Transportation, Distribution & Logistics (TDL) Contextualized Bridge Curriculum

Science Resources

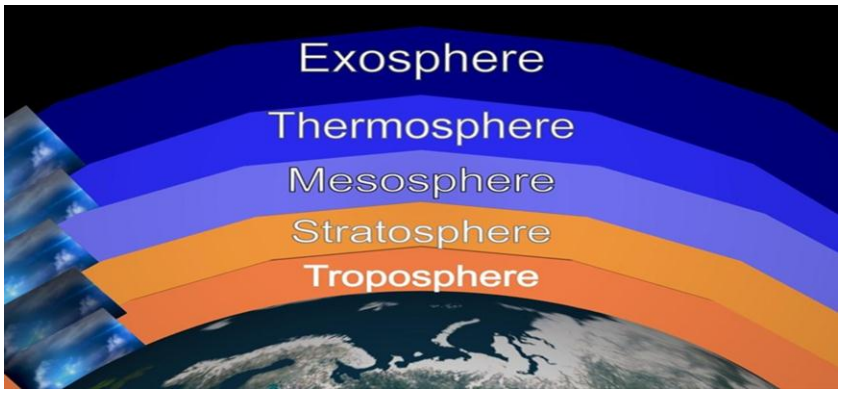
Outcome #1

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.

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

Outcome #2

Newton's Laws of Motion

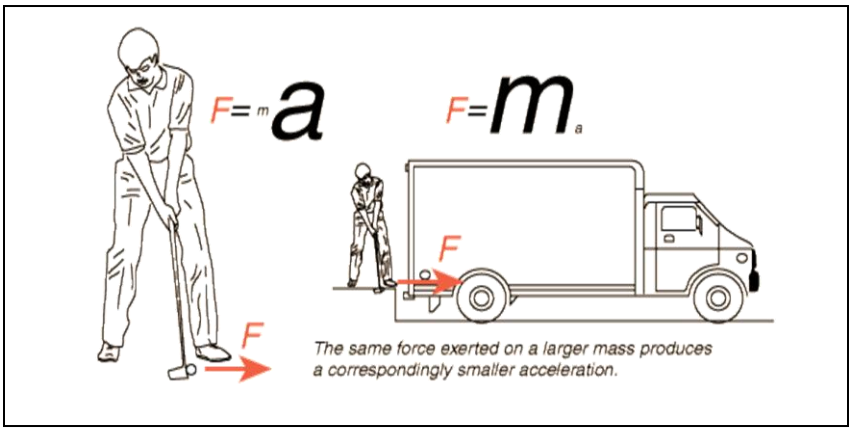
In the career pathway of TDL, truck drivers will be required to transport a wide variety of materials and products in a designated time frame. Depending upon the geographic location and weather conditions, the time-sensitive transported materials may include lumber, livestock, hazardous chemicals, new 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*).

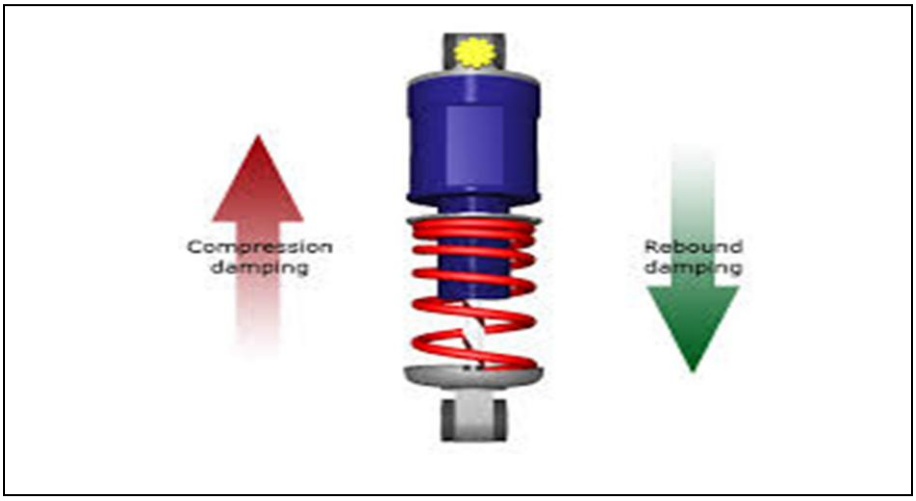
(The mathematical formula is: F=ma, Force = mass times acceleration.)

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.

Outcome #3

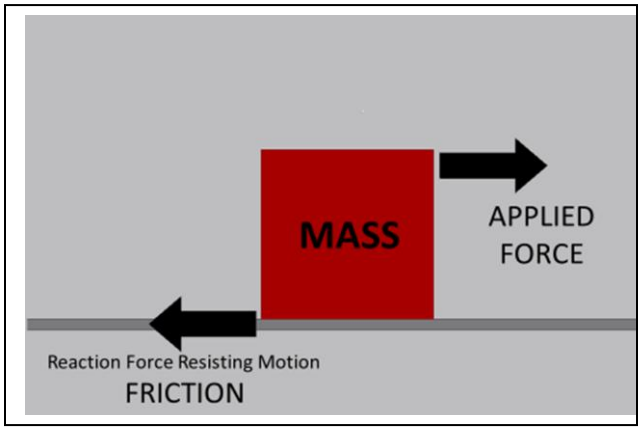
Transportation and Friction

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

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

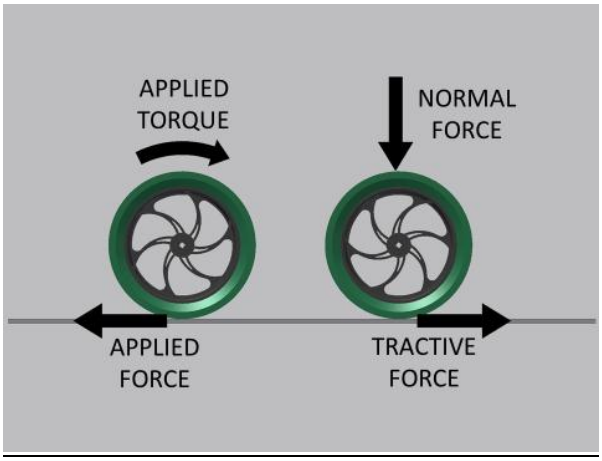
Similar to rain, snow poses a severe threat to motorists. When snow begins to accumulate it packs the roads and forms a slippery surface. The tires are no longer directly in contact with the road; therefore, the grip to the road is lost, causing a variety of issues.

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.

Comprehension Questions

1. What is the primary difference between static friction and kinetic friction?

A) Static friction occurs when two objects are in motion, while kinetic friction occurs when they are at rest.
B) Static friction is stronger than kinetic friction when both objects are moving.
C) Static friction resists the initiation of motion, while kinetic friction resists motion once it has started.

2. If a truck is stationary and the driver applies force to the brakes, which type of friction is primarily being resisted?

A) Kinetic friction
B) Rolling friction
C) Static friction

3. Which of the following scenarios best demonstrates kinetic friction?

A) A truck is parked on an incline and is not moving.
B) The truck is accelerating from a stop at a red light.
C) A truck's tires slide on the road while braking on icy pavement.

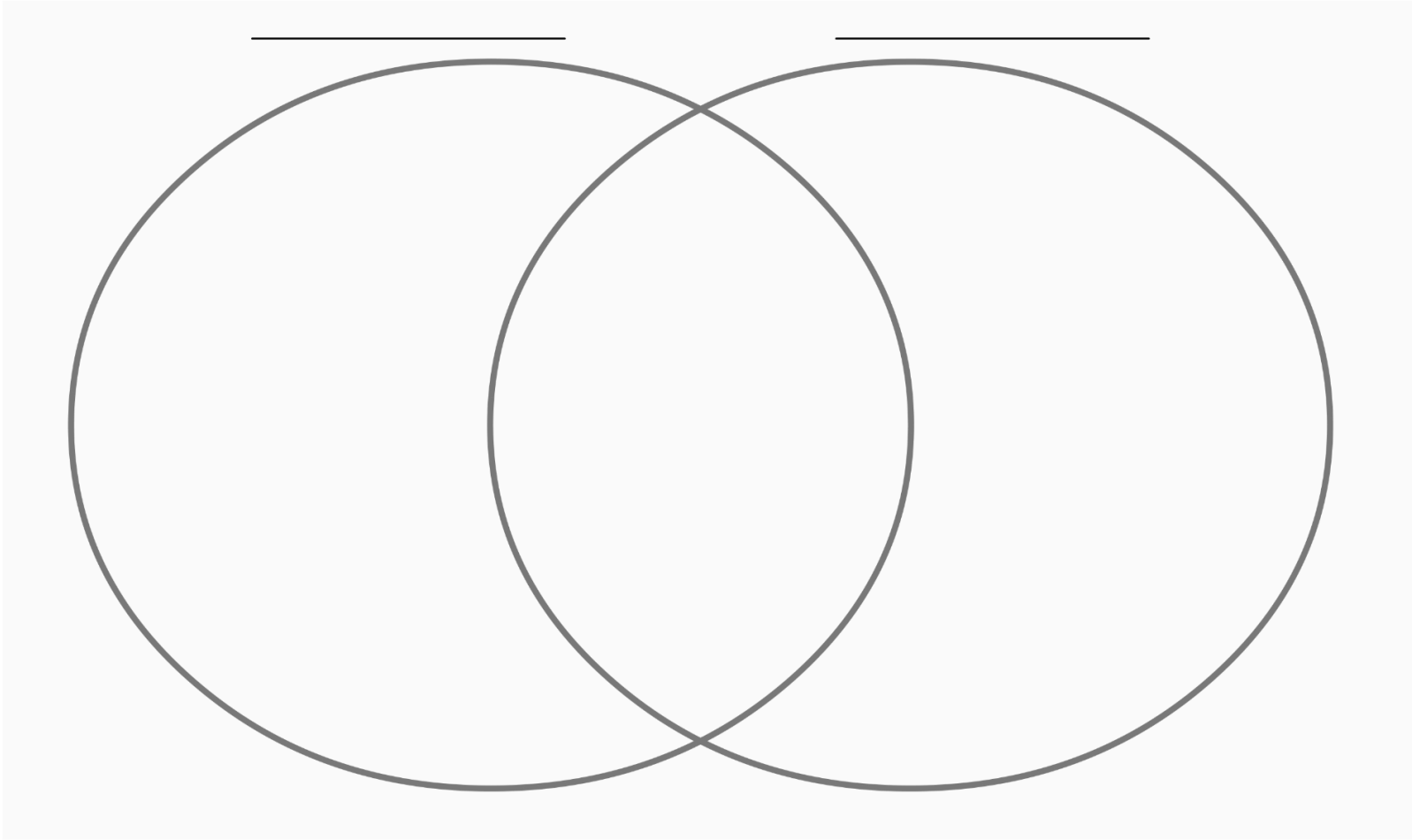
4. Which of the following is typically true about static friction compared to kinetic friction?

