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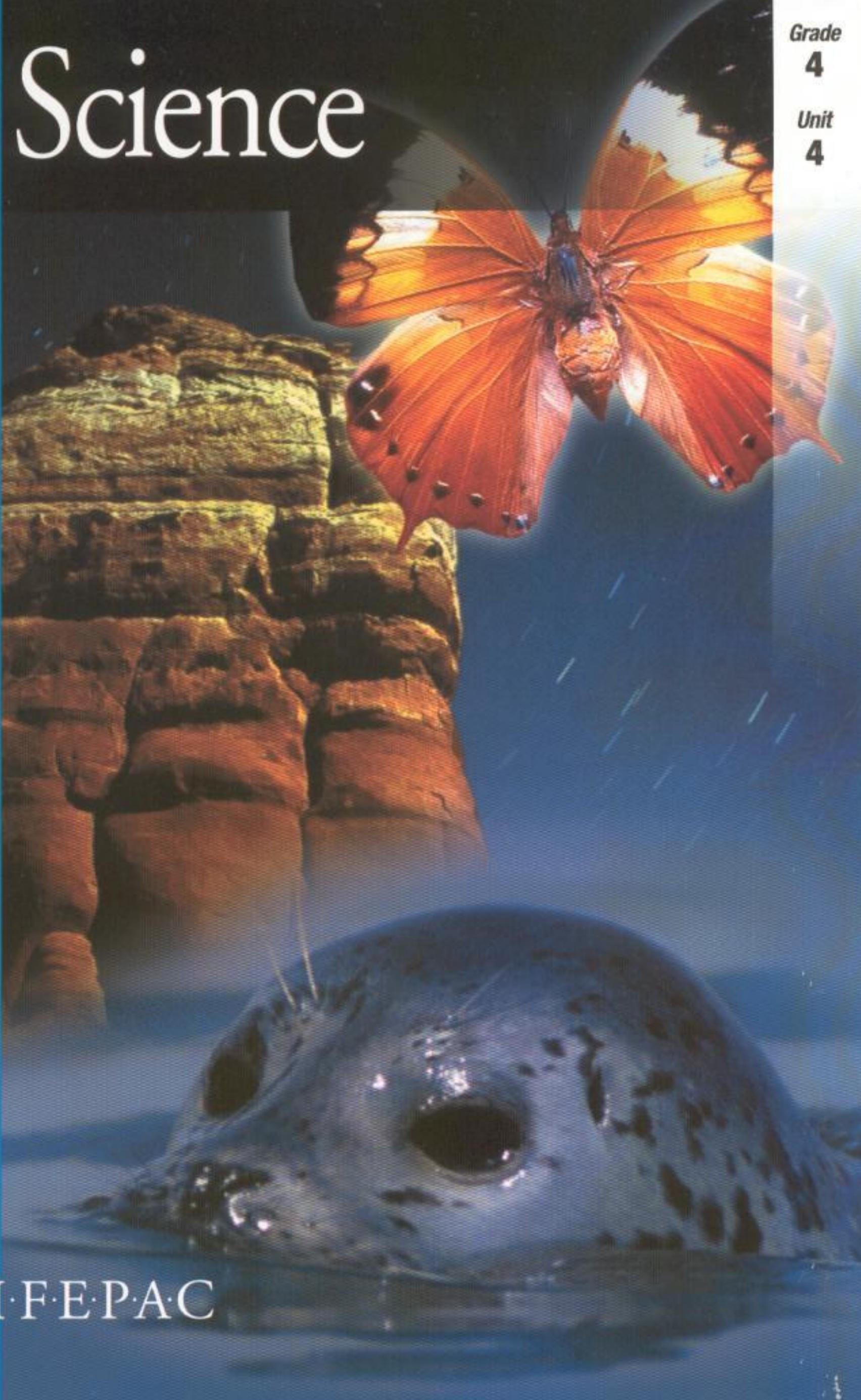
Science

Grade

4

Unit

4



LIFE PAC

SCIENCE 404: MACHINES

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MACHINES

King Solomon had a great Temple built many years before Jesus was born. In the Bible in the book of First Kings, Chapters 5 and 6, you can read about the Temple. The stones were cut and fitted into place. The workmen built the Temple in seven years. Buildings are constructed in a much shorter time today. Solomon's workers had no electricity or big machines to help them. They used simple machines. In this LIFEPAAC you will read about the kinds of machines they used. You will find out that you use the same type of machines today!

OBJECTIVES

Read these objectives. The objectives tell you what you should be able to do when you have successfully completed this LIFEPAAC.

When you have finished this LIFEPAAC, you should be able to:

1. Define *work*.
2. Tell the meaning of gravity and friction.
3. Explain about the two forms of energy.
4. Name four kinds of energy.
5. Explain why simple machines are needed to do work.
6. Name six simple machines.
7. Give an example of each simple machine.
8. Tell how each simple machine makes work easier.
9. Tell the meaning of simple and complex machines.
10. Name four complex machines.

VOCABULARY

Study these new words. Learning the meanings of these words is a good study habit and will improve your understanding of this LIFEPAAC.

block and tackle (blok and tak' ul). A set of two or more pulleys (the blocks) with ropes (the tackles) used to move objects.

bulldozer (bul' dō zēr). A power tractor with a wide steel blade that pushes rocks and earth.

complex (kum pleks'). Made up of a number of parts.

construction (kun struk' shun). Act of building.

crane (krān). A machine with a long, swinging arm, for lifting heavy objects.

dredge (drej). A machine with a scoop for deepening a harbor.

energy (en' ur jē). The ability to do work.

energy in action (en' ur jē in ak' shun). Energy that is being used to move something.

force (fōrs). Power, strength.

foundation (foun dā' shun). The part on which other parts rest.

friction (frik' shun). A rubbing of one thing against another.

fulcrum (ful' krum). The support on which a lever turns or is supported in moving or lifting something.

gravity (grav' u tē). The natural force that causes objects to move or tend to move toward the center of the earth.

groove (grüv). A long, narrow channel.

inclined plane (in klīnd' plān). A sloping, flat surface.

lever (lev' ur). A bar for raising or moving a weight at one end by pushing down at the other end.

load (lōd). What one is carrying.

machine (mu shēn'). A device for applying power.

mesh (mesh). To engage, as gear teeth.

pile driver (pīl driv' vur). A machine for pushing posts down into the ground.

pitch (pich). Amount of slope.

principle (prin' su pul). Basic truth or law.

pulley (pūl' ē). A wheel with a grooved rim in which a rope can run, and so lift weights.

ramp (ramp). A sloping way connecting two different levels.

screw (skrū). A kind of nail which has a ridge twisted evenly around its length.

spiral (spī' rul). A winding and gradually widening coil.

stored energy (stōrd en' ur jē). Energy at rest.

streamlined (strēm līnd). A shape that offers the least resistance to air or water.

thread (thred). The sloping ridge that winds around a screw.

wedge (wej). A piece of wood or metal thick at one end and tapering to a thin edge at the other.

wheel and axle (hwēl and ak' sul). A wheel with the shaft on which it turns.

wheelbarrow (hwēl' bar' ō). A small vehicle which has one wheel and two handles.

windlass (wind' lus). A machine for pulling or lifting things.

work (wèrk). A force moving an object.

Note: All vocabulary words in this LIFE PAC appear in **boldface** print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.

Pronunciation Key: hat, **â**ge, c**â**re, f**â**r; let, **ê**qual, t**ê**rm; it, **î**ce; hot, **ô**pen, **ô**rder; **oil**; **out**; cup, p**û**t, r**û**le; **child**; long; **thin**; /TH/ for **then**; /zh/ for **measure**; /a/ represents /a/ in about, /e/ in taken, /o/ in lemon, and /u/ in circus.

I. MACHINES ARE NEEDED

In this first section of this LIFE PAC, you will learn why you need machines to help you to do work. Solomon's men did not have many **machines**, but they did have some machines to help them lift heavy rocks as they built the Temple. They had machines to help them fasten wooden boards together.

They had machines to help them carry stones to the Temple. Do you use a machine to fasten two boards together? Do you use a machine to carry the family to the ballgame? Do you use only four fingers to fasten parts of a toy together? Read this section to find how machines help you to do work.

Review these objectives.

When you have finished this LIFE PAC, you should be able to:

1. Define *work*.
2. Tell the meaning of gravity and friction.
3. Explain about the two forms of energy.
4. Name four kinds of energy.
5. Explain why simple machines are needed to do work.

Restudy these words.

energy	friction	stored energy
energy in action	gravity	streamlined
force	machine	work

WORK

Solomon's builders pushed and pulled the heavy stones toward the Temple. When they pushed or pulled, they were doing **work**. Anytime you force something to move it, you are doing work. Did you push or pull the door open to come into the classroom today? If you did, you were doing work.

Force is another name for the push or pull needed to do work. Force moves things. What was the force used when you opened the door? _____ Yes, your muscles were the force that pushed on the door.

When Solomon's men moved the big stones for the Temple, would their job have been easier if they had moved the stones uphill or downhill? _____ Yes, downhill would be easier. Why?

The reason that the stones were easier to move downhill is that

gravity pulls things toward the center of the earth. Downhill would be toward the earth's center.

Gravity makes it safe for you to live on the earth. Everything is pulled by gravity. Roots of plants grow down. Your feet walk solidly on the ground. When you fall, you fall down instead of up. Water runs downhill. A ball tossed into the air always falls back down to the ground.

