

Automechanics Fourth Year

Module 6 Plastic Man (Steering and Suspension System)

What this module is about

This module dwells on the parts and functions of the steering and suspension system of a vehicle.

The steering system allows the driver to control the direction of the moving car. A well-designed steering system requires the least effort of the driver to make a turn or swing the front wheel to the left or the right.

The parts and functions of the steering system are the steering wheel, steering gearbox assembly, pitman arm, linkage steering arm, the rod ender, steering damper and idler arm.

This module aims to do the following:

1. Explain the functions of the steering system.
2. Describe the type of steering system.
3. Identify the basic parts of the steering system.
4. Identify the parts of the steering linkage.
5. Explain the functions of each part of the system.
6. Diagnose trouble on the steering system, their causes and remedies.
7. Discuss the function of the suspension system.
8. Explain the two sub-systems of the suspension system.
9. Identify the types of front suspension.
10. Discuss the function of the different parts of the front and rear suspensions.
11. Explain the toe-in and toe-out patterns.
12. Adjust the toe-in patterns.
13. Discuss the caster and camber measurement.
14. Diagnose the problems, causes and remedies of malfunctioning suspension systems.

PRETEST

Directions: Select the letter of the answers to the following questions. Write the letter of your answer on your answer sheet.

1. It is connected between the steering gear sector shaft and the steering linkage.
 - a. steering gear
 - b. pitman arm
 - c. steering shaft
 - d. other arm

2. The front wheel spindle that is supported by the upper and lower ball joints and by the wheel to support the front wheel.
 - a. steering gear
 - b. steering knuckle
 - c. ball joint
 - d. steering shaft

3. It is located at the top of the steering shaft which is used by the driver to guide or steer the car.
 - a. steering post
 - b. steering wheel
 - c. tie rod end
 - d. steering gear

4. It consists of a socket and a ball stud in a housing that rotates and tilts to steer action.
 - a. idler arm
 - b. tie rod end
 - c. steering post
 - d. housing

5. It is the extension from the steering gear to the steering wheel into the gearbox.
 - a. steering arm
 - b. steering shaft
 - c. steering knuckle
 - d. pitman arm

6. It is a type of steering system provided with a hydraulic system to assist in steering the wheel.
 - a. worm steering
 - b. power steering
 - c. pinion type
 - d. recirculating type

7. This spring suspension is commonly used in light vehicle.
 - a. leaf spring
 - b. coil spring

- c. rubber spring
 - d. torsion bar
8. This spring has a series of flat steel plates of different lengths.
- a. rubber spring
 - b. leaf spring
 - c. torsion bar
 - d. coil spring
9. It minimizes dangerous movements of the car.
- a. spring
 - b. stabilizer
 - c. shock absorber
 - d. rubber damper
10. It is a device that controls the up and down movements of a car while running.
- a. shock absorber
 - b. spring
 - c. rubber damper
 - d. caster

Lesson 1 The Steering System

The steering system includes the steering wheel, tie rods, steering-knuckle arm, and the steering gear which makes the pitman arm swing from left or right. As the pitman arm swings, it pulls or pushes the tie rods. This action pulls or pushes on the steering knuckle arms. The steering knuckles and the wheels are thus turned as intended by the driver in order to steer the car.

The driver should always maintain the steering system of the car to ensure smooth and safe driving on the road.

