UNIT 1

FASTENERS ARD SAFETYINGDEVICES

PRONUNCIATION PRACTICE

threaded	safety wire
metal	rivets
nuts	screws
Lighten	bolts
washers	fasteners
lock washers	engaged
plain washers	fasten
special washers	cotter pins

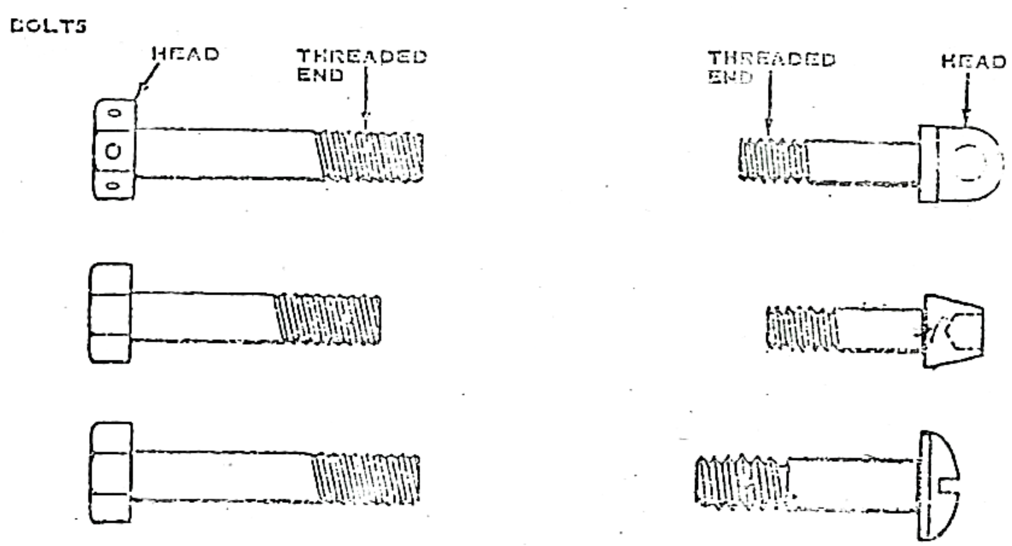
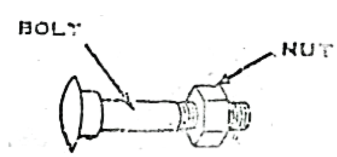


FIGURE 1-1. BOLTS.

These are bolls. Bolts are used to hold parts together. That is, bolts are used to fasten parts together. They are threaded to receive nuts. In other words, bolts are threaded to engage nuts. They are threaded to interlock with nuts. The threaded end of the bolt is shown in figure 1-1. Look at it.

This bolt and this nut are engaged.
The nut is interlocked with the belt.



Bolls are called fasteners. They are known as fasteners because they are used to fasten parts together. Bolts are made of metal.

NUTS

These are nuts. Nuts are used to tighten and fasten parts together. They are threaded to fit bolts. Nuts are shaped to fit wrenches.

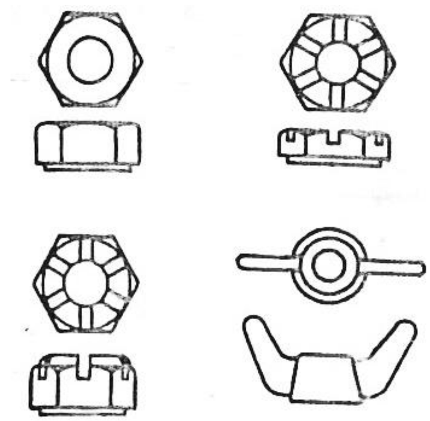
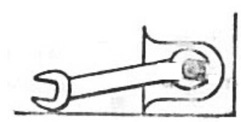


FIGURE 1-2. NUTS.

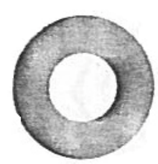
This wrench and this nut fit.



Nuts are shaped to engage wrenches. In other words, they are shaped to interlock with wrenches. Nuts are made of metal. Like bolts, nuts are usually made of steel or an alloy. An alloy is a mixture of metals. Steel is the metal used for making knives, nails, scissors and the like.

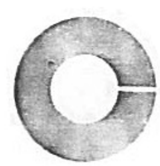
WASHERS

This is a plain washer.



Plain washers are used to provide a smooth surface. They are used under some lock washers to protect surfaces of soft material.

This is a lock washer.



Lock washers are used to lock nuts in the proper position.

This is a special washer.

There are many types of special washers.
Special washers are used for specific installations.

NOTE TO INSTRUCTOR:

It is suggested that the following approaches be tried in presenting the Fluency Practice.

1. Instructor: What is this?

Student A: a plain washer

Student B: This is a plain washer.

The instructor then asks the next question eliciting responses from another pair of students in the class.

2. Instructor: What is this?

Student A: a washer, or this is a washer.

Instructor: What kind of washer is it?

Student A: a lock washer, or it's a lock washer.

Instructor: What is the lock washer made of?

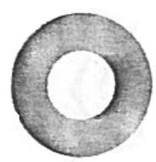
Student A: metal, or it's made of metal.

Then the instructor asks Student B a similar series of questions about the next item. such as a nut, a bolt, or a cotter pin. The instructor then moves on to the next series of interrelated questions.

FLUENCY PRACTICE

Practice the following answers until you can say them fluently.

1. What kind of washer is this?
   a. a plain washer
   b. This is a plain washer.



2. What is this?
   a. a washer
   b. This is a washer.

3. What kind of washer is it?
   a. a lock washer
   b. It is a lock washer.

4. And what is this?
   a. a washer
   b. This is a washer,

5. Can you tell me what kind of washer it is?

a. a special washer

b. Yes, it is a special washer.

6. What are washers usually made of?

a. metal

b. They are usually made of metal.

c. steel

d. They are usually made of steel.

7. What are special washers used for?

a. for specific installations

b. They are used for specific installations.

8. Can you tell me what plain washers are used for?

a. to provide a smooth surface

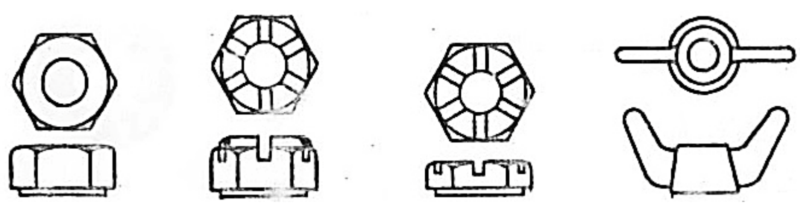
b. Yes, they are used to provide a smooth surface.

9. And what are lock washers used for?

a. to lock nuts in position

b. They are used to lock nuts in position.

10. What are these?



a. nuts

b. These are nuts.

11. What are puts used for?

a. to tighten and hold parts together

b. Nuts are used to tighten and fasten parts together.

12. Why are nuts threaded?

a. to it bolts

b. Nuts are threaded to fit bolts.

13. How are nuts shaped?

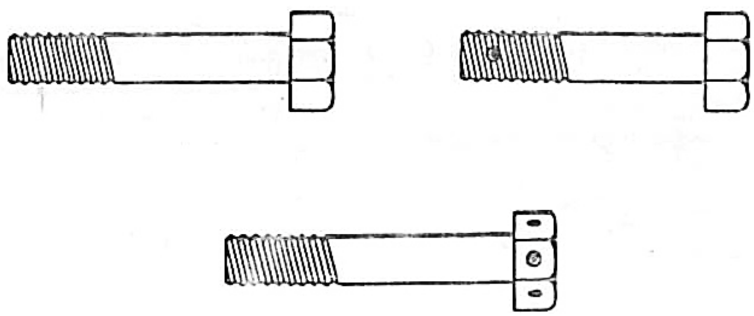
a. to receive wrenches

b. Nuts are shaped to receive wrenches.

c. to engage wrenches

d. Nuts are shaped to engage wrenches.

14. What are these?



a. bolts

b. These are bolts.

15. And what are bolts used for?

a. to fasten parts together

b. Bolts are used to fasten parts together.

16. What are bolts?

a. fasteners

b. They are fasteners.

c. fastening devices

d. Bolts are fastening devices.

17. Why are bolts threaded?

a. to engage nuts

b. Bolts are threaded to engage nuts.

18. What kind of metal are bolts usually made of?

a. steel

b. They are usually made of steel.

COTTER PINS

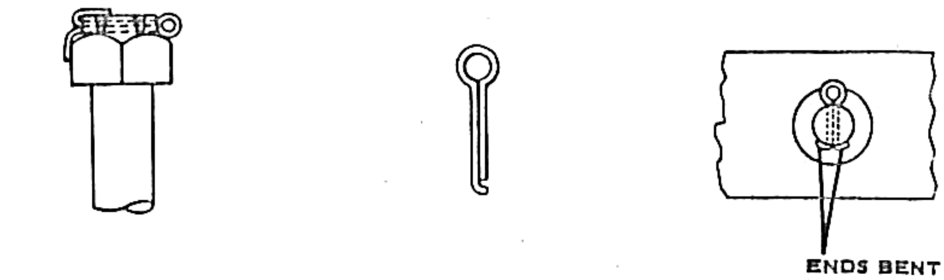


FIGURE 1-3. COTTER PINS.

A cotter pin is a split metal pin. Cotter pins are used to hold nuts in place. They are locking devices. We also refer to cotter pins as safetying devices. As you can see in figure 1-3, the ends are bent to keep the pin from coming out. Cotter pins are also used to safety bolts and other pins. Cotter pins are made of steel.

SAFETY WIRE

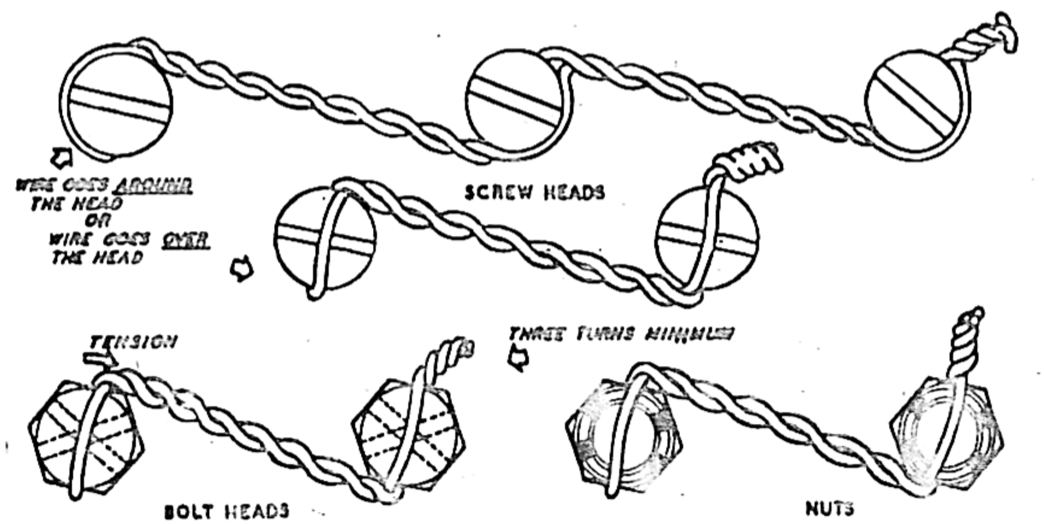


FIGURE 1-4. SAFETY WIRE.

Safety wire is used to lock bolts, nuts, and screws, You can also say safety wire is used to secure bolts, nuts and screws. It is made of either copper or steel. As you can see in figure 1-4, it can be twisted. Safety wire is easily twisted or bent. That is, it is flexible. Safety wire is often inserted into a hole in a bolt or a nut and twisted.

RIVETS

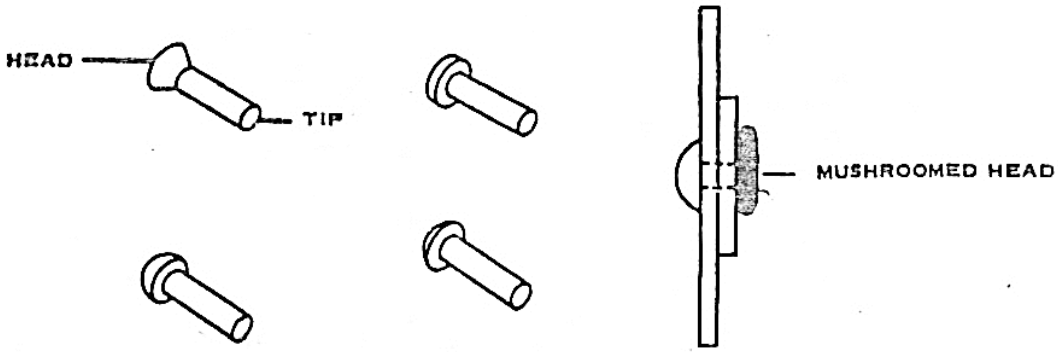
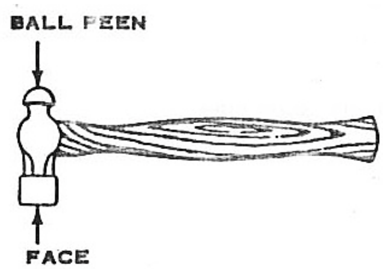


FIGURE 1-5. RIVETS.

A rivet is a metal pin. Rivets are designed to hold pieces of material together. A rivet is a fastener. Rivets are used to fasten together pieces of material. Rivets are generally inserted into holes in material and pounded to form a second head. We say the tip of the rivet is pounded or mushroomed to form another head. The tip and the mushroomed head are shown in figure 1-5.

To mushroom the tip, we use a hammer like this one.



SCREWS

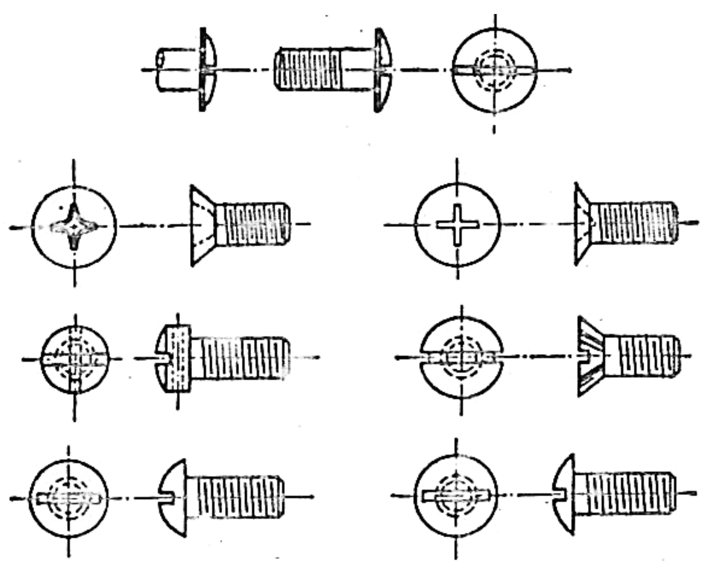


FIGURE 1-6. SCREUS.

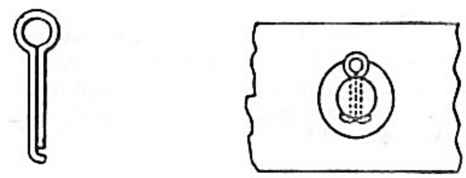
Screws are threaded fastening devices. Screws are used to fasten parts together. Screws are made of metal. The heads of screws are slotted. They are slotted to engage screwdrivers.

This is the slot in the head of a screw. Usually, we can describe a screw by the shape of its head. The slotted head helps us in identifying screws.

FLUENCY PRACTICE

Practice the following answers until you can say them fluently.

1. What are these?



a. cotter pins

b. These are cotter pins.

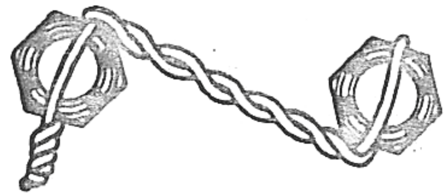
2. What are cotter pins used for?
   a. to hold nuts in place
   b. Cotter pins are used to hold nuts in place.
   c. to safety bolts and other pins
   d. Cotter pins are also used to safety bolts and other pins.

3. What are cotter pins?
   a. locking or safetying devices
   b. They are locking or safetying devices.
   c. Cotter pins are locking or safetying devices.

4. Why are the ends of cotter pins bent?
   a. to keep the pin from coming out
   b. The ends are bent to keep the pin from coming out.

5. What kind of metal are cotter pins made of?
   a. steel
   b. They are made of steel.

6. What is this?



a. safety wire

b. This is safety wire.

7. What is safety wire used for?

a. to secure bolts, nuts and screws

b. Safety wire is used to secure bolts, nuts and screws.

8. What is safety wire made of?

a. copper or steel

b. Safety wire is made of either copper or steel.

9. What are these?

a. rivets

b. These are rivets.

10. What is a rivet?

a. a metal pin

b. A rivet is a metal pin.

11. What are rivets used for?

a. to hold pieces of material together

b. Rivets are designed to hold pieces of material together.

c. to fasten together pieces of material

d. Rivets are used to fasten together pieces of material.

12. And what are these?

a. screws

b. These are screws.

13. What are screws?

a. threaded fastening devices

b. Screws are threaded fastening devices.

14. What are screws used for?

a. to fasten parts together

b. Screws are used to fasten parts together.

15. Why are the heads of screws slotted?

a. to engage screwdrivers

b. The heads are slotted to engage screwdrivers.

UNIT 2
HOSES, TUBING, FITTINGS, AND HAND TOOLS

PRONUNCIATION PRACTICE

hoses	hammers
flexible	driving
synthetic rubber	pounding
tubes, tubing	Wrenches
fittings	loosen
connectors	steel
attach	snips
screwdrivers	straight cut
slot	curved cut
pliers	hacksaws
grip	

HOSES

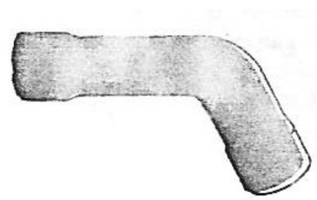


FIGURE 2-1. SYNTHETIC RUBBER HOSE.

Hoses are used to carry liquids to systems. Hoses are also used to carry gases to systems. You can say, “Hoses are used to convey or to transmit liquids or gases to systems." A familiar example is a hose used to convey brake fluid to the brake system of an automobile. Another example is a hose used to transmit water in the cooling system.

Hoses are made of flexible material. Material is flexible if it can be easily bent. Synthetic rubber is usually used in making hoses.

QUESTIONS

1. Are hoses made of flexible or rigid materials?
2. Material is flexible if it can be....................... .
3. What is usually used in making hoses?
4. We can say, Hoses are used to carry or …………………. liquids to systems.
5. Name a substance other than a liquid that is carried by hoses.

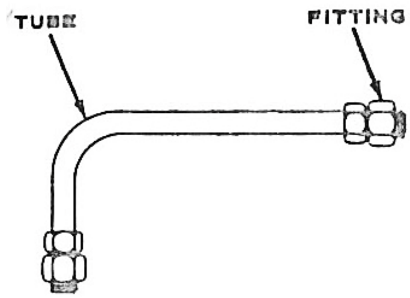


FIGURE 2-2. TUBES

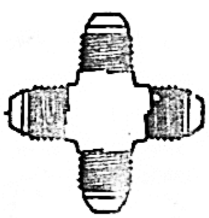
TUBING

Tubing is used to carry liquids or gases to systems. Tubes convey or transmit liquids or gases. A familiar example is tubing used to convey gasoline, a fluid, from the fuel tank to the carburetor of an automobile. Tubing is made of metal. In general, it is made of aluminum, copper, or steel.

FITTINGS

Fittings are used for connecting pieces of tubing to other tubing as you see in figure 2-4. In other words, sittings are used to fasten pieces of tubing together. Fittings come in many sizes and shapes. They are often called connectors. Fittings are also used to attach pieces of tubing to system units. The carburetor, for example, is a unit of the fuel system. It is a system unit. We use a fitting to attach a piece of tubing to the carburetor, a fuel system unit. Fittings are made of metal.

FIGURE 2-3. FITTING



CROSS: FLARED TUBE.

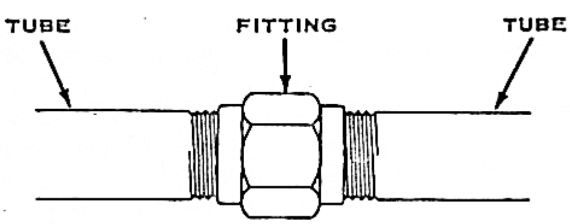
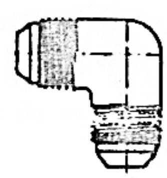


FIGURE 2-4. FITTING AND TUBES.



ELBOW: FLARED TUBE 90º

QUESTIONS

1. What are fittings made of?
2. What are they used for?
3. What are fittings often called?
4. In figure 2-4, are the tubes connected or disconnected?
5. What is used to fasten the tubes together?

SCREWDRIVERS

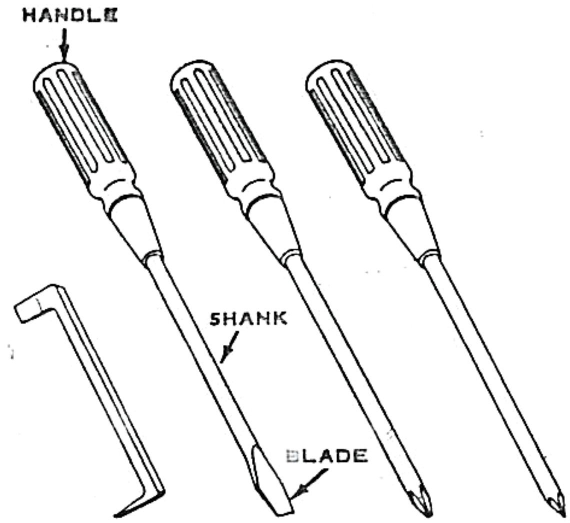
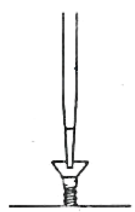


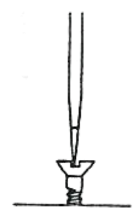
FIGURE 2-5. SCREWDRIVERS.

Screwdrivers are used to turn screws. They are shaped to fit slotted heads of screws. You can also say, “Screwdrivers are designed to fit heads of screws." We insert screws by turning them to the right (clockwise). We remove them by turning them to the left (counterclockwise). As you can see in figure 2-5, a screwdriver consists of a handle, a shank, and a blade. The blades are designed to interlock with the slotted heads of screws.

This screwdriver and this screw head are interlocked. The screwdriver fits the slot in the screw.



Is this a correct fit? What will probably occur if you turn this screw?



PLIERS

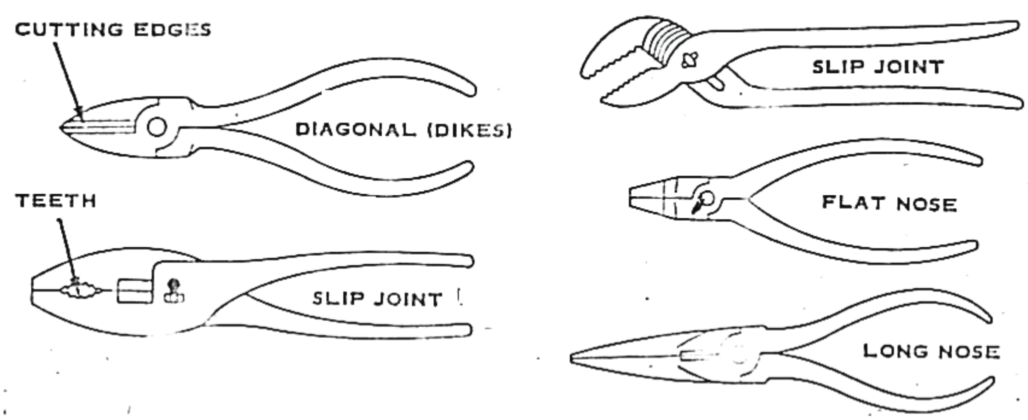


FIGURE 2-6. PLIERS.

Pliers are used to grip things the singers cannot hold. They are used to work in areas where the fingers cannot reach. Pliers are used to cut wire or cotter pins. We use pliers to bend small wire a soft metal. We also use pliers to twist safety wire. Pliers come in many sizes and shapes. Pliers used for ripping things have teeth. Those used for cutting have sharp cutting edges. Pliers are made of metal.

QUESTIONS

1. State the purpose of pliers.
2. What material is used in making pliers?
3. Pliers should not be used to turn fittings. Can you explain why pliers should not be used?

HAMMERS

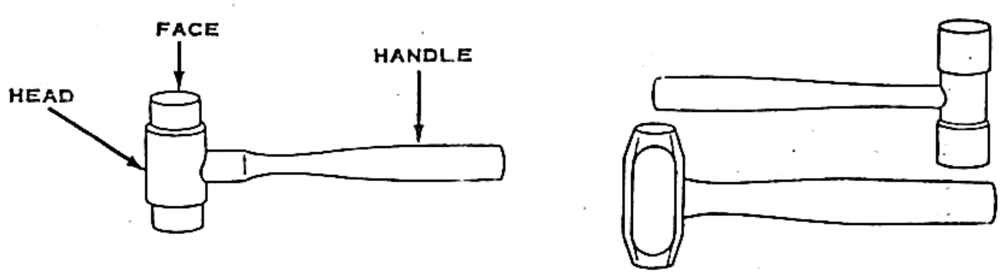


FIGURE 2-7. HAMMERS.

A hammer consists of a handle and a head. Hammers are used for driving and pounding, example, we usually use the brass hammer for driving cotter pins into drilled holes. Then we may use the hammer to pound the bent ends of the cotter pins. Hammers are also used to shape soft metal. Hammer heads are made of metal, rubber, wood and rawhide.

WRENCHES

Wrenches are used to tighten or loosen bolts and nuts. We tighten or loosen bolts and nuts by turning them with wrenches. Wrenches are made of very tough steel. Tough steel is material that is hard to bend or break.

These are socket wrenches and socket wrench handles.

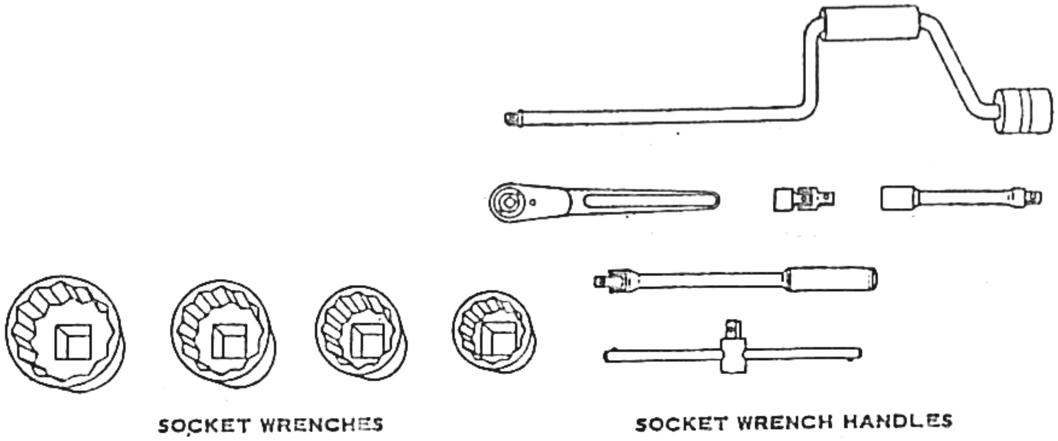


FIGURE 2-8

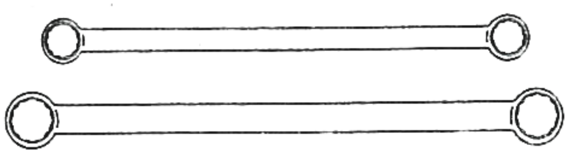
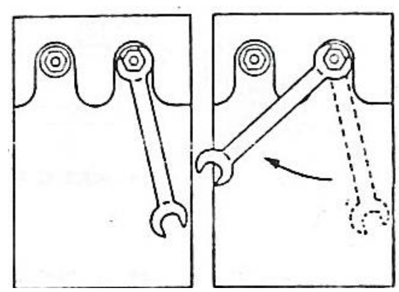


FIGURE 2-9

These are box-end wrenches. They are made of tough steel. The box-end wrench gets its name because of its shape. The end is enclosed or boxed in.

These are open-end wrenches. Like other wrenches, open-end wrenches are used to tighten or loosen bolts and nuts. In other words, they are used to insert or remove bolts and nuts.



