TOPIC: Physics and Car Crashes
GRADES: 9 - 12
STANDARD(S): Common Core State Standards for Science & Technical Subjects

OBJECTIVES

- Understand Newton's laws of motion
- Understand additional physics terms and concepts including: Acceleration, Energy, Friction, Inertia, Joule, Kinetic Energy, Matter, Mass, Momentum, Potential Energy, Speed, Velocity, Weight, Work
- Identify the symbols used to represent the physics terms
- Evaluate the relationships between the physics concepts and the laws of motion
- Recognize how understanding physics helps in car design and transportation technology and infrastructure
- Create a presentation applying knowledge of physics and how they have been used in automotive and transportation technology

PROCEDURE

- Assign videos and readingfor students to watch:
    - Understanding Car Crashes: It's Basic Physics created by the Insurance Institute for Highway Safety
    - Newton's 3 Laws, with a bicycle - Joshua Manley a Ted-ed produced video
    - The Fascinating Physics of Car Crashes video and online article
- After students complete viewing the videos and reading the information, they should be instructed to review and complete the handouts and presentation.
    - More reading or research could be assigned by the instructor for additional resources for the project.
- Students could perform their presentation over Zoom, record themselves presenting, or simply send it in to be reviewed by their instructor.

SUPPLEMENTAL MATERIALS

- Laws of Motion Presentation Assignment
- Physics Terms Sheet
- Physics Terms Quiz

Answers to Quiz:

1. C	2. D	3. A	4. A.	5. B
1. H	2. I	3. B	4. G	5. E
6. M	7. L	8. O	9. N	10. F
11. J	12. D	13. K	14. C	15. A

OPTIONAL ACTIVITIES

- Little Newton in the Energy of Motion Online Game : This resource is an engaging platform game that helps the player review the laws of motion and other physics principles while playing.

SUMMARY

By the end of this lesson students should be able to have a working knowledge of some basic physics terms, identify the ways automotive and transportation technology has been improved because of knowledge of the laws of motion, and identify common symbols used to describe physics terminology and equations.

Common Core State Standards for Science & Technical Subjects

CCSS.ELA-LITERACY.RST.9-10.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

CCSS.ELA-LITERACY.RST.9-10.5
Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

CCSS.ELA-LITERACY.RST.9-10.6
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

CCSS.ELA-LITERACY.RST.11-12.2
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CCSS.ELA-LITERACY.RST.11-12.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CCSS.ELA-LITERACY.RST.11-12.6
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

PHYSICS TERMS

Review the definitions for each Physics term.

ACCELERATION: A change in velocity over a given time period.

ENERGY: The ability of an object (or in some cases a non-object, such as a magnetic force field) to accomplish work.

FRICTION: Any force that resists the motion of body in relation to another with which it is in contact.

INERTIA: The tendency of an object in motion to remain in motion, and of an object at rest to remain at rest.

JOULE: The measure of work. One joule (1 J) is equal to the work required to accelerate 1 kilogram of mass by 1 meter per second squared (1 m/s^2) over a distance of 1 meter. Due to the small size of the joule, however, it is often replaced by the kilowatt-hour, equal to 3.6 million(3.6 · 106) J.

KINETIC ENERGY: The energy that an object possesses by virtue of its motion.

MATTER: Physical substance that occupies space, has mass, is composed of atoms (or in the case of subatomic particles, is part of an atom), and is convertible into energy.

MASS: A measure of inertia, indicating the resistance of an object to a change in its motion—including a change in velocity. A kilogram is a unit of mass, whereas a pound is a unit of weight. The mass of an object remains the same throughout the universe, whereas its weight is a function of gravity on any given planet.

MOMENTUM: The product of mass multiplied by velocity.

MOTION: a continuous change in the position of a body relative to a reference point

POTENTIAL ENERGY: The energy that an object possesses by virtue of its position.

SPEED: The rate at which the position of an object changes over a given period of time.