Since gravity pulls down, work is needed to move anything up, against the pull of gravity. Lifting the heavy stones for the Temples was hard work. The men used **machines** to help them.

Gravity pulled on the stones that the men would have to push uphill. The work would have been harder than pushing the stones downhill. If the men had been going downhill, gravity would have pulled on the stones, and the work would have been easier. Gravity would have helped the men.



Look up the facts!

A man named Galileo was born in Pisa, Italy, in the sixteenth century. He became the first real scientist of modern times. Read about Galileo in an encyclopedia, or find a good story of his life. Try to find the answers to these questions.

- 1.1 What did Galileo teach about the value of observing and experimenting? _____

1.2

What did Galileo's ideas have to do with the law of gravity?

Have you ever ridden a sled down a snowy hill at a rapid speed? At the bottom of the hill you suddenly hit a bare spot of sidewalk with no snow on it. What happened? _____ Gravity helped pull you downhill. What made you stop? _____

Another force was at work to stop you. **Friction** makes things stop. Friction is the name of the force that is present when two things rub against each other. The sled runners and the snow were smooth, so very little friction slowed your slide

downhill. The sidewalk was rough, so more friction resulted.

Without friction you would have a hard time moving about without slipping and sliding. You could not go anywhere in a car or on a bicycle because the wheels would spin around in one spot. Friction helps you by pushing against the wheels to make them turn. Even the air pushing against you causes friction. Airplanes are **streamlined** to lessen friction. Friction, like gravity, can be a help to you.



Think about things! Write your answer on the blank line. Lift a sheet of paper in one hand and a book in the other. Now let them fall.

1.3 Which hits the floor first? _____

1.4 Which one is slowed by air friction? _____

1.5 Do you think they would fall with equal speed if there were no friction from the air? _____

1.6 Why? _____

(If you're not sure of your answer to "why?" look back at what you learned about Galileo and falling objects.)

- 1.7 Why are airplanes streamlined with rounded instead of square wings and bodies? Write your idea in one or two sentences. _____
- 1.8 Does your idea have anything to do with the friction caused by moving through the air? _____

ENERGY

Energy is the ability to do work. Energy makes it possible to push or pull. When Solomon's builders pushed the stones with their shoulders, they used the energy in their bodies.

Many kinds of energy can be used to do work. Light, sound, heat, and electricity are four kinds of energy. Whatever kind of energy is used to do work, all energy comes from the sun.



Stored Energy



Energy in Action

At a baseball game, you watch the pitcher hold the ball before he throws it. Then you see him throw the ball. You have seen two forms of energy. As the pitcher stands with the ball, you see **stored energy**. As he throws the ball the stored energy becomes **energy in action**.

Energy is needed to make force. When force moves things, work is done. If you can't move something with your own force, you can use a machine to help you. Using a machine will make the work easier for you.



1.9

Think about things! Write your answer on the lines. Your energy comes from the life within you. Think about where your life starts. Read Job 33:4. Write the verse on the lines.

1.10

Can you use your energy as a force to do work? _____

1.11

When do you store energy? _____

1.12

When does stored energy become energy in action? _____



1.13

Try this experiment. Answer the questions as you do each step.

Rub your hands together, long and hard. What do you feel? _____ The heat you feel is caused by friction. Friction happens when two things are rubbed together.

1.14

Think: When a shuttle enters the atmosphere, it needs a "heat shield" to keep it from burning up. This is because friction from the air has caused _____.



1.15

Look up the facts!

In your encyclopedia, look up James Watt. Find out how he put the steam engine to work. Write a short paragraph about his experiments. Use paper from your classroom.



Teacher check _____

Initial

Date



Solve the word puzzle:

1.16

Some words have the same sound in them, but the words are spelled differently. Sometimes *au*, *aw*, and *ou* have the same sound, the sound of *aw* in *saw*. Hints are given to help you to think of words to fill in the puzzle. Each word that you use has either an *aw*, *au*, or *ou* that sounds like the *aw* in *saw*. The first letter in each word is given for you.

Nouns			Verbs			Adjectives		
a. j	_____		f. y	_____		k. r	_____	
b. s	_____		g. c	_____		l. l	_____	
c. a	_____		h. t	_____		m. h	_____	
d. a	_____		i. b	_____		n. n	_____	
e. d	_____		j. f	_____		o. n	_____	

Hints

Nouns

- Samson used this as a weapon
- Your father uses this to cut wood smoothly
- You ride in it nearly every day
- Another name for it is *fall*
- A child, but not a son

Verbs

- You do it when you are sleepy
- What you did to the fish in the frying pan
- Your teacher did this to you
- The way your father got a new car
- Both boys had black eyes from doing this

Adjectives

- Not cooked
- Within the rules or laws
- A scary house, full of frightening sounds
- Anything to do with the sea
- Bad enough to be punished



1.17

Study about syllables.

In a word when the vowel is followed by *-cle*, the word is divided into syllables between the vowel and *-cle* as in *icicle* (*i ci cle*). In a word when the vowel is followed by *-dge*, the vowel and *-dge* are in the same syllable as in *ledge*.

Divide the following words into syllables following the rule for *-cle* and *-dge*. Draw a slanted line (/) between each syllable in each word. Beside the word, write the number of syllables in each word.

- | | | | |
|------------|-------|------------|-------|
| a. bicycle | _____ | e. miracle | _____ |
| b. bridge | _____ | f. monocle | _____ |
| c. edge | _____ | g. ridge | _____ |
| d. fudge | _____ | h. sludge | _____ |



1.18

Think about machines.

Check the statements in the following group which you know to be true.

- a. _____ Gravity pulls things up.
- b. _____ Friction is greater on rough surfaces.
- c. _____ Men can use energy to run machines.
- d. _____ Men can do work without machines.



Make a chart for I SPY.

Before you start on the next two sections, you will need to do a small project. You remember that Galileo taught that a true scientist must be a good observer. In other words, he must see things exactly as they are. Then he must make an accurate record of what he sees.

You have chance to test yourself to see how well you can follow directions.

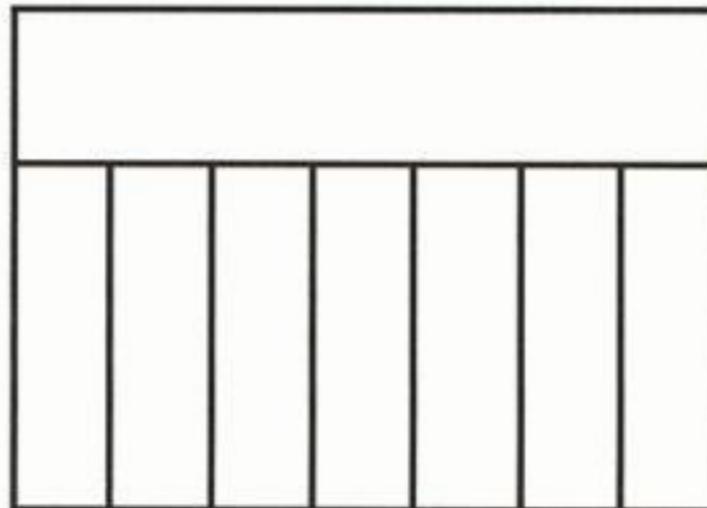


These supplies are needed:

- one sheet of poster board (any color)
- one meter stick (or yard stick)
- two felt tip pens (black or red)
- one sharp pencil with an eraser

Use your pencil lightly to do all the lines and printing. When you have the lines and printing just right, go over your marks with a pen. Check the boxes as you do each step.

- 1. Turn your poster board sideways. Draw a line all the way across the board 10 cm from the top.
- 2. Divide the space beneath the line into seven equal columns. If you do your work carefully, your poster board should look like this.



- 3. On the long line across the board, print very neatly: MACHINES
- 4. At the top of each column, print the name of one simple machine in red. Print the simple machines in the order you find them on the contents page of this LIFE PAC under Machines Are Simple.
- 5. At the top of the seventh column, print the words, "Complex Machines"

You are going to play your own game of "I Spy" in a very special way. You will be "spying out" many different forms of simple machines which are used in everyday life. You will need to have a "sharp eye" like a real detective.

Hang your poster in your classroom where you can easily reach it. You will be using it each day as you complete this LIFEPAK. If you do your work carefully, you will have a useful chart.

For Sections II and III it would be more fun for you to have a partner. It is easier to do experiments and to build models when you work with someone. If you have to work alone, however, you will have no problems. Just remember to read and follow directions carefully.



Review the material in this section to prepare for the Self Test. The Self Test will check your understanding of this section. Any items you miss on this test will show you what areas you need to study.

SELF TEST 1

Answer the questions on the lines (each answer, 5 points).

1.01 What is *work*? _____

1.02 What is the difference between stored energy and energy in action? _____

1.03 From where does all energy come? _____

Write the correct word in each blank (each answer, 3 points).

- | | |
|---------------|------------------|
| stored energy | earth |
| work | energy in action |
| force | friction |
| gravity | energy |
| machines | |

1.04 Work is made easier when you use _____.

1.05 All lifting work is done against a pull called _____.

1.06 When an object is moved across a surface, _____ happens.

1.07 Heat, light, sound, and electricity are forms of _____.

1.08 Gravity pulls all objects toward the center of the _____.

1.09 The push or pull needed to do work is called _____.

1.010 Picking up a book is an example of _____.

Read the clues. Write the name of the person that the clues describe (each answer, 5 points).