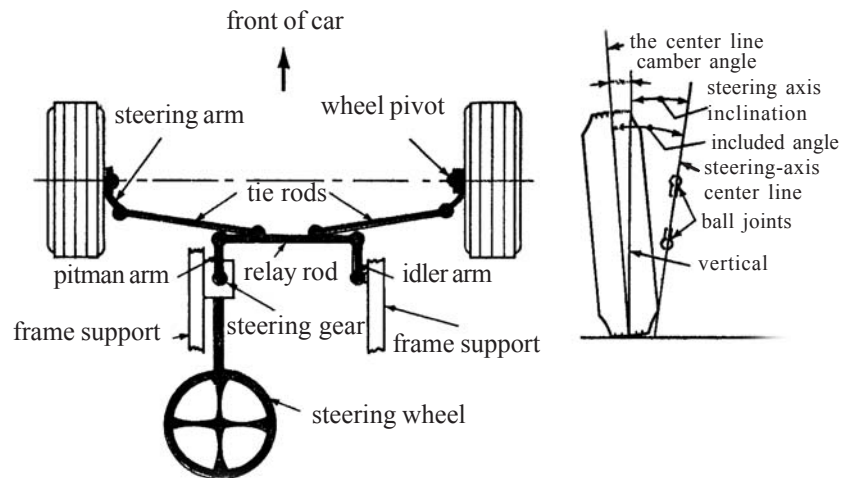
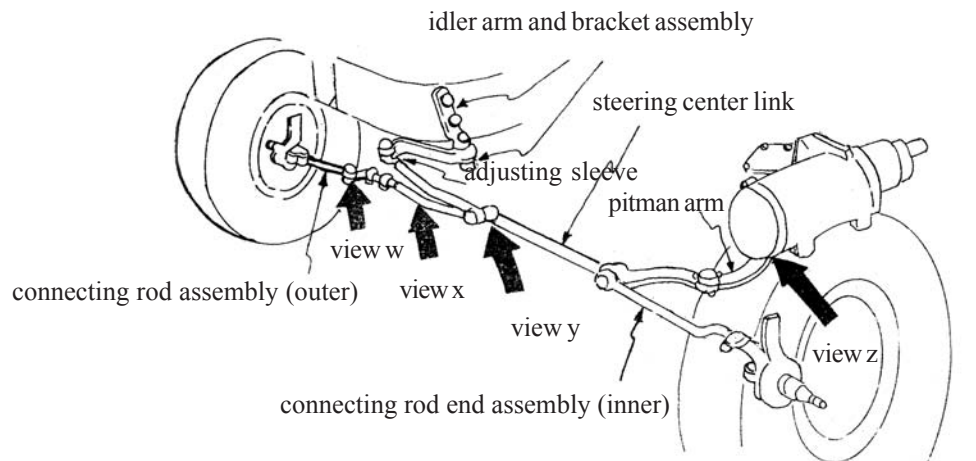
The parts and function of the steering system are as follows:

1. Pitman arm - connected between the steering gear sector shaft and the steering linkage or tie rod, it swings back and forth to steer as the steering wheel is turned.
2. Steering arm - attached to the steering knuckle that turns the knuckle and wheel for steering.
3. Steering gear - the part of the steering system that is located at the lower end of the steering shaft; it carries the rotary motion of the steering wheel to the car wheels for steering.
4. Steering knuckle - the front wheel spindle which is supported by upper and lower ball joints and by

the wheel; the part on which the front wheel is mounted and which is turned for steering.

5. Steering shaft - the extension from the steering gear to the steering wheel.
6. Steering wheel - located at the top of the steering shaft, it is used by the driver to guide or steer the car.
7. Idler arm - a link that supports the tie rod and transmits steering motion to both wheels through the tie rod ends.
8. Tie rod ends - a socket and a ball stud and a housing that rotates and tilts to transmit steering action in all conditions.
9. Tie rod - the rod in the steering system that links the pitman arm to the steering knuckle arm; the small still components that connect the front wheel to the steering mechanism.

Below is a typical manual steering system:



Simplified drawing of a steering system.

Activity 1

1. Draw the parts of the steering system in your notebook. Label the parts and define the functions of each.
2. Replace tie rod ends and worn-out parts.

Self-check:

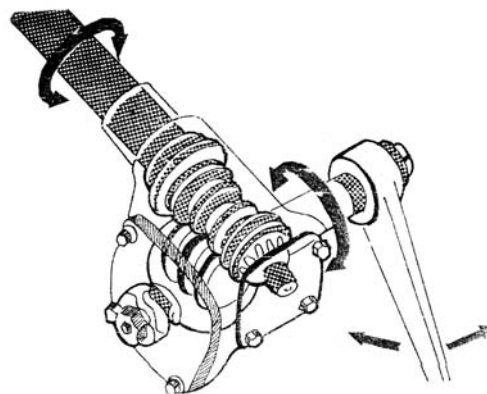
1. Did you draw the different parts of the steering system? How many parts are there?
2. Did you define the parts and function of the steering system? How did you define it?

