



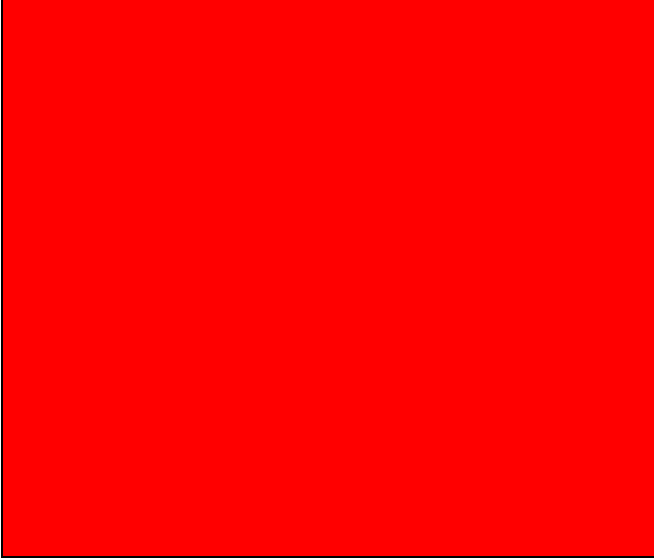
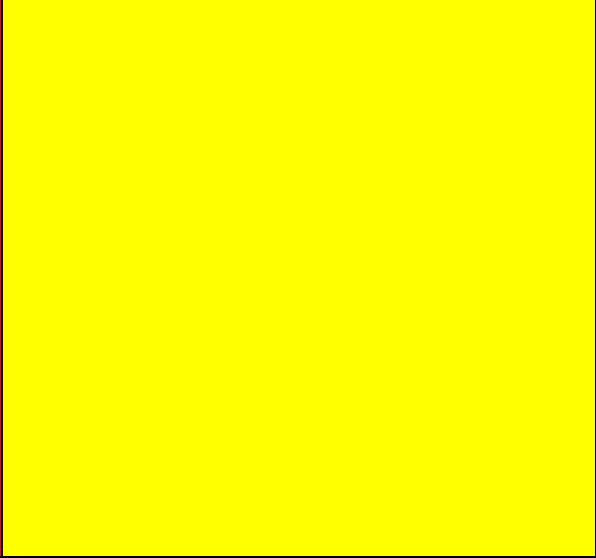


Statewide
Manufacturing Bridge
Science Activities &
Resources

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| <p>https://www.mysafetysign.com/biohazard-symbol-iso-warning-sign/sku-is-2023</p> | <p>https://www.safety signs.co.za/shop/fb2-sabs-fire-extinguisher-safety-sign-1289#attr=199</p> |
| <p>Dangerous – Prohibition – Stop – Shutdown</p> | <p>Warning – Take Precautions – Be Careful</p> |

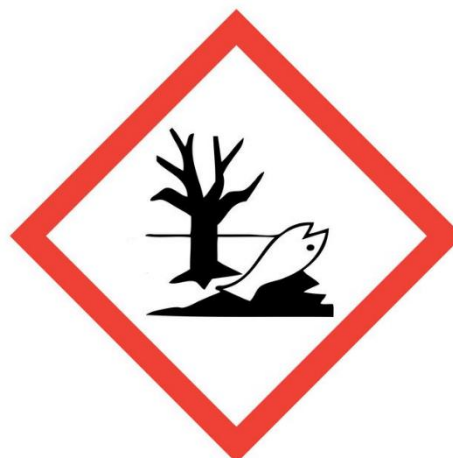
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| <p>Fire Extinguisher</p> | <p>Biohazard</p> |
| <p>Corrosive</p> | <p>Flammable</p> |

| | |
|---|---|
| <p>Toxic</p> | <p>Wear Protective Gear</p> |
| <p>Emergency Escape- First Aid</p> |  |
|  | <p>Explosive</p> |

Hazardous to the Environment

<https://ehs.princeton.edu/news/know-your-hazard-symbols-pictograms>

<https://ehs.princeton.edu/news/know-your-hazard-symbols-pictograms>



Eye Protection Information

Phototropic (photochromic) lenses change depth of tint when exposed to varying degrees of ultraviolet light—that is, they darken when exposed to sunlight and fade when removed from the sunlight. These lenses do comply with current American National Standards Institute (ANSI) Z87.1 standards with limitations.

Photochromic lenses have limitations in operations requiring critical visual acuity or fast reaction to visual stimuli, particularly in operations where the wearer passes from outdoors to indoors in the course of his/her work activity. Also, these types of lenses should not be used as a substitute for the proper protection in hazardous optical radiation environments, for example, certain laboratory and shop operations such as welding or foundry work.

If an individual must wear **tinted lenses**, as prescribed by an eye specialist, industrial quality eye and face protection devices appropriate for the hazard involved should also be worn.

Posting of Eye Hazardous Areas

The entrance to all shops, laboratories or other areas that require industrial quality eye protection should be posted with a sign indicating the requirements. In addition, machines, equipment or process areas and laboratories requiring operators to wear specific eye and face protection should be posted with warning signs.

Visitors must wear the protective devices that are required in the area. Extra devices should be available at all times to lend to visitors. Devices called “visitors specs” do not meet ANSI standards.

Fitting and Maintenance

Safety eyewear must be fitted properly. It should be the responsibility of the person in charge of dispensing safety glasses or goggles to see that properly fitted and adjusted eyewear is provided for each individual.

Lenses of eye protectors must be kept clean. Restricted vision due to dirty lenses is sometimes a contributing factor to accidents. Eye protective devices that are shared shall be disinfected between uses.

Cleaning and Disinfecting Procedures

The following cleaning procedures are recommended in the ANSI Z87.1. Products shall be cleaned according to the manufacturer's instructions. If none are available, clean with mild soap and warm water solution by soaking the device in the soap solution maintained at 120°F for 10 minutes. Rinse thoroughly and allow to air dry. Use appropriate glove protection and other personal protective equipment as required of hazardous and combustible standards apply.

To disinfect, completely immerse the protector for 10 minutes in a solution of modified phenol, hypochlorite, quaternary ammonium compound or other disinfections reagent in a strength specified by the manufacturer of the protective equipment at room temperature of 20°C (68°F).

Remove protector from solution and suspend in a clean, dry place for air-drying at room temperature or with heated air. Do not rinse because this will remove the residual effect of the disinfectant.

Spray type disinfectant solutions and bactericides may be utilized when such pressurized spray solutions can be demonstrated to provide comparable disinfections with the immersion procedure outlined above. Store dry devices in a clean, dustproof container or area.

Protectors showing the need for extensive cleaning should be disassembled to the extent possible without tools prior to the washing and disinfections procedure.

We recommend each student have their own pair of safety glasses and goggles to reduce spread of eye disease.

Inspection of Protectors

Instructors and students should make a visual inspection of their eye protectors prior to use. Protective devices with broken parts, heat distortion, or excessive scratches on the lens are unsuitable for use and should not be worn. Pitted and scratched lenses may reduce vision and also, along with worn-out headbands, seriously reduce protection. Replace defective parts with new ones.

Eye Protective Devices



**The illustrations shown are only representative of protective devices commonly available at the time of the writing of this standard. Protective devices do not need to take the forms shown, but they must meet the requirements of the standard.

NOTES

1. Care shall be taken to recognize the possibility of multiple and simultaneous exposure to a variety of hazards. Adequate protection against the highest level of each of the hazards must be provided.
2. Operations involving heat may also involve optical radiation. Protection from both hazards shall be provided.
3. Face shields shall only be worn over primary eye protection.
4. Filter lenses shall meet the requirements for shade designations.

5. Persons whose vision requires the use of prescription (Rx) lenses shall wear either protective devices fitted with prescription (Rx) lenses or protective devices designed to be worn over regular prescription (Rx) eyewear.
6. Wearers of contact lenses shall also be required to wear appropriate covering eye and face protection devices in a hazardous environment. It should be recognized that dusty and/or chemical environments might represent an additional hazard to contact lens wearers.
7. Caution should be exercised in the use of metal frame protective devices in electrical hazard areas.
8. Welding helmets or hand shields shall be used only over primary eye protection.
9. Nonsided shield spectacles are available for frontal protection only.

American National Standard Institute Z87.1

Reprinted from *American National Standards Practice for Occupational and Educational Eye and Face Protection*, ANSI Z87.1.

MFG Eye Protection Guided Reading Notes

1. Why are phototropic (photochromic – transition darkening lenses) not a substitute for safety glasses? List three reasons:

| | |
|---|--|
| 1 | |
| 2 | |
| 3 | |

2. Where would you find the posting of eye hazardous areas? List two specific places mentioned that require posting of eye hazardous areas.

| | |
|---|--|
| 1 | |
| 2 | |

3. Who is responsible to make sure your safety eyewear fits properly?

4. How can safety eyewear contribute to accidents?

5. What should happen when safety eyewear is shared?

6. What can you use at home to clean your safety eyewear?

7. What should you look for when inspecting safety eyewear before use? List two issues and the problems they may cause.

| | |
|---|--|
| 1 | |
| 2 | |

8. If you wear prescription lenses or contact lenses, how can you protect your eyesight?

9. Why should you not wear metal framed eyewear in electrical hazard areas?

MFG Eye Protection Guided Reading Notes ANSWER KEY

1. Why are phototropic (photochromic – transition darkening lenses) not a substitute for safety glasses? List three reasons:

| | |
|---|--|
| 1 | Do not comply with ANSI (American National Standards Institute Z87.1 |
| 2 | There are limitations in operations requiring critical visual acuity. (The ability of the eye to distinguish shapes and the details of an object) |
| 3 | Does not protect eyes in hazardous optical radiation environments, welding, or foundry work. |

2. Where would you find the posting of eye hazardous areas? List two specific places mentioned that require posting of eye hazardous areas.

| | |
|---|--|
| 1 | Entrance to shops, laboratories, and other places requiring quality eye protection |
| 2 | Machines, equipment or process areas in shops and laboratories |

3. Who is responsible to make sure your safety eyewear fits properly?

It is the responsibility of the person in charge of dispensing safety eyewear. If you must provide your own – then the owner of the safety eyewear.

4. How can safety eyewear contribute to accidents?

Dirty lenses can contribute to restricted vision, as well as scratches.

5. What should happen when safety eyewear is shared?

If you share safety eyewear, then they need to be disinfected between each use.

6. What can you use at home to clean your safety eyewear?

Mild soap and water at 120 0 – soak for 10 minutes. OR

A disinfecting solution provided by the manufacturer.

7. What should you look for when inspecting safety eyewear before use? List two issues and the problems they may cause.

| | |
|---|--|
| 1 | Pitted and scratched lenses can cause visual distortion |
| 2 | Broken parts and heat distortion can cause the safety eyewear to not fit properly. |

8. If you wear prescription lenses or contact lenses, how can you protect your eyesight?

Purchase protective, safety eyewear with your prescription or wear safety eyewear over your glasses or contact lenses. If you wear contact lenses in a dusty environment or one with chemical exposure, you may need safety eyewear and a face shield/protection device.

9. Why should you not wear metal framed eyewear in electrical hazard areas?

Could increase the likelihood of a shock or arc flash into the electrical area.

FIRE PREVENTION

The best defense against a fire is to prevent a fire from starting in the first place. Although many products stored in a warehouse or work area are not flammable, some packaging types commonly used today, such as cardboard, foam compositions, and paper packing are definite fire hazards. In addition, some of the chemicals you work with may be able to start or feed a fire. And, faulty wiring can start an electrical fire in any workplace.

You need to know what to do to keep fires from starting, as well as how to deal with a fire emergency.

Where Are the Regulations?

The Occupational Safety and Health Administration (OSHA) regulates several aspects of fire prevention and response. Fire prevention plans are addressed in 29 CFR 1910.39. In addition, the provisions for fire extinguishers and other protection are addressed at 29 CFR 1910.157.

What Kind of Fire Is It?

The National Fire Protection Association (NFPA) has classified five general types of fires, based on the combustible materials involved and the kind of extinguisher needed to put them out. The five fire classifications are A, B, C, D, and K.

General Classes of Fires

Class A. This type of fire is the most common. The combustible materials are wood, cloth, paper, rubber, and plastic. The common extinguishing agent is water, but dry chemicals are also effective.

Class B. Flammable liquids, gases, and greases create class B fires. The most common extinguisher to use is dry chemical. Also, foam and carbon dioxide extinguishers can be used.

Class C. Because class C fires are electrical fires, use a nonconducting agent to put them out, for example, carbon dioxide and dry chemical extinguishers. Never use foam or water-type extinguishers on these fires.

Class D. Fires arising from combustible metals, such as magnesium, titanium, zirconium, and sodium are categorized as class D fires. These fires require specialized techniques to extinguish them. None of the common extinguishers should be used. Use dry powder extinguishers specific for the metal hazard present on these fires.

Class K. Fires resulting from the combustion of cooking oils and fats are class K fires. Commercial kitchens usually have special extinguishers for class K fires.

Multi-purpose extinguishers (ABC) will handle all A, B, and C fires. **Be sure to read the label.**

Housekeeping to Prevent Fires

The importance of good housekeeping ties in closely with fire prevention. If you allow debris or flammable material to accumulate, the risk of starting a fire increases. Everyone must help to keep the work area clutter-free and safe from other fire hazards, such as improperly used or stored chemicals.



Fire Checklist

When a fire starts, think first of your safety and the safety of others. Alert the fire department. Try to put out the fire only if you have been trained to use extinguishers and the fire is small and tame enough to be extinguished by a hand-held extinguisher.

When the fire is spreading quickly, the combustible material is unknown, or you have not been trained in the proper use of extinguishers, leave the fire fighting to professionals with the proper equipment. In this case, sound the fire alarm, and evacuate.

If the fire can be contained or extinguished, a **properly trained person should use the right extinguisher on the fire.**

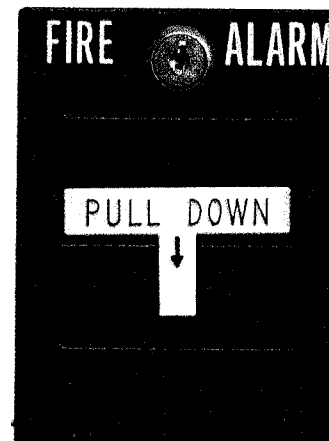
When using a typical extinguisher, follow the "PASS" method. Hold the extinguisher upright, and:

- Pull the pin; stand back eight to ten feet.
- Aim at the base of the fire.
- Squeeze the handle.
- Sweep at the base of the fire with the extinguishing agent.

Remember, too, that most extinguishers have a very limited operation time, only 8-10 seconds, so you have to act fast and spray

correctly at the base of the fire.

Know the location of fire alarms and extinguishers. Know your nearest fire exit, and proceed to it in an orderly fashion.



Smoke and fumes can leave a person unconscious. All fires consume oxygen to burn. Most victims of a fire suffocate from lack of oxygen and die. They are already unconscious or dead before the flames reach them.

Inside a building that is in flames, get to your hands and knees and crawl to an exit. This is important because smoke and heat rise rapidly, and you will inhale less smoke near the floor. Outside, get upwind of the smoke.

The Chemical Fire

Many of the thousands of chemicals in use in the workplace are both highly toxic and highly volatile. Extreme caution must be used to prevent and fight fires resulting from chemical spills and accidents. Know the hazards of the chemical substances you use on the job and how to handle and store them properly to prevent dangerous chemical fires.

Chemical Hazards

Chemicals can cause serious injuries through physical (fire or explosion) or health (burns or poisons) hazards. Many chemicals have inherent properties that make them very hazardous.

They might include:

- **Flammability** — These chemicals catch fire very easily.
- **Reactivity** — A reactive material can undergo a chemical reaction under certain conditions; reactive substances can burn, explode, or release toxic vapor if exposed to other chemicals, air, or water.
- **Explosivity** — An explosive can undergo a very rapid chemical reaction producing large amounts of gas and heat.

As a result of these properties, chemicals can produce fires that start and spread quickly.

Flammable Liquid Handling and Storage

Flammable liquids give off ignitable vapors. Also, nearly all flammable liquid vapors are heavier than air and will accumulate in low areas with poor ventilation. When they accumulate sufficiently, they spread and can travel to an ignition source. These ignition sources might be cigarettes, a hand tool that sparks, a cutting torch, or a motor.

Storage

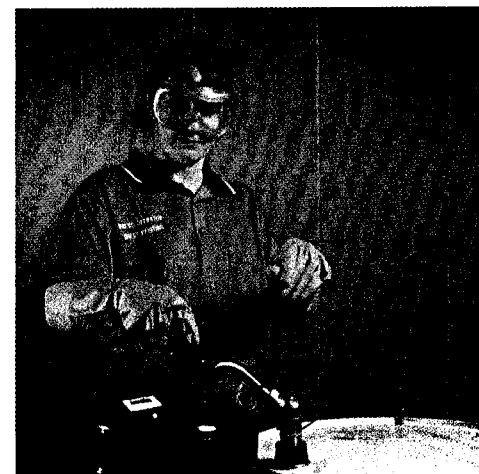
The typical plant stores flammable liquids in two ways: reserve storage in drums and operational storage in small quantities (for use at work stations.) For reserve storage safety, as soon as a drum is unloaded, the bung cap should be replaced with a drum vent; this prevents pressure build-up if the drum is exposed to heat. Proper vents also incorporate emergency relief devices, which blow out under extreme pressure.

Drums should also be connected to a grounding system; this eliminates static electrical build-up when dispensing from the drum. If your plant does not have a drum storage room, drums should be stored in a safety cabinet; they are available in sizes to hold drums vertically or horizontally.

Transfer

Liquids can be dispensed from drums by two methods: gravity flow from drums stored horizontally, and pumping from drums stored vertically.

For gravity flow safety, liquids are dispensed into a safety can using a self-closing drum valve. OSHA requires the use of approved safety cans for transfer purposes.



A drip can should be placed under the valve to catch spills and leaks. The drip can and receiving container must be bonded to the drum to draw off any static electrical charge.

The pump method is faster, empties the drum almost completely, and saves space because drums are stored vertically. Drip cans are not required. Bond the receiving containers if the pump hoses are not self-bonding.

Mobile solvent tanks (liquid caddies) are used to distribute flammable liquids to work stations using large production line equipment. They are equipped with rubber wheels, a measuring pump, and a self-bonding hose.

Use

Use safety cans to hold and dispense flammable liquids as you work. There are many work station cans from which to choose. Keep containers closed when not in use, and put containers back into safety cabinets for storage.

Disposal

Disposing of waste flammable liquids requires proper procedures. Oily, solvent-soaked rags can easily start a fire. To prevent this, specially designed waste cans should always be used for temporary storage. These cans have spring-loaded lids and a raised bottom with vent holes to dispense heat. Collect waste flammable liquids in approved liquid disposal cans.

Dipping and Coating Operations Using Flammable Liquids

A dip tank means a container holding a liquid other than water and that is used for dipping or coating. Examples of dipping and coating operations are paint dipping, electroplating, pickling, quenching, tanning, degreasing, stripping, cleaning, roll coating, flow coating, and curtain coating.

Dip tanks for flammable and combustible liquids are designed and installed with fire prevention safeguards, but employees need to be aware of some other fire prevention procedures:

- To prevent sparks that can cause fires, electrical wiring and electrical equipment used in the area of the dip tank must be approved for a hazardous location.
- If portable containers are used to pour flammable or combustible liquids into the dip tank, there is a risk that the pouring action could cause sparks due to static electricity discharge. To prevent this, wires must be used to ground and bond portable containers to the dip tank.
- The dip tank area must be kept free of any combustible debris. Rags contaminated with flammable or combustible liquids must be placed in approved waste cans immediately after use. The waste must be properly disposed of at the end of each shift.
- Smoking is prohibited near dip tanks containing flammable or combustible liquids.
- Fire extinguishers must be available in the area.

There are other safe procedures to follow in any dipping or coating operation:

- Dip tanks must be emptied and ventilated before cleaning. Employees who enter a dip tank must follow permit-required confined space entry procedures, as applicable.
- If ventilation does not adequately reduce exposures to hazardous chemicals, employees will need to wear respirators and follow the procedures of the employer's Respiratory Protection Program.
- Employees need to know first aid procedures that are appropriate to the hazards of the operation.
- If the liquids could harm employees' skin, the employer must provide storage space for employees' street clothes, an emergency shower and eye wash station, and basins with hot-water faucets.

Spill Cleanup

Only specially trained emergency response team members may respond to an emergency release or spill.

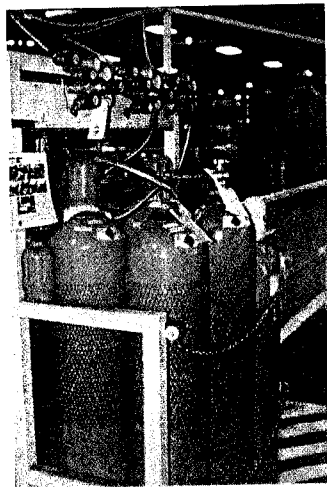
Specially designed absorbent materials have been developed for spill cleanup. These products are offered in pillows, pads, sheets, tubes, and other shapes to fit all cleanup needs. Once the absorbent material is saturated, it should be placed in a large disposal drum and sealed with a drum cover. Another spill cleanup technique involves the use of specialized vacuum equipment.



Compressed and Liquefied Gases

To avoid fires resulting from ignition of compressed gases:

- Never roll or drag cylinders when gases are stored, transported, or used. Use a hand cart or truck specially designed for gas cylinders.
- Store all cylinders upright and secure them to walls or bench tops during storage or use.
- Compressed gases should be stored in dry, cool and well ventilated areas, protected from the weather,



and away from flammable materials. The area should be posted for no smoking.

- Keep compressed gas cylinders which contain oxygen away from oil, grease, or liquid flammables.
- Separate fuel and oxidizing gas cylinders by at least 20 feet or a fire wall.
- Be very careful about fittings or connections. Before any connections are made, inspect the cylinder carefully. Do not change, modify, repair, or tamper with pressure relief devices on cylinders.
- When more information, advice, or help is needed, call the gas supplier; when in doubt about handling, contents, or cylinder condition, seek an expert's advice.