VELOCITY: The speed of an object in a particular direction.

WEIGHT: A measure of the gravitational force on an object. A pound is a unit of weight, whereas a kilogram is a unit of mass. Weight thus would change from planet to planet, whereas mass remains constant throughout the universe.

WORK: The exertion of force over a given distance. Work is the product of force and distance, where force and distance are exerted in the same direction.

The Physics of Car Crashes

NAME: **DATE:**

QUIZ

Choose the best option to answer the following multiple choice questions.

1. **Which of the following is not an example of acceleration?**
    a. **Turning right onto a different street**
    b. **Pressing the gas pedal in your car**
    c. **Pressing the brake pedal in your car**
    d. **Maintaining speed at 65 mph**
    e. **Putting a car into reverse**

2. **Every action or force upon an object must have an equal and _____ reaction.**
    a. **Measurable**
    b. **Accurate**
    c. **Correct**
    d. **Opposite**
    e. **Directionless**

3. **In a vacuum, you throw a baseball. It travels at the _____ forever due to _____.**
    a. **Initial velocity, inertia**
    b. **Gravitational velocity, inertia**
    c. **Initial velocity, gravity**
    d. **Initial acceleration, inertia**
    e. **Initial acceleration, gravity**

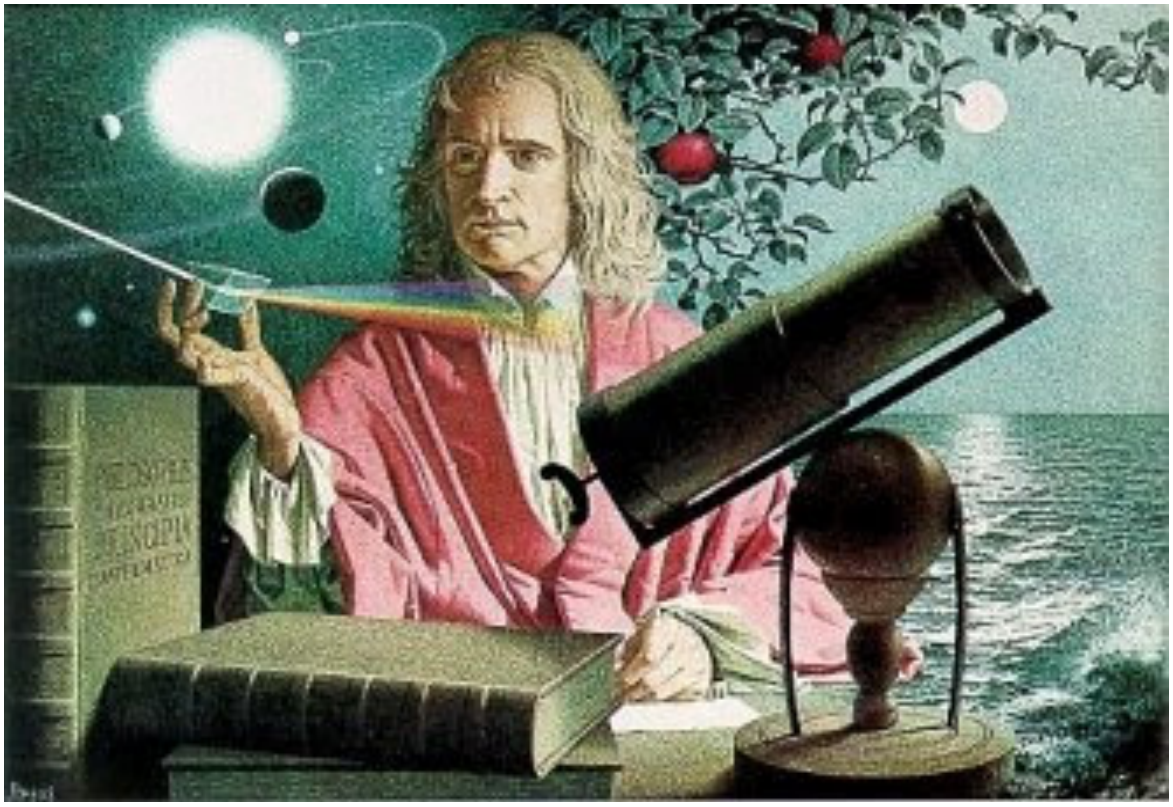
4. **Objects in motion will _____ until acted upon by another force.**
    a. **Stay in motion**
    b. **Lose potential energy**
    c. **Lose kinetic energy**
    d. **Lose in both potential and kinetic energy**
    e. **None of the above**

