

# **Activities/ Resources for Outcomes**

# **Activities/ Resources for Outcome #1**

## Outcome # 1

### Transportation and Environment

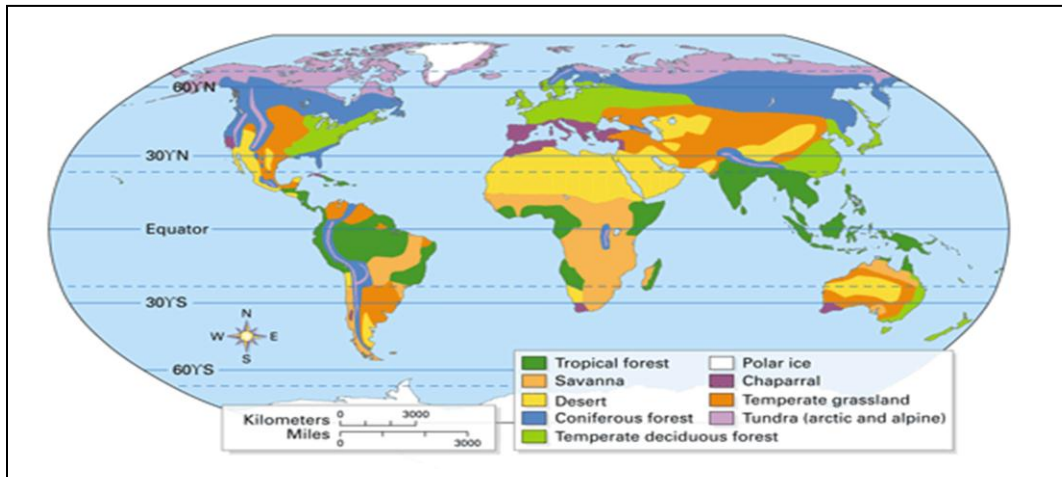
Transportation generates many issues concerning the environment. The environment is a very delicate organism, comprised of multiple ecosystems. **Ecosystems** are communities of living and non-living things that work together. Each ecosystem is composed of multiple biomes. **Biomes** are large geographical areas with distinctive climates, landscapes, plants, and animal groups. Depending on the biome, challenges are created for transportation and distribution of goods and services.

#### Biomes

There are primarily two types of biomes, aquatic and terrestrial. Within the two classifications of biomes are many other sub-types:

- **Aquatic** - freshwater and saltwater, also known as marine.
  - **Aquatic Freshwater** - lakes, ponds, rivers, streams, and wetlands. This type is important because they provide humans with drinking water, food, energy, transportation, employment, and recreation.
  - **Aquatic Saltwater (Marine)** - covering nearly 70% of the Earth, including oceans, coral reefs, and estuaries. This type includes the five major oceans: Atlantic, Arctic, Indian, Pacific, and Southern and provides humans with energy, transportation, employment, and recreation as well as food, medicines, oil, and other natural resources.
- **Terrestrial** - land including: desert, forest, grassland, and tundra.
  - **Desert** - classified by the amount of precipitation each year. Typically, deserts receive less than 50cm of rainfall per year. Deserts cover approximately one fifth of the Earth's surface. Deserts are typically classified by climate, including hot and dry, semi-arid, coastal, and cold.
  - **Forest** - dominated by trees and vegetation. Forests occupy approximately one third of Earth's land surface. Forests are classified according to latitude, including tropical rainforests, temperate, and taiga. This type provides humans with many resources, including food, timber, and oxygen.
  - **Grassland** - classified as land dominated by grasses. Grasslands are rich with nutrients that provide humans with soil for farming and agriculture. There are two types of grasslands: temperate grasslands which include prairies and steppes, and tropical grasslands which include savannas.

- **Tundra** - characterized by dry frigid temperatures. This type represents one fifth of the land on Earth. Tundra can be separated into two categories, arctic and alpine. *Arctic tundra* is a cold dry area of land with forests like landscape. *Alpine tundra* is located on the tops of mountains where trees are unable to grow. This type provides humans with employment in the mining and oil industry.



The previous image provided by Pearson Education illustrates the Earth's biomes.

### Transportation and Pollution

Although TDL provides many necessities and luxuries, it also poses serious threats for the environment's ecosystems. TDL generates many forms of pollution. **Pollution** is any substance that has a harmful effect on the environment. Two forms of pollution generated by TDL are air pollution and water pollution.

**Air pollution** is caused from the heavy use of fossil fuels. Air pollution occurs when harmful chemicals and toxins are released into the Earth's atmosphere. Global warming has been reported as a result of air pollution. Global warming is the rise of the Earth's average temperature. Global warming has also been reported as the *greenhouse effect*, which is the natural heating of the Earth's surface by atmospheric gases. This rise in temperature is due to pollution through the emissions of fossil fuels in energy production and its use in transportation. Air pollution may result in damaging soil, vegetation, and agriculture. The U.S. government attempts to regulate air pollution by enforcing air quality standards for vehicle emissions and power plants.