Work at Working Safely

Prevention is the key to eliminating fire hazards:

1. Keep work areas clean and clutter-free.
2. Know how to handle and store the chemicals you work with.
3. Know what you are expected to do in case of a fire emergency.
4. Make sure you are familiar with your facility's emergency action plan for fires.

Safe at Home

It's fairly common for local laws to require homes to have smoke and carbon monoxide detectors installed. This valuable equipment can give you and your family precious time to escape from a fire. Everyone should plan ahead on how the family will evacuate from a fire in the home. Just as you probably have fire drills at work, it's a good idea to practice your home evacuation plan, too. If you hear an alarm, take it seriously and leave the building quickly.

FIRE

To help prevent fires at home:

- Minimize collections of papers, cardboard, and other combustible materials.
- Have a fire extinguisher available, and periodically check to ensure it's properly charged and ready for use.
- Keep your exit routes clear (for example, make sure children put away their toys).
- Supervise children when they help you cook.
- Don't leave candles, fireplaces, or cigarettes unattended, and be sure to extinguish them if you're feeling sleepy.
- If you need to use flammable liquids for a home improvement project, buy only the amount you'll need, and properly dispose of any excess.

1. What must be present to produce fire?

2. Complete the following chart with information on the five general types of fires.

| Class | Color | Symbol | Type of Fire | Type of Fire Extinguisher | Materials in These Types of Fires |
|--------------|--------------|---------------|---------------------|----------------------------------|--|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

3. What is the best way to prevent fires at home and in the workplace?

4. Read the Fire Checklist section on page 53. Summarize and create a 6 step fire checklist.

| Step | Checklist |
|------|-----------|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

5. What are the hazardous properties that chemicals have that can cause serious injuries?

| | | |
|----|----|----|
| 1. | 2. | 3. |
|----|----|----|

6. Where should chemicals be stored to prevent fires?

7. How are liquid chemicals transferred from their containers?

8. What is used to safely hold and dispense flammable liquids?

9. What is used for disposing of flammable liquids?

10. Who is needed to respond to an emergency chemical spill?

11. What are the four steps to working safely in the workplace?

| Step | Action |
|------|--------|
| 1 | |
| 2 | |
| 3 | |
| 4 | |

12. Why should you have a home evacuation plan?

13. List three ways you can prevent fires at home.

1.

2.

3.

1. What must be present to produce fire?

2. Complete the following chart with information on the five general types of fires.

| Class | Color | Symbol | Type of Fire | Type of Fire Extinguisher | Materials in These Types of Fires |
|-------|--------|----------------------------|--|--|---|
| A | Green | Flame | Common household fire | Water – dry chemicals | Wood, cloth, paper fires |
| B | Red | Gas can & flames | Ignitable vapors Spread easily | Foam and carbon dioxide Dry chemicals | Flammable liquids, gases and greases |
| C | Blue | Electrical socket & outlet | Electrical equipment | Dry chemical | Electrical shorts, power lines, wiring, electrical panels |
| D | Yellow | Solid with flams on top | Combustible metals Found in foundries and factories | Dry powder | Magnesium titanium, sodium |
| K | black | Pan with a fire on top | Kitchen fires | Special extinguishers | Cooking oils and fats |

3. What is the best way to prevent fires at home and in the workplace?

Good housekeeping

4. Read the Fire Checklist section on page 53. Summarize and create a 6-step fire checklist. *Answers could vary*

| Step | Checklist |
|------|---|
| 1 | Safety first – yourself and others. Alert everyone to leave, including yourself – sound the fire alarm |
| 2 | Alert the fire department |
| 3 | If the fire is small , try to put out with fire extinguisher if you have been trained on it – otherwise leave for fire department |
| 4 | Know the location of the fire extinguishers |
| 5 | Get trained in using the fire extinguisher |
| 6 | Once outside, get upwind of the smoke and fire for safety. |

5. What are the hazardous properties that chemicals have that can cause serious injuries?

| | | |
|--------------------|------------------|-------------------|
| 1. Flammability | 2. Reactivity | 3. Explosivity |
|--------------------|------------------|-------------------|

6. Where should chemicals be stored to prevent fires?

Reserve storage tanks or drums in a designated storage area

7. How are liquid chemicals transferred from their containers?

Gravity flow from drums

Pumping from drums stored vertically.

8. What is used to safely hold and dispense flammable liquids?

Safety can

9. What is used for disposing of flammable liquids?

Specially designed waste cans

10. Who is needed to respond to an emergency chemical spill? **Trained emergency response teams**

11. What are the four steps to working safely in the workplace?

| Step | Action |
|------|--|
| 1 | Keep work area clean and clutter free |
| 2 | Know how to handle and store chemicals you work with |
| 3 | Know what you are expected to do in case of a fire emergency |
| 4 | Make sure you are familiar with your facility's emergency action plan for fires |

12. Why should you have a home evacuation plan?

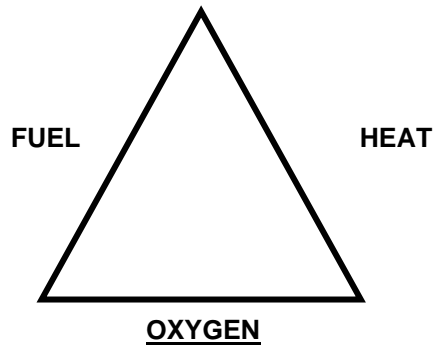
In case of a fire or other type of emergency that makes the building unsafe.

13. List three ways you can prevent fires at home.

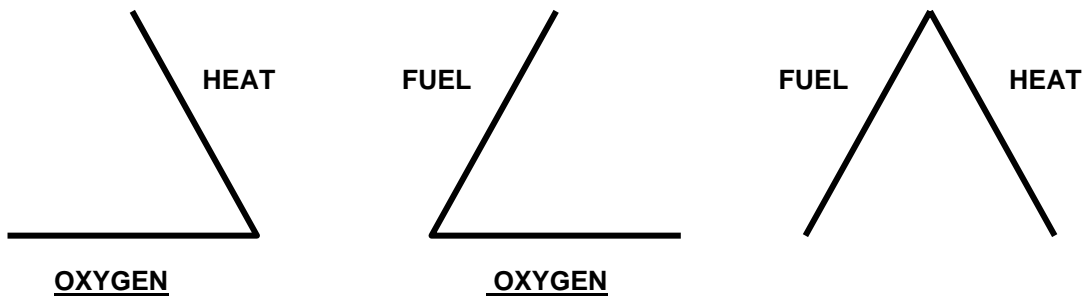
Minimize collections of paper and trash, supervise children when cooking, keep exit routes clear, don't leave open fires unattended – answers will vary

The Fire Triangle

To produce fire, three things must be present at the same time.



If any one of the three is missing, a fire cannot be started; or with the removal of any one element, the fire will be extinguished.



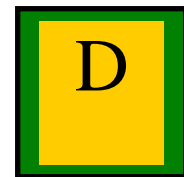
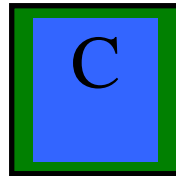
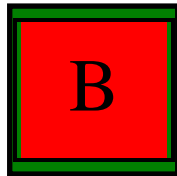
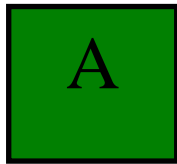
Standard Letter Symbols for Fire Extinguishers

GREEN

RED

BLUE

YELLOW



**ORDINARY
COMBUSTIBLES**

**FLAMMABLE
LIQUIDS**

**ELECTRICAL
EQUIPMENT**

**COMBUSTIBLE
METALS**

Distinctive letters, shapes, and colors mark extinguishers according to the classes of fires on which they should be used.

Types of Fire Extinguishers



Dry Chemical extinguishers are usually rated for multipurpose use. They contain an extinguishing agent and use a compressed, nonflammable gas propellant.



Halon or halatron extinguishers contain a gas that interrupts the chemical reaction that takes place when fuels burn. These types of extinguishers are often used to protect valuable electrical equipment since they leave no residue to clean up.



Water extinguishers contain water and compressed gas and should be used on Class A (ordinary combustibles) fires.



Carbon Dioxide (CO₂) extinguishers are most effective on Class B and C (liquids and electrical) fires. Since the gas disperses quickly, these extinguishers are only effective from 3 to 8 feet. The carbon dioxide is stored as a compressed liquid in the extinguisher.

This Is Your New ABCDs of Portable Fire Extinguishers

A fire extinguisher is a storage container for an extinguishing agent such as water or chemicals. It is designed to put out a small fire, not a big one.

An extinguisher is labeled according to whether the fire on which it is to be used occurs in wood or cloth, flammable liquids, electrical, or metal sources. Using one type extinguisher on another type fire can make the fire much worse. So learn how extinguishers are labeled and used.

Traditionally the labels A, B, C, or D have been used to indicate the type of fire on which an extinguisher is to be used.

Recently pictograms have come into use. These picture in blue the type of fire on which an extinguisher is to be used. Shown in black with a red slash are pictures of fires on which the extinguisher is not to be used. For example, on a class “A” type, the following symbols would appear:



NFPA 10, Standard for Portable Fire Extinguishers, recommends that extinguishers be labeled with pictograms. However, the user may find the traditional A, B, C, D labels or both the pictograms and the A, B, C, D labels on an extinguisher.

You need an extinguisher at home.

If you plan to buy one extinguisher, a multipurpose dry chemical labeled ABC puts out most types of fires—wood, paper, and cloth, flammable liquid, or electrical fires.

If you buy more than one, you might want to get a BC for the kitchen, an A for the living room, and an ABC for the basement or garage.

Fire extinguishers where you work.

It is *management's* job to have extinguishers available for use and *your* job to know how they work.

Buying and maintaining an extinguisher.

1. Extinguishers come in dry chemical, foam, carbon dioxide, water or halon types. Whatever type you buy, a testing laboratory should label it.

2. The higher the number rating on the extinguisher, the more fire it puts out. High-rated ones are often (not always) the heavier models. Make sure you can hold and operate the one you buy for home use or be required to use at work.
3. Ask your dealer how to have your extinguisher serviced and inspected. Recharge it after ANY use. A partially used extinguisher might as well be empty.
4. Extinguishers should be installed away from potential fire hazards and near an escape route.

ABCDs



Class A—Extinguish ordinary combustibles by cooling the material below its ignition temperature and soaking the fibers to prevent re-ignition.

Fires in paper, cloth, wood, rubber, and many plastics require a water-type extinguisher labeled A.



Class B—Extinguish flammable liquids, greases or gases by removing the oxygen, preventing the vapors from reaching the ignition source or inhibiting the chemical chain reaction.

Fires in oils, gasoline, some paints, lacquers, grease in a frying pan or in the oven, solvents, and other flammable liquids require an extinguisher labeled B.



Class C—Extinguish energized electrical equipment by using an extinguishing agent that is not capable of conducting electrical currents.

Fires in wiring, fuse boxes, energized electrical equipment, and other electrical sources require an extinguisher labeled C.



Class D—Extinguish combustible metals such as magnesium, titanium, potassium, and sodium with dry powder extinguishing agents specially designated for the material involved.

Combustible metals such as magnesium and sodium require special extinguishants labeled D.

Science
Outcome 2

Supply & Demand: How Markets Work

The two basic terms used most often by economists are *supply* and *demand*. The amount of something that is available (the *supply*) and the amount of something that people want (the *demand*) make up a working market. The market is the way in which an economic activity is organized between buyers and sellers through their behavior and interaction with one another. Buyers, as a group, determine the overall demand for a particular product at various prices while sellers, as a group, determine the supply of a particular product at various prices.

The interaction of buyers and sellers in the market helps to determine the market price, thereby allocating scarce goods and services efficiently. The price is taken into account when deciding how much of something to consume, and also how much to produce. The relationship between price and quantity demanded is so universal that it is called the *law of demand*. This law states that with all else equal, when the price of goods rise, the quantity demanded falls - and when the price falls, the quantity demanded rises. The *supply curve* provides the opposite information: the higher the price, the higher the quantity supplied - and the lower the price, the lower the quantity supplied.

A key function of the market is to find the equilibrium price when supply and demand are in balance. At this price, the goods supplied are equal to what is being demanded thereby bringing about the most efficient allocation of the goods. An efficient allocation of goods in a market is one in which no one can be made better off unless someone else is made worse off.

There are influences other than price, however, that can play a role in keeping the market from being truly efficient and at equilibrium.

Variables that Influence Buyers (Demand)

- Price
- Income
- Prices of related goods
- Tastes
- Expectations
- Number of Buyers

Variables that Influence Sellers (Supply)

- Price
- Input prices
- Technology
- Expectations
- Number of Sellers

On the demand side, income can play a significant role. As income rises, people will buy more of some goods or even begin to purchase higher quality or more expensive goods. The price of related goods can also alter demand. For example, if the price of one cereal increases, demand will likely switch to a similar cereal, which would be considered *substitute* goods. If the goods are considered to be *complimentary*-- or are typically used together--a decrease in the price of one of the goods will increase the demand for another. Examples of complimentary goods are cars and gasoline, where the price of gasoline depends partly on the number of cars. Personal tastes and expectations of the future also influence individual demands as does the number of buyers. An increase in buyers vying for a specific number of goods will increase the demand and likely increase the overall purchase price.

On the supply side, both expectations and the number of sellers can influence the number of goods produced. In addition, the cost of producing the goods--or the input prices--and the level of technology used to turn the inputs into goods greatly influence the final price and quantity supplied.

Although most economic analyses focus on finding the market equilibrium, there exist a number of other market forms. When it comes to the utilization of natural resources or other environmental quality amenities, it is often difficult to find the equilibrium through mere market pricing since they are not true market goods. Efficiency would require maximizing current costs and benefits of using or extracting natural resources while taking into consideration future costs and benefits, including the intrinsic and existence value of the resources. When the market fails to allocate the resources efficiently, market failure can occur. An example of this is the creation of externalities which often occurs when clear property rights are absent, as with air and some water resources. Attempts to promote efficiency and bring the market back into equilibrium can be through market options, like economic incentives and disincentives, or the establishment of property rights, or through government intervention.

Updated by Dawn Anderson

Recommended Resources

Price Theory, Lecture 2: Supply and Demand

Glen Whitman, an Associate Professor of Economics at California State University, Northridge, compiled information on his website based on his lecture notes. He includes principles of supply and demand, constructing the market, and various types of competition.

Supply and Demand

An excellent summary on the topic by Wikipedia, the free encyclopedia.

Introduction to Economic Models of Natural Resource Utilization

Richard Kazmierczak, Jr., an Associate Professor at Louisiana State University compiled this information based on his class in Natural Resource Economics.

Demand

Willingness and ability of the consumer to purchase a given amount of a good or service at a given price.

| Variables/Determinants | | |
|---|------------------------------|-------------------------------|
| Income | Demand | Shifts on Demand Curve |
| Goes up | Increases for normal goods | Right |
| Goes down | Decreases for normal goods | Left |
| Goes up | Decreases for inferior goods | Left |
| Goes down | Increases for inferior goods | Right |
| Prices of Related Goods | Demand | Shifts on Demand Curve |
| Substitute price goes up | Increases | Right |
| Substitute price goes down | Decreases | Left |
| Compliment price goes up | Decreases | Left |
| Compliment price goes down | Increases | Right |
| Tastes | Demand | Shifts on Demand Curve |
| Preference for goods increase | Increases | Right |
| Preference for goods decrease | Decreases | Left |
| Expectations | Demand | Shifts on Demand Curve |
| Anticipate more income, higher future prices, more popularity, etc. | Increase | Right |
| Anticipate less income, lower future prices, less popularity, etc. | Decrease | Left |
| Number of Buyers | Demand | Shifts on Demand Curve |
| Increase | Increases | Right |
| Decreases | Decreases | Left |

Supply

Sellers/Manufacturers willingness to offer a good or service for a given price.

| Variables/Determinants | | |
|--|------------------|------------------------------|
| Inputs | Supply | Shift on Supply Curve |
| Labor, materials, infrastructure increases | Less is supplied | Left |
| Labor, materials, infrastructure decreases | More is supplied | Right |
| Technology | Supply | Shift on Supply Curve |
| Reduces cost | Increase | Right |
| Increases cost | Decrease | Left |
| Expectations | Supply | Shift on Supply Curve |
| Anticipate higher prices | Decrease | Left |
| Anticipate lower prices | Increase | Right |
| Number of Sellers | Supply | Shift on Supply Curve |
| Number of sellers increase | Supply increases | Right |
| Number of sellers decrease | Supply decreases | Left |

Globalization and Its Impact on Manufacturing Facilities

<https://www.planettogether.com/blog/globalization-and-its-impact-on-manufacturing-facilities>

The concept of globalization has been around for several decades now, and it has had a profound impact on the way we live, work, and do business. As the world becomes more connected, manufacturing facilities are facing new challenges and opportunities that require them to adapt to changing global trends. In this blog, we will explore the impact of globalization on manufacturing facilities and discuss strategies that businesses can use to thrive in the global marketplace.

What is Globalization?

Globalization is the process of integrating economies, societies, and cultures through the exchange of goods, services, information, and people. The rise of global trade and communication has enabled businesses to expand their reach beyond their domestic markets and tap into new opportunities around the world. This has led to increased competition, but it has also opened up new markets and allowed companies to take advantage of economies of scale.

The Impact of Globalization on Manufacturing Facilities

Globalization has had a significant impact on manufacturing facilities. Here are some of the keyways in which globalization has affected the manufacturing industry:

1. **Increased competition:** As businesses expand their reach globally, they face increased competition from companies around the world. This can put pressure on manufacturing facilities to lower costs, improve efficiency, and differentiate themselves from their competitors.
2. **Access to new markets:** Globalization has opened up new markets for manufacturing facilities to sell their products. This can provide new opportunities for growth and expansion.
3. **Supply chain complexity:** As companies source materials and components from around the world, supply chains have become more complex. This can increase the risk of disruptions and require manufacturing facilities to manage their supply chains more carefully.
4. **Cultural differences:** Doing business in different parts of the world requires an understanding of cultural differences. Manufacturing facilities need to be able to adapt their products and processes to meet the needs of different cultures.
5. **Technological advancements:** Globalization has also led to technological advancements that have transformed the manufacturing industry. Automation, robotics, and artificial intelligence are just a few examples of technologies that are changing the way manufacturing facilities operate.

Strategies for Thriving in the Global Marketplace

To thrive in the global marketplace, manufacturing facilities need to be able to adapt to changing global trends. Here are some strategies that businesses can use to succeed in the global marketplace:

1. **Embrace technology:** Manufacturing facilities that embrace technology can improve efficiency, reduce costs, and stay ahead of the competition. Investing in automation, robotics, and artificial intelligence can help manufacturing facilities stay competitive in the global marketplace.

Globalization and Its Impact on Manufacturing Facilities

<https://www.planettogether.com/blog/globalization-and-its-impact-on-manufacturing-facilities>

2. Focus on quality: As competition increases, manufacturing facilities need to differentiate themselves by focusing on quality. Providing high-quality products and services can help businesses build a reputation for excellence and stand out in a crowded marketplace.
3. Manage supply chains carefully: With supply chains becoming more complex, manufacturing facilities need to manage their supply chains carefully to reduce the risk of disruptions. This can include diversifying suppliers, building redundancy into the supply chain, and using technology to track and manage the supply chain.
4. Cultivate cultural intelligence: Manufacturing facilities that do business in different parts of the world need to be able to understand and adapt to cultural differences. This can include hiring local employees, partnering with local businesses, and adapting products and processes to meet the needs of different cultures.
5. Build strong partnerships: Building strong partnerships with suppliers, customers, and other stakeholders can help manufacturing facilities succeed in the global marketplace. Strong partnerships can provide access to new markets, reduce costs, and provide a competitive advantage.

Globalization has had a profound impact on manufacturing facilities, and it has created both challenges and opportunities for businesses. By embracing technology, focusing on quality, managing supply chains carefully, cultivating cultural intelligence, and building strong partnerships, manufacturing facilities can succeed in the global marketplace. As the world becomes more connected, businesses that adapt to changing global trends will be better positioned to thrive.

However, it is also important for businesses to be aware of the potential downsides of globalization. One of the biggest challenges is the risk of outsourcing jobs to countries with lower labor costs. This can result in job losses in the home country and can create economic inequality.

Another potential downside is the environmental impact of global trade. As goods are transported around the world, they contribute to greenhouse gas emissions and other environmental problems. Manufacturing facilities need to be mindful of their environmental impact and take steps to reduce their carbon footprint.

RESOURCE

ARTICLE



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Effects of Economic Globalization

Globalization has led to increases in standards of living around the world, but not all of its effects are positive for everyone.

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Science Outcome 2

Bangladesh Garment Workers

The garment industry in Bangladesh makes clothes that are then shipped out across the world. It employs as many as four million people, but the average worker earns less in a month than a U.S. worker earns in a day.

PHOTOGRAPH BY MUSHFIQUL ALAM

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BACKGROUND INFO

VOCABULARY

Put simply, globalization is the connection of different parts of the world. In economics, globalization can be defined as the process in which businesses, organizations, and countries begin operating on an international scale. Globalization is most often used in an economic context, but it also affects and is affected by politics and culture. In general, globalization has been shown to increase the standard of living in developing countries, but some analysts warn that globalization can have a negative effect on local or emerging economies and individual workers.

A Historical View

Globalization is not new. Since the start of civilization, people have traded

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elsewhere. The Silk Road, an ancient network of trade routes used between Europe, North Africa, East Africa, Central Asia, South Asia, and the Far East, is an example of early globalization. For more than 1,500 years, Europeans traded glass and manufactured goods for Chinese silk and spices, contributing to a global economy in which both Europe and Asia became accustomed to goods from far away. Following the European exploration of the New World, globalization occurred on a grand scale; the widespread transfer of plants, animals, foods, cultures, and ideas became known as the Columbian Exchange. The Triangular Trade network in which ships carried manufactured goods from Europe to Africa, enslaved Africans to the Americas, and raw materials back to Europe is another example of globalization. The resulting spread of slavery demonstrates that globalization can hurt people just as easily as it can connect people.