This is a crescent wrench. The crescent wrench has a jaw that can be moved to fit different fasteners. The size of the opening can be adjusted by moving the jaw. This wrench is referred to as an adjustable-jaw wrench. There are other types of adjustable-jaw wrenches such as the monkey and the pipe wrenches shown in figure 2-10.

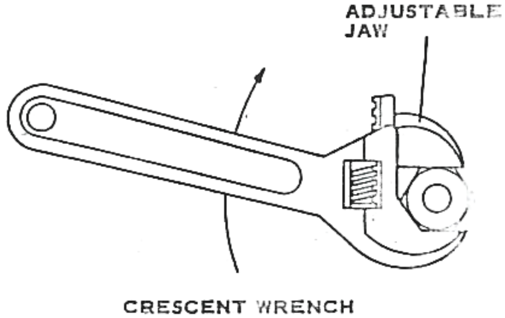
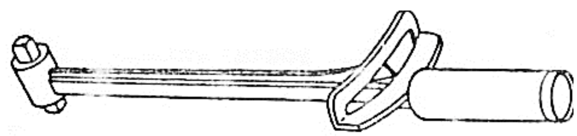
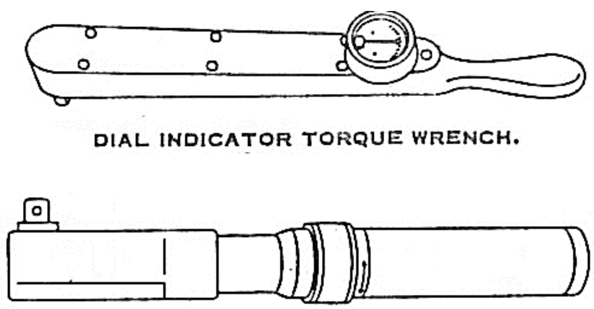


FIGURE 2-10



TORQUE WRENCH

This is a torque wrench. When you twist a bolt or nut, you apply torque. If you apply too much torque, you may break a bolt or strip threads. If you use too little force, you may not fasten parts together tight enough. Torque Wrenches are used to apply the correct torque or force to bolts and nuts. A torque Wrench has a scale to indicate force being applied. There is also a chart to show the proper torque for different sizes of bolts. There are several types of torque Wrenches such as those shown in figure 2-11.



DIAL INDICATOR TORQUE WRENCH.

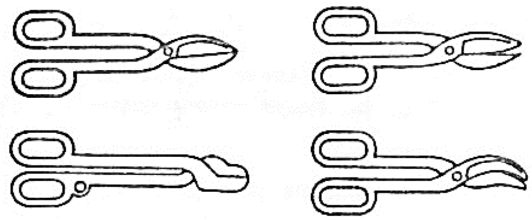
AUTOMATIC RELEASE OR BREAK AWAY TORQUE WRENCH.

FIGURE 2-11

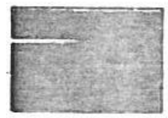
QUESTIONS

1. How would you determine the proper torque to apply to a bolt?
2. What indicates the amount of torque being applied to a bolt or nut?
3. If you applied too much torque to a bolt, what would happen?
4. Why do mechanics use torque Wrenches?
5. When you turn a bolt or nut, you apply…………………………. .

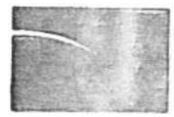
These are band snips, Snips are used to cut pieces of metal. The most commonly used snips cut in a straight line. Some snips are useful in making curved cuts.



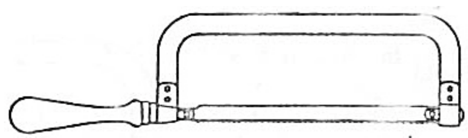
This is a straight cut.



This is a curved cut.

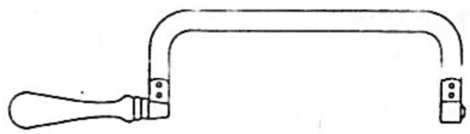


Snips are used to cut thin or soft pieces of metal.



Hacksaws are used to cut pieces of metal. They are useful in cutting metal too thick or hard for snips.

This is a hacksaw frame.



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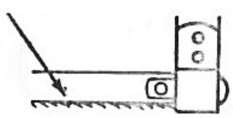
This is a hacksaw blade.

These are hacksaw blade teeth.



FLUENCY PRACTICE

Practice the following short and complete answers until you can say them fluently.

1. What is this?

a. a hose

b: This is a hose.

2. What is the purpose of hoses?

   a. to convey liquids and gases

   b. Hoses serve to convey liquids and gases to systems.

3. What are hoses usually made of?

   a. synthetic rubber

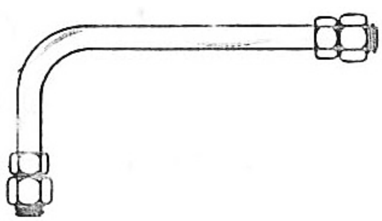
   b. Hoses are usually made of synthetic rubber.

4. Are hoses made of flexible or rigid material?

   a. flexible material

   b. Hoses are made of flexible material.

5. What is this?



   a. a tube

   b. This is a tube.

6. What is the purpose of tubes?

   a. to carry liquids and gases

   b. Tubes serve to carry liquids and gases to systems.

7. What material is used in making tubes?

   a. metal

   b. Metal is used in making tubes.

8. What are fittings, used for?

   a. for connecting pieces of tubing

   b. Fittings are used for connecting pieces of tubing to other tubing.

   c. to attach pieces of tubing to system units

   d. Fittings are also used to attach pieces of tubing to system units.

9. Name some of the purposes of pliers.

   a. to grip things the fingers cannot hold

   b. to work in areas where the fingers cannot reach

   c. to cut wire or cotter pins

   d. to bend small wire or soft metal

10. What are hammers used for?

    a. for driving and pounding

    b. Hammers are used for driving and pounding.

11. Name some materials used in making hammer heads.

    a. metal and rubber

    b. wood and rawhide

12. What are wrenches made of?

    a. very tough steel

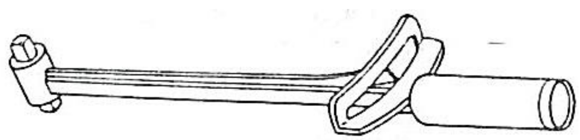
    b. Wrenches are made of very tough steel.

13. What are they used for?

    a. to tighten or loosen bolts and nuts

    b. They are used to tighten or loosen bolts and nuts.

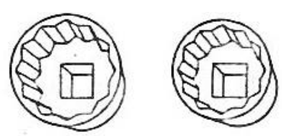
14. What kind of wrench is this?



    a. a torque Wrench

    b. It is a torque Wrench.

15. What are these wrenches called?



    a. socket wrenches

    b. They are called socket wrenches.

UNIT 3
POWER TOOLS AND HAND TOOLS

PRONUNCIATION PRACTICE

power tools	smooth surface
electric drills	bright surface
portable	polishing
drill press	polishing wheels
drill bits	buffing
twist drills	buffing wheels
twisted	chisels
grinders	carbon steel
sharpen	punches
grinding stones	indentations
grinding wheels	dents
abrasive material	files
bench polisher	cut
surface	convenient

Mechanics use power tools to do work easier and faster. It would take a lot of time and effort to make holes in metal with a drill like the one shown here.

ELECTRIC DRILLS

Electric drills are power tools used to make holes in metal or wood. An important advantage of this type of drill is that it is portable. Portable means capable of being easily carried from one place to another.

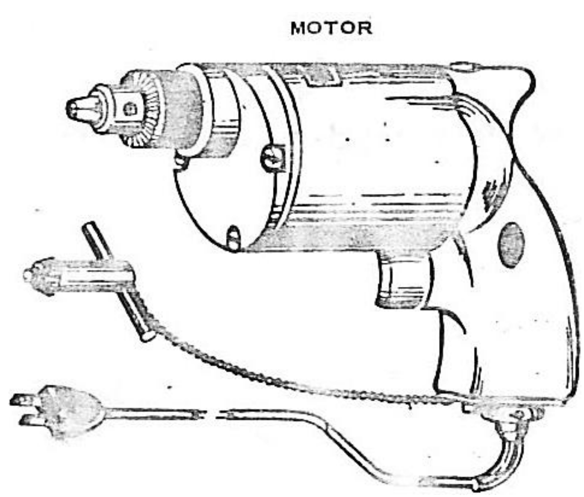


FIGURE 3-1. ELECTRIC DRILL.

This is another Type of electric drill. This is an electric drill press. It is generally combed press. It's used to drill (make) holes in metal or wood. In general. We use the electric drill press to make holes in tough or thick pieces of metal. The drill press is use full in doing work that requires accuracy.

QUESTION

1. what kind of power is used to operate the power tools we have take about here?

2. why do we call the electric drill a portable drill?

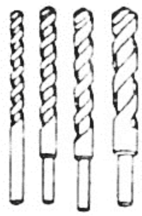
3. we use a Greek word to describe a power tools that uses air for power part of the

word is pneumatic what is it?

4. we also use a Greek word to describe a power tools that uses a liquid for power. What is the word if part of it is hydraulic?

5. when would you use the drill press?

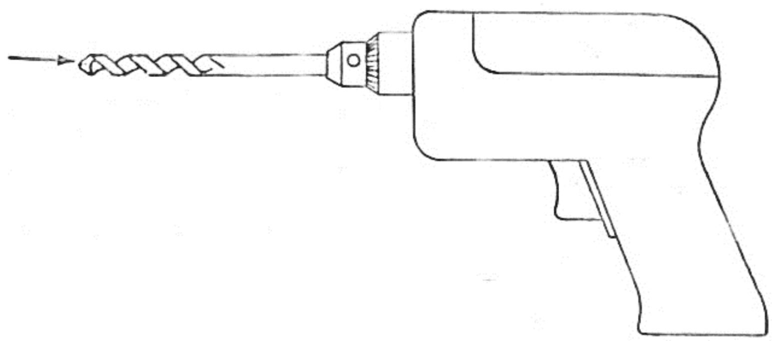
6. what is the purpose of drills?



DRILL BITS

Drill bits are used with the hand drill or the electric drill for boring holes. Drill bits are also called twist drills because they are turned or twisted. Twist drills are end-cutting tools.

This is the cutting edge.



The electric motor causes the Drill bit to turn. In other words, The motor operates the drill bit.

QUESTIONS

1. What are drill bits used with?
2. What are they used for?
3. What are drill bits called? Why?
4. Are drill bits side-cutting or end-cutting tools?

GRINDERS

FIGURE 3-3. GRINDER

This is an electric grinder. Grinders are used to sharpen tools. A sharpening operation is shown in figure 3-3. The man is sharpening a chisel. Grinders also used to smooth rough in surfaces.

GRINDING STONES

Grinding stones are made of abrasive material. Sand, as used on sandpaper, is a familiar example of abrasive material. However, sand is not hard enough to use in making grinding stones. Grinding stones are also called "grinding wheels." Grinding wheels are driven by motors.

QUESTIONS

1. State two purposes of grinders.
2. How are grinding wheels driven?
3. What are grinding stones made of?
4. Name some tools you could sharpen on a grinder.

POLISHERS

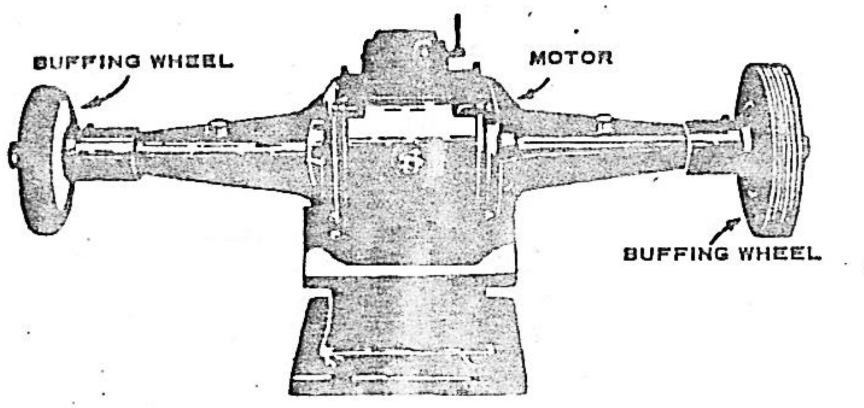


FIGURE 3-4. BENCH POLISHER.

Polishing is a process of removing a very slight (tiny) amount of material from a part. This is done by using a wheel softer than the material to be polished. Polishing differs from grinding in that it does not change the size or shape of the part) It simply makes a bright or smooth surface. Most polishing wheels are made of cloth or leather. We speak or buffing or polishing and call the wheels buffing or polishing wheels.

QUESTIONS

1. Explain the difference between the process of polishing and grinding.
2. What are most polishing wheels made of?
3. What is another name for a polishing wheel?
4. What is the opposite of "slight" as used here?
5. What word has the same meaning?

CHISELS

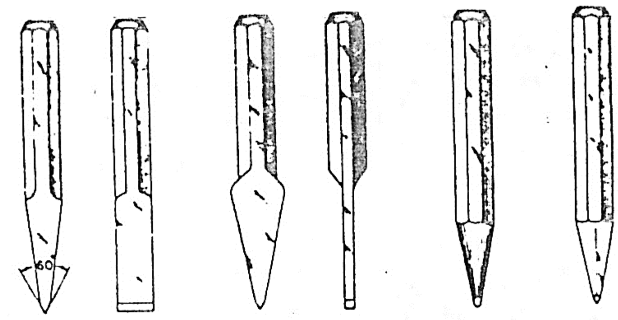


FIGURE 3-5. COLD CHISELS

Chisels are metal tools used in culling wood, metal, stone, etc. The mechanic usually uses a cold chisel in cutting cold metal. Chisels are useful in cutting metal such as bolts in places impossible to reach with a hacksaw. Figure 3-6 illustrates the process of cutting with a cold chisel. Chisels are usually made of carbon steel. Their blades are made in a variety of shapes for different types of work. Chisels have sharp edges.

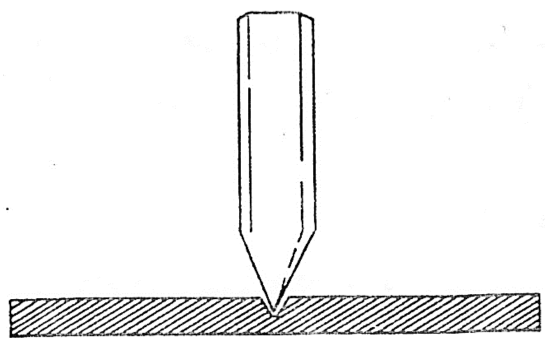
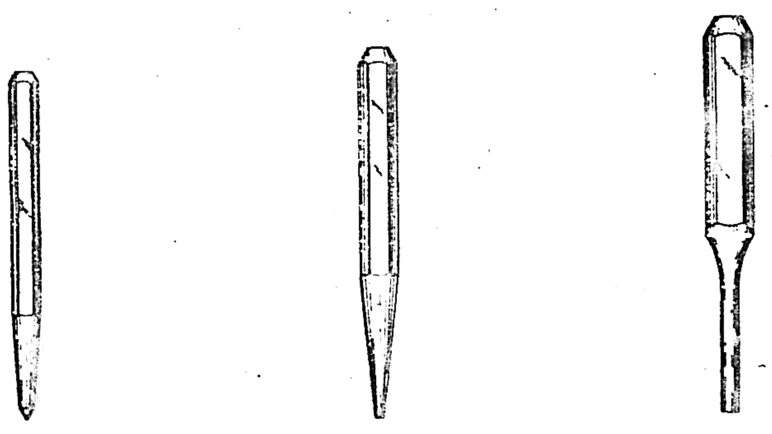


FIGURE 3-6. USING A COLD CHISEL.

PUNCHES



CENTER PUNCH   DRIVE PUNCH   PIN PUNCH

FIGURE 3-7. TYPES OF PUNCHES

There are several different type of punches. There common types are shown in figure 3-7. The center punch is used to made indentations (dents) in metal in order to start a twist drill. Without indentations such as those shown here, the holes might be drilled in the wrong places.

Drive punches and pin punches are used to drive pins and bolts out of holes in which they are sometimes tight. Punches are usually made of carbon steel, very tough metal.

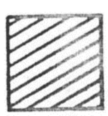
QUESTION

1. What are chisels and punches usually made of?
2. What is the purpose of chisels?
3. What is the purpose of center punches?
4. What do we use drive punches and pin punches for?
5. What would you use to sharpen these tools?
6. What would you use to hit them?

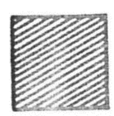
FILES

FIGURE 3-6. FILE

Files are convenient for removing high or rough spots on metal parts. Files come in various sizes, shapes, and cuts. Coarse cuts like this are used for rough filing.



Smooth cuts like this are used for finish filing.



QUESTIONS

1. How do files come?
2. What are they convenient for?
3. What kind of work do we do with coarse cuts? smooth cuts?
4. Would a file or a grinder be more convenient for working in places hard to reach?

FLUENCY PRACTICE

A. Practice the following short and complete answers until you can say them fluently.

1. What is this?

a. a file

b. This is a file

2. What are files convenient for?

a. for removing high or rough spots

b. They are convenient for removing high or rough spots.

3. Are these punches or chisels?

a. Punches

b. These are punches.

4. What are the purposes of punches?

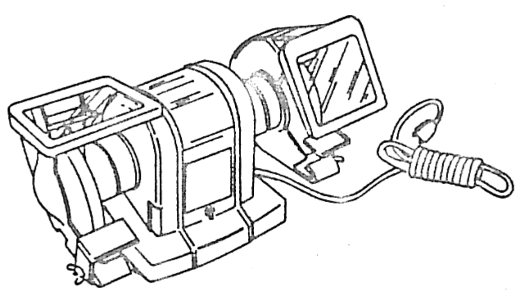
a. I to make indentations in metal

b. Punches are used to make indentations in metal.

c. to drive pins and bolts out of holes

d. Punches are used to drive pins and bolts out of holes.

5. What is this?



a. a grinder

b. It's a grinder.

c. It's an electric grinder.

6. Is an electric grinder a power tool?

a. Yes.

b. Yes, it is.

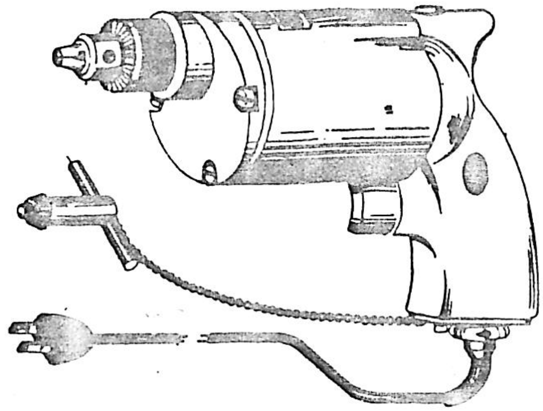
c. Yes, it's a power tool.

7. What is the purpose of grinders?

a. to sharpen tools

b. Grinders are used to sharpen tools.

8. What is this?



a. an electric drill

b. It's an electric drill.

9. What kind of work do we do with drills?

a. make holes in metal and wood

b. We make holes in metal and wood.

10. What is used with drills to cut the holes?

a. drill bits

b. Drill bits are used to cut the holes.

B. Listen to the sentence and select the correct word to complete the sentence.

Example: The instructor or a student will say,

“Drill bits are made of brass, carbon steel, leather.

" The student should say,

“Drill bits are made of carbon steel."

1. Grinding wheels are made of materials that are:

abrasive

soft

smooth

2. A tool used to make holes in metal is:

a hacksaw

a drill

a file

3. A tool used to remove a slight amount of material from a part is called:

a chisel

a hammer

a polisher

4. A tool used to make indentations is called:

a screwdriver

a punch

a drill

5. Files are convenient for removing:

high spots from material

soft spots from material

Smooth spots from material

C. Listen to the following questions and give complete answers.

1. If you needed to remove high or rough spots from a part, what would you use?
2. If you wanted to bore a hole in a piece of metal or wood, what would you use?
3. If you wanted to drive a pin or bolt out of a hole in which it was tight, what would you use?
4. What would you use if you needed to sharpen a chisel?
5. What should be used to make an indentation in metal?

1) electric drill 2) drill press 3) drill bits 4) grinder 5) polisher 6) File

7) punch 8) chisel

UNIT 4
MEASURING INSTRUMENTS

PRONUNCIATION PRACTICE

measuring instruments	dimensions
precise	micrometers
accurate	dividers
steel rules	arcs
graduated	circles
linear measurements	Scribers
steel tapes	thickness gages
calipers	feeler gages
diameters	clearances
	gap

A mechanic's work must be precise. If it is not accurate, the parts and materials he is working on will not fit right. He uses measuring instruments to be sure that his work is accurate.

The most common unit of measurement used in repair and maintenance is the inch. A few examples of measuring instruments are steel rules and flexible steel tapes, calipers, thickness gages and screw-pitch gages.

STEEL RULES

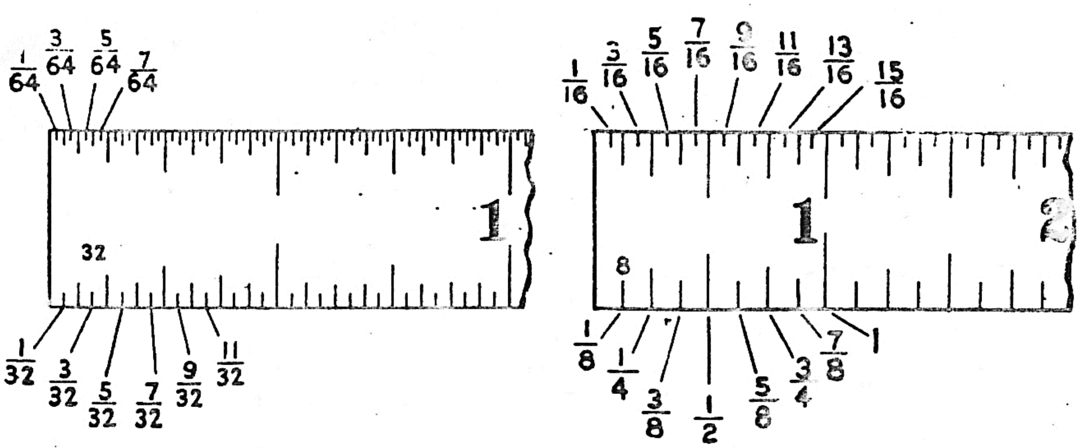


FIGURE 4-1. STEEL RULES (ENLARGED).

Rules are graduated metal instruments. They vary in length from four to twelve inches. The -edges-of-a- twelve-inch. rule are usually graduated (divided) into 8ths and 16ths of an inch on one side, and into 32nds and 64ths on the other, as you can see in figure 4-1.

The steel rule is used for linear measurements. Linear measurements are those made in a straight line. You will use the steel rule for measurements such as depth, length, or width of objects, as illustrated in figure 4-2.

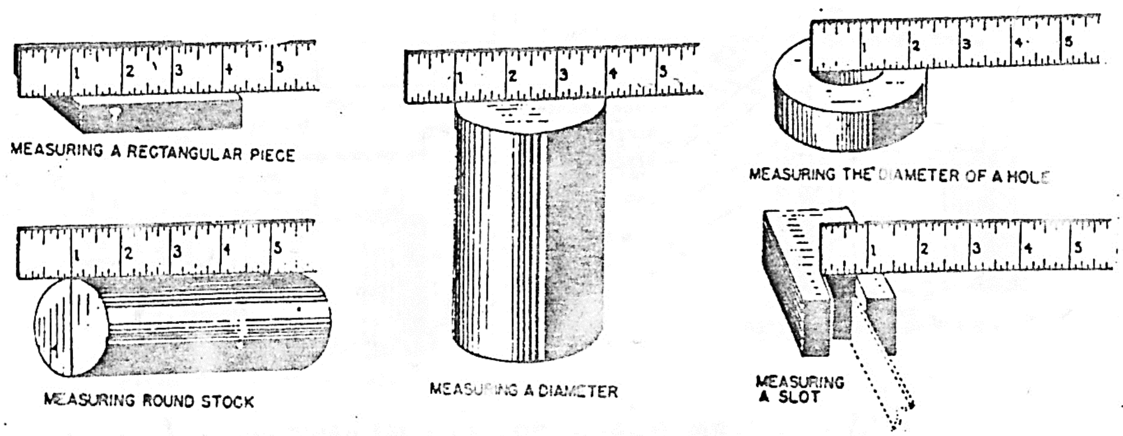


FIGURE 4-2. MAKING LINEAR MEASUREMENTS.

STEEL TAPES

There are several kinds and lengths of tapes. The one used by the mechanic is usually six feet long and made of flexible steel. If something is easily bent, it is flexible. Tapes are usually graduated into 16ths or 32nds of an inch. This type of tape is coiled in a metal case. You draw it out when you want to use it. The kind shown in figure 4-3 is reeled in when not in use. Like steel rules, tapes are used. for making linear measurements.

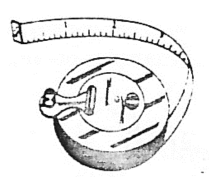


FIGURE 4-3. STEEL TAPE

QUESTIONS

1. What kind of measurements are made with the steel rule and the steel tape?
2. Give an example of a linear measurement. (Rotate question.)
3. What do we mean when we say that the steel tape is flexible?
4. What do we mean when we say that the steel rule is a graduated instrument?
5. What is the most common unit of measurement used in repair and maintenance?

CALIPERS

Calipers are used for taking measurements. Pocket slide calipers, outside calipers, and inside calipers are three common types used by the mechanic.

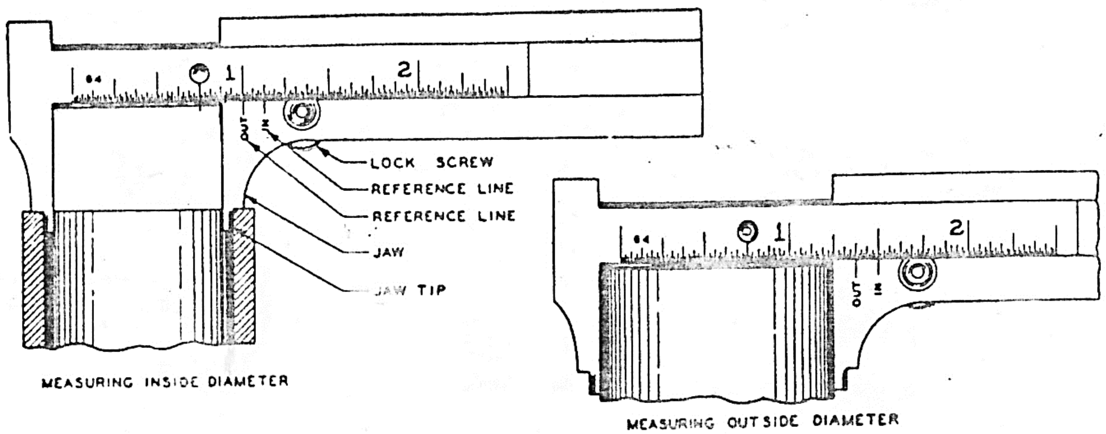


FIGURE 4-4. PAKET SLIDE CALIPERS.

The slide caliper is used to measure inside diameters and outside diameters, as you can see in figure 44. “Slide caliper" is short for “pocket slide caliper." You cantoke fairly accurate measurements with this instrument. To determine a measurement, you adjust the calipers inside or outside the object and read the scale. The slide caliper is usually graduated into 64ths of an inch.

Outside calipers are used for measuring outside dimensions. As you can see in figure 4-5, for example, outside calipers are used for measuring the diameter of a round bar.