**Water pollution** may happen directly or indirectly. Water pollution is the contamination of bodies of water. This may result directly from an oil spill, or indirectly from the drainage of fertilizers from a farm field. Additionally, water pollution may result from air pollution. For example, gases generated from industrial activities may travel from the air to the water, causing a great deal of impurities. Water pollution may result, adversely impacting ecosystems including the endangerment of humans, plants, and animals.

### Concept Check

1. What factors determine each type of biome?
2. Discuss the biomes that TDL will encounter most frequently.
3. Brainstorm how the human population can reduce the amount of air and water pollution.

### Visualizing Concepts

1. Make and complete a table (like the one shown below) to compare and contrast the six types of biomes discussed.

Terrestrial Biome	Climate Conditions	Typical Organisms
Desert	Less than 30 cm of rain per year. Temperatures may be hot or cold.	Cacti, small burrowing mammals
Savanna		

# **Activities/ Resources for Outcome #2**

## Outcome # 2

### Transportation, Earth's Atmosphere and Weather Conditions

- TDL is a very time sensitive career pathway. The weather may have very serious effects on TDL deadlines. **Weather** is the condition of the atmosphere at any time or place, including variations of severity of conditions.

#### Earth's Atmosphere

The Earth's atmosphere is composed of the following 5 layers:

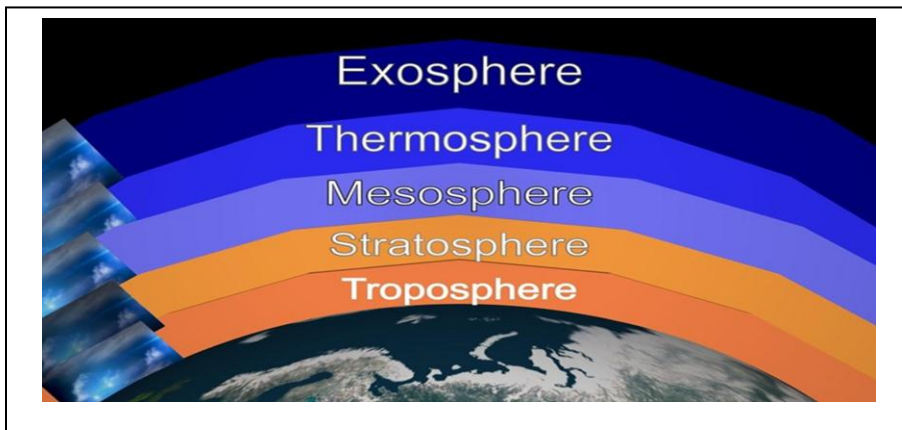
**Troposphere** is the atmospheric layer that humans live in. Additionally, this is the layer where most of the weather occurs.

**Stratosphere** is the atmospheric layer that the **ozone** occupies. The **ozone** protects living things from the Sun's harmful ultraviolet rays.

**Mesosphere** is the atmospheric layer where gravitational waves are created.

**Thermosphere** is the atmospheric layer where ultraviolet rays are transformed into energy.

**Exosphere** is the atmospheric layer that extends into space.



The previous image provided by Illinoishomepage illustrates the Earth's atmospheric layer divisions.

### Weather Conditions

As previously mentioned, weather occurs within the Troposphere. Depending upon the region, truck drivers may encounter a wide variety of weather conditions. Some of the most common conditions include:

**Wind** in its simplest form is air currents in motion.

**Tornadoes** are windstorms comprised of severe dangerous wind gusts. Tornadoes can

happen anywhere, but occur most often in a warm flat grassland biome or a desert biome.

**Rain** is water droplets, also known as condensation/precipitation, that form in clouds and fall from the Earth's atmosphere.

It is important to note that all precipitation begins as **ice**, also known as snow crystals. As precipitation descends towards Earth, atmospheric temperatures determine the consistency in which it will fall.

**Freezing rain** is frozen rain droplets, which create a glaze on the Earth's surface. Freezing rain may cause extremely dangerous conditions for travelers, due to the glaze of ice it creates on roads, bridges, and overpasses. Freezing rain may also be referred to as **sleet**.

**Thunderstorms** are severe rainstorms, also called electrical storms. Thunderstorms are composed of heavy rain and wind gusts. **Hail**, which is frozen rain droplets, can also occur during thunderstorms.

**Snow** is frozen precipitation that requires the Earth's temperatures to be below freezing. Snow accumulation may make transporting goods and services difficult and dangerous.

Each form of the weather conditions previously mentioned may influence TDL. Also, weather does not have to be severe to have a negative impact. Even mild amounts of precipitation will influence the friction a tire has with the surface of the road.

### **Concept Check**

1. Identify the layers of the Earth's atmosphere.
2. Discuss how the different weather conditions may influence travel.
3. Read and discuss the importance of weather radar.