1.011 Clues:
I lived in the sixteenth century.
I was the first real scientist of modern times.
I studied the law of gravitation.
My name is _____

1.012 Clues:
I was an Englishman.
I found uses for the steam engine.
My initial or last name is on a light bulb.
My name is _____

1.013 Clues:
I was a very wise king.
I built a house for God.
My workmen used simple machines.
My name is _____

List four kinds of energy mentioned in Section I (each answer, 4 points).

- 1.014 _____
- 1.015 _____
- 1.016 _____
- 1.017 _____

Answer the following questions in good sentences (each answer, 5 points).

1.018 What forces would Solomon's men have used for building the Temple? _____

1.019 What is *energy*? _____

1.020 Why does man need simple machines? _____

Match these items by writing the correct letter in the blank (each answer, 2 points).

- | | | | | |
|-------|-------|------------------|----|-------------------------------------|
| 1.021 | _____ | streamlined | a. | pull toward the center of the earth |
| 1.022 | _____ | gravity | b. | from the sun |
| 1.023 | _____ | force | c. | push or pull |
| 1.024 | _____ | work | d. | less air friction |
| 1.025 | _____ | friction | e. | boy ice skating |
| 1.026 | _____ | energy in action | f. | makes things stop |
| 1.027 | _____ | stored energy | g. | helps to move something |
| 1.028 | _____ | energy | h. | push or pull |
| 1.029 | _____ | machine | i. | boy sleeping |



Possible Score 100

My Score _____

Teacher check _____

Initial

Date

II. MACHINES ARE SIMPLE

You have learned that a machine is a tool which makes work easier to do. Machines help you to lift heavy things or to move things from place to place. Machines speed up your work, so you do more work in less time than if you had no machines to help you. Today, you use the same

type of simple machines as Solomon's men used long ago. In this section of your LIFEPAK, you will learn about these simple machines: the **lever**, the **inclined plane**, the **wedge**, the **wheel and axle**, the **pulley** and the **screw**.

Review these objectives.

When you have finished this LIFEPAK, you should be able to:

6. Name six simple machines.
7. Give an example of each simple machine.
8. Tell how each simple machine makes work easier.

Restudy these words.

block and tackle

fulcrum

groove

inclined plane

lever

load

mesh

pitch

principle

pulley

ramp

screw

spiral

thread

wedge

wheel and axle

wheelbarrow

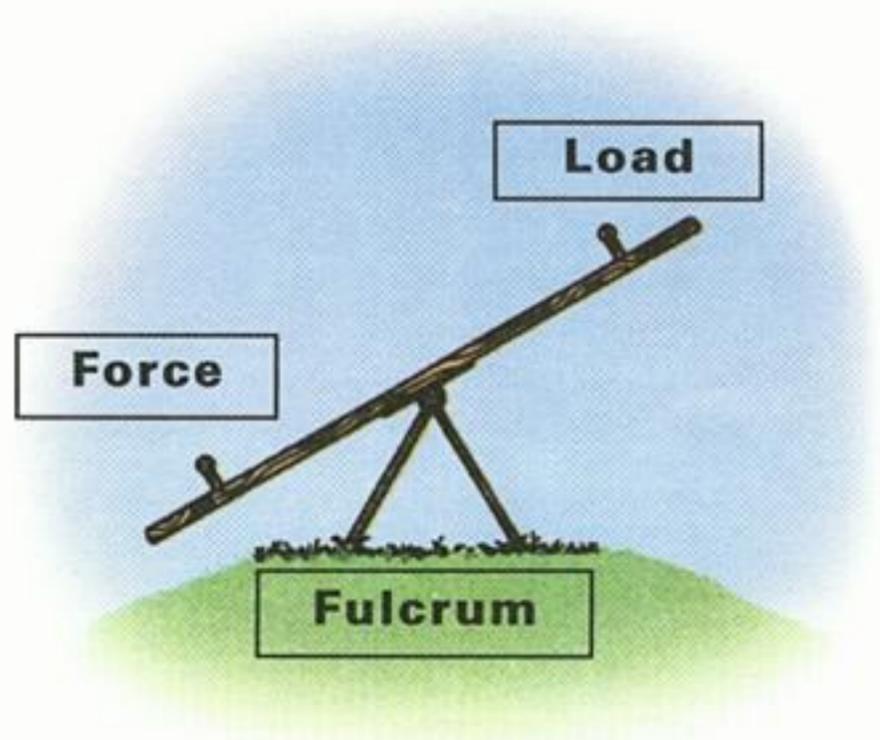
windlass

LEVER

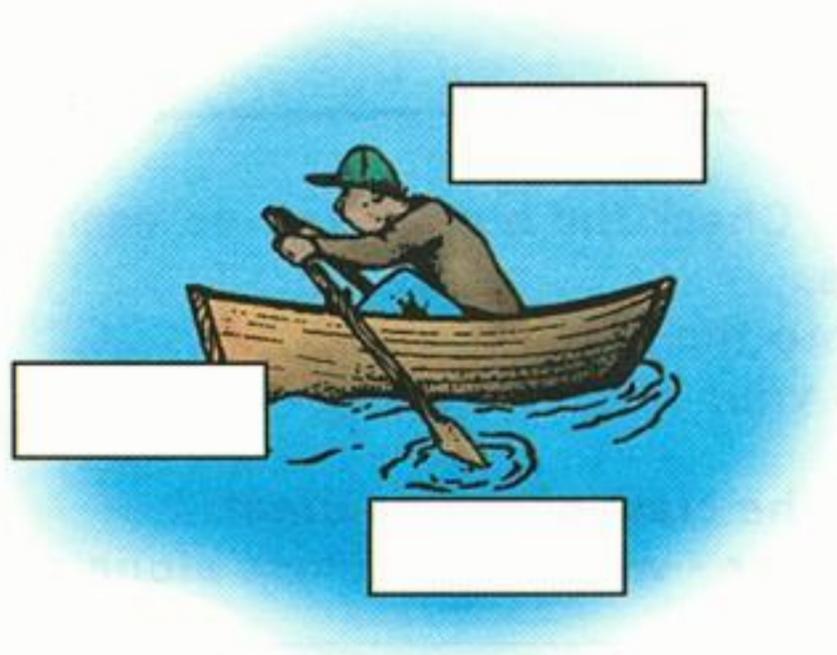
Joe and Bill are good friends. As they walked home from school each day, the boys stopped to visit their pastor, Pastor Miller. Each day Pastor Miller showed the boys around the new construction on their church. New rooms were being built onto the older parts of the building. Each day Pastor Miller explained about the machines that the builders were using. The boys were interested as they were studying about machines in science class.

"An important simple machine is

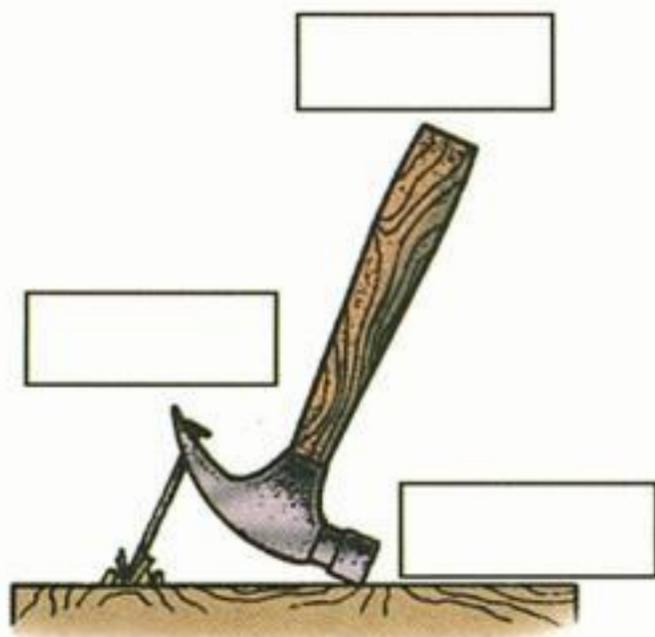
the **lever**. The seesaw over in the playground is a lever."



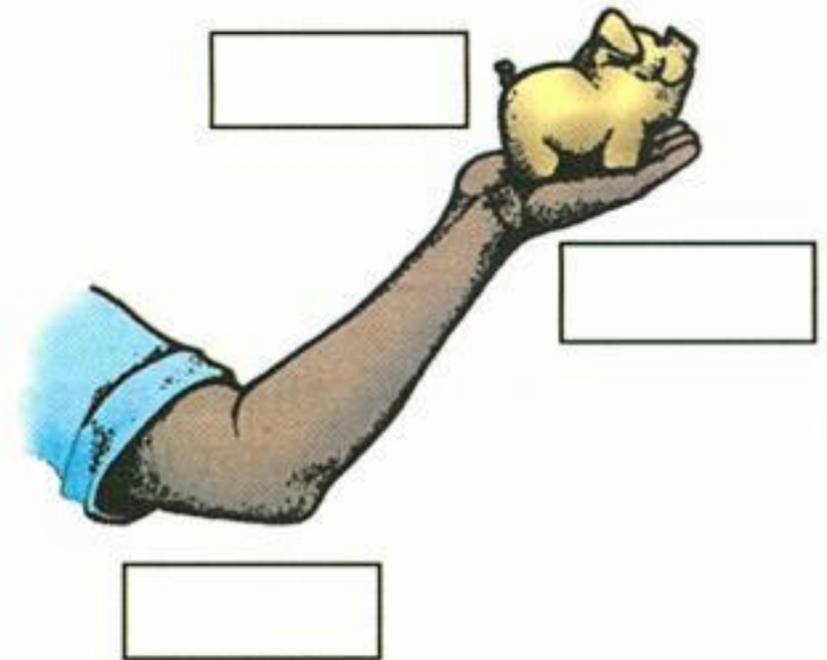
"When your Sunday school class went on a rowboat ride at the lake, the oars that you used to row the boat were levers."