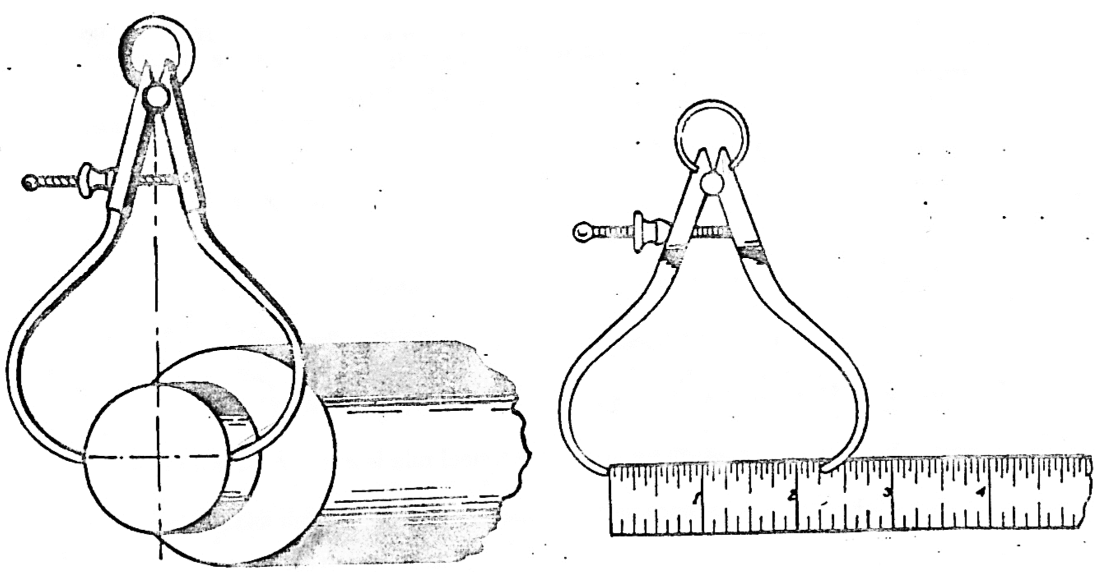


FIGURE 4-5. USE OF OUTSIDE CALIPERS.

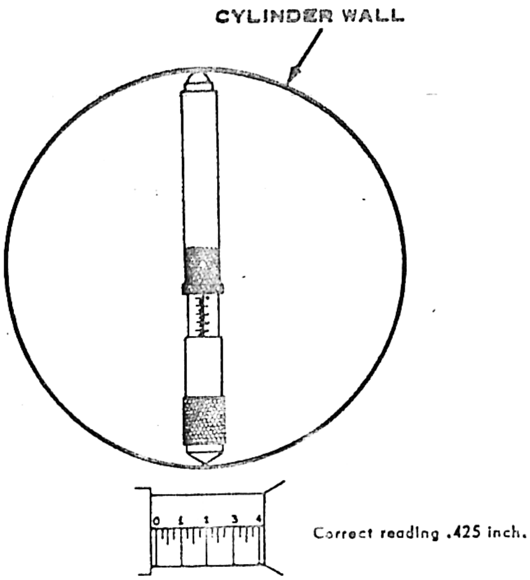


FIGURE 4-8. INSIDE MICROMETER.

The inside micrometer is also an adjustable measuring instrument. You would use it to measure the-ins ide diameters of cylinders and the width of recesses. One use of the inside micrometer is shown in figure 4-8 where the inside diameter of a cylinder is measured.

DIVIDERS

As shown in figure 4-9, dividers consist of two steel picks with sharp points. They are used to mark arcs and circles and to transfer measurements. When the mechanic needs to indicate how a piece of material is to be cut or shaped, he marks it with a divider. In other words, he scratches the arc or circle on the material and cuts or shapes to the marks.

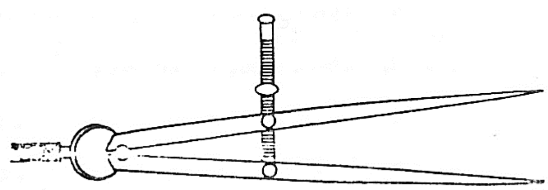


FIGURE 4-9. DIVIDERS.

QUESTIONS

1. Is the micrometer a fixed or an adjustable measuring instrument?
2. Name a fixed measuring instrument.
3. Is a micrometer more or less accurate than a caliper?
4. State a purpose of the outside micrometer; the inside micrometer.
5. Describe a divider.
6. What are dividers used for?

Inside calipers are used to measure inside diameters. Figure 4-6 shows you an inside caliper being used to make an inside measurement.

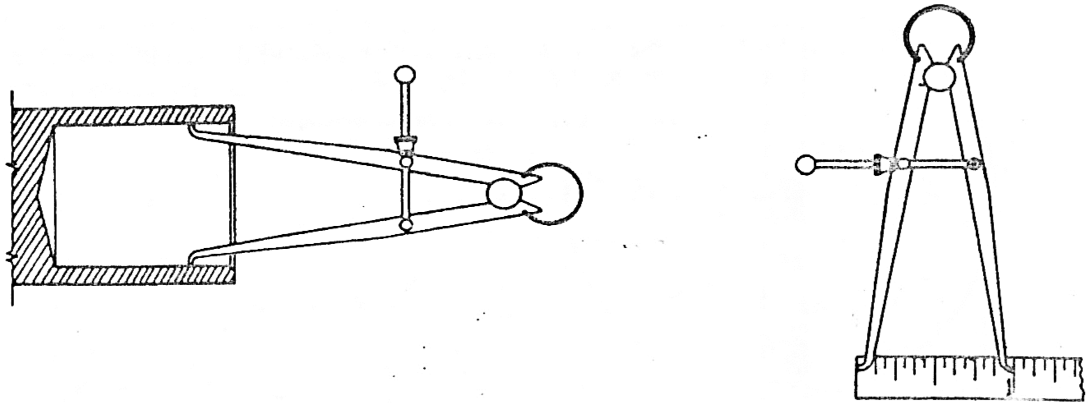


FIGURE 4-6. USE OF INSIDE CALIPERS.

QUESTIONS

1. Name one common type of caliper. (Rotate question.)
2. What are inside calipers used for?
3. What are outside calipers used for?
4. And what is the purpose of pocket slide calipers?
5. If someone asked you for a caliper with a scale, which one would you give him?
6. You can move the parts of calipers toward the object you are measuring. If a near equivalent for “Love" as used here begins with “adjust” what is the word?
7. If one jaw of the slide caliper is fixed, not movable, how is the other jaw?
8. Are the legs of calipers adjustable?
9. Which caliper would you use to measure the diameter of a bolt?

MICROMETERS

The most accurate of the adjustable measuring instruments is the micrometer. The mechanic uses an outside micrometer more than any other type. He uses this type, for example, to measure the outside diameter of objects and the thickness of materials. An outside micrometer is shown in figure 4-7.

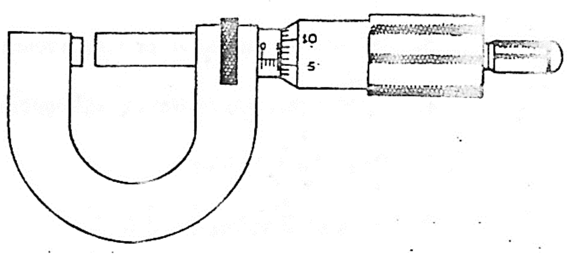


FIGURE 4-7. OUTSIDE MIROMETER.

SCRIBERS

As shown in figure 4-10, a scriber consists of a double-pointed hard-steel pick with a hand le between the pick ends. It is used to mark, or, as we say, lay out works on metal.

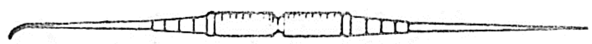


FIGURE 4-10. SCRIBER.

THICKNESS GAGES

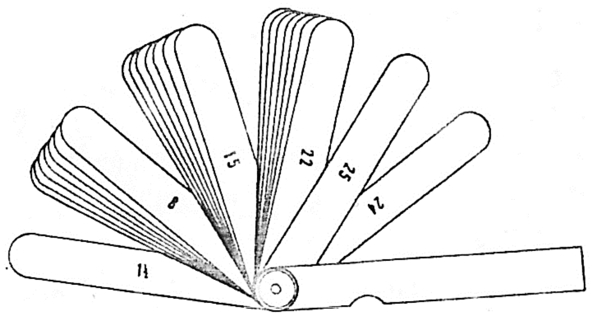


FIGURE 4-11. THICKNESS GAGE.

A thickness gage consists of thin hard-steel leaves. Each leaf is ground to a definite thickness. Thickness gages are used to measure clearances. Thickness gages are also called “feeler gages." Feeler gages, for example, are used to measure the clearances between spark plug parts.

The clearance indicated by the arrow is commonly called the “gap."

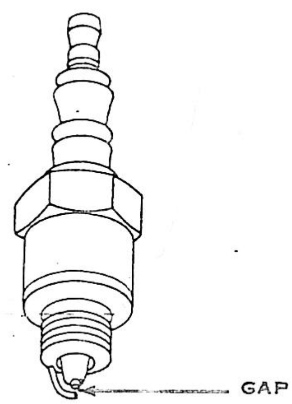


FIGURE 4-12. SPARK PLUG.

SCREW-PITCH GAGES

The screw-pitch gage is used to determine the number of threads per inch on screws, bolts, or other threaded objects. As you can see in figure 4-13, the edge of each leaf has a different number of teeth. The number on each leaf indicates the number of threads per inch, figure 4-14.

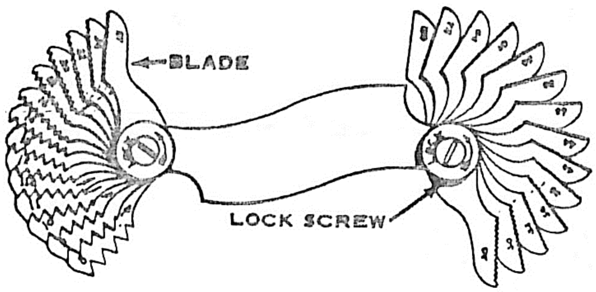


FIGURE 4-13

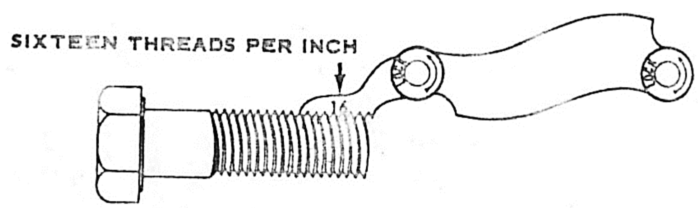


FIGURE 4-14

QUESTIONS

1. What would you say if you needed an instrument to mark arcs or circles on a piece ofmetal?

2. How would you ask for an instrument to measure the clearance between two parts?

3. What would you say if you wanted an instrument to determine the number of threads perinch on a bolt?

4. Describe a thickness gage.

5. Describe a screw-pitch gage.

6. What is the purpose of a scriber?

7. If the mechanic said he needed a tool to scribe a circle, what would you give him?

8. If someone asked for an instrument to measure spark plug gaps, what would you give him?

9. If the mechanic said he wanted an instrument to measure the inside diameter of a cylinder, what would you give him?

10. What would you give a person to make a linear measurement?

FLUENCY PRACTICE

Practice the following answers until you can say them fluently.

1. What is this?

a. a steel rule

b. It is a steel rule.

2. What is the purpose of the steel rule?

a. to make linear measurements

b. The purpose of the steel rule is to make linear measurements.

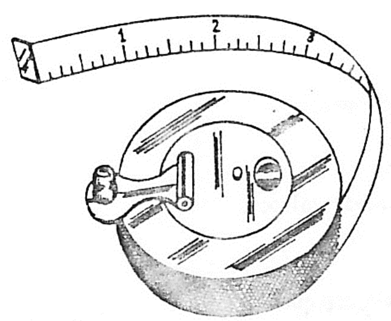
c. The steel rule is used to make linear measurements.

3. What kind of measurements would you make with a steel rule?

a. linear measurements

b. I'd make linear measurements.

4. And what is this instrument?



a. a steel tape

b. It's a steel tape.

5. What is the steel tape used for?

a. to make long linear measurements

b. It's used to make long linear measurements.

6. What kind of measurements do we make with the steel tape?

a. long linear measurements

b. We make long linear measurements.

7. Is the steel tape rigid or flexible?

a. flexible

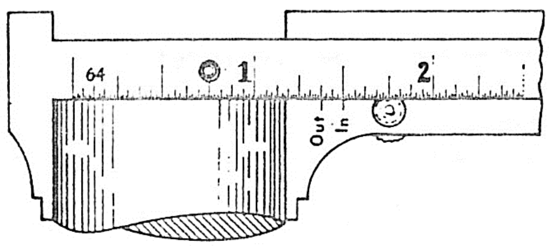
b. It's flexible.

8. What do you mean by "flexible"?

a. easily bent

b. Flexible means easily bent.

9. Is this a measuring instrument?



a. Yes.

b. Yes, it is.

10. What do we call this instrument?

a. a pocket slide caliper

b. It's called a pocket slide caliper.

11. What kind of measurements are made with it?

a. measurements of diameters

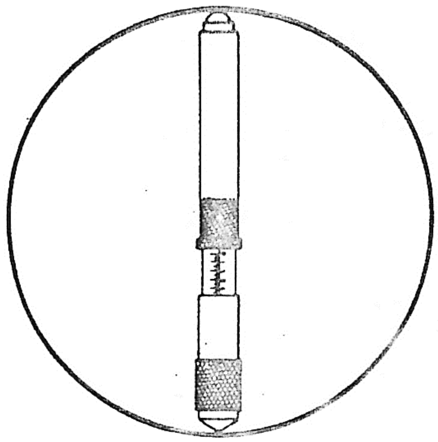
b. Measurements of diameters are made with it.

12. Can you make both inside and outside measurements with the pocket slide caliper?

a. Yes.

b. Yes, you can.

13. What is this instrument known as?



a. a micrometer

b. It is known as a micrometer.

14. Is it an outside micrometer or an inside micrometer?

a. an inside micrometer

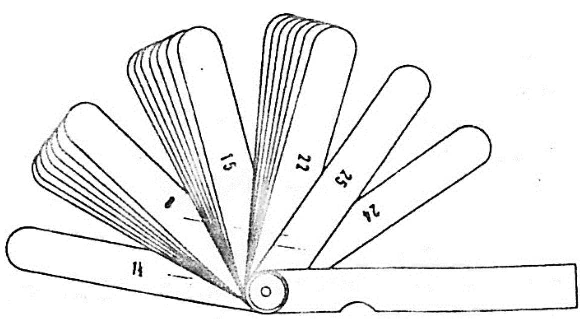
b. It's an inside micrometer.

15. Are micrometers accurate measuring instruments?

a. Yes.

b. Yes, they are very accurate.

16. What kind of gage do we have here?



a. a thickness gage

b. It's a thickness gage.

17. And what is the purpose of the thickness gage?

   a. to measure clearances

   b. The thicknes8 gage is used to measure clearances between two points.

18. Give me a familiar example of how it is used.

   a. to measure spark plug gaps

   b. The thickness gage is used to measure spark plug gaps.

19. What is another name for the thickness gage?

   a. feeler gage

   b. It is called a feeler gage.

UNIT 5

SIMPLE MACHINES

PRONUNCIATION PRACTICE

simple machines	wedge
complex machines	tapering
lever	splitting
crowbar	screw
pulley	lift screws
wheel and axle	fulcrum
inclined plane	groove
rigid substance	foot-pounds

We can get a better understanding of complex machines by learning about simple machines, because complex machines are made up of simple machines. The lever, the pulley, the wheel and axle, the inclined plane, the wedge, and the screw are simple machines.

A machine is a device used to do work. Work is done when a force moves the object it acts upon through distance. If a man holds a 50-pound weight at rest at a height of five feet from the floor, no work is done. On the other hand, work is done if he lifts the weight to a height of five feet.

We can express work with a simple formula. We can call the force F, the distance D, and the work W. Here is the formula.

W = FD (Work equals force times distance.)

This is the way the word "work" is used in mechanics. If you lift a 50-pound weight a distance of five feet, you do 250 foot-pounds of work.

The earliest devices used to do work for man were simple machines. Man learned that he could move things faster and with greater ease by using such devices.

THE LEVER

s

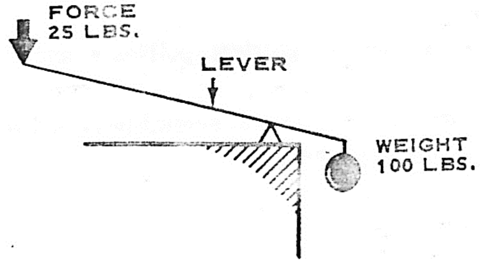


FIGURE 5-1. LIFTING A 100-POUND WEIGHT.

A lever is a bar used to apply force. A familiar example of the lever is the crowbar used to lift things. (Figure 5-2.)

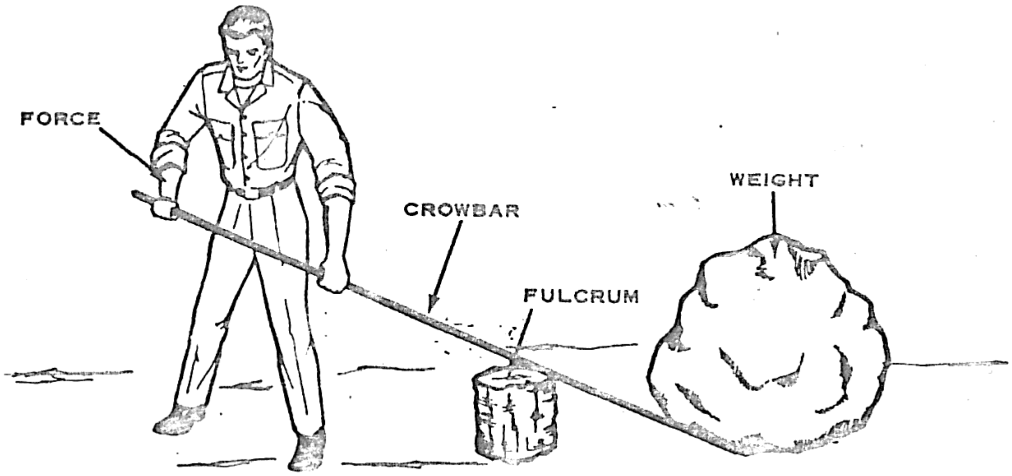


FIGURE 5-2. USING A LEVER.

You couldn't lift a 1,000-pound weight with your hands, but you could with a crowbar. Look at figure 5-2. If the distance from Weight to Fulcrum is half that from Fulcrum to where force is applied, force need be only half that of Weight in order to move Weight.

QUESTIONS

1. What is the formula for work?
2. What is a lever?
3. What are levers used for?
4. What is a machine?
5. What kind of machine is the lever?
6. What kind of machines are grinders, polishers, and electric drills?
7. What kind of machines are pliers, screwdrivers and wrenches?

THE PULLEY

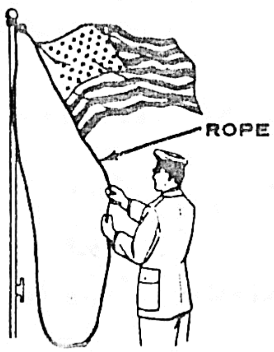


FIGURE 5-3A

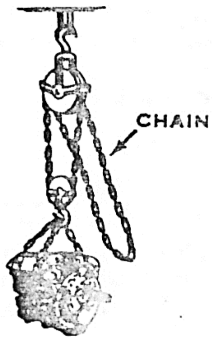


FIGURE 5-3B

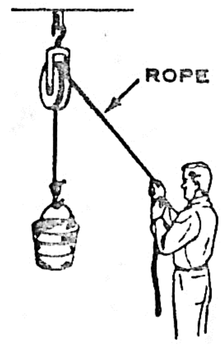


FIGURE 5-3C

FIGURE 5-3. USING PULLEYS.

A pulley is a wheel. A pulley usually has a groove in the rim. The purpose of the groove is to keep a chain or a rope in place. Pulleys are used by the mechanic to lift objects too heavy to raise by hand. Figure 5-3 illustrates some of the applications of pulleys.

QUESTIONS

1.Explain what is being done in figure 5-3a. (Rotate question.)

2. What is a pulley?

3. What is the purpose of the groove in the pulley?

4. What are pulleys used for?

THE WHEEL AND AXLE

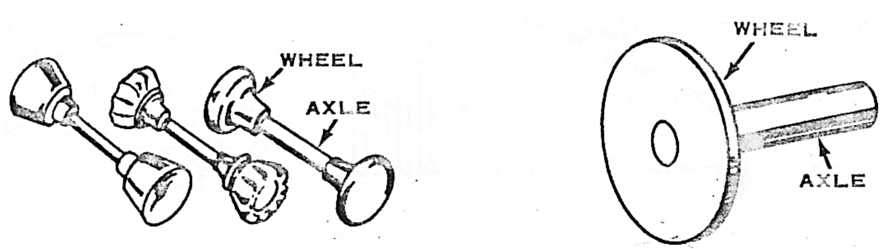


FIGURE 5-4. WHEELS AND AXLES.

The wheel and axle consists of a wheel fastened to an axle. When the wheel is turned, the axle also turns. The doorknob) is a familiar example of a wheel and axle. When you apply force to -the-wheel, -thetorque (turning force) is transmitted to the axle. We can express the same idea by saying the turning force is transferred or conveyed from the wheel to the axle. A slight force on the wheel transmits a large amount of force to the axle, giving us a mechanical advantage. When you wind your watch, you apply the wheel and axle principle.

You might be interested in knowing how to figure the mechanical advantage of a wheel and axle.

$$\text{Mechanical Advantage} = \frac{\text{diameter of wheel}}{\text{diameter of axle}}$$

The formula is read: The mechanical advantage of the wheel and axle is equal to the diameter of the wheel divided by the diameter of the axle.

QUESTIONS

1. What does a wheel and axle consist of?
2. Give a familiar example of a wheel and axle.
3. What principle is applied when you wind your watch?
4. What is the purpose of the wheel on a doorknob?
5. Did you already know the word "diameter" or did you have to look it up?
6. Did you already know the meaning of the term “transmit"?

THE INCLINED PLANE

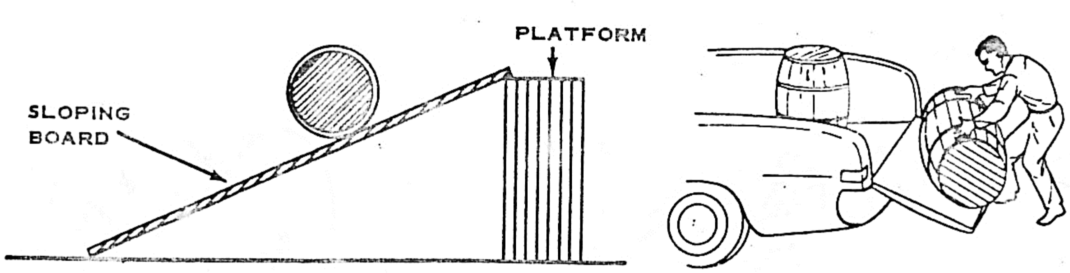


FIGURE 5-5. USING AN INCLINED PLANE.

Perhaps the lever or the inclined plane was the earliest machine used by man! He discovered that he could move heavy objects from the ground to a higher place by using an inclined plane. Figure 5-5 illustrates a use of the principle. One use of the inclined plane is to raise ax lower objects from one level to another. You can increase the mechanical advantage by increasing the length of the plane if the height remains the same. A sloping board can be used as an inclined plane. A sloping approach to a bridge is another familiar example. An inclined plane may be made of wood, metal, or other rigid substances.

QUESTIONS

1. Is an inclined plane a complicated (complex) machine?
2. What kind of machine is it?
3. Give an example of an inclined plane. (Rotate question.)
4. What could you do to increase the mechanical advantage of an inclined plane?
5. Give one use of the inclined plane.
6. Name some substances that can be used to make inclined planes.

THE WEDGE

A wedge is a piece of rigid material tapering to a thin edge. Figure 5-6 illustrates a piece of plain and a piece of tapered material.

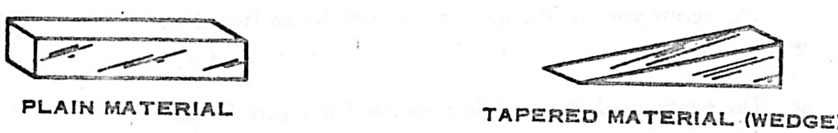


FIGURE 5-6

Wedge's are generally made of wood or steel. A familiar example of a wedge is shown in figure 5-7. Like other simple machines, wedges have many uses. They are usually used for splitting. The process of splitting is shown in figure 5-8.

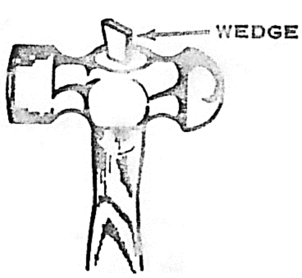


FIGURE 5-7

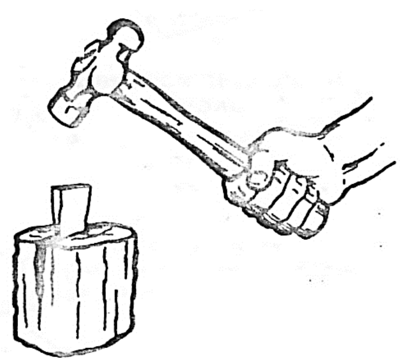


FIGURE 5-8

QUESTIONS

1. What is a wedge?
2. What are wedges generally made of?
3. What are they usually used for?
4. Give me an example of a wedge.

THE SCREW

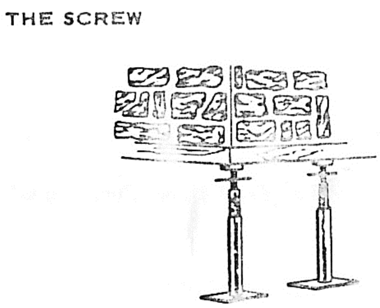
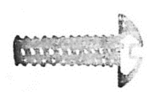


FIGURE 5-9.

RAISING A HOUSE WITH JACKS.

You have already learned one use of the screw. We also use the screw in making screw-type jacks. Jacks are machines used to raise automobiles and houses. Figure 5-9 illustrates one use of the jack.

The screw you are already familiar with looks like this.



The screw used in a jack is illustrated in figure 5-10.

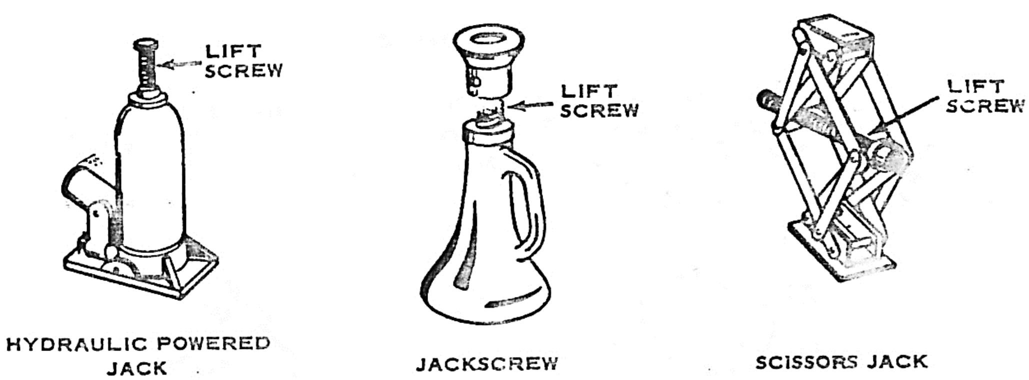
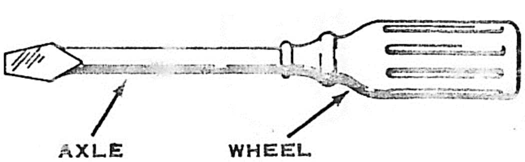


FIGURE 5-10



The bolt is one form of a screw. A wrench is used as a lever with a bolt. With a screw, the machine is a screwdriver. The screwdriver makes use of the wheel and axle principle.

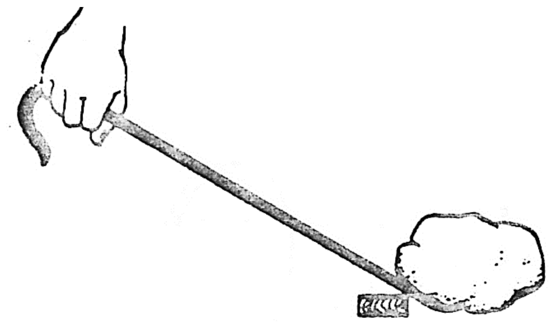
QUESTIONS

1. How can cars be lifted?
2. What is a screw jack used for?
3. What is an essential part of a screw jack?
4. What principle does the wrench make use of?
5. What principle does the screwdriver make use of?

FLUENCY PRACTICE

Practice the following short and complete answers until you can say them fluently.

1. What is this called?



    a. a lever
    b. It's called a lever.

2. What is a lever?
    a. a bar used to apply force.
    b. A lever is a bar used to apply force.

3. What kind of machine is a lever?
    a. a simple machine
    b. A lever is a simple machine.

4. Can you do many things with a simple machine?
    a. Yes.
    b. Yes, you can.

5. What is a common use of the lever?

a. .to lift things

b. A common use of the lever is to lift things.

6. The wrench is used as a lever, isn't it?

a. Yes.

b. Yes, it is.