A) Static friction is always less than kinetic friction.
B) Static friction is usually stronger than kinetic friction.
C) Static friction only applies to objects with smooth surfaces.

Answer Key
1. C) Static friction resists the initiation of motion, while kinetic friction resists motion once it has started.
2. C) Static friction
3. C) A truck's tires slide on the road while braking on icy pavement
4. B) Static friction is usually stronger than kinetic friction

Outcome #3 - Activity 2

Venn Diagram



Outcome #3 - Activity 3

Why Tires Blowout More in Hot Weathers | Causes and Prevention Tips

by Hadie Erfan, 2025

https://tiredepth.com/tire-guides/why-tires-blowout-more-in-hot-weathers/

Ever wonder why tires blowout seem more common during scorching summer days? It's not just bad luck—it's science. Hot weather can wreak havoc on your tires, increasing the risk of sudden failures when you least expect it. As temperatures rise, so does the air pressure inside your tires. Combine that with long drives on heated roads, and your tires face extreme stress. If they're already worn or underinflated, the chances of a blowout skyrocket.

Understanding how heat impacts your tires can help you stay safer on the road. A little knowledge and preparation go a long way in avoiding those frustrating—and dangerous—situations.

Understanding Tire Blowouts

Tire blowouts occur when a tire suddenly bursts, causing a rapid loss of air pressure. This can lead to loss of control, especially at high speeds, and poses a significant safety hazard while driving.

What Is A Tire Blowout?

A tire blowout happens when internal pressure exceeds the tire's structural capacity. During a blowout, air escapes explosively, often accompanied by a loud noise and damage to the tire's surface. Unlike a slow leak, blowouts result in immediate deflation, making it difficult to maintain vehicle stability. Situations like driving on poorly maintained tires or under extreme temperature conditions increase the likelihood of this event.

1. Underinflation: Low air pressure increases heat buildup due to excessive friction with the road, eventually weakening the tire's structure and leading to a failure. Vehicles with underinflated tires, especially on long highway trips, face this risk.
2. Overloading: Carrying more weight than the tire's load rating can cause internal strain. The added stress makes the tires more susceptible to blowouts when combined with high road temperatures.

3. Worn-Out Tire Treads: Tires with insufficient tread depth provide less heat resistance. Bald patches or visible inner linings are signs of increased vulnerability to blowouts.
4. Road Hazards: Sharp objects, potholes, or rough surfaces can puncture or cut tires, initiating structural failure. Driving on damaged roadways without inspecting tires afterward amplifies the risk.
5. Extreme Temperatures: Excessive heat expands the air inside tires, increasing pressure. Combined with prolonged exposure to hot surfaces, this can push tires beyond their limits.
6. Manufacturing Defects: Tires with design or production flaws may weaken under stress. Issues such as weak sidewalls or improper bonding often contribute to blowout cases.

How Heat Affects Tires

Higher temperatures directly influence tire performance and durability, creating conditions that make blowouts more likely. Understanding the connection between heat and tire behavior is essential for safer driving in hot weather.

The Science Of Heat And Tire Pressure

Heat increases the air pressure inside tires due to gas expansion. For every 10°F rise in external temperature, tire pressure can increase by approximately 1-2 psi. This added pressure causes the tire to stretch beyond its designed capacity, especially if the recommended psi has already been exceeded. Overinflated tires become less flexible, making them more prone to damage from potholes or sharp objects. Conversely, underinflated tires, already warmer from excessive friction, build even more heat on hot pavement as they face added stress. In either scenario, the risk of a blowout becomes significant.

Impact Of High Temperatures On Tire Material

Tire materials, usually a combination of rubber compounds and internal structural layers, degrade faster in excessive heat. Prolonged exposure to elevated temperatures softens rubber, weakening its resistance to abrasion and cuts. Simultaneously, the internal components like polyester cords or steel belts can lose tensile strength, reducing overall durability. If road temperatures, which can exceed 140°F during summer, persistently heat the tire, the rubber may become brittle, making it more likely to crack or fail under stress. Older tires or those with visible sidewall damage are particularly vulnerable as they lack the structural integrity to withstand thermal expansion.

Why Tires Blow Out More In Hot Weathers

Tires are more prone to blowouts during hot weather due to the intense stress caused by heat. Rising temperatures directly affect air pressure, tire structure, and load-handling capacity, creating a hazardous environment for driving.

Role Of Heat In Increased Pressure

Hot air expands, and tire pressure rises significantly in elevated temperatures. For every 10°F increase, pressure within a tire can climb by 1-2 psi. This additional pressure strains the tire walls, especially during long drives on heated pavement. Overinflated tires can lose flexibility, making them susceptible to ruptures when encountering road hazards. High speeds combined with this pressure imbalance further amplify the risk of blowouts under hot weather conditions.

Weakened Tire Structure Due To Heat

Heat softens a tire's rubber material and deteriorates its internal components. Extended exposure to high temperatures can degrade essential layers like steel belts and nylon reinforcements, reducing structural integrity. Older or damaged tires are particularly vulnerable since heat can accelerate crack formation and cause separation of layers. Even newer tires can weaken if they're subjected to prolonged friction and elevated surface temperatures.

Overloading And Hot Weather: A Dangerous Combination

Tires carrying loads beyond their recommended capacity face excessive stress, which multiplies in hot weather. Heat exaggerates the effects of overloading by increasing friction and internal pressure, making blowouts more likely. For instance, vehicles carrying heavy cargo or towing trailers may overburden tires, leaving them unable to dissipate heat effectively. Combine overloading with prolonged driving on hot asphalt, and the likelihood of sudden tire failure becomes significantly higher.

Why truck tires blowout more in hot weathers

Truck tires experience increased blowout risks in hot weather due to their heavier load demands and extended usage. Trucks frequently carry substantial weights, adding strain that intensifies under high temperatures. This combination accelerates wear and increases internal friction, raising the likelihood of tire failure.

Hot pavement exacerbates stress by heating truck tires more quickly during long hauls. Tire air pressure rises as heat expands the air inside, often exceeding the tire's maximum capacity.

High-speed driving on scorching roads compounds this effect, further weakening the tire's structure.

Oversized loads and improper weight distribution push truck tires beyond their designed capabilities in extreme heat. Excessive weight creates more contact between the rubber and road, generating additional heat. If tires lack proper maintenance, such as routine pressure checks, these factors work together to increase blowout risks.

Manufacturing differences also play a role in why truck tires fail more during hot conditions. Heavy-duty truck tires often face higher stress thresholds compared to passenger vehicles, exposing flaws in their materials faster when subjected to heat. If tires display signs of wear, such as fading treads or small cracks, they risk rapid deterioration under excessive thermal exposure.

Driving conditions further magnify the problem in hot weather. Poor road quality, such as potholes or rough surfaces, generates higher impact forces, increasing vulnerability to sudden ruptures. External factors like sharp debris can penetrate softened rubber quicker, making bursts more frequent for truck tires under intense heat.

Preventing Tire Blowouts In Hot Weather

Keeping tires in good condition is essential to reducing the risk of blowouts during hot weather. Extreme heat puts additional strain on your tires, making consistent care and attention crucial for safe driving.

Regular Tire Maintenance Tips

Inspect tires weekly for signs of wear, bulges, or cracks that may compromise their strength. Pay special attention to the tread depth, ensuring it meets the legal minimum of 2/32 of an inch or more for adequate road grip. Replace worn or damaged tires promptly.