(<http://usatoday30.usatoday.com/weather/wearadar.htm>)



# **Activities/ Resources for Outcome #3**

## Outcome # 3

### Newton's Laws of Motion

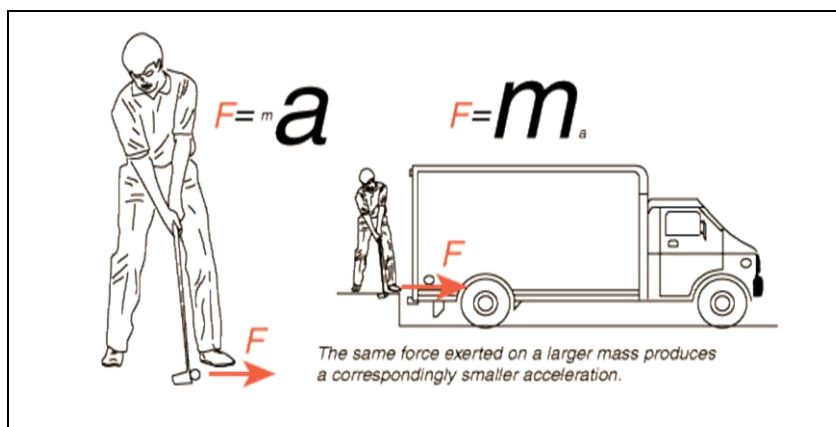
In the career pathway of TDL, truck drivers will be required to transport a wide variety of materials and products in a designated timeframe. Depending upon the geographic location and weather conditions, the time-sensitive transported materials may include lumber, livestock, hazardous chemicals, new vehicles, and many more possibilities. Regardless of the product, one factor influencing the load will remain the same. This factor is Newton's Laws of Motion.

**Newton's First Law of Motion**, also known as the *Law of Inertia*, suggests that an object at rest will stay at rest and an object in motion will stay in motion. There will be no change to the state of the object unless an external force is applied to it. This law presents that objects will continue with their state unless that state is challenged. For example: Motorists are required to wear seat belts because of this law. Motorists who are in a collision and are not wearing a seat belt will physically continue with the first motion. The seat belt provides resistance to the previous motion, thus keeping the passenger inside the car.

**Newton's Second Law of Motion** presents a relationship between an object's mass ( $m$ ), its acceleration ( $a$ ), and the applied force or energy ( $F$ ).

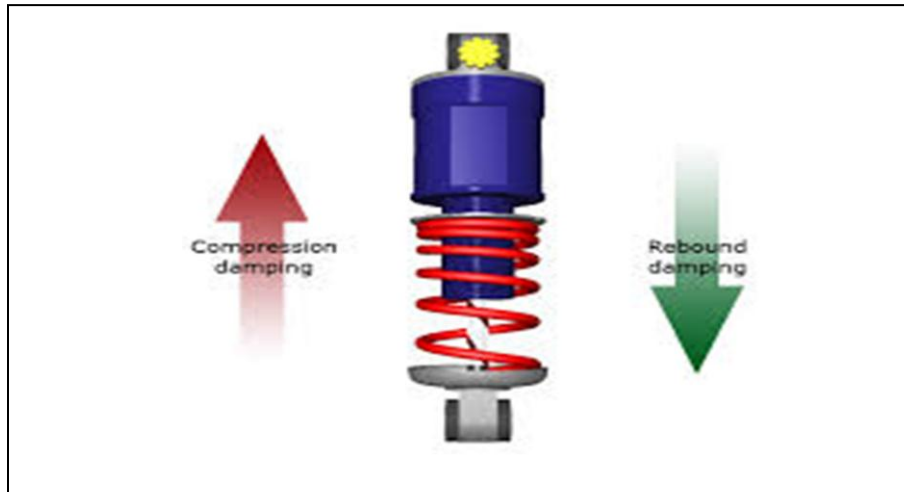
**(The mathematical formula is:  $F=ma$ , Force = mass times acceleration.)**

Newton's Second Law suggests that the greater the mass of an object, the greater the amount of force will be needed in order for the object to accelerate. The amount of acceleration is dependent upon the amount of force, which is determined by the object's mass. For example: A truck transporting a full load will be much more difficult to haul than an empty load. The weight determines the amount of force needed to accelerate and move the load.



The previous image provided by Georgia State University: Hyperphysics illustrates Newton's Second Law of Motion.

**Newton's Third Law of Motion** suggests that for every action, regarding the amount of exerted force, there is an equal and opposite reaction. For example: A vehicle's shock is designed to absorb the imperfections of the traveled terrain. The vehicle's reaction to the condition of the road will be determined by the traveled speed, as well as the condition of the road. A deep pothole will cause the vehicle's shock to expand and compress more severely than a small crack in the pavement. Regardless of the road's condition, the vehicle will experience some form of reaction to the imperfection.