"The carpenter pulling out the nail from the board, is using the hammer as a lever."



"Even your two arms are levers."



"Every lever has three parts that are the same," said Pastor Miller. "Every lever has to be pushed down. The end that is pushed is called the *force*. The end of the hammer handle that is held is the force. The lever rests on the board. Where the lever rests is called the **fulcrum**. The hammer is the fulcrum. Whatever is being moved is the **load**. The nail is the load."

"Do all levers have a force, a fulcrum, and a load?" asked Joe.

"Yes," said Pastor Miller. "In the seesaw, the load and force change each time you ride up or down. As you ride up, you are the load, Joe. When you have to push down, Bill, you are the force. But as you ride up, Bill, you become the load, and Joe is the force pushing you down."

Study the pictures.

2.1 Look at the pictures of the different kinds of levers. Find the fulcrum, force, and load on each picture. Write the word *fulcrum*, *force* and *load* in the box beside each lever. The seesaw is done for you.



Do this experiment:

These supplies are needed:

- a large nail
- a hammer
- a block of wood



Follow these directions. Check the box as you do each step. Answer the questions.

- 1. Hammer the nail halfway into the block of wood.
 - 2. Try to remove the nail with your fingers. Can you do it?

 - 3. Try to remove the nail with the claw of the hammer.
- 2.2 In which way is the work easier - with your muscle alone or with the hammer? _____
- 2.3 Why? _____

Try this experiment

Find out if the distance between the fulcrum, the force, and the load makes a difference in the amount of force needed to raise the load.

These supplies are needed:

- one seesaw
- one friend



Follow these directions. Check the box as you do each step. Answer the questions.

With a friend who weighs about the same as you do, try this experiment on the seesaw.

You will be the *force* and your friend the *load*.

- 1. First place the load and the force at the same distance from the fulcrum. Notice that it takes quite a lot of effort to raise the load.

2. Have the *load* slide closer to the fulcrum. You, the *force*, stay where you are. This puts *more* distance between the force and the fulcrum than between the load and the fulcrum.

3. Let the force raise the load again.

2.4 Is it easier or harder for the force to raise the load since the distance from the fulcrum has been changed? _____

4. Slide the load very close to the fulcrum.

5. Try raising the load again. Think back to what you have studied, and to what you have just observed.

2.5 Does the nearness of the fulcrum to the load have an effect on the amount of force needed? _____

2.6 The closer the fulcrum is to the load, the _____ effort will be needed to raise the load.

Fill in your I SPY chart.

2.7 On your chart, in the first column under the word *LEVER*, draw a picture of a lever. Look for levers at home, at school, in Dad's workshop, among your toys. Find every example of a lever that you can and write the name of each in Column 1 of your chart. Draw pictures of the lever too, if you wish. Find pictures of levers that you can cut and paste on your poster. Print the name of each neatly.



Teacher check _____

Initial

Date

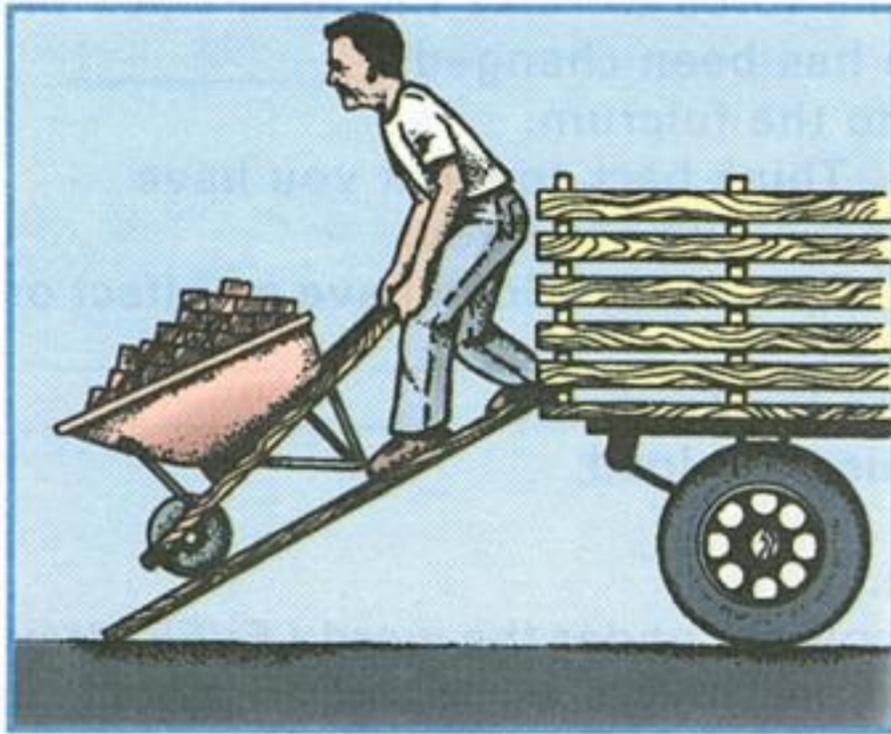
INCLINED PLANE

The next time that Joe and Bill stopped to see Pastor Miller, men were unloading bricks from a truck. They were pushing **wheelbarrows** down a **ramp** to the wall of the building. "I'm glad that you boys stopped today," said Pastor Miller.

"You can see the men using another simple machine. The board that the men have placed from the ground to the truck is an **inclined plane**. You can see that it is a sloping surface. In public buildings, ramps for wheelchairs are inclined planes. If

you have ridden a car up a mountain road, you have gone up an inclined plane."

Raising the load over a sloping distance is easier than lifting it



straight up. This simple machine does the job. The advantage of the inclined plane is that with it a man uses less force to do his work by increasing the distance he moved his load.

When the men use wheelbarrows on a ramp, they are using two simple machines, the lever and the inclined plane. Think about the wheelbarrow, which is a lever, and the ramp, which is an inclined plane. The other four types of simple machines come from these two ideas. The **pulley** and the **wheel and axle** are forms of the lever. The **wedge** and **screw** are forms of the inclined plane.



Do this experiment.

These supplies are needed:

- four textbooks, each at least 3 cm thick
- a toy truck or car
- a board about 1 meter long that is wider than the toy truck
- a spring scale



Follow these directions. Check the box as you do each step. Write the answers to the questions.

1. On the floor lay the four textbooks on top of each other.
2. Place one end of the board on the books and the other end on the floor. You now have an inclined plane.
3. Hook the spring scale to the front of the toy truck.
4. With the scale, lift the truck straight up off the floor.
5. Read the spring scale indicator.

2.8 How much force does it take to lift the truck into the air?

- 6. Put the truck on the floor again.
- 7. Hook the spring scale to the front of the truck.
- 8. This time draw the truck up the board.
- 9. Read the spring scale indicator.

2.9 How much force does it take to pull the truck up the inclined plane? _____

2.10 Does it take less effort to lift the truck or to pull it up the inclined plane? _____

2.11 Why? _____
(Think ahead: Do you have another simple machine helping when you draw the truck up the inclined plane?)



Write about what you observed.

2.12 In a short paragraph, write a record of facts about your experiment, as Galileo might have done. Be sure you tell:
 what you used
 what you did
 what you learned

2.13 Draw a sketch of your experiment. When you finish, look at your record carefully. Make improvements or correct mistakes.

2.14 Ask your partner to read your record and help you rate yourself as an observer. You rate:

- _____ excellent
- _____ good
- _____ poor

Friend's name _____



Fill in your I SPY chart.

2.15

Back to your poster and more research! In the second column you will want to list all the examples of inclined planes that you can think of or that you can see about you. Keep your eyes open. Notice carefully all the different kinds of everyday work that people do. Do you see any inclined planes in use?

In our research you may see a lever that you don't have in Column 1. Be sure to go back and add it to your list. Remember that pictures and sketches will improve your poster and make it more useful.



