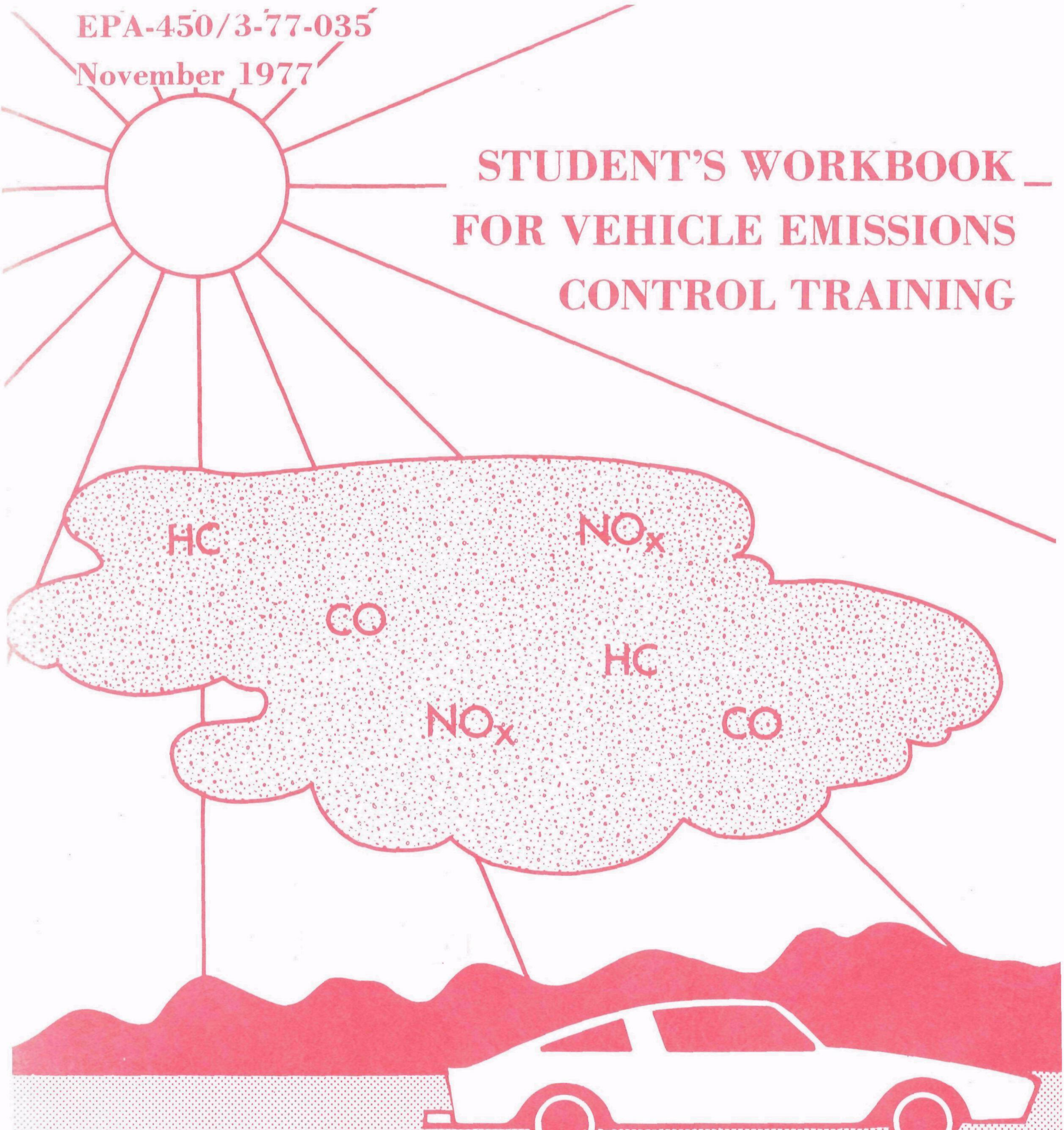
EPA-450/3-77-035
November 1977

STUDENT'S WORKBOOK FOR VEHICLE EMISSIONS CONTROL TRAINING



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

EPA-450/3-77-035

STUDENT'S WORKBOOK FOR VEHICLE EMISSIONS CONTROL TRAINING

by

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Foreword

Motor vehicle emissions control is becoming an increasingly large part of each person's life who is associated with the automotive industry. This is particularly true of the people that have to service today's motor vehicles. Since the beginning of motor vehicle emissions control in the mid-1960's, a number of different emissions control systems have evolved. These systems have been augmented with a variety of other devices that only add to the cluttered and confusing array of wires, plumbing and vacuum hoses that are found under the hood of most cars today. It is of little wonder that a large number of service people feel intimidated and confused when they look under the hood of today's cars.

It is the intent of this student workbook to explain each basic emissions control system and some of the more common devices found on today's cars. Each discussion and exercise will be concerned with the basic concept (what does the system do?) of a certain system. If a service technician can understand the concept of a system and how it relates to driveability and emissions, he is on the right road for increasing profits, satisfying customers, and aiding in the effort toward clean air.

Another advantage to learning the concepts of emissions control systems is that the same system concept applies to nearly every car. This reduces some of the confusion that results from studying Ford's system today, AM's system tomorrow and Chrysler's the day after. Once a concept is understood that knowledge can be applied to nearly all cars. The hardware may be somewhat different in appearance, but the job it is performing is essentially the same.

We hope these booklets will help remove some confusion and aide the mechanic in the performance of his job.

ACKNOWLEDGMENTS

The Motor Vehicle Emissions Control Staff of the Department of Industrial Sciences at Colorado State University would like to acknowledge the efforts extended by the Environmental Protection Agency, Research Triangle Park, for their contributions to the development of this booklet.

A special thanks must be extended to the automotive vehicle equipment and parts manufacturers for their cooperation and assistance in the development of this training material.

Student's Workbook

The Student Workbook is designed to lead the student through the key points of each emissions control system.

Each basic emissions control system presented will have the following information provided.

PART IDENTIFICATION

The basic parts of each emissions control system will be identified. Physical identification of each part involved in a system is important. The identification of parts related to a specific system allows a person to look under the hood of a car and "see" systems, rather than a confusing mass of hoses, switches, and other devices. A very brief description of what the part does is also provided.

SYSTEM OPERATION

In this section the individual parts of each system are explained. The total system is studied from a functional viewpoint which tells what it is supposed to do. The way the system operates is explained, showing flow paths, and variations due to different modes of engine operation. Understanding how a system operates makes troubleshooting and correcting problems a much simpler task.

SYSTEM CONTROL

This section deals with the control of a system. Many emissions control systems are controlled by various temperature devices and/or sources of engine vacuum. This section will deal with how a particular system is or may be controlled. Understanding of this portion also enhances the troubleshooting ability of the service technician.

SYSTEM EFFECTS ON HC-CO AND DRIVEABILITY

This section deals with the effect of the system on emissions and driveability. It explains how and why the system affects emissions and driveability. It is hoped this section will build an appreciation of the need for proper operation and adjustment of any system that affects the internal combustion engine.

WORKSHEETS

For each system a basic worksheet is included. The purpose of this worksheet is to enforce the previously covered material. The use of hands-on and the effects that establishing different system conditions have on emissions are extremely important tools in the learning process. Incorporated with the worksheets are quick operational checks that can be made on each system.

CONTENTS

STUDENT WORKBOOK

Cause and Effect

Unit 1

NOTES:

Throughout this course of study, the terms, Hydrocarbons (HC), Carbon Monoxide (CO) and Oxides of Nitrogen will be used frequently. These are terms that should be understood by today's service technician. These terms appear in all information relating to emissions control. They appear on the majority of VEHICLE EMISSIONS CONTROL INFORMATION labels found under the hood of today's cars. A service technician must understand these terms if he is to properly adjust today's automobiles, and properly use today's test equipment. Knowledge of these terms also aids the technician in giving explanations to customer-related questions.

A. Hydrocarbons

Hydrocarbons, abbreviated HC, are the chemical components that make up all petroleum products. This includes gasoline, fuel oil, and lubricating oil. In regard to today's cars, hydrocarbon (HC) emissions indicate gasoline that did not burn. This may be expressed as unburned hydrocarbon emissions.

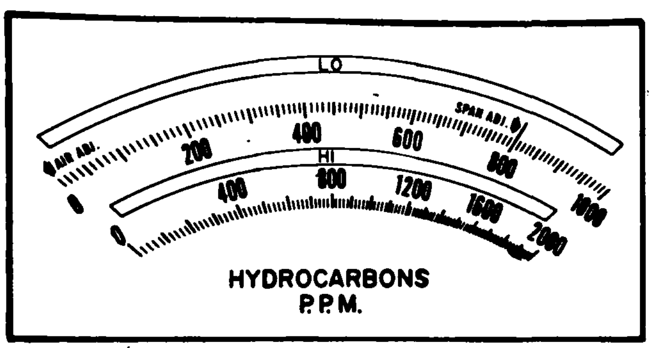


Figure 1-1

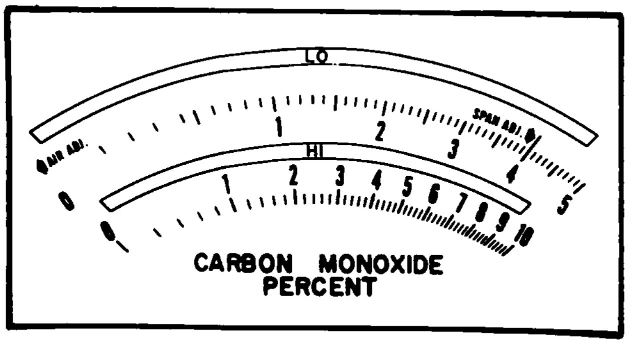
This meter shows us how much unburned gasoline (HC) is leaving the engine and being exhausted to the air.

Hydrocarbon emissions contribute to the following conditions.

1. The formation of photochemical smog.
2. Eye irritation
3. Health hazards - some unburned hydrocarbons are suspected of causing cancer and other health related problems.

B. Carbon Monoxide

Carbon Monoxide (CO) results from incomplete comubstion. In order to burn a given amount of gasoline completely, a certain amount of air must be present. If these is too much fuel present for the amount of air, carbon monoxide (CO) emissions increase. As the proper amount of air becomes available for a certain amount of fuel - CO emissions decrease.



This meter shows us how closely the carburetor is adjusted. Low CO - close to proper air/fuel ratio. High CO - rich mixture; too much fuel, not enough air.

Figure 1-2

Carbon Monoxide is a colorless, ODORLESS, DEADLY gas. CO emissions can cause

1. Death - if inhaled in large enough quantities
2. Headaches and nausea in lesser amounts
3. Increased difficulty in breathing for people having respiratory problems.

C. Oxides of Nitrogen

Oxides of nitrogen (NO_x) result from the combustion or burning process in the engine. Seventy-eight (78%) percent of the air we breathe is made up of nitrogen. When this air is drawn into the engine and burned at temperatures greater than approximately 2500°F, NO_x or oxides of nitrogen are formed.

> Instruments are available that read NO_x emissions. Because of their high cost, they are not usually found in automobile service facilities.

Oxides of nitrogen (NO_x) emissions contribute to the following conditions.

1. NO_x + sunshine and hydrocarbons form photochemical smog.
2. NO_x contributes to the dirty brown color associated with photochemical smog.
3. Ozone (O_3) results from chemical reactions involving NO_x.
    a) Ozone contributes to the smell associated with photochemical smog.
    b) Ozone also acts as an irritant to the eyes and lungs.
    c) Ozone causes rubber products to rapidly deteriorate and is harmful to many types of plants.