The rate of globalization has increased in recent years, a result of rapid advancements in communication and transportation. Advances in communication enable businesses to identify opportunities for investment. At the same time, innovations in information technology enable immediate communication and the rapid transfer of financial assets across national borders. Improved fiscal policies within countries and international trade agreements between them also facilitate globalization. Political and economic stability facilitate globalization as well. The relative instability of many African nations is cited by experts as one of the reasons why Africa has not benefited from globalization as much as countries in Asia and Latin America.

Benefits of Globalization

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Globalization also gives organizations the opportunity to take advantage of lower labor costs in developing countries, while leveraging the technical expertise and experience of more developed economies.

With globalization, different parts of a product may be made in different regions of the world. Globalization has long been used by the automotive industry, for instance, where different parts of a car may be manufactured in different countries. Businesses in several different countries may be involved in producing even seemingly simple products such as cotton T-shirts.

Globalization affects services, too. Many businesses located in the United States have outsourced their call centers or information technology services to companies in India. As part of the North American Free Trade Agreement (NAFTA), U.S. automobile companies relocated their operations to Mexico, where labor costs are lower. The result is more jobs in countries where jobs are needed, which can have a positive effect on the national economy and result in a higher standard of living. China is a prime example of a country that has benefited immensely from globalization. Another example is Vietnam, where globalization has contributed to an increase in the prices for rice, lifting many poor rice farmers out of poverty. As the standard of living increased, more children of poor families left work and attended school.

Consumers benefit also. In general, globalization decreases the cost of manufacturing. This means that companies can offer goods at a lower price to consumers. The average cost of goods is a key aspect that contributes to increases in the standard of living. Consumers also have access to a wider

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increases in unhealthy food consumption and diabetes.

Downsides

Not everything about globalization is beneficial. Any change has winners and losers, and the people living in communities that had been dependent on jobs outsourced elsewhere often suffer. Effectively, this means that workers in the developed world must compete with lower-cost markets for jobs; unions and workers may be unable to defend against the threat of corporations that offer the alternative between lower pay or losing jobs to a supplier in a less expensive labor market.

The situation is more complex in the developing world, where economies are undergoing rapid change. Indeed, the working conditions of people at some points in the supply chain are deplorable. The garment industry in Bangladesh, for instance, employs an estimated four million people, but the average worker earns less in a month than a U.S. worker earns in a day. In 2013, a textile factory building collapsed, killing more than 1,100 workers. Critics also suggest that employment opportunities for children in poor countries may increase negative impacts of child labor and lure children of poor families away from school. In general, critics blame the pressures of globalization for encouraging an environment that exploits workers in countries that do not offer sufficient protections.

Studies also suggest that globalization may contribute to income disparity and inequality between the more educated and less educated members of a society. This means that unskilled workers may be affected by declining wages, which are under constant pressure from globalization.

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Regardless of the downsides, globalization is here to stay. The result is a smaller, more connected world. Socially, globalization has facilitated the exchange of ideas and cultures, contributing to a world view in which people are more open and tolerant of one another.

Video

CrashCourse: Globalization 1: The Upside: Crash Course World History #41

NPR: Planet Money Explores the Economics of T-Shirts

Articles & Profiles

Oxford Martin Programme on Global Development, University of Oxford: Our World in Data: Trade and Globalization

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4 EFFECTS OF GLOBALIZATION ON THE ENVIRONMENT



15 APR 2021

Tim Stobierski |  Contributors

 Business in Society, Global Business, Strategy

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Globalization—defined in the online course [Global Business](#) as the increased flow of goods, services, capital, people, and ideas across international boundaries—has brought many changes in its wake.

While globalization can impact society both positively and negatively, its effect on the environment is primarily negative. Here's a breakdown of how globalization impacts society and the environment and what business leaders can do to reduce negative consequences.

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HOW DOES GLOBALIZATION AFFECT SOCIETY?

The world has become more connected than ever before through the increase in technological advancements and economic integrations. Advanced economies are formed as domestic businesses transform into international ones and further contribute to the spread of technology around the world.

There are several benefits of globalization, such as increased international trade and cooperation and less international aggression. Social globalization—the sharing of ideas and information between countries—has led to innovation in the medical, technological, and environmental preservation industries.

Additionally, globalization has improved the quality of life in several developing nations. This includes implementing efficient transportation systems and ensuring accessibility to services such as education and healthcare.

However, globalization can also have negative effects on society, such as increased income inequality and substandard working conditions in developing countries that produce goods for wealthier nations. Income inequality is directly related to globalization as it further increases the gap between more advanced and developing areas of a nation. As a result, it can also increase the risk of societal violence.

Along with its societal effects, globalization has a lasting impact on the environment—and typically not a positive one.

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WHAT ARE THE EFFECTS OF GLOBALIZATION ON THE ENVIRONMENT?

1. Increased Transport of Goods

One of the primary results of globalization is that it opens businesses up to new markets in which they can sell goods and source labor, raw materials, and components.

Both of these realities mean finished products travel farther now than ever before—potentially halfway around the globe. In the past, products were more likely to be produced, sold, and consumed more locally. This increased transport of goods can impact the environment in several ways, including:

- **Increased emissions:** The farther a product travels, the more fuel is consumed, and a greater level of greenhouse gas emissions is produced. According to a report by the International Transport Forum, CO2 emissions from transport will increase 16 percent by 2050. These emissions contribute to pollution, climate change, and ocean acidification around the world and have been shown to significantly impact biodiversity.

- **Habitat destruction:** Transportation—especially when land-based—requires infrastructure like roads and bridges. The development of such infrastructure can lead to issues including habitat loss and pollution. The more ships that travel by sea, the greater the chances for major oil spills or leaks that damage the delicate marine environment.
- **Invasive species:** Every shipping container and vessel presents an opportunity for a living organism—from plants to animals to fungus—to hitch a ride to a new location where it can become invasive and grow without checks and balances that might be present in its natural environment.

2. Economic Specialization

One oft-overlooked side effect of globalization is that it allows nations and geographical regions to focus on their economic strengths, content in knowing they can turn to trading partners for goods they don't produce themselves. This economic specialization often boosts productivity and efficiency.

Unfortunately, overspecialization can threaten forest health and lead to serious environmental issues, often in the form of habitat loss, deforestation, or natural resource overuse. A few examples include:

- **Illegal deforestation in Brazil** due to an increase in the country's cattle ranching operations, which requires significant land for grazing
- **Overfishing in coastal areas** that include Southeast Asia, which has significantly contributed to reduced fish populations and oceanic pollution
- **Overdependence on cash crops**, such as coffee, cacao, and various fruits, which has contributed to habitat loss, especially in tropical climates

It's worth considering that globalization has allowed some nations to specialize in producing various energy commodities, such as oil, natural gas, and timber. Nations that depend on energy sales to fund a large portion of their national budgets, along with those that note "energy security" as a priority, are more likely to take intervening actions in the market in the form of subsidies or laws that make transitioning to renewable energy more difficult.

The main byproduct of these energy sources comes in the form of greenhouse gas emissions, which significantly contribute to global warming and climate change.

3. Decreased Biodiversity

Increased greenhouse gas emissions, ocean acidification, deforestation (and other forms of habitat loss or destruction), climate change, and the introduction of invasive species all work to reduce biodiversity around the globe.

According to the World Wildlife Fund's recent [Living Planet Report](#), the population sizes of all organisms—including mammals, birds, fish, amphibians, and reptiles—have decreased 68 percent since 1970. Latin America and Africa—two rapidly developing regions important to global trade—have seen disproportionate levels of biodiversity loss, especially among environmentally sensitive fish, reptiles, and amphibians.

While this decrease in biodiversity has many causes, it's widely believed that the issues listed above have contributed in part.

4. Increased Awareness

While many of globalization's environmental effects have been negative, its increase has heightened environmental awareness worldwide.

Greater connectivity and higher rates of international travel have made it easier than ever for individuals to see the effects of deforestation, habitat loss, and climate change on the environment. This, in turn, has contributed to new laws, regulations, and processes that limit negative effects.



THE ROLE OF BUSINESS

Globalization has allowed society to enjoy many benefits, including increased global cooperation, reduced risk of global conflict, and lower prices for goods and commodities. Unfortunately, it's also led to serious negative effects on the environment.

Because it isn't feasible for globalization to end or reverse, it's likely the situation will worsen until nations, governing bodies, and other organizations are compelled to implement laws and regulations that limit negative effects.

Businesses and industries that operate globally have an incentive to take whatever voluntary actions they can to reduce the potential for negative consequences. Doing so can not only give an organization greater control over its initiatives, but also be a powerful marketing and communication tool.

Investing in renewable energy and packaging, embracing responsible land-use management, and shifting goods production to be closer to the end customer are all viable options businesses can and should consider. The challenge lies in balancing a desire to embrace corporate social responsibility with the need to turn a profit and run a successful business.

Are you interested in breaking into a global market? Sharpen your knowledge of the international business world with our four-week Global Business course, and explore our other online courses related to business in society.

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About the Author

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Natural disasters and your supply chain



What type of natural disasters can affect your supply chain?

By their very nature, natural disasters are unpredictable and can have a devastating impact on your manufacturing supply chain. 123 Insight ourselves were at the mercy of such a disaster when our own offices were flooded over a bank holiday weekend in 2017, forcing the office to be closed for several week and staff working from home. So, what impact might natural disasters have on your manufacturing supply chains?

Disruption of Production Facilities

Science Outcome 2

Natural disasters such as flooding, earthquakes or wind damage can cause significant damage to production facilities, resulting in a halt in manufacturing operations and perhaps even a temporary shut-down of the facility, bringing production delays.

Delayed Delivery of Raw Materials and Finished Goods

The next link in the chain will be your transportation networks. Any disruption here will cause delays in delivering raw materials and finished goods. Floods and landslides can block roads, while hurricanes and typhoons will cause port closures, making it difficult for manufacturers to receive shipments of raw materials. The US, Japan and Australia have all seen their infrastructure hit hard, with events such as Hurricane Katrina, taking out roads and bridges. The Tohoku earthquake and subsequent tsunami damaged roads, ports, airports, and railways all along the north-eastern coast.

Cost increases

A by-product of these issues is that they are likely to lead to increased costs for manufacturers. For example, if a manufacturer's production facility is damaged, they may have to invest in repairs and equipment replacement. Additionally, manufacturers may have to pay more for transportation and logistics services, perhaps also finding alternative routes due to the disruption caused.

Reputational Damage

A side effect that is not always considered is that this can also lead to reputational damage. If you are unable to deliver products to customers, it can lead to customer dissatisfaction and damage to the manufacturer's reputation. Of course, this cuts both ways – if you have better management of your supply chain and have potential alternatives available should the worst happen, you'll be in a better position than your competitors to meet demand when it becomes more critical.

Contingency plans against natural disasters

It's worthwhile investing time to examine your exposure to supply chain issues of any kind. Not only will you be better-prepared when the worst happens, but this due diligence also helps you to ensure that your current methods and vendors are still competitive. Our own 'natural disaster' of 2017 did not impact on our customer base, as we already had mechanisms in place that meant that our IT infrastructure and telecoms were back up and running in under 60 minutes, with most customers unaware of any issues. The first time they heard about it was in a subsequent newsletter! A little planning goes a long way.

Summary

From disruption of production facilities to delayed delivery of raw materials and finished goods - manufacturers need to have robust contingency plans in place to mitigate the impact of natural disasters. By building resilience and redundancy into their supply chains, companies can minimize the impact of natural disasters and ensure business continuity when the unexpected rears its head.

Impact of Delivery Vehicles on the Environment

Directions

You will be comparing the carbon emissions of a conventionally fueled delivery vehicle to electric powered vehicles.

Part 1

- In groups of three, each student will choose one of the three gasoline powered delivery vehicles to drive.

| 2021 Ford Transit Connect Van FWD | 2021 Mercedes-Benz Metris (Cargo Van) | 2021 Ram Promaster City |
|---|--|---|
| <ul style="list-style-type: none"> 20 City MPG, 348-mile range Tailpipe CO₂ = 397 grams per mile | <ul style="list-style-type: none"> 19 City, unknown range Tailpipe CO₂ = 432 grams per mile | <ul style="list-style-type: none"> 21 City MPG, 386-mile range Tailpipe CO₂ = 374 grams per mile |

My Delivery Van: _____

- Each line on the data table below represents one delivery on your route. Each column represents one mile.
- At your turn, roll the dice, and add the numbers. This represents the total miles of the delivery. *Example: For the 1st delivery, you roll a 1 and a 2, which represents 3 miles. Color in three boxes for the 1st delivery.*
- Repeat step #3 for the rest of the deliveries (10 total).
- Add the miles driven for all ten deliveries and record on the line “Total miles driven”.

| Delivery | | | | | | | | | | | | |
|----------|--|--|--|--|--|--|--|--|--|--|--|--|
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |

Total Miles Driven: _____

6. Calculate the mass of CO₂ emitted by your delivery route. Use the following formula.

| | | | | |
|---------------------------|----------|---|----------|-----------------------------|
| Total Miles Driven | X | Tailgate CO₂ grams per mile | = | Grams CO₂ |
| | X | | = | |

Part 2

1. Your fleet manager has now decided to switch to electric-powered delivery vans to drive. Each person in your group should choose one electric-powered van to drive.

| 2022 Ford E-Transit Cargo Van | GM's BrightDrop EV600 Van | Rivian's Custom Amazon Electric Van |
|--|--|--|
| <ul style="list-style-type: none"> • 126-mile range • Tailpipe CO₂ = 0 grams per mile | <ul style="list-style-type: none"> • 250-mile range • Tailpipe CO₂ = 0 grams per mile | <ul style="list-style-type: none"> • 150-mile range • Tailpipe CO₂ = 0 grams per mile |

My Delivery Van: _____

2. Complete the following data table, rolling the dice, adding the numbers and marking the boxes as you did in Part 1, step #3.

| Delivery | | | | | | | | | | | | |
|-----------------|--|--|--|--|--|--|--|--|--|--|--|--|
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |

Total Miles Driven: _____

3. Calculate the mass of CO₂ emitted by your delivery route. Use the following formula.

| Total Miles Driven | X | Tailgate CO ₂ grams per mile | = | Grams CO ₂ |
|--------------------|---|---|---|-----------------------|
| | X | | = | |

Part 3

A vehicles range is how far it can travel before it needs to be fueled. Driving a gasoline powered vehicle just goes to the nearest fueling station, adds gasoline and it is ready to drive again.

An electric-powered vehicle needs to be plugged in to an appropriate charging station and allowed to recharge. This process can take 30 minutes to several hours.

1. Review your gasoline vehicles mile range. Did you exceed your mile range for your total miles driven?
2. Review your electric-powered vehicles mile range. Did you exceed your mile range for your total miles driven?
3. Brainstorm a list of pros and cons in your group for using an electric-powered vehicle.

| Pros | Cons |
|------|------|
| | |

4. Brainstorm a list of pros and cons in your group for using gasoline powered vehicles.

| Pros | Cons |
|-------------|-------------|
| | |

5. Which vehicle would be the better choice for a delivery company to choose? Explain.

Household Products Activity

Assignment: Observe the products at your table. List three of the active ingredients in each product. In class we will research the MSDS of the active ingredients in the household products you have listed. A sample has been provided for you.

| CHEMICAL PRODUCT | ACTIVE INGREDIENTS |
|------------------------------------|--|
| A. Lysol Disinfectant Spray | 1. Alkyl |
| | 2. Dimethyl Benzyl Ammonium Saccharinate |
| | 3. Ethanol |
| B. | 1. |
| | 2. |
| | 3. |
| C. | 1. |
| | 2. |
| | 3. |
| D. | 1. |
| | 2. |
| | 3. |

KMPozniak.03.2011

Material Safety Data Sheet (MSDS)

Objectives:

1. Explain what a Material Safety Data Sheet (MSDS) is.
2. Demonstrate an ability to obtain helpful information from an MSDS.
3. Know that an MSDS exists for every chemical and includes important emergency information.

Discussion:

Potential hazards occur in the workplace, and many of these hazards involve chemicals. Chemicals are not just found in the laboratory. Everything is composed of chemicals. People need to become aware of the possible hazards of chemicals exposed to them in the workplace, in school, in the home, and other places that they frequent.

The use of Material Safety Data Sheets (MSDS) helps employees, students, and others become more aware of potential chemical hazards. Although they have no standard for, the sheet usually contains information including chemical name, formula, physical and chemical data, flammability, other hazards, and disposal techniques. Before you use a particular chemical in this class or at work, you should become familiar with its MSDS.

Procedures:

1. Complete the list of active ingredients in household products from the samples provided.
2. Using your classroom computer, look up the active ingredients MSDS. HINT: type in the name of the active ingredient followed by MSDS.
3. Use the MSDS to help complete the following observations
4. Be prepared to share with classmates.

| | | |
|---|--|----------------------|
| 1 | Name of Chemical | |
| 2 | Chemical Formula | |
| 3 | List two hazards of this chemical | 1. _____ 2. _____ |
| 4 | List first aid measures if this chemical is spilled on your skin | |
| 5 | List first aid measures for your chemical if it is ingested | |
| 6 | List first aid measures if this chemical gets in your eyes | |
| 7 | List two physical or chemical properties of your chemical | 1. _____ 2. _____ |
| Incompatible means that the chemical should not come in contact with another chemical | | |
| 8 | What chemicals are incompatible with your chemical | |



SAMPLE MATERIAL SAFETY DATA SHEET



1. CHEMICAL PRODUCT

General Product Name: **Biodiesel (B100)**
Synonyms: Methyl Soyate, Rapeseed Methyl Ester (RME)
Product Description: Methyl esters from lipid sources
CAS Number: Methyl Soyate: 67784-80-9; RME: 73891-99-3;

2. COMPOSITION/INFORMATION ON INGREDIENTS

This product contains no hazardous materials.

3. HAZARDS IDENTIFICATION

Potential Health Effects:

INHALATION:

Negligible unless heated to produce vapors. Vapors or finely misted materials may irritate the mucous membranes and cause irritation, dizziness, and nausea. Remove to fresh air.

EYE CONTACT:

May cause irritation. Irrigate eye with water for at least 15 to 20 minutes. Seek medical attention if symptoms persist.

SKIN CONTACT:

Prolonged or repeated contact is not likely to cause significant skin irritation. Material is sometimes encountered at elevated temperatures. Thermal burns are possible.

INGESTION:

No hazards anticipated from ingestion incidental to industrial exposure.

4. FIRST AID MEASURES

EYES:

Irrigate eyes with a heavy stream of water for at least 15 to 20 minutes.

SKIN:

Wash exposed areas of the body with soap and water.

INHALATION:

Remove from area of exposure; seek medical attention if symptoms persist.

INGESTION:

Give one or two glasses of water to drink. If gastro-intestinal symptoms develop, consult medical personnel. (Never give anything by mouth to an unconscious person.)

5. FIRE FIGHTING MEASURES

Flash Point (Method Used): 130.0 C or 266.0 F min (ASTM 93)

Flammability Limits: None known

EXTINGUISHING MEDIA:

Dry chemical, foam, halon (may not be permissible in some countries), CO₂, water spray (fog). Water stream may splash the burning liquid and spread fire.

SPECIAL FIRE FIGHTING PROCEDURES:

Use water spray to cool drums exposed to fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Biodiesel soaked rags or spill absorbents (i.e. oil dry, polypropylene socks, sand, etc.) can cause spontaneous combustion if stored near combustibles and not handled properly. Store biodiesel soaked rags or spill absorbents in approved safety containers and dispose of properly. Oil soaked rags may be washed with soap and water and allowed to dry in

well ventilated area. Firefighters should use self-contained breathing apparatus to avoid exposure to smoke and vapor.

6. ACCIDENTAL RELEASE MEASURES SPILL CLEAN-UP PROCEDURES

Remove sources of ignition, contain spill to smallest area possible. Stop leak if possible. Pick up small spills with absorbent materials and dispose of properly to avoid spontaneous combustion (see unusual fire and explosion hazards above).

Recover large spills for salvage or disposal. Wash hard surfaces with safety solvent or detergent to remove remaining oil film. Greasy nature will result in a slippery surface.

7. HANDLING AND STORAGE

Store in closed containers between 50°F and 120°F.

Keep away from oxidizing agents, excessive heat, and ignition sources.

Store and use in well ventilated areas.

Do not store or use near heat, spark, or flame, store out of sun.

Do not puncture, drag, or slide this container.

Drum is not a pressure vessel; never use pressure to empty.

8. EXPOSURE CONTROL /PERSONAL PROTECTION

RESPIRATORY PROTECTION:

If vapors or mists are generated, wear a NIOSH approved organic vapor/mist respirator.

PROTECTIVE CLOTHING:

Safety glasses, goggles, or face shield recommended to protect eyes from mists or splashing. PVC coated gloves recommended to prevent skin contact.

OTHER PROTECTIVE MEASURES:

Employees must practice good personal hygiene, washing exposed areas of skin several times daily and laundering contaminated clothing before re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point, 760 mm Hg:>200°C

Volatiles, % by Volume: <2

Specific Gravity (H₂O=1): 0.88

Solubility in H₂O, % by Volume: insoluble

Vapor Pressure, mm Hg: <2

Evaporation Rate, Butyl Acetate=1: <1

Vapor Density, Air=1:>1

Appearance and Odor: pale yellow liquid, mild odor

10. STABILITY AND REACTIVITY

GENERAL:

This product is stable and hazardous polymerization will not occur.

INCOMPATIBLE MATERIALS AND CONDITIONS TO AVOID:

Strong oxidizing agents

HAZARDOUS DECOMPOSITION PRODUCTS:

Combustion produces carbon monoxide, carbon dioxide along with thick smoke.

11. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL:

Waste may be disposed of by a licensed waste disposal company. Contaminated absorbent material may be disposed of in an approved landfill. Follow local, state and federal disposal regulations.

12. TRANSPORT INFORMATION

UN HAZARD CLASS: N/A

NMFC (National Motor Freight Classification):

PROPER SHIPPING NAME: Fatty acid ester

IDENTIFICATION NUMBER: 144920

SHIPPING CLASSIFICATION: 65

13. REGULATORY INFORMATION:

OSHA STATUS:

This product is not hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1910.1200. However, thermal processing and decomposition fumes from this product may be hazardous as noted in Sections 2 and 3.