7. What is applied with the wrench?

a. force

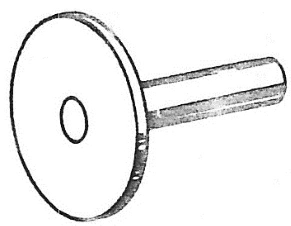
b. Force is applied with the wrench.

8. What is turning force called?

a. torque

b. Turning force is called torque.

9. What is this machine known as?



a. the wheel and axle

b. It's known as the wheel and axle.

10. What does it consist of?

a. a wheel and an axle

b. It consists of a wheel and an axle.

11. The wheel and axle is used to do many things, isn't it?

a. Yes,

b. Yes, it is.

12. Give me an example of a tool that makes use of the wheel and axle principle.

a. the screwdriver

b. The screwdriver is an example.

13. And what is applied with the screwdriver?

a. torque

b. Torque is applied with the screwdriver.

14. Is turning force applied with the door knob?

a. Yes.

b. Yes, it is.

15. What kind of simple machine is the doorknob?

a. a wheel and axle

b. It's a wheel and axle.

16. Force is transmitted from the wheel …………………….. .

a. to the axle

b. Force is transmitted from the wheel to the axle.

17. Then the axle transmits the force to the latch, doesn't it?

a. right

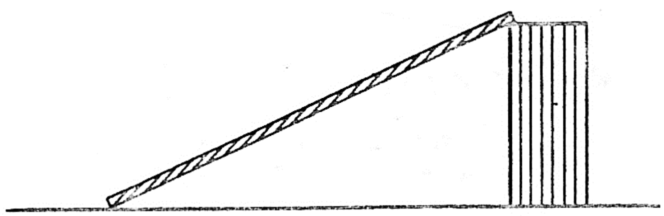
b. That is right.

18. You can see the latch move in and out when you turn the doorknob, can't you?

a. Yes.

b. Yes, I can.

19. Is this a simple or a complex machine?



a. a simple machine

b. It's a simple machine.

20. What is it known as?

a. an inclined plane

b. It's known as an inclined plane.

21. Name two substances commonly used in making inclined planes.

a. wood and natal

b. Wood and metal are commonly used.

22. Give one use of the inclined plane.

a. to raise and lower heavy objects

b. It's used to raise and lower heavy objects.

23. Give a familiar example of the inclined plane.

a. a sloping board

b. A sloping board is an example.

24. A bridge sometimes has a sloping approach, doesn't it?

a. right

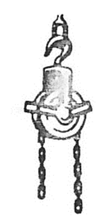
b. That is right.

25. Then we can define an inclined plane as a sloping plane?

a. correct

b. That is correct.

26. This is a wheel with a groove in it. What is it called?



a. a pulley

b. It is called a pulley.

27. What is it probably made of?

a. metal

b. It is probably made of metal.

28. What is the pulley used for?

a. to lift heavy objects

b. It's used to lift heavy objects.

29. What is this simple machine called?

a. a wedge

b. It's called a wedge.

30. What are wedges usually made of?

a. wood or metal

b. Wedges are usually made of wood or steel.

31. And what are wedges usually used for?

a. for splitting things

b. They are usually used for splitting things.

UNIT 6
GROUND SAFETY

PRONUNCIATION PRACTICE

ground safety	violent reaction
jet intake duct areas	flammable material
zones	stuff
jet exhaust blast areas	catch on fire
stay clear	ignite
expel	stored
propeller danger area	extinguish
rotating	hazard
clearing the area	ear defenders
precautions	earplugs
work stand	ear muffs
goggles	ear helmets
safety glasses	exposure
sulphuric acid	

In order to avoid danger areas, you must know where the danger zones are and why they are dangerous. It is also well to know which areas are most dangerous. You must also be careful about dangerous materials and acts.

JET INTAKE DUCT AREAS

Look at figure 6-1, (page 72) and you will see areas in front of a jet aircraft marked “intake duct area." When jet engines are running, jet intake ducts are danger areas. You must stay clear. of these zones by at least a 25-foot radius. The suction of the engines will draw (suck) personnel or equipment into the intake ducts.

Remember:

1. Jet intake ducts are danger areas.
2. You must stay clear of these zones by at least 25 feet.

QUESTIONS

1. Where are jet intake duct areas?
2. Are these areas danger areas?
3. What will happen if personnel enter these areas?
4. What will happen if equipment is left in the intake areas?
5. Personnel must stay clear by at least a distance of …………………. .

What Is Energy?

Part I: Pre-Reading

A. Pronunciation Practice

spe.cial (spĕsh'əl)
mate.ri.al (mə-tîr'ē-al)
current (kûr'ənt)
mus.cle (mŭs'əl)
mus.cu.lar (mŭs´kyə-lər)
wind.mill (wĭnd mĭl)
me.chan.i.cal (mĭ-kån' ĭ-kəl)
gas.o.line (găs´ə-lēn)
har.ness (här´nĭs)
water (wô'tər)
var.i.ous (vâr'sē-əs)
fu.el (fyōō´ əl)
huge (hyōōj)
a.mount (ə-mount')
dis.cov.er (dĬ-skŭv'ər)
source (Sôrs)
ki.net.ic (kĭ-nĕt'ĭk)
po.ten.tial (pə-tĕn'shəl)
grav.i.ty (grăv'ĭ-tē)
twist (twĭst)
wound (waund)
wind (wīnd)
sur.round (sə-round')
down.ward (doun' wərd)
pull (pōōl)

B. Word Study: Definitions

matter:	substance of which a physical thing is made
current:	flow of electricity
mechanical:	of machines; connected with machines; produced by machines
windmill:	mill operated by the wind
water wheel:	wheel made to rotate by the flow of water
gasoline:	petrol; motor spirit
kinetic:	of motion; caused by motion
pull:	force
gravity:	force of attraction between any two objects, especially that force which attracts objects towards the center of the earth

UNIT 6

C. Word Study: Definitions and Exemplifications

take up: occupy time or space; fill time or space

Gases take up the whole space of their containers. bring

about: cause to happen

Heat often brings about chemical changes in matter.

lock up: hold

A great amount of energy is locked up in the atom.

bend: cause something to be out of a straight line or surface

When rays of light pass through a piece of glass, they bend.

twist: turn especially by the use of force

We can twist a strong wire and make a spring.

D. Grammatical Points

An adjective clause is usually introduced by a relative pronoun: that, which, who, whom, etc. It always follows the noun modified, but it may be reduced to a prepositional adjective either single or compound.

1. Model: a. Water which is running has kinetic energy.

b. Running water has kinetic energy.

2. Model: a. This energy is stored in the stone which is lifted.

b. This energy is stored in the lifted stone.

However, if an adjective clause is in the passive form, the relative pronoun and the verb 'be' may be deleted, and the remaining adjective phrase kept after the noun.

3. Model: a. Rubber which is produced by a chemical process in factories is known as synthetic rubber.

b. Rubber produced by a chemical process in factories is known as synthetic rubber.

The majority of statements in technical writing are in the passive form because the technical writer wants to be objective and impersonal. The form of the passive is as follows:

(Pro) noun + a form of be+ past participle + the agent

In technical writing, however, it is not usual to add the name of the agent to a sentence if the agent is a person. But very often the agent is not a person, and it may be necessary to add it.

4. Model: a. Such things as heat, light, sound, and electric current bring about many changes in matter.

b. Many chances in matter are brought about by such things as

Part II: Reading for Comprehension

What Is Energy?

In science, we have a special word for all materials. We call all materials matter. Matter is anything that takes up space and has weight. Plants, animals, air, water, soil, rock-all living and non-living things – are made from matter. Matter itself is made up of very small particles called molecules, and molecules are made up of tiny particles called atoms.

Many changes in matter are brought about by such things as heal, light, Sound, and electric current. Yet these things are not matter because they do not take up space and do not have weight. So there is something besides matter in our world which makes matter move or change. We have a special word for it; we call it energy. Heat, light, sound, and electric current are just some of its different forms. The energy of the muscles that move the parts of your body is called muscular energy. Mechanical devices such as windmills, water wheels, and steam or gasoline engines harness various forms of energy and change them into another form, called mechanical energy. Mechanical energy can be used to run our machines.

Another form of energy is stored in the molecules of some materials. We call this form chemical energy. Coal, gasoline, and other fuels have chemical energy stored in them. When any fuel is burned, the stored energy is released. Huge amounts of still another form of energy are locked up in atoms. This kind of energy is called atomic energy. As new and better ways of releasing atomic energy are discovered, atoms will become one of our most important sources of energy.

Though energy exists in various forms, scientists have found that there are really just two kinds of energy. Running water, a falling weight, or any moving object has energy. You know that this is true because of what happens when they strike something. This kind of energy is called kinetic energy. It is the kind of energy that matter has because of its motion. However, materials and objects often have energy even if they are not moving. If you lift a stone, energy has to be used to overcome the downward pull of gravity. This energy is stored in the listed stone. When you release the stone it falls back to the ground. And the energy stored in the stone is set free. So the other kind of energy is the energy stored in matter. We call this kind potential energy. Springs that have been pulled, pressed, bent, twisted, or wound up contain energy stored as potential energy.

Energy does not take up space and does not have weight, but we can often feel or see what it does. Whenever matter moves or changes, it is energy that causes this to happen. Also, when matter changes, the form or kind of energy, or both will change. For example, when light energy from the sun strikes the earth, much of it is changed into heat energy. But some of it is changed into chemical energy and stored in the food made by green plants. When this food is used in our bodies, the chemical energy is changed into muscular energy and heat.

A. Read each statement and decide whether it is true or false. Write To before true statements and F' before false statements. Base your answers on the information in this passage only, even if you disagree with what the author has said.

……… 1. Water above a dam has potential energy which is released when the

water rushes clown the spillway.

……… 2. We cannot see or feel what energy does.

……… 3. Heat, light, sound, and electric current are the materials that bringabout many changes in matter.

……… 4. A stretched rubber band has kinetic energy.

……… 5. The metabolism of food in our bodies results in muscular energyand heat.

B. Circle a, b, c, or d which best completes the following items.

1. Paragraph 3 mainly discusses ……… .

    a. how chemical energy is released

    b. the importance of atomic energy

    c. chemical energy and atomic energy

    d. atomic energy stored in matter

2. To run a machine, a gasoline engine harnesses .... energy.

    a. mechanical energy and changes it into chemical

    b. chemical energy and changes it into mechanical

    c. heat energy and changes it into chemical

    d. mechanical energy and changes it into heat

3. The food that we obtain from green plants is the result of the change of

.... energy.

    a. light energy into heat

    b. chemical energy into muscular

    c. light energy into chemical

    d. chemical energy into heat

4. It is not true that matter

    a. is anything that occupies space and has weight

    b. is of fundamental importance in the composition of the universe

    c. and energy are the two fundamental factors in the composition of the universe

    d. is the only factor that brings about various changes in the forms of energy.

5. It is not true that energy

    a. can cause matter to move

    b. can take up space

    c. has different forms

    d. has two main kinds

C. Answer the following questions orally.

1. How do you define the two main kinds of energy?
2. What is energy? Can you name at least five different forms of energy mentioned in the passage?
3. Why does a stone fall to the ground when you lift and release it?
4. What is an example of the change of chemical energy into heat energy?
5. What is the scientific word for all materials?

Part III: Homework

Section One: Vocabulary Exercises

A. Fill in the blanks with the words from the following table to complete thesentences. Base your choices on the items of the table only. Make necessary changesif required.

Verb	**Noun**	**Adjective**	**Adverb**
exist	existence	existing	-------
specialize	specialist	special	-------
mechanize	mechanics	mechanical	mechanically
press	pressure	-------	-------

1. They have invented an instrument for measuring the .... of liquids orgases.
2. Some of the .... elements cannot be found in the pure state in nature.
3. If you .... that button, a bell will ring.

4. We have a good .... working with us in our field of study.

5. Farming is .... in order to increase the amount of grains produced.

6. When a man troubled or worried about a problem, he is sometimes unable to concentrate; therefore, he does his work …....... .

7. Our .... depends upon the energy we receive from the sun.

8. Some of the students at the anthropology department will.......... in economic anthropology.

9. Her work is entirely ....; it does not involve imagination or innovation.

10. Most scientists think that water does not .... on the surface of the moon.

11. The science that deals with energy and forces and their effect on bodies

12. Each department in a university has regulations of its own; in other words, each department has .... regulations.

B. Fill in the blanks with the appropriate words from the list below. There are more options than required.

transformed	rotary	capacity	attraction
reaction	force	thermal	weightless
potential	mass	motion	measured

1. The downward.......... exerted by an object is the same as its weight.

2. It is known that energy can be .... from one system to another.

3. In water turbines, the kinetic energy of running or falling water is converted into mechanical ....motion.

4. A nuclear reactor serves to convert nuclear energy into ....energy.

5. The force of attraction exerted by the .... of the earth is called gravity.

6. When a force acts upon a rigid body, it is balanced by an equal force acting in the opposite direction.

7. Energy is commonly defined as the .... of a system to do work.

8. When a body escapes from gravity, it becomes ………. .

C. Match the words in Column I with their appropriate equivalents in Column II. Insert the letters a, b, c, ... in the parentheses provided. There are more options in Column II than required.

Column I **Column II**

1. transmit ( ) a. something invented or adapted for a special

2. rotate ( )purpose

UNIT 7

Oil

Part I: Pre-Reading

A. Pronunciation Practice

pol.i.ti.cian (pŏlĭ-tĭsh'ən)
air.plane (ârplān)
lu.bri.cate (lōō'brĭ-kāt)
re.fine (rĭ-fīn')
com.bus.tion (kəm-bŭs'chən)
car.riage (kărĭj)
war.fare (wôr'fâr)
su.pe.ri.or (Sōō-pîr'ē-ər)
il.lu.mi.nation (ĭ-lōōmə-nā-shən)
slip.per.y (slĭp'ə-rē)
friction (frĭkshən)
prop.er (pròp' ər)
suf.fi.cient (sə-fĭsh'ənt)
air.craft (âr'krăst)
con.fi.dent (kŏn' fĭ-dənt)
for.ma.tion (fôr-mā'shən)
o.rig.i.nate (ə-rĭj'ə-nāt)
dis.tant (dĭs'tənt)
mi.nute (mĭ-nyōōt')
de.pos.it (dĭ-pòz' ĭt)
mud (mŭd)
proc.ess (prŏs'ĕs)
im.pris.on (ĭm-prĭz'ən)
con.firm (kən-fûrm')
glance (glăns)
crude (krōōd)
re.fin.er.y (rĭ-fī' nə-rē)
treat (trēt)
va.por (vā'pər)
com.mon (kŏm'ən)
va.por.ize (vā'pə-rīz)
con.dense (kən-dĕns')

B. Word Study: Definitions

warship:	ship for use in war
lubricate:	put oil or grease into machine parts to make them work easily
internal Combustion engine:	engine in which combustion of a fuel takes place within the cylinder, and products of combustion form the working medium during the power stroke
carriage:	vehicle, especially one with four wheels, pushed by a horse for carrying people

illuminate: give light to

illumination: action of illuminating or state of being illuminated

slippery: causing one to slide or fall; smooth, wet, polished surface so that it is difficult to hold on or to stand on

friction: resistance to relative motion between two bodies in contact

treat: put (a substance) through a process (in manufacture, etc.)

vapor: substance in the gaseous state as distinguished from the liquid or solid state; steam

vaporize: convert into vapor; become vapor

Condense: cause a liquid to increase in density or strength; become thicker; make more compact

C. Word Study: Definitions and Exemplifications

politician: person taking part in politics or much interested in politics

The mayor is a skilled politician.

warfare: making war; condition of being at war; fighting

Warfare raged along the border for days.

sufficient: enough

Do we have **sufficient** fuel for the trip?

aircraft: any machine(s) made to fly in the air

Airplanes, helicopters, gliders, and airships are all aircraft.

confident: having trust or faith; certain; sure

He feels confident of passing the examination.

formation: process of forming or shaping; that which is formed The formation of ice from water requires a temperature of less than thirty-two degrees Farenheit.

originate: bring into being; come into being; start; begin The fire originated in an old deserted building.

distant: far away in space or time

Pluto is the most distant planet from the sun.

minute: very small; tiny

A minute piece of dust blew into his eye.

huge: very big; very great; enormous

Elephants are hug animals.

deposit: something that has settled and is left as a layer

There is often a deposit of mud and sand at the mouth of a river.

mud:	soft, wet, sticky earth or dirt
	Rain turns dust into mud.
imprison:	put into prison; keep as in prison; lock up
	To become oil, some creatures are imprisoned between layers of rock.
confirm:	show to be true or correct
	The report of an earthquake in Gorgan has now been confirmed.
glance:	quick look
	He took a glance at the newspaper headlines.
crude	in a natural or raw state; not refined or manufactured Crude rubber is rubber as it is drained from the bark of rubber trees.
commonest:	most usual
	The commonest form of oil treatment is heating.
grade:	step, stage, or degree (in rank, quality, value, etc.) The various grades of lubricating oils are classified according to their application in industry.

D. Grammatical Points

With reference to the Grammatical Point explained in Lesson 2, notice the following Model sentences.

1. Model: a. They produce oil of different grades.

b. Oil of different grades is produced.

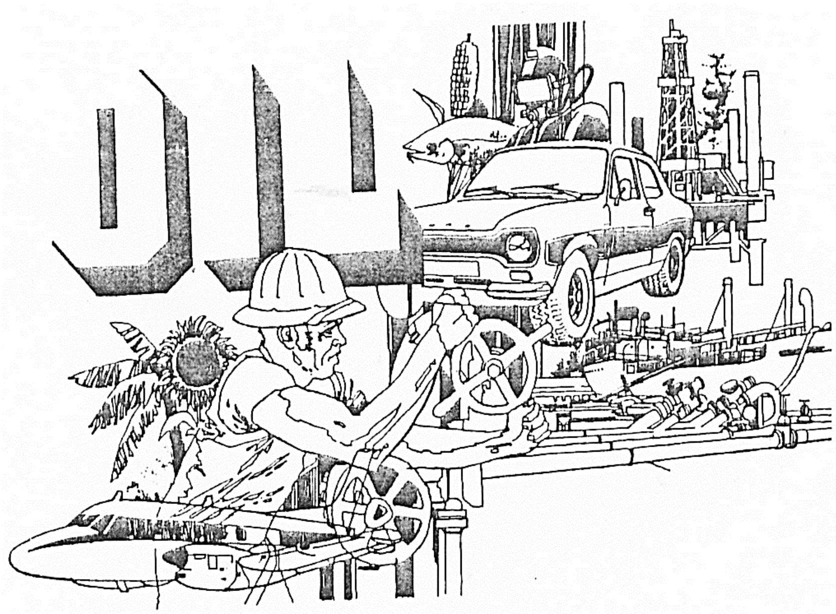
One of the commonest ways of showing that one event is dependent in some way on another event taking place is through the use of the conditional sentences. In other words, conditional sentences indicate that something will happen if something else happens first. A conditional sentence consists of two parts: The if clause and the result clause. If the verb in the if clause has the present tense verb form, the result may be either present or future. However, a technical writing, the present verb form is preferred. The is clause or the result clause may appear initially.

2. Model: a. The cylinder temperature rises if the quantity of steam flowing through the cylinders (be increased) ……….. .

b. The cylinder temperature rises if the quantity of steam flowing through the cylinders is increased.

Part II: Reading for Comprehension

Oil



There are three main groups of oils: animal, vegetable, and mineral. To the ordinary man, one kind of oil may be as important as another. But when the politician or the engineer refers to oil, he almost always means mineral oil, the oil that drives tanks, airplanes, warships, motor-cars, and diesel locomotives; the oil that is used to lubricate all kinds of machinery. This is the oil that has changed the life of the ordinary man. When it is refined into petrol, it is used to drive the internal combustion engine. To it we owe the existence of the motor-car, which has replaced the private carriage drawn by the horse. To it we owe the possibility of flying. It has changed the methods of warfare on land and sea. This kind of oil comes out of the earth. Because it burns well, it is used as fuel; in some ways it is superior to coal in this respect. Many big ships now burn oil instead of coal. Because it burns brightly, it is used for illumination; countless homes are still illuminated with oil-burning lamps. Because it is very slippery, it is used for lubrication. Two metal surfaces rubbing together cause friction and heat; but if they are separated by a thin film of oil, the friction and heat are reduced. No machine would work for long if it were not properly lubricated. The oil used for this purpose must Be of the correct thickness; if it is too thin, it will not give sufficient lubrication, and if

It is too thick, it will not reach all parts that must be lubricated.

What was the origin of the oil which now drives our motor-cars and aircraft? Scientists are confident about the formation of coal, but they do not teem so sure when asked about oil. They think that the oil under the surface of the earth originated in the distant past and was formed from living things in the sea. Countless billions of minute sea creatures and plants lived and sank to the sea bed. They were covered with huge deposits of mud; and by Processes of chemistry, pressure, and temperature they were changed through long ages into what we know as oil. For these creatures to become oil, it was necessary that they should be imprisoned between layers of rock for an enormous length of time. The statement that oil originated in the sea is confirmed by a glance at a map showing the chief oilfields of the world: very new of them are far distant from the oceans of today.

When the crude oil is obtained from the field, it is taken to the refineries and be treated. The commonest form of treatment is heating. When the oil is heated, the first vapors to rise are cooled and become the finest petrol. Petrol has a low boiling point; if a little is poured into the hand, it soon vaporizes Gas that comes off the oil later is condensed into kerosene. Last of all the Lubricating oils of various grades are produced. What remains is heavy oil that is used as fuel.

A. Read each statement and decide whether it is true or false. Write ‘T’ before true statements and 'F' before false statements.

...... 1. Scientists are quite sure about the formation of oil.

...... 2. Most of the oilfields of the world are near the seas and oceans of today.

...... 3. Heating is a very important factor in refining oil.

...... 4. Lubricating oils are used to produce friction in machines.

...... 5. Petrol easily vaporizes.

...... 6. Kerosene is the condensed gas obtained from oil.

B. Circle a, b, c, or d which best completes the following items.

1. Oil-burning lamps ....

    a. are used in more and more homes nowadays

    b. are not used very much now

    c. burn more brightly than any other kind of lamp

    d. are used by a large number of people, although not so many aspreviously

2. The purpose of lubrication is ……… .

a. to produce heat
c. to reach all parts of a machine
b. to reduce friction
d. to produce oil of the right thickness

3. Scientists think that …….. .

a. coal was formed from layers under the surface of the earth
b. coal was formed from large deposits of mud on the sea bed
c. oil was formed from sea creatures caught between layers of rock
d. oil was formed from sea water by processes of chemistry, pressure,and temperature

4. When crude oil is heated, petrol rises from it first because

a. it has a low boiling point
b. we want to collect it first
c. it can be cooled easily
d. it is the most important product of crude oil

5. Paragraph 3 mainly discusses ……… .

a. different boiling points of oil
c. the properties of petrol
b. how petrol is produced
d. the refining of oil

C. Answer the following questions orally.

1. What are some of the uses of mineral oil?
2. What is the refined oil called, and what is it used for?
3. What happens if a machine is not lubricated?
4. What happens if the oil used for lubrication is too thick?
5. What are some main factors responsible for the changing of living creatures into oil?
6. How does the writer support the idea that oil originated in the sea?

Part III: Homework

Section One: Vocabulary Exercises

A. Fill in the blanks with the words from the following table to complete thesentences. Base your choices on the items of the table only. Make necessary changes if required.

Verb	Noun	Adjective	Adverb
thicken	thickness	thick	thickly
suffice	sufficiency	sufficient	sufficiently
think	thought	thoughtful	thoughtfully
illuminate	illumination	illuminated	-------

One of the main disadvantages of concrete is its low tensile strength. That is to ay, it is not able to resist forces tending to pull it apart. This may be overcome by reinforcing with steel bars any part of a concrete structure where - ensile stresses are likely to occur.

Concrete shrinks when it dries out and will expand and contract every time is wetted and dried. This may set up tensile stresses in the concrete and rink age cracking may occur. The designer can help to avoid this by specifying contraction joints in suitable places. The supervisor on the site can also help to reduce the effect of shrinkage if he ensures that the concrete is slept wet for as long as possible.

Another property of concrete which may be responsible for cracking is its expansion and contraction due to heating and cooling. The designer can overcome this by including expansion and contraction joints in suitable places, as to allow the concrete to move freely when the temperature changes. eel also expands when it is heated, and it is very fortunate that it expands e same amount as concrete does for a given temperature rise. For this a son steel embedded in concrete will move with the concrete without setting 'any tensile stress.

Determine the Persian equivalents of the following technical terms and write them in the spaces provided.

abrasion……………………………

adaptability......................................

aggregate ………………………….

batch ……………………………....

bind ……………………………….

cement……………………………..

Coarse ……………………………..

Compact……………………………

Concrete …………………………...

Content ……………………………

contraction joint …………………...

crush ………………………………

density ……………………………..

ductility …………………….…..

expand ……………………………..

expansion …………………………..

finely-ground ………………………

hydration …………………………...

mold…………………………………

particle ……………………………….

paste ………………………………….

porous ………………………………..

property ………………………………

proportion ……………………………

ratio …………………………………..

reinforce ………………………………

shrink …………………………………

shrinkage cracking ……………………

silt …………………………………….

site …………………………………….

stiff ……………………………………

stress …………………………………..

technology ……………………………

tensile …………………………………

treatment ……………………………….

UNIT 8

Gasoline Engine

Part I: Pre-Reading

A. Pronunciation Practice

de.scend (dĭ-Sĕnd')
cy.cle (sī'kəl)
al.ter.na.tive (ôl-tûr'nə-tĭv)
in.stan.ta.ne.ous (ĭnstən-tā'nē-əs)
oth.er.wise (ŭth'ər-wīz)
pressure (prĕsh'ər)
ex.pan.sion (ĭk-spăn' shən)
assist (ə-sĭst')
clear.ance (klîr'əns)
prop.a.ga.tion (prŏp ə-gā'shən)
flame (flām)
tur.bu.lence (tûr'byə-ləns)
def.i.nite (dĕf' ə-nĭt)
reg.u.lar (rĕg'yə-lər)
sequence (sēkwəns)
torque (tôrk)
im. part (ĭm-pärt')
un.e.ven (ŭnē'vən)
li.a.ble (lī' ə-bəl)
Ily.wheel (flī'hwēl)
damp (dămp)
var.i.a.tion (vâr ē-ā 'shən)
ap.pro.pri.ate (ə-prō'prē-ĭt)
ac.tu.ate (ăk'chōō-āt)
cam.shaft (kám'shăft)
ef.fi.cien.cy (ĭ-lĭsh' ən-sē)
quar.ter (kwôr'lər)
steam (stēm)
wheel (hwēl)
mo.tor.car (motər-kar)
jour.ney (jûr'nē)
tire (tīr)
rub.ber(rŭb' ər)
flag (flăg)
im.prove (ĭm-prōōv')
com.fort.a.ble (kŭm'fər-tə-bəl)
in.vent (ĭn-vĕnt')
weigh (wā)
pound (pound)
horse.pow.er (hôrs'pouər)
in.flam.ma.ble (ĭn-flăm' ə-bəl)
charge (chärj)
en.er.gy (ĕn'ər-jē)
mix.ture (mĭks' chər)
ig.nite (ĭg-nīt')
spark (spärk)
com.pres.sion (kəm-prĕsh'ən)
dis.trib.u.tor (dĭ-strĭb'yə-tər)
prod.uct (prŏd'əkt)
ex.pand (ĭk-spănd')
re.cip.ro.cate (ră-sĭp'rə-kāt)
pis.ton (pĭs'tən)
ro.ta.tion (rō-tā'shən)
move.ment (mōōv'mənt)
crankshaft (krăngk'shăft)
cyl.in.der (sĭl'ən-dər)
stroke (strōk)

B. Word Study: Definitions

cylinder:	tubular chamber in which the piston of an engineer ciprocates
pound:	unit of weight
horse power:	unit of mechanical power equal to the power needed to raise 33,000 pounds at the rate of one foot per minute
energy:	capacity of a body for doing work
ignite:	heat a gaseous mixture to the temperature at which combustion occurs
spark:	flash of a discharge of electric current
compression:	stroke during which the working agent is compressed in an internal combustion engine
distributor:	device for distributing electric current to the sparkplugs of a gasoline engine so that they fire in proper order
reciprocate:	move backward and forward alternately
piston:	cylindrical metal piece which reciprocates in a cylinder
rotation:	act of turning on an axis or hub
crankshaft:	main shaft of an engine which carries a crank or cranks
	for the attachment of connecting rods
connecting rod:	in a reciprocating engine, the rod connecting the piston to the crank
exhaust valve:	valve controlling the discharge of the exhaust gas in an internal combustion engine
valve:	any device which controls the passage of a fluid through a pipe
exhaust:	steam or gas carried off after use
cylinder head:	closed end of the cylinder of an internal combustion engine
stroke:	piston travel in the cylinder of an engine
inlet valve:	inlet port; induction valve; induction port; port or valve through which the charge is induced into the cylinder during the suction stroke
top dead center:	inner dead center; piston position at the beginning of the outstroke, i.e., when the crank-pin is nearest to the cylinder
clearance:	distance between two objects or between a moving and stationary part of a machine
propagation:	extending through space as light
turbulence:	fluid flow in which the particle motion at any point

varies rapidly in magnitude and direction

fire: become ignited; ignite

torque: turning moment exerted by a tangential force acting at a distance from the axis of rotation or twist

llywneer: heavy wheel attached to a shaft either to reduce the speed fluctuation or to store up kinetic energy

camshaft: shaft on which cams are keyed or formed integrally, used to operate the valves of internal combustion engines

C. Word Study: Definitions and Exemplifications

take: need; require

The project took us three months to complete. rubber on the rim of a motor-car wheel

tire: He put a new tire on the wheel.

warn: give somebody notice of possible danger or unpleasant Consequences; inform in advance of what may happen

I warned him not to go skating on such thin ice

inflammable: easily ignited

Kerosene is used for burning in lamps; gasoline is too inflammable for this purpose.

charge: load

It is important to control the charge all the time.

mixture: something made by putting different things together Molten metals are put together; the mixture, then, is put into a mold.

product: that which is produced

Gasoline and kerosene are products of crude petroleum.

expand: make or become longer

Metals expand when they are heated.

descend: come or go down

It is advisable to use engine braking when descending a steep hill.

cycle: series of events taking place in a regularly repeated order

The burnt gases in the cylinder are exhausted at the end of the cycle.

alternative: choice between two things

	Your plan is not applicable; we must try to think of an alternative.
instantaneously:	happening or done in an instant
	An excess amount of air entered the furnace instantaneously.
otherwise:	in another or different way
	You think he should have been working, but he was otherwise doing his military service.
pressure:	force exerted on a body tending to change its shape or volume
	A safety valve is provided to allow excess pressure to escape.
expansion:	becoming longer or bigger
	When substances are heated, expansion takes place.
definite:	clear; not doubtful or uncertain
	A good chairman helps his committee members reach definite decisions.
Sequence:	connected line of events; order in which events occur Piston travels in the cylinder occur in a sequence.
impart:	give or pass on a share of something Thermal energy must be imparted to the molecules to free them.
liable:	have a tendency to; be likely to Since gasoline is an inflammable substance, an explosion is liable to occur at any minute in a gas station.
damp out:	cause to die away
	The purpose of springing is to damp out the short, sharp jolts from the road.
actuate:	cause to act; put into motion
	The pistons are actuated by the mixture of air and gasoline in the cylinder.
phase:	stage in development
	The initial phase of the building operation was completed in eight months.
efficiency:	ratio of energy expended to power produced
	The efficiency of a gasoline engine is higher than that of a steam engine.

quarter: one of four equal parts of anything

It took me a quarter of an hour to assemble the spark plug.