The previous image provided by The Suspension Bible illustrates a vehicle's shock.

#### **Concept Check**

1. Review Newton's three Laws of Motion.
2. Discuss why seat belts are important; be sure to include Newton's 1<sup>st</sup> Law.
3. Practice solving Newton's Law of Motion.
4. If space and resources are available, test Newton's Law with a golf club and multiple golf balls. (*See the previous image for assistance.*)

# **Activities/ Resources for Outcome #4**

## Outcome # 4

### Transportation and Friction

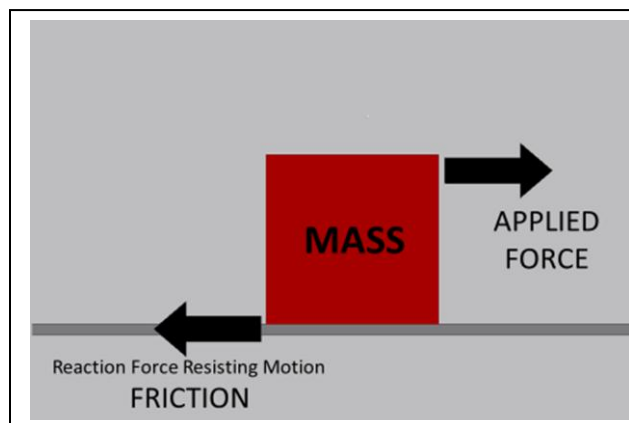
**Force** is an influence or energy that causes an object to undergo a change or an interaction with another object.

**Friction** is the force between two objects as they move over one another, such as a vehicle's tire and the surface it is traveling on. There are two types of friction: static and kinetic.

**Static friction** is the frictional force between two or more objects that are not moving. If the force trying to move the object is less than the static friction, the object will not move. For example: Static friction can prevent an object from sliding down a slope.

**Kinetic friction** is the frictional force between two objects that are moving. Once an object overpowers static friction, and begins to move, the constant constraint of the movement is kinetic friction.

**Coefficient of friction** is the degree of “stickiness” between two surfaces. This “stickiness” or binding determines the strength of the force needed to be exerted to move an object and keep it in motion. Coefficient of static friction is typically greater than the coefficient of kinetic friction.



The image provided by VEX Robotics Design System illustrates the opposing relationship between an object's force and friction.

### Friction and Driving

The friction between the road and your tires will determine your acceleration, as well as the distance it will take to come to a stop. The distance it takes to stop a vehicle will depend on the weather conditions, and the vehicle's tires.

## Friction and Weather Conditions

### *Rain*

As mentioned in outcome #2, rain is defined as droplets of precipitation. Rain generates a dangerous driving condition because of the possibility of hydroplaning. **Hydroplaning** can happen on any wet surface. It occurs when a vehicle's tires skid or slide over a wet surface. This is a result of water between the tires and the road, therefore eliminating the frictional force and causing a loss of steering, braking, and power control.

### *Snow*

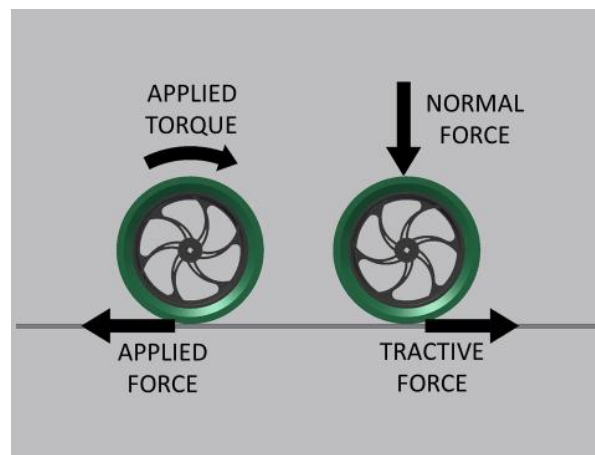
Similar to rain, snow poses a severe threat to motorists. When snow begins to accumulate it packs the roads and forms a slippery surface. The tires are no longer directly in contact with the road; therefore, the grip to the road is lost, causing a variety of issues.

First, the tire has lost the connection with the surface of the road: therefore, the tires begin to slip. There is no longer static friction, causing the vehicle's tires to spin, and for the vehicle to be stuck.

Second, snow may cause a vehicle's tires to leave the pavement and lose control. This may cause the vehicle to slide. The vehicle will stay in motion until it runs out of kinetic energy as a result of reconnection with the surface of the road or until it collides with an object.

## Friction & Traction

As previously mentioned, depending upon the weather conditions, a vehicle's tires may slip. This is the result of the loss of traction. **Traction** is the friction between the wheel and the surface of the road.



The image provided by VEX Robotics Design System illustrates the relationship between torque and frictional force. This image also illustrates the necessary connection between the tire and the ground in order to generate movement.