Rotate tires every 5,000-7,500 miles, as specified in your vehicle's manual, to ensure even wear. Misalignment or imbalanced tires increase friction and heat buildup, which heighten the chance of blowouts. Keep tire alignment and balancing checked during regular service appointments.

Clean tires periodically to remove debris and maintain their structural integrity. Residues, like oils and chemicals from the road, can accelerate rubber degradation. Avoid exposing tires to direct sunlight for prolonged periods when parked to prevent unnecessary heat damage.

Importance Of Monitoring Tire Pressure

Check tire pressure at least once a month, and always before long drives, to prevent overinflation or underinflation. Use a reliable gauge, and compare the readings to the manufacturer's recommended psi level, typically located in your vehicle's manual or door jamb.

Remember, tire pressure varies with temperature. For example, a 10°F rise increases pressure by 1-2 psi. Adjust for these fluctuations to maintain optimal pressure and reduce heat-related risks. Underinflated tires increase rolling resistance, causing excess heat; overinflated ones lose flexibility, making them more vulnerable to rupture.

Inspect spare tires as well to ensure they're properly inflated. Many drivers neglect spares, though emergencies can arise during the most demanding conditions, such as hot weather.

Best Practices For Driving In Hot Conditions

Reduce vehicle load to ease pressure on the tires. Avoid exceeding the Gross Vehicle Weight Rating (GVWR), which is indicated in your owner's manual, to minimize stress. Spread cargo evenly to maintain balance and prevent concentrated strain on specific tires.

Drive at moderate speeds, particularly on scorching roads, to decrease friction and lower heat buildup. Abrupt braking or high-speed maneuvers can intensify strain. Use cruise control when possible for steady driving on highways.

Plan trips for cooler parts of the day, such as mornings and evenings, to avoid peak heat. Ensure proper vehicle ventilation to reduce internal heat effects on rubber components. Maintaining a safe following distance also reduces the need for sudden stops, which create additional stress on tires.

Frequently Asked Questions

Why are tire blowouts more common in hot weather?

Tire blowouts are more common in hot weather because heat causes air inside tires to expand, increasing pressure. This added stress, combined with heated pavement and prolonged driving, weakens tire structure and increases the risk of sudden failure, especially for underinflated or worn tires.

How does temperature affect tire pressure?

For every 10°F increase in temperature, tire pressure rises by about 1-2 psi. Excessive pressure stretches tires beyond their design limits, while underinflated tires generate more heat through friction, making both conditions dangerous.

What are the main causes of tire blowouts?

The main causes include underinflation, overloading, worn-out treads, road hazards, and excessive heat. Each factor increases stress on tires, reducing durability and increasing vulnerability to rupture.

Are older tires more prone to blowouts in summer?

Yes, older tires are more prone to blowouts during summer. Heat softens their rubber, weakens internal components, and makes them brittle, increasing their likelihood of cracking or sudden failure.

How can overloading a vehicle lead to tire blowouts?

Overloading puts excessive strain on tires, increasing internal pressure and making it harder to dissipate heat. This combination significantly raises the risk of blowouts, especially during hot weather.

Why do truck tires fail more often in extreme heat?

Truck tires carry heavy loads and endure long drives on hot pavement, creating intense internal friction and stress. When combined with manufacturing flaws or poor road conditions, this makes them more prone to failure.

Can driving at high speeds increase the risk of blowouts?

Yes, driving at high speeds generates more heat within tires, especially on hot pavement. This added heat increases pressure and stress, making tires more likely to fail.

Outcome #3 - Activity 3, Article 2

Semi Truck Winter Tires: A Crucial Investment for Safety and Efficiency

By Williams Logistics, Inc on 12-31-2024
https://www.drivewli.com/post/semi-truck-winter-tires-a-crucial-investment-for-safety-and-efficiency

As winter approaches, trucking companies like Williams Logistics must prioritize safety and efficiency on the roads. One of the most critical decisions for fleet managers and drivers is whether to invest in winter tires for their semi trucks. Let's explore what winter tires are, their benefits, and why they might be essential for your fleet.

What Are Winter Tires?

Winter tires are specially designed to perform in cold temperatures, snow, ice, and slush. They differ from all-season or standard tires in several key ways:

- Unique Rubber Compounds: Winter tires use rubber compounds that remain flexible in cold temperatures, providing better grip and traction.
- Specialized Tread Patterns: These tires feature deep grooves and open tread designs that efficiently evacuate snow and slush, preventing build-up and maintaining traction.
- Biting Edges and Sipes: Winter tires have a high density of sipes (tiny slits in the tread blocks) that create additional biting edges for improved grip on icy surfaces.

Do Winter Tires Make a Difference?

The short answer is yes, winter tires can make a significant difference in semi truck performance and safety during cold weather conditions:

- Improved Traction: Winter tires provide superior grip on snow and ice compared to all-season tires. This translates to better acceleration, braking, and cornering in winter conditions.
- Shorter Stopping Distances: Winter tire road tests show that they can bring a heavy truck to a stop three times faster than all-season or all-weather tires.
- Better Handling: The increased traction allows for safer cornering and improved overall vehicle control in challenging winter conditions.
- Reduced Risk of Hydroplaning: The specialized tread design of winter tires helps channel water, slush, and snow away from the tire's surface, reducing the risk of hydroplaning.

- Flexibility in Cold Temperatures: Winter tires are designed to remain flexible in temperatures below 7 degrees Celsius, ensuring optimal performance in cold weather.

Do I Need Winter Tires?

The decision to invest in winter tires depends on several factors:

- Geographic Location: If your routes frequently take you through areas with severe winter conditions, winter tires are a wise investment.
- Legal Requirements: Some regions may have specific regulations regarding winter tire use for commercial vehicles. For example, in Colorado, vehicles must have winter-appropriate tires with a minimum of 3/16" tread depth during Traction Law periods.
- Safety Considerations: If you prioritize driver safety and want to minimize the risk of accidents in winter conditions, winter tires are highly recommended.
- Operational Efficiency: Winter tires can help maintain schedules by allowing for safer driving at higher speeds in winter conditions compared to all-season tires.
- Cost-Benefit Analysis: While winter tires represent an additional expense, they can potentially save money by reducing accidents, improving fuel efficiency, and extending the life of your standard tires.

It's important to note that winter tires are not just for extreme winter conditions. They start to outperform all-season tires when temperatures drop below 7°C (45°F), even on dry roads.

Conclusion

For Williams Logistics and other trucking companies operating in areas with cold winters, investing in winter tires for semi trucks is a decision that can significantly enhance safety, efficiency, and peace of mind. While the initial cost may be substantial, the benefits in terms of improved traction, shorter stopping distances, and better overall performance in winter conditions can far outweigh the investment.

Remember, winter tires are not just about navigating through snow and ice – they're about maintaining optimal performance and safety in all cold weather conditions. As you prepare your fleet for the winter season, carefully consider the routes your trucks will travel and the conditions they'll face. Making the switch to winter tires could be one of the most important decisions you make for your drivers' safety and your company's bottom line.

Outcome #4

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/SirIsaac/daniel2.htm)*

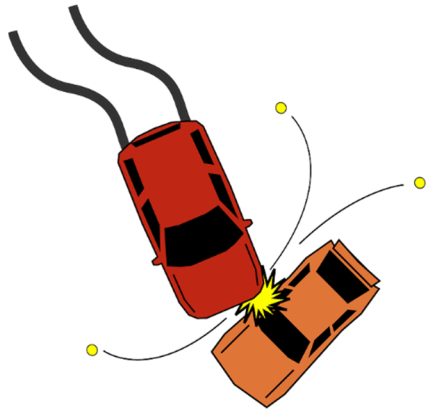
Kinetic Energy

Kinetic energy is the energy of motion. It is the opposite of potential energy, which is the result of the position or state of an object. Objects at rest have potential energy. Moving objects have kinetic energy. The word "kinetic" is derived from the Greek word *kinesis*, which means motion.

An object's kinetic energy is a constant as long as an object remains the same size and continues to move at the same speed. Kinetic energy increases with speed. Kinetic energy also has a direct relationship with an object's mass. When the mass of an object doubles, so does its kinetic energy. In physics, which is the branch of science that studies the nature and properties of matter and energy, kinetic energy is measured in joules (J).

Potential energy becomes kinetic energy when an object begins to move. For example, an object at rest on a table has potential energy that becomes kinetic energy when it falls off the table. Moving objects also have potential energy. A classic example of this is the roller coaster. As a car moves up the coaster its potential energy increases. At the peak of the incline it has achieved its peak of potential energy. On its descent, as it gets faster and faster, its kinetic energy increases in direct proportion to its speed. Thus kinetic and potential energy are inversely related. The more potential energy an object has, the less kinetic energy it has, and vice versa.

Kinetic energy can be transferred between objects during collisions. For example, when a moving car crashes into a car that is not moving and the car that was not moving then moves forward, that's a transfer of kinetic energy. If the car that began to move after the collision then crashes into another car, that car, too, may begin to move, and so on, until all the kinetic energy is dissipated.



QUESTIONS: Kinetic Energy

Circle the correct answer.