Teacher check _____

Initials

Date

WEDGE

The boys and Pastor Miller walked into the church. Mr. Thomas was busy near a window. He was using a chisel. He hit the chisel with the hammer. The chisel sent little pieces of wood flying. As the boys

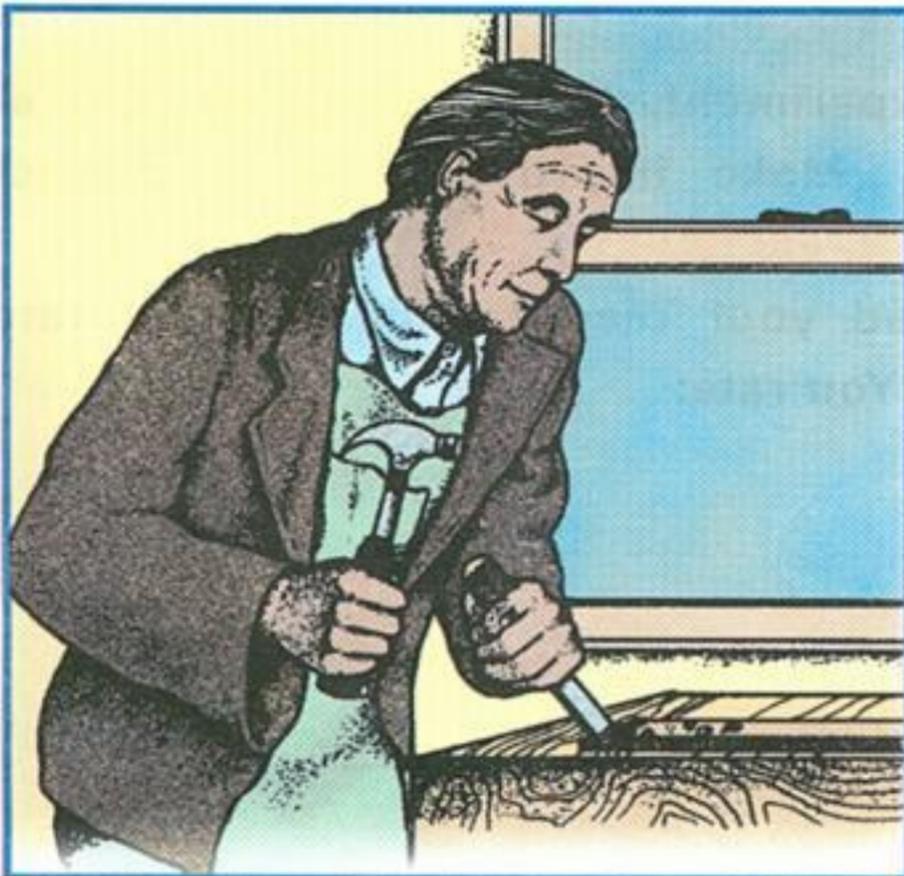
watched, Mr. Drew fit a piece of board into another board to make a window frame. Mr. Thomas stopped his work long enough to explain to the boys how a wedge works.

"The wedge, a special kind of inclined plane, is a very simple tool," said Mr. Thomas. "It is used to split things apart, or to cut things."

"An axehead is a wedge. Notice how it is made. The two sides slope together to a sharp edge.

"A wedge increases force. Splitting a log with a dull tool would be difficult or nearly impossible. But the sharp edge of the wedge enters the wood. Then the sloping sides follow. When force is used the log splits into two pieces.

"Another wedge which carpenters use is the chisel. Even the point of a nail is a kind of wedge.



"In the kitchen you use a wedge called a knife. When your mother sews, she uses little wedges called pins and needles. "Simple as it is, the wedge makes your work much easier to do."



Find out!

2.16

What President of the United States had a nickname that showed he was an expert with using a wedge? _____ (Hint: He became an expert at this when he was a young man, long before he became the president)

Use your history book, ask your friends, or ask for help from your parents in finding the answer.



2.17

Fill in your I SPY chart.

List all the wedges you can find in Column 3 of your poster. Do not overlook God's feathered and furry creation. Look up when you hear a rat-a-tat-tat on the tree outside your window! God supplied some of these animals with built-in wedges! You might use the nature books in your library to find some of them.

SCREW

Mr. Drew walked up to join the group in the church. He held a screw in his hand. "I heard you talking about simple machines," he said. "I'm putting up a light, and I must use screws so the light will hang safely above everyone in church. Let me explain about a screw, which is another simple machine."

"A screw is a special kind of inclined plane. The inclined plane goes around and around, and we call it the **thread** of the screw.



“The distance between the threads is called the **pitch**. The wider the pitch, the faster the screw can move up or down when force or effort is applied.”



Try this experiment.

This experiment will help you to see how the screw is a special kind of inclined plane.

These supplies are needed:

- a long pencil
- a metric ruler
- scissors
- a magic marker
- a piece of paper 14 x 28 cm



Follow these directions. Check the box as you do each step. Answer these questions.

- 1. Draw a line between opposite corners of your piece of paper.
- 2. Cut the paper in half on the lines. You now have two triangles. The long side of the triangles are inclined planes.
- 3. Color the long edge of one triangle with your felt tip pen.
- 4. Beginning with the shortest side of the triangle, wind the triangle around the pencil. You will see the colored inclined plane move up and around the pencil in a **spiral** just like the threads move up and around a screw.
- Take your metric ruler and measure the pitch.

- 2.18 How many millimeters wide is it? _____
- Now take the same triangle and wind it around your felt tip pen, which is thicker than the pencil. Measure the pitch again.
- 2.19 Is the pitch wider or narrower than on the pencil? _____
- 2.20 If the pencil and felt tip pen were really screws, which one would move up or down faster if the same amount of effort were used to move them? _____
- 2.21 Why? _____
- 2.22 Screws are used in many ways. Probably the most commonly used is the wood screw. Why is the screw often used instead of a nail? _____



Try this experiment.

These supplies are needed:

- one wood screw and one nail - each about 2 $\frac{1}{2}$ cm long
- two thin pieces of wood less than 1 cm thick
- two thicker pieces of wood
- one hammer
- one screwdriver



Follow these directions. Check the box as you do each step. Answer the questions.

- Place one thin piece of wood on top of one thicker piece. Use the hammer and nail to fasten them together.
- Take the other two pieces of wood and fasten them together with the wood screw.
- Try to pull the pieces of wood apart.

screwdriver is a form of a wheel and axle, another simple machine.

"The wheel by itself is not a machine, but is simply a roller. As a roller, the wheel helps do work by making the friction less. When the wheel is connected to a rod called an axle, however, the combination is a very useful simple machine.

"When you look around you, you see many forms of the wheel and axle in use. Probably you have already thought of the automobile as an example.

"Every time you turn a doorknob to open a door, you use a wheel and axle. The rod through the door is the axle and knob is the wheel. Your

hand supplies the force. Your hand and the rod work together to turn the latch.

"You may not think of a screwdriver as a wheel and axle, but it is. The rod (or axle) fits the slot in the head of the screw. The handle serves as the wheel which turns the axle. Your hand supplies the force.

"The wheel and axle turn and move things easily. In this way it makes work easier to do.

"Look around at home and at school. You will be surprised how many examples of the wheel and axle you can find. A **windlass** is a good example of a wheel and axle."



Do this experiment.

These supplies are needed:

a drawing compass	nails
a spring scale	heavy twine
corrugated cardboard (from the sides of a heavy box)	
a piece of wood about 60 cm long and 30 cm wide	
a broomstick cut to a length of 60 cm	
two wood sidepieces (2 x 2's would be best) at least 30 cm long, each notched on one end so the broomstick will lay loosely in the notches	

Have your parent or an adult friend help you cut the wood, or you could buy ready-cut pieces at a home supply store.

With these supplies you can build a windlass which is a kind of wheel and axle. The windlass will show you how this simple machine can be made to move things.

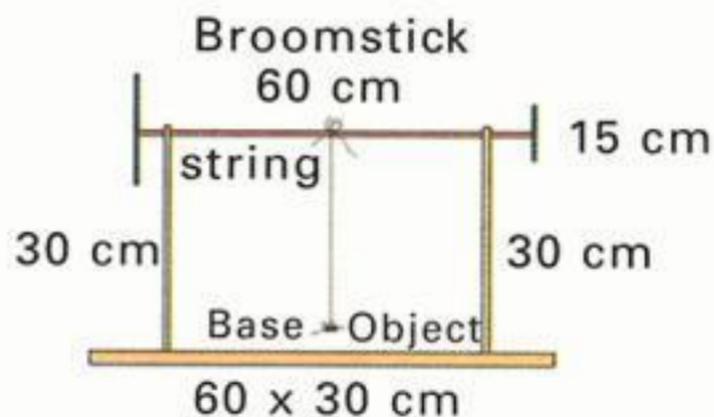


Follow these directions. Check the box as you do each step. Answer the questions.

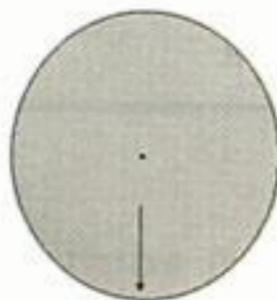
1. On your 60 x 30 cm piece of wood, find the center line (15 cm from each long edge). Draw a line down the center. This is your baseboard.



2. Now measure 10 cm from each end on the center line and make an x on that spot.



3. Nail one of your notched posts on each x. Be sure the notches run the same direction as the center line. Your broomstick will lay in these notches and become the axle.
4. Set your drawing compass at 15 cm and make a circle on the cardboard.
5. Set the compass again at 7 1/2 cm and make another circle on the cardboard.
6. Draw an arrow at some point on each wheel.



7. Cut these circles out and nail one on each end of the broomstick. Be sure your nail is at the exact center of the circle (where the compass point made a hole). If you do not have a compass, tie a piece of string on a nail and do steps 8, 9, and 10. (Otherwise, go now to # 11.)

- 8. Measure 15 cm of string out from the nail.
- 9. Tie your pencil firmly at the 15 cm distance.
- 10. Stick the point of the nail into the cardboard, stretch string tight, and draw your circle around the nail holding the pencil very straight.
- 11. Tie one end of the string around the middle of the axle. (Staple or tape it so it will not slip.)
- 12. To the other end of the string tie a small object. Let the object rest on the base board, with the string taut.
- 13. Now turn the big wheel. As it turns, the axle will turn and the object will be lifted off the baseboard.
- 14. Hold your ruler beside the windlass and measure the distance the object is lifted as you turn the big wheel one complete turn. The arrow will help you to know when you have made one complete turn.