Steam: water in the vapor state

The first steam engine was built during the nineteenth century.

D. Grammatical Points

In Lesson 6, a grammatical point concerning the structure of the sentence in the passive voice was mentioned. Here the same point is of concern. Pay close attention to the verb form in the following sentences.

1. Model: a. We have used the gasoline engine to drive almost every kind of vehicle running on wheels.

b. The gasoline engine has been used to drive almost every kind of vehicle running on wheels.

One of the structures expressing result was mentioned in Lesson 1. Another commonly-used structure for the same purpose is as follows:

such + adjective + noun + that

Notice that such a' and 'such an are used before singular count nouns. ‘Such is used before mass nouns and plural nouns.

2. Model: a. The cars made a lot of noise.

Everyone knew when they were coming.

b. The cars made such a noise that everyone knew when they were coming.

This structure is also used to express emphasis.

Part II: Reading for Comprehension

Internal Combustion Engine: Gasoline Engine

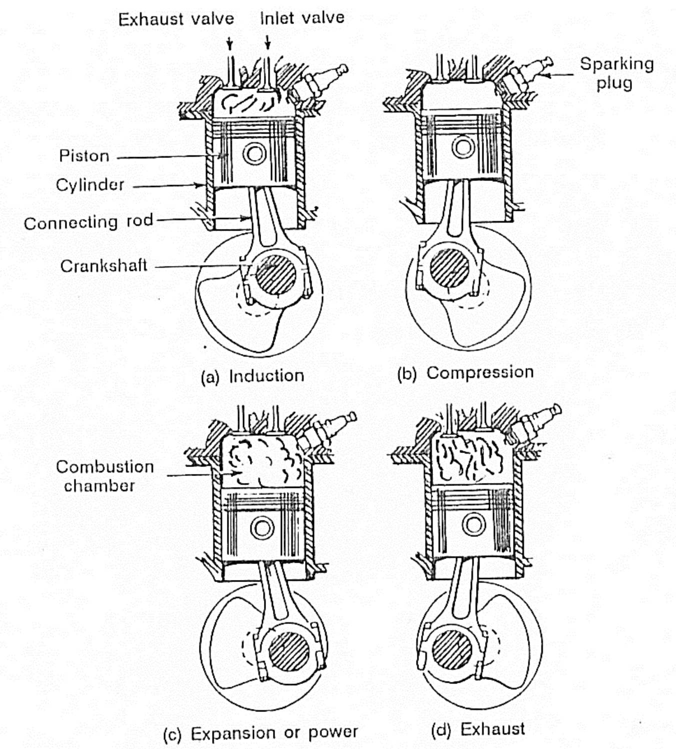
The gasoline engine is an internal combustion engine. The gasoline engine has been used to drive almost every kind of vehicle running on wheels-motor-cars, motor-bicycles, trucks, etc. It is also used in many kinds of airplanes. Journeys that used to take weeks can now be made in a day.

The first car driven by an internal combustion engine was seen on the roads in 1894. Early cars were very strange; their engines had only one cylinder and the tires on the wheels were made of iron or of solid rubber. The cars made such a noise that everyone knew when they were coming. In those days, a cart with an engine instead of a horse was thought to be dangerous. A man, carrying a red flag, had to walk in front of a car to warn people of the danger. From that time motor-cars have been greatly improved. Now we can ride very comfortably and quietly in a car which on a good road can easily reach 70miles an hour. Racing cars, with more powerful engines, can travel much faster. At the moment, the greatest speed reached by a racing car is about 600 miles an hour, and perhaps by the time you read this, men will have traveled at even greater speeds.

A gasoline engine is excellent for an airplane because it is not heavy; in fact, airplanes only became possible when this kind of engine had been invented. Airplane engines are now made so that they weigh little more than one pound for every horse-power. Thus a 1,000 horse-power engine weighs little more than 1,000 pounds. The engine works in the same way as the motor-car engine, but it is much more powerful.

In the internal combustion engine, heat is generated by the combustion of an inflammable charge inside a cylinder, and the heat energy is immediately converted into mechanical energy. Some heavy internal combustion engines use a gas fuel or diesel oil, and the fuel-air mixture may be ignited either by a spark or by compression of the mixture. However, for small internal combustion engines, such as those which are used in motor-cars, the charge is a mixture of gasoline and air, and the mixture is ignited by a spark from the distributor.

When the mixture is ignited, the products of combustion expand down the cylinder, which is fitted with a reciprocating piston. The downward movement of the piston is converted into a rotational movement of the crankshaft by means of a connecting rod. As the crankshaft rotates, the piston is driven upwards again, and the exhaust gases are forced out through the exhaust valve in the cylinder head. When the piston nears the top of this stroke, the inlet valve is opened and the exhaust valve closed. The piston then descends on the induction stroke and draws a fresh charge into the cylinder. As the piston rises again on the compression stroke, the charge is compressed and ignited, and the cycle begins again. This is the four-stroke cycle which is in common use. An alternative cycle is the two-stroke cycle, which combines the exhaust and compression strokes into one.



four-stroke cycle

The combustion of the mixture does not take place instantaneously. The spark is therefore timed to occur before the piston reaches top dead center; otherwise, maximum pressure would not be reached in time. By the time the piston is at top dead center, combustion is well under way and the expansion of the gases is beginning. Once combustion starts, it should be carried through the mixture very rapidly, and this is assisted by making the clearance space above the piston as small as possible and by careful design of the cylinder head. Rapid propagation of the flame through the compressed gas is also assisted by creating turbulence in the gas.

Most small internal combustion engines in common use have four cylinders, which fire in a definite and regular sequence. This is necessary, otherwise the torque which the pistons impart to the crankshaft will be irregular and uneven. The torque is liable to be uneven in any case when the engine is running slowly, so a flywheel is fitted to the crankshaft to damp out these variations.

It is essential for the inlet and exhaust valves to open and close at exactly the appropriate moment in relation to the position of the piston. Therefore, they are actuated by a camshaft running in phase with the crankshaft.

The efficiency of a gasoline engine is about 25%; that is, about one quarter of the energy from the gasoline does useful work. This is better than the efficiency of a steam engine, but it is not still good. Gasoline is not cheap; only a small part of the petroleum obtained from the ground consists of gasoline.

A. Read each statement and decide whether it is true or false. Write 'T' before true statements and 'F' before false statements.

……. 1. The efficiency of a steam engine is about 25%.

……. 2. There is a loss of about three quarters of the energy from the gasoline in an internal combustion engine.

……. 3. Gasoline engines are also used in airplanes.

……. 4. The engines of early cars had only one cylinder.

……. 5. Airplanes were invented when gasoline engines were invented.

……. 6. When the crankshaft rotates, the piston is forced upward.

……. 7. Combustion should be carried through the mixture very quickly.

……. 8. Most small four-cylinder engines fire in a definite and regulars equence.

B. Circle a, b, c, or d which best completes the following items.

1. In the time of early cars, everybody knew when a car was coming because ……. .

a. the car made a lot of noise

b. a man warned people of the danger

c. somebody had to walk in front of the car

d. it was thought to be dangerous

2. The writer compares a gasoline engine with a steam engine by stating that the Efficiency of ....

a. a gasoline engine is about 25%, but that of a steam engine is about one quarter of the energy

b. a gasoline engine is better than that of a steam engine

c. a steam engine is better than that of a gasoline engine

d. a steam engine is about 25%, and that of a gasoline engine is about one quarter of the energy

3. Heat is generated in an internal combustion engine by ....

a. an inflammable charge inside a cylinder

b. the conversion of the heat energy into mechanical energy

c. the compression of the combustible mixture inside the cylinder

d. the burning of the charge present in the cylinder

4. The mixture of gasoline and air is ignited because …….. .

a. they are too inflammable

b. the mixture is compressed

c. a spark is produced by the distributor

d. a pressure is developed in the engine

5. It is not true that ……… .

a. when the mixture is ignited, combustion forces the cylinder downward

b. some heavy internal combustion engines use a gas fuel

c. the charge in a motor-car engine is usually a mixture of gasoline and air

d. a reciprocating piston is fitted with the cylinder

6. The piston is forced upward because ……. .. .

a. the crankshaft rotates c. the inlet valve is closed

b. the connecting rod is actuated d. the cylinder nears top dead center

7. It is true that ……… .

a. as the piston rises, the cycle begins again

b. when the piston descends on the induction stroke, a fresh charge is drawn into the cylinder

c. the inlet valve closes when the piston nears the top of the stroke

d. the movement of the piston starts when a rotational movement is produced

8. In line 47, fit' refers to ……... .

a. piston c. combustion

b. expansion d. top dead center

C. Answer the following questions orally.

1. What does the author mean when he says that the efficiency of a gasoline engine is not still good'?

2. What were the tires of early cars made of?

3. Why are gasoline engines appropriate for airplanes?

4. What is the function of an internal combustion engine?

5. What is the function of a connecting rod?

6. Why is the spark timed to occur before the piston reaches top dead center?

should always be stored and handled carefully.

The fluid must meet a number of requirements before it can be used in the brake hydraulic system. A high boiling temperature is necessary so that it will remain a liquid in high-temperature brake parts. A loss of brake will occur if the fluid boils and becomes a vapour in the hydraulic system. The viscosity, or thickness, of the liquid is important to provide rapid application and release times at low ambient temperatures. The fluid must have good lubrication properties to prevent wear of the rubber and metal parts in the system. It must contain inhibitors to prevent swelling of the rubber parts and to prevent the formation of rust and corrosion.

B. Find the Persian equivalents of the following terms and write them inthe spaces provided.

1. air compressor ....
2. anchor pin ....
3. back plate ....
4. brake hoses ....
5. brake line ....
6. brake lining ....
7. brake shoe ....
8. compensating port ....
9. coupling ....
10. drum brake ....
11. emergency braking ....
12. fluid reservoir ....
13. hub ....
14. hydraulic fluid ....
15. leverage ....
16. master cylinder ....
17. number plates ....
18. outlet port ....
19.pressure gauge ....
20. pressure governor ....
21. pull back spring ....

UNIT 9

Part I. Pre-Reading

A. Word Study: Definitions

ball bearing /bɔ :1 'beərirŋ /: a ring of small metal balls used in a machine to enable the parts to turn smoothly on the rolling metal balls; one of these small metal balls

drive /draɪv/: the equipment in a vehicle that takes power from the engine to the wheels

pillow /pɪləʊ /: anything that supports like a pillow

tractive/'træktɪv/: of, relating to the adhesive friction, as of tyres on pavement

universal joint/ˌju:nɪ'vɜ :sl dʒ ɔ ɪnt/: joint or coupling that permits a swing of limited angle in any position, especially one used to transmit rotary motion from one shaft to another not in line with it

B. Word Study: Definitions and Examples

coast /kə ʊ st/: move, usually down a hill, without using any power
While descending the hill, he disengaged the clutch and the car coasted downhill.

commonly/'kɒ mə nlɪ/: usually
The most commonly used oil for cooking is vegetable oil.

cross-country /krɒ s' kʌ ntri/: across the country or field, not along roads

A cross-country rally was held across the desert last month in which 25 drivers were competing with each other.

employ /ɪm'plɔ ɪ/: make use of

Motor-cars usually employ electric warning horns.

intermediate/ˌɪntɔ 'mi:diɔ t/: situated between two places, things, states, etc.

Intermediate technology is suitable for use in developing countries as it is cheap and simple and can use local materials.

level /'levl/: having a flat surface which does not slope

The campers pitched their tent on level ground.

meet /mi:t/: do or satisfy what is needed or what is asked for

You need a station Wagon to meet your requirements.

reverse /rr:' vɜ :S/: put a mechanism in reverse; cause to go in the opposite direction.

He **reversed** into a parking space.

skid /skɪd/: to slide sideways or forwards in an uncontrolled way

While driving on an icy road, besides driving very carefully, your car should be equipped with tyre chain to prevent **skidding**.

to stretch right across something, from one side to the other

The river was about one hundred metres wide which was **spanned** by a series of bridges.

an area of land (or water), especially and one as road is not crowded; you rarely see vehicles on this stretch of road.

under way/ˌʌndə 'weɪ/: having started

Preparations are **under way** for holding the next World Championship in Asia.

Part II. Reading

The Drive Line

The drive line of an automobile is designed to transmit torque from the engine to the wheels and to vary it in magnitude and direction. The main drive line units are clutch, transmission (gear box), propeller shaft (card an drive), final drive, differential and axle shafts.

On cross-country vehicles travelling on bad roads and off the roads, both the front and rear axles are driving. The drive line of such automobiles, apart from the above-listed mechanisms, include an additional propeller shaft and front driving axle with a final drive, a differential and axle shafts with universal joints. In these automobiles the engine torque is distributed between the driving axles and the front driving axle is engaged with the aid of a special gear box called **transfer** case. The transfer case has a step-down gear for increasing the driving wheel tractive force and is usually arranged behind the transmission and is coupled to it by a propeller shaft.

The **clutch** transmits torque from the engine to the drive line, temporarily disconnects and smoothly reconnects them for changing gears and starting the automobile. Modern cars use friction clutches, ones employing friction forces to transmit power. The friction surfaces in such clutches are provided by discs. Most commonly used are single and double-disc clutches.

The main parts of the clutch are a pressure plate, and a driven disc. The pressure plate is coupled with the flywheel, while the driven disc is fitted to the transmission input shaft. The pressure plate is pressed to the disc by the springs so that the torque is transmitted owing to friction forces from the engine to the input shaft of the transmission.

The **transmission** is designed for changing the torque transmitted from the engine crankshaft to the propeller shaft, reversing the vehicle movement and disengaging the engine from the drive line for a long time at parking or coasting.

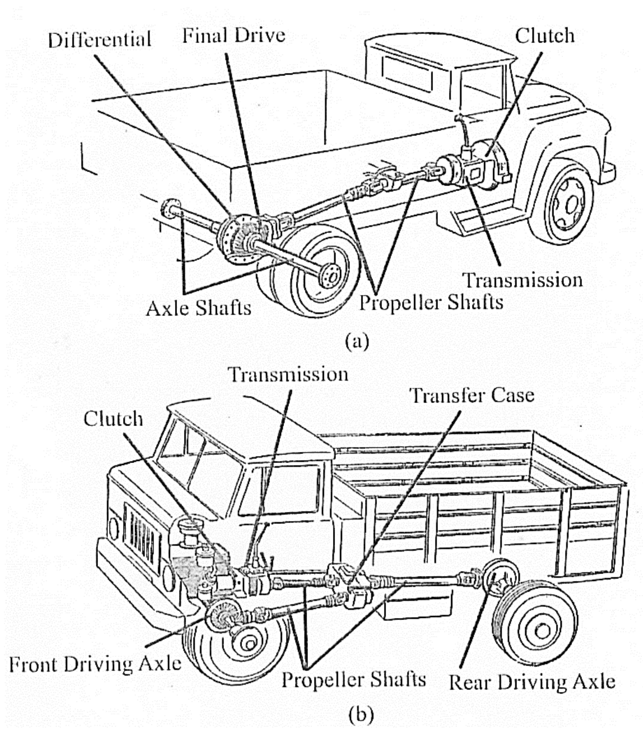


Figure 13-1. Drive Line of Automobile: (a) With One Driving Axle; (b) With Two Driving Axles.

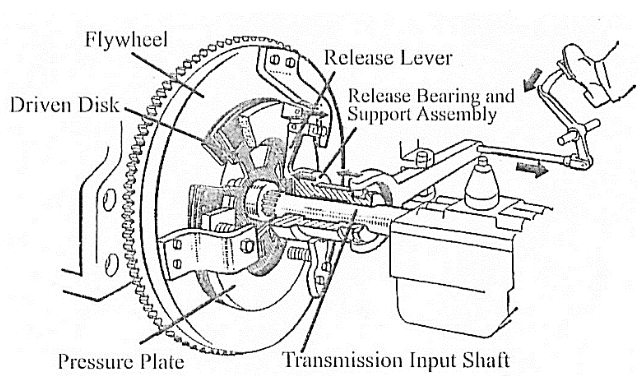


Figure 13-2. Operation of Clutch Mechanism.

A higher torque should be applied to the wheels to set an automobile in motion or move uphill with a full load than to keep it rolling after it gets under way on level stretches of the road, when inertia is high and tractive resistance is low. To meet these variable torque requirements, special gear boxes are used. Such gear boxes are called fixed-ratio transmissions.

In a gear train consisting of a driving gear and a driven gear, the torque at the driven gear will increase as many times as the number of teeth of the driven gear is larger than that of the driving gear. The figure obtained by dividing the number of driven gear teeth by that of the driving gear is called gear ratio.

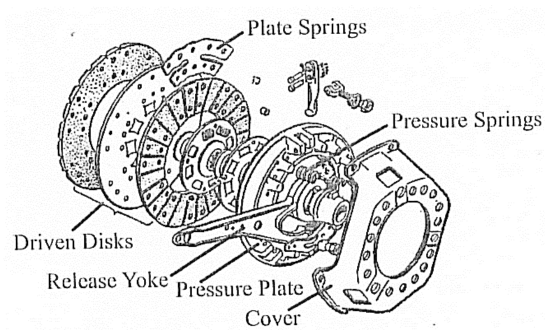


Figure 13-3. Single-Disc Clutch.

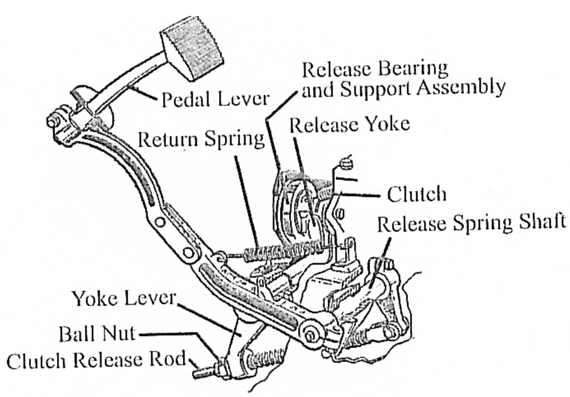


Figure 13-4. Clutch Release Mechanism.

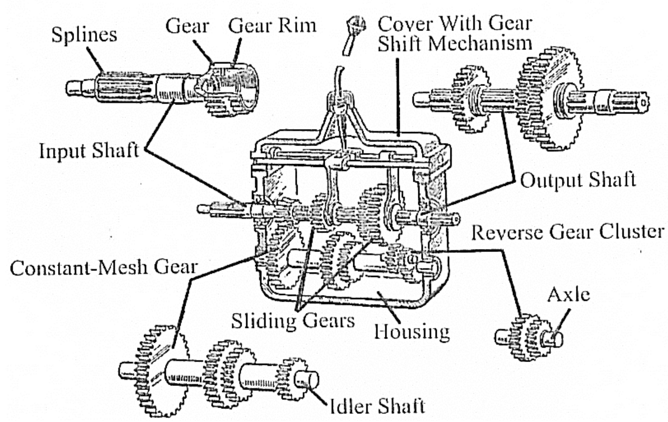


Figure 13-5. Typical Transmission.

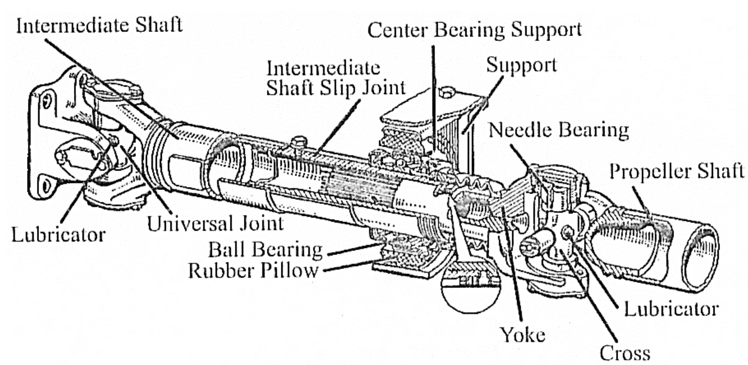


Figure 13-6. Propeller Shaft of a Truck.

The propeller shaft drive transfers the engine torque from the transmission to the driving axle at an angle which varies with the load and during jolts on bumpy roads. It includes shafts, a split joint, universal joints and a centre bearing support. Since the distance to be spanned by the propeller shaft is great, an intermediate shaft is additionally used. One end of the intermediate shaft is connected to the transmission output shaft and the other, to the main propeller shaft. The intermediate shaft rotates in a centre bearing consisting of a support, rubber pillow and a ball bearing.

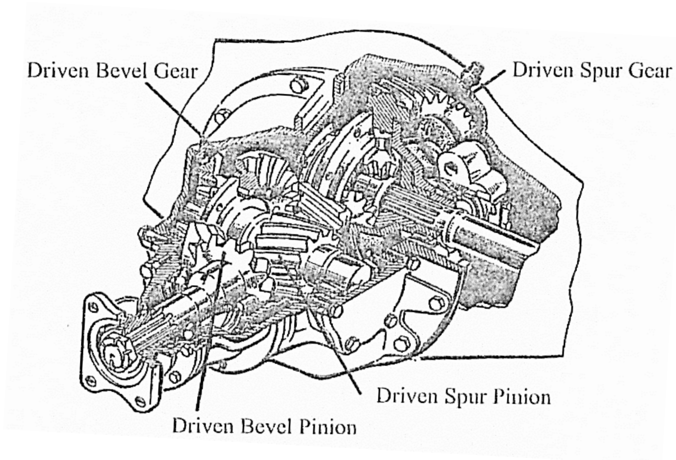


Figure 13-7. Final Drive of a Truck.

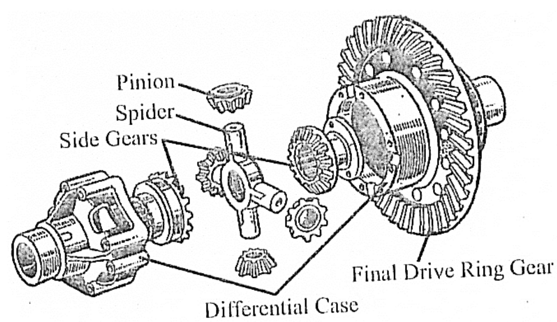


Figure 13-8. Differential Gear.

The axle shafts which rotate the driving wheels are located at angles of 90° to the automobile line and to the propeller shaft. To increase the torque and transmit it at right angles to the wheels, use it made of a special gearing called fin al drive.

When the automobile rounds a corner or travels over uneven ground, its right and left wheels cover different distances. If the wheels rotate at equal speeds, one of them (that covers a shorter distance) would be forced to skid.

To prevent skidding, there must be a mechanism allowing the wheels to rotate - at different speeds. This mechanism is called differential.

Comprehension Questions

A. Read each statement and decide whether it is true or false. Write ‘T’ before true statements and 'F” before false statements.

…….. 1. The automobiles with one driving axle have no transfer case.

…….. 2. Cross-country vehicles have two separate transmissions.

…….. 3. The clutch has two main functions.

…….. 4. The driven disc is fitted to the flywheel.

…….. 5. The torque at the driven gear has a direct relationship with thenumber of the teeth of the driving gear.

…….. 6. The main propeller shaft is connected to the transmission through the intermediate shaft.

…….. 7. The axle shafts are at angles of 90° to the propeller shaft.

…….. 8. Final drive changes the angle of the torque and transmits it to thewheels.

B. Circle a, b, c, or d which best completes the following items.

1. In the second line of the first paragraph, fit' refers to …….. .

   a. the torque   b. the engine

   c. the automobile   d. the wheel

2. On cross-country vehicles the tractive force of the driving wheel is increased ……..

   a. by the transfer case and the additional propeller shaft

   b. by means of a step-down gear used in the transfer case

   c. because the engine torque is distributed between two axles

   d. because they include two final drives

3. In the third paragraph (line two), 'them' refers to ……..

   a. the clutch and its units

   b. the clutch and the engine

   c. the engine and the drive line

   d. the drive line and gears

4. The .... can be used to disengage the engine for a longer period.

a. transmission b. clutch

c. differential d. engine shaft

5. It is **not** true that …….. .

a. it is easier to keep a vehicle rolling than set it in motion

b. on level roads inertia is higher than uphill ones

c. inertia is high when the tractive resistance is low

d. after the automobile has gotten under way, a higher torque is needed to keep it moving

6. In the seventh' paragraph (line three), that' refers to …….. .

a. the torque b. the number of teeth

c. the gear train d. the driven gear

7. On bumpy roads ....

a. the engine torque increases

b. the engine torque decreases as the angle of the driving axle varies

c. the angle of the transmission and the driving axle changes from time to time

d. much less load should be carried in the vehicle

8. The differential …….. .

a. rotates in a centre bearing

b. increases the torque

c. allows the driving wheels to rotate at different speeds

d. allows the driving wheels to skid at equal speeds

C. Answer the following questions orally.

1. How is gear ratio obtained?
2. How is the tractive force increased in the transfer case?
3. What are the functions of the transmission?
4. What is the function of the final drive?
5. What necessitates the use of an intermediate shaft?