1. Kinetic energy is the energy of:
   A. potential
   B. objects at rest
   C. objects in motion
   D. accelerating objects

2. Kinetic energy _____ speed.
   A. decreases with
   B. increases with
   C. is the same as its
   D. is unrelated to

3. An object's kinetic energy remains constant as long as:
   A. an object remains the same size and continues to move at the same speed
   B. an object remains the same size
   C. an object continues to move at the same speed
   D. an object doesn't move

4. Potential energy becomes kinetic energy when:
   A. an object gets bigger
   B. an object gets smaller
   C. an object starts to move
   D. an object stops moving

5. Kinetic energy can:
   A. become potential energy during a collision
   B. decrease during a collision
   C. increase during a collision
   D. be transferred between objects during a collision

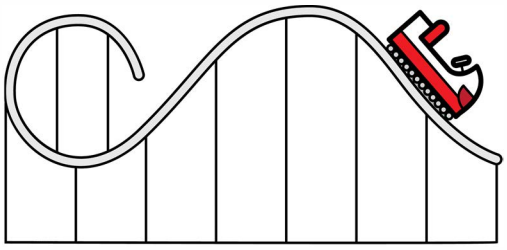
Kinetic Energy Worksheet - Answer Key

1. C
2. B
3. A
4. C
5. D

Potential Energy

Potential energy is the energy that exists in an object when it is not moving. Like its opposite, kinetic energy, potential energy is measured in joules (J).

Potential energy is inversely related to kinetic energy. This means that the more potential energy there is in an object, the less kinetic energy there is, and vice versa. For example, if you hold an object up in the air on your flat, open palm, that object has potential energy because it is at rest. When the object falls, that potential energy becomes kinetic energy.



Moving objects have potential energy, too. A classic example of this is the case of the roller coaster. As a car moves up the coaster its potential energy increases. At the peak of the incline it has achieved its peak of potential energy. On its descent, as it gets faster and faster, its kinetic energy increases in direct proportion to its speed. You could say that potential energy is kinetic energy that hasn't happened yet.

There are different types of potential energy. Gravitational potential energy (GPE) comes from Earth's gravity. GPE is the potential energy that is stored in an object based on its mass and how high it is off the ground. The larger an object is and the higher it is off the ground, the more potential energy it has. Elastic potential energy is the amount of energy that is stored when materials like springs, rubber bands, and slingshots are stretched or compressed. Electric potential energy is the capacity to do work based on an object's electric charge. Nuclear potential energy is the potential energy of the particles inside an atom. Chemical potential energy is the energy stored in substances as a result of their chemical bonds, i.e., the amount of energy that will be released if the bond is broken.

QUESTIONS: Potential Energy

1. What is potential energy?

2. What unit of measurement is used to express potential energy?

3. What is the relationship between potential and kinetic energy?

4. Give an example of a moving object having potential energy.

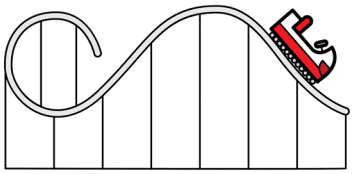
5. What is gravitational potential energy?

6. What is nuclear potential energy?

7. What is elastic potential energy?

8. What is chemical potential energy?

9. What is electric potential energy?



ANSWERS

1. the energy that exists in an object when it is not moving

2. joules (J)

3. they have an inverse relationship

4. as a roller coaster car moves up the coaster its potential energy increases. At the peak of the incline it has achieved its peak of potential energy.

5. GPE is the potential energy that is stored in an object based on its mass and how high it is off the ground. The larger an object is and the higher it is off the ground, the more potential energy it has.

6. Nuclear potential energy is the potential energy of the particles inside an atom.

7. Elastic potential energy is the amount of energy that is stored when materials like springs, rubber bands, and slingshots are stretched or compressed.

8. Chemical potential energy is the energy stored in substances as a result of their chemical bonds, i.e., the amount of energy that will be released if the bond is broken.

9. Electric potential energy is the capacity to do work based on an object's electric charge.

Outcome #5

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.

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

Outcome #5 - Activity 1

Difference Between Velocity and Acceleration

Key Differences, 2025
https://keydifferences.com/difference-between-velocity-and-acceleration.html#google_vignette

Velocity and acceleration are the two key concepts which are always discussed while studying motion. **Velocity** can be understood as the speed of a moving body in a particular direction whereas **acceleration** is any change in the velocity of the object, with respect to time.

Motion implies movement; it is the act of moving or more specifically, the change in position of the body, concerning time. Whenever you walk, run or drive you are actually in motion and not only this, flying of birds, swimming of fishes, flowing of water from the river, falling of leaves from trees, rotation and revolution of the earth, is also motion.

For a layperson, these two terms are one and the same thing, but in physics, there are subtle differences between velocity and acceleration.

Comparison Chart

Basis for Comparison	Velocity	Acceleration
Meaning	Velocity implies the speed of an object, in the given direction.	Acceleration alludes to any change in the velocity of the object with respect to time.
What is it?	Rate of change of displacement.	Rate of change of velocity.
Ascertains	How fast something is moving and in which direction.	How fast the moving object's velocity changes with time.
Formula	Displacement/time	Velocity/time
Unit of measurement	m/s	m/s^2

Definition of Velocity

In physics, velocity is described as a vector measurement as it has both magnitude and direction, wherein the magnitude represents speed and direction shows its direction of motion.

Velocity is a physical quantity which describes the rate at which an object moves, along with its direction. It implies the rate of change in position of someone or something, with respect to time, i.e. how fast an object displaces itself over time from one point to another.

One can change the velocity of the moving body, by making a change in its speed, direction or both. At any point, the velocity of the body is tangent to its path at that point.

Definition of Acceleration

A measure of change in velocity, with respect to time, is termed as acceleration. Whenever an object changes its velocity, it is said to be accelerating. It is a vector expression that has both magnitude and direction. An object is said to be accelerated when there is an increase or decrease in its speed or change in the direction of motion or both. It is concerned with how the body's motion is changing with respect to time.

The change in object's speed and direction are indicated by the component of acceleration, i.e. direction. When the direction of acceleration is parallel to velocity, then it is believed that the object is accelerating or its speed is going up. However, when the direction of acceleration is anti-parallel to velocity, then the object is decelerating, or its speed is slowing down. Moreover, if the component of acceleration is perpendicular to velocity, then it reflects the amount of change in the object's direction. There can be two types of acceleration, which are:

- **Centripetal acceleration**: When the object travels at a uniform speed in a circular motion, like the revolution of the earth, then this acceleration is called centripetal acceleration because there is a change in the direction of the object.
- **Tangential acceleration**: When there is no change in the direction of motion but the speed changes with time, this is called tangential acceleration.

Key Differences Between Velocity and Acceleration

The difference between velocity and acceleration can be drawn clearly on the following grounds:

1. The velocity of an object refers to the speed in a specific direction. Acceleration implies any change in the velocity of the object with respect to time.
2. Velocity is nothing but the rate of change of displacement. On the other hand, acceleration is the rate of change of velocity with respect to time.
3. Velocity determines the speed of the moving object along with the direction of motion. Conversely, acceleration ascertains the speed of change in velocity of the moving object over a period of time.

4. Velocity is calculated as displacement divided by the time taken in which it takes place. On the contrary, acceleration can be calculated as: change in velocity divided by the time taken while the change took place.
5. The unit of measurement of velocity is meter per second (m/s) whereas the standard unit of acceleration is meter per second squared (m/s2).

Similarities

- Both velocity and acceleration are vector quantities, which have both magnitude and direction.
- Both the expressions can be positive, negative and zero.

Conclusion

The motion of an object can be explained as distance traveled, which can be uniform or non-uniform, depending on the velocity of the object. The velocity of an object is its displacement per unit of time whereas acceleration is the rate of change of object's velocity over a period of time.

Outcome #6

Basic Chemistry

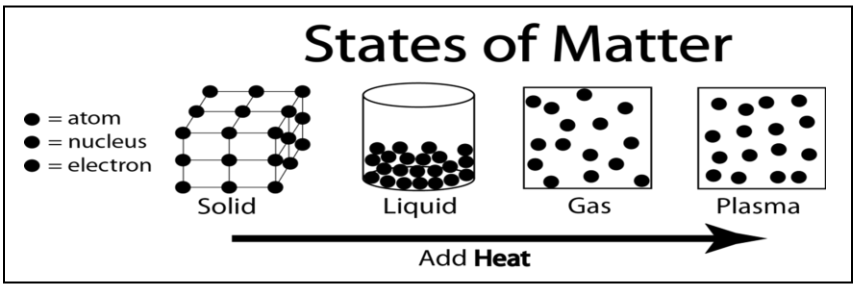
In the career pathway of TDL, the main concern is the product that is being transported and distributed. One must understand the product's chemical composition, as well as its sensitivity to temperature. To understand the product's sensitivity, the transportation company must acknowledge and understand 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.

Outcome #6 - Activity 1

7 freight truck types & what they haul

by Alex Dryjowicz, August 1, 2024

Nearly every industry relies on freight trucks to transport goods, but not every type of cargo can be transported in the same way. Luckily, different types of freight trucks meet different industry needs to move goods around the country and the world.

