a motor vehicle;
- 2.2. demonstrate the ability to make appropriate decisions while operating a motor vehicle;
- 2.3. consistently display respect for other users of the highway transportation system; and
- 2.4. develop positive habits and attitudes for responsible driving.

3. Visual Skills

- 3.1. know proper visual skills for operating a motor vehicle;
- 3.2. communicate and explain proper visual skills for operating a motor vehicle;
- 3.3. demonstrate the use of proper visual skills for operating a motor vehicle; and
- 3.4. develop habits and attitudes with regard to proper visual skills.

4. Vehicle Control

- 4.1. demonstrate smooth, safe and efficient operation of a motor vehicle; and
- 4.2. develop positive habits and attitudes relative to safe, efficient and smooth vehicle operation.

5. Communication

- 5.1. consistently communicate driving intentions (i.e., use of lights, vehicle position, and personal signals);
- 5.2. adjust driver behavior based on observation of the highway transportation system and other roadway users;
- 5.3. adjust communication (i.e., use of lights, vehicle position, and personal signals) based on observation of the highway transportation system and other users; and
- 5.4. develop positive habits and attitudes for effective communication.

6. Risk Management

- 6.1. understand driver risk-management principles;
- 6.2. demonstrate driver risk-management strategies; and
- 6.3. develop positive habits and attitudes for effective driver risk-management.

7. Lifelong Learning

- 7.1. identify and use a range of learning strategies required to acquire or retain knowledge, positive driving habits, and driving skills for lifelong learning;
- 7.2. establish learning goals that are based on an understanding of one's own current and future learning needs; and
- 7.3. demonstrate knowledge and ability to make informed decisions required for positive driving habits, effective performance, and adaptation to change.

8. Driving Experience

- 8.1. acquire at least the minimum number of BTW hours over at least the minimum number of days, as required by law, with a Montana-approved driver education teacher; and
- 8.2. acquire additional behind-the-wheel driving experience with a parent or guardian's assistance in a variety of driving situations (i.e., night, adverse weather, gravel road, etc.).