STUDENT'S WORKBOOK

Infrared Exhaust Gas Analyzer

Unit 2

Introductory Notes:

A. Explain the basic parts of the infrared exhaust gas analyzer.

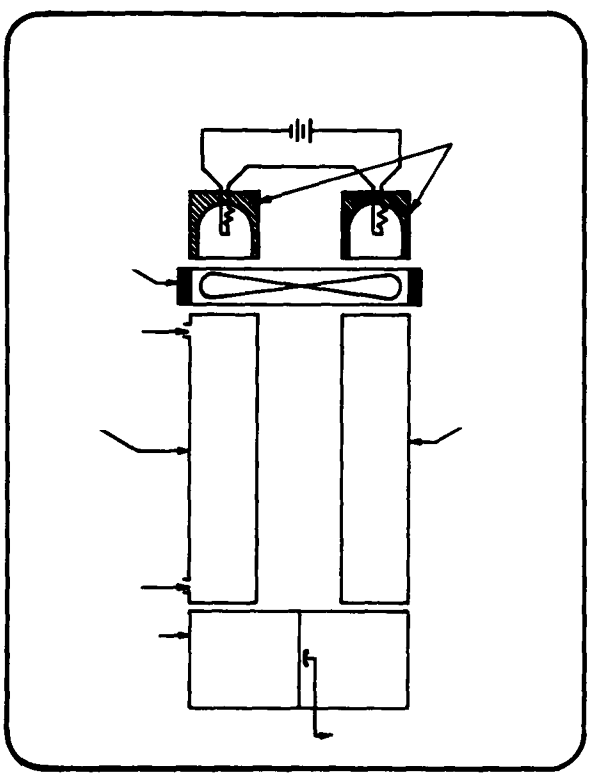


Figure 2-1

Label each main part listed.

1.

2.

3.

4.

5.

6.

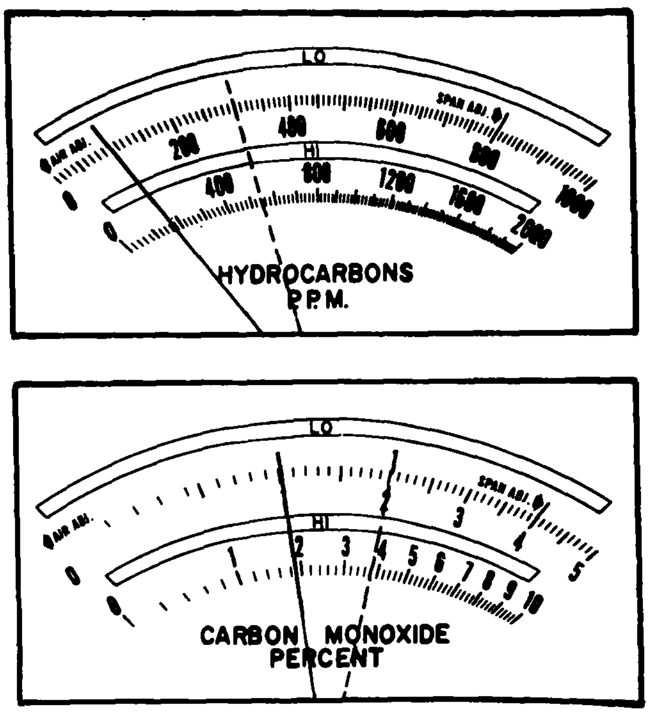
B. Figures 2-2 through 2-10 are exhaust gas analyzer readings. List the possible causes for the readings shown.

NOTES:

1.

a)

b)

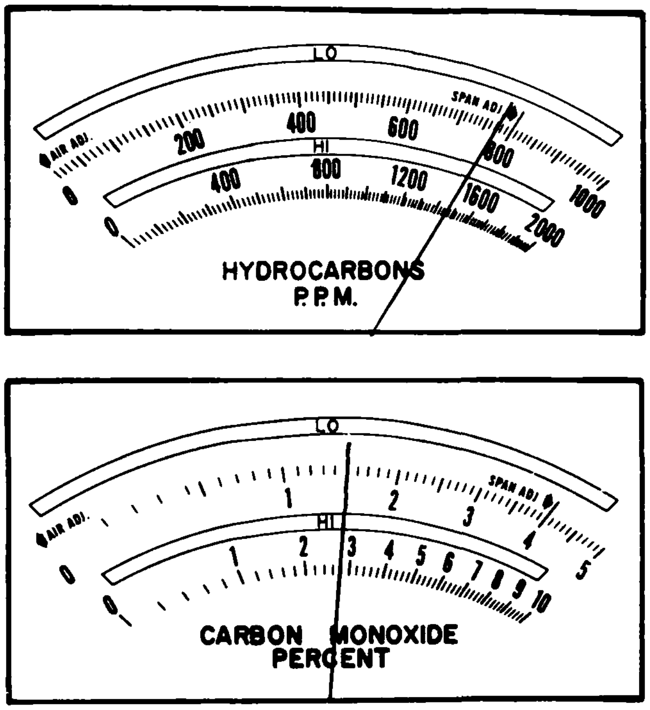


Lo Scale

Lo Scale

Figure 2-2

NOTES:



Hi Scale

Lo Scale

Figure 2-3

2. Symptoms - Rough engine idle

a)

1)

2)

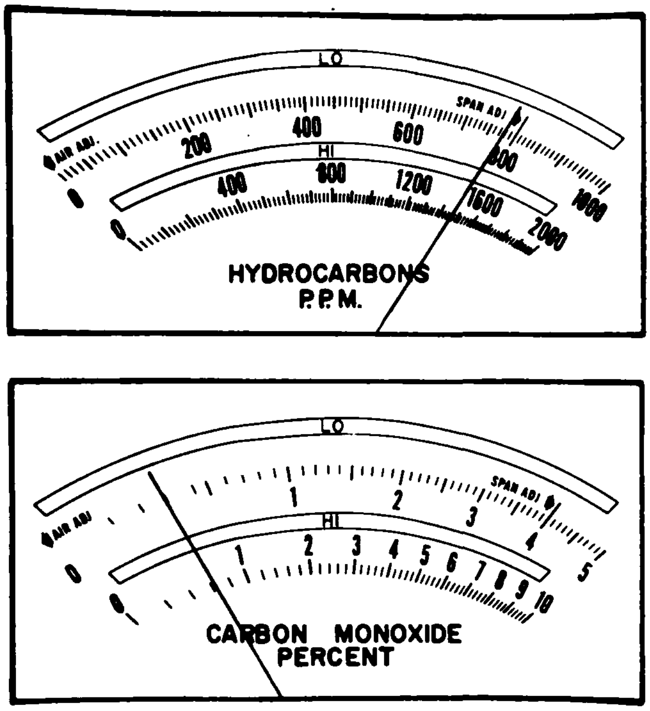
3)

4)

5)

6)

7)



Hi Scale

Lo Scale

Figure 2-4

3. Symptoms - Rough idle

a)

1)

2)

3)

NOTES:

4. Symptoms - Rough Idle

a)

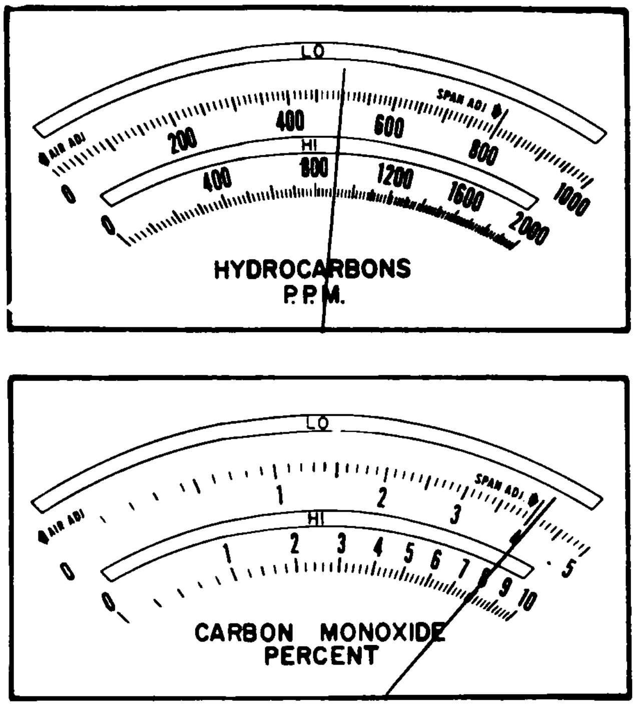
1)

2)

3)

4)

5)



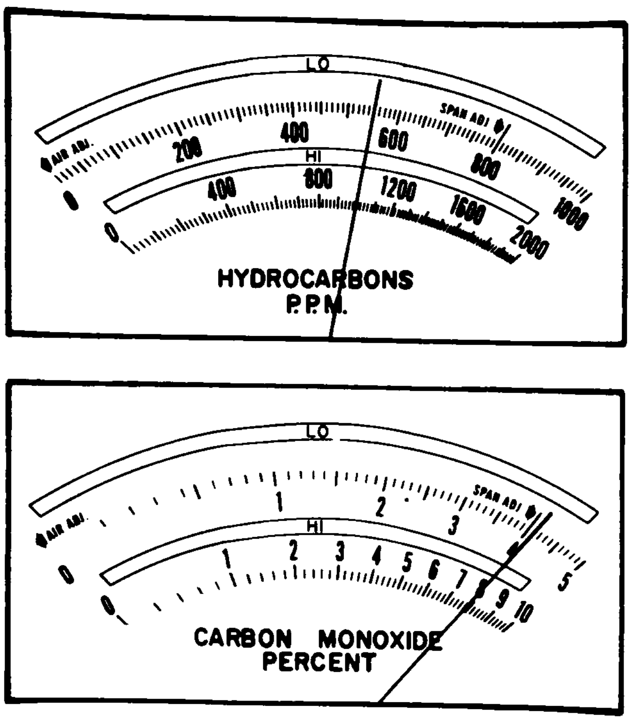
Lo Scale

Hi Scale

Figure 2-5

5. Normal Idle

a)



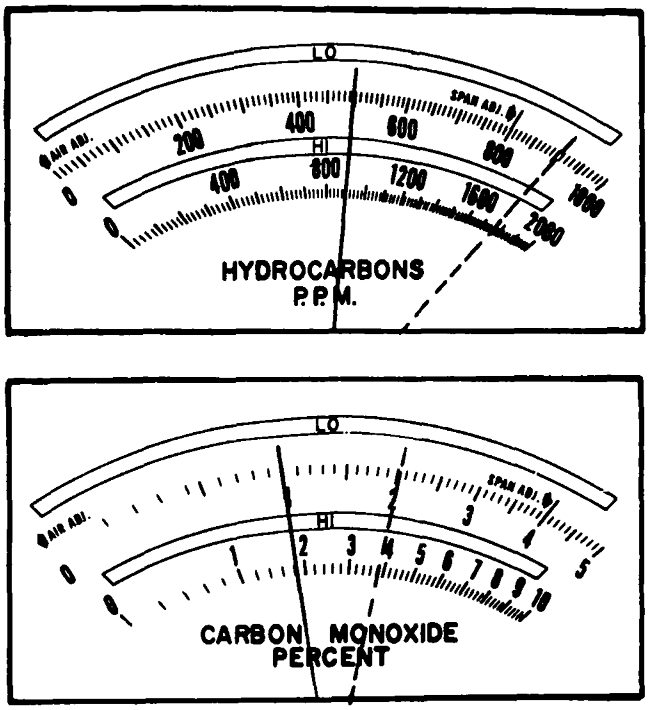
Lo Scale

Hi Scale

Figure 2-6

6. Symptoms - Engine surging, 1500 rpm

a)



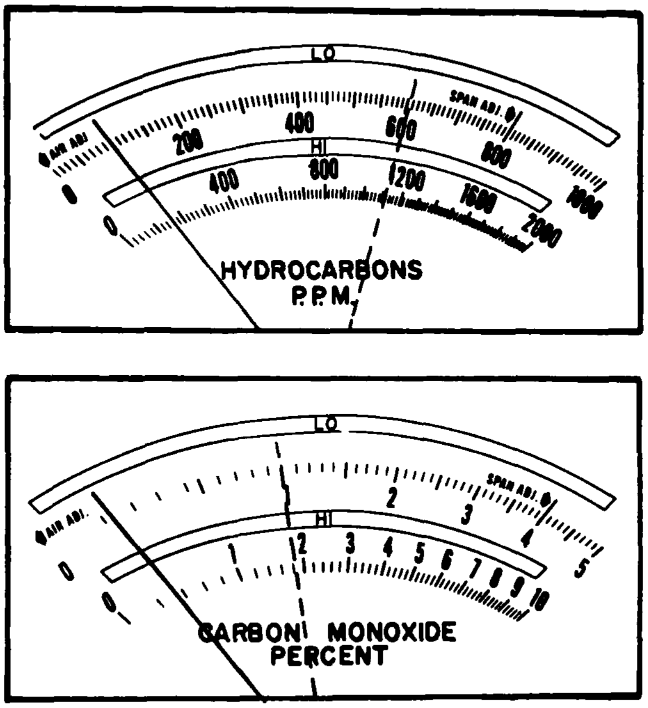
Lo Scale

b)