UNIT 10

Part I. Pre-Reading

A. Word Study: Definitions

are /ɑ :k/:	part of a circle or a curved line; a curved shape
coaxial /kəʊ 'æksiəl/:	having a common axis
felt /felt/:	a soft thick fabric made from wool or hair that has been pressed tightly together
globoid /'glɔ ʊ bɔ id/:	shaped somewhat like a globe or ball
knuckle /nʌ kl/:	something resembling a knuckle, as the joint of a hinge, where the pin goes
linkage /'lɪŋ kɪdʒ /:	a device that links two or more things; a series or system of links; especially a series of connecting rods for transmitting power or motion
power steering/'paʊ ə(r) stɪərɪŋ /:	a system that uses power from engine to help the driver change direction (It is also called power assisted steering'.)
servo /'sɜ :vəʊ /:	a device, as an electric motor, hydraulic piston, etc. that is controlled by an amplified signal from a command device of low power
steering/'stɪərɪŋ /:	the mechanism of a vehicle that you use to control the direction it goes in
triple /'trɪpl/:	having three parts; consisting of or including three
Worm /wɜ :m/:	a mechanical device spiral or vermiculate in form or appearance such as a short revolving screw whose threads gear with the teeth of a worm wheel or rack

B. Word Study: Definitions and Examples

assist /ə 'sɪst/:	to help somebody to do something
	Can the Employment Exchange assist you in finding a permanent job?
build in to /'bɪld 'ɪntu:/:	make something a permanent part of a system, plan, etc.
	A certain amount of flexibility is **built into** the system.
build up (bɪldʌ p/:	create or develop something; make something higher or stronger than it was before
	By launching the new model of the furniture in the company, they have built up a successful business.
curve /kɜ :v/:	a line or surface that bends gradually; a smooth bend
	The driver lost control on a curve and the vehicle hit a tree.
ensure /ɪn' ʃ ʊ ə(r)/:	make sure that something happens or is definite
	Before leaving the house ensure that all lights are switched off and the main gas tapis turned off.
leakage /li:kɪdʒ /:	an amount of liquid or gas escaping from a hole in something; an occasion when there is a leak
	Oil leakage from the transmission may be caused by damage gaskets, worn seals, and cracks in the housing.
minimize /'mɪnɪmɑ ɪz/:	to reduce something, especially something

bad, to the lowest possible level

You should try to minimize your pronunciation errors.

put forth ('pʊ tfɔ :θ: bring into action; exert

The wrestler had to **put forth** much effort to win.

Swing /swiIy: move backward and forward or from side to side while hanging from a fixed point; cause to turn or pivot, as on a hinge or swivel

She **swung** the door open.

Part II. Reading

The Steering System

The steering system enables the driver to guide the vehicle down the road and turn right or left by turning the front wheels. There are two types of steering systems. These are manual and power.

The **manual steering** system includes the steering wheel, a steering gear, and a steering linkage. The steering gear converts the rotary motion of the steering wheel into a straight-line motion, which is transmitted to the steering linkage to swing the front wheels left or right for steering and reduces the steering effort, i.e., the effort the driver must put forth to turn the steering wheel.

There are several types of steering gear: worm and roller, worm and sector, screw and nut, etc. The worm and roller type of steering gear is used on so me automobiles that can be steered manually. The steering gear includes triple roller and globoid worm which make up a worm gearing with a high gear ratio.

The steering system is lubricated with transmission oil poured into the steering box through a hole closed by a plug. The leakage of oil from the steering box is prevented by a lip-type seal, a felt ring, and sealing gaskets.

The steering linkage carries the movement of the steering arm to the

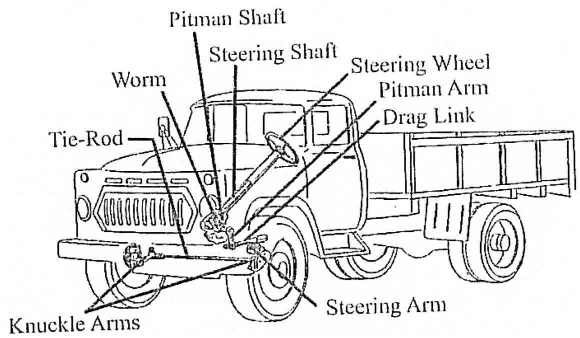


Figure 14-1. Steering System.

steering knuckles. The steering linkage is constructed so as to make all the wheels move on turns without side slipping, which ensures easy steering and minimizes tyre wear. To achieve this, all the wheels must turn about a common centre. Because the outside front wheel on a curve turns about a longer arc than does the inside wheel, it is therefore necessary to have the inside wheel turn at a sharper angle than the outside wheel. The difference in angles between the two front wheels when they are making a turn is reffered to as the turning radius or toe-out on turns.

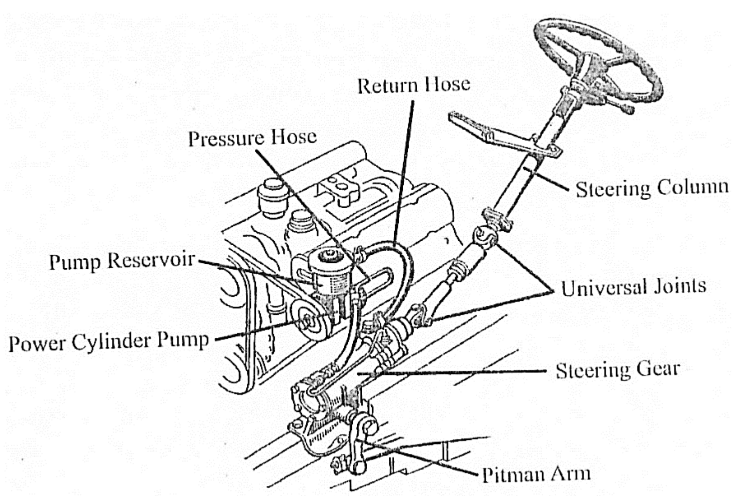


Figure 14-2. Power Steering System.

The system operates as follows. When the driver turns the steering wheel clockwise (right), the steering worm and roller in the steering box cause the steering arm to swing backward. As the steering arm swings back, it pulls on the steering linkage, which causes the front wheels to turn to the right. When the steering wheel is turned counterclockwise, the front wheels turn to the left.

To reduce steering effort, some automobiles are equipped with power steering systems. The **power steering** system uses hydraulic pressure built up by an engine-operated pump to assist the driver in turning the front wheels. Power steering therefore is also known as the hydraulic servo, or booster, steering. Two types of power steering are in common use: a power-assist linkage and a power-assist piston operating within the steering box. The former is known as the linkage-type power steering gear and the latter, the integral, or coaxial, power steering gear. In all power steering designs, driver 'feel' is built into the system by having the driver do some of the work.

With any type of power steering, the movement of the steering wheel moves a valve which directs oil, under pressure, to a piston to help the driver

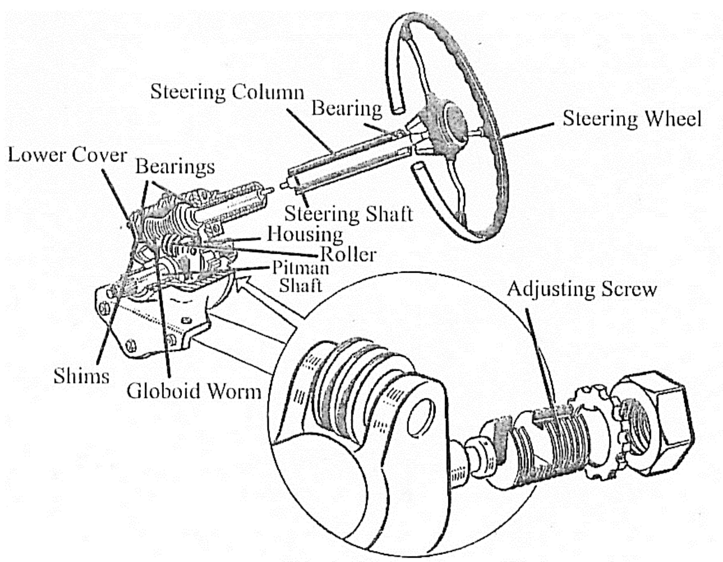


Figure 14-3. Steering Mechanism of a Truck.

turn the front wheels. The valve mechanism is designed so that the more pressure the driver applies to the steering wheel, the more hydraulic pressure is applied to the power-assist piston.

The integral power steering gear is basically a worm-and-sector manual steering gear that has a hydraulic control system built into it. If the power assist system should fail, the vehicle can still be steered manually, but with So me difficulty.

Comprehension Questions

A. Read each statement and decide whether it is true or false. Write 'T' before true statements and 'F' before false statements.

…….. 1. The steering system helps the driver direct the vehicle by turning all the wheels.

…….. 2. The steering gear has two functions.

…….. 3. Power steering systems use the worm and roller type of steering gear.

…….. 4. A special oil pump is used to lubricate the steering system.

…….. 5. The steering linkage prevents side slipping of all the wheels on turns.

…….. 6. 'Turning radius' is the difference in angles between the two front wheels when they are moving on a road.

…….. 7. If the steering wheel is turned right, the steering arm moves backward.

…….. 8. The integral power steering gear is the same as coaxial power steering gear.

…….. 9. The amount of hydraulic pressure applied to the power-assist piston is directly proportional to the pressure applied to the steering wheel.

B. Circle a, b, c, or d which best completes the following items.

1. In the second paragraph (line three), which' refers to ……..

a. the steering wheel   b. the rotary motion

c. the straight-line motion   d. the steering gear

UNIT 11

Building an Aircraft

Part I: Pre-Reading

A. Pronunciation Practice

rig.ging (rĭgĭng)
flim.sy (flĭm'zē)
rig.id (rĭjĭd)
canvas (kăn'və s)
al.loy (ăl' oi)
hol.low (hŏl' ō)
strain (strān)
up.ward (ŭp' wərd)
sat.is.fac.to.ry (sătĭs-făk'tə -rē)
tri.plane (trī'plān)
bi.plane (bī'plān)
mon.o.plane (mŏńə-plān)
rar.i.ty (rârĭ-tē)
pre.cise (prĭ-sīs)
fa.tigue (fə-tēg')
dis.tinct (dĭ-stĭngkt')
star.board (stär'bərd)
ac.cu.rate (ák'yər-ĭt)
fur.nish.ing (fûr´nĭ-shĭng)
fu.se.lage (fyōō'sə-läzh)

B. Word Study: Definitions

rigging wires: wires used for holding the wooden frames of early airplanes in shape
flimsy: weak; structurally loose
designer: person who designs machinery, aircraft, etc.
tube: hollow piece of metal or any other material made in the shape of pipe
skin: outer covering of the body of an aircraft
mass: large quantity or number
wing: structure located on either side of an airplane
Strain: amount of force applied to something
list: component of aerodynamic forces supporting an aircraft in flight
monoplane: plane with one wing
fatigue: weakness in metals caused by prolonged stress

stress:	great pressure or force
fuselage:	body of an aircraft
port:	left-side of an airplane
starboard:	right-side of an airplane
Solid:	hard; able to support weight or resist pressure
assembly line:	a line in a factory for fitting parts together to make a whole, as in making automobiles, airplanes, etc.
furnishings:	furniture and accessories needed in an airplane
cabin:	part of an airplane for crew members
apparatus:	set of instruments or other mechanical appliances put together for a certain purpose

C. Word Study: Definitions and Exemplifications

aircraft:	machines made to fly in the air
	Airplanes, helicopters and gliders, are all aircraft.
frame:	structure that supports something
	The frame of a car is made of strong metal beams.
rigid:	stiff; firm and hard; unbending
	Rigid steel beams are used in building.
body:	main part of a structure
	Wings are soldered to the body of airplanes.
canvas:	strong heavy cloth
	Tents, sails, and truck covers are made of canvas.
manufacture:	produce; make
I	Iran-Khodrow manufactures cars, trucks, and minibuses.
rarity:	condition of being rare; uncommonness
	Horse-driven carriage is a rarity today.
call for:	require; demand; need
	The identification of finger prints calls for considerable skill.
distinct:	not the same; different
	The philosophy of Aristotle is quite distinct from that of Plato's.
undergo:	pass through
	An airplane has to undergo a routine technical check up at least once a year.
trial:	test The trial of the new helicopter was delayed due to the bad

D. Grammatical Points

The negative word ‘nor' links two negative sentences together. It is important to notice that, in this case, inversion must be used. Inversion means putting the verb, either main or auxiliary, before the subject.

1. Model: a. The mass-manufacturing techniques for building light structures in iron and steel did not exist. The light-weight alloys that were later to replace iron and steel to a large extent did not exist.

   b. The mass-manufacturing techniques for building light structures in iron and steel did not exist, nor did the light-weight alloys that were later to replace iron and steel to a large extent.

A clause of result introduced by so that can be stated by a causative clause as follows:

2. Model: a. The body of the airplane moves down the assembly line so that its engines are added.

   b. The body of the airplane moves down the assembly line to have its engines added.

Part II: Reading for Comprehension
Building an Aircraft

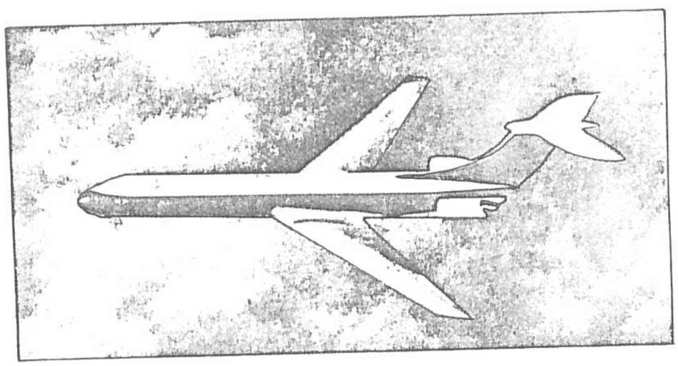
Early airplanes were built up from wooden frames covered by fabric and held in shape by rigging wires. These flimsy structures served well until the World War I when designers in Germany first started using welded steel tubes to build rigid bodies, which they covered with metal skins instead of canvas. The idea was not seriously developed; however, because the mass-manufacturing techniques for building light structures in iron and steel did not exist, nor did the lightweight alloys that were later to replace iron and steel to a large extent.

Out of these early designs grew the idea that a hollow metal wing might be strong enough to take the strains caused by the downward push of the load and the upward push, or lift, exerted by the air. Thus the decision to use hollow metal wings was one that had to be made before any airplane could fly satisfactorily.

Some of the early planes had a lot of wings of various sizes fixed in different positions. The number was soon reduced to a maximum of three, one from the sky long ago.

The biplane, with two wings, lasted longer and could be seen fairly frequently up to the war of 1939, though, later it became a rarity. The monoplane is now the commonest type of aircraft. It has the advantage that it faces less resistance from the air than other types and therefore it can fly faster with the same power.

Modern aircraft are mass-produced, so all parts must fit exactly; at the same time the materials used must be as light and as strong as possible. This calls for precise engineering; it also means designing the plane in such a way that no part of the structure will fail through 'fatigue' – the result of subjecting a material to intense alternations of stress. Each airplane is designed and assembled in several distinct sections, such as front and rear fuselage and port and starboard wings. Each section is itself assembled from smaller parts in a jig, which is a solid and accurately constructed frame. Only parts that are themselves perfectly accurate will fit onto the jig. When the main sections are completed, they are joined together; and the airplane moves down the assembly line to have its engines, furnishings, cabin equipment, radios, and other apparatus added before it is ready to undergo trials and to go into service.



monoplane

A. Read each statement and decide whether it is true or false. Write 'T' before true statements and 'F' before false statements.

.... 1. We call the left-side of an airplane ‘port'.

….... 2. Mass production requires that most of the parts be prepared accurately so that they fit onto a jig exactly.

……. 3. German designers built flimsy structures which served well during World War I mean that it is ready to undergo trials.

.... 5. According to the author, an aircraft could fly adequately even if a fixed wing were not used.

B. Circle a, b, c, or d which best completes the following items.

1. The advantage of a monoplane over the other types of aircraft is that …….. .
   a. it presents more resistance to the air and therefore can fly faster
   b. it can fly faster even though it does not present any resistance to the air
   c. it can fly faster with an increased power
   d. the air presents less resistance to it and therefore it can fly faster
2. The idea of using welded steel tubes to build rigid bodies was not seriously developed because ....
   a. rigid bodies could not be covered with canvas
   b. the steel tubes were flimsy structures
   c. the techniques of mass production of light structures in iron and steel did not exist
   d. it was war-time and factories were occupied in manufacturing large quantities of supplies for war.
3. The hollow metal wings of a modern airplane ....
   a. are not strong enough to take the strains caused by the downward push of the load
   b. take the forces exerted by the air
   c. are not basically rigid structures
   d. are held in shape by rigging wires
4. In line 2, the term flimsy structures' refers to ....
   a. wooden frames   c. fabric and wooden frames
   b. rigging wires   d. airplanes
5. Paragraph 4 ....
   a. describes how a modern aircraft is manufactured in mass production
   b. shows how an aircraft can undergo trials
   c. introduces factors required for the precise engineering of an aircraft
   d. specifies the position of fuselage, port, and starboard in an aircraft
6. Reducing the number of wings of an airplane resulted in .... of air pressure and .... of speed.
   a. the increase / the decrease   c. the decrease / the decrease
   b. the decrease / the increase   d. the increase / the increase
7. The modern airplane owes its development to the idea that ....

b. an airplane subjected to intense alternations of stress should be strong enough to bear them
c. only a rigid fuselage may react to the opposing forces exerted by the air
d. a hollow but strong wing fixed to the plane can withstand all the forces exerted on it

8. Paragraph 1 mainly states that ....
a. German designers suggested metal to be used in the structure of airplanes
b. even mass production could not satisfy human needs because lightweight alloys did not exist
c. although German designers replaced wood with metal for building aircraft, the technological deficiencies did not allow any great advance in this direction

C. Answer the following questions orally.

1. What causes fatigue in metal?
2. Why were rigging wires used in early airplanes?
3. Who first started using welded steel tubes instead of wooden frames in building an aircraft?
4. What is the difference between a biplane and a monoplane?
5. How would you describe the process of building a modern airplane?

Part III: Homework

Section One: Vocabulary Exercises

A. Fill in the blanks with the words from the following table to complete the sentences. Base your choices on the items of the table only. Make necessary changes if required.

Verb	Noun	Adjective	Adverb
solidify	Solid	Solid	solidly
necessitate	necessity	necessary	necessarily
center	center	central	centrally
-------	exactness	exact	exactly

1. Most of the factories are located in the .... part of the country.
2. While rooding n passage it is not necessary to know the .... meaning

UNIT 12

Part I. Pre-Reading

A. Word Study: Definitions

brake drum /breɪk 'drʌ m/:	the metal cylinder, as on the hub of a wheel, to which the brake band is applied in braking
brake lining /breɪk 'larɪnɪŋ/:	a material of asbestos, minerals, fine wire, etc. riveted or bonded to a brake band to create the friction necessary for braking
brake shoe /breɪk 'ʃu:/:	part of a brake that presses against the wheel or drum and acts as a brake; it is a block curved to fit the shape of a wheel
coupling /'kʌ plɪŋ:	the act of joining; link etc. that joins two parts especially two vehicles
leverage /li:vərɪdʒ /:	action of, power or advantage gained by using a lever; the force used to do something with a lever
pneumatic /nju:'mætik/:	worked or driven by compressed air

B. Word Study: Definitions and Examples

actuate /'æktʃueɪt/:	cause to act; put in action or motion
	The camshaft actuates the rocker arms to open and close the valves.
as regards /əz rɪ'gʊ ɑ :dz/:	(prep) with reference to; concerning
	As regards their application, cargo cars are used for various purposes.

bump /bʌ mp/: a swelling or bulge on any surface The bumps on the rough road caused some damage to our car.

com pensate /'kɒ mpenseɪt/: add to make up the loss of; make equivalent or suitable return to If the engine loses oil or there is any leakage, you should add oil to compensate for it.

con ventional /kən'venʃ ənl/: following what has been customary or considered acceptable; traditional; ordinary

Most of our electricity is generated at conventional power stations, we still don't have an operative nuclear reactor.

exert /ɪg' zɜ :t/: put into action or use; apply with great energy

The driver should exert enough pressure on the clutch pedal to depress it all the way down.

integral /'ɪntɪgrəl/: necessary for completeness The arms and legs are integral parts of a human being.

in tend /ɪn'tend/: mean something to be or be used for; design

These shelves are intended for my personal library.

law /lɔ :/: the whole system of rules that everyone in a country or society must obey

The law doesn't allow to drive a car without having a driving licence.

reservoir /'rezəvwa:(r)/: anything for holding or storing a liquid

Oil-burning lamps include a reservoir which should be filled with kerosene.

retract /rɪ'trækt/: draw back or in; move back or in

The airliner retracted its undercarriage after taking off.

simultaneously /, sɪml 'teɪniəsli/:	at the same time Three persons can take part in a telephone call simultaneously if the service is provided by the network.
slope /slɔ ʊ p/:	slanting line; a piece of ground that is not flat or level That hill is too steep; the slope is about 2 in 5.
station ary /' steɪʃ ənri/:	not moving or intended to move While driving on the road, his car collided with a stationary vehicle.

Part II. Reading

The Braking System

The braking system is one of the most important vehicle systems. Its purpose is to slow down and stop the moving automobile and also to hold it stationary in parking. The vehicle brake system is a complex combination of hydraulic, vacuum, electrical, and mechanical systems. Vehicles use several types and combinations of brakes.

Each vehicle must, by law, have two separate brake systems for safety. The main brake system, called the service brake system, is usually hydraulically operated. The secondary or parking brake system is mechanically operated. It is designed to hold the vehicle on a 30% slope and is capable of stopping the vehicle if the service brake system should fail. (A third system, the auxiliary or steering brake system, is also used on some vehicles such as farm tractors to help the operator make sharp turns.)

Automotive service brake systems are divided into three basic types: drum brakes, disc brakes, and disc-drum combination brakes. All three are used; however, only disc and disc-drum combination systems are used on new vehicles.

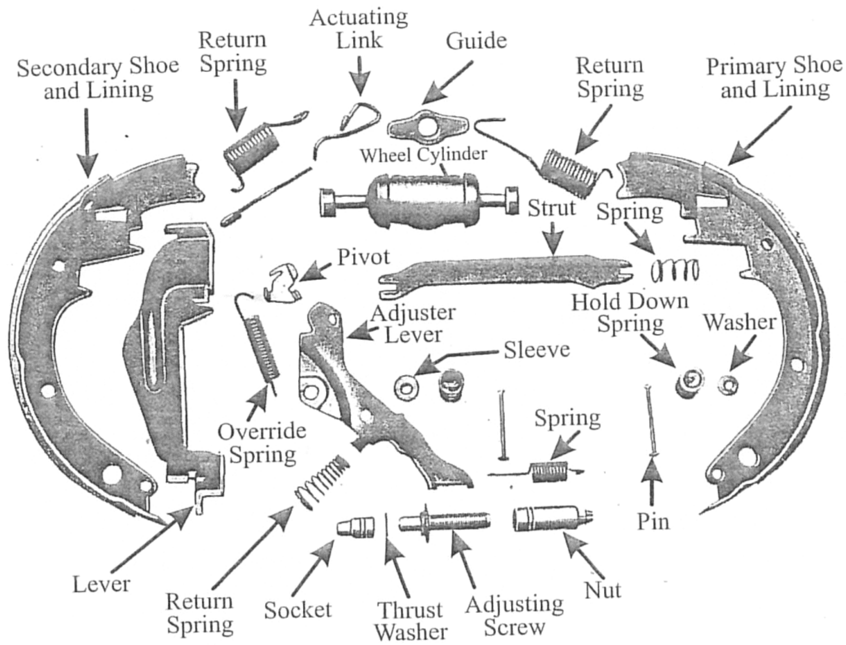


Figure 12-1. Parts of Dual-Servo Brake.

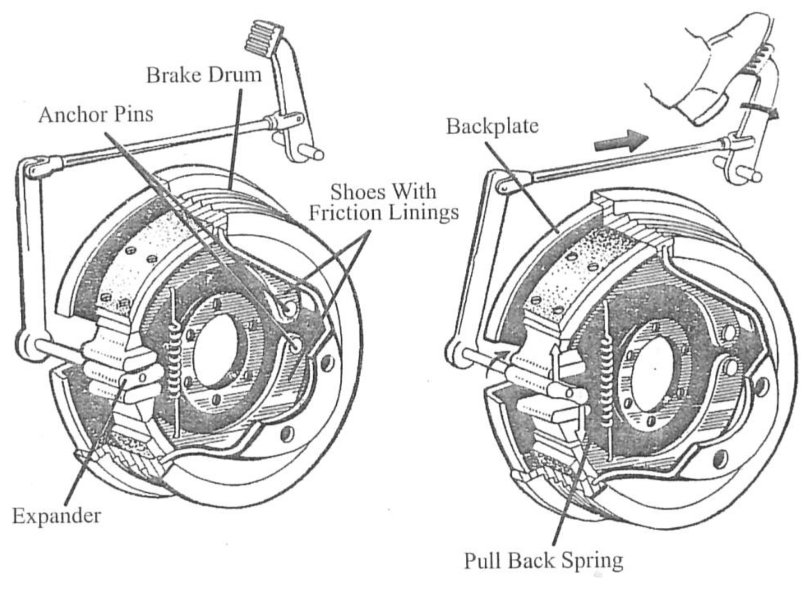


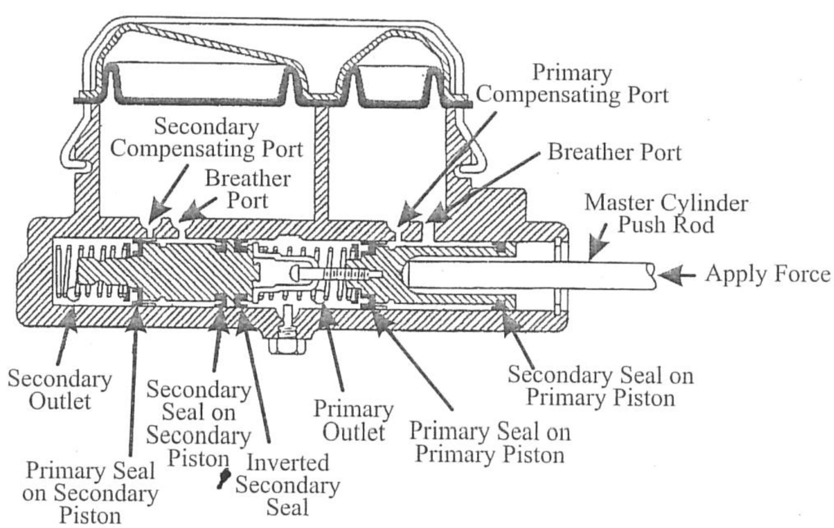
Figure 12-2. Operation of Drum Brake: (a) Released and (b) Applied.

As regards their place of application, automotive brakes are divided into wheel (hub) brakes and transmission (shaft) brakes. The former act upon - the wheel hubs, whereas the latter act upon one of the drive-line shafts. The wheel brakes belong to the service brake system and the transmission brakes are used in the parking brake system. The wheel brake is located in the wheel. It consists of a brake drum, an expander, a pullback spring, a stationary back late, two shoes with friction linings, and anchor pins.

To apply brakes, the driver pushes the foot pedal, the expander expands the shoes and presses them to the drum. Friction between the brake drum and the friction linings brakes the wheels and the automobile stops. To release brakes, the driver releases the pedal, the pull back spring retracts the shoes thus permitting free rotation of the wheels.

To decelerate and stop the moving automobile, the service brakes are usually used. When the pedal is pushed, the brake assemblies of all four wheels operate simultaneously. The parking brake is intended to hold the automobile at rest.

As to their principle of operation, the brake assemblies are actuated by mechanical, hydraulic, or pneumatic (air) devices. The mechanical leverage is usually used in parking brakes used on automobiles. It is also used on most farm tractors.



Seal Figure 12-3. Parts of a Typical Tandem Master Cylinder in the Apply Position.