TSCA STATUS:

This product is listed on TSCA.

CERCLA (Comprehensive Response Compensation and Liability Act):

NOT reportable.

SARA TITLE III (Superfund Amendments and Reauthorization Act):

Section 312 Extremely Hazardous Substances:

None

Section 311/312 Hazard Categories:

Non-hazardous under Section 311/312

Section 313 Toxic Chemicals:

None

RCRA STATUS:

If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as a hazardous waste, (40 CFR 261.20-24)

CALIFORNIA PROPOSITION 65:

The following statement is made in order to comply with the California Safe Drinking Water and Toxic Enforcement Act of 1986. This product contains no chemicals known to the state of California to cause cancer.

14. OTHER INFORMATION:

This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any other process. Such information is to the best of the company's knowledge and believed accurate and reliable as of the date indicated. However, no representation, warranty or guarantee of any kind, express or implied, is made as to its accuracy, reliability or completeness and we assume no responsibility for any loss, damage or expense, direct or consequential, arising out of use. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use.

Biodiesel Sample Material Safety Data Sheet Questions



1. CHEMICAL PRODUCT

What is the General Product Name? _____

2. COMPOSITION/INFORMATION ON INGREDIENTS

Does this product contain hazardous materials? _____

3. HAZARDS IDENTIFICATION

List the potential health effects if you get Biodiesel in your eye.

4. FIRST AID MEASURES

If you get Biodiesel on your skin, what should you do?

5. FIRE FIGHTING MEASURES

What are the special fire fighting procedures for Biodiesel?

6. ACCIDENTAL RELEASE MEASURES SPILL CLEAN-UP PROCEDURES

If you have an accidental spill of Biodiesel, you should remove sources of ignition and _____

7. HANDLING AND STORAGE

You should store Biodiesel in closed containers between what temperatures?

8. EXPOSURE CONTROL/PERSONAL PROTECTION

What type of protective clothing should you wear when working with Biodiesel?

9. PHYSICAL AND CHEMICAL PROPERTIES

What is the appearance and odor of Biodiesel?

10. STABILITY AND REACTIVITY

Is Biodiesel stable? _____

11. DISPOSAL CONSIDERATIONS

You should follow _____ disposal regulations when dumping Biodiesel.

12. TRANSPORT INFORMATION

What is the shipping classification for Biodiesel? _____

13. REGULATORY INFORMATION

Is this product listed on TSCA (Toxic Substances Control Act)? _____

Biodiesel Sample Material Safety Data Sheet Questions



1. **CHEMICAL PRODUCT**

What is the General Product Name? Biodiesel

2. **COMPOSITION/INFORMATION ON INGREDIENTS**

Does this product contain hazardous materials? No

3. **HAZARDS IDENTIFICATION**

List the potential health effects if you get Biodiesel in your eye.

may cause irritation to eyes

4. **FIRST AID MEASURES**

If you get Biodiesel on your skin, what should you do?

Wash exposed area of the body with water and soap

5. **FIRE FIGHTING MEASURES**

What are the special fire fighting procedures for Biodiesel?

Use water spray to cool drums exposed to fire

6. ACCIDENTAL RELEASE MEASURES SPILL CLEAN-UP PROCEDURES

If you have an accidental spill of Biodiesel, you should remove sources of ignition and _____ contain spill to smallest area possible stop leak pick up spills with absorbent materials

7. HANDLING AND STORAGE

You should store Biodiesel in closed containers between what temperatures?
50 ° F and 120 ° F

8. EXPOSURE CONTROL/PERSONAL PROTECTION

What type of protective clothing should you wear when working with Biodiesel?
safety glasses goggles or face shield PVC coated gloves

9. PHYSICAL AND CHEMICAL PROPERTIES

What is the appearance and odor of Biodiesel?
pale yellow liquid, mild odor

10. STABILITY AND REACTIVITY

Is Biodiesel stable? yes

11. DISPOSAL CONSIDERATIONS

You should follow local, state, federal disposal regulations when dumping Biodiesel.

12. TRANSPORT INFORMATION

What is the shipping classification for Biodiesel? Fatty acid ester 65

13. REGULATORY INFORMATION

Is this product listed on TSCA (Toxic Substances Control Act)? yes

All matter can store heat. Different kinds of matter can store different amounts of heat. To begin this lesson, let's look at different states of matter with a SIM (interactive computer model).

Part 1 – States of Matter

Directions

1. Access this website: <https://phet.colorado.edu/en/simulations/states-of-matter-basics> .
2. Play with the SIM.
3. Answer the following questions.

Questions

1. Complete the chart using States of Matter to compare the characteristics of the three states of matter.

| Characteristics | Gases | Liquids | Solids |
|---|--------------|----------------|---------------|
| What happens when the atoms and molecules are heated? | | | |
| What happens to the atoms and molecules when cooled? | | | |

2. Switch to Phase Changes. Click on the Phase Diagram. Explain the correlation between pressure and temperature.

Part 2 – Specific Heat Capacity

Your task is to determine the relative specific heat capacities of four materials: brick, iron, olive oil and water. You will use a simulation to conduct the experiment, located here:

<https://phet.colorado.edu/en/simulation/energy-forms-and-changes>

Click the right-facing triangle inside the circle on the screenshot; it should play right in your web browser.

We're not looking to calculate the specific heat capacity; we're just trying to place the objects in the correct order, from lowest to highest values of c (heat capacity)

Please don't cheat by looking up these values somewhere. Play fair! You will be using a series of comparisons to determine their final order. Assume all materials have the same mass.

Before you begin, read through the directions, and record your results.

1. Click the "Intro" icon to start the simulation.
2. Click the "Link Heaters" box in the top-right part of the screen. This will ensure the two heaters give out the same amount of energy per second.
3. Place two different materials on the stands by clicking and dragging them there.
4. Click and drag a thermometer from the top-left corner of the screen onto each material. The thermometer is correctly placed when the left-facing triangle turns the same color as the material.
5. Click and hold one of the heater temperature controls, then drag it up towards "Heat" and hold it there. You should see the temperature change. When you let go of the heater slider, the materials will slowly cool down; if you need to heat them up again, just click, drag and hold the slider back up again.
6. When you're done, click the orange Reset button in the bottom-right corner of the screen. You will have to re-check "Link Heaters" and add new thermometers to each object.
7. Go through all the possible combinations of materials, compare results, and rank them from lowest to highest value of c .

| Lowest c | | | Highest c |
|------------|--|--|-------------|
| | | | |

INSTRUCTOR KEY

All matter can store heat. Different kinds of matter can store different amounts of heat. To begin this lesson, let's look at different states of matter with a SIM (interactive computer model).

Part 1 – States of Matter

Directions

1. Access this website: <https://phet.colorado.edu/en/simulations/states-of-matter-basics> .
2. Play with the SIM.
3. Answer the following questions.

Questions

1. Complete the chart using States of Matter to compare the characteristics of the three states of matter.

| Characteristics | Gases | Liquids | Solids |
|---|---|---|---|
| What happens when the atoms and molecules are heated? | Start to move faster, the space becomes greater between the molecules | Break apart and start to move faster, the space becomes greater between the molecules | Vibrate, start to break apart and move, the space becomes greater between the molecules |
| What happens to the atoms and molecules when cooled? | Molecules slow down | Molecules slow down | Molecules slow down |

2. Switch to Phase Changes. Click on the Phase Diagram. Explain the correlation between pressure and temperature.

The correlation is directly proportional. When one increases, so does the other.

Part 2 – Specific Heat Capacity

Your task is to determine the relative specific heat capacities of four materials: brick, iron, olive oil and water. You will use a simulation to conduct the experiment, located here:

<https://phet.colorado.edu/en/simulation/energy-forms-and-changes>

Click the right-facing triangle inside the circle on the screenshot; it should play right in your web browser.

We're not looking to calculate the specific heat capacity; we're just trying to place the objects in the correct order, from lowest to highest values of c (heat capacity)

Please don't cheat by looking up these values somewhere. Play fair! You will be using a series of comparisons to determine their final order. Assume all materials have the same mass.

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6. When you're done, click the orange Reset button in the bottom-right corner of the screen. You will have to re-check "Link Heaters" and add new thermometers to each object.
7. Go through all the possible combinations of materials, compare results, and rank them from lowest to highest value of c .

| Lowest c | | | Highest c |
|------------|-----------|------------|-------------|
| Water | Olive oil | Iron block | Brick |

Formulas Table 1

| | |
|---------|-------------------------|
| Density | Mass/Volume |
| Mass | Density x Volume |
| Volume | Length x Width x Height |

1. Obtain a sample block. Weigh the block to the nearest tenth of a gram on the electronic scale balance. Record the mass in table 2.
2. Measure the length, width, and height of the sample block in cm and record in table 2.
3. Calculate the density of sample block using the formula from Table 1. Record in Table 2.
4. Repeat for the remaining sample blocks.

Table 2

| Sample | Mass (g) | L (cm) | W(cm) | H(cm) | Volume (cm ³) | Density (g/cm ³) |
|---------------|----------|--------|-------|-------|---------------------------|------------------------------|
| Copper (Cu) | | | | | | |
| Aluminum (Al) | | | | | | |
| Brass (Br) | | | | | | |

| Sample | Mass (g) | L (cm) | W(cm) | H(cm) | Volume (cm ³) | Density (g/cm ³) |
|-----------|----------|--------|-------|-------|---------------------------|------------------------------|
| Iron (Fe) | | | | | | |
| Acrylic | | | | | | |
| Nylon | | | | | | |
| Pine | | | | | | |
| Maple | | | | | | |
| Poplar | | | | | | |
| PVC | | | | | | |

5. Obtain the chart of the actual mass of each block from your instructor and determine the accuracy of your mass calculations using the following percent error formula.

$$\text{Percent Error} = \frac{[\text{Calculated mass} - \text{Actual mass}]}{\text{Actual mass}} \times 100$$

| Sample | Percent Error |
|---------------|---------------|
| Copper (Cu) | |
| Aluminum (Al) | |
| Brass (Br) | |
| Iron (Fe) | |
| Acrylic | |
| Nylon | |

| Sample | Percent Error |
|---------------|----------------------|
| Pine | |
| Maple | |
| Poplar | |
| PVC | |

Formulas Table 1

| | |
|---------|-------------------------|
| Density | Mass/Volume |
| Mass | Density x Volume |
| Volume | Length x Width x Height |

1. Obtain a sample block. Weigh the block to the nearest tenth of a gram on the electronic scale balance. Record the mass in table 2.
2. Measure the length, width, and height of the sample block in cm and record in table 2.
3. Calculate the density of sample block using the formula from Table 1. Record in Table 2.
4. Repeat for the remaining sample blocks.

Table 2 The densities should be rounded to the tenth place. Student answers may vary.

| Sample | Mass (g) | L (cm) | W(cm) | H(cm) | Volume (cm ³) | Density (g/cm ³) |
|---------------|----------|--------|--------|--------|---------------------------|------------------------------|
| Copper (Cu) | 145.6 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 9.3 g/cm ³ |
| Aluminum (Al) | 43.3 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 2.8 g/cm ³ |
| Brass (Br) | 138.5 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 8.9 g/cm ³ |

| Sample | Mass (g) | L (cm) | W(cm) | H(cm) | Volume (cm ³) | Density (g/cm ³) |
|-----------|----------|--------|--------|--------|---------------------------|------------------------------|
| Iron (Fe) | 123.5 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 7.9 g/cm ³ |
| Acrylic | 18.6 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 1.2 g/cm ³ |
| Nylon | 18.7 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 1.2 g/cm ³ |
| Pine | 5.6 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 0.4 g/cm ³ |
| Maple | 10.5 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 0.7 g/cm ³ |
| Poplar | 7.6 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 0.5 g/cm ³ |
| PVC | 24.9 g | 2.5 cm | 2.5 cm | 2.5 cm | 15.6 cm ³ | 1.6 g/cm ³ |

5. Obtain the chart of the actual mass of each block from your instructor and determine the accuracy of your mass calculations using the following percent error formula.

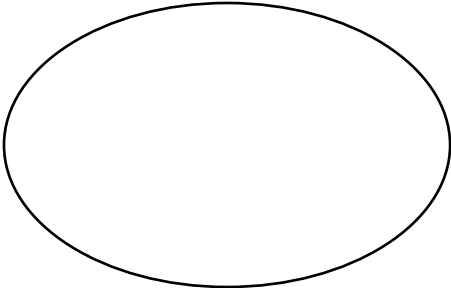
$$\text{Percent Error} = \frac{[\text{Calculated mass} - \text{Actual mass}]}{\text{Actual mass}} \times 100$$

| Sample | Percent Error |
|---------------|--|
| Copper (Cu) | Depending on student values, answers may vary |
| Aluminum (Al) | |
| Brass (Br) | |
| Iron (Fe) | |
| Acrylic | |
| Nylon | |

| Sample | Percent Error |
|---------------|----------------------|
| Pine | |
| Maple | |
| Poplar | |
| PVC | |

| Sample | Actual Mass |
|---------------|--------------------|
| Copper (Cu) | 145.6 g |
| Aluminum (Al) | 43.3 g |
| Brass (Br) | 138.5g |
| Iron (Fe) | 123.5g |
| Acrylic | 18.6g |
| Nylon | 18.7g |
| Pine | 5.6g |
| Maple | 10.5g |
| Poplar | 7.6g |
| PVC | 24.9g |

Energy - Follow along with your instructor to make a Mind Map for Energy.



Using the following vocabulary terms to fill in the blanks. One word is used twice.

| | | | | |
|-------|---------|--------|------------|---------|
| Light | Thermal | Motion | Electrical | Kinetic |
|-------|---------|--------|------------|---------|



1. The Light Bulb

Some energy from the light bulb is converted into _____ energy. After a while, this makes the light bulb hot. _____energy is transmitted through the light bulb wire. Part of the energy is changed from electrical energy to _____ energy. Only about one-tenth of the energy is converted into _____ energy.

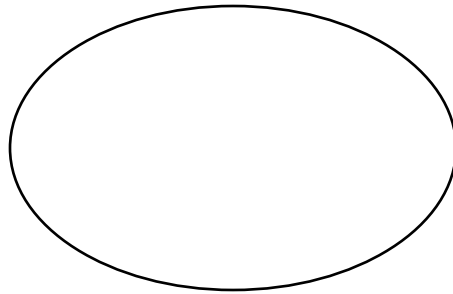


2. Climbing the Hill

The rock climber is demonstrating _____ energy. This is the energy of _____.

Energy - Follow along with your instructor to make a Mind Map for Energy.

See Answer Key Part 1



Using the following vocabulary terms to fill in the blanks. One word is used twice.

| | | | | |
|-------|---------|--------|------------|---------|
| Light | Thermal | Motion | Electrical | Kinetic |
|-------|---------|--------|------------|---------|



1. The Light Bulb

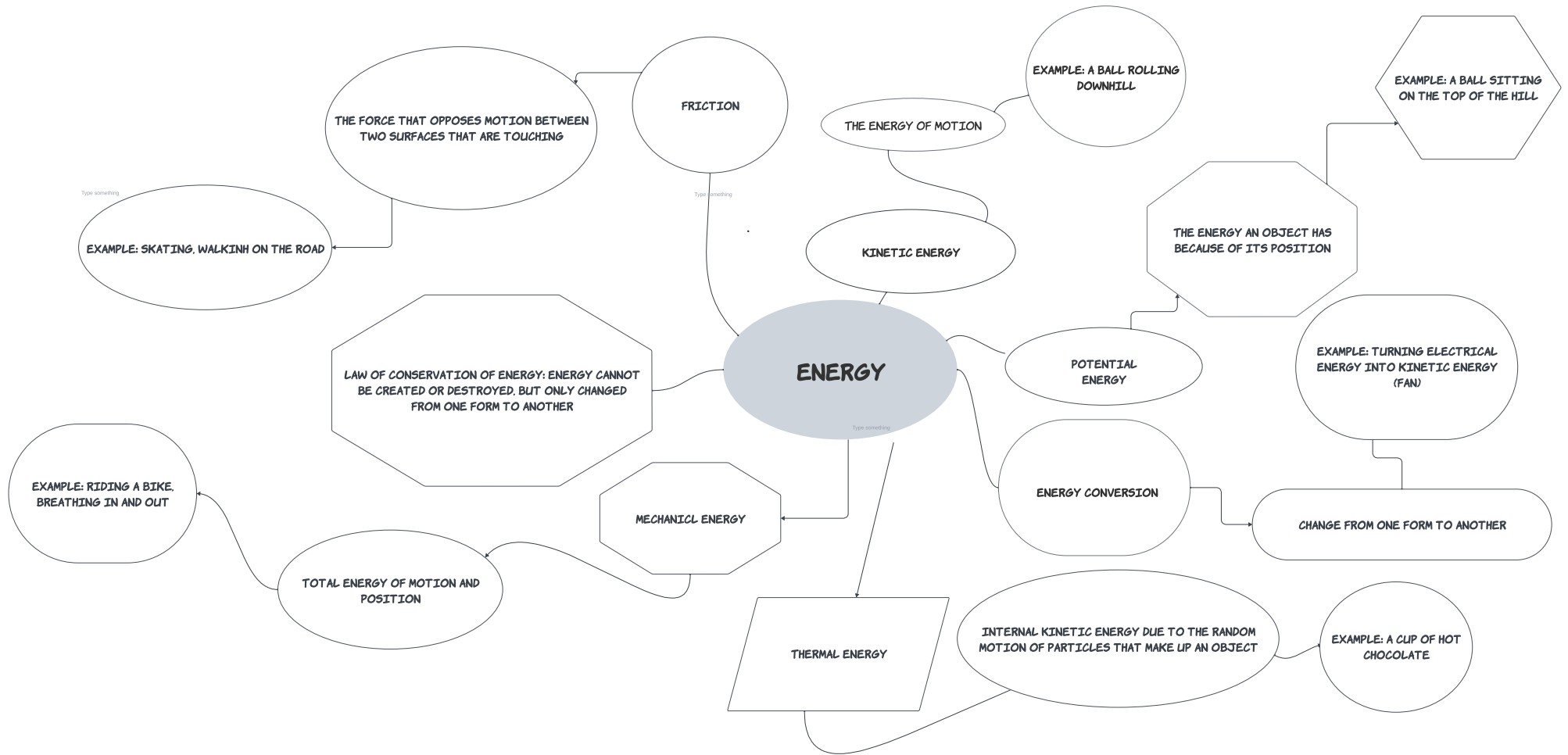
Some energy from the light bulb is converted into Thermal energy. After a while, this makes the light bulb hot. Electrical energy is transmitted through the light bulb wire. Part of the energy is changed from electrical energy to Kinetic energy. Only about one-tenth of the energy is converted into Light energy.



2. Climbing the Hill

The rock climber is demonstrating Kinetic Energy energy. This is the energy of Motion.

Instructor Copy



Slinky Part 1

Potential vs. Kinetic

Background: Slinky toys are an excellent device for demonstrating various physical properties of physics. The Slinky tends to resist change in motion (***inertia- an object exists in a state of rest, until acted upon from an external source***).

Because of this ***inertia***, when a Slinky is placed at the top of the stairs, it stays at rest. At this point it has ***potential*** energy or stored energy.

If you were to make the Slinky move down the stairs, ***gravity (the force that attracts a body toward the center of the earth)*** now affects the Slinky toy and the potential energy is converted to ***kinetic*** energy.

In this activity, you will use three sizes of Slinky toys, Giant, Original and Junior to demonstrate how quickly a Slinky toy will move under the influence of ***gravity***. It may look like a simple movement, the movement of the Slinky down the stairs is quite complex.

| | |
|-----------|---|
| Materials | 1. Slinky toy: Giant, Original & Junior 2. Stairs or books stacked like stairs |
|-----------|---|

Procedure:

1. Find an area with several stairs OR build a set of stairs from stacked books on the table/floor will work. This will be the ramp for the Slinky to move on.
2. If using books to make a ramp, make sure the rise between the books is even.
3. Place a small Slinky toy and either one of the larger Slinky toys on the top stair or ramp. The Slinky toys will be demonstrating _____ energy at this time.
4. Think about Newton's first law of motion: A body at rest will remain at rest unless an external force acts upon it. How does Newton's first law of motion apply to the Slinky toys at the top of the stairs/ramp? Explain.
5. Grip a coil of each of the Slinky toys at the top of the stairs/ramp and flip it over toward the middle of the next lower step, releasing your hold. This action is _____ energy being converted to _____ energy.

6. Which Slinky reached the bottom first? _____

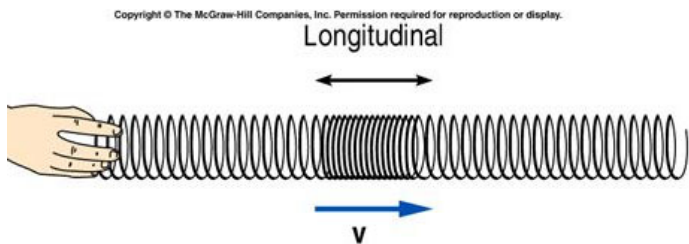
7. Explain why you think this Slinky won:

Vocabulary to define to prepare for the Slinky Toys Activity Part 2.

| | |
|---------------------------|--|
| Frequency | |
| Longitudinal Waves | |
| Transverse Waves | |

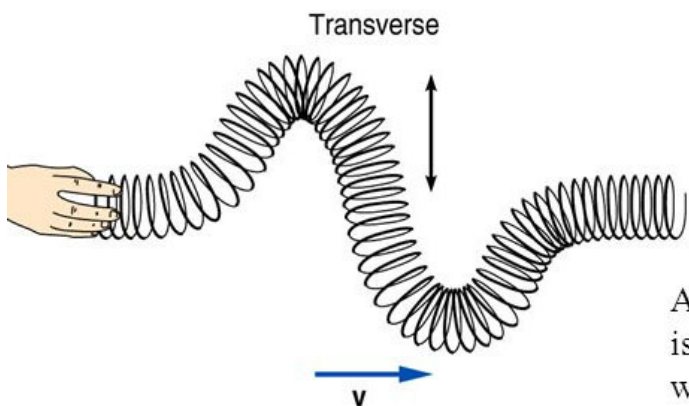
| | |
|-------------------------|--|
| Wavelength | |
| Crest | |
| Amplitude | |
| Low energy wave | |
| High energy wave | |

Types of waves



Longitudinal wave is one in which the disturbance is parallel to the line of travel of the wave.