Lo Scale

Figure 2-7

7. Symptoms - Engine surging, 1500 rpm



Lo Scale

Lo Scale

Figure 2-8

NOTES:

8. Symptoms - Black smoke, 2500 rpm

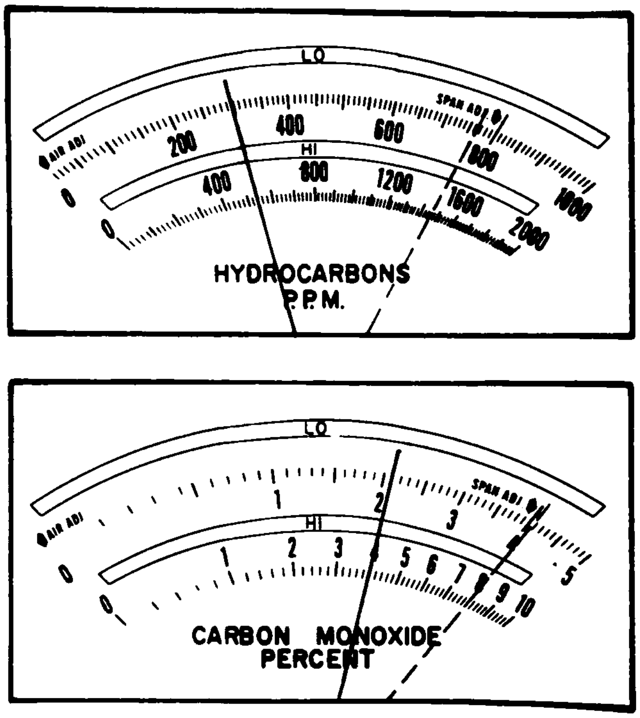
a)

1)

2)

3)

4)



Lo Scale

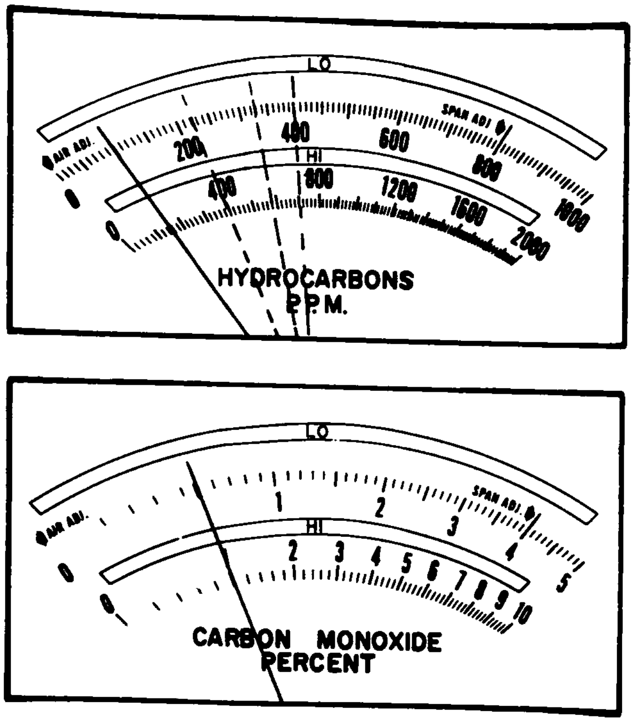
Hi Scale

Figure 2-9

9. Symptoms - Occasional miss, 1500 rpm

a)

b)



Lo Scale

Lo Scale

Figure 2-10

Fill out the following worksheet as you perform the checks.

Engine Speed	Worksheet Test Conditions	HC (PPM)	CO (%)
0	Warm up - Zero and Span Analyzer	--	--
0	Remove gas cap. Hold probe next to filler neck. Which meter indicates unburned gasoline?		
Idle	Record HC and CO for reference reading.		
Idle	Remove and ground one spark plug wire.		
Idle	Remove air cleaner unit.		
Idle	Partially close choke.		

STUDENT'S WORKBOOK

Ignition and Carburetion

Unit 3

Introductory Notes:

A. Explain how carburetor idle mixture adjustments affect CO emissions.

1. What are CO emissions directly related to?

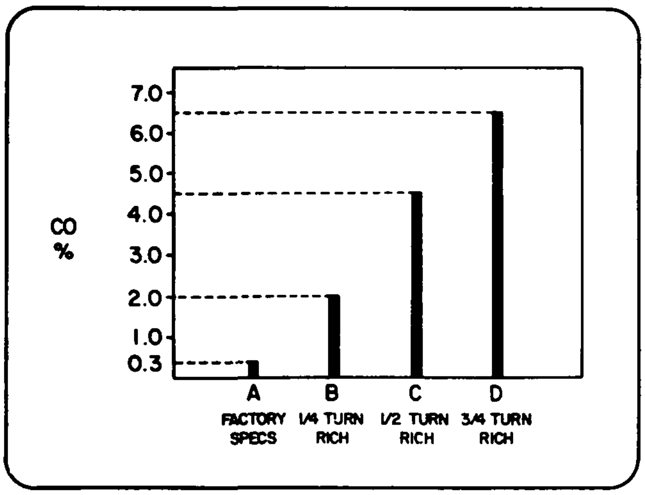


Figure 3-1

Figure 3-1 has points marked A-D. Explain what each of these points represents.

a)

b)

c)

d)

NOTES:

B. Explain how carburetor idle mixture screw adjustments affect HC emissions.

1. What causes more unburned fuel to be exhausted as the air/fuel mixture becomes richer?

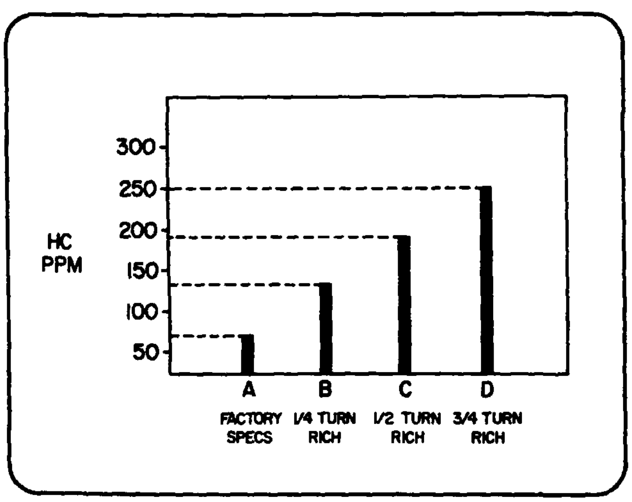


Figure 3-2

Figure 3-2 has points marked A-D. Explain what each of these points represents.

a)

b)

c)

d)

C. Explain why advancing ignition timing increases HC emissions.

1. Explain why HC emissions increase as ignition timing is advanced.

Figure 3-3 has points marked A-D. Explain what each of these points represents.

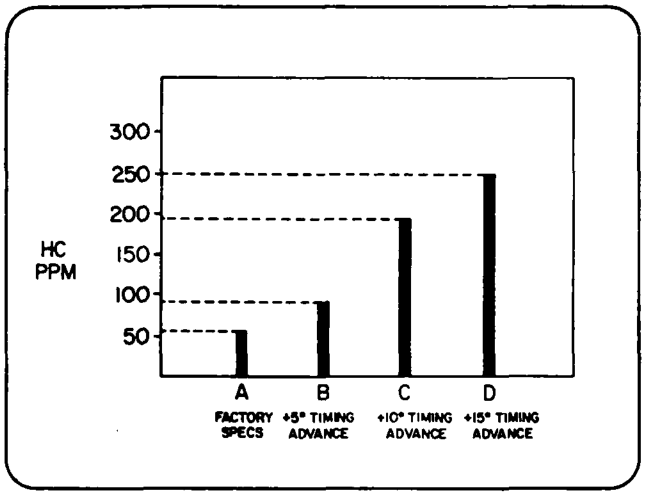


Figure 3-3

a)

b)

c)

d)

Fill out the following worksheets as you perform the tests.

IGNITION AND CARBURETION

WORKSHEET

Engine Speed	Test Conditions	HC (PPM)	CO (%)
Idle (manufacturer's specs)	Carburetor set at manufacturer's specs.		
Idle - maintain manufacturer's recomended idle speed	1/4 turn rich on idle mixture adjustment screw(s)		
	1/4 turn rich on idle adjustment screw(s)		
	1/4 turn rich on idle adjustment screw(s)		
	1/4 turn rich on idle adjustment screw(s)		
	Reset idle mixture adjustment screws to manufacturer's specs.		
Idle - maintain manufacturer's recommended idle specs	Timing set at manufacturer's specs		
	Advance timing 5°		
	Advance timing 5°		
	Advance timing 5°		
	Advance timing 5°		
	Reset timing to manufacturer's specs		

STUDENT'S WORKBOOK

Positive Crankcase Ventilation System

Unit 4

Introductory Notes:

A. Define the term "CRANKCASE."

List the areas that are part of the crankcase.

1.

2.

3.

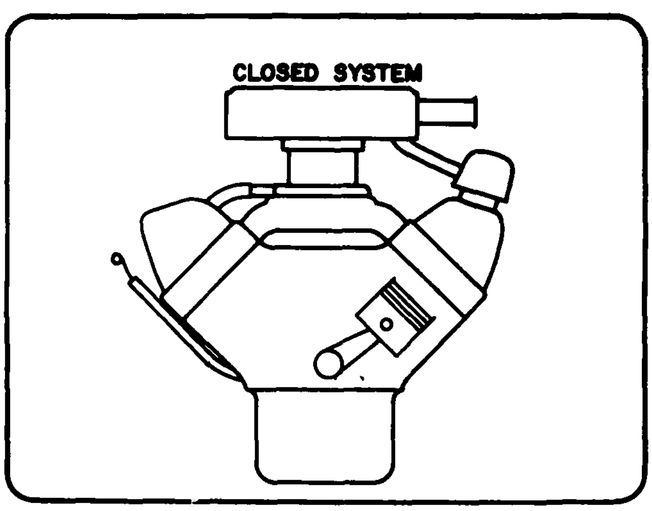


Figure 4-1

Draw arrows to crankcase areas.

B. Explain what is meant by the term "VENTILATION."

List the problems blowby gases can cause if the crankcase is not ventilated.

1.

2.

3.

4.

C. List the four main parts of the "closed" PVC system.

1.

2.

3.

4.

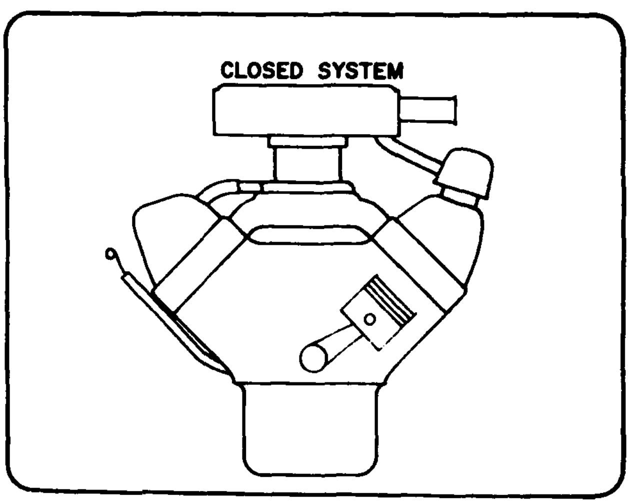


Figure 4-2

Label the four main parts of the closed PCV system.

D. Explain the flow of blowby gases in the closed PCV system.

Notes:

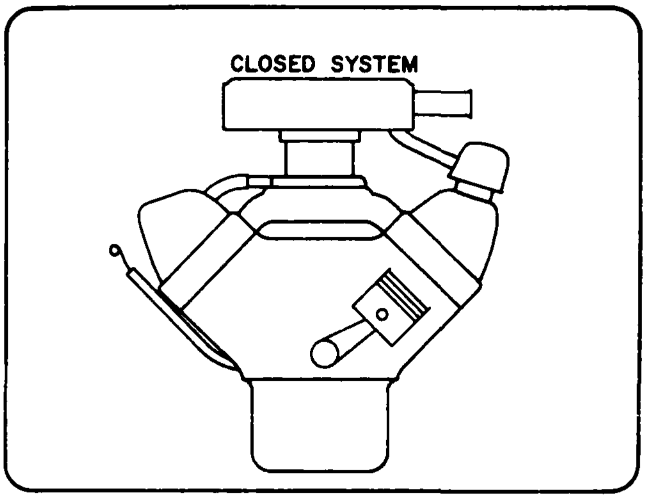


Figure 4-3

Show the normal flow path of blowby gases and fresh air in the closed PCV system.