Semi trailers, flatbeds, step decks, dry vans, reefers, box trucks, and tankers are some of the many different types of trucks for freight. Keep reading to learn more about these types of freight trucks and what they haul during the transportation process.

What is a freight truck?

A freight truck is a powerful specialized vehicle that transports goods from one place to another. All freight trucks have two major components: the truck tractor in the front, where the engine and cab are located, and a trailer, where the freight is stored. Freight trucks are driven by truck drivers who hold a Commercial Driver's License (CDL). However, some types of freight trucks require drivers to have even higher levels of training.

7 common types of freight trucks & what they haul

There are seven main types of trucks for hauling — semi-trailers, flatbeds, step decks, dry vans, reefers, box trucks, and tankers — all of which haul different types of cargo.

Semi trailer

Semi trailers are known by many names, including semi trucks, 18-wheelers, tractor trailers, and big rigs. They are one of the most commonly seen types of freight trucks on the road. They get the name "semi" because the trailer's design has no front axle or front wheels. Instead, it rests on a hitch or fifth-wheel coupling. Semi trailers can also tow one or two additional trailers for carrying added cargo.

Semi trucks are incredibly versatile, hauling everything from consumer products to raw materials. Since a semi truck can tow more than one trailer, they're popular for carrying cargo over long distances.

Flatbed freight truck

Instead of carrying goods inside a closed trailer, a flatbed truck has a flat, open trailer without any roofs or sides. A flatbed trailer truck is excellent for carrying oversized loads.

They are easier to load and unload than other freight trucks. Cargo is typically secured on flatbed trailers using straps. With an impressive load-bearing capacity and versatile cargo space, flatbed trucks are ideal for hauling construction materials, other vehicles, heavy machinery, oversized cargo, and even houses.

Step deck

Like a flatbed truck, a step deck is an open trailer. The difference between the two is that a step deck is specially designed to haul tall cargo. Also called a drop deck or lowboy trailer, a step deck has two decks. The lower deck is designed to allow for more overhead clearance for hauling tall or oversized cargo. As a result, they are easier to load and unload.

Step deck trailers are specifically designed to haul tall and oversized cargo without additional permits. It's also possible to transport additional goods on the other deck.

Dry van

A dry van is a type of semi truck with a non-temperature-controlled trailer. A dry van is fully enclosed with four walls and a roof, which protects goods from the elements. Typically, dry van trailers are 53 feet long and can carry a wide variety of freight. New truck drivers usually start by driving dry van trucks since they are common and can be driven with only a Class A CDL.

Dry van trucks can haul a wide variety of pallets and boxed cargo. Almost everything you have in your home was likely once transported by a dry van, including furniture, apparel, and non-perishable food.

Reefer

A reefer, or refrigerated truck, is a temperature-controlled freight truck that hauls goods that must be kept within a specific temperature range. Reefers commonly transport food and deliver it to grocery warehouses and stores. The refrigeration unit sits at the front of the trailer or above the truck's cab. The temperature must be monitored continuously by the driver to avoid spoilage.

Anything that needs to be kept at a specific temperature is transported by reefer trucks, including food products, pharmaceuticals, chemicals, and hazmat materials. Since refrigerated products can spoil quickly, reefer truck deliveries are more time-sensitive than other types of cargo.

Box truck

Box trucks are known for their box-shaped cargo compartment and smaller freight truck types. The cargo box of a box truck sits directly on the frame. It is usually separate from the truck's cabin. Box trucks are great for local deliveries since they are easier to maneuver down small streets and around tight corners.

Box trucks are popular for transporting goods short distances. These goods tend to be home appliance and furniture deliveries, last-mile deliveries, food delivery, and even moving-related transportation.

Tanker

There are two tanker trucks — dry bulk tankers and liquid tankers. Dry bulk tankers carry loose bulk dry goods. Liquid tankers transport liquids and gasses. Rather than a boxy trailer, a tanker has a cylindrical tank that mounts onto a semi-truck. Tankers are more challenging to operate since drivers have to minimize sloshing.

However, the tanks also have compartments to help reduce this sloshing and carry multiple loads. The tank can be pressurized, insulated, or refrigerated if the cargo requires it.

Dry bulk tankers are designed to carry loose materials that drivers cannot transport any other way, including construction materials like sand and powders or bulk foods like sugar and grain. Liquid tankers haul liquids of all varieties, including beverages like milk or wine and chemicals like gasoline.

Highest paying trucking jobs

The highest paying types of trucking work typically include:

Hazardous materials transport

Hauling hazardous materials, chemicals, and other dangerous loads requires extensive additional certifications and training. As a result, it pays top driver salaries and bonuses exceeding $100,000 per year. While very lucrative, hazmat work also carries much higher risk and responsibility.

Heavy haul

Specialized freight like oversized loads, construction equipment, and bulk commodities can pay $80,000 to $120,000 for drivers and owner-operators. These kinds of loads require more difficult long-haul transport logistics and permitting needs for non-standard shipments.

Ice road trucking

Navigating seasonal ice roads in arctic regions is among the most challenging, intense trucking jobs. Annual salaries reach over $100,000 for resilient drivers able to handle severe weather and road conditions.

Oil and gas industry transport

Hauling machinery, water, fuel, drilling equipment, and other supplies for oil and gas companies tends to pay generous rates. Average pay is around $75,000 to $95,000 annually, but the work can be volatile depending on oil market price swings.

In a nutshell, harder jobs that require moving hazardous, oversized, arctic, industrial, or high-value cargo generally provide the highest pay ceilings and earning power for fully certified commercial drivers in the trucking business. These niches compensate for danger and difficulty through premium salaries.

What is the most common freight truck?

The most common type of freight truck in the U.S. is the Class 8 tractor trailer. This truck transports everything from consumer goods to produce across the country. Specifically, the Freightliner Cascadia is the most popular truck model on American highways. Over 50% of long-haul fleets are made up of these versatile, durable Freightliner trucks pulling 53-foot dry goods trailers. Known for fuel efficiency, driver comfort, and safety upgrades, Cascadias are sometimes called the workhorse of the trucking industry.

What is the best type of freight to haul for new drivers?

The best type of freight for new truck drivers to haul is dry van freight. Dry van trailers transport general freight that is stacked on pallets or shelving. This freight does not require refrigeration, special handling, or additional certifications. Hauling dry van freight allows new drivers to gain experience loading, unloading, and securing cargo. It also allows them to drive long distances, follow delivery timelines, and learn the logistics of the trucking industry.

Once a driver has miles and confidence under their belt, they can then consider expanding into different types of trucks for hauling, such as flatbeds, refrigerated trucks, tankers, or hazmat. Starting out in dry van freight allows for that initial on-the-job training that sets up newer truckers for success across different types of hauls. The workflow and processes are more easily transferable after cutting teeth in routine dry van transport.

Jump start a new career driving a freight truck

Nearly everything we touch was transported by a freight truck at some point. This heightened demand for transportation and logistics services means there are plenty of jobs out there for

truck drivers. There are numerous opportunities to specialize in different types of trucks for freight. No matter which type of freight truck you choose to drive or what you choose to haul, you're sure to have a rewarding career in the trucking industry.

FAQ

What type of freight is most commonly hauled?

The most commonly hauled type of freight involves general dry goods and non-perishable consumer products. These products include packaged or canned foods, furniture, paper goods and packaging products, clothing items, appliances, and other retail merchandise loads. These general commodities comprise over 60% of total trucking tonnage and gross freight revenue for the American trucking industry.

What do LTL and FTL mean?

LTL stands for "less than truckload" and refers to shipments that do not require an entire trailer, allowing for multiple customers' partial loads to be combined. FTL means "full truckload," where a shipper books an entire trailer for their cargo requiring point-to-point transport directly from origin to destination without stopping to combine with other freight.

What are large tow trucks called?

Tow trucks designed for hauling large and heavy passenger vehicles like buses, RVs, and tractor trailers are known as heavy duty wrecker trucks or rotator tow trucks. They have dual rear axles or more to handle such sizable loads and feature expanded rigging capabilities like underlift and wheel-lift attachments. Other equipment may include more powerful winches and booms, plus large-capacity rotating flatbeds to maneuver and pull extra-large vehicles.

Outcome #7

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 is 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.

Non-Renewable Resources

- **Definition:** Resources that cannot be replenished on a human timescale. Once used up, they are gone for a long time or indefinitely.
- **Examples:** Fossil fuels (coal, oil, natural gas), minerals (gold, copper), nuclear fuel (uranium).
- **Availability:** Limited and finite.
- **Regeneration:** Cannot regenerate on a human timescale, takes millions of years to form.
- **Environmental Impact:** Can lead to pollution, habitat destruction, and contribute to climate change (e.g., carbon dioxide emissions from burning fossil fuels).
- **Usage:** Typically used in energy production (electricity, heating, transportation), manufacturing (metals, plastics), and other industrial processes.
- **Cost:** Can be expensive to extract and use, particularly as resources become scarcer or harder to access.
- **Sustainability:** Not sustainable long-term due to finite supply.
- **Energy Output:** High energy output (e.g., fossil fuels provide a large amount of energy when burned).