Example: Sound wave in air is a longitudinal wave.



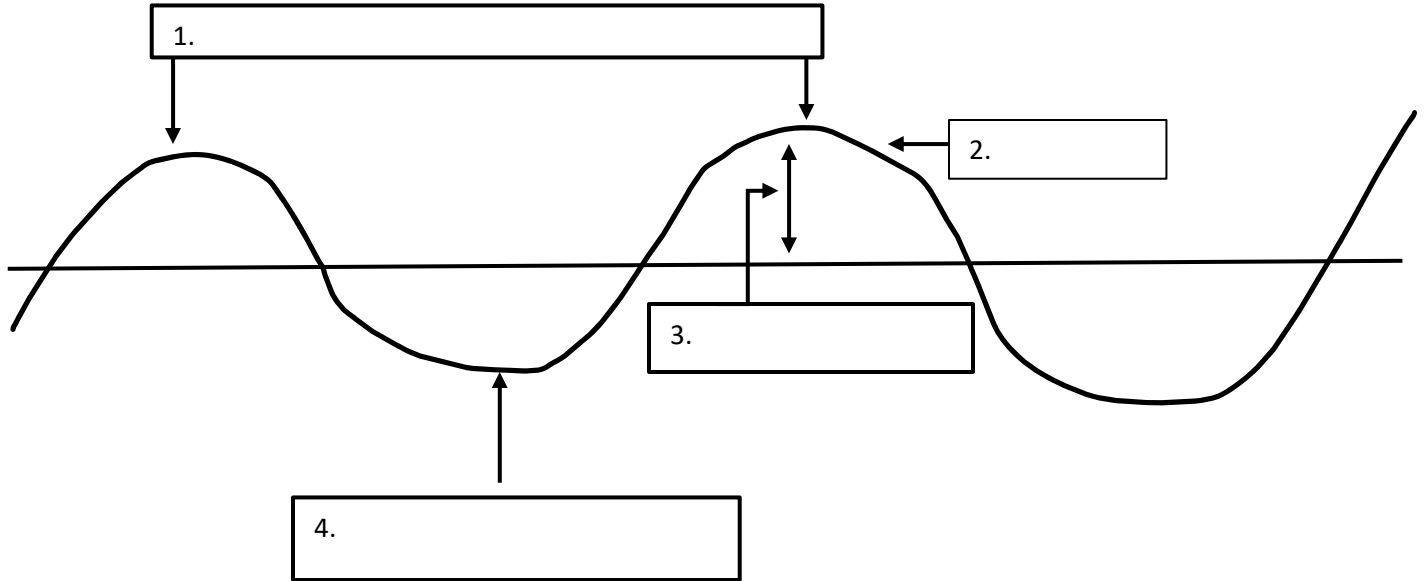
A transverse wave is one in which the disturbance is perpendicular to the direction of travel of the wave.

Examples: Light wave, waves on a guitar string.

<https://www.meritnation.com/ask-answer/question/sound-waves-are-longitudinal-waves-explain/sound/13305373>

1. Review the diagram of the longitudinal wave. With each partner taking one end of the Slinky, move in a straight line from each other. The coils move from _____ to _____.
2. Review the diagram of the transverse wave. With each partner holding the end of the Slinky, wiggle the Slinky. The coils now are moving _____ and _____.
3. In both actions, what direction is the energy moving? _____ to _____

4. Label the parts of the wave with the following vocabulary terms: crest, trough, amplitude, wavelength.



Review the following diagram and complete questions 5 through 8.



5. A high energy wave is characterized by high _____.

6. A low energy wave is characterized by low _____.

7. **Research Question** What is the relationship between wavelength and frequency?

Background: Slinky toys are an excellent device for demonstrating various physical properties of physics. The Slinky tends to resist change in motion (***inertia- an object exists in a state of rest, until acted upon from an external source***).

Because of this ***inertia***, when a Slinky is placed at the top of the stairs, it stays at rest. At this point it has ***potential*** energy or stored energy.

If you were to make the Slinky move down the stairs, ***gravity (the force that attracts a body toward the center of the earth)*** now affects the Slinky toy and the potential energy is converted to ***kinetic*** energy.

In this activity, you will use three sizes of Slinky toys, Giant, Original and Junior to demonstrate how quickly a Slinky toy will move under the influence of ***gravity***. It may look like a simple movement, the movement of the Slinky down the stairs is quite complex.

| | |
|-----------|---|
| Materials | <ol style="list-style-type: none"> 1. Slinky toy: Giant, Original & Junior 2. Stairs or books stacked like stairs |
|-----------|---|

Procedure:

1. Find an area with several stairs OR build a set of stairs from stacked books on the table/floor will work. This will be the ramp for the Slinky to move on.
2. If using books to make a ramp, make sure the rise between the books is even.
3. Place a small Slinky toy and either one of the larger Slinky toys on the top stair or ramp. The Slinky toys will be demonstrating ___**potential**___ energy at this time.
4. Think about Newton's first law of motion: A body at rest will remain at rest unless an external force acts upon it. How does Newton's first law of motion apply to the Slinky toys at the top of the stairs/ramp? Explain.

Unless the student pushes the Slinky down the ramp or pulls the Slinky off the top stair, it will not move on its own.

5. Grip a coil of each of the Slinky toys at the top of the stairs/ramp and flip it over toward the middle of the next lower step, releasing your hold. This action is ___**potential**___ energy being converted to ___**kinetic**___ energy.
6. Which Slinky reached the bottom first?

The smaller Slinky should win.

7. Explain why you think this Slinky won:

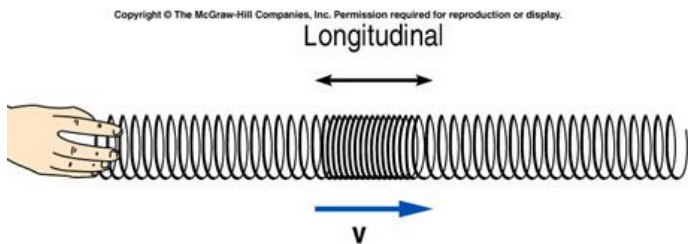
The smaller the mass, the tighter the tension, the tighter the tension, the faster the wave speed. The Wave moves faster through the smaller Slinky

Vocabulary to define to prepare for the Slinky Toys Activity Part 2.

| | |
|---------------------------|---|
| Frequency | The number of waves produced in a given time period. This is usually measured in waves per second called Hertz (H) |
| Longitudinal Waves | A longitudinal wave is where the particles move parallel to the direction the wave is moving. |
| Transverse Waves | A transverse wave is where the particles move at right angles to the direction of wave travel. |
| Wavelength | The length of the wave. It is measured easily from crest to crest or from trough to trough. |

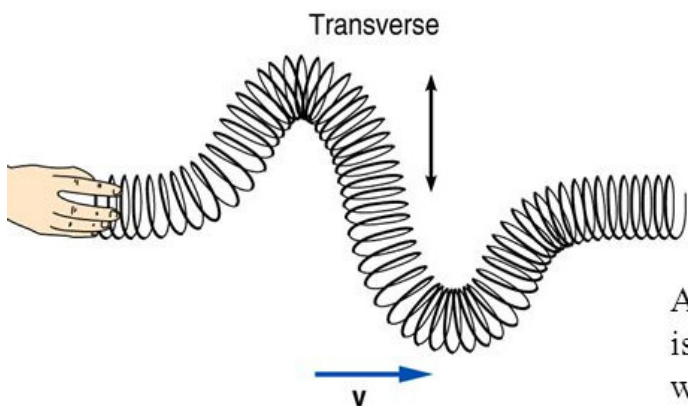
| | |
|--------------------------------|--|
| <p>Crest</p> | <p>The top of the wave at its highest point</p> <p>The Trough is the bottom of the wave at its lowest point</p> |
| <p>Amplitude</p> | <p>The height or depth of the wave. The amount of energy carried by a wave is related to amplitude.</p> <p>A high energy wave is characterized by high amplitude.</p> <p>A low energy wave is characterized by a low amplitude.</p> |
| <p>Low energy wave</p> | <p>Low amplitude</p> |
| <p>High energy wave</p> | <p>High amplitude</p> |

Types of waves



Longitudinal wave is one in which the disturbance is parallel to the line of travel of the wave.

Example: Sound wave in air is a longitudinal wave.



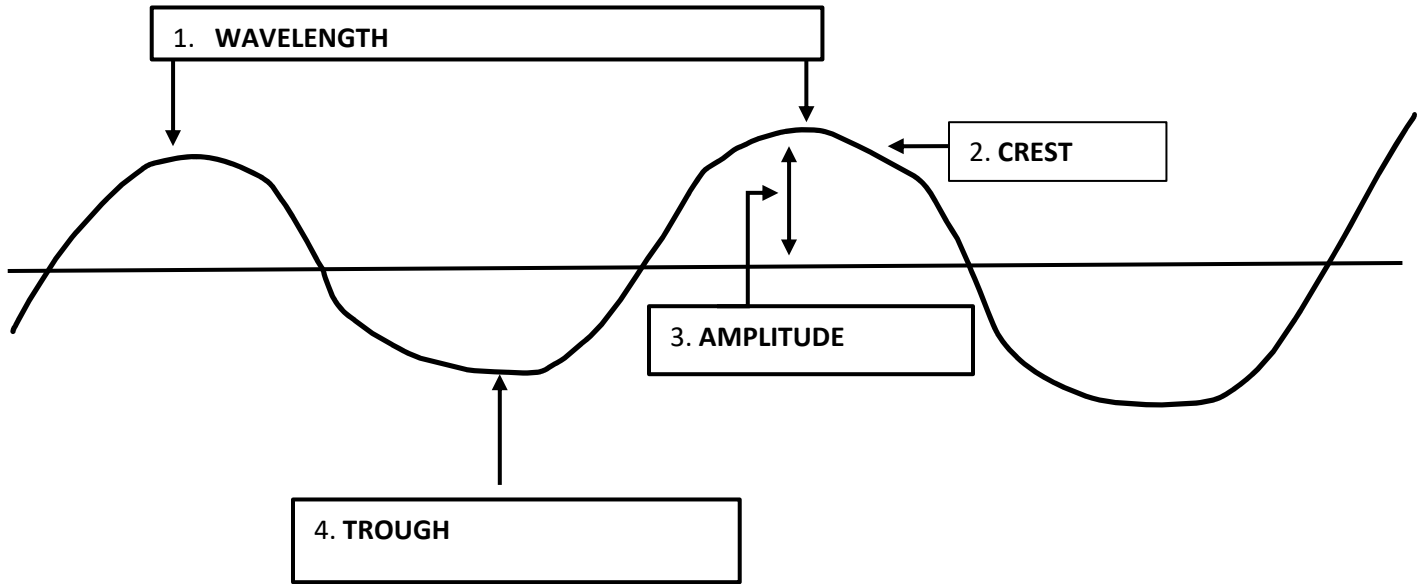
A transverse wave is one in which the disturbance is perpendicular to the direction of travel of the wave.

Examples: Light wave, waves on a guitar string.

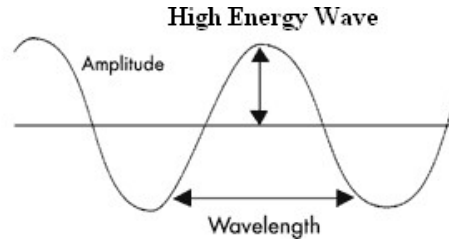
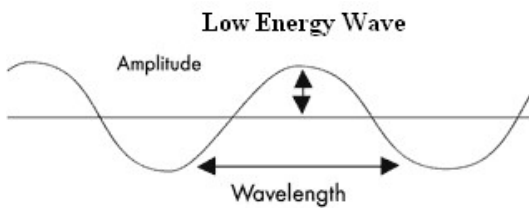
<https://www.meritnation.com/ask-answer/question/sound-waves-are-longitudnal-waves-explain/sound/13305373>

1. Review the diagram of the longitudinal wave. With each partner taking one end of the Slinky, move in a straight line from each other. The coils move from **left** to **right**.
2. Review the diagram of the transverse wave. With each partner holding the end of the Slinky, wiggle the Slinky. The coils now are moving **left** and **right**.
3. In both actions, what direction is the energy moving? **left** to **right** or **away from the source**

4. Label the parts of the wave with the following vocabulary terms: crest, trough, amplitude, wavelength.



Review the following diagram and complete questions 5 through 8.



5. A high energy wave is characterized by high **amplitude** .
6. A low energy wave is characterized by low **amplitude** .

7. **Research Question** What is the relationship between wavelength and frequency?

They are indirectly proportional. the higher the frequency, the smaller the wavelength and vice-versa.

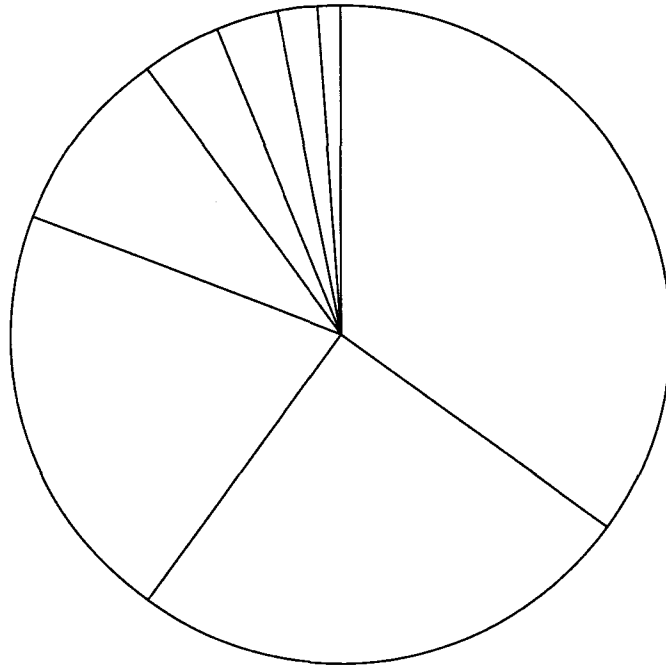


Problem 1: Energy Source Use Circle Graph

Directions

Using the data below, label the sections of the circle graph.

| | |
|------------------------------------|-----|
| Petroleum | 35% |
| Natural Gas | 25% |
| Coal | 21% |
| Uranium | 9% |
| Biomass | 4% |
| Hydropower | 3% |
| Propane | 2% |
| Other (Solar, Wind, Geothermal) | 1% |



Directions

Using the graph and what you know about energy sources, answer these questions.

1. Which energy source provides the most energy?

2. What percentage are renewable energy sources?

3. What percentage are nonrenewable energy sources?

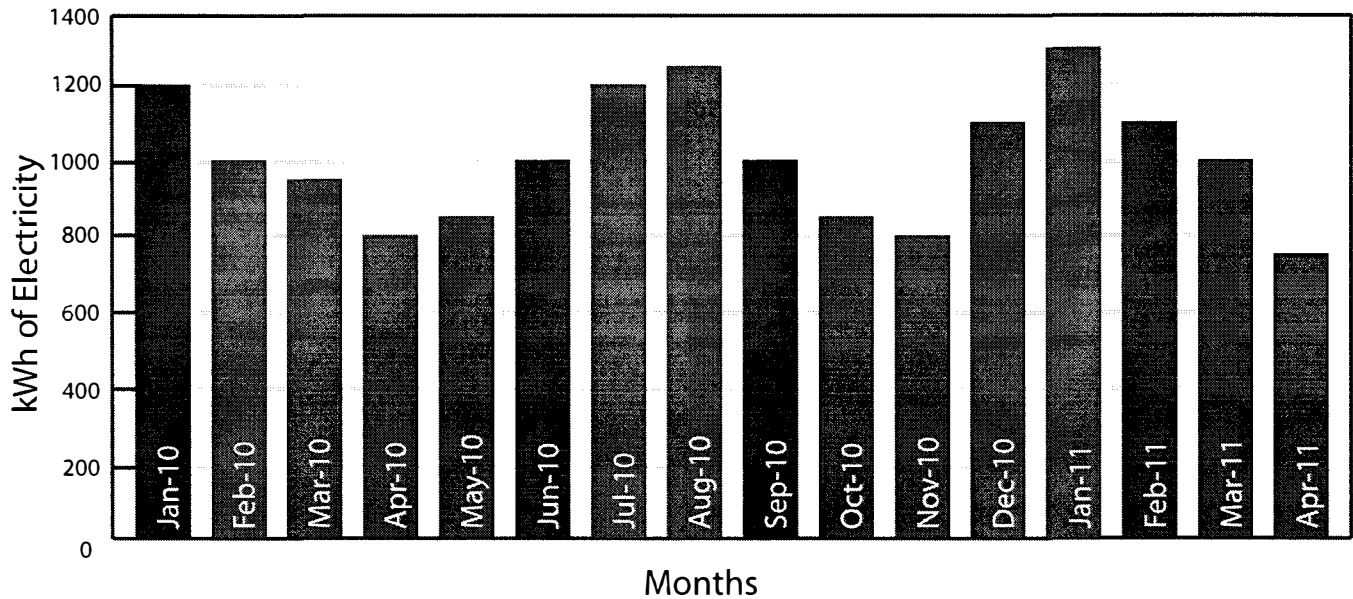
4. What percentage of the energy sources are fossil fuels?

5. What percentage of the energy sources are found underground?



Problem 2: Electricity Use Chart

This is a graph of the Smith Family's electricity use for 2010 and part of 2011 by month. The Smiths have an all-electric house.



Directions

Using the graph, answer these questions.

1. In what month and year did the family use the most electricity?

2. In what month and year did the family use the least electricity?

3. What summer month and year do you think was the hottest?

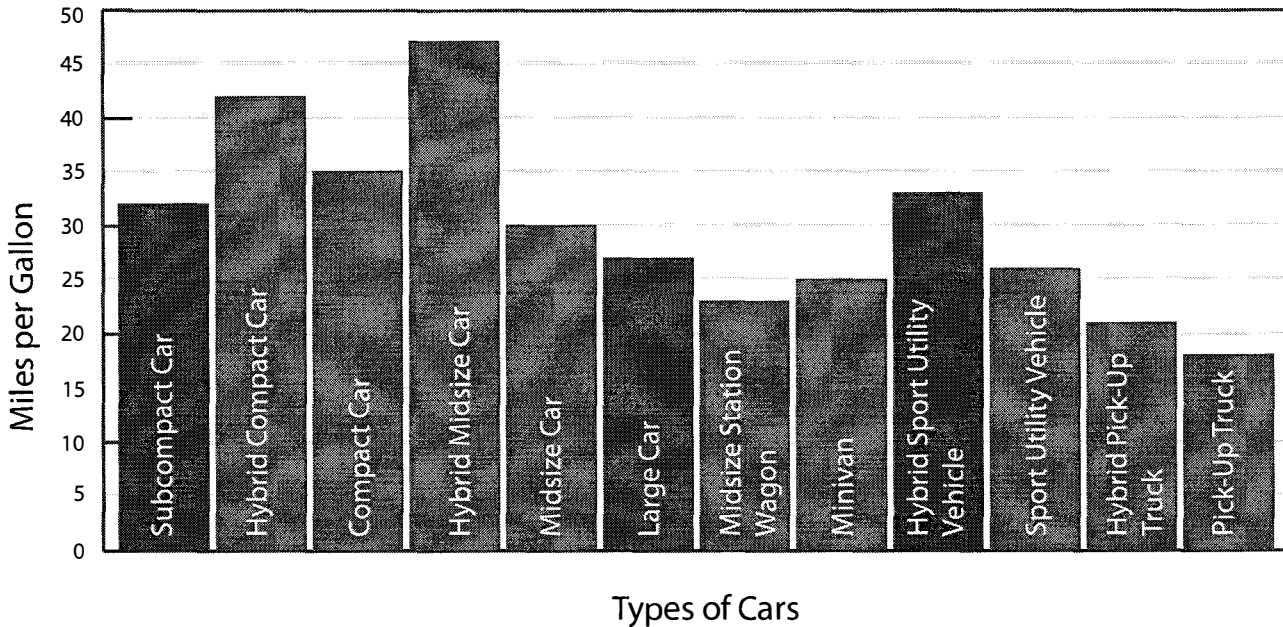
4. How much more electricity did the family use in Jan. 2011 than in Jan. 2010?

5. How many kWh of electricity did the family use in 2010?



Problem 3: Fuel Economy Chart

This is a graph of the best gasoline mileage of different types of cars.



Directions

Using the graph, answer these questions.

1. What type of car gets the most miles per gallon?

2. What type of car gets the fewest miles per gallon?

3. How many miles can a compact car travel on two gallons of gasoline?

4. How many miles can a large car travel on three gallons of gasoline?

5. If a midsize car travels 60 miles, how many gallons of gas will it use?

BONUS: If the gas tank of a minivan can hold 20 gallons of gas, how far can it travel on a full tank of gasoline?



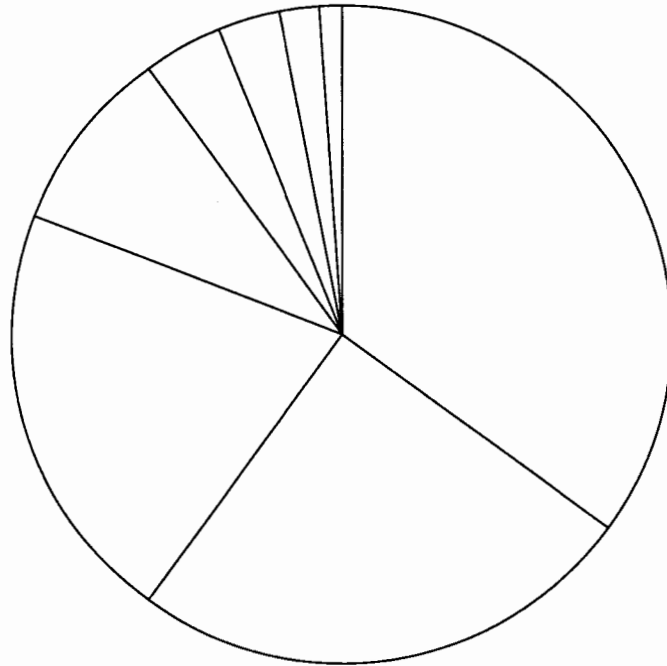
Problem 1: Energy Source Use Circle Graph

Directions

INSTRUCTOR KEY

Using the data below, label the sections of the circle graph.

| | |
|---------------------------|-----|
| Petroleum | 35% |
| Natural Gas | 25% |
| Coal | 21% |
| Uranium | 9% |
| Biomass | 4% |
| Hydropower | 3% |
| Propane | 2% |
| Other | 1% |
| (Solar, Wind, Geothermal) | |



Directions

Using the graph and what you know about energy sources, answer these questions.