2.29 How far was the object lifted? _____

- 15. Now let the object down again and do the same with the little wheel.

2.30 How far was the object lifted this time? _____

2.31 What do you notice about these measurements? _____

- 16. Now cut a piece of string exactly the same length as the distance the object was raised. Wind it around the axle.

2.32 What do you discover? _____

Now you know that when you turn a wheel one complete turn, the load will be lifted the same distance as the distance around the axle.

You also know that the big wheel and the little wheel lifted the load the same distance in one full turn. Was it easier to do the work with the big wheel? _____ Yes, it was easier with the big wheel. You might want to prove this by hooking a spring scale into each wheel to measure the force used.

You know now that the larger the wheel, the _____ effort is needed to do the work.



Mrs. Miller was in the church kitchen when Pastor Miller and the boys entered. She was setting the tables for a church dinner.

Pastor Miller said, "Joe and Bill are finding out about simple machines. Do you have any simple machines in your kitchen?"

"Oh, yes," said Mrs. Miller. "Let me tell you about gears. *Gears* are sets of wheels working together. Many times work can be made even easier if one wheel turns another

wheel. Look at this eggbeater. See how the wheels are notched? Notice how the notches or teeth in the big wheel **mesh**, or fit into, the teeth in the little wheel. When you turn the handle, the teeth in the big wheel make the little wheels turn. These little wheels turn the beaters that do the work.

"Notice that the beaters go much faster than the handle you turn. They spin perhaps four or five times for every time you turn the handle. The eggs are beaten much faster than if you were using a fork. The eggbeater makes work easier because it uses gears—big wheel turning the little wheels."

"Your bicycle is built by putting the same **principle** into action. One wheel turns another, but this time a chain is used to help them," said Pastor Miller.

"Look at the wheel connected to the pedals. Then look at the small wheel connected to the large back wheel. Both wheels have teeth, and the chain fits into these teeth, connecting the two wheels together."



Do this activity at home.

Turn your bicycle upside down, and prop it so that it will set solidly. Push the pedal around slowly with your hand.

Watch the two wheels connected by the chain. Which turns faster? _____. Yes, the little one. The larger one is making the smaller one move. The larger wheel is supplying the force to the smaller wheel. The speed with which your bicycle moves is caused by speed with which the little wheel turns. The big back wheel on the bicycle moves as fast as the little wheel connected to it, and pushes the bicycle forward.



Remember what you have learned about wheels.

Complete these statements correctly.

2.35

Using wheels as rollers reduces _____.

2.36

By adding a rod to the wheel you have a simple machine called the _____.

2.37

The larger the wheel, the _____ force is needed to lift an object.

2.38

Wheels with teeth that turn other wheels are called _____.

2.39

When a large gear turns a small one, _____ is increased.



Write the answers in a few words (make complete sentences).

2.40

Explain the difference between a wheel and a gear. _____

2.41

Explain how the chain on a bicycle works. _____



Fill in your I SPY chart.

2.42

You may run out of space in your poster column for this machine! Have fun — if you really look you'll find wheels and axles and gears all around you! Fill in column five.



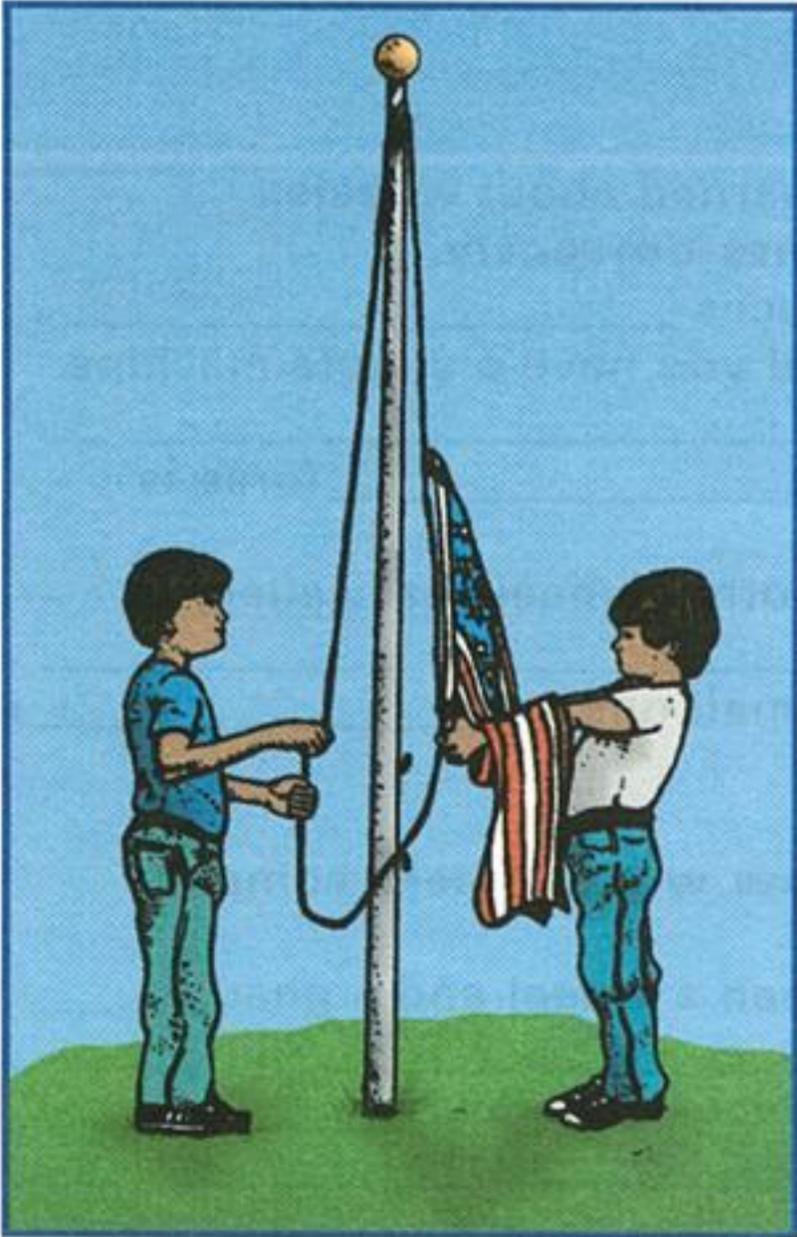
Teacher check _____

Initials

Date

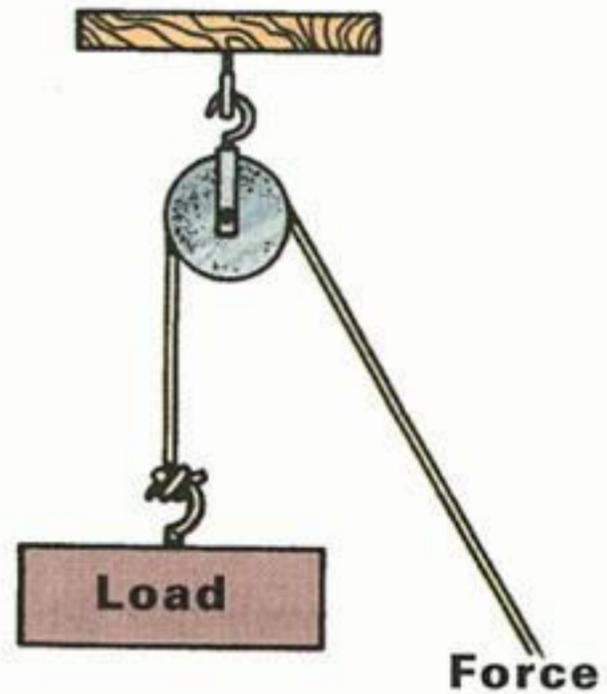
PULLEY

Every morning at Good Shepherd School, Bill and Joe watched as someone raised the flag up the flagpole. "How can he do that?" asked Joe.



Mrs. Brown answered, "A pulley, another simple machine, helps to move the rope smoothly up the pole. I will tell you more about the work of a pulley. Tomorrow you two boys will have your turn at raising the flag."

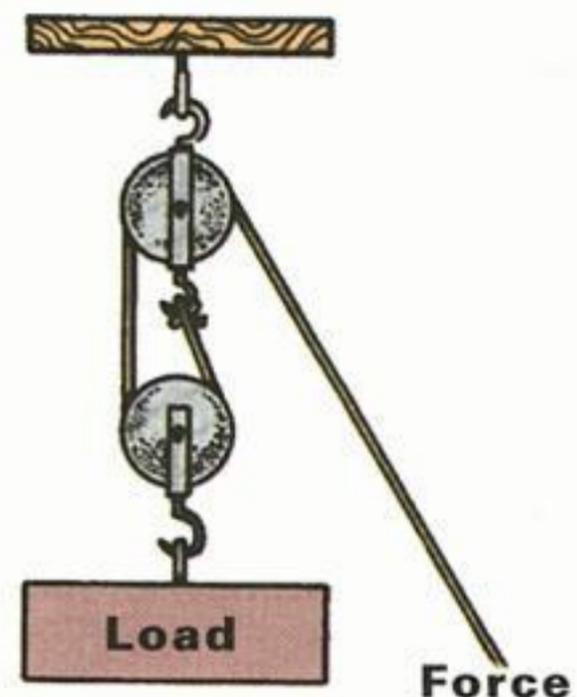
Back in the classroom, Mrs. Brown continued, "a pulley is a wheel with a **groove** in its edge. A rope fits into the groove. When the rope is pulled, the wheel turns. A load attached to the other end of the



rope is moved and work is done."