Renewable Resources

- **Definition**: Resources that are naturally replenished on a human timescale and can be used indefinitely if managed sustainably.
- **Examples**: Solar energy, wind energy, hydroelectric power, geothermal energy, biomass, and tidal energy.
- **Availability**: Generally abundant and available in specific regions or globally.
- **Regeneration**: Regenerates naturally and rapidly on a human timescale (e.g., sunlight, wind).
- **Environmental Impact**: Can still have some environmental impact (e.g., wind turbine production, hydropower effects on ecosystems), but much lower compared to non-renewables.
- **Usage**: Used for electricity generation, heating, transportation (biofuels), and industrial processes.
- **Cost**: Initially higher in installation or infrastructure, but operational costs can be lower. Over time, renewable resources can be more cost-effective.

- **Sustainability**: Sustainable over the long term as they are naturally replenished.
- **Energy Output**: Typically, lower energy output compared to non-renewables (though this can vary with technology and scale).

Key Differences

Feature	Non-Renewable Resources	Renewable Resources
Definition	Limited resources, not replenished	Naturally replenished resources
Examples	Coal, oil, natural gas, minerals	Solar, wind, hydro, biomass
Regeneration	Very slow or impossible	Replenished quickly
Environmental Impact	High pollution and carbon emissions	Generally lower impact
Sustainability	Unsustainable long-term	Sustainable long-term
Cost	Can be expensive due to scarcity	Higher initial cost, but low operational cost
Energy Output	High energy output	Varies, generally lower than non-renewables

In conclusion, non-renewable resources are limited and can have a significant environmental impact, while renewable resources are sustainable and cleaner, though they may still require advancements in technology and infrastructure to become as efficient as non-renewables in certain areas.

Outcome #8

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, Work= Force x Distance

The rate of work is shown in this mathematical equation:

P=W/T, 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:

MA= F(out)/F(in) , Mechanical Advantage= Output force/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

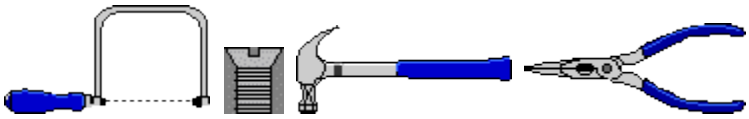
A vehicle's brakes are compound machines that utilize many simple machines to slow down a vehicle. The decrease in speed is the result of the vehicle operator's force on the brake pedal, also known as a lever. This creates friction on the brake boot and the brake pad, which is connected to the road wheel. 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.

Simple Machines



by Todd Kranz, a graduate student at the University of Houston

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: 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.

Lever

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: 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

Inclined Plane

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.

Wheel and Axle 

Examples of Wheels and Axles:

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

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

Screw 

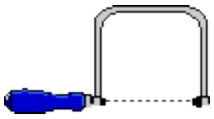
screws are used to lower and raise things. They are also used to hold objects together.

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

Outcome #8 - Activity 3

Examples Of Simple Machines & Complex Machines

By Michelle Nickolaisen
Updated Mar 24, 2022
https://www.sciencing.com/examples-machines-amp-complex-machines-7221376/

A machine is a tool used to make work easier. It can do so by changing the direction of a force, increasing the distance or speed of a force, transferring a force from one place to another or increasing the magnitude of a force. Machines are everywhere in our daily lives and make peoples' lives today much simpler, but no matter how complex a machine may appear, it is simply a combination of the six simple machines.

Inclined Plane: Easy Lifting
An inclined plane is simply an even, sloping surface. One common example of an inclined plane is a ramp. Lifting heavy items onto a higher surface is much easier if you just slide the item up a ramp.

Wedge: Splitting and Separating
A wedge is a modification of an inclined plane. Wedges are usually used as either separating or holding devices. An axe blade is one example of a wedge — you can make a small crack much larger by using an axe blade. Another example is a door stop.

Screw: Fastening and Moving
A screw is another modified inclined wedge. This can be hard to visualize, but just think of a screw as an inclined plane wrapped around a cylinder.

Lever: Multiplying Force

Any tool that is used to help pry something loose is a lever. A lever is an arm that pivots against a fulcrum. An example is the claw end of a hammer, being used to pry nails out of wood. Another example is a seesaw.

Wheel and Axle: Rolling

A wheel and axle consist of a large wheel secured to a smaller shaft, here referred to as an axle. If the wheel turns but the axle remains stationary, it isn't a true wheel-and-axle machine. Wheels and axles are everywhere — think of a childhood play wagon for one example of a wheel and axle in motion.

Pulley: Hoisting Heavy Loads

A pulley is a machine similar to a wheel and axle, but where rope is turned rather than the axle. As the wheel rotates, the cord is moved in either direction. This can help lift or move objects. A flagpole is one example of a pulley.

Scissors: Making the Cut

As a machine, a pair of scissors seems pretty simple, though it's actually a complex machine. A scissors combines two levers with the cutting action of the wedge. The levers multiply the force on the object to be cut, making it easier to use and more effective than a knife.

Hand Truck: Mover's Friend

Like the scissors, a two-wheeled hand truck is also a complex machine. The lever and the wheel and axle partner to make a machine that lets you lift and move furniture, appliances and other objects too awkward or heavy to carry by hand.

Automobile: Many Machines

It should be no surprise that an automobile with a gasoline engine is a complex machine, made of thousands of simple machines. Inside the engine, each rocker arm that operates the many valves is a lever. The timing belt is a type of pulley, and the car rides on four wheels mounted to two axles.

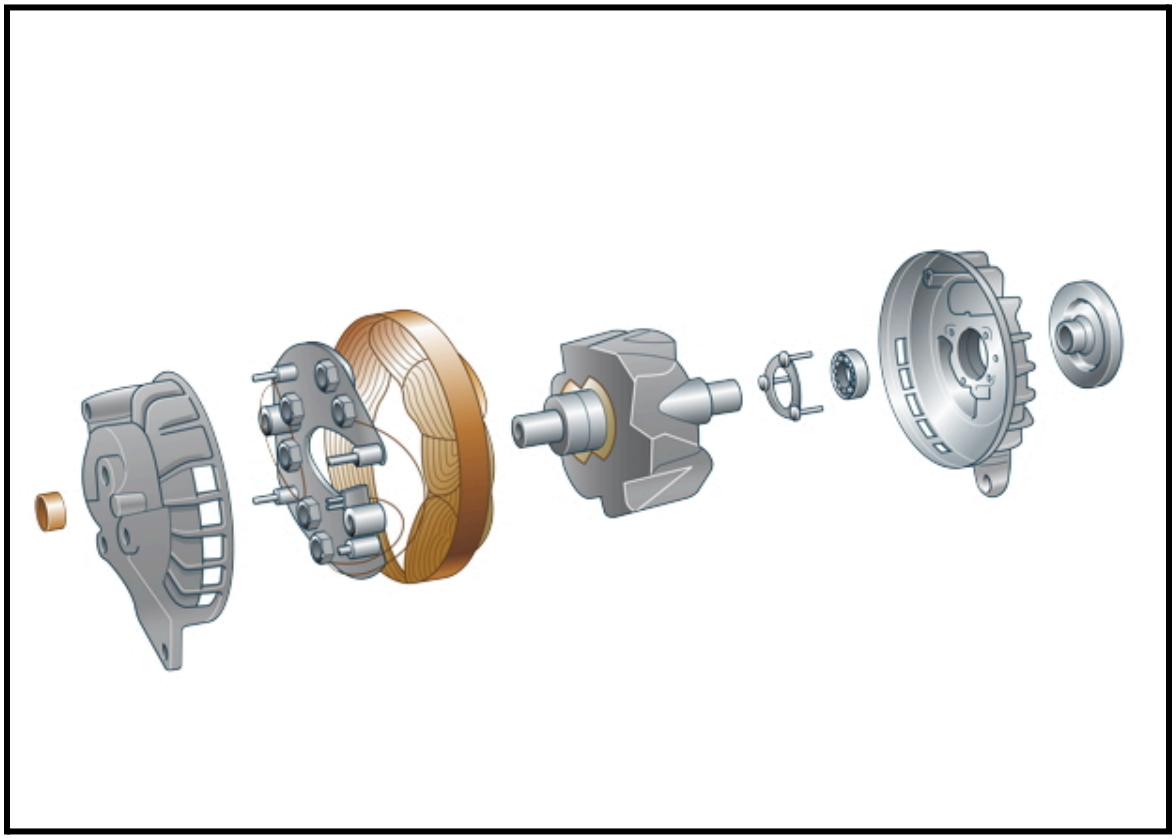
References

[Georgia State University: Simple Machines]

Outcome #8 - Activity 4

Automotive alternators

by How It Works Team · 12/05/2013
https://www.howitworksdaily.com/automotive-alternators/



Alternators are electromechanical devices that convert mechanical energy into alternating-current (AC) electrical energy. This process is useful in an automotive context as it allows the vehicle to self-charge its battery while being driven.

In an automotive alternator, the mechanical energy is delivered by the vehicle's crankshaft, which rotates. This rotational energy is passed via a drive belt and pulley to the alternator, and replicates it in an internal rotor shaft.

The turning of the alternator's rotor shaft causes an attached iron core, surrounding field winding and set of staggered magnetic claw poles to rotate at high speed (up to thousands of times per minute). This entire assembly is referred to as the alternator's rotor, with it slotting into another element called the stator.