1. Which energy source provides the most energy?

Petroleum

2. What percentage are renewable energy sources?

8%

3. What percentage are nonrenewable energy sources?

92%

4. What percentage of the energy sources are fossil fuels?

83%

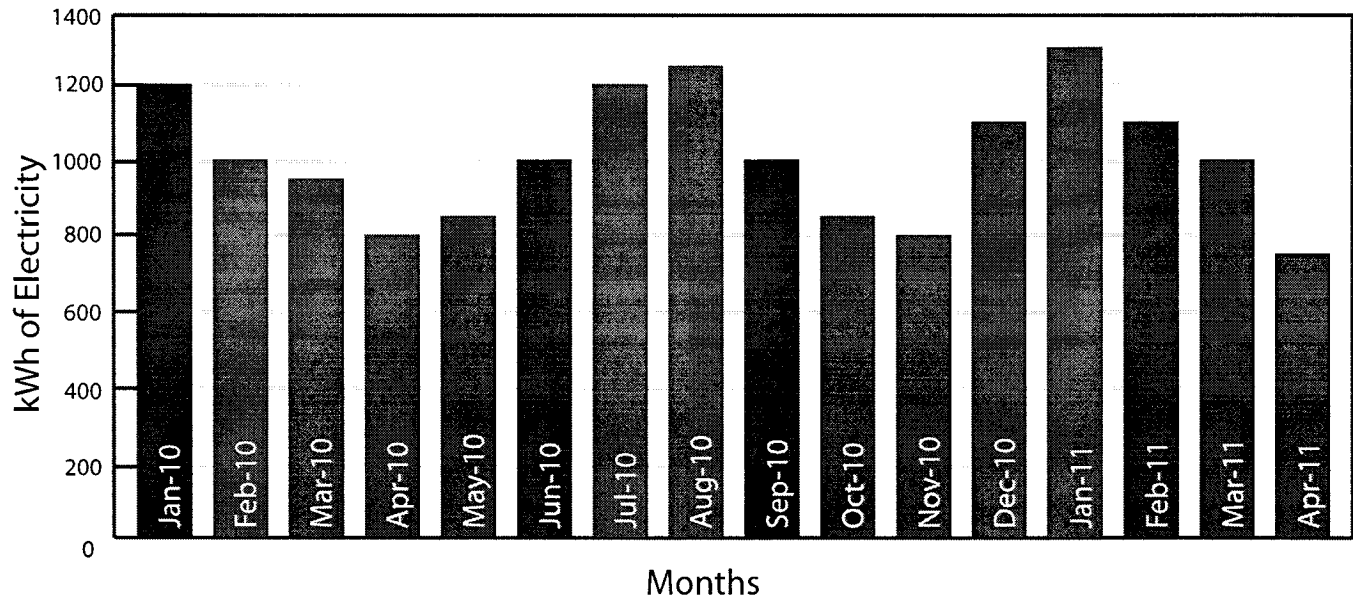
5. What percentage of the energy sources are found underground?

92%



Problem 2: Electricity Use Chart

This is a graph of the Smith Family's electricity use for 2010 and part of 2011 by month. The Smiths have an all-electric house.



Directions

Using the graph, answer these questions.

1. In what month and year did the family use the most electricity?

January 2011

2. In what month and year did the family use the least electricity?

April 2011

3. What summer month and year do you think was the hottest?

August 2010

4. How much more electricity did the family use in Jan. 2011 than in Jan. 2010?

100 kWh

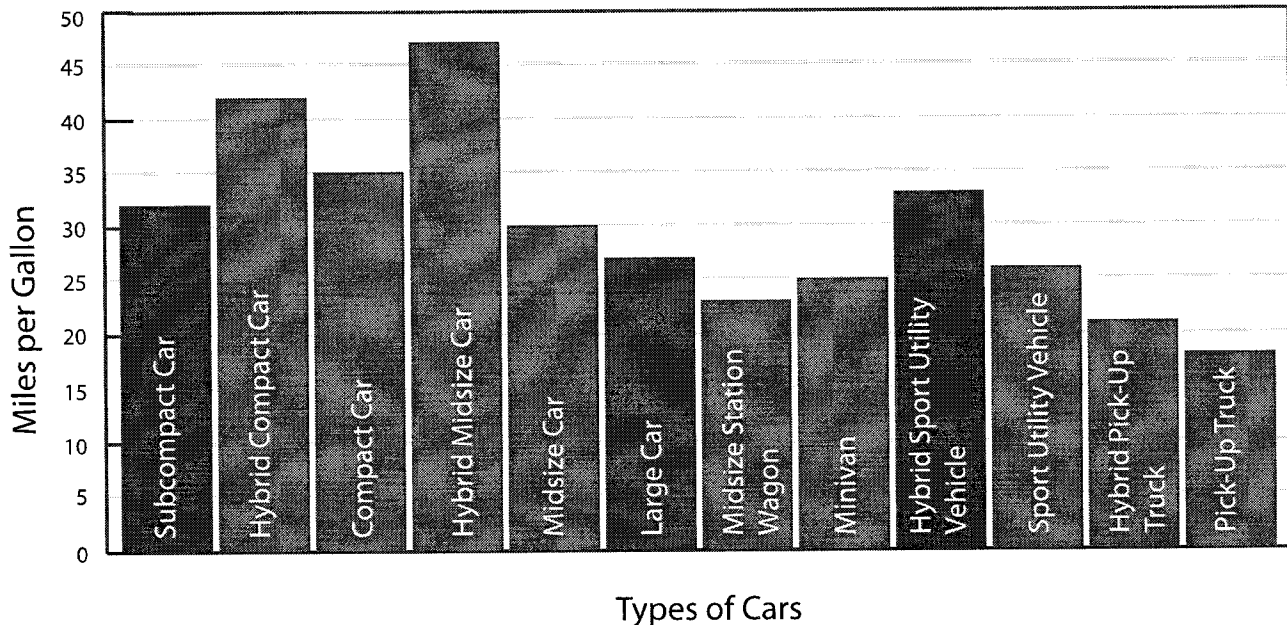
5. How many kWh of electricity did the family use in 2010?

12,000 kWh



Problem 3: Fuel Economy Chart

This is a graph of the best gasoline mileage of different types of cars.



Directions

Using the graph, answer these questions.

1. What type of car gets the most miles per gallon?

Hybrid Midsize

2. What type of car gets the fewest miles per gallon?

Pick-Up

3. How many miles can a compact car travel on two gallons of gasoline?

70 miles

4. How many miles can a large car travel on three gallons of gasoline?

81 miles

5. If a midsize car travels 60 miles, how many gallons of gas will it use?

2 gallons

BONUS: If the gas tank of a minivan can hold 20 gallons of gas, how far can it travel on a full tank of gasoline?

Minivan gets 25 miles per gallon

25 miles x 20 gallons = 500 miles

Directions:

1. Read the following problems and fill in the chart after each problem, following the instructor’s modeling of the problem.

2. Choose one of the following formulas to solve the problem:

$$KE = (0.5) \times (m) \times (v^2)$$

$$v^2 = (2)(KE)/m$$

$$m = (2)(KE)/v^2$$

| | | | |
|--|--------------------------|--|--|
| KE = Kinetic Energy Expressed a J (Joules) | 0.5 is a constant | M = mass Mass is expressed as kg (kilograms) | V = velocity Velocity is expressed as m/s (meters per second or <i>distance/time</i>) |
|--|--------------------------|--|--|

A. What is the kinetic energy of a 150 kg object that is moving with a speed of 15 m/s?

| | |
|----------------|-----|
| KE | |
| 0.5 | 0.5 |
| m | |
| v ² | |
| Formula | |

Solve: Show your work

B. An object has a kinetic energy of 25 J and a mass of 34kg, how fast is the object moving?

| | |
|---------|-----|
| KE | |
| 0.5 | 0.5 |
| m | |
| v^2 | |
| Formula | |

Solve: Show your work

C. An object moving with a speed of 35 m/s and has a kinetic energy of 1500 J, what is the mass of the object?

| | |
|---------|-----|
| KE | |
| 0.5 | 0.5 |
| m | |
| v^2 | |
| Formula | |

Solve: Show your work

Directions: KEY

1. Read the following problems and fill in the chart after each problem, following the instructor’s modeling of the problem.

2. Choose one of the following formulas to solve the problem:

$$KE = (0.5) \times (m) \times (v^2)$$

$$v^2 = (2)(KE)/m$$

$$m = (2)(KE)/v^2$$

| | | | |
|--|--------------------------|--|--|
| KE = Kinetic Energy Expressed a J (Joules) | 0.5 is a constant | M = mass Mass is expressed as kg (kilograms) | V = velocity Velocity is expressed as m/s (meters per second or <i>distance/time</i>) |
|--|--------------------------|--|--|

A. What is the kinetic energy of a 150 kg object that is moving with a speed of 15 m/s?

| | |
|----------------|---|
| KE | 16875J |
| 0.5 | 0.5 |
| m | 150 kg |
| v ² | 15 m/s squared = 225 m/s |
| Formula | KE = (0.5) x (m) x (v²) |

Solve: Show your work

B. An object has a kinetic energy of 25 J and a mass of 34kg, how fast is the object moving?

| | |
|----------------|------------------------------------|
| KE | 25 J |
| 0.5 | 0.5 |
| m | 34 kg |
| v ² | $= \sqrt{1.47} = 1.28 \text{ m/s}$ |
| Formula | $v^2 = (2)(KE)/m$ |

Solve: Show your work

C. An object moving with a speed of 35 m/s and has a kinetic energy of 1500 J, what is the mass of the object?

| | |
|----------------|---------------------------|
| KE | 1500J |
| 0.5 | 0.5 |
| m | 2.45 kg |
| v ² | 35 m/s squared = 1225 m/s |
| Formula | $m = (2)(KE)/v^2$ |

Solve: show your work

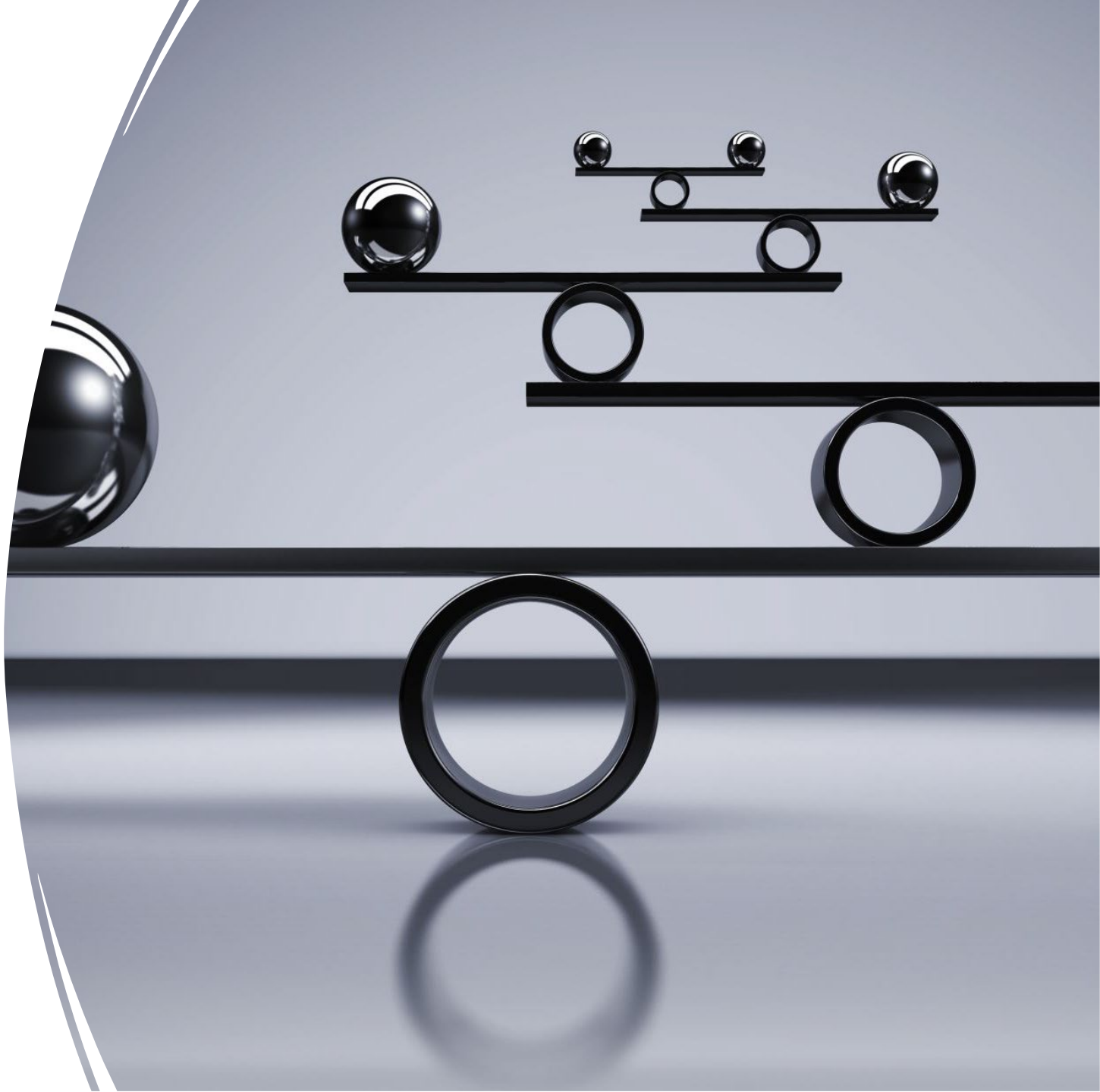
Newton's Laws

Manufacturing Bridge

2023

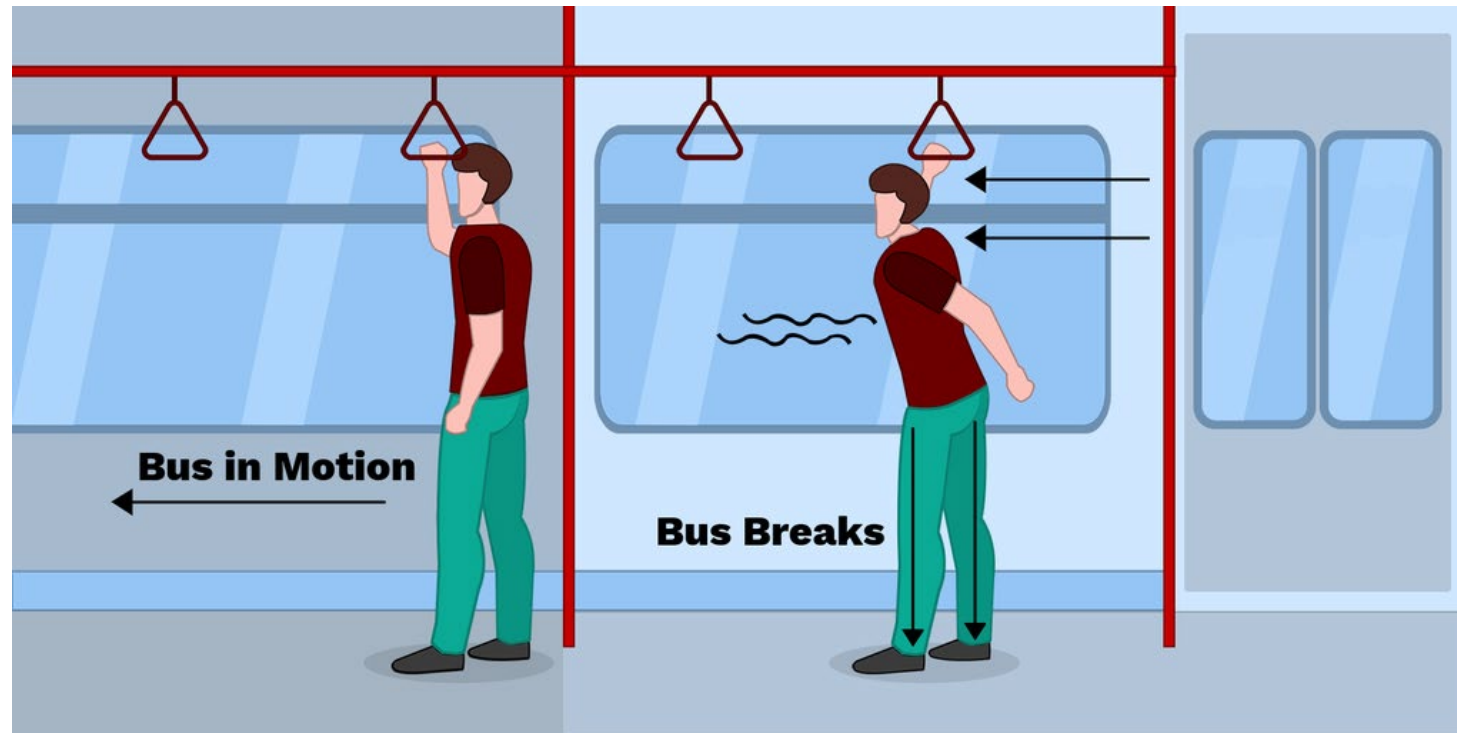
I. Newton's First Law of Motion

- Also known as the LAW of INERTIA
- States:
 - a. if an object is not moving, or at REST will stay at REST and
 - b. an object that is moving will keep moving with constant VELOCITY which means at the same SPEED and in the same DISTANCE unless
 - c. an OUTSIDE force acts on that object.



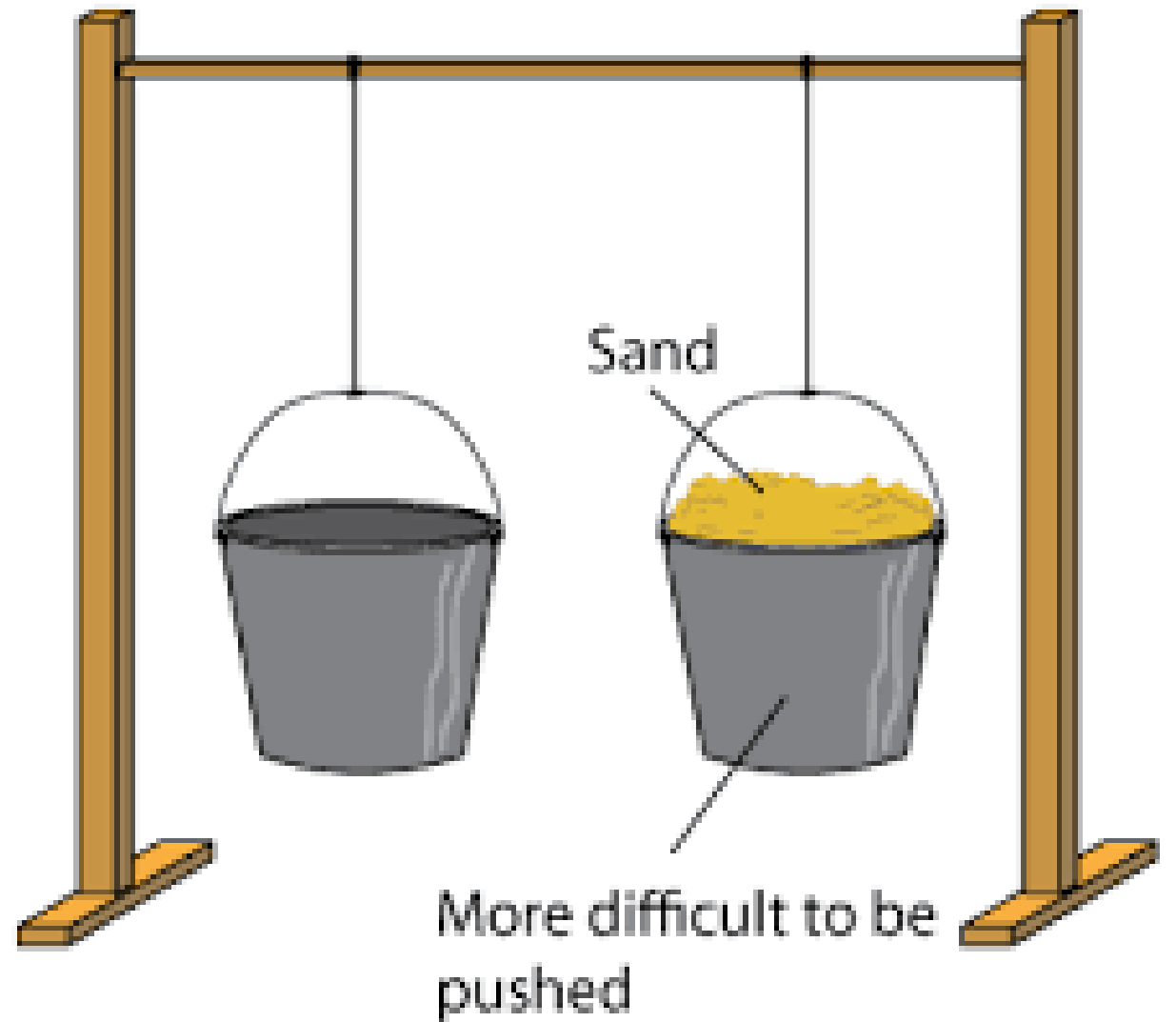
What is inertia?