Notes:

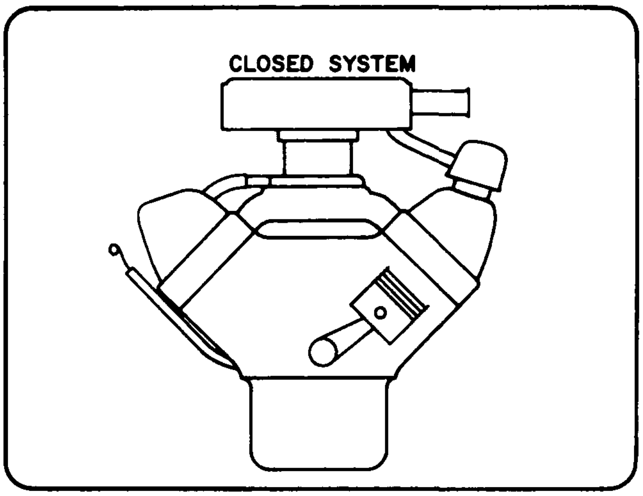
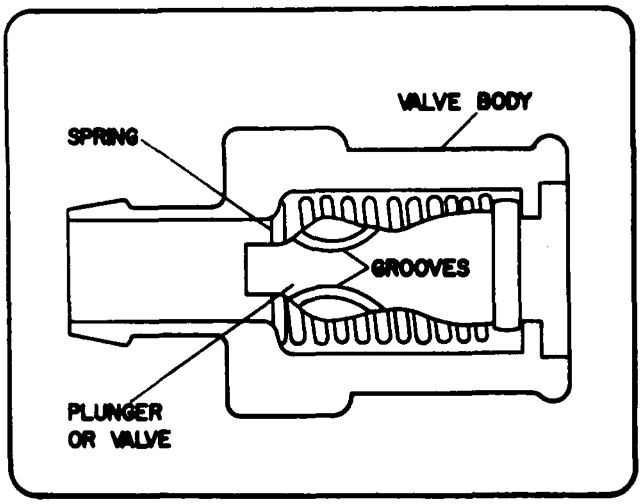


Figure 4-4

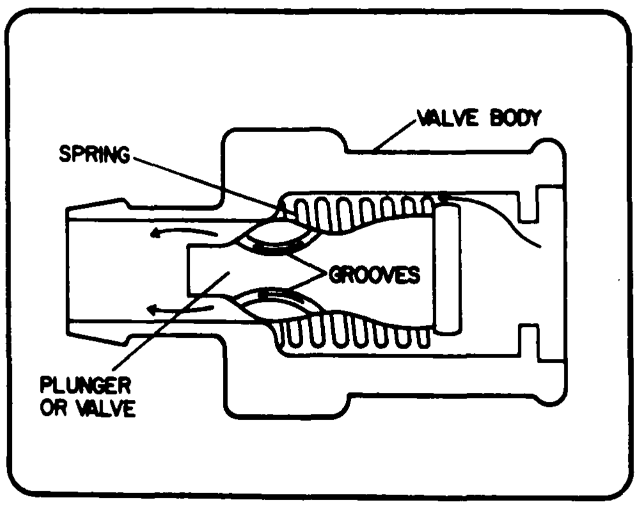
Show the flow of blowby gases during full throttle operation.

E. Explain the purpose of the PCV valve.



What engine conditions correspond to this PCV valve position?

Figure 4-5



What engine conditions correspond to this PCV valve position?

Figure 4-6

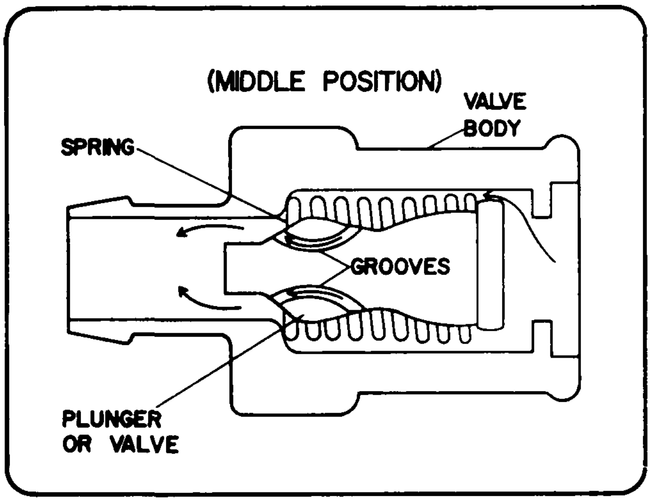


Figure 4-7

What engine conditions correspond to this PCV valve position?

F. Explain the effect the PCV system can have on HC and CO emissions and driveability?

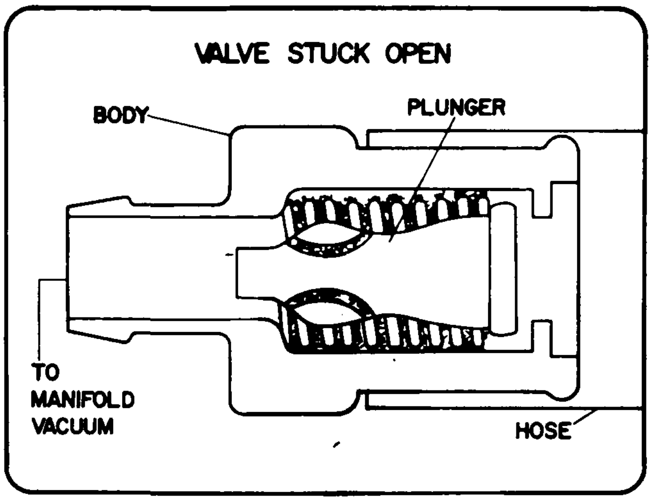


Figure 4-8

1. List the conditions a PCV valve stuck in the maximum flow position causes.

   a)

   b)

   c)

   d)

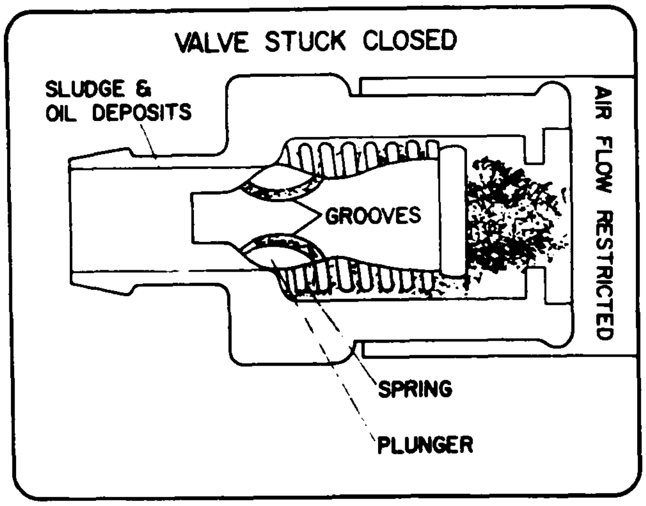


Figure 4-9

2. List the conditions a PCV valve stuck in the minimum flow position could cause.

   a)

   b)

   c)

G. List the reasons for always checking the manufacturer's service manual.

   a)

   b)

   c)

   d)

H. PCV System Operational Checks.

   1. Figure 4-10 shows a vacuum draw test being performed. List the basic steps of this procedure.

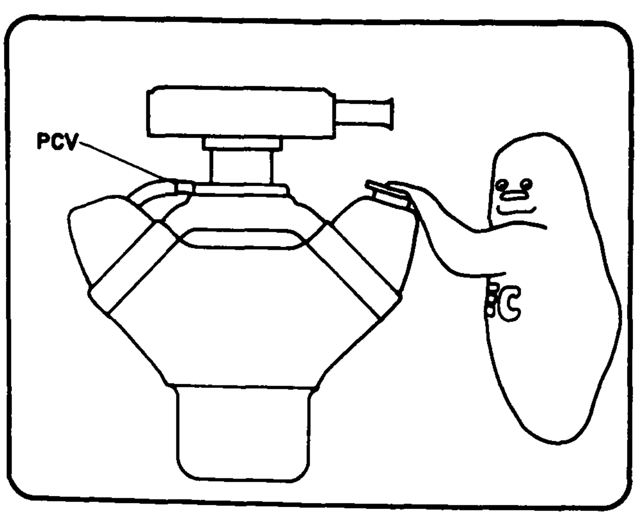


Figure 4-10

   a)

   b)

   c)

Explain how you would know if the PCV system were operating properly.

2. Figure 4-11 shows a crankcase vacuum draw test being performed using the inclined ramp and ball tester. List the basic steps for performing this test.

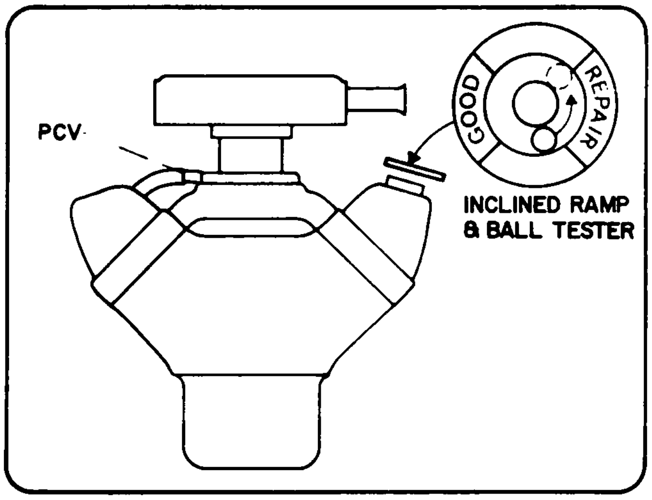


Figure 4-11

a)

b)

c)

Explain how you would know if the PCV system is operating properly.

3. Figure 4-12 shows a crankcase vacuum draw test being performed with an adjustable PCV system tester. List the basic steps required to perform this test.

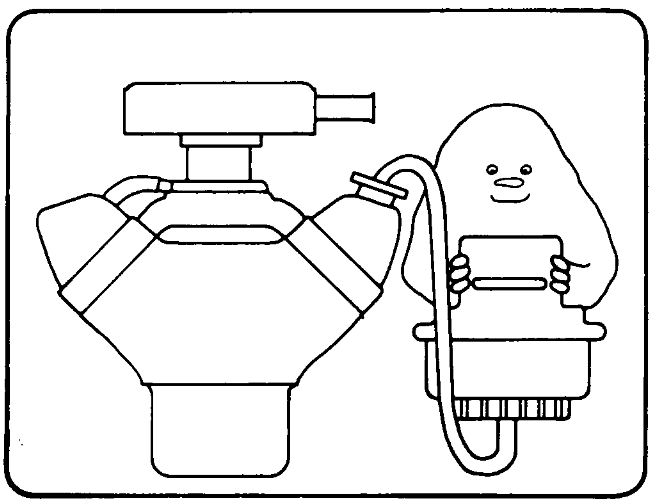


Figure 4-12

a)

b)

c)

d)

e)

Explain how you would know if the PCV system were operating properly.

I. PCV Valve Checks

1. Figure 4-13 shows a PCV valve being tested. List the basic steps required to perform this test.

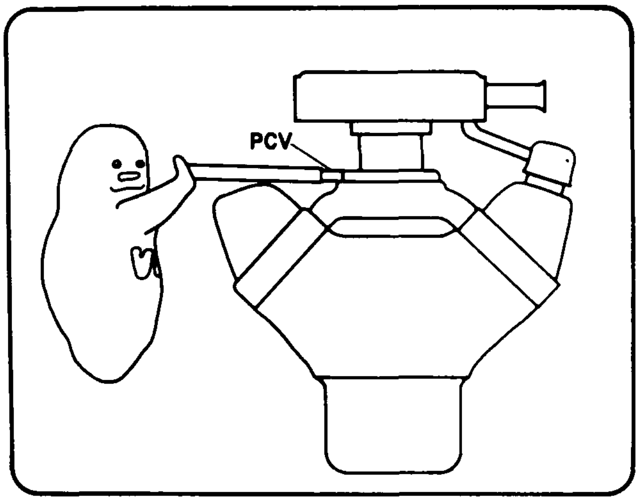


Figure 4-13

a)

b)

c)

d)

e)

List the probable cause of no vacuum being felt at step e).