Lesson 2 Types of Steering Systems

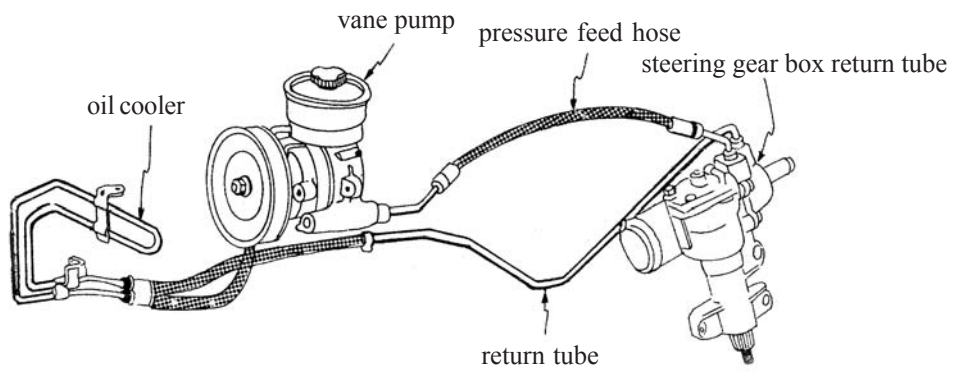
There are four types of steering systems namely: power steering, the rack and pinion type, the worm and nut type, and the recirculating ball and knot type. Some of these types are seldom used in assembling steering systems.

1. Worm Type - a type of gear with teeth resembling thread; used in the lower end of the steering shaft.
2. Power Steering Type - the type that is provided with a hydraulic system to help in steering. It uses oil under pressure for steering force on the front wheels.
3. Pinion Type Gearbox - consists of two smaller meshing gears to tilt the pitman arm right and left.
4. Recirculating Ball and Knot Type - the most common type of steering gearbox used in many cars today.

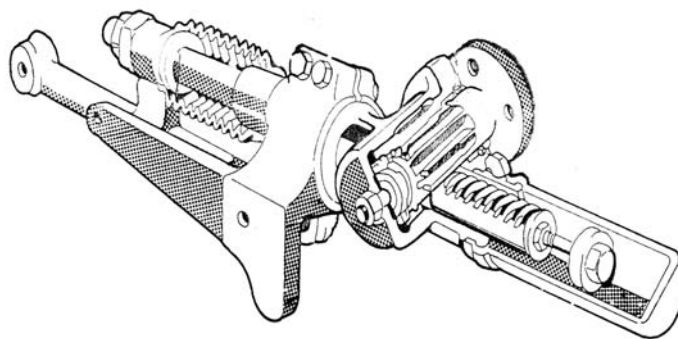
Following are illustrations of different types of steering systems:



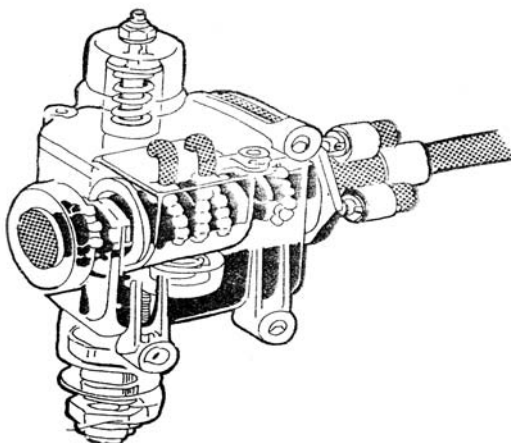
Worm and Nut Type



Power Steering Components



Rack and Pinion Type Gearbox



Recirculating Ball and Nut Type of Gearbox

Activity 2

1. Draw the different types and kinds of steering systems and label their parts.
2. Familiarize each part of the various steering systems.

Self-check:

1. Did you draw the different types and kinds of steering systems and label each part?
2. Did you familiarize yourself with each part of the various steering systems?

Lesson 3 Steering Systems Troubles, Causes and Remedies

Steering systems have troubles, the causes and remedies of these should be identified to correct and eliminate them. One has to apply appropriate remedies for smooth steering of the car. Below are common troubles of the steering system, their possible causes and remedies.