"There are two main kinds of pulleys. A fixed pulley is attached to a support such as a wall or a flagpole. You saw a fixed pulley work when you saw the flag raised. It can only work to move the load in one direction." She opened a book and pointed to an illustration.

"The other kind of pulley is called a **block and tackle**. The pulleys are called the block. One pulley stays in one place. The other pulley is fastened to the load and moves when the load moves. The rope through the pulleys is called the tackle.



"Notice that it uses more than one rope. The more pulleys and ropes that are used, the less force it takes to move the object.

"So when you use pulleys, you say that the *mechanical advantage* is the same as the number of ropes holding the load."

"What does mechanical

advantage mean?" asked Bill.

"Mechanical advantage is the force gained by using machines," replied Mrs. Brown.

"The experiment that you will do with pulleys will help you to understand this idea when you study it again in the future."



Try this experiment.

These supplies are needed:

Two pulleys
a light rope about two meters long
a two-kilogram weight
a spring scale
a broomstick



Follow these directions. Check the box as you do each step. Answer the questions.

PART 1

- 1. Lay the broomstick across two desks set about one meter apart.
- 2. Cut a short piece off the length of rope and use it to tie one pulley to the broomstick. This is your fixed pulley.
- 3. Tie one end of the rope to the two-kilogram weight.
- 4. Run the other end over the pulley, and make a small loop in the loose end.
- 5. Hook the spring scale in the loop.
- 6. Slowly lift the weight by pulling with the spring scale.

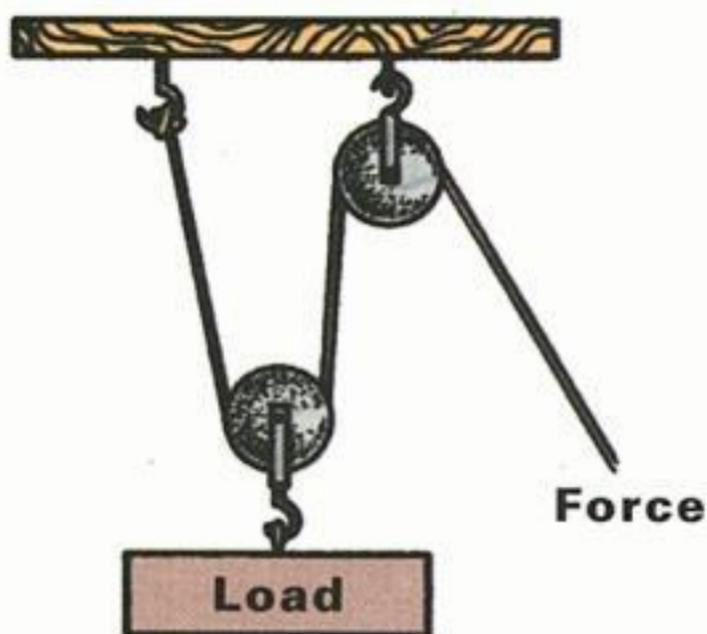
2.43 How much weight does the spring balance show?

2.44 Does the use of one fixed pulley change the weight of the load? _____

The only advantage of one fixed pulley is to change the direction of the force. You pull down to make the load move up!

PART 2

- 7. Tie one end of the rope tightly to the broomstick.
- 8. Thread it under your second (or movable) pulley and over your fixed pulley.



- 9. Tie a string around the weight and hook it to the movable pulley.

- 10. Tie your spring scale to the loose end of the rope, and pull downward with the balance. This will raise the weight off the floor.

2.45 What does the spring scale show this time? _____

The weight should be about one-half the weight measured in Part 1.

2.46 Find out why, in Part 2, the weight is one-half of the weight recorded in Part 1. _____

2.47 The mechanical advantage in Part 2 is _____ because the weight is lifted by two strands of rope.

Fill in your I SPY chart.

2.48

Sometimes pulleys in use are not as easily recognized as some other simple machines. Use encyclopedias as well as observation to fill in the sixth column on your poster.



Review the material in this section to prepare for the Self Test. The Self Test will check your understanding of this section and will review the first section. Any items you miss on this test will show you what areas you need to restudy.

SELF TEST 2

Write the names of six simple machines (each answer, 3 points).

- 2.01 _____
- 2.02 _____
- 2.03 _____
- 2.04 _____
- 2.05 _____
- 2.06 _____

Match the type of simple machine to each modern tool in the following list (each answer, 2 points).

- | | | | |
|-------|-------|------------------|-------------------|
| 2.07 | _____ | wheelbarrow | a. lever |
| 2.08 | _____ | knife | b. inclined plane |
| 2.09 | _____ | gangplank | c. screw |
| 2.010 | _____ | hammer | d. wedge |
| 2.011 | _____ | screwdriver | e. wheel and axle |
| 2.012 | _____ | Mason jar lid | f. pulley |
| 2.013 | _____ | block and tackle | |
| 2.014 | _____ | nail | |
| 2.015 | _____ | spiral stairway | |
| 2.016 | _____ | doorknob | |
| 2.017 | _____ | piano stool | |

Write in each blank the missing word(s) which will make each sentence correct (each answer, 3 points).

All of the words you will need are in the following list, but you will probably be able to complete the sentences without even looking at the list. (Words may be used more than once.)

advantage	fulcrum	pitch
axle	gears	sloping
direction	inclined plane	spiral
force	work	thread
simple machines	less	wedge
friction	lever	

- 2.018 Every lever must have a support point called a _____.
- 2.019 The closer the support point of a lever is to the load, the _____ effort will be needed to raise the load.
- 2.020 An inclined plane helps us to do work by providing a _____ surface over which the load is gradually raised.
- 2.021 We carry the load over an inclined plane further but with less _____.
- 2.022 The pulley and the wheel and axle are forms of the _____.
- 2.023 The wedge and screw are forms of the _____.
- 2.024 The simple machine used to split things apart is called a _____.
- 2.025 Any wheel used as a roller helps us do work by reducing _____.
- 2.026 To lift a load with a wheel and axle, you know that when a wheel is turned one complete revolution, the load will be lifted a distance equal to the distance around the _____.
- 2.027 The larger the wheel, the less _____ is needed to lift the load.
- 2.028 Bicycles use wheels in the form of _____ to gain speed.
- 2.029 A single pulley can only change the _____ in which the load can move.
- 2.030 The more strands of rope used with pulleys to raise a load, the _____ effort is needed to do their work.
- 2.031 Mechanical _____ is important in measuring how useful any machine is.

- 2.032 The answer to 2.031 shows you how much a _____
 _____ can be done with a small amount of
 b. _____.
- 2.033 The inclined plane on a screw is called the _____.
- 2.034 The wider the _____, the faster the screw can
 do work when effort is applied.
- 2.035 An inclined plane shaped like a screw is a _____
 stairway.
- 2.036 The builders of Solomon's Temple used _____
 like the ones you use today.



Possible Score 100

My Score _____

Teacher check _____
 Initial _____ Date _____

III. MACHINES ARE COMPLEX

In this LIFE PAC you have learned ways to increase your ability to do work. You have learned that machines used with muscles can do much more work than muscles can do alone. You will learn that using machines together can do more work than a simple machine and muscles can do.

Review these objectives.

When you have finished this LIFE PAC, you should be able to:

9. Tell the meaning of simple and complex machines.
10. Name four complex machines.

Restudy these words.

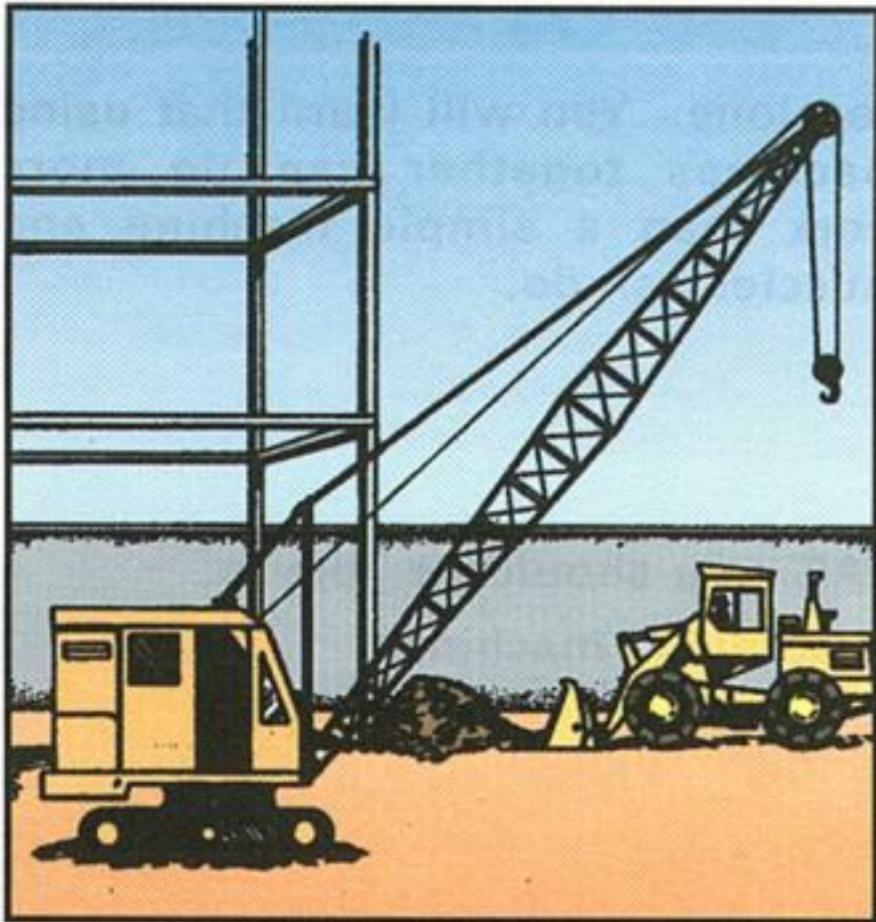
bulldozer	dredge
complex	foundation
construction	pile driver
crane	

SIMPLE MACHINES TOGETHER

Machines that are made of two or more simple machines are called **complex** machines.