The alternator's stator is a laminated soft iron, roughly spherical component wrapped with, typically, three sets of copper phase windings. The stator, unlike the rotor, is fixed

in place, attached to the inside of the alternator's housing. As mentioned, the rotor sits within the stator while it spins, with the two offset slightly to avoid any direct contact. As the rotor assembly rotates the staggered magnetic claw poles (with north and south poles alternating) generate a magnetic field. Because the field lines continuously change, however – due to the north-south polarity of the claw poles – the flux within the stator changes too, inducing an alternating current to flow through its phase windings.

As the current in the stator's phase windings is alternating, it needs to be converted into direct current (DC) for use in battery charging. This is achieved by feeding the alternating current in each phase winding through stator leads and into a set of diodes (two for each lead). Known as rectifiers, these diodes ensure that current flows in a single direction.

The total flow of direct current from each of the phase windings combined is controlled by a regulator unit. This prevents an excess of direct current from being fed into the vehicle's battery – something that if left unchecked would cause it to overcharge and potentially explode.

Outcome #8 - Activity 5, Article 1

Air Brakes vs Hydraulic Brakes? Which One Does Your Truck Use?

Iron Buffalo Truck and Trailer - February 21, 2025
https://www.ironbuffalohd.com/articles/air-brakes-vs-hydraulic-brakes-which-one-does-your-truck-use

Modern diesel trucks are available with two different options of braking systems. One system is hydraulic brakes, whereas the other is air brakes. As an operator or fleet owner, you need to be aware of the best braking system required by your truck. This is a crucial topic since the answer directly influences vehicle safety, price, driver pool availability, and operational expenses.

To help guide the brake selection process, we'll outline the different braking systems, including how they function, the proper vehicle size and application for each, and other considerations.

What are hydraulic brakes?

Fluid is used to power hydraulic brakes. When the driver presses the brake pedal, the hydraulic fluid pressure rises to the point where the brake pistons at each wheel are forced to push the brake pad against the drum (or rotor in the case of disc brakes),

causing friction, slowing the wheels, and eventually bringing the vehicle to a complete stop.

The technology for hydraulic brakes is quite similar to that used in passenger vehicles, and the components are substantially more significant in order to accommodate larger weight standards.

What are air brakes?

As the name indicates, air brakes utilize air to provide stopping power rather than fluid. The brakes are deactivated when the air tanks are completely inflated. When the driver presses the brake pedal, air enters the braking chamber, prompting the chamber diaphragm, spinning the "S-cam," and finally pushing the brake pads on the brake drum the truck to a halt. The air is then released when the brake pedal is retracted, enabling the brakes to relax and the wheels to roll. The compressor restores the original air pressure in the system.

Air brakes vs. Hydraulic brakes

The unmistakable hiss of air coming off a large rig as it pulls to a halt next to you can be heard all over any major city and on roads nationwide. However, have you ever wondered why semi-trucks use air brakes? Why aren't they able to utilize hydraulic brakes like smaller vehicles?

It all boils down to resource availability and dependability. The more weight a vehicle has, the more probable it can deploy air brakes. Small automobile brake lines need hydraulic fluid to be supplied and maintained manually, while air is readily available and ready to be utilized in any truck braking system. But that's just one of the reasons they're so popular in the business.

Let's start with an explanation of how air brakes operate. A compressor fills storage tanks to a predetermined pressure, which a governor controls. A valve ensures that air only flows in one direction via the pipe, ensuring that the air tanks do not leak even if the compressor does. The air is then sent into the brake lines, where pressure variations (due to the brake pedal being pressed) are utilized to move a sequence of rods, cams, and brake components as required while driving.

Furthermore, if the brake line in the hydraulic system leaks, the whole system will fail since it will be unable to refill the pressure required to engage the brakes and slow the wheels. Hydraulics are just too risky to employ in a fully loaded truck or other heavy-duty equipment since their default setting does not slow the vehicle the same.

They're also inconvenient: at a GVWR of around 26,000 lbs., the required equipment becomes too heavy, inefficient, and too hot to be usable during semi-truck operation.

Why do semi-trucks, on the other hand, utilize air brakes?

The "inactive" option on these systems is closed, which means that if all of the pressure suddenly drops below 45 psi, the brakes will immediately engage. They use extremely powerful springs behind pistons that stretch out and keep all drive wheels in place until an air pressure of roughly 65 psi drives the pistons back into driving position. Semi-trucks and other tractor-type vehicles must have this emergency system for obvious reasons: they are safer overall, and their stopping strength is substantially larger.

These emergency brakes are engaged by a simple switch on the dash, allowing the pressure to be released and the springs to take over, bringing the vehicle to a complete stop. Furthermore, a single truck may manage numerous trailers, allowing the driver to apply standard brakes for all trailers at the same time – and if the tractor splits from the others, all emergency parking brakes shut immediately.

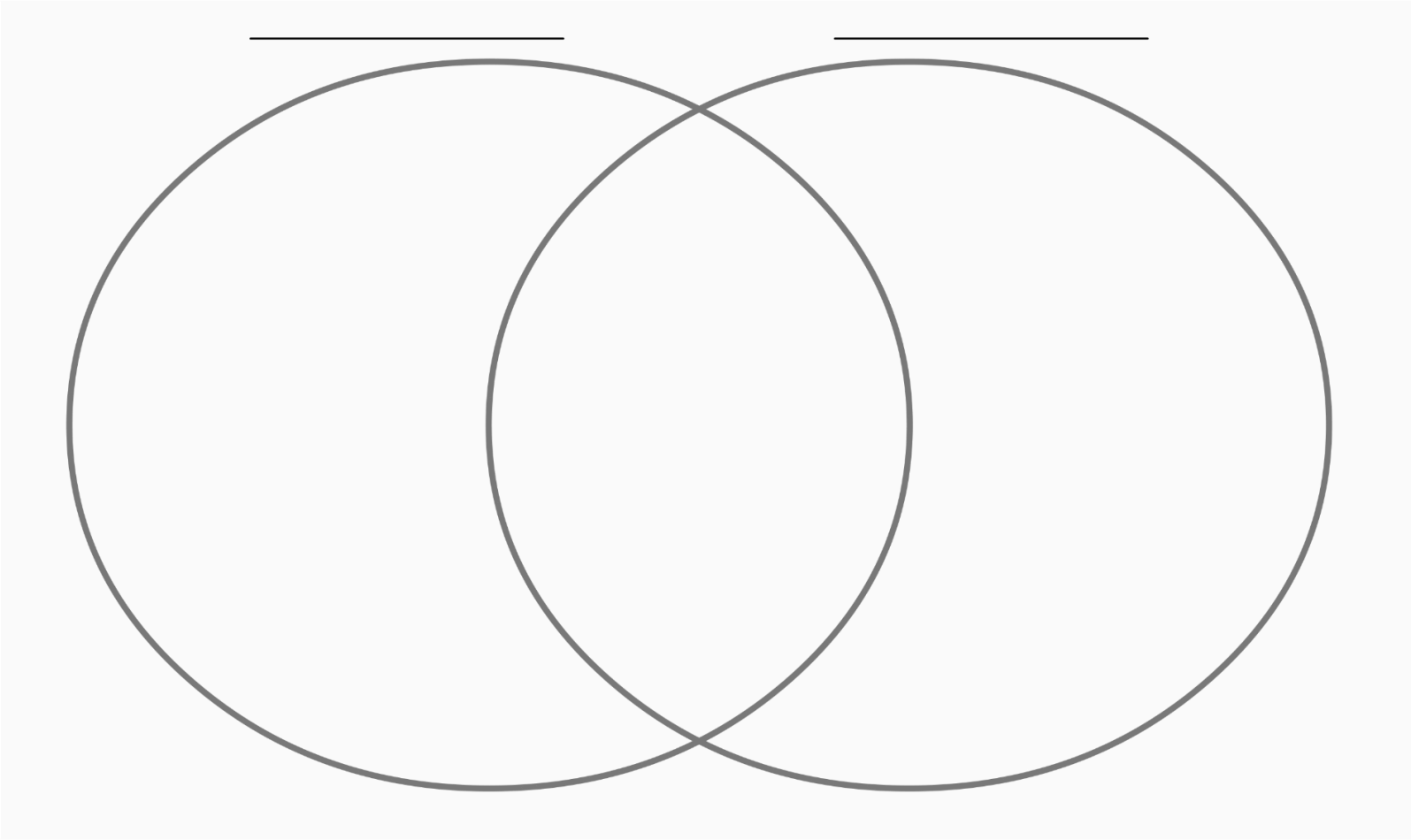
If the lines are opened during maintenance on a hydraulic system, the whole system must be flushed out and the damaged line replaced to guarantee no air remaining (because the bubbles would react differently than the fluid inside, causing unexpected shifts in pressure). With air brakes, on the other hand, you need to repair a leaky or defective line, which saves you a lot of time and effort. Dual air brake systems, in which each axle has its own set of lines and storage tanks, may reduce the need to go through the whole system during maintenance.

Is there a disadvantage to employing air brakes?