Trouble Shooting the Steering System		
Problem	Causes	Remedies
1. Hard steering	<ol style="list-style-type: none"> 1. Steering gear not properly adjusted 2. Incorrect wheel adjustment 3. Insufficient lubrication of ball joints and steering linkages 4. Low tire pressure 	<ul style="list-style-type: none"> - Adjust - Align - Lubricate - Inflate to correct pressure
2. Excessive play	<ol style="list-style-type: none"> 1. Incorrect steering gear adjustment 2. Worn-out bearing in steering gearbox 3. Worn-out tie rod ends and idler arm 	<ul style="list-style-type: none"> - Adjust - Replace - Replace
3. Poor directional stability	<ol style="list-style-type: none"> 1. Steering gear not at high point 2. Insufficient lubrication of steering gear linkages 3. Uneven tire pressure 4. Incorrect wheel alignment 5. Defective suspension components such as the stabilizer, shock absorbers and wheel bearings 	<ul style="list-style-type: none"> - Adjust - Lubricate - Inflate - Align - Replace
4. Car pulls to one side	<ol style="list-style-type: none"> 1. Uneven tire pressure 2. Dragging brakes 3. Incorrect wheel alignment 4. Improper adjustment of wheel bearings 5. Bent spindle 	<ul style="list-style-type: none"> - Inflate - Repair - Align - Adjust - Replace

Trouble Shooting the Steering System		
Problem	Causes	Remedies
	6. Defective car frame	- Repair or Replace
5. Car wanders from side to side	1. Loose steering gear 2. Weak shock absorbers 3. Incorrect wheel alignment 4. Bent spindle	- Adjust/replace - Replace - Align - Replace
6. Tires squel on turns	1. Low tire pressure 2. Toe-out-on turns incorrect 3. Excessive cornering speed 4. Bent spindle 5. Incorrect wheel alignment	- Inflate - Adjust - Slow down - Replace - Align

Activity 3

1. Identify the troubles of the steering system and know the causes of the troubles.
2. Apply remedial measures in the steering system.

Self-check:

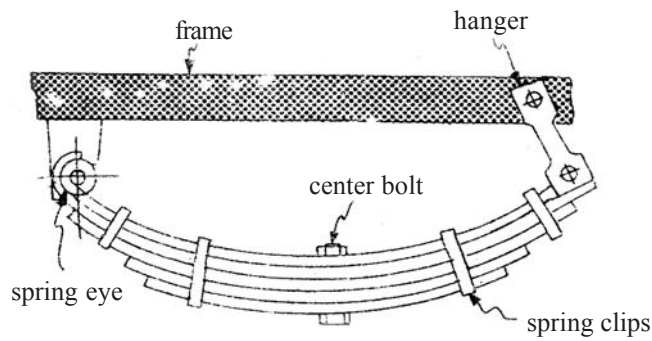
1. Did you identify the troubles and their causes?
2. Did you apply the appropriate remedy and were you able to replace worn-out parts?

Lesson 4 The Suspension System

The main function of the suspension system is to absorb load surface irregularities and transform these into controlled vertical movements. The car body should be maintained in a level position as much as possible, while the vehicle is in motion. This means that all shocks, impacts, sways and other undesirable effects must be prevented by the suspension system. Suspension systems also have the function of attaching the components of the brick system, the wheel and the tire to the car frame.

Parts and Functions of the Suspension System, Sub-system, and Types of Suspension System

1. Leaf spring - This is an assembly of a series of flat steel plates of different lengths. Spring leaves are drilled through the center and held together by a center bolt. Rebound clips prevent and retard displacement of the lever. The vehicle has the disadvantage of giving a rough ride.

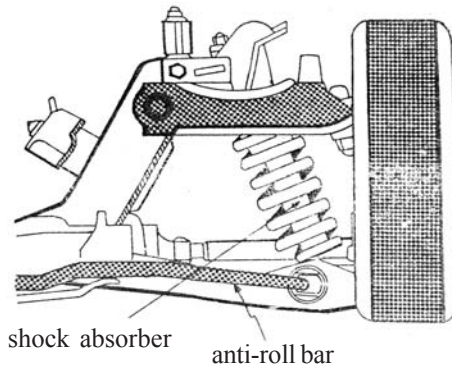


Leaf Spring (semi-elliptic)

Parts of the Leaf Spring Connection

1. Hanger - a piece of metal connected to the car frame and leaf spring with a bolt in nut.
2. Frame - the chassis unit of a vehicle that gives support to the wheel structure put together to sustain and give shape to the whole.
3. Center bolt - fastens all the flat leaf spring with a bolt in nut.
4. Spring clips - holds the flat leaf spring in the original position.
5. Spring eye - the place where the rubber bushing is installed.