Tires will have different ratios of traction based on different surfaces. The coefficient or “stickiness” of friction is dependent upon the surface. A tire sliding on pavement has a coefficient of friction where a tire on its own does not. A “sticky” surface may have a very high coefficient of friction. Contrastingly, a slippery surface may have a low coefficient of friction. Different tires are manufactured for different surfaces.



The above image provided by Goodyear Racing illustrates the difference between racing performance tires and street tires, which are traditionally on most vehicles. This photo also represents that different tires will have different ratios of traction and coefficients of friction.

### Concept Check

1. Review the two types of friction.
2. Demonstrate static friction and kinetic friction with a brick and a toy car as shown in the following video.  
(<http://www.youtube.com/watch?v=CTLXubXOTUQ>)
3. If resources are available and weather permits, watch the YouTube video describing tire tread and the penny test. Provide each student with a penny, and have the students test the faculty's car tire tread depths.  
(<http://www.youtube.com/watch?v=hFuUE567mTU>)

# **Activities/ Resources for Outcome #5**



## Outcome # 5

### Energy in Motion

A key component within TDL is energy. **Energy** has been defined as the ability to do work. This may include transporting products, goods, and services. It is important to mention that energy does not appear nor disappear. The fundamental principle of physics states that the total energy of an isolated system is constant despite internal changes. This is known as the **Law of Conservation**. When energy is conserved, it is typically transformed into a different form of energy. For example: A motorized vehicle, such as a truck, traditionally burns gasoline. This is the process of converting the energy within the gasoline into mechanical energy.

Although there are many forms of energy, a form of energy that is influential in TDL is kinetic energy. **Kinetic energy** is the energy an object has when it is in motion. For example: A motorized vehicle driving along a highway has kinetic energy and momentum. **Momentum** is the product of velocity and mass. If another motorized vehicle crosses paths with the first vehicle, it will be very challenging to avoid an accident due to the kinetic energy.

Another form of energy influential in TDL is potential energy. **Potential energy**, also known as stored energy, is the energy that *may* be executed. For example: A motorized vehicle parked at the top of the hill has potential energy. If the emergency brake fails, and the vehicle begins to move downhill, kinetic energy has been created.

Both kinetic energy and potential energy are influenced by an object's mass. The heavier an object weighs, the faster it will be able to move. This is important to consider when hauling heavy loads. A heavy load will be more difficult for the motorized vehicle's drive train to accelerate and decelerate.

#### Concept Check

1. Define Energy.
2. Discuss the differences between Kinetic and Potential Energy.

#### Concept Experiment:

1. Kinetic and Potential Energy: Can a Slinky® have both?

At the top of a staircase, allow the Slinky® to descend to each of the next steps and then proceed to the lowest level. (If steps are not available, stack cardboard boxes or books to create steps.) The Slinky® will demonstrate kinetic energy as well as potential energy. Report the results. (<http://www.gpb.org/education/features/sep04/Sirlsaac/daniel2.htm>)

# **Activities/ Resources for Outcome #6**

## Outcome # 6

### Speed, Velocity, and Acceleration

The career pathway of TDL focuses on the constant change of the position of objects, otherwise known as **motion**. Maintaining motion ensures that products are moving. If objects remain stationary, they are non-moving and potentially a profit loss. A key component in TDL is the timeliness of deliveries. Products will be transported over vast distances. **Distance** is a measurement of the change of position of an object. An objective of TDL is ensuring that products, goods, or services are delivered to their destination in good condition and on time.

**Speed** is the change of distance an object travels. Speed is measured in units of distance per a unit of time.

$$\text{Average Speed} = \frac{\text{Distance Traveled}}{\text{Time of Travel}}$$

**Velocity** incorporates speed and distance. Similar to speed, velocity identifies the speed or rate of change of an object. However, velocity provides the direction an object is moving.

$$\text{Average Velocity} = \frac{\Delta \text{position}}{\text{time}} = \frac{\text{displacement}}{\text{time}}$$

**Acceleration** is the change in velocity, where there is an increase in speed. Acceleration also occurs when the vehicle changes directions. A decrease in speed is known as **deceleration**. Deceleration may occur when the motorist applies force on the brakes.

$$\text{Ave. acceleration} = \frac{\Delta \text{velocity}}{\text{time}} = \frac{v_f - v_i}{t}$$

**Concept Check**

1. Define the characteristics of speed, velocity, and acceleration.
2. Test the equations for speed, velocity, and acceleration using the following resource.