- It is the resistance of a physical object to any change in its state of motion



What property of an object determines how much inertia it has?

Mass



Which of the following has more inertia?

a. Bowling Ball

or

Tennis Ball



https://img.freepik.com/premium-vector/bowling-ball-crashing-into-pins_420555-164.jpg



https://t3.ftcdn.net/jpg/03/95/46/18/360_F_395461888_4VbGNpuxGs5BP1J1uxVRZ7fQDIWmHZmB.jpg

Bonus ? : When traveling in a car and turning right, which way does your body go? Why?

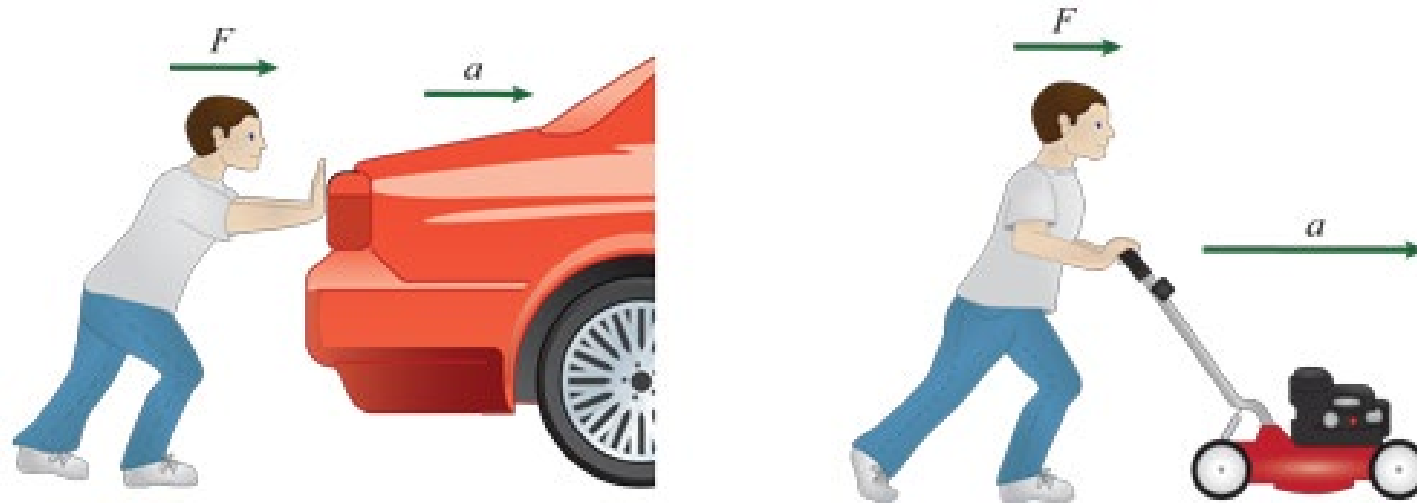
- Image: You are a passenger in a car, the car is making a right-hand turn. As the car turns to the right, you feel as though you are sliding to the LEFT!
- In actuality, the car is beginning its turning motion (to the right) and you are continuing in a STRAIGHT-LINE PATH!



shutterstock.com · 2188817639

II. Newton's Second Law of Motion

- Also known as an ACCELERATION.
- When an UNBALANCED force is applied to a MASS(OBJECT), it causes it to ACCELERATE.

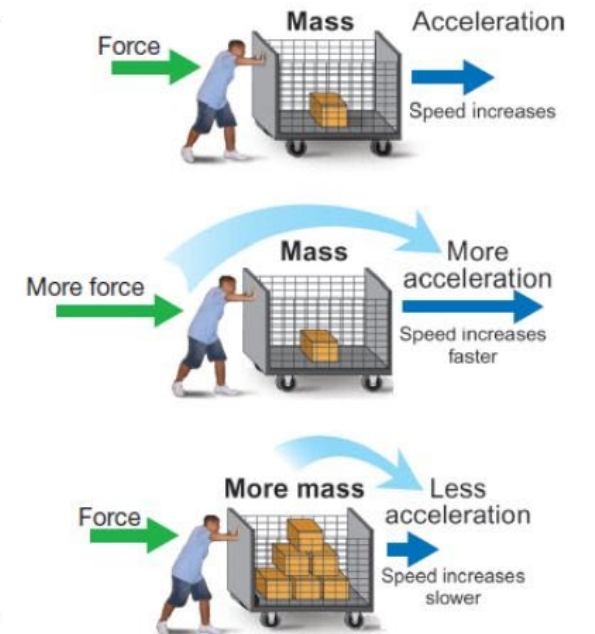


Newton's Second Law

- The greater the force that is applied, the **GREATER** the acceleration.
- The lesser the force that is applied, the **LESSER** the acceleration.
- If the same force is applied to an object with a large mass, it will have a **LESSER** acceleration.
- If the same force is applied to an object with a small mass, it will have a **GREATER** acceleration.

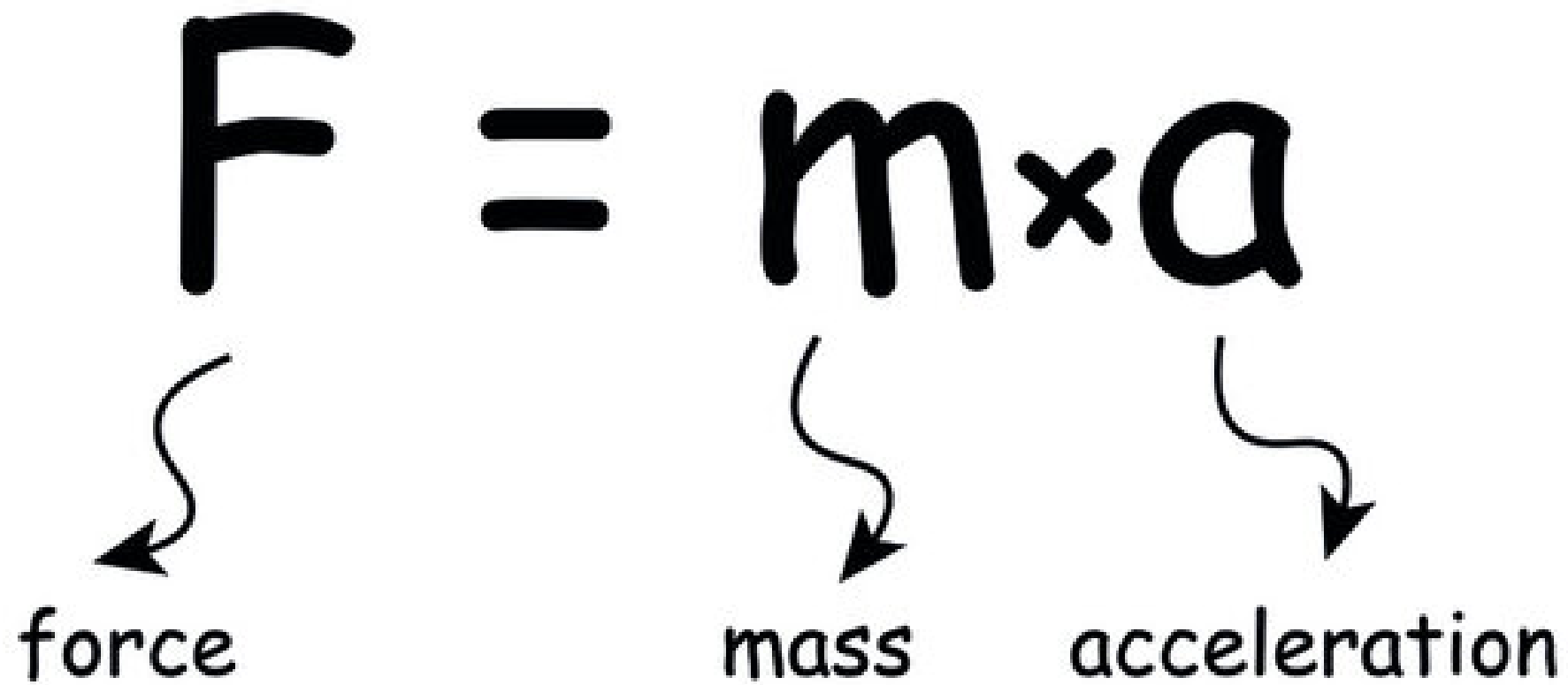
$$a = \frac{F}{m}$$

Acceleration (m/s²) Force (N)
Mass (kg)



$$F = m \times a$$

force mass acceleration

The image shows the equation F = m x a in a large, bold, black font. Below the letter 'F' is a curved arrow pointing down and to the left towards the word 'force'. Below the letter 'm' is a curved arrow pointing down and to the left towards the word 'mass'. Below the letter 'a' is a curved arrow pointing down and to the left towards the word 'acceleration'. The words 'force', 'mass', and 'acceleration' are written in a simple, black, sans-serif font.

$$F = ma$$


N


kg


 m/s^2

III. Newton's Third Law of Motion

Also known as Law of ACTION-REACTION

Every time there is an ACTION force, there is also a REACTION force that is EQUAL in size and acts in the OPPOSITE direction.

Forces must ALWAYS occur in PAIRS.



What is the REACTION
force?

IV Understanding

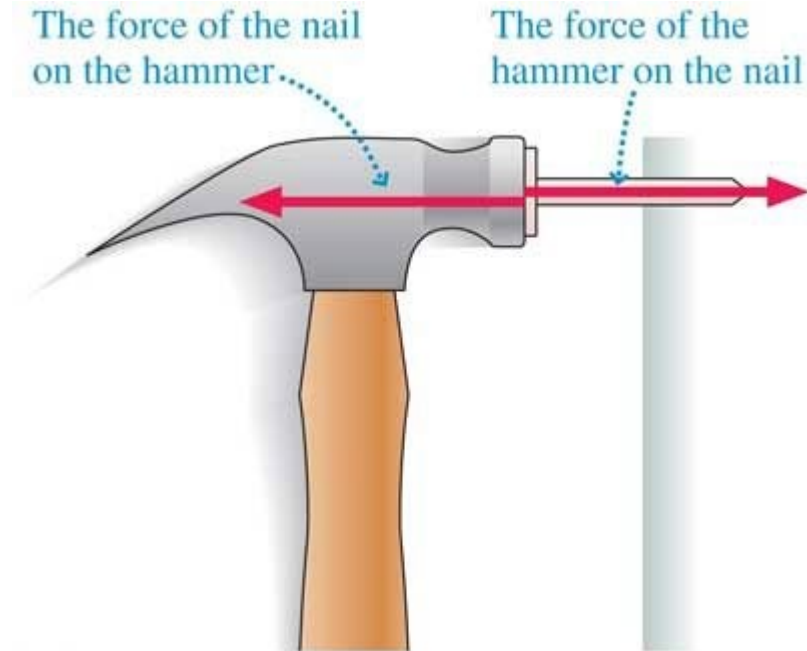
Which law is being depicted in the images? Explain.



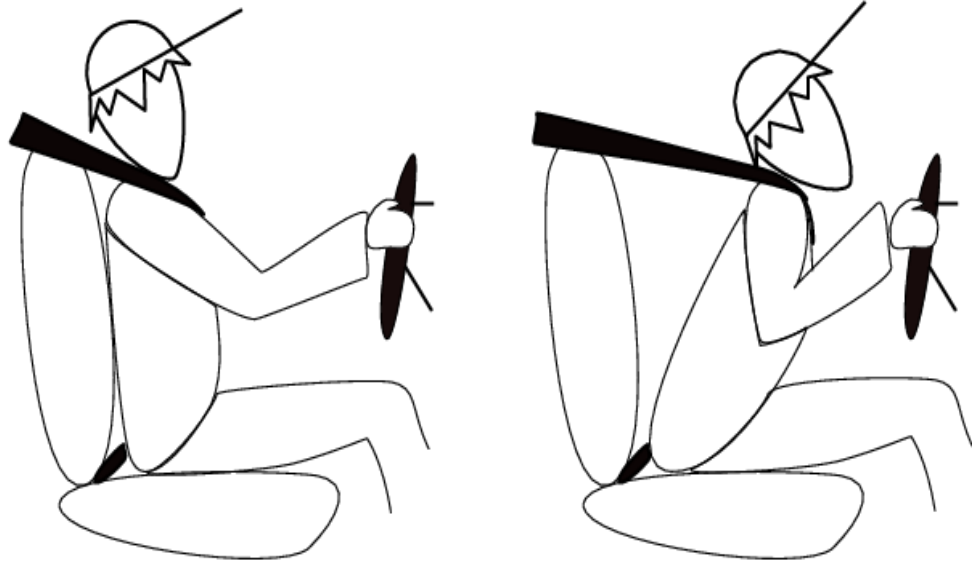
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www.physicstutorials.org

$$F=m.a$$
$$20\text{N}=5\text{kg}.a$$
$$a=4\text{m/s.s}$$

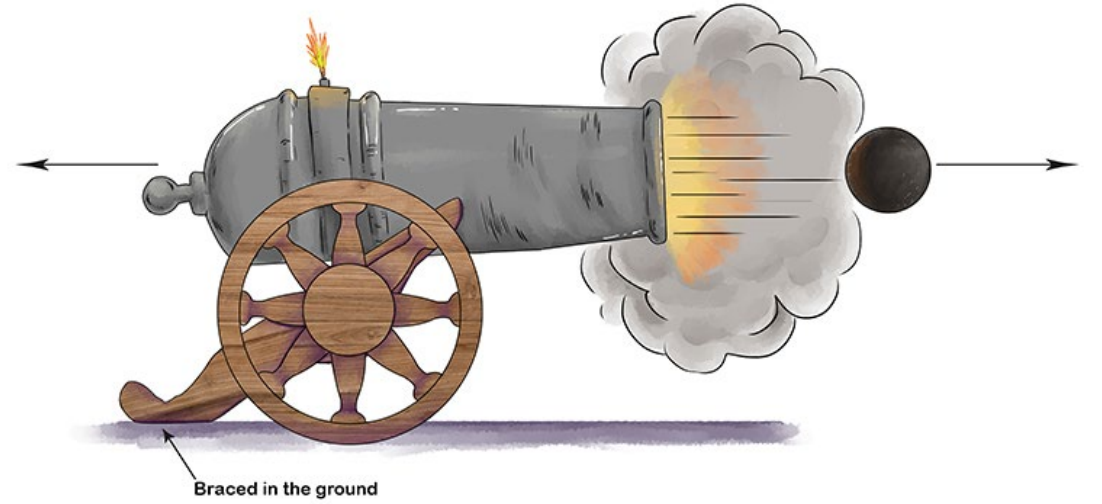
<https://www.physicstutorials.org/images/Dynamics/example16son.png>



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<https://nigerianscholars.com/assets/uploads/2017/12/newton-s-first-law-in-action.png>



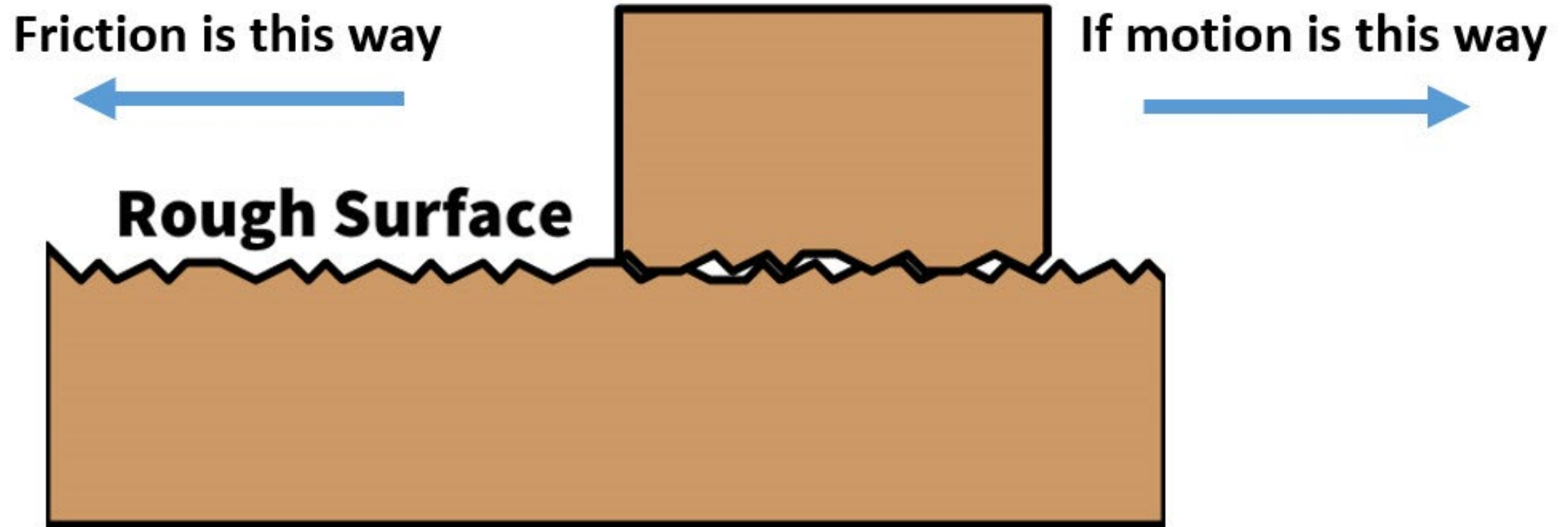
<https://mammothmemory.net/images/user/base/Physics/Newtons%20laws%20of%20motion/example-5-cannon-firing.5bfc1bc.jpg>

Friction

Kishwaukee College
Manufacturing Bridge
2023

What is friction?

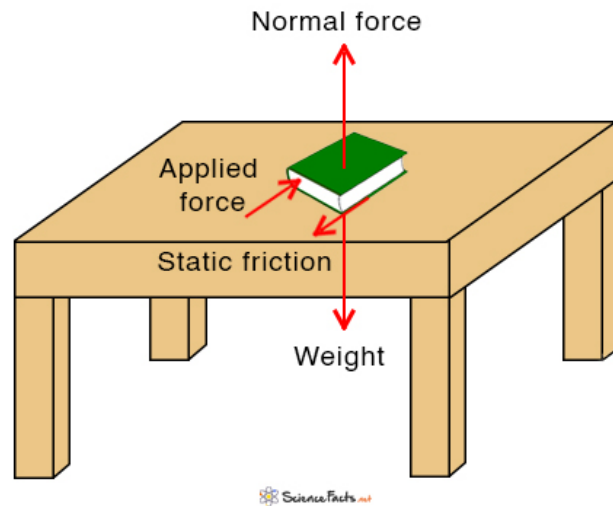
- The resistance **FORCE** that one surface or object encounters when moving over another: slowing or preventing an object's motion between two surfaces.



Types of Friction

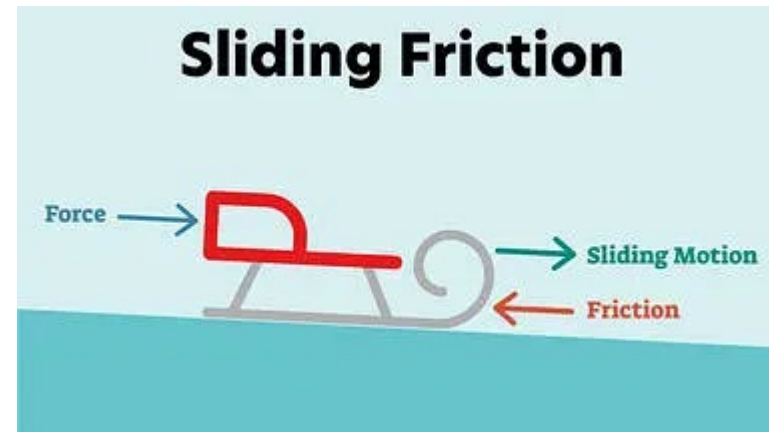
- **STATIC** – Friction at rest

Static Friction Example



<https://www.sciencefacts.net/static-friction.html>

- **SLIDING** – Friction as surfaces slide across each other



<https://images.collegedunia.com/public/image/af908deee2e81e9d477b9d6222bf099c.png?tr=w-384,h-216,c-force?tr=w-384,h-216,c-force>

Types of Friction

- Rolling

Rolling Friction Example

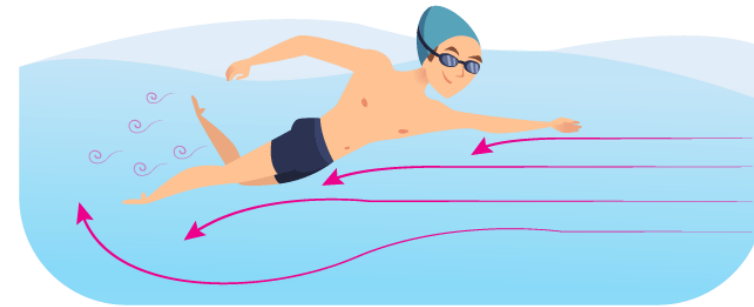


<https://www.sciencefacts.net/wp-content/uploads/2020/11/Rolling-Friction-Example.jpg>

- Fluid

FLUID FRICTION

BYJU'S
The Learning App



<https://cdn1.byjus.com/wp-content/uploads/2023/03/Fluid-friction.png>

True or False?

- Static Friction prevents you from slipping when you walk on a sidewalk.
- Sliding Friction is stronger than static friction.