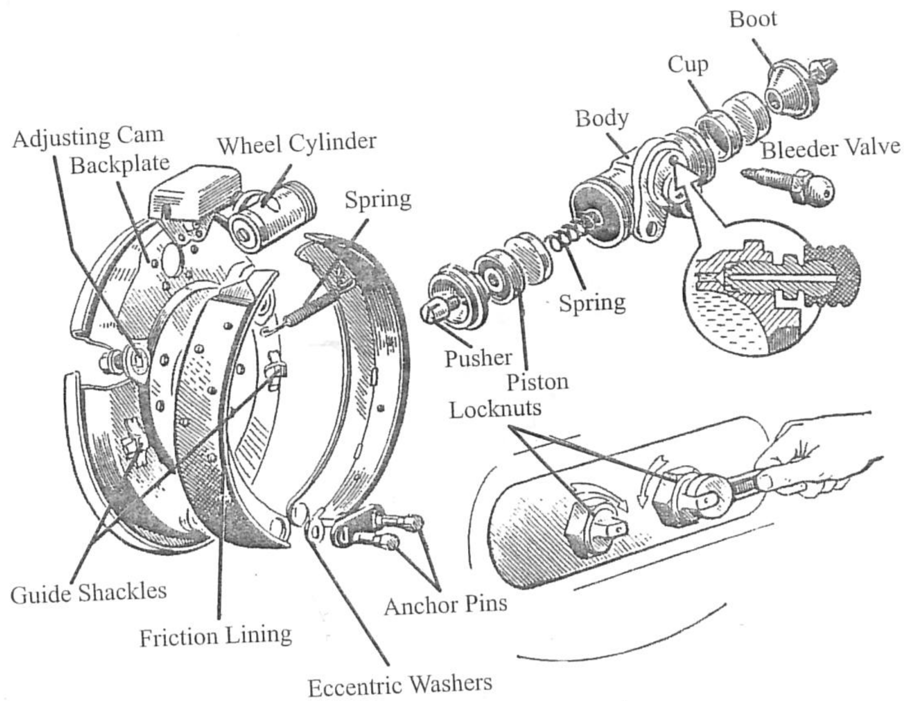


Figure 12-4. Hydraulic Drum Brake.

A typical hydraulic brake system has a master cylinder, wheel cylinders, and hydraulic valves. Steel brake lines and flexible brake hoses deliver the brake fluid under pressure to the wheel cylinders. The pressure in the system is the same throughout the brake lines regardless of the size or length of the lines. Flexible hoses transmit the pressure to the wheels while the vehicle travels over bumps and steers through turns.

The master cylinder increases the pressure and moves hydraulic fluid in the brake system. It does this by changing the mechanical force exerted on the brake pedal to hydraulic pressure. A tandem master cylinder is used on conventional passenger vehicles. It is sometimes called a dual master cylinder. It is designed with two separate hydraulic pressure areas, each connected to one half of the brake system. One half of the system will provide emergency braking if the other half should fail. Each half of the master cylinder includes a fluid reservoir, a compensating port, and an outlet port. Some master cylinders include an integral boost unit. It has an electrically operated pump to provide fluid pressure to assist in braking.

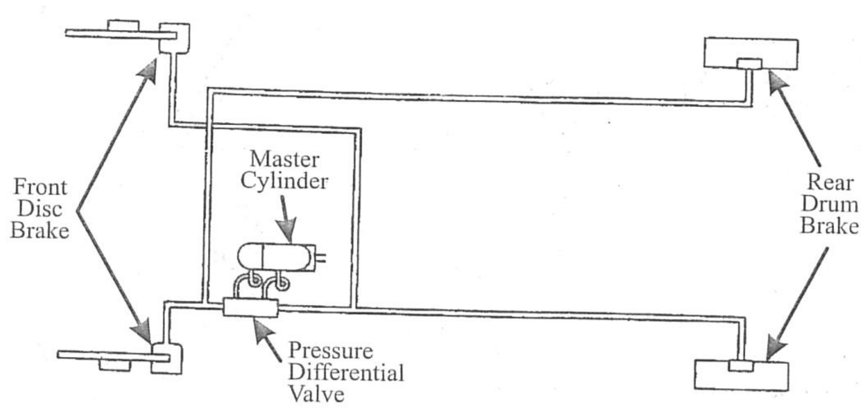


Figure 12-5. Typical Diagonal Split Hydraulic Brake System.

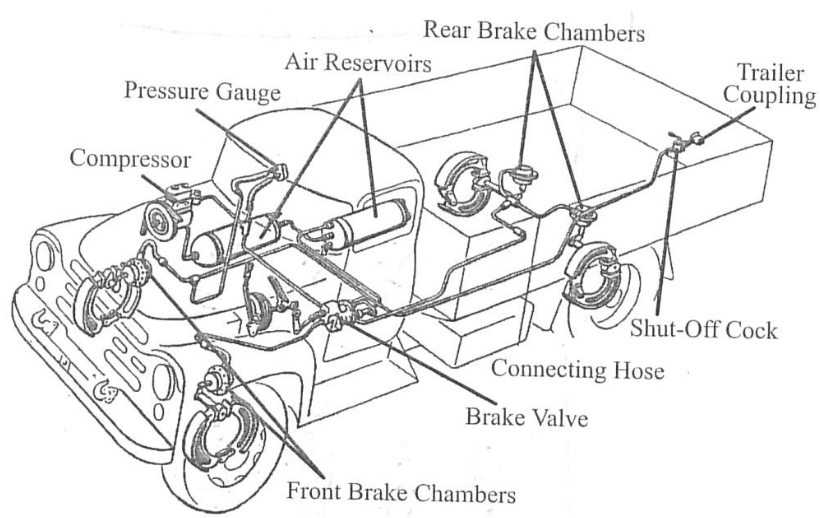


Figure 12-6. Air-Operated Brakes of a Truck.

Air brakes are usually used on heavy vehicles such as trucks and buses. The air brake system includes a compressor, brake assemblies, brake valve, piping and hoses, a pressure governor, a pressure gauge, air reservoirs, brake chambers, a shut-off cock and a trailer coupling.

The air brakes are fed from the compressor and air reservoirs. The compressor may be mounted on the engine cylinder head and is driven via a belt by the engine cooling fan pulley. The air pressure in the system is controlled by the governor.

Comprehension Questions

A. Read each statement and decide whether it is true or false. Write 'T' before true statements and 'F' before false statements.

…….. 1. The braking system has two functions.

…….. 2. It is compulsory for each vehicle to have two separate brake systems.

…….. 3. Transmission brakes act on the wheel hubs.

…….. 4. The operation of both parking and service brake systems is the same

…….. 5. The automobile stops because of the friction produced between linings and the brake drum.

…….. 6. The brake assemblies of rear and front wheels operate one after the other.

…….. 7. The pressure of the fluid is higher in narrower hoses.

…….. 8. The hydraulic force applied on the brake pedal is changed to a mechanical one.

…….. 9. The integral booster helps in braking by providing fluid pressure.

B. Circle a, b, c, or d which best completes the following items.

1. The secondary brake system …….. .
   a. is operated by pressing the foot pedal
   b. can act as the main braking system in urgent situations
   c. is used just to hold the vehicle on a 30% slope
   d. is a combination of different systems
2. In paragraph three it is implied that …….. .
   a. all the three types of automotive brakes can be used in a single vehicle
   b. the three basic automotive brakes can be combined into one
   c. drum brakes are rather old and perhaps out of date

UNIT 13

Forces in engineering

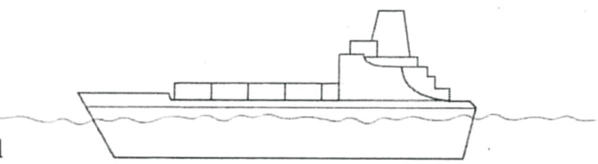
Tuning-in

Task 1 Working in your group, try to explain these problems.

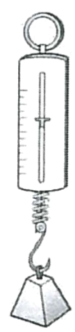
1 Why doesn't the ship sink?

2 What makes the spring stretch and what keeps the weight up?

3 Why doesn't the box slide down the slope?



1



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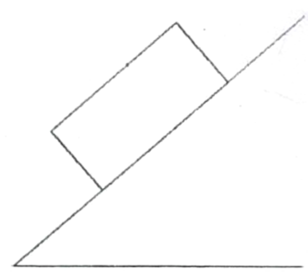


3

Reading 1 *Predicting*

As you learnt in Unit 1, it is important to think about what you are going to read before you read. Do not start to read a text immediately. One way to help your reading is to think about the words which might appear in the text. The title might help to focus your thoughts. Which words might appear in a text with the title Forces in engineering?

Task 2 The text you are going to read is called Forces in engineering. Here are some of the words it contains. Can you explain the link between each word and the title of the text?

weight	buoyancy	equilibrium
elasticity	magnitude	resultant
newton	gravity	

Task 3 Now read the text. Use the information in the text to check the explanations you made in Task 1.

Forces in engineering

To solve the ship problem, we must look at the forces on the ship (Fig. 1). The weight, w, acts downwards. That is the gravity force. The buoyancy force, B, acts upwards. Since the ship is in equilibrium, the same.

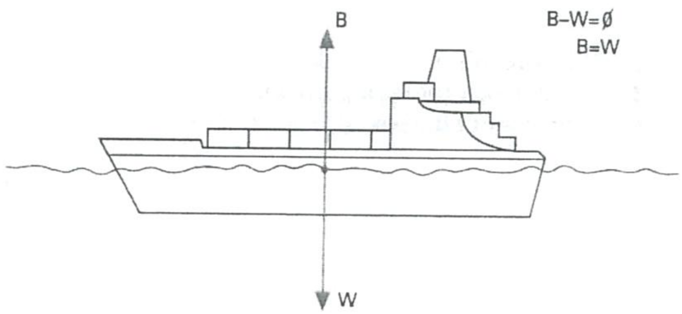


Fig. 1

Another very important force in engineering is the one caused by elasticity. A good example of this is a spring. Springs exert more force the more they are stretched. This property provides a way of measuring force. A spring balance can be calibrated in new tons, the unit of force. The block in Fig. 2 has a weight of 10 new tons. The weight on the balance pulls the spring down. To give equilibrium, the spring pulls up to oppose that weight. This upward force, F1, equals the weight of the block, W.

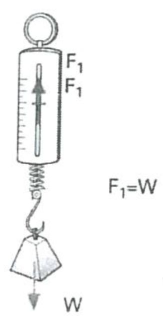


Fig. 2

It is important to get the distinction between mass and weight absolutely clear. Mass is the quantity of matter in an object. Weight is the force on that object due to gravity. Mass is measured in kilograms, whereas weight, being a force, is measured in new tons. We have looked at buoyancy, elasticity, and gravity. There is a fourth force important in engineering, and that is friction. Friction is a help in some circumstances but a hindrance in others. Let us examine the forces on the box (Fig. 3). Firstly, there is its weight, W, the gravity force, then there is the reaction, R, normal to the plane. R and W have a resultant force trying to pull the box down the slope. It is the friction force, F, acting up the slope, that stops it sliding down.

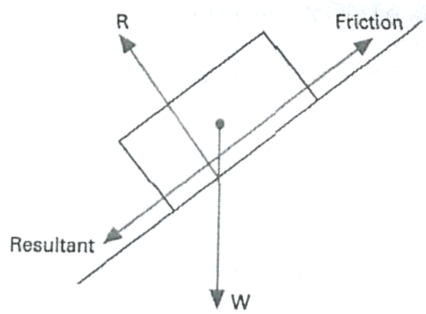


Fig. 3

Reading 2 *Grammar links in texts*

One of the ways in which sentences in a text are held together is by grammar links. In this extract, note how each expression in italics links with an earlier expression.

Another very important force in engineering is the one caused by elasticity. A good example of this is a spring. Springs exert more force the more they are stretched. This property provides a way of measuring force.

Sometimes these links cause problems for readers because they cannot make the right connection between words in different parts of a text. Study these common grammar links:

1. A repeated noun becomes a pronoun.
   Springs becomes they.
2. A word replaces an earlier expression.
   Force in engineering becomes one.
3. A word replaces a whole sentence or clause.
   Springs exert more force the more they are stretched becomes This property.

Task 4 With which earlier expressions do the words in italics link? Join them as in the example above.

Friction in machines is destructive and wasteful. It causes the moving parts to wear and it produces heat where it is not wanted. Engineers reduce friction by using very highly polished materials and by lubricating their surfaces with oil and grease. They also use ball bearings and roller bearings because rolling objects cause less friction than sliding ones.

Source: S: Larkin and L. Bernbaum (eds.), The Penguin Book of the Physical World

Language study *The present passive*

Study these instructions for a simple experiment on friction.

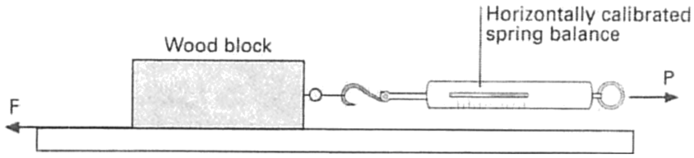


Fig. 4

1 Place a block of wood on a flat surface.

2 Attach a spring balance to one end of the block.

3 Apply a gradually increasing force to the balance.

4 Note the force at which the block just begins to move.

5 Pull the block along so that it moves at a steady speed.

6 Note the force required to maintain movement.

7 Compare the two forces.

When we describe this experiment, we write:

> A block of wood is placed on a flat surface. A spring balance is attached to one end of the block.

This description uses the present passive. We form the present passive using is/are + past participle.

Task 5 Complete this description of the experiment using the present passive.

A block of wood …………. on a flat surface. A spring balance ………… to one end of the block. A gradually increasing force ………… to the balance. The force at which the block just begins to move ………… .

The block ………..… along at a steady speed. The force required to maintain movement …………. . The two forces …………. It is found that the first force is greater than the second.

What does this experiment show?

Listening *Listening to lectures*

The listening passage you are going to hear is an extract from a typical engineering lecture. Here are some of the features of lectures.

1 Incomplete sentences: Spoken language is not divided neatly into sentences and paragraphs. For example:

Now what I thought I might do today ... What we are going to talk of ...

2 Repetition and rephrasing: Lecturers often say the same thing more than once and in more than one way. For example:

It will turn, revolve.

3 Signpost expressions: Lecturers often use expressions to help the students know what they are going to do next, what is important, etc. For example:

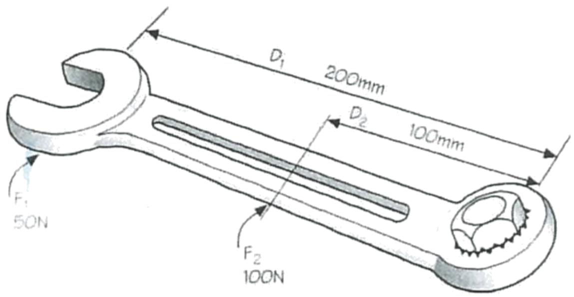
What we are going to talk of is the extension of a force.

Task 6 In the same way as when reading, it is helpful to think about the topic of a lecture before you listen. The topic here is The Moment of a Force. Can you explain the links between these words from the lecture and the topic? Use a dictionary to help you if necessary.

turning	distance	product
pivot	perpendicular	leverage
fulcrum	hinge	

Task 7 Now listen to the lecture to check your explanations.

Task 8 During the lecture, the lecturer drew this diagram on the board. Which of the words in Task 6 can be used to talk about the diagram?



Task 9 Here are some signpost expressions from the lecture. What do you think the lecturer is indicating each time? Select from the labels below, **a** to **e**.

1 We're going to talk about the moment of a force.
2 If you can think of a spanner ...
3 But what you have to remember is ...
4 Something simple to illustrate.
5 I'm thinking of a practical job.
6 Why do we put a handle there on the door?
7 Is that understood? All right?
8 Well that is then a little explanation of how you calculate moments.

a Emphasizing an important point
b Showing that the lecture is over
c Checking that the students can follow him
d Introducing the topic of the lecture
e Giving examples to illustrate the points

Task 10 Listen to the tape again and answer these questions according to the information given by the lecturer.

1 What advantage does a longer spanner offer in loosening a tight nut?
2 What is the formula for calculating the moment of a force?
3 Why is it sometimes difficult to apply a force at right angles in a motor car engine?
4 Why is the handle of a door at the edge?
5 Write down the formulae for calculating force and distance.

UNIT 14

Central heating

Tuning-in

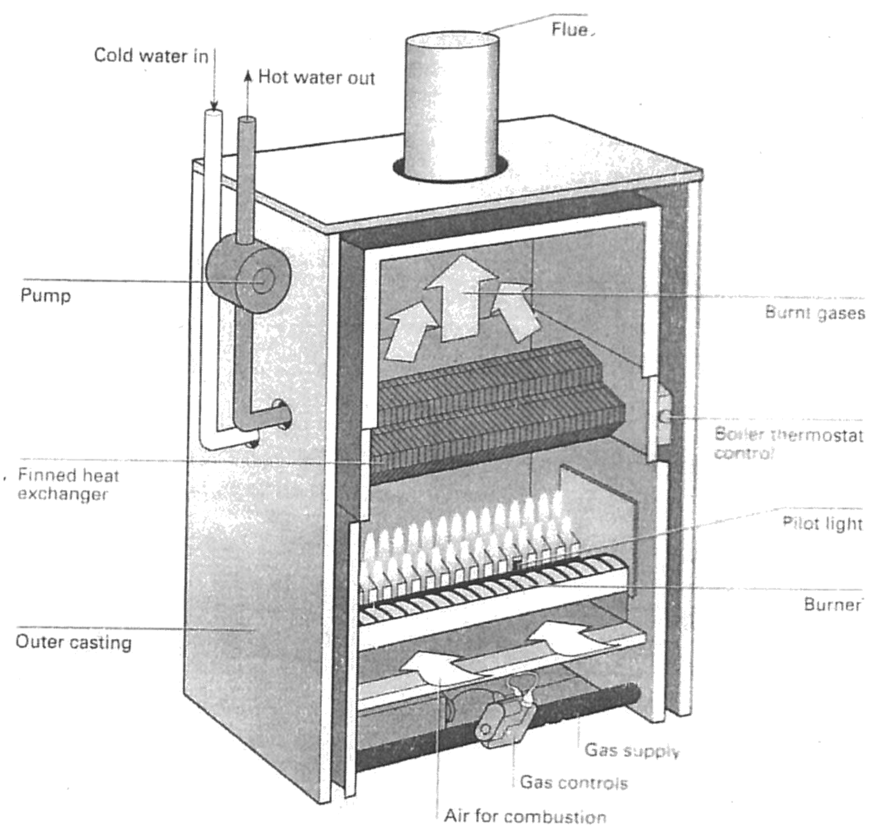
Task 1 How can you heat a house in cold weather: List the possible ways.

Reading *Predicting*

In Unit 5 we learnt how using the title can help us to predict the contents of a text. Diagrams are also very useful in helping the reader to make the right guesses about what a text will contain. Before you read a text, read the title and look at any diagrams it contains.

Task 2 Using the diagram, try to explain the function of these components

1 the pilot light
2 the heat exchanger fins
3 the flue
4 the thermostat
5 the pump



Task 3 Scan this text quickly to check the explanations you made in Task 2. You may not find all the information you want.

Gas central heating

Most gas central heating works on the swet' system of heat transfer between water flowing through pipes. A typical system includes a boiler, a network of pipes, a feed, and expansion tank, radiators, and a hot water storage system.

In conventional boilers, water is heated by gas burners. It is then pumped around the central heating system and the hot water storage cylinder. The flow of gas to the burner is controlled by a valve (or valves) which can be operated by a time switch or by a boiler thermostat, hot water cylinder thermostat, or by a thermostat located in one of the rooms.

Air is necessary for complete combustion and is supplied to the burners either from inside the house, when adequate ventilation must be ensured, or directly from outside through a balanced flue.

Water is circulated through a heat exchanger above the burner. The heat exchanger is made of tubes of cast iron or copper, which resist corrosion. Both types use fins to increase the surface area in contact with water, which improves the transfer of heat. A thermostat located in the boiler causes the gas control valve to shut off when the water temperature reaches the pre-set level.

After being pumped through a diverter or priority valve, water circulates around either one of two loops of pipe work, which act as heat exchangers. One loop passes through the inside of the hot water storage cylinder in a coil arrangement. Heat is transferred to the surrounding water, which can then be drawn off from this cylinder from various hot taps in the house when required. The loop then returns to the boiler for re-heating.

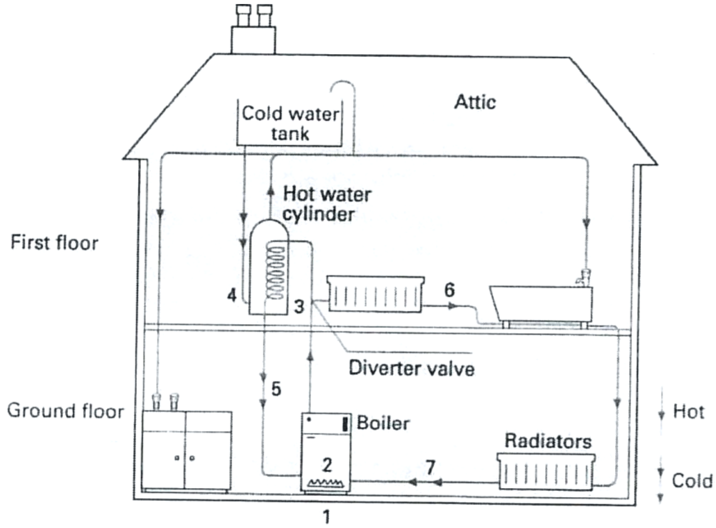
The other loop of the circuit passes to the radiators, which provide room heating. Several radiators are generally connected, where one pipe provides the hot water input and the other carries the cold water back to the boiler. In this way, all radiators receive hot water directly from the boiler.

Source: 'Inside out: Central Heating', Education Guardian

Task 4 Put these statements in the correct sequence. The first and last have been done for you.

a	Water is circulated through a heat exchanger.	1
b	The loop returns to the boiler for re-heating.	…….
c	One loop passes through the inside of the hot water storage cylinder in a coil of pipes.	…….
d	Water is heated by gas burners.	…….
e	The hot water is pumped through a diverter valve.	…….
f	The other loop of the circuit passes to the radiators.	…….
g	Cold water from the radiators returns to the boiler.	7

Task 5 Use the statements in Task 4 to label the stages shown in this diagram of a heating system.



Language study *Time clauses*

What is the relationship between these pairs of actions? How can we link each pair to show this relationship?

1 Cold water passes through a heat exchanger.

The water is heated. The water is heated.

2 It reaches a pre-set temperature.

The water is heated.

3 It is pumped to a diverter valve.

The water temperature reaches the right level.

4 The gas control valve shuts off.

We can show how actions are linked in time by using time clauses.

We can use as to link two connected actions happening at the same time. For example:

1 **As** cold water passes through a heat exchanger, the water is heated.

We can use until to link an action and the limit of that action. For example:

2 The water is heated **until** it reaches a pre-set temperature.

Note that until normally comes between the stages.

We can use after to show that one action is followed by another action. For example:

3 ***After*** *the water is heated, it is pumped to a diverter valve.*

We can use when to show that one action happens immediately after another. For example:

4 ***When*** *the water temperature reaches the right level, the gas control valve* shuts off.

Note that when the time word comes first in the sentence, a comma (.) is used after the time clause.

Task 6 Link these sets of actions with appropriate time words.

1 The system is switched on.
Cold water passes through a heat exchanger in the boiler.

2 The water passes through the heat exchanger.
The water becomes hotter and hotter.
The water reaches a pre-set level.

3 The water temperature reaches the pre-set level.
A thermostat causes the gas control valve to shut off.

4 The water is pumped to a diverter valve.
The water goes to the hot water cylinder or the radiators.

5 Hot water passes through the inside of the hot water storage cylinder in a coil arrangement.
Heat is transferred to the surrounding water.

6 The hot water flows through the radiators.
The hot water loses heat.

7 The water passes through the radiators.
The water returns to the boiler.

Word study

Task 7 The words listed in the first column of this table are common in descriptions of technical plant. They describe how substances are moved from one stage of the process to the next. Some of these words can be used for any substance:

others are more specific. Write an X under Solids, Liquids, or Gases if the word on the left can be used to talk about them. The first example has been done for you.

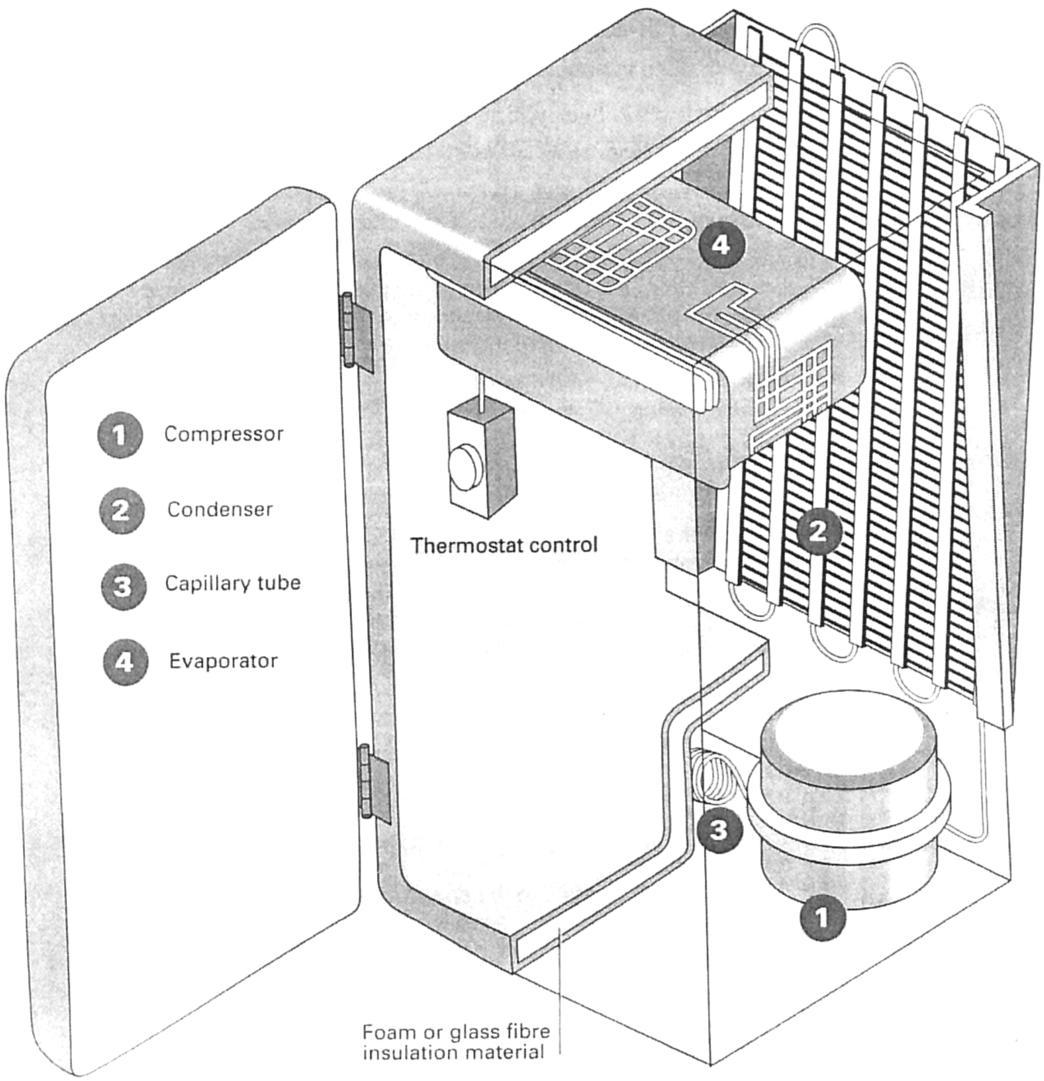
	Solids	**Liquids**	**Gases**
carried	X	X	X
circulated		X	X
conveyed	X	X	X
distributed		X	X
fed		X	X
piped		X	X
pumped		X	X
supplied	X	X	X

UNIT 15

Refrigerator

Tuning-in

Task 1 Study this diagram. It explains how a refrigerator works. In your group try to work out the function of each of the numbered components using the information in the diagram.



Reading Dealing with unfamiliar words, 1

You are going to read a text about refrigerators. Your purpose is to find out how they operate. Read the first paragraph of the text below. Underline any words which are unfamiliar to you.

> Refrigeration preserves food by lowering its temperature. It slows down the growth and reproduction of micro-organisms such as bacteria and the action of enzymes which cause food to rot.

You may have underlined words like micro-organisms, bacteria, or enzymes. These are words which are uncommon in engineering. Before you look them up in a dictionary or try to find translations in your own language, think! Do you need to know the meaning of these words to understand how refrigerators operate?

You can ignore unfamiliar words which do not help you to achieve your reading purpose.

Task 2 Now read the text to check your explanation of how a refrigerator works. Ignore any unfamiliar words which will not help you to achieve this purpose.

Fridge

para

Refrigeration preserves food by lowering its temperature. 1
It slows down the growth and reproduction of micro-organisms such as bacteria and the action of enzymes which cause food to rot.

Refrigeration is based on three principles. Firstly, if a liquid is 2
heated, it changes to a gas or vapour. When this gas is cooled, it changes back into a liquid. Secondly, if a gas is allowed to expand, it cools down. If a gas is compressed, it heats up. Thirdly, lowering the pressure around a liquid helps it to boil.