2. Coil spring - Mostly used in light vehicles. These are made of special spring steel, usually round and wound in the form of a coil. It is also used in the rear suspension of a car.

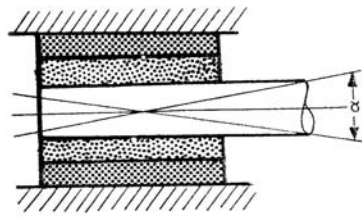


Long and Short Arm Coil Spring Suspension

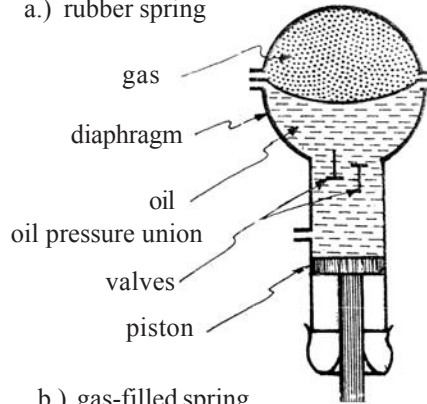
3. Torsion bar - A rod attached to the lower control arm of the suspension system, and the other rod, to the car through a leveling device. Some torsion bars are made of solid bars in round section and others, cubes and laminated strips.

The Rubber spring and gas-filled spring

Other springs which are of special applications are the rubber spring and gas-filled spring.



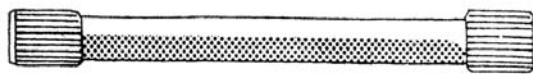
a.) rubber spring



b.) gas-filled spring

4. Rubber spring and gas-filled spring - A rubberized spring that absorbs irregularities when the vehicle encounters rough road situations.

The torsion bar is a rod of spring steel. One end is attached to the lower control arm of the suspension system, and the other end to the car frame through a leveling device. Some torsion bars are made of solid bars in round sections but others are made of tubes and laminated strips.



torsion bar

5. Stabilizer - The function of this system is to minimize dangerous movements which can make the car roll over or turn turtle. Attached to the left suspension system, its other end is attached to the right suspension system.
6. Shock absorber - A device that helps control the up and down rolling motion of the car body. It restricts the oscillation of the spring. In operation, the shock absorber has two chambers that work during compression and rebound. Fluid passes through restricted orifices or holes from one chamber to another, thereby slowing down the compression and rebound movements.

Activity 4

1. Replace worn-out shock absorber and stabilizer bushing.
2. Identify the worn-out parts in the suspension system.

Self-check:

1. Did you replace worn-out parts of shock absorber and stabilizer bushing?
2. Did you familiarize and replace the worn-out parts?

Lesson 5 The Suspension System (Toe-in and Toe-out)

This refers to the various angles between the front wheels, the frame and the attachment parts. One has to look at each of these angles in the operation of the suspension system. The mechanic should always check all these angles during the alignment job. Each angle is important, because it is difficult to control the car, and excessive tire wear can develop.

Toe-in and toe-out in the suspension system is also very important to car operation.

1. Toe-in - is the turning of the front wheels. This means that the distance of the front wheel is shorter than their rear distance. When distance grows longer, it is referred to as toe-out.
2. Toe-out - when the car makes a turn, the inner wheel turns in a smaller radius than that of the outer wheel. Hence, the inner wheel must describe a sharper angle regarding the vehicle frame. This difference in angles between the front wheels and the car frame during turns is referred to as toe-out.

Activity 5

1. Conduct toe-in and toe-out in the suspension system.

Self-check:

1. Did you conduct toe-in and toe-out in the suspension system?

Lesson 6

The Suspension System (Camber and Caster)

Camber is the tilting of the front wheels from the vertical. When the wheel tilts outward at the top, the camber is positive. When the tilt is inward, the camber is negative.

Caster is the tilting of the front wheels inward toward the center of the car. The steering axis may also be tilted forward or backward from the vertical. Positive caster promotes directional stability, because the centerline of the ball joints passes through the road surface ahead of the centerline of the wheel.

The front wheel alignment sometimes called front suspension geometry refers to the angular relationship between the suspension attaching components of a car.

1. Caster - is the tilt of the front steering axis either forward and backward from the vertical. When the tilt is backward, it is called positive caster; and when the tilt is forward, it is called negative caster.