(<http://www.physicsclassroom.com/class/1DKin/Lesson-1/Speed-and-Velocity>)

# **Activities/ Resources for Outcome #7**

## Outcome # 7

### Basic Chemistry

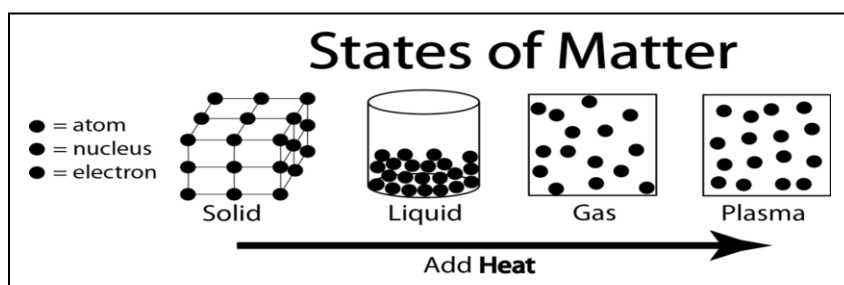
In the career pathway of TDL, the main concern is the product that is being transported and distributed. One must understand the product's chemical composition, as well as its sensitivity to temperature. To understand the product's sensitivity, the transportation company must acknowledge and understand the load type. For example, a driver must be concerned about what form of matter the load is transported in. **Matter** is anything that has a mass and takes up space. There are four states of matter: solids, liquids, gases, and plasma. Each form of matter is comprised of particles. The arrangement of the particles determines in which form the matter will be.

**Solids** retain a fixed volume and shape because the particles are tightly compressed together. Examples of transported solids may include lumber, livestock, steel, and coal.

**Liquids** have a defined volume, but they do not have a defined shape. Liquids assume the shape of the container. The particles are linked together, but loosely linked. Examples of transported liquids may include water, fertilizers, gasoline, and petroleum oil.

**Gases** have neither a defined volume nor a defined shape. The particles that compose gases are free to move, and similar to liquids, assume the shape of the container. Examples of gases transported may include oxygen, natural gas, hydrogen, and propane.

**Plasma** is not always referred to as a state of matter. This may be because plasma is technically a form of gas that has experienced extreme heat, or had an electrical current introduced to it. Plasma has no defined volume or shape. Plasma is the matter that is found in fluorescent lights.



The above image provided by Fusion Future illustrates the four states of matter.

The physical properties of matter are simply the current state of matter. The state of matter including solid, liquid, gas, or plasma is dependent on the temperature. Different types of matter change with different temperatures. Depending upon the temperatures, a physical change may occur to the matter. This physical change may alter and damage the product being transported. Therefore, it is necessary to understand the temperature, as well as time sensitivity, of the product being transported.

**Concept Check**

1. Define the four forms of matter.
2. Brainstorm a list of the forms of matter that may be transported within TDL.

**Visualizing Concepts**

1. Make a compare and contrast list of the four forms of matter. Include how temperature may influence each specific form.

# **Activities/ Resources for Outcome #8**



## Outcome # 8

### Resources & Fossil Fuels

The possible products, goods, and services that may be transported within the career pathway of TDL are endless. Additionally, the method of transportation is also quite extensive. Transportation of the products, goods, and services may be by land, water, or air. Regardless of the method of transportation, the motorized vehicle requires a resource of energy to produce power.

TDL depends on non-renewable resources such as fossil fuels to produce energy. **Non-renewable** resources are limited, meaning that they do not renew themselves at a sustainable rate to meet the demands of humans. Most commonly, these non-renewable resources are also known as fossil fuels. **Fossil Fuels** are resources found from the Earth. Fossil fuels are composed of different molecules and are extracted from the Earth in different forms of matter. Some examples of non-renewable resources used within TDL include the following fossil fuels:

#### Coal

Coal is a non-renewable resource that is generated from decaying vegetation. This fossil fuel is found deep within the Earth's crust and is retrieved through mining. The quality of coal is determined by the type of vegetation it originated from, the depth within the Earth's crust where it is located, as well as the length of time it has had to form. Most commonly, coal is used as a source of energy. This energy may be used to create electricity for manufacturing.

#### Crude Oil

Crude oil, also known as petroleum, is found deep within the Earth's crust. This fossil fuel requires drilling to obtain it. Once this non-renewable resource is extracted from the Earth, it is then transported to a refinery, where it is heated to extremely high temperatures. This process removes the impurities. Once the liquid has cooled, it is then separated and sold to a wide variety of manufacturers. Crude oil is most commonly used to create gasoline.

#### Natural Gas

Natural gas is another non-renewable fossil fuel heavily used by humans. Similar to crude oil, natural gas is found deep within the Earth's crust. This non-renewable resource may be dangerous to humans because it is a colorless and odorless gas. This highly flammable and combustible gas is most commonly used as an energy source for heating homes, fuel, and electricity.

Given that fossil fuels are non-renewable resources, eventually we are going to run out. This is why there is a great deal of attention on renewable resources. A **renewable resource** is a natural resource that is not limited. Renewable resources may be generated. Similar to non-renewable resources, they are used to create power and energy. Some forms of renewable resources used to generate power and energy include the following:

### **Biofuel**

Biofuel, also known as alternative fuel, is a fuel that is produced from living organisms. Most commonly, biofuels are created from plant materials. This is done through the process of converting the plant material into energy in the form of solid, liquid, or gas. As we continue to deplete the Earth of its non-renewable fossil fuels, the creation and sustainability of biofuels will become more important.