One is a buildup of water vapor in the pipes, which may create problems if it freezes during winter driving. This can be prevented with good maintenance and air dryers and drain valves. Because huge trucks' brakes don't transmit braking force as well, it may take a bit longer for them to slow down. Another factor to consider is that air brakes can only be used by drivers with a Class 1 license, requiring further training, knowledge, and financial compensation. But none of these drawbacks are significant compared to the tremendous increases in safety and dependability of air brake systems in semi-trucks and other commercial vehicles, as well as the fact that they are intended to leap into action even in the worst-case situation.

Outcome #8 - Activity 5

Venn Diagram



Outcome #8 - Activity 6

How to Operate a Forklift: Mastering Backing Up, Parking, and More

Art Merino, Forklift Academy, 2025
https://www.forkliftacademy.com/how-to-operate-a-forklift-mastering-backing-up-parking-and-more/

Operating a forklift might seem straightforward, but there's a lot more to it than hopping in and driving off. From understanding the controls to mastering safety techniques, it's a skill that takes time and practice. Whether you're new to forklifts or just need a refresher, this guide will help you get the hang of it. And if you're looking to get certified, Forklift Academy has affordable training options that meet OSHA standards.

Key Takeaways

- Always secure your seatbelt and follow startup procedures to ensure safety.
- Mastering load balance and proper fork positioning is critical for smooth operation.
- Properly parking and shutting down the forklift prevents accidents and extends its lifespan.

Mastering Forklift Controls and Safety

Understanding the Dashboard and Pedals

Before you even start the forklift, you need to get to know its dashboard and pedals. These are your main tools for operating the machine. Most dashboards include a fuel gauge, oil pressure gauge, temperature gauge, and hour meter. Each one has a specific purpose, like monitoring fuel levels or tracking engine temperature. Pay close attention to warning lights—they're there to alert you to potential issues like low brake fluid or overheating.

When it comes to pedals, you'll typically find an accelerator and a brake, similar to a car. Some forklifts also have an inching pedal, which lets you move slowly while keeping the engine running at higher speeds. This is especially useful for precise operations like aligning the forks with a pallet. Always start your forklift with the parking brake engaged and make sure all controls are in the neutral position.

Familiarizing Yourself with Lifting Mechanisms

The lifting controls are what make a forklift, well, a forklift. These usually include levers or knobs for raising and lowering the forks, tilting the mast, and sometimes adjusting the fork width. Some models even allow you to shift the forks side to side for better alignment. Before using these controls, make sure you know your forklift's load capacity. Overloading the forks isn't just risky—it's a recipe for tipping over.

When lifting a load, position the forks evenly under the pallet and tilt the mast slightly backward. This gives the load extra stability. Never raise or lower the forks while the forklift is moving. If you're unsure about any control, consult your operator's manual or ask a seasoned coworker for advice.

Ensuring Proper Visibility During Operation

Visibility is key to operating a forklift safely. Always check your surroundings before moving, especially in busy areas. If your load blocks your view, drive in reverse to maintain a clear line of sight. Use your mirrors and, if available, backup alarms to help you stay aware of your environment.

Here are a few tips to improve visibility:

- Make eye contact with pedestrians and other operators when possible.
- Use the horn to alert others when entering blind spots or crossing intersections.

- Keep your headlights on in low-light conditions or warehouses with poor lighting.

By staying vigilant and practicing these habits, you reduce the risk of accidents and create a safer work environment.

Techniques for Lifting and Transporting Loads

Positioning Forks for Stability

Getting the forks in the right position is the first step to safely lifting and moving a load. Always approach the load slowly and squarely to ensure proper alignment. Once you're about 8–12 inches away, stop and double-check that the forks are level and at the correct height. Slide them fully under the load—ideally, at least two-thirds of the load's length. If the load is uneven or oddly shaped, adjust the forks to balance the weight as evenly as possible. For tightly packed pallets, be cautious not to push the forks through to the other side, as this could snag another pallet or cause damage.

Balancing and Securing Loads

A balanced load is a safe load. Center the weight between the forks to prevent tipping or instability. If the load is off-center and can't be adjusted, place the heavier side closer

to the forklift's mast for better control. Use tools like a fork positioner if your forklift has one, or manually adjust the forks as needed. Once the load is lifted slightly off the ground, tilt the mast back a bit to secure it against the backrest. For high-stacking tasks, always place heavier items on the bottom and lighter ones on top to avoid overloading the stack.

Avoiding Common Load Handling Mistakes

Mistakes during load handling can lead to accidents like tip-overs, dropped loads, or collisions. Here are some common errors to watch out for and how to avoid them:

- Overloading the forklift: Know your forklift's load capacity and never exceed it. Remember, capacity decreases if the load isn't centered.
- Lifting without clearance: Always ensure there's enough overhead space before raising the forks. Low ceilings, beams, or other obstacles can be a hazard.
- Moving too quickly: Approach, lift, and lower loads at a controlled pace. Sudden movements can destabilize the forklift or the load.
- Ignoring load inspections: Always check for damaged pallets or loose items before lifting. Secure any unstable materials with straps or bands.

By mastering these techniques, you'll minimize risks and ensure that loads are transported safely and efficiently. For additional safety tips, check out these essential forklift safety and maintenance guidelines and pallet handling best practices.

Safe Maneuvering and Navigation

Driving in Reverse with Limited Visibility

Operating a forklift in reverse can be tricky, especially when your view is blocked by a load. Always prioritize safety by maintaining a clear line of sight. If your visibility is obstructed, use mirrors or ask a spotter to guide you. Here are some tips for driving in reverse:

- Turn your head and shoulders to look behind you instead of relying solely on mirrors.
- Drive slowly and steadily to maintain control.
- Use the horn to alert others of your movement, especially in busy areas.
- If equipped, ensure the backup alarm is functional to warn pedestrians.

Navigating Tight Spaces and Corners

Forklifts are built to handle tight spaces, but it still takes skill to maneuver safely. Rear-wheel steering allows for sharper turns, but it also means the back end swings wide. To avoid accidents:

1. Slow down when approaching corners or narrow aisles.
2. Keep the forks low to the ground to maintain stability.
3. Center the load on the forks to prevent tipping.
4. Be aware of your surroundings and use your horn to signal your presence.

Pay close attention to load positioning, especially in narrow aisles, as improper placement can lead to accidents or inefficiencies.

Operating on Inclines and Declines

Driving on slopes requires extra caution. When moving uphill or downhill:

- Always keep the load uphill to prevent it from sliding off the forks.
- Drive straight up or down the incline—never at an angle.
- Use low speeds and avoid sudden stops or starts.
- If you need to stop on an incline, engage the parking brake and ensure the forklift is secure before proceeding.

By following these practices, you'll minimize risks and ensure smoother operations.

Proper Parking and Shutdown Procedures

Selecting a Safe Parking Area

Parking your forklift in the right spot is not just about convenience—it's about safety. Start by picking a flat, stable surface to park on. Avoid slopes, as even a slight incline can make the forklift roll if not secured properly. Never park in high-traffic zones or block aisles and exits, as this could lead to accidents or obstruct emergency pathways. If your workplace has designated parking areas for forklifts, make sure to use them. Following these steps minimizes risks and keeps the work environment organized.

Engaging the Parking Brake and Lowering Forks

After stopping the forklift, shift the controls into neutral. This ensures that the machine won't accidentally move forward or backward. Next, engage the parking brake firmly to lock the forklift in place. Lower the forks completely to the ground, as this reduces tripping hazards and removes pressure from the hydraulic system. If you're on a slight incline or decline, consider using wheel blocks for added security.

Shutting Down the Forklift Safely

When it's time to turn off the forklift, follow these steps for a safe shutdown process:

1. Double-check that the parking brake is engaged.
2. Lower the forks to the ground if you haven't already.
3. Turn off the ignition and remove the key to prevent unauthorized use.

For diesel forklifts, always engage the parking brake and lower the forks before shutting down the engine. This ensures stability and safety. If the forklift is disabled and the forks can't be lowered, follow lockout/tagout procedures to secure the machine.

By following these procedures, you ensure that the forklift is parked securely and ready for its next use. It's a small effort that pays off by keeping both people and equipment safe.

Conclusion

Operating a forklift may seem daunting at first, but with the right training and consistent practice, it becomes second nature. Always prioritize safety—both yours and those around you—by following proper procedures and staying alert. Remember, a well-trained operator not only ensures smooth operations but also prevents accidents and costly mistakes. If you're looking to get certified or improve your skills, Forklift Academy offers affordable and comprehensive training programs to help you meet OSHA standards and excel in your role. Take the first step today and become a confident, safety-conscious forklift operator.

Frequently Asked Questions

How do I start a forklift safely?

Begin by approaching the forklift from the left side. Secure your seatbelt, engage the parking brake, and ensure all controls are in neutral. Once ready, start the engine and let it warm up before moving.

What are the key steps to safely lift and transport a load?

Position the forks evenly under the load, making sure it's balanced and secure. Tilt the mast slightly backward for stability, and keep the load low while moving. Avoid sudden stops or sharp turns to prevent tipping.

How should a forklift be parked properly?

Choose a flat, safe area away from traffic. Lower the forks to the ground, engage the parking brake, and place all controls in neutral. Turn off the engine and remove the key to ensure it's safely parked.