5. **According to Newton, force is equal to mass multiplied by _____.**
    a. **Velocity**
    b. **Acceleration**
    c. **Speed**
    d. **Momentum**
    e. **Inertia**

Match each physics term to its correct definition.

1. Acceleration	A. Continuous change in the position of a body relative to a reference point
2. Momentum	B. The ability of an object (or in some cases a non-object, such as a magnetic force field) to accomplish work.
3. Energy	C. The speed of an object in a particular direction.
4. Kinetic Energy	D. A measure of the gravitational force on an object. A pound is a unit of weight, whereas a kilogram is a unit of mass. Weight thus would change from planet to planet, whereas mass remains constant throughout the universe.
5. Potential Energy	E. The energy that an object possesses by virtue of its position.
6. Joule	F. Physical substance that occupies space, has mass, is composed of atoms (or in the case of subatomic particles, is part of an atom), and is convertible into energy.
7. Inertia	G. The energy that an object possesses by virtue of its motion.
8. Friction	H. A change in velocity over a given time period.
9. Mass	I. The product of mass multiplied by velocity.
10. Matter	J. The rate at which the position of an object changes over a given period of time.
11. Speed	K. The exertion of force over a given distance. Work is the product of force and distance, where force and distance are exerted in the same direction.
12. Weight	L. The tendency of an object in motion to remain in motion, and of an object at rest to remain at rest.
13. Work	M. The measure of work.
14. Velocity	N. A measure of inertia, indicating the resistance of an object to a change in its motion—including a change in velocity.
15. Motion	O. Any force that resists the motion of body in relation to another with which it is in contact.

THE LAWS OF MOTION



NAME: **DATE:**

PRESENTATION

Review explanations of the laws in via the links below. Then, chose one of the laws of motion and create a presentation in Google Slides or Powerpoint.

1) **The First Law of Motion states, "A body at rest will remain at rest, and a body in motion will remain in motion unless it is acted upon by an external force." This property of massive bodies to resist changes in their state of motion is sometimes called *inertia*.**

2) **The Second Law of Motion describes what happens to a massive body when it is acted upon by an external force. It states, "The force acting on an object is equal to the mass of that object times its acceleration." This is written in mathematical form as F = *m*a, where F is force, *m* is mass, and a is acceleration.**

3) **The Third Law of Motion states, "For every action, there is an equal and opposite reaction." This law describes what happens to a body when it exerts a force on another body. Forces always occur in pairs, so when one body pushes against another, the second body pushes back just as hard.**

Your presentation should do the following:

1) **Define and explain the Law and any additional terms**
    a. **Include the symbolic questions**
2) **Give two real examples of where you see this Law**
    a. **Use video or pictures to describe**
3) **Describe how this law relates to driving or transportation**
    a. **Use video or pictures to describe**
    b. **Feel free to refer to anything presented in the video by IIHS**
4) **Describe potential applications of a better understanding of the law to invent new or advance current technology or designs.**

Presentation Guidelines:

- **Title slide with your name and an engaging title**
- **At least 5 pictures, graphics, or short videos; try to tie the picture into the idea you are presenting. Pictures should add to the idea being presented rather than distracting.**
- **A reference slide with any additional resources or websites you used**
- **A more useful rule of thumb may be no more than 1 idea per slide.**
- **Use a minimum 18 point font size.**