### **Ethanol**

Biofuels made from starch crops are called bioethanol, typically referred to as ethanol. This fuel source is made from fermentation of starchy crops such as corn and sugar cane. Ethanol is becoming more commonly used as gasoline. Other vegetation such as trees and grasses are being developed to create additional biofuels.

### **Biodiesel**

Biodiesel is an additional alternative fuel source generated from the recycling of animal fats and vegetable oils. Biodiesels are renewable resources primarily used as energy in the form of gasoline.

#### **Concept Check**

1. Describe differences between non-renewable and renewable resources.
2. Classify household products that are made from non-renewable and renewable resources.
3. Brainstorm ways to conserve fossil fuels.

#### **Visualizing Concepts**

1. Create a compare and contrast list of non-renewable and renewable resources.
2. Create a list of the alternative fuels you may be able to utilize.

# **Activities/ Resources for Outcome #9**

## Outcome # 9

### Transportation and Machinery

TDL involves the movement of people, goods, and services by land, water, and air. Machinery and technology have helped reduce the amount of work people have to do. In TDL, **work** refers to the amount of force needed to move an object in the same direction. The amount of work is shown in the following mathematical equation.

$$W=Fd, \text{ Work= Force x Distance}$$

The rate of work is shown in this mathematical equation:

$$P=W/T, \text{ Power= Work/Time}$$

The unit of measurement or the product for work is defined as a joule (J). It is important to understand that work is done by an individual force. Each force does its own amount of work and creates its own joule. No work happens either when there is no position change in the object, or when no force is being applied to the object.

### Machines

In order to do work in an effective and efficient manner, machines may be used. A machine may be any device that makes work easier. There are two classifications of machines: simple and compound.

#### Simple Machines

A simple machine is an elementary device that has very few components. A simple machine may conduct work with one movement. Simple machines are considered the building blocks of more complicated machines. There are 6 primary types of simple machines:

##### *Screw*

A screw is a simple machine that has spiral threads wrapped around a cylinder. A screw is commonly used to fasten two items together. Screws are fastened using a circular motion, otherwise known as rotational force. This force is determined by the amount of torque placed on the screw. A screw may be used to keep a windshield fastened to the frame of the vehicle.

##### *Wedge*

A wedge is a triangular-shaped tool that is used by applying force to its blunt edge. A wedge may be used to separate two objects, lift an object, or hold an object in place. Additionally, a wedge may be used to change the direction of the object. A wedge may be used to keep a vehicle's tires from rotating.

### *Inclined Plane*

An inclined plane is a flat surface titled at an angle to a horizontal surface. An inclined plane, also known as a ramp, may be used for raising or lowering a object. Inclined planes are commonly used to move heavy objects over obstacles. An inclined plane may be used on loading docks to load goods into a trailer.

### *Lever*

A lever is a rod or bar that is free to rotate at a fixed point. This fixed point at which the lever rotates is known as the fulcrum. The position of the fulcrum determines the lift of the load. The input force exerted on the lever determines the output of the load. An example of a lever would be a tire iron or a crowbar.

### *Wheel and axle*

A wheel and axle is a special type of lever that is composed of two circular pieces of different sizes. The wheel is attached to the axle, they rotate together, and the force is transferred from one to the other. A vehicle's steering wheel is a prime example of a wheel and axle.

### *Pulley*

A pulley is a grooved wheel that is designed to change the direction of an object. A rope, chain, or cable is fed through the grooves of the wheel and attached to an object. As force is applied to the rope, chain, or cable, the object moves opposite to the force. Typically, pulleys are used to lift or lower heavy objects. An example of a pulley system is a winch.

## **Compound Machines**

Compound machines are comprised of two or more simple machines. The combinations of simple machines create a mechanical advantage. The mechanical advantage is the amount of assistance the machine provides, or the amount of work the machine conducts. The mechanical advantage is the ratio of the output force to the input force and may be determined using the following mathematical equations:

$$\text{MA} = F(\text{out})/F(\text{in}) , \text{ Mechanical Advantage} = \text{Output force}/\text{Input force}$$

The following three compound machines are commonly found within TDL:

### *Engines*

An engine is composed of many simple machines such as screws, wheel and axles, also known as gears. A gear changes the direction of the force. An engine is designed with the purpose to create energy. More specifically, an engine is designed to convert energy into motion. This motion may be created by burning fossil fuels to create heat, which creates motion. In regard to motorized vehicles, the burning of fossil fuels generates mechanical movements within the cylinder and pistons of the engine. This mechanical movement then rotates the crankshaft, which transmits mechanical energy and motion to other parts of the vehicle.