To keep the refrigerator at a constant low temperature, heat must 3
be transferred from the inside of the cabinet to the outside. A refrigerant is used to do this. It is circulated around the fridge, where it undergoes changes in pressure and temperature and changes from a liquid to a gas and back again.

One common refrigerant is a compound of carbon, chlorine, and 4
fluorine known as R12. This has a very low boiling point: -29°C. At normal room temperature (about 20°C) the liquid quickly turns into gas. However, newer refrigerants which are less harmful to the environment, such as KLEA 134a, are gradually replacing R12.

The refrigeration process begins in the compressor. This 5
compresses the gas so that it heats up. It then pumps the gas into a condenser, a long tube in the shape of a zigzag. As the warm gas passes through the condenser, it heats the surroundings and cools down. By the time it leaves the condenser, it has condensed back into a liquid.

Liquid leaving the condenser has to flow down a very narrow tube (a capillary tube). This prevents liquid from leaving the condenser too quickly, and keeps it at a high pressure. 6

As the liquid passes from the narrow capillary tube to the larger tubes of the evaporator, the pressure quickly drops. The liquid turns to vapour, which expands and cools. The cold vapour absorbs heat from the fridge. It is then sucked back into the compressor and the process begins again. 7

The compressor is switched on and off by a thermostat, a device that regulates temperature, so that the food is not over-frozen. 8

Source: 'Inside out: Fridge', Education Guardian

Language study Principles and laws

Study these extracts from the text above. What kind of statements are they?

1 If a liquid is heated, it changes to a gas or vapour.

2 Ifa gas is allowed to expand, it cools down.

3 Is a gas is compressed, it heats up.

Each consists of an action followed by a result. For example:

Action	Result
a liquid is heated	it changes to a gas or vapour

These statements are principles. They describe things in science and engineering which are always true. The action is always followed by the same result.

Principles have this form:

If/ When (action - present tense). (result - present tense).

Task 3 Link each action in column **A** with a result from column **B** to describe an important engineering principle.

A Action	**B Result**
1 a liquid is heated	**a** it heats up
2 a gas is cooled	**b** there is an equal and opposite reaction
3 a gas expands	**c** it changes to a gas
4 a gas is compressed	**d** it extends in proportion to the force
5 a force is applied to a body	**e** it is transmitted equally throughout the fluid
6 a current passes through a wire	**f** a current is induced in the wire
7 a wire cuts a magnetic field	**g** it cools down
8 pressure is applied to the surface of an enclosed fluid	**h** it sets up a magnetic field wire around the
9 a force is applied to a spring fixed at one end	**i** it changes to a liquid

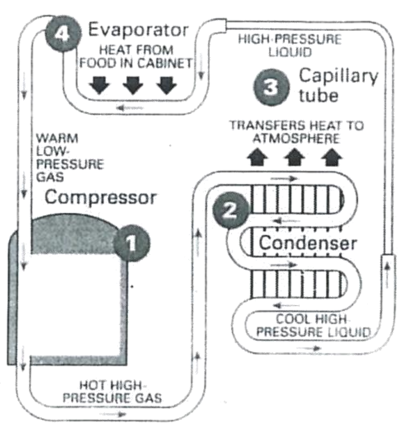
Word study Verbs and related nouns

Task 4 Each of the verbs in column **A** has a related noun ending in -er or -or in column **B**. Complete the blanks. You have studied these words in this and earlier units. Use a dictionary to check any spellings which you are not certain about.

	A Verbs	**B Nouns**
	For example:	
	Refrigerate	refrigerator
1	condense	……………
2	……………	evaporator
3	Compress	……………
4	resist	……………
5	……………	charger
6	generate	……………
7	conduct	……………
8	……………	exchanger
9	radiate	……………
10	control	……………

Writing Describing a process, 2: location

Study this diagram. It describes the refrigeration process.



In Unit 13 we learnt that when we write about a process, we have to:

1 Sequence the stages
2 Locate the stages
3 Describe what happens at each stage
4 Explain what happens at each stage

For example:

sequence location description

The refrigeration process begins in the compressor. This compresses the gas explanation

so that it heats up.

In this unit we will study ways to locate the stages.

Task 5 Put these stages in the refrigeration process in the correct sequence with the help of the diagram above. The first one has been done for you.

a	The liquid enters the evaporator.	……..
b	The gas condenses back into a liquid.	……..
c	The vapour is sucked back into the compressor.	……..
d	The gas is compressed.	1
e	The liquid turns into a vapour.	……..
f	The gas passes through the condenser.	……..
g	The liquid passes through a capillary tube.	……..
h	the high pressure is maintained.	……..

There are two ways to locate a stage in a process.

1 Using a preposition + noun phrase. For example:

The liquid turns to vapour **in the evaporator**.

The gas cools down **in the condenser**.

2 Using a where-clause, a relative clause with where rather than which or who, to link a stage, its location and what happens there. For example:

The warm gas passes through the condenser, **where it heats the surroundings and cools down**.

The refrigerant circulates around the fridge, **where it undergoes changes in pressure and temperature**.

Task 6 Complete each of these statements.

1 The gas passes through the compressor, where …………… .

2 It passes through the condenser, where …………… .

3 The liquid passes through a capillary tube, where …………… .

4 The liquid enters the evaporator, where …………… .

5 The cold vapour is sucked back into the compressor, where …………… .

Task 7 Add sequence expressions to your statements to show the correct order of events. For example:

First the gas passes through the condenser ...

Make your statements into a paragraph adding extra information from the text in Task 2 if you wish. Then compare your paragraph with paragraphs 6, 7. and 8 from the text.

UNIT 16

Engineering Thermodynamics

1.1 Fundamentals
Basic Concepts and Definitions • The First Law of Thermodynamics, Energy · The Second Law of Thermodynamics, Entropy • Entropy and Entropy Generation
1.2 Control Volume Applications
Conservation of Mass • Control Volume Energy Balance • Control Volume Entropy Balance • Control Volumes at Steady State
1.3 Property Relations and Data
Basic Relations for Pure Substances • P-v-T Relations • Evaluating Ah, Au, and As • Fundamental Thermodynamic Functions • Thermodynamic Data Retrieval · Ideal Gas Model• Generalized Charts for Enthalpy, Entropy, and Fugacity • Multi component Systems
1.4 Combustion
Reaction Equations • Property Data for Reactive Systems • Reaction Equilibrium
1.5 Exergy Analysis
Defining Exergy • Control Volume Exergy Rate Balance • Exergetic Efficiency • Introduction to Exergy Costing
1.6 Vapor and Gas Power Cycles
Rankine and Brayton Cycles • Otto, Diesel, and Dual Cycles • Carnot, Ericsson, and Stirling Cycles
1.7 Guidelines for Improving Thermodynamic Effectiveness
1.8 Exergoeconomics
Exergy Costing • Cost Balance • Auxiliary Costing Equations •General Example • Exergoeconomic Variables and Evaluation
1.9 Design Optimization
An Iterative Exergoeconomic Procedure for Optimizing the Design of a Thermal System • The Case Study . Additional Iterations
1.10 Economic Analysis of Thermal Systems
Estimation of Total Capital Investment • Principles of Economic Evaluation • Calculation of the Product Costs

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Although various aspects of what is now known as thermodynamics have been of interest since antiquity, formal study began only in the early 19th century through consideration of the motive power of heat: the capacity of hot bodies to produce work. Today the scope is larger, dealing generally with energy and entropy, and with relationships among the properties of matter. Moreover, in the past 25 years engineering thermodynamics has undergone a revolution, both in terms of the presentation of fundamentals and in the manner that it is applied. In particular, the second law of thermodynamics has emerged as an effective tool for engineering analysis and design.

1.1 Fundamentals

Classical thermodynamics is concerned primarily with the macrostructure of matter. It addresses the gross characteristics of large aggregations of molecules and not the behavior of individual molecules. The microstructure of matter is studied in kinetic theory and statistical mechanics (including quantum thermodynamics). In this chapter, the classical approach to thermodynamics is featured.

Basic Concepts and Definitions

Thermodynamics is both a branch of physics and an engineering science. The scientist is normally interested in gaining a fundamental understanding of the physical and chemical behavior of fixed, quiescent quantities of matter and uses the principles of thermodynamics to relate the properties of matter. Engineers are generally interested in studying systems and how they interact with their surroundings. To facilitate this, engineers have extended the subject of thermodynamics to the study of systems through which matter flows.

System

In a thermodynamic analysis, the system is the subject of the investigation. Normally the system is a specified quantity of matter and/or a region that can be separated from everything else by a well-defined surface. The defining surface is known as the control surface or system boundary. The control surface may be movable or fixed. Everything external to the system is the surroundings. A system of fixed mass is referred to as a control mass or as a closed system. When there is flow of mass through the control surface, the system is called a control volume, or open, system. An isolated system is a closed system that does not interact in any way with its surroundings.

State, Property

The condition of a system at any instant of time is called its state. The state at a given instant of time is described by the properties of the system. A property is any quantity whose numerical value depends on the state but not the history of the system. The value of a property is determined in principle by some type of physical operation or test.

Extensive properties depend on the size or extent of the system. Volume, mass, energy, and entropy are examples of extensive properties. An extensive property is additive in the sense that its value for the whole system equals the sum of the values for its parts. Intensive properties are independent of the size or extent of the system. Pressure and temperature are examples of intensive properties.

A mole is a quantity of substance having a mass numerically equal to its molecular weight. Designating the molecular weight by M and the number of moles by n, the mass m of the substance is m = nM. One kilogram mole, designated kmol, of oxygen is 32.0 kg and one pound mole (lbmol) is 32.0 lb. When an extensive property is reported on a unit mass or a unit mole basis, it is called a specific property. An over bar is used to distinguish an extensive property written on a per-mole basis from its value expressed per unit mass. For example, the volume per mole is $\bar{v}$, whereas the volume per unit mass is v, and the two specific volumes are related by $\bar{v}$= Mv.

Process, Cycle

Two states are identical if, and only if, the properties of the two states are identical. When any property of a system changes in value there is a change in state, and the system is said to undergo a process. When a system in a given initial state goes through a sequence of processes and finally returns to its initial state, it is said to have undergone a cycle.

Phase and Pure Substance

The term phase refers to a quantity of matter that is homogeneous throughout in both chemical composition and physical structure. Homogeneity in physical structure means that the matter is all solid, or all liquid, or all vapor (or, equivalently, all gas). A system can contain one or more phases. For example, a system of liquid water and water vapor (steam) contains two phases. A pure substance is one that is uniform and invariable in chemical composition. A pure substance can exist in more than one phase, but its chemical composition must be the same in each phase. For example, if liquid water and water vapor form a system with two phases, the system can be regarded as a pure substarice because each phase has the same composition. The nature of phases that coexist in equilibrium is addressed by the phase rule (Section 1.3, Multicomponent Systems).

Equilibrium

Equilibrium means a condition of balance. In thermodynamics the concept includes not only a balance of forces, but also a balance of other influences. Each kind of influence refers to a particular aspect of thermodynamic (complete) equilibrium. Thermal equilibrium refers to an equality of temperature, mechanical equilibrium to an equality of pressure, and phase equilibrium to an equality of chemical potentials (Section 1.3, Multi component Systems). Chemical equilibrium is also established in terms of chemical potentials (Section 1.4, Reaction Equilibrium). For complete equilibrium, the several types of equilibrium must exist individually.

To determine if a system is in thermodynamic equilibrium, one may think of testing it as follows: isolate the system from its surroundings and watch for changes in its observable properties. If there are no changes, it may be concluded that the system was in equilibrium at the moment it was isolated. The system can be said to be at an equilibrium state. When a system is isolated, it cannot interact with its surroundings; however, its state can change as a consequence of spontaneous events occurring internally as its intensive properties, such as temperature and pressure, tend toward uniform values. When all such changes cease, the system is in equilibrium. At equilibrium. temperature and pressure are uniform throughout. If gravity is significant, a pressure variation with height can exist, as in a vertical column of liquid.

Temperature

A scale of temperature independent of the thermometric substance is called a thermodynamic temperature scale. The Kelvin scale, a thermodynamic scale, can be elicited from the second law of thermodynamics (Section 1.1, The Second Law of Thermodynamics, Entropy). The definition of temperature following from the second law is valid over all temperature ranges and provides an essential connection between the several empirical measures of temperature. In particular, temperatures evaluated using a constant volume gas thermometer are identical to those of the Kelvin scale over the range of temperatures where gas thermometry can be used.

The empirical gas scale is based on the experimental observations that (1) at a given temperature level all gases exhibit the same value of the product $\overline{pv}$ (p is pressure and $\bar{v}$ the specific volume on á molar basis) if the pressure is low enough, and (2) the value of the product pv increases with the temperature level. On this basis the gas temperature scale is defined by

$$T = \frac{1}{R} \lim_{p \to 0} (p\bar{v})$$

where T is temperature and $\bar{R}$ is the universal gas constant. The absolute temperature at the triple point of water (Section 1.3, P-v-T Relations) is fixed by international agreement to be 273.16 K on the Kelvin temperature scale. $\bar{R}$ is then evaluated experimentally as $\bar{R}$ = 8.314 kJ/kmol · K (1545 ft · lbf/lbmol · °R).

The Celsius temperature scale (also called the centigrade scale) uses the degree Celsius (°C), which has the same magnitude as the Kelvin. Thus, temperature differences are identical on both scales. However, the zero point on the Celsius scale is shifted to 273.15 K, as shown by the following relationship between the Celsius temperature and the Kelvin temperature:

$$T(°C) = T(K) - 273.15 \qquad (1.1)$$

On the Celsius scale, the triple point of water is 0.01°C and OK corresponds to –273.15°C.

Two other temperature scales are commonly used in engineering in the U.S. By definition, the Rankine scale, the unit of which is the degree Rankine (°R), is proportional to the Kelvin temperature according to

$$T(°R) = 1.8T(K) \qquad (1.2)$$

The Rankine scale is also an absolute thermodynamic scale with an absolute zero that coincides with the absolute zero of the Kelvin scale. In thermodynamic relationships, temperature is always in terms of the Kelvin or Rankine scale unless specifically stated otherwise.

A degree of the same size as that on the Rankine scale is used in the Fahrenheit scale, but the zero point is shifted according to the relation

$$T(°F) = T(°R) - 459.67 \qquad (1.3)$$

Substituting Equations 1.1 and 1.2 into Equation 1.3 gives

$$T(°F) = 1.8T(°C) + 32 \tag{1.4}$$

This equation shows that the Fahrenheit temperature of the ice point (0°C) is 32°F and of the steam point (100°C) is 212°F. The 100 Celsius or Kelvin degrees between the ice point and steam point corresponds to 180 Fahrenheit or Rankine degrees.

To provide a standard for temperature measurement taking into account both theoretical and practical considerations, the International Temperature Scale of 1990 (ITS-90) is defined in such a way that the temperature measured on it conforms with the thermodynamic temperature, the unit of which is the Kelvin, to within the limits of accuracy of measurement obtainable in 1990. Further discussion of ITS90 is provided by Preston-Thomas (1990).

The First Law of Thermodynamics, Energy

Energy is a fundamental concept of thermodynamics and one of the most significant aspects of engineering analysis. Energy can be stored within systems in various macroscopic forms: kinetic energy, gravitational potential energy, and internal energy. Energy can also be transformed from one form to another and transferred between systems. For closed systems, energy can be transferred by work and heat transfer. The total amount of energy is conserved in all transformations and transfers.

Work

In thermodynamics, the term work denotes a means for transferring energy. Work is an effect of one system on another that is identified and measured as follows: work is done by a system on its surroundings if the sole effect on everything external to the system could have been the raising of a weight. The test of whether a work interaction has taken place is not that the elevation of a weight is actually changed, nor that a force actually acted through a distance, but that the sole effect could be the change in elevation of a weight. The magnitude of the work is measured by the number of standard weights that could have been raised. Since the raising of a weight is in effect a force acting through a distance, the work concept of mechanics is preserved. This definition includes work effects such as is associated with rotating shafts, displacement of the boundary, and the flow of electricity.

Work done by a system is considered positive: $W > 0$. Work done on a system is considered negative: $W < 0$. The time rate of doing work, or power, is symbolized by W and adheres to the same sign convention.

Energy

A closed system undergoing a process that involves only work interactions with its surroundings experiences an adiabatic process. On the basis of experimental evidence, it can be postulated that when a closed system is altered adiabatically, the amount of work is fixed by the end states of the system and is independent of the details of the process. This postulate, which is one way the first law of thermodynamics can be stated, can be made regardless of the type of work interaction involved, the type of process, or the nature of the system.

As the work in an adiabatic process of a closed system is fixed by the end states, an extensive property called energy can be defined for the system such that its change between two states is the work in an adiabatic process that has these as the end states. In engineering thermodynamics the change in the energy of a system is considered to be made up of three macroscopic contributions: the change in kinetic energy, KE, associated with the motion of the system as a whole relative to an external coordinate frame, the change in gravitational potential energy, PE, associated with the position of the system as a whole in the Earth's gravitational field, and the change in internal energy, U, which accounts for all other energy associated with the system. Like kinetic energy and gravitational potential energy, internal energy is an extensive property.

In summary, the change in energy between two states of a closed system in terms of the work W_{ad} of an adiabatic process between these states is

$$(KE_2 - KE_1) + (PE_2 - PE_1) + (U_2 - U_1) = -W_{ed} \qquad (1.5)$$

where 1 and 2 denote the initial and final states, respectively, and the minus sign before the work term is in accordance with the previously stated sign convention for work. Since any arbitrary value can be assigned to the energy of a system at a given state 1, no particular significance can be attached to the value of the energy at state 1 or at any other state. Only changes in the energy of a system have significance.

The specific energy (energy per unit mass) is the sum of the specific internal energy, u, the specific kinetic energy, $v^2/2$, and the specific gravitational potential energy, gz, such that

$$\text{specific energy} = u + \frac{v^2}{2} + gz \qquad (1.6)$$

where the velocity v and the elevation z are each relative to specified datums (often the Earth's surface) and g is the acceleration of gravity.

A property related to internal energy u, pressure p, and specific volume v is enthalpy, defined by

$$h = u + pv \qquad (1.7a)$$

or on an extensive basis

$$H = U + p^V \qquad (1.7b)$$

Heat

Closed systems can also interact with their surroundings in a way that cannot be categorized as work, as, for example, a gas (or liquid) contained in a closed vessel undergoing a process while in contact with a flame. This type of interaction is called a heat interaction, and the process is referred to as no adiabatic.

A fundamental aspect of the energy concept is that energy is conserved. Thus, since a closed system experiences precisely the same energy change during a no nadiabatic process as during an adiabatic process between the same end states, it can be concluded that the net energy transfer to the system in each of these processes must be the same. It follows that heat interactions also involve energy transfer. Denoting the amount of energy transferred to a closed system in heat interactions by Q, these considerations can be summarized by the closed system energy balance:

$$(U_2 - U_1) + (KE_2 - KE_1) + (PE_2 - PE_1) = Q - W \qquad (1.8)$$

The closed system energy balance expresses the conservation of energy principle for closed systems of all kinds.

The quantity denoted by Q in Equation 1.8 accounts for the amount of energy transferred to a closed system during a process by means other than work. On the basis of an experiment, it is known that such an energy transfer is induced only as a result of a temperature difference between the system and its surroundings and occurs only in the direction of decreasing temperature. This means of energy transfer is called an energy transfer by heat. The following sign convention applies:

$Q > 0$: heats transfer to the system

$Q < 0$: heat transfer from the system

The time rate of heat transfer, denoted by 2, adheres to the same sign convention.

Methods based on experiment are available for evaluating energy transfer by heat. These methods recognize two basic transfer mechanisms: conduction and thermal radiation. In addition, theoretical and empirical relationships are available for evaluating energy transfer involving combined modes such as convection. Further discussion of heat transfer fundamentals is provided in Chapter 3.

The quantities symbolized by W and Q account for transfers of energy. The terms work and heat denote different means whereby energy is transferred and not what is transferred. Work and heat are not properties, and it is improper to speak of work or heat “contained in a system. However, to achieve economy of expression in subsequent discussions, W and Q are often referred to simply as work and heat transfer, respectively. This less formal approach is commonly used in engineering practice.

Power Cycles

Since energy is a property, over each cycle there is no net change in energy. Thus, Equation 1.8 reads for any cycle

$$Q_{cycle} = W_{cycle}$$

That is, for any cycle the net amount of energy received through heat interactions is equal to the net energy transferred out in work interactions. A power cycle, or heat engine, is one for which a net amount of energy is transferred out by work: $W_{cycle} > 0$. This equals the net amount of energy transferred in by heat.

Power cycles are characterized both by addition of energy by heat transfer, Q_A, and inevitable rejections of energy by heat transfer, Q_R:

$$Q_{cycle} = Q_A - Q_R$$

Combining the last two equations,

$$W_{cycle} = Q_A - Q_R$$

The thermal efficiency of a heat engine is defined as the ratio of the net work developed to the total energy added by heat transfer:

$$\eta = \frac{W_{cycle}}{Q_A} = 1 - \frac{Q_R}{Q_A} \qquad (1.9)$$

The thermal efficiency is strictly less than 100%. That is, some portion of the energy QA supplied is invariably rejected $Q_R \neq 0$.

The Second Law of Thermodynamics, Entropy

Many statements of the second law of thermodynamics have been proposed. Each of these can be called a statement of the second law or a corollary of the second law since, if one is invalid, all are invalid. In every instance where a consequence of the second law has been tested directly or indirectly by experiment it has been verified. Accordingly, the basis of the second law, like every other physical law, is experimental evidence.

Kelvin-Planck Statement

The Kelvin-Plank statement of the second law of thermodynamics refers to a thermal reservoir. A thermal reservoir is a system that remains at a constant temperature even though energy is added or removed by heat transfer. A reservoir is an idealization, of course, but such a system can be approximated in a number of ways — by the Earth's atmosphere, large bodies of water (lakes, oceans), and so on. Extensive properties of thermal reservoirs, such as internal energy, can change in interactions with other systems even though the reservoir temperature remains constant, however.

The Kelvin-Planck statement of the second law can be given as follows: It is impossible for any system to operate in a thermodynamic cycle and deliver a net amount of energy by work to its surroundings while receiving energy by heat transfer from a single thermal reservoir. In other words, a perpetual motion machine of the second kind is impossible. Expressed analytically, the Kelvin-Planck statement is

$$W_{cycle} \leq 0 \text{ (single reservoir)}$$

where the words single reservoir emphasize that the system communicates thermally only with a single reservoir as it executes the cycle. The “less than” sign applies when internal irreversibilities are present as the system of interest undergoes a cycle and the “equal to” sign applies only when no irreversibilities are present.

Irreversibilities

A process is said to be reversible if it is possible for its effects to be eradicated in the sense that there is some way by which both the system and its surroundings can be exactly restored to their respective initial states. A process is irreversible if there is no way to undo it. That is, there is no means by which the system and its surroundings can be exactly restored to their respective initial states. A system that has undergone an irreversible process is not necessarily precluded from being restored to its initial state. However, were the system restored to its initial state, it would not also be possible to return the surroundings to their initial state.

There are many effects whose presence during a process renders it irreversible. These include, but are not limited to, the following: heat transfer through a finite temperature difference; unrestrained expansion of a gas or liquid to a lower pressure; spontaneous chemical reaction; mixing of matter at different compositions or states; friction (sliding friction as well as friction in the flow of fluids); electric current flow through a resistance; magnetization or polarization with hysteresis; and inelastic deformation. The term irreversibility is used to identify effects such as these.

Irreversibilities can be divided into two classes, internal and external. Internal irreversibilities are those that occur within the system, while external irreversibilities are those that occur within the surroundings, normally the immediate surroundings. As this division depends on the location of the boundary there is some arbitrariness in the classification (by locating the boundary to take in the immediate surroundings, all irreversibilities are internal). Nonetheless, valuable insights can result when this distinction between irreversibilities is made. When internal irreversibilities are absent during a process, the process is said to be internally reversible. At every intermediate state of an internally reversible process of a closed system, all intensive properties are uniform throughout each phase present: the temperature, pressure, specific volume, and other intensive properties do not vary with position. The discussions to follow compare the actual and internally reversible process concepts for two cases of special interest.

For a gas as the system, the work of expansion arises from the force exerted by the system to move the boundary against the resistance offered by the surroundings:

$$W = \int_1^2 Fdx = \int_1^2 pAdx$$

where the force is the product of the moving area and the pressure exerted by the system there. Noting that Adx is the change in total volume of the system,

$$w = \int_1^2 pdV$$

This expression for work applies to both actual and internally reversible expansion processes. However, for an internally reversible process p is not only the pressure at the moving boundary but also the pressure of the entire system. Furthermore, for an internally reversible process the volume equals mv, where the specific volume v has a single value throughout the system at a given instant. Accordingly, the work of an internally reversible expansion (or compression) process is

$$w = m\int_1^2 pdV \qquad (1.10)$$

When such a process of a closed system is represented by a continuous curve on a plot of pressure vs. specific volume, the area under the curve is the magnitude of the work per unit of system mass (area a-b-c'-d' of Figure 1.3, for example).

Although improved thermodynamic performance can accompany the reduction of irreversibilities, steps in this direction are normally constrained by a number of practical factors often related to costs. For example, consider two bodies able to communicate thermally. With a finite temperature difference between them, a spontaneous heat transfer would take place and, as noted previously, this would be a source of irreversibility. The importance of the heat transfer irreversibility diminishes as the temperature difference narrows; and as the temperature difference between the bodies vanishes, the heat transfer approaches ideality. From the study of heat transfer it is known, however, that the transfer of a finite amount of energy by heat between bodies whose temperatures differ only slightly requires a considerable amount of time, a large heat transfer surface area, or both. To approach ideality, therefore, a heat transfer would require an exceptionally long time and/or an exceptionally large area, each of which has cost implications constraining what can be achieved practically.

Carnot Corollaries

The two corollaries of the second law known as Carnot corollaries state: (1) the thermal efficiency of an irreversible power cycle is always less than the thermal efficiency of a reversible power cycle when each operates between the same two thermal reservoirs; (2) all reversible power cycles operating between the same two-thermal reservoirs have the same thermal efficiency. A cycle is considered reversible when there are no irreversibilities within the system as it undergoes the cycle, and heat transfers between the system and reservoirs occur ideally (that is, with a vanishingly small temperature difference).

Kelvin Temperature Scale

Carnot corollary 2 suggests that the thermal efficiency of a reversible power cycle operating between two thermal reservoirs depends only on the temperatures of the reservoirs and not on the nature of the substance making up the system executing the cycle or the series of processes. With Equation 1.9 it can be concluded that the ratio of the heat transfers is also related only to the temperatures, and is independent of the substance and processes:

$$\left(\frac{Q_C}{Q_H}\right)_{\substack{rev \\ cycle}} = \Psi(T_C, T_H)$$

where Q_H is the energy transferred to the system by heat transfer from a hot reservoir at temperature T_H, and Q_C is the energy rejected from the system to a cold reservoir at temperature T_C. The words rev cycle emphasize that this expression applies only to systems undergoing reversible cycles while operating between the two reservoirs. Alternative temperature scales correspond to alternative specifications for the function y in this relation.

The Kelvin temperature scale is based on y(T_C, T_H) = T_C/T_H . Then

$$\left(\frac{Q_C}{Q_H}\right)_{\substack{rev \\ cycle}} = \frac{T_C}{T_H} \tag{1.11}$$

This equation defines only a ratio of temperatures. The specification of the Kelvin scale is completed by assigning a numerical value to one standard reference state. The state selected is the same used to define the gas scale: at the triple point of water the temperature is specified to be 273.16 K. If a reversible cycle is operated between a reservoir at the reference-state temperature and another reservoir at an unknown temperature T, then the latter temperature is related to the value at the reference state by

$$T = 273.16 \left(\frac{Q}{Q'}\right)_{\substack{rev \\ cycle}}$$

where Q is the energy received by heat transfer from the reservoir at temperature T, and Q' is the energy rejected to the reservoir at the reference temperature. Accordingly, a temperature scale is defined that is valid over all ranges of temperature and that is independent of the thermometric substance.

Carnot Efficiency

For the special case of a reversible power cycle operating between thermal reservoirs at temperatures T_H and T_C on the Kelvin scale, combination of Equations 1.9 and 1.11 results in

$$\eta_{max} = 1 - \frac{T_C}{T_H} \qquad (1.12)$$

called the Carnot efficiency. This is the efficiency of all reversible power cycles operating between thermal reservoirs at T_H and T_C. Moreover, it is the maximum theoretical efficiency that any power cycle, real or ideal, could have while operating between the same two reservoirs. As temperatures on the Rankine scale differ from Kelvin temperatures only by the factor 1.8, the above equation may be applied with either scale of temperature.