I. NEWTON'S FIRST LAW OF MOTION

1. Newton's first law of motion is also known as the LAW OF _____.
2. Newton's first law says that
 - a. an object that IS NOT MOVING, or is at _____, will stay at _____, **AND**
 - b. an object that IS MOVING will keep moving with constant _____, which means at the same _____ and in the same _____, **UNLESS**
 - c. an _____ force acts on that object.
3. What is inertia?
4. What property of an object determines how much inertia it has?
5. Which of the following has more inertia?
 - a. Bowling ball or Tennis ball
 - b. Hammer or Feather

II. NEWTON'S SECOND LAW OF MOTION

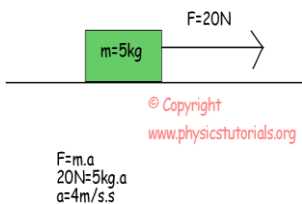
6. Newton's second law of motion is also known as the LAW OF _____.
7. Newton's second law says that when an _____ force is applied to a _____, it causes it to _____.
8. The greater the force that is applied, the _____ the acceleration.
9. The lesser the force that is applied, the _____ the acceleration.
10. If the same force is applied to an object with a large mass, it will have a _____ acceleration.
11. If the same force is applied to an object with a small mass, it will have a _____ acceleration.
12. The equation that is used to solve second law problems is **$F = ma$** .
 - a. What do each of the variables mean?
 $F =$ _____ $m =$ _____ $a =$ _____
 - b. What unit of measurement must be used with each variable?
 $F =$ _____ $m =$ _____ $a =$ _____

III. NEWTON'S THIRD LAW OF MOTION

13. Newton's third law of motion is also known as the LAW OF _____.
14. Newton's third law says that every time there is an _____ force, there is also a _____ force that is _____ in size and acts in the _____ direction.
15. Newton's third law states that forces must ALWAYS occur in _____.
16. Listed below are ACTION forces. Tell the REACTION force.
- Your bottom pushing on your desk seat
 - A bat hitting a baseball
 - Your finger pressing on your phone screen while texting

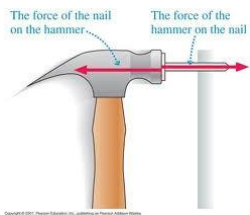
IV. UNDERSTANDING.....

Label each of the following images/descriptions below as being examples of 1st, 2nd, or 3rd law. Then EXPLAIN your answer!



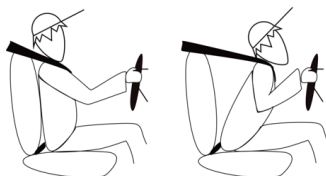
1st law 2nd law 3rd law

Explanation:



1st law 2nd law 3rd law

Explanation:



1st law 2nd law 3rd law

Explanation:



1st law 2nd law 3rd law

Explanation:

1. How much force is needed to accelerate a 1000-kg car at a rate of 3 m/s²?

| GIVEN | WORK |
|----------|----------|
| | |
| ANSWER: | |

2. If a 70-kg swimmer pushes off a pool wall with a force of 250 N, what is her acceleration?

| GIVEN | WORK |
|----------|----------|
| | |
| ANSWER: | |

3. Find the mass of a football player who has 1250 N of force and has an acceleration of 1.5 m/s².

| GIVEN | WORK |
|----------|----------|
| | |
| ANSWER: | |

4. How much acceleration is given to a 45 kg child with a 0.75N push on a swing?

| GIVEN | WORK |
|----------|----------|
| | |
| ANSWER: | |

5. What is the mass of a car that its going 2 m/s² and then hits a tree with a force of 6000N

| GIVEN | WORK |
|----------|----------|
| | |
| ANSWER: | |

NEWTON'S LAWS WORKSHEET - KEY

I. NEWTON'S FIRST LAW OF MOTION

1. Newton's first law of motion is also known as the LAW OF **INERTIA**
2. Newton's first law says that
 - a. an object that IS NOT MOVING, or is at **AT REST** will stay at **AT REST AND**
 - b. an object that IS MOVING will keep moving with constant **VELOCITY** which means at the same **SPEED** and in the same **DISTANCE UNLESS**
 - c. an **OUTSIDE** force acts on that object.
3. What is inertia?
The resistance of any physical object to any change in its state of motion
4. What property of an object determines how much inertia it has?
Mass
5. Which of the following has more inertia?
 - a. **Bowling ball** or Tennis ball
 - b. **Hammer** or Feather

II. NEWTON'S SECOND LAW OF MOTION

6. Newton's second law of motion is also known as the LAW OF **ACCELERATION**
7. Newton's second law says that when an **UNBALANCED** force is applied to a **MASS (OBJECT)**, it causes it to **ACCELERATE**.
8. The greater the force that is applied, the **GREATER** the acceleration.
10. The lesser the force that is applied, the **LESSER** the acceleration.
11. If the same force is applied to an object with a large mass, it will have a **LESSER** acceleration.
12. If the same force is applied to an object with a small mass, it will have a **GREATER** acceleration.
13. The equation that is used to solve second law problems is **$F = ma$** .
 - a. What does each of the variables mean?
 $F =$ **FORCE** $m =$ **MASS** $a =$ **ACCELERATION**
 - b. What **unit** of measurement must be used with each variable?

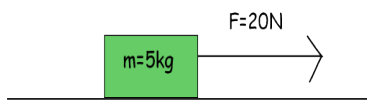
$$F = \text{kg}\cdot\text{m}/\text{s}^2 \text{ (N - Newton)} \quad m = \text{kg} \quad a = \text{m}/\text{s}^2$$

III. NEWTON'S THIRD LAW OF MOTION

14. Newton's third law of motion is also known as the LAW OF **ACTION – REACTION.**
15. Newton's third law says that every time there is an **ACTION** force, there is also a **REACTION** force that is **EQUAL** in size and acts in the **OPPOSITE** direction.
16. Newton's third law states that forces must ALWAYS occur in **PAIRS.**
17. Listed below are ACTION forces. **Tell the REACTION force.**
 - a. Your bottom pushing on your desk seat: **SEAT PUSHING UP ON YOUR BOTTOM**
 - b. A bat hitting a baseball: **BASEBALL HITTING THE BAT**
 - c. Your finger pressing on your phone screen while texting: **PHONE SCREEN PUSHING BACK ON YOUR FINGER**

IV. UNDERSTANDING.....

Label each of the following images/descriptions below as being examples of 1st, 2nd, or 3rd law. Then EXPLAIN your answer!



$$F = m \cdot a$$
$$20\text{N} = 5\text{kg} \cdot a$$
$$a = 4\text{m/s}^2$$

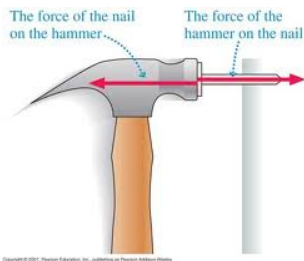
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1st law

2nd law

3rd law

A 20 N force is being applied to a 5kg mass. The resulting calculation is acceleration. $F=ma$

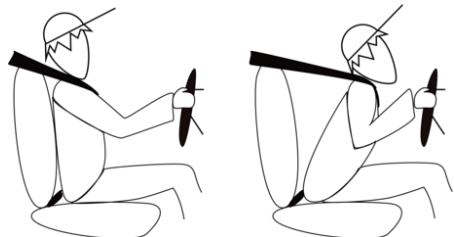


1st law

2nd law

3rd law

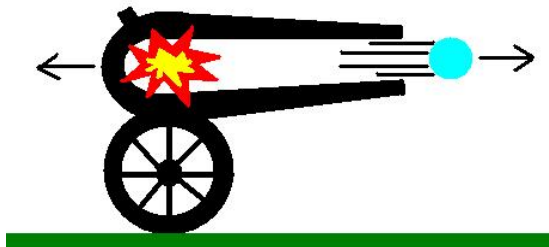
Diagram labels action & reaction forces between the hammer and the nail.



1st law 2nd law 3rd law

Explanation:

The person would continue moving forward if the outside force of the seatbelt didn't stop him.



1st law 2nd law 3rd law

Explanation:

The action & reaction forces between the cannonball and the cannon displayed.

1. How much force is needed to accelerate a 1000-kg car at a rate of 3 m/s²?

| GIVEN | WORK |
|---------|---|
| | $F = (m)(a)$ $(1000\text{kg})(3 \text{ m/s}^2) = 3000 \text{ N}$ |
| ANSWER: | |

2. If a 70-kg swimmer pushes off a pool wall with a force of 250 N, what is her acceleration?

| GIVEN | WORK |
|---------|--|
| | $a = F/m$ $250\text{N} = (70\text{kg})(\text{m/s}^2)$ $250/70 = 3.6\text{m/s}^2$ |
| ANSWER: | |

3. Find the mass of a football player who has 1250 N of force and has an acceleration of 1.5 m/s².

| GIVEN | WORK |
|---------|---|
| | $m = F/a$ $1250 \text{ N} = (m) (1.5 \text{ m/s}^2)$ $1250/1.5 = 833\text{kg}$ |
| ANSWER: | |

4. How much acceleration is given to a 45 kg child with a 0.75N push on a swing?

| GIVEN | WORK |
|---------|---|
| | $a = F/m$ $0.75\text{N} = (45\text{kg}) (\text{m/s}^2)$ $0.75/45=0.017\text{m/s}^2$ |
| ANSWER: | |

5. What is the mass of a car that its going 2 m/s² and then hits a tree with a force of 6000N

| GIVEN | WORK |
|---------|--|
| | $m = F/a$ $6000\text{N} = (m) (2 \text{ m/s}^2)$ $6000/2=3000\text{kg}$ |
| ANSWER: | |

Work and Machines 1

Exploring “Work” as a Scientific Term

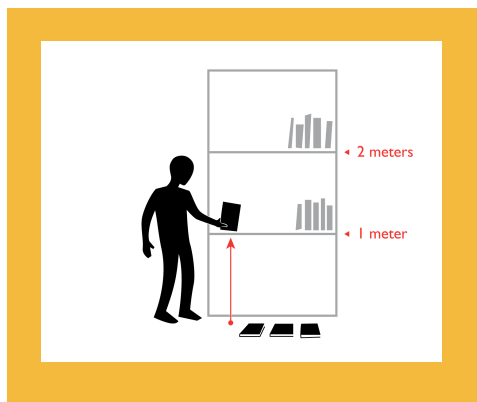
Olivia, Hamza, and Cooper have volunteered to do some **work** for the book fair at their local K-8 school. Here’s what you need to know:

The book fair coordinator has decided to display the books for younger children on a lower shelf and the books for middle school students on a higher shelf. All the books weigh the same. The lower shelf is 1 meter high and the higher shelf is 2 meters high. The books are all on the floor near the shelves. Each book weighs 10 newtons. A newton is a way to measure force. (Think of 1 newton as how much force it takes to hold an apple. It’s reasonable, then, to say that the book weighs 10 newtons, right?)

This is what the volunteers are doing:

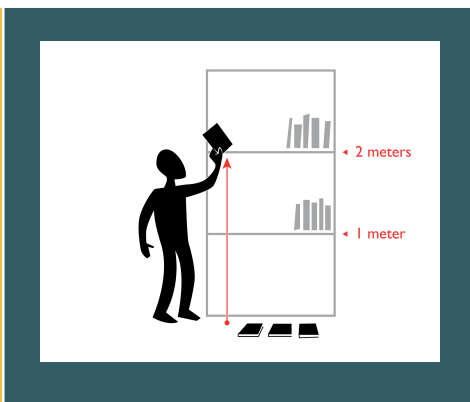
Hamza is...

lifting 1 book at a time and putting it on the 1 meter shelf.



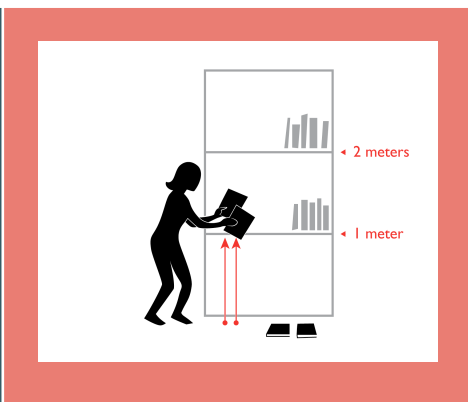
Cooper is...

lifting 1 book at a time and putting it on the 2 meter shelf.



Olivia is...

lifting 2 books at a time and putting them on the 1 meter shelf.



TURN AND TALK

Before figuring this out scientifically, who do you think is doing the most **work**? The least **work**?

- Okay. Here we go with the scientific calculation!
- To figure out **work**, you multiply **force** by distance.
- The **force** needed to hold the book in this situation is 10 newtons.
- The distance the book moves in this situation is either 1 or 2 meters.

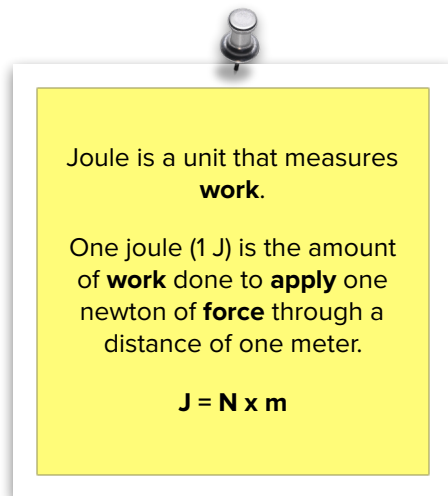
→ **Warm-up Question:** If it takes 10 newtons to hold 1 book, how many newtons does it take to hold 2 books? _____

If you said 20, then you’re right!

To determine Hamza’s **work**, we multiply 10 newtons (the weight of one book) by 1 meter. So the amount of **work** Hamza did was 10. But to say he **worked** “10” is kind of strange: 10 what? Well, we can measure **work** with something called newton-meters, but most scientists call these units *joules* (“joolz”). So...

by lifting 10 newtons 1 meter, Hamza did 10 joules of work.

By using this system of measuring **work**, can you determine the joules of **work** Cooper and Olivia did?



Key

Work and Machines 1

Exploring “Work” as a Scientific Term

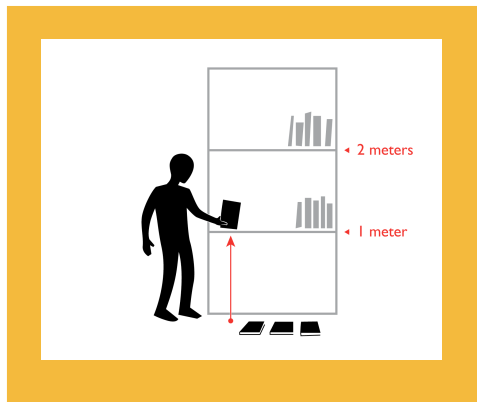
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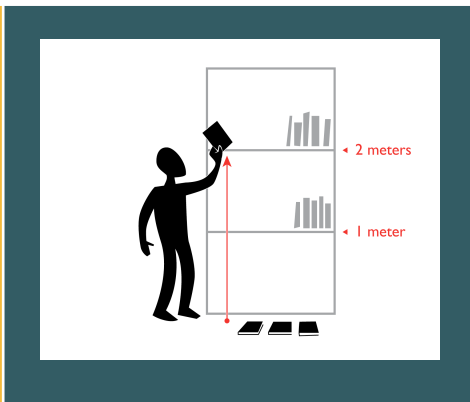
Hamza is...

lifting 1 book at a time and putting it on the 1 meter shelf.



Cooper is...

lifting 1 book at a time and putting it on the 2 meter shelf.



Olivia is...

lifting 2 books at a time and putting them on the 1 meter shelf.



TURN AND TALK

Before figuring this out scientifically, who do you think is doing the most **work**? The least **work**? Hamza is doing the least, Cooper and Olivia are equal but doing the most work

- Okay. Here we go with the scientific calculation!
- To figure out **work**, you multiply **force** by distance.
- The **force** needed to hold the book in this situation is 10 newtons.
- The distance the book moves in this situation is either 1 or 2 meters.

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by lifting 10 newtons 1 meter, Hamza did 10 joules of work.

By using this system of measuring **work**, can you determine the joules of **work** Cooper and Olivia did?

$$\text{Cooper } 10\text{N} \times 2\text{m} = 20\text{ J}$$

$$\text{Olivia } 20\text{N} \times 1\text{ m} = 20\text{ J}$$

Joule is a unit that measures **work**.

One joule (1 J) is the amount of **work** done to **apply** one newton of **force** through a distance of one meter.

$$\mathbf{J = N \times m}$$

LAB: THE HELPFUL PULLEY

1. Build both systems.

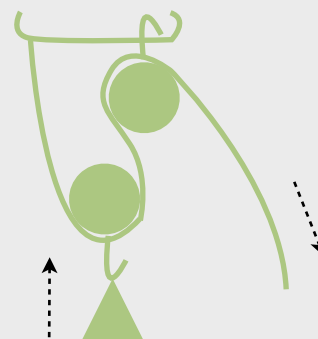
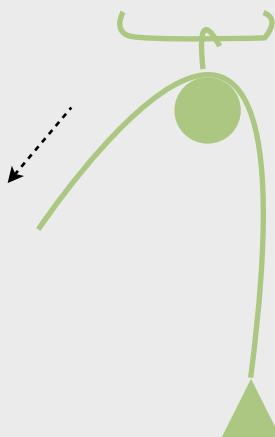
Schematic Drawing
Pulley System #1



Schematic Drawing
Pulley System #2



2. Devise a method to pull the string a distance of 30 cm in both systems.



Also indicate in the chart below which pulley system required more **force** to pull the string. If you don't remember, try it again.

Measure the distance the **load** moved in System #1 when you pulled the string a distance of 30 cm.

Measure the distance the **load** moved in System #2 when you pulled the string a distance of 30 cm.

| | Force needed | Distance the string was pulled | Distance the load moved |
|-------------------------|--|--------------------------------|-------------------------|
| Pulley System #1 | <input type="checkbox"/> less <input type="checkbox"/> more | 30 cm | |
| Pulley System #2 | <input type="checkbox"/> less <input type="checkbox"/> more | 30 cm | |

Summarize your findings:

What is the scientific definition of **work**?

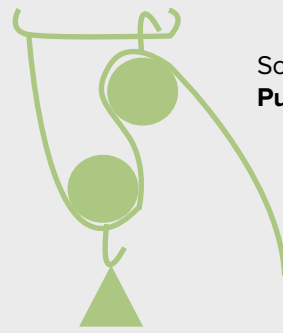
LAB: THE HELPFUL PULLEY

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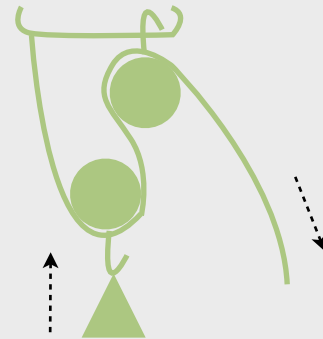
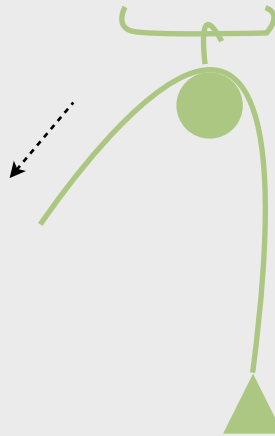
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| | Force needed | Distance the string was pulled | Distance the load moved |
|-------------------------|---|--------------------------------|-------------------------|
| Pulley System #1 | <input type="checkbox"/> less <input checked="" type="checkbox"/> more | 30 cm | varies |
| Pulley System #2 | <input checked="" type="checkbox"/> less <input type="checkbox"/> more | 30 cm | varies |

Summarize your findings:

Pulley #1 - more force is needed so a greater amount of work is needed

Pulley #2 less force - less work - did not go up as far as Pulley #1

What is the scientific definition of **work**?



Lesson 5.1.1 reviewed the vocabulary and formula for **Newton's Laws of Motion**. Lesson 5.1.3 reviewed how to calculate **work** using force and distance, using **pulleys**.

Pulleys are a simple machine that can combine with other simple machines to make work easier by changing the direction of the force on an object. By allowing the work to be done in the same direction as gravity – pulling down towards the ground – pulleys allow an object to be lifted or moved with less force. Pulleys can be used to move objects over one another.

Friction is the force between two objects as they move over one another, such as a car's tire and the surface on which it is travelling.

There are two types of friction – **static** and **kinetic**.

Static friction is the frictional force required to start an object moving on another surface.

Kinetic frictional force is the force to keep the object in motion.

The amount of friction in a system can influence the amount of force needed to move an object. Friction can slow down movement or make it harder to move an object.

Materials:

| | | | |
|----------------------------|-----------|--------|-------|
| Ramp with various surfaces | Halls Car | Timers | Scale |
|----------------------------|-----------|--------|-------|

Part 1a. Going DOWN! Gradient 1

Record the time it takes for the Halls Car to go down the ramp with each of the ramp surfaces in the following data table. Average the trials.

| Ramp Surface | Trial 1 | Trial 2 | Trial 3 | Average time |
|--------------|---------|---------|---------|--------------|
| None | | | | |
| Red | | | | |
| Green | | | | |
| Purple | | | | |

Part 1b. Going DOWN! Gradient 2

Record the time it takes for the Halls Car to go down the ramp with each of the ramp surfaces in the following data table. Average the trials.

| Ramp Surface | Trial 1 | Trial 2 | Trial 3 | Average time |
|---------------|---------|---------|---------|--------------|
| None | | | | |
| Red Carpet | | | | |
| Green Rubber | | | | |
| Purple Rubber | | | | |

Which of the gradients, the lower or the upper slowed the car down? Did the surface matter? Explain.

Part 2 – Going UP!

In the next trials, the Halls car will be pulled up the ramp with a string, comparing the various surfaces.

1. Mass the car in grams. _____ grams
2. Convert the mass to kilograms. _____ kg
3. Measure the distance of the ramp in centimeters using Gradient 1. _____ cm
4. Convert the centimeters to meters. _____ m

5. Divide the weight of the car in kilograms by the distance of the ramp in meters. This formula determines force.

$$\text{Kg/m} = \text{Force (N)}$$

6. Use the information from the table below to calculate the effect of friction on the car going up the ramp.

| Surface | Mass of Car (kg) | Gravity Constant | Friction Co-efficient |
|---------------|------------------|-----------------------|-----------------------|
| None | | 9.81 m/s ² | 0.05 |
| Red Carpet | | 9.81 m/s ² | 0.300 |
| Green Rubber | | 9.81 m/s ² | 1.15 |
| Purple Rubber | | 9.81 m/s ² | 1.0 |

Using the Halls car and the ramp, determine which substrate on the ramp produces the least amount of friction when pulling the car **UP** the ramp using the following formula. Show your work for each of the surfaces.

$$\text{Force (N)} = (9.81 \text{ m/s}^2) \times (\text{friction coefficient of the surface}) \times (\text{mass} - \text{kg of the car})$$

No Surface

Red carpet

Green Rubber

Purple Rubber

Which surface produced the most friction?

Which surface produced the least friction?