### *Alternators*

An alternator is controlled by many simple machines such as levers and pulleys also known as belts. Belts convert the mechanical energy created by the engine into electrical energy through induction. An alternator has a belt that is connected to the crank shaft and serves the purpose of charging the vehicle's battery. This battery is responsible for the electrical power supply which powers the ignition. The alternator possesses electromagnetic wires that transmit an electrical current. The electrical current is then used to power many of the vehicle's accessories such as maintaining the engine's cooling fans, winches, headlights, air conditioning, and radio.

### *Brakes*

A vehicle's brakes are compound machines that utilize many simple machines to slow down a vehicle. The decrease in speed is the result of the vehicle operator's force on the brake pedal, also known as a lever. This creates friction on the brake boot and the brake pad, which is connected to the road wheel. Most commonly, friction brakes are utilized on motorized vehicles. Two brake types commonly found in transportation include drum brakes and disc brakes.

Drum brakes slow a vehicle by generating friction, using a brake shoe. This shoe presses and expands on the inner surface of the rotating drum. This drum is connected to the rotating road wheel.

Disc brakes slow a vehicle by utilizing a brake pad that compresses around the rotating wheel. This compression creates friction and results in the reduction of road wheel movement as well as a reduction in speed.

Air brakes are commonly used in large heavy vehicles such as buses, trucks, and trailers. Air brakes utilize compressed air, which applies pressure to a piston that is connected to the brake pad. Frictional force from the compressed air applies pressure to the brake pad. This brake pad, either drum or disc, is attached to the road wheel and results in a decrease in the vehicle's speed.

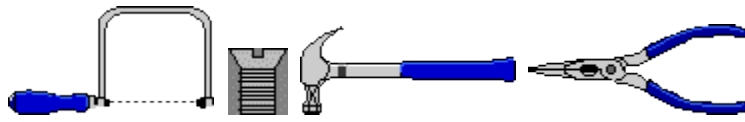
#### **Concept Check**

1. Describe work.
2. Calculate the amount of being work done utilizing the equations.  
( <http://www.physicsclassroom.com/class/energy/Lesson-1/Calculating-the-Amount-of-Work-Done-by-Forces>)
3. Review the 6 simple machines.  
(<http://www.youtube.com/watch?v=okYcBt1aU3Y>)

#### **Visualizing Concepts**

1. Brainstorm a list of simple machines that are utilized within compound machines in TDL.

# SIMPLE MACHINES



by Todd Kranz, a graduate student at the [University of Houston](https://www.uh.edu/)

Simple machines are tools that make work easier. They have few or no moving parts. These machines use energy to work. There are six simple machines.

Lever



**Lever:** A lever is a simple machine. A lever is a board or bar that rests on a turning point. This turning point is called the fulcrum. An object that a lever moves is called the load. The closer the object is to the fulcrum, the easier it is to move.

## Examples of Levers:

A hammer is a lever when it is used to pull a nail out of a piece of wood.

- Bottle openers
- Crow bars

Inclined Plane



**Inclined Plane:** An inclined plane is a simple machine. It is a flat surface that is higher on one end. You can use this machine to move an object to a lower or higher place. Inclined planes make

the work of moving things easier. You would need less energy and force to move objects with an inclined plane.

### **Examples of Inclined Planes:**

- Ramp
- Slanted Road
- Path up a Hill
- Slide

**Wheel and Axle:** The wheel and axle is another simple machine. The axle is a rod that goes through the wheel. This lets the wheel turn. It is easy to move things from place to place with wheels and axles.

### **Examples of Wheels and Axles:**

- Cars
- Roller Skates
- Wagons
- Door Knobs
- Gears in Watches, Clocks, and Bicycles

Wheel and Axle



Screw



**Screw:** A screw is a simple machine that is made from another simple machine. It is actually an inclined plane that winds around itself. A screw has ridges and is not smooth like a nail. Some



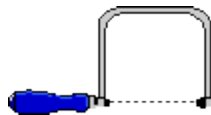
screws are used to lower and raise things. They are also used to hold objects together.

#### Examples of a screw:

- Jar Lids
- Light Bulbs
- Stools
- Clamps
- Jacks
- Wrenches
- Key Rings
- Spiral Staircase

**Wedge:** A wedge is a simple machine used to push two objects apart. A wedge is made up of two inclined planes. These planes meet and form a sharp edge. This edge can split things apart.

Wedge



#### Examples of wedges:

- Knives
- Axes
- Forks
- Nails

**Pulley:** This simple machine is made up of a wheel and a rope. The rope fits on the groove of the wheel. One part of the rope is attached to the load. When you pull on one side of the pulley, the wheel turns and the load will move. Pulleys let

Pulley



you move loads up, down, or sideways. Pulleys are good for moving objects to hard to reach places. It also makes the work of moving heavy loads a lot easier.

**Examples of where pulleys can be used:**

- Flag Poles
- Clothes Lines
- Sailboat
- Blinds
- Crane