Complex machines do not have to be huge. A common tool such as an axe is a lever (the handle) with a wedge (the cutting edge). Since two simple machines are put together in an axe, an axe is called a complex machine.

Most complex machines are harder to understand. Sometimes recognizing the simple machines that are together in a complex machine is difficult.



COMPLEX MACHINES AROUND YOU

Complex machines are used to do every kind of work. Watch a **construction** company putting up a large building. First, you will see them dig a hole for the **foundation** with a giant shovel. As the building rises, a **crane** will lift heavy beams and posts into place.

At the shipyards you will see cranes used to load ships. You may see a **pile driver** hammering posts deep into the water to be used for the foundation for a dock.

Out on the river you may see a **dredge** at work making a harbor deeper. Back on land a **bulldozer** may be clearing an area for a parking lot.

On the farm a tractor is used to pull many types of farming equipment. On large farms, a huge harvester does many different jobs.

A few of the machines that you might see around you have been listed. Look at all of the work that is being done, and you will see that machines are everywhere.



Write your answers on the lines.

- 3.1 Notice the complex machines that are used about your own house and yard. What are some of them? _____

- Look at the different methods of transportation in your town or city. Airplanes and helicopters are above you, and perhaps, subways are beneath you. All around you are more machines for transportation than you have room to name here.
- 3.2 How many can you list? _____

- 3.3 Are there factories in the part of the country where you live?

- 3.4 Do they use complex machines to do their work? _____

- 3.5 What factories are located in or near your town? _____

- 3.6 How do you get light and water at your house? _____

- 3.7 Are machines necessary to keep you warm enough or cool enough for comfort? _____
- 3.8 What machines keep you warm and cool? _____

- 3.9 Where does your food come from? _____

- 3.10 How does your food get packaged? _____
- 3.11 How is food transported to the grocery store?

- 3.12 Are machines necessary to get food to the store? _____

- 3.13 What are some machines used in food production? _____

- 3.14 Is there mining or oil drilling done near where you live?

- 3.15 What kinds of machines are used in mining and drilling?
(You may have to do research from a book on this one if you do not live near such an area.) _____

By now, you probably have the idea that complex machines are very important in your life. You can find many ways and places in which machines are used other than the ones listed here.



3.16

Fill in your I SPY chart.

In the seventh column of your poster, try to list a wide variety of complex machines. Use your observations to complete this column. Now go back and see if you can add to the first six columns. You are probably “seeing” things now as you look about you that you never saw before. If you are, this will help you to make a very useful poster. Of course you could never list all machines, but you can list many different kinds.



Before you take this last Self Test, you may want to do one or more of these self checks.

1. _____ Read the objectives. See if you can do them.
2. _____ Restudy the material related to any objectives that you cannot do.
3. _____ Use the SQ3R study procedure to review the material:
 - a. **S**can the sections,
 - b. **Q**uestion yourself,
 - c. **R**ead to answer your questions,
 - d. **R**ecite the answers to yourself, and
 - e. **R**evise areas you did not understand.
4. _____ Review all vocabulary, activities, and Self Tests, writing a correct answer for every wrong answer.

SELF TEST 3

Write true or false in each blank (each answer, 2 points).

- 3.01 _____ Complex machines are always very complicated.
3.02 _____ Solomon had a great Temple built long ago.
3.03 _____ It is sometimes hard to recognize which simple machines are used in complex ones.
3.04 _____ You cannot see complex machines just by looking about you.
3.05 _____ Sometimes you look at things around you without really seeing them.
3.06 _____ A simple machine to split things apart is a wheel and axle.
3.07 _____ Friction pulls things toward the center of the earth.
3.08 _____ Gears are sets of wheels working together.

Write the correct words in each blank (each answer, 4 points).

- 3.09 Another name for the push or pull to do work is _____

3.010 Machines made of two or more simple machines are called _____ machines.
3.011 An axe is a _____ machine.

Answer each question in one or two good sentences (each answer, 6 points).

- 3.012 What is *work*? _____

3.013 What is *gravity*? _____

3.014 What is *friction*? _____

3.015 What is an example of *stored energy*? _____

3.016 What is an example of *energy in action*? _____

Complete the statements by supplying the correct words (each answer, 3 points).

- | | |
|----------|---------|
| energy | gravity |
| friction | lever |
| Galileo | machine |

3.017 In order for work to be done, a. _____ and _____ b. must be overcome.

3.018 The ability to do work is called _____.

3.019 The man who taught that a true scientist must observe everything very carefully was _____.

3.020 A seesaw is an example of a _____.

3.021 A tool which makes work easier is called a _____.

Name the six simple machines and name one common tool which is an example of each (each numbered answer, 4 points).

	Machine	Tool
3.022	_____	_____
3.023	_____	_____
3.024	_____	_____
3.025	_____	_____
3.026	_____	_____
3.027	_____	_____

	Possible Score 100	My Score _____
	Teacher check _____	Initial _____ Date _____



Before taking the LIFEPAC Test, you may want to do one or more of these self checks.

1. _____ Read the objectives. See if you can do them.
2. _____ Restudy the material related to any objectives that you cannot do.
3. _____ Use the SQ3R study procedure to review the material.
4. _____ Review activities, Self Tests, and LIFEPAC vocabulary words.
5. _____ Restudy areas of weakness indicated by the last Self Test.

NOTES

SCIENCE

4 0 4

LIFEPAC TEST

Name _____

Date _____

Score _____

Possible Score _____ 100

SCIENCE 404: LIFE PAC TEST

Match these items (each answer, 2 points).

- | | | | | |
|-----|-------|----------|----|----------------------------|
| 1. | _____ | gravity | a. | wheel and axle |
| 2. | _____ | force | b. | point on which lever rests |
| 3. | _____ | gears | c. | made up of parts |
| 4. | _____ | machine | d. | pull toward the earth |
| 5. | _____ | doorknob | e. | whatever is being moved |
| 6. | _____ | hammer | f. | push or pull |
| 7. | _____ | complex | g. | ability to do work |
| 8. | _____ | energy | h. | lever |
| 9. | _____ | fulcrum | i. | wheels meshing together |
| 10. | _____ | load | j. | tool to make work easier |

Write true or false in each blank (each answer, 2 points).

- | | | |
|-----|-------|--|
| 11. | _____ | Friction does not help man in any way. |
| 12. | _____ | In using a lever, the closer the fulcrum is to the load, the less force is needed. |
| 13. | _____ | Gravity pulls things up. |
| 14. | _____ | Complex machines are always hard to understand. |
| 15. | _____ | Work is moving something by a push or a pull. |
| 16. | _____ | Energy in motion is when a girl is jumping rope. |
| 17. | _____ | All energy comes from the sun. |
| 18. | _____ | A block and tackle is a kind of pulley. |
| 19. | _____ | Muscles are enough to do all the work. |
| 20. | _____ | Friction makes things go faster. |

Write the letter of the correct answer in each blank (each answer, 2 points).

- | | |
|-----|--|
| 21. | The first real scientist of modern times was _____ . |
| | a. Galileo b. James Watt c. Solomon |
| 22. | An example of a wheel and axle is a _____ . |
| | a. shovel b. screwdriver c. hammer |

23. Streamlining an airplane cuts down _____ .
 a. friction b. gravity c. pitch
24. The force gained by using a machine is called _____ .
 a. kinetic b. potential c. mechanical
25. Moving an object from one place to another is called _____ .
 a. force b. work c. pull
26. An example of a wedge is a _____ .
 a. hammer b. a knife c. block and tackle
27. To raise and lower a flag on a flagpole, you use a _____ .
 a. lever b. pulley c. inclined plane
28. The wedge and the screw are forms of the _____ .
 a. lever b. inclined plane c. pulley

List the six simple machines and name one common tool which is an example of each (each numbered answer, 4 points).

	Machine	Tool
29.	_____	_____
30.	_____	_____
31.	_____	_____
32.	_____	_____
33.	_____	_____
34.	_____	_____

Complete these items (each numbered item, 4 points).

35. Name a complex machine that might be used
 a. on a farm _____
 b. for transportation _____
 c. in building a church _____
 d. at the waterfront _____
36. Name four kinds of energy.
 a. _____
 b. _____
 c. _____
 d. _____
37. Name two forms of energy.
 a. _____
 b. _____
38. Name the two kinds of machines. The first letter is given.
 a. S _____
 b. C _____

Define this word (this answer, 4 points).

39. work _____

NOTES