Fill out the following worksheet as you perform the checks.

Engine Speed	Test Condition	Pass	Fail
Idle	VACUUM DRAW TEST Place a sheet of paper over oil filler hole		
Idle	VACUUM DRAW TEST Inclined Ramp and Ball		
Idle	VACUUM DRAW TEST Adjustable Tester		
Idle	PCV VALVE TEST		

STUDENT'S WORKBOOK

Thermostatic Air Cleaners

Unit 5

INTRODUCTORY NOTES:

A. Identify the two types of air cleaners shown below.

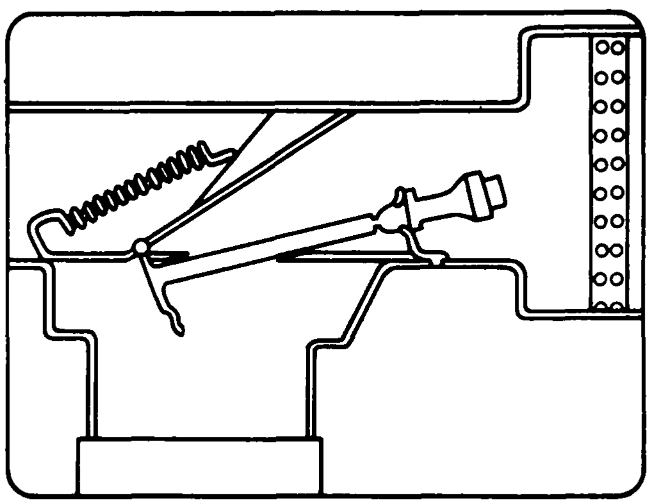


Figure 5-1

1.

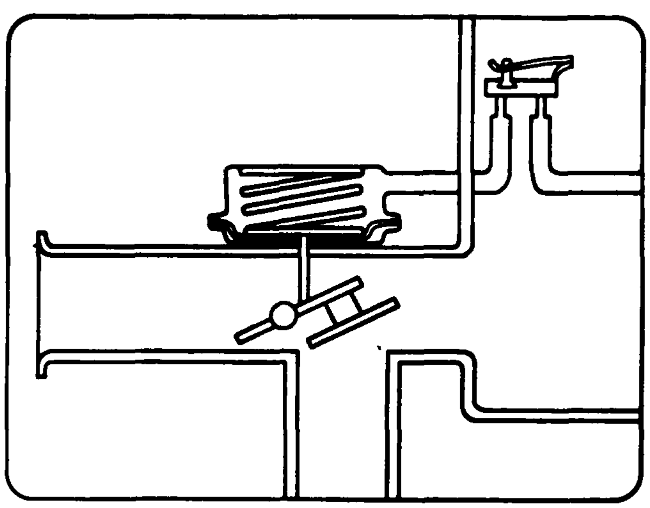


Figure 5-2

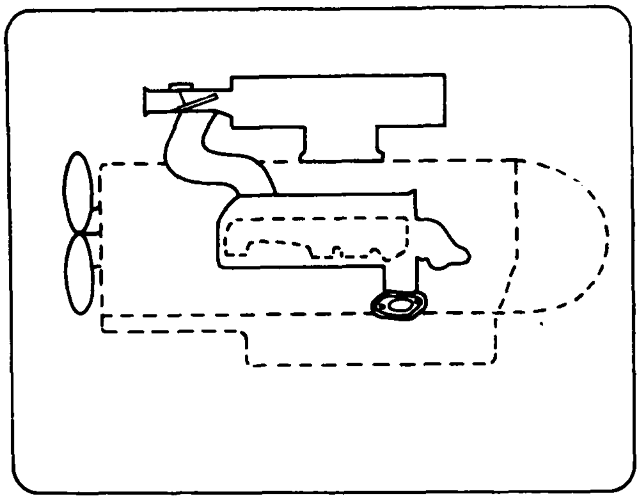
2.

B. List the parts that are common to both systems.

a)

b)

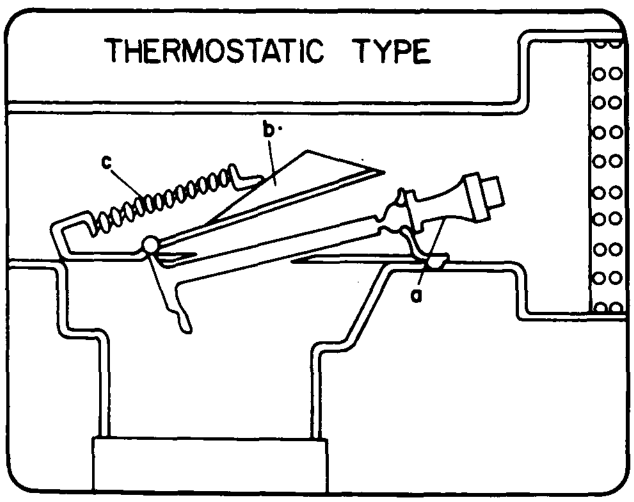
c)



Label the parts that are common to both systems.

Figure 5-3

C. Identify the parts of the thermostatic air cleaner.



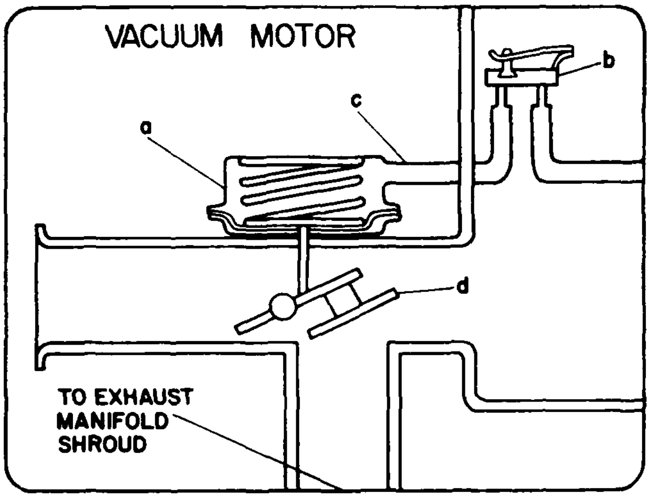
a)

b)

c)

Figure 5-4

D. Identify the parts of the vacuum motor system.



a)

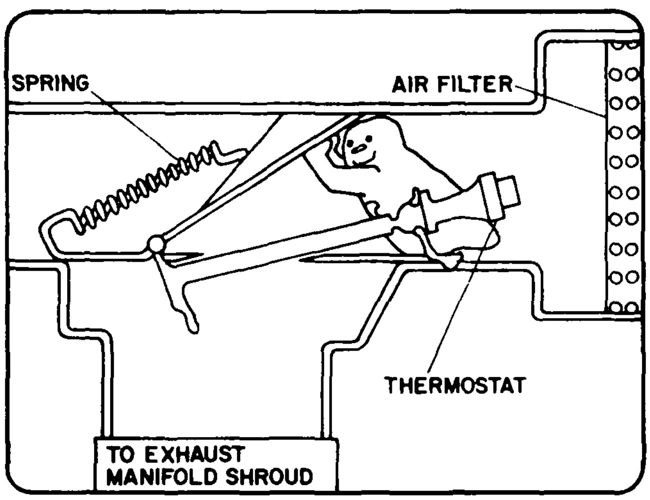
b)

c)

d)

Figure 5-5

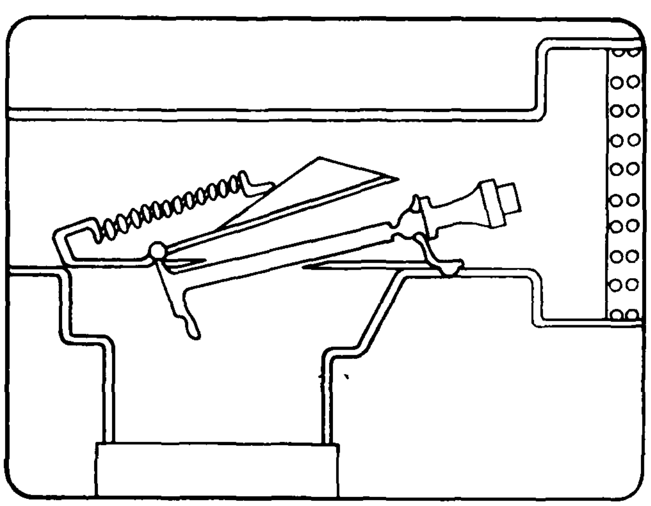
E. Identify the three operating modes common to both types of air cleaners.



1. ________________ mode.

List the temperature conditions necessary for this mode of operation. Draw in the air flow path for this mode.

Figure 5-6



2. ________________ mode.

List the temperature conditions necessary for this mode of operation. Draw in the air flow path for this mode.

Figure 5-7

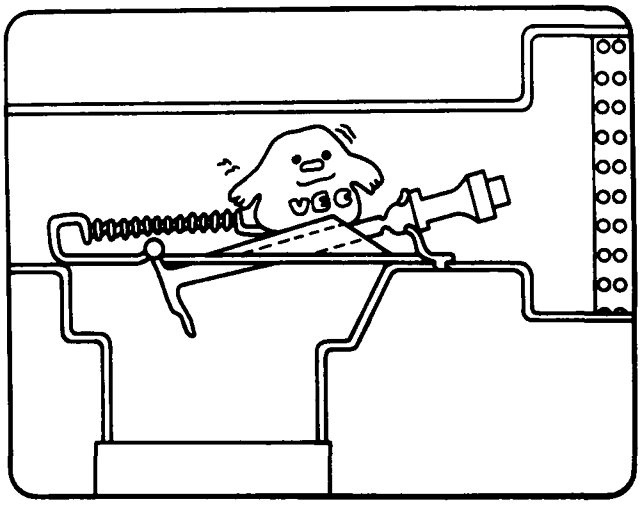


Figure 5-8

3. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ mode.

List the temperature conditions necessary for this mode of operation. Draw in the air flow path for this mode.

F. List the events that control the thermostatic air cleaner from cold startup through normal operating temperature.

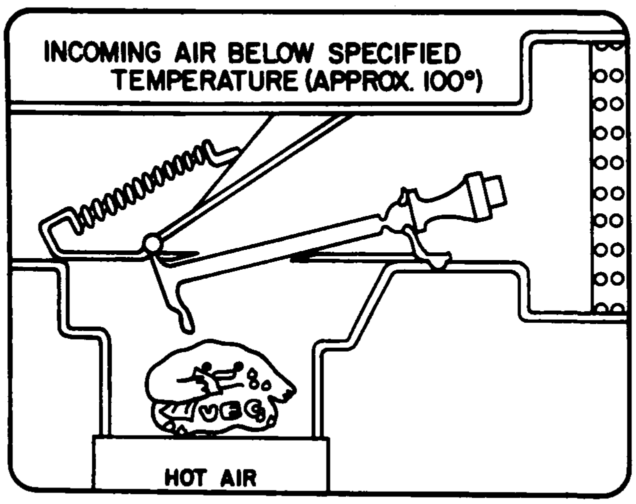


Figure 5-9

1. Below approximately 100°F the thermostat is retracted.

   a) Explain how the damper assembly is positioned.

   b) Is heated air or cold air allowed into the carburetor?

   c) Explain when and how the intake air is preheated.

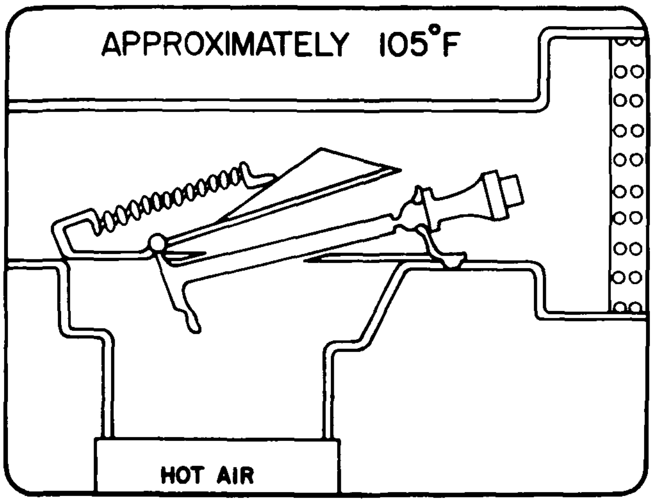


Figure 5-10

2. At approximately 105°F, the thermostat begins to expand.

   a) Explain how the damper assembly is positioned.

   b) Is heated or cold air allowed to enter the carburetor?