2. Camber - refers to the tilt of the front wheels from the vertical. Camber is positive when the wheels tilt outward at the top. When the tilt is inward at the top then it is negative camber. When the camber angle is not properly adjusted, the front wheels will be worn-out on the sides.

Activity 6

1. Conduct caster and camber operation in the suspension system.

Self-check:

1. Did you conduct caster and camber operation?

Lesson 7

Suspension System Troubles, Causes and Remedies

There are troubles, causes and remedies in the suspension system. The driver must always maintain the suspension system of a car for smooth safe driving, and the car should be in normal operating condition.

The list below shows the troubles, causes and remedies of the suspension system.

Problem	Causes	Remedies
1. Hard riding quality	1. Defective shock absorber 2. Excessive tire pressure 3. Excessive number of plies of tires used	- Replace - Deflate to correct pressure - Replace to correct

Problem	Causes	Remedies
2. Excessive sway	<ol style="list-style-type: none"> 1. Worn-out stabilizer bushing or damaged stabilizer fixing brackets. 2. Defective shock absorbers. 3. Damaged suspension bushings. 4. Misalignment or cracked frame under the body. 5. Bent or twisted suspension arms. 	<ul style="list-style-type: none"> - Replace - Replace - Replace - Repair/replace - Replace
3. Noises	<ol style="list-style-type: none"> 1. Defective bushings or shock absorbers and suspension arms. 2. Loose suspension bolts, stabilizer bar attachments, wheel nuts, and wheel bearings. 3. Worn-out tie rod ends. 4. Insufficient lubrication of ball joints and steering linkages. 	<ul style="list-style-type: none"> - Replace - Tighten - Replace - Lubricate

Activity 7

1. Identify troubles in the suspension system and their causes and remedies.
2. Replace defective parts of the suspension system.

Self-check:

1. Did you identify the troubles, causes and remedies in the suspension system?
2. Did you replace defective parts in the suspension system?

LET'S SUMMARIZE

This module discusses various steering and suspension complaints about the vehicle and how to remedy these. The driver can always detect steering and suspension troubles. A variety of steering and suspension troubles takes the driver to the mechanic.

The lessons and activities in this module will help you know the troubles and their causes as well as the remedies. A good mechanic is capable of quality performance, particularly the replacement of various parts of the vehicle.

It is hoped that after going through the lessons in this module, you already know how vehicles undergo trouble shooting.

POSTTEST

Directions: Select the letter that corresponds to the following questions. Write your answers on the answer sheet.

1. A device that controls up and down movements of a car while in motion is called
 - a. shock absorber
 - b. spring
 - c. rubber damper
 - d. caster

2. It is connected between the steering gear sector shaft and the steering linkage.
 - a. steering gear
 - b. pitman arm
 - c. steering shaft
 - d. other arm

3. The front wheel spindle that is supported by upper and lower ball joint and by the wheel to support the front wheel.
 - a. steering gear
 - b. steering knuckle
 - c. ball joint
 - d. steering shaft

4. It is located at the top of the steering shaft which is used by the driver to guide or steer the car.
 - a. steering post
 - b. steering wheel
 - c. tie rod end
 - d. steering gear

5. A socket and a ball stud in a housing that rotates and tilts to transmit steering action.
 - a. idler arm
 - b. tie rod end
 - c. steering post
 - d. housing

6. It is the extension from the steering gear to the steering wheel.
 - a. steering arm
 - b. steering shaft
 - c. steering knuckle
 - d. pitman arm

7. A type of steering system that is provided with a hydraulic system to assist in steering the steering wheel.
 - a. worm steering
 - b. power steering

- c. pinion type
 - d. recirculating type
8. This spring suspension is commonly used in light vehicle.
- a. leaf spring
 - b. coil spring
 - c. rubber spring
 - d. torsion bar
9. This spring has a series of flat steel plates of different lengths.
- a. rubber spring
 - b. leaf spring
 - c. torsion bar
 - d. coil spring
10. It minimizes the dangerous movement of the car.
- a. spring
 - b. stabilizer
 - c. shock absorber
 - d. rubber damper

KEY TO CORRECTION

Pretest

1. b
2. b
3. b
4. b
5. b
6. b
7. b
8. b
9. b
10. b

Posttest

1. b
2. b
3. b
4. b
5. b
6. b
7. b
8. b
9. b
10. b