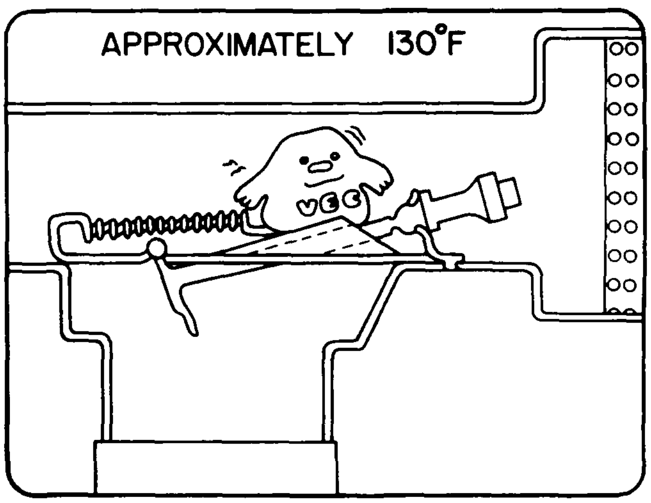


Figure 5-11

3. At approximately 130°F, the thermostat has expanded to full length.

   a) Explain how the damper assembly is positioned.

   b) Is heated or cold air allowed to enter the carburetor?

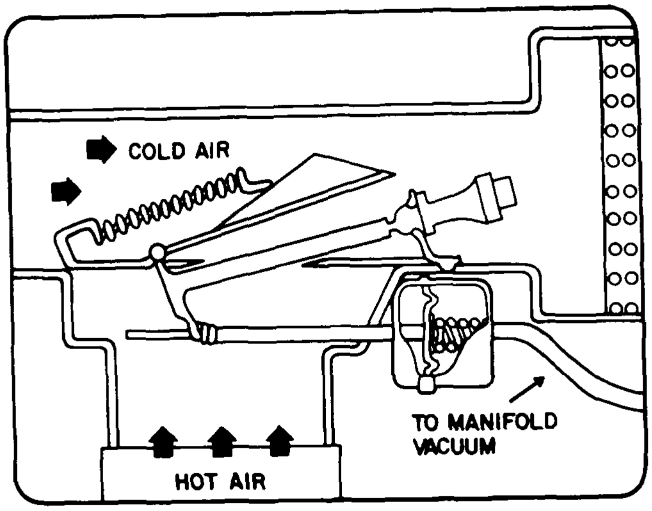


Figure 5-12

4. Label the vacuum override motor.

   a) During what engine condition will the vacuum motor allow cold air to enter the carburetor?

G. List the events that control the vacuum motor air cleaner.

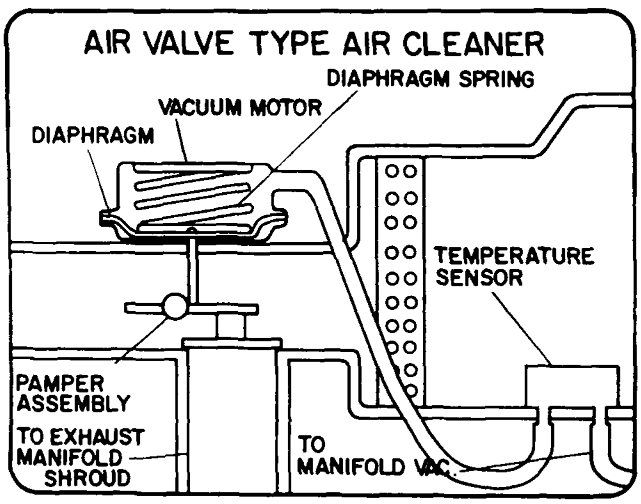


Figure 5-13

1. With the engine shut off, what mode should the damper assembly be in?

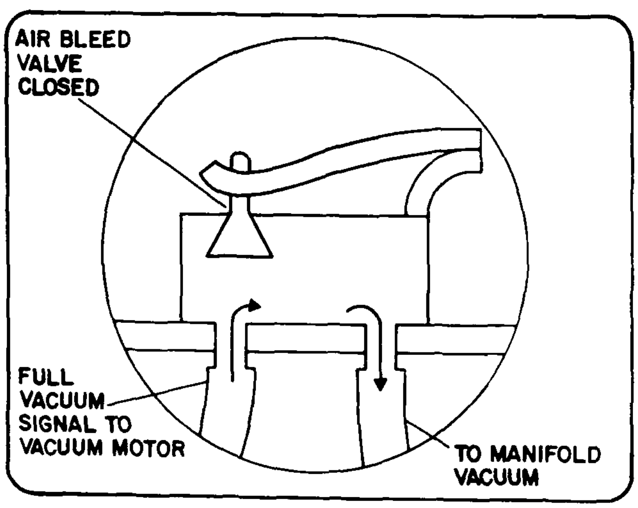


Figure 5-14

2. What is the position of the air bleed valve below 85°F?

   Explain what holds the valve in this position.

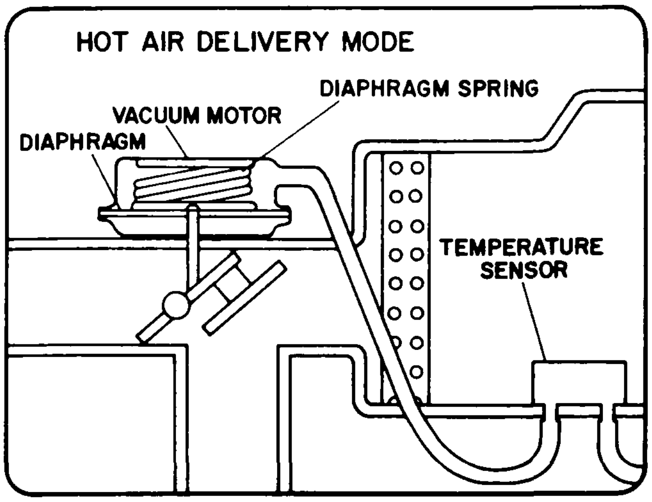


Figure 5-15

3. Explain how the damper assembly is moved when the engine is started.

   Is heated or cold air allowed to enter the carburetor?

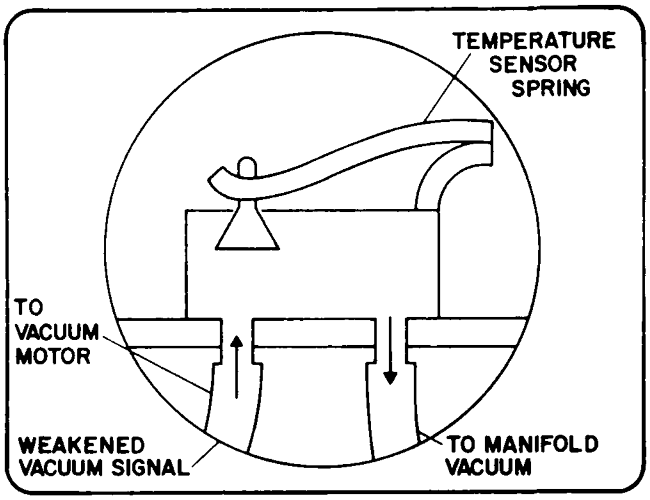


Figure 5-16

4. Explain how some vacuum is destroyed between 85-105°F.

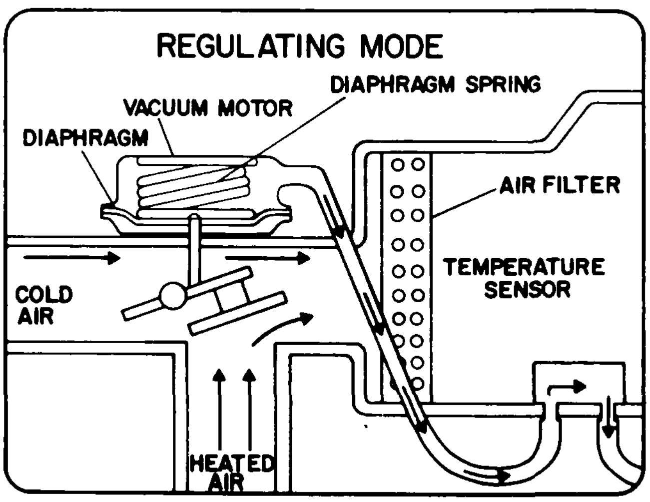


Figure 5-17

5. Explain how the damper assembly is moved into the regulating mode when vacuum decreases.

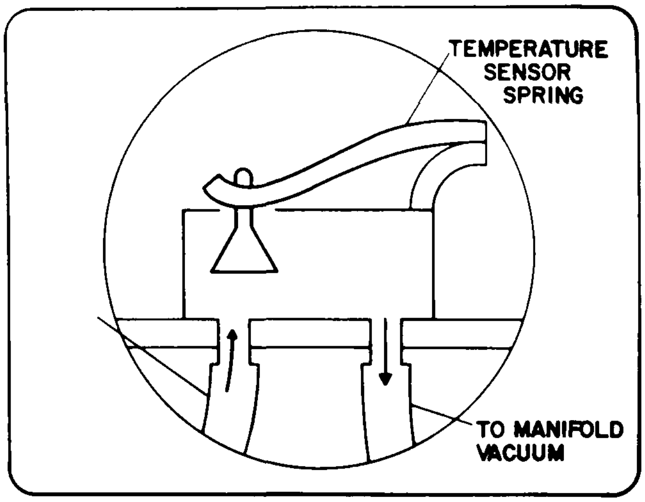


Figure 5-18

6. Explain what causes the vacuum to decrease lower at approximately 130°F.

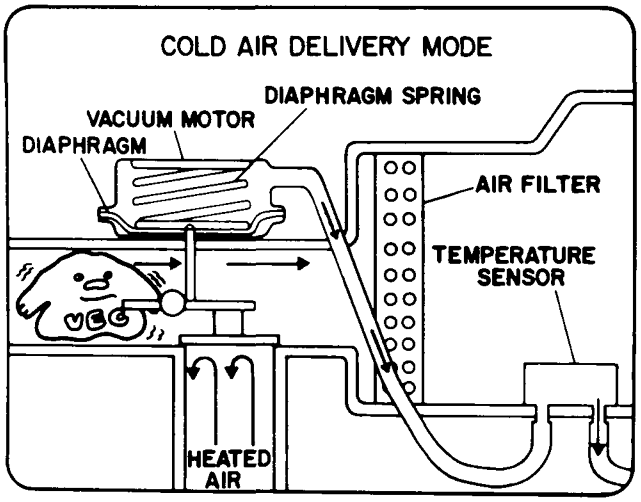


Figure 5-19

7. What mode does the damper assembly move to when vacuum reaches approximately 3-8" Hg in the vacuum motor?

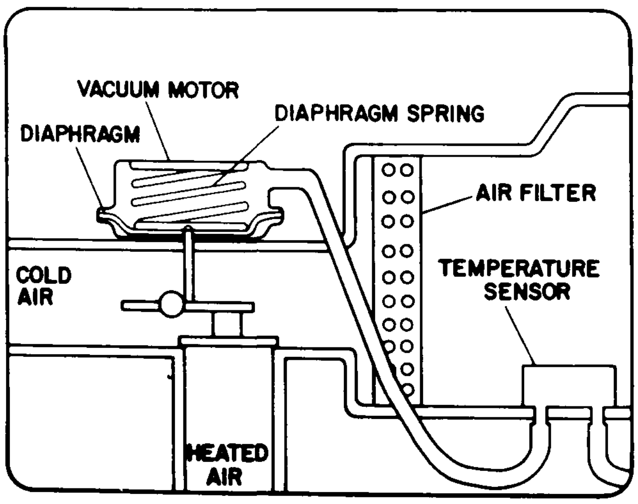


Figure 5-20

8. Explain how during acceleration, the damper assembly is moved into the cold air delivery mode.

H. Explain the effect heated air systems can have on HC-CO and drive-ability.

NOTES:

1. List the advantages of using a heated air system.

   a)

   b)

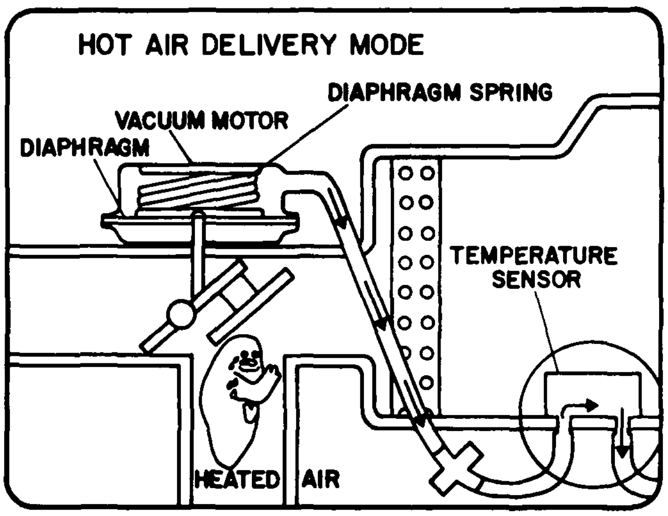


Figure 5-21

2. Explain the purpose of the vacuum delay valve shown in Fig. 5-21.

   a)

   b)

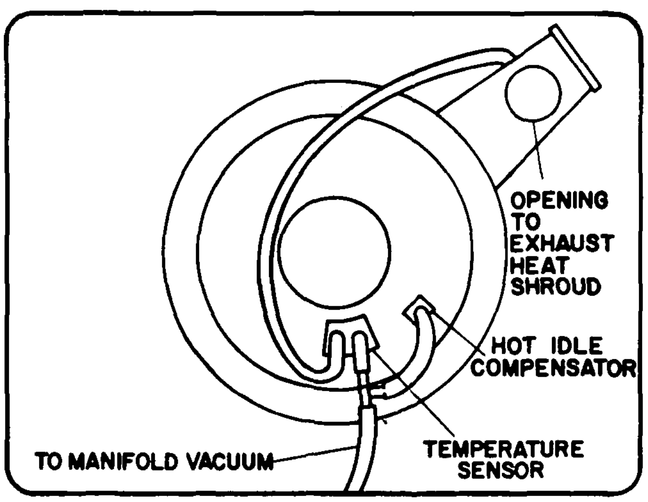


Figure 5-22

3. Explain the purpose of the hot idle compensator shown in Fig. 5-22.

   a)

   b)

   c)

   d)

I. Thermostatic Air Cleaner Operational Checks.

1. Figure 5-23 shows a thermostatic air cleaner. List the basic steps of the operational check.

a)

b)

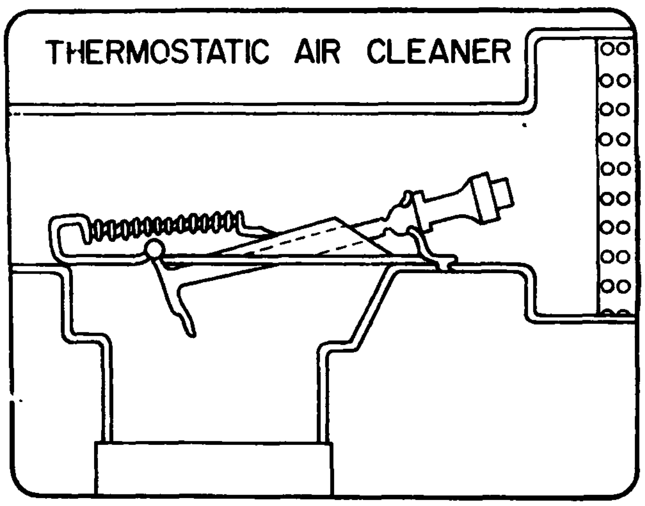


Figure 5-23

c)

d)

e)

f)

g)

h)

2. Fig. 5-24 shows a vacuum motor air cleaner. List the basic steps of the operational checks.

a)

b)

c)

d)

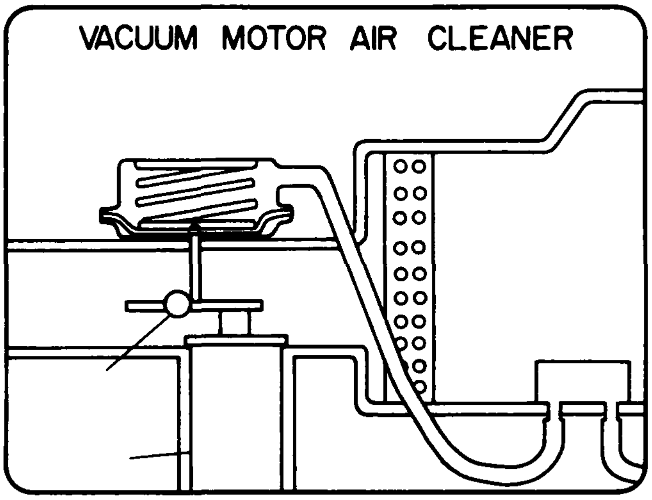


Figure 5-24

If the damper assembly does not move, list the steps to take to pinpoint the problem.

1)

2)

3)

4)

Explain what modes the damper assembly should go through as the engine warms up.

a)

b)

c)

Fill out the following worksheet as you perform the tests.

THERMOSTATIC AIR CLEANER WORKSHEET

Engine Speed	Test Conditions	Cold Air Mode	Regulating Mode	Hot Air Delivery Mode
THERMOSTATIC TYPE				
Off	Temperature Below 80°F			
Idling	Temperature Between 100-130°F			
If equipped with vacuum override motor				
Snap Accel-eration	Temperature Between 100-130°F			
Idling	Temperature Above 130°F			
VACUUM MOTOR TYPE				
Off	Check Position			
Idling	Temperature Below 80°F			
Idling	Temperature Between 100-120°F			
Idling	Temperature Above 130°F			

STUDENT'S WORKBOOK

Air Injection Systems

Unit 6

Introductory Notes:

A. Identify the main components of the Air Injection System.

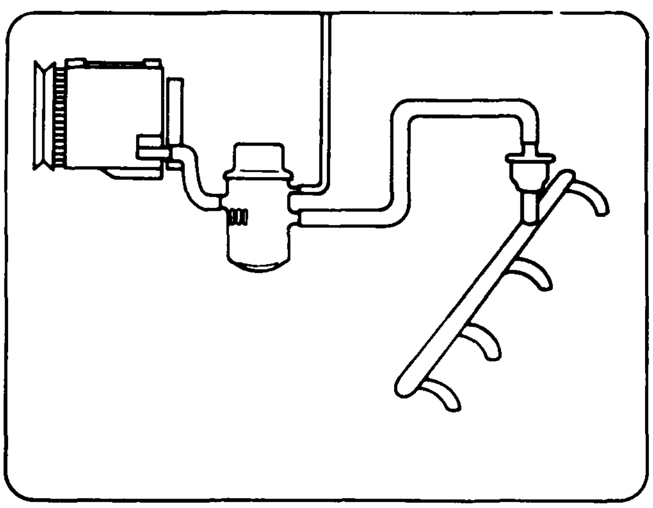


Figure 6-1

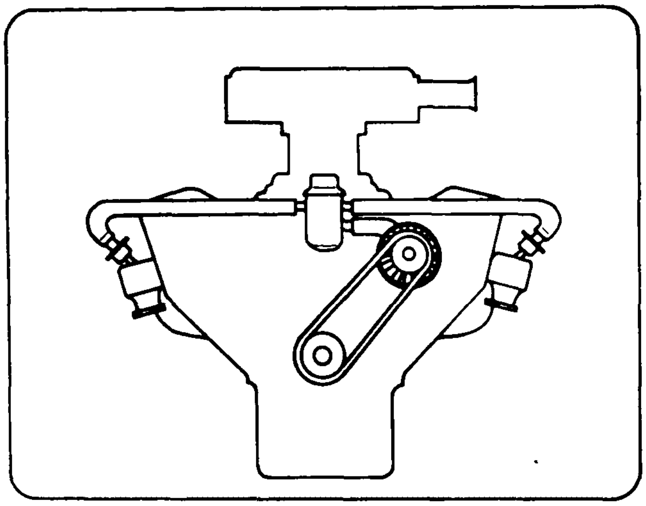
1.

2.

3.

4.

B. Show the flow path of air through the air injection system during normal operation.



Notes:

Figure 6-2

C. Show the operation of the diverter valve.

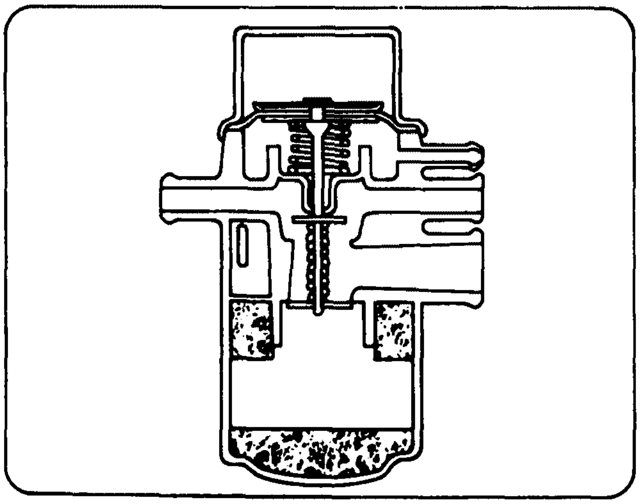


Figure 6-3

1. Show the normal flow of air through the diverter valve during idle, and cruise conditions.

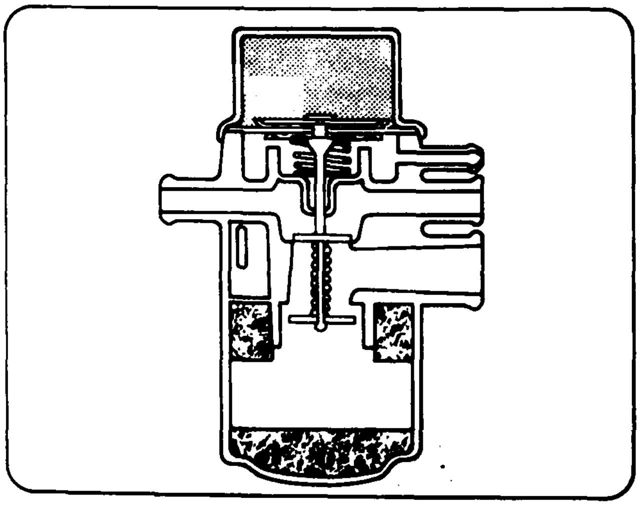


Figure 6-4

2. Show the air flow through the diverter valve during deceleration.

   a) What is the purpose of the manifold vacuum sensing line?

   b) How long does the "dump" condition last?

   c) What condition does the diverter valve prevent?

Notes:

D. Show the flow of air through the diverter valve when excessive pressure builds up in the system.

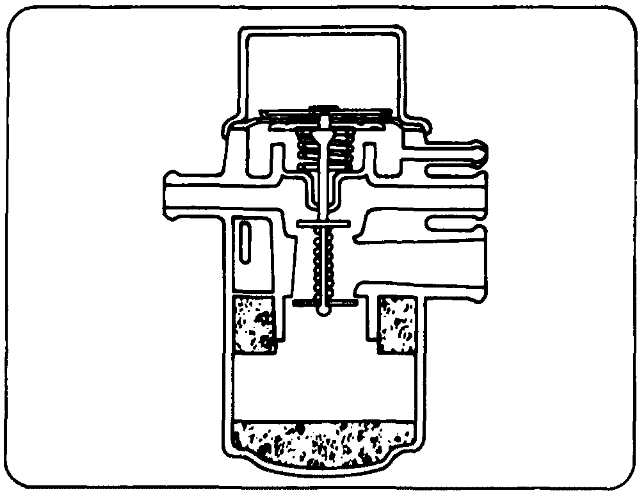


Figure 6-5

Notes:

E. Explain the operation of the air switching valve.

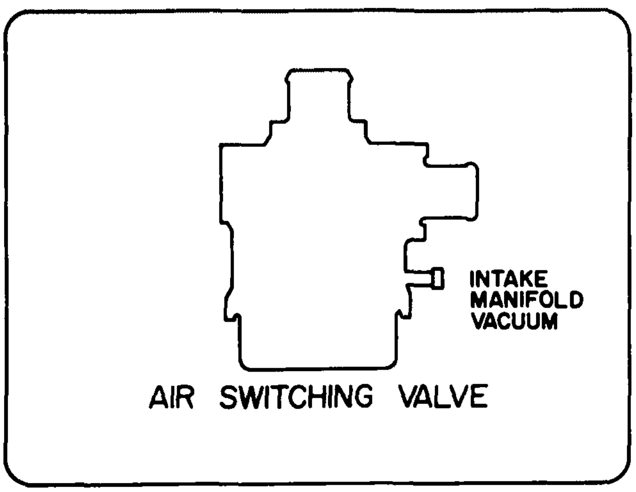


Figure 6-6

1. What device controls vacuum to the air switching valve?

2. Where is all pump air directed at low coolant temperatures?

3. Above specified coolant temperature where is pump air directed?

F. Show the operation of the air injection system check valve.

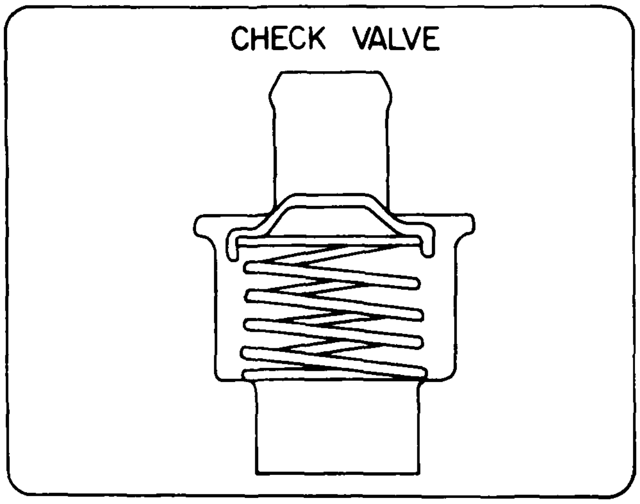


Figure 6-7

1. Show the normal flow of air through the check valve.

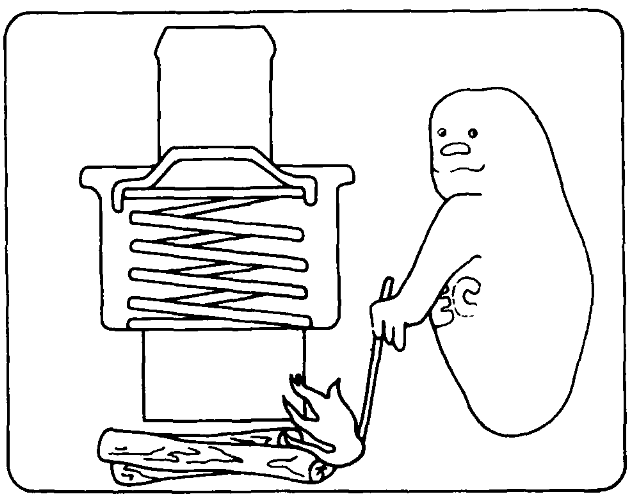


Figure 6-8

2. Explain how the check valve prevents exhaust gases from flowing back into the system in case of a belt, pump or hose failure.

G. Explain the operation of the "GULP" valve.

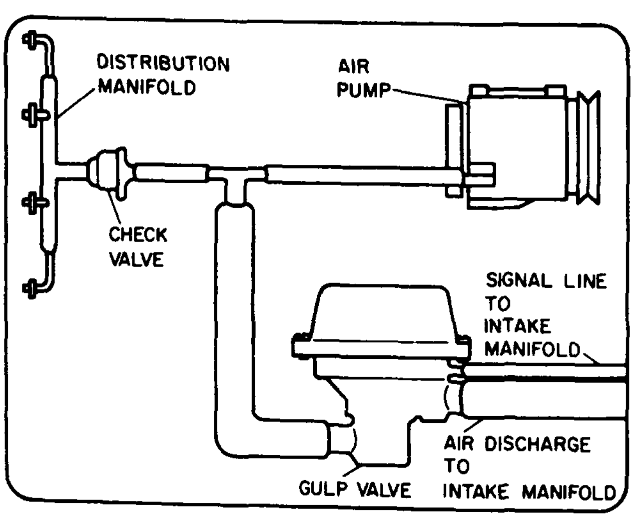


Figure 6-9

1. What condition does the gulp valve prevent?

2. When does the gulp valve operate?

3. Explain how the gulp valve "leans out" the air/fuel mixture in the intake manifold.

4. Where would the relief valve be located in a system with a gulp valve?

H. Explain the effect the air injection system can have on HC-CO emissions and driveability.

1. If the air injection system is disconnected how much higher will HC-CO emissions be?

2. List the conditions that can cause the air injection system to cause a rough idle.

   a)

   b)

   c)

3. What condition can occur if the diverter valve fails to operate on deceleration?

4. Will disconnecting an air pump show a significant increase in power or fuel economy?

Notes:

I. Air Injection System Operational Checks

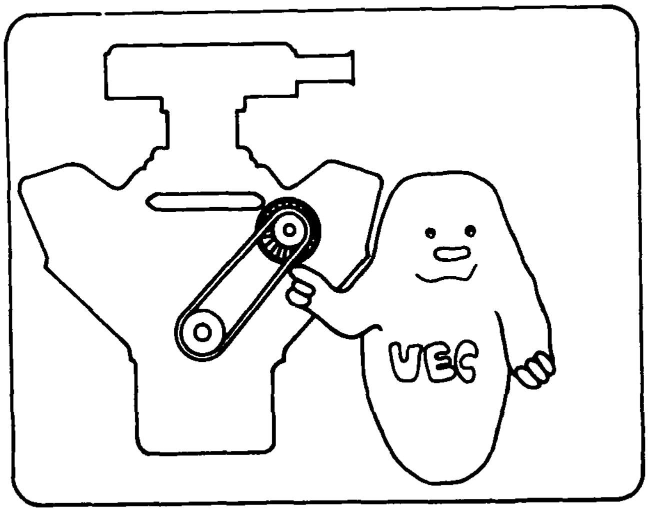


Figure 6-10

1. Figure 6-10 shows an air pump drive belt. List the checks that are necessary on this belt.

   a)

   b)

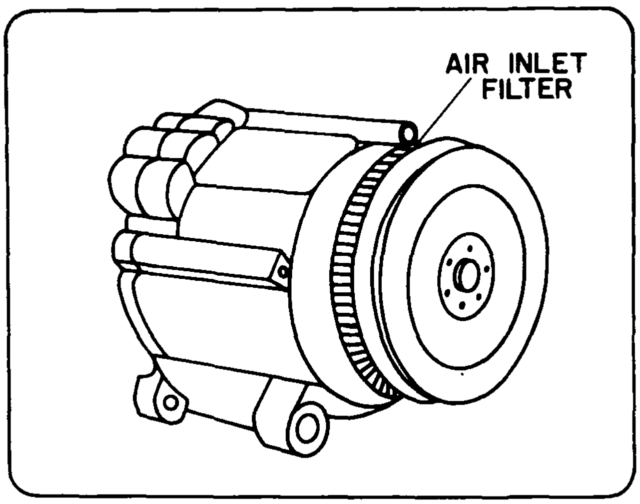


Figure 6-11

2. Figure 6-11 shows the centrifugal air filter on the air pump. List the necessary checks for this air filter.

   a)

   b)

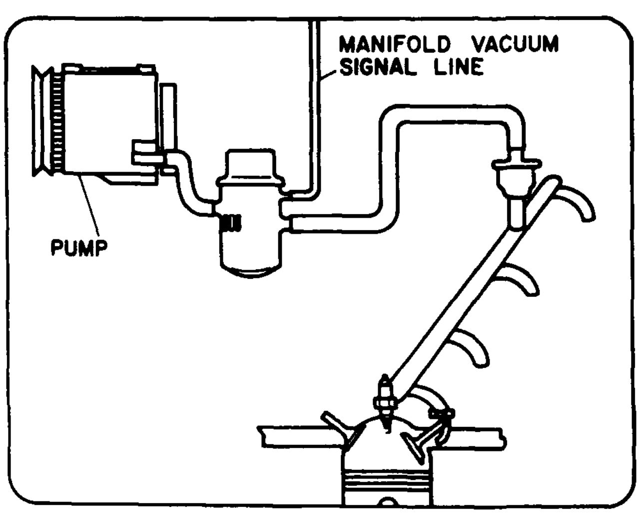


Figure 6-12

3. List the conditions that should be checked during a visual inspection of air and vacuum hoses.

   a)

   b)

   c)

   d)

4. Figure 6-13 shows an air pump flow test being performed. List the basic steps necessary to perform this test.

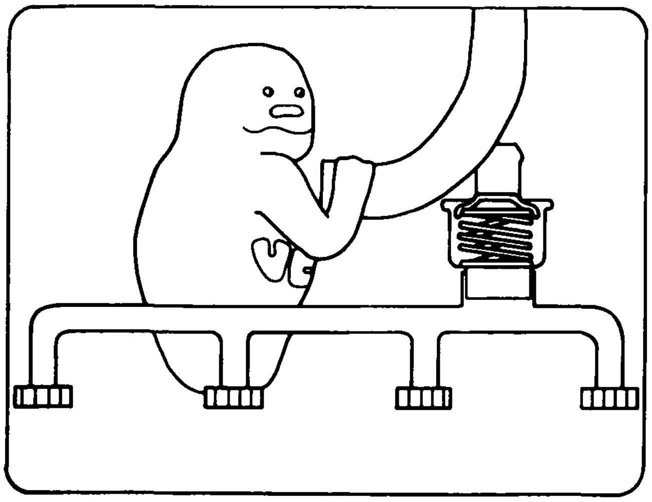


Figure 6-13

a)

b)

c)

d)

Notes:

5. Figure 6-14 shows a diverter valve being tested. List the basic steps necessary to perform this test.

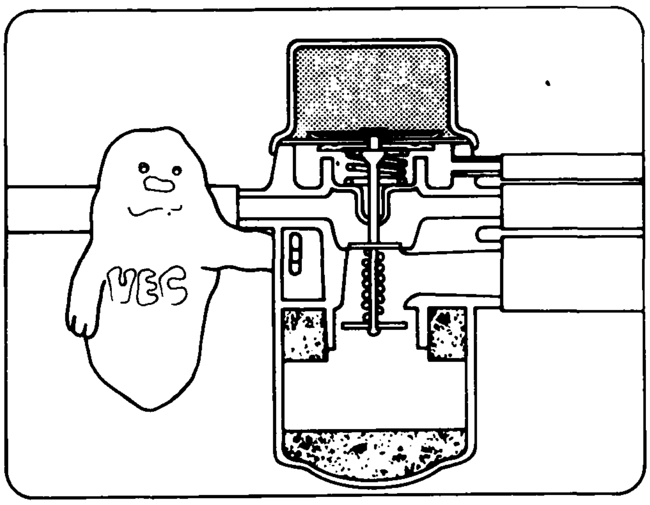


Figure 6-14

a)

b)

c)

d)

Notes:

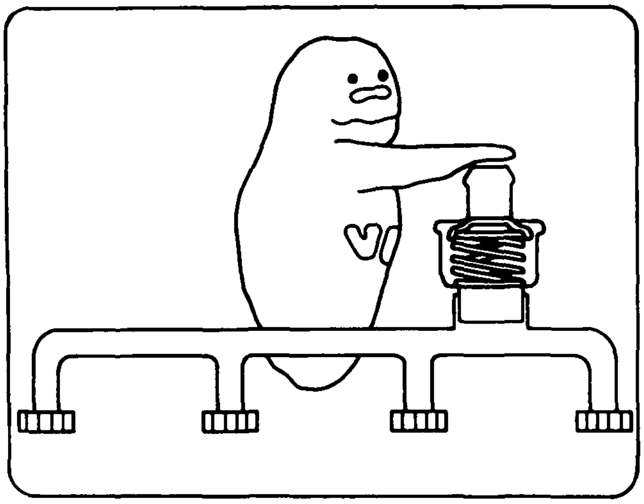


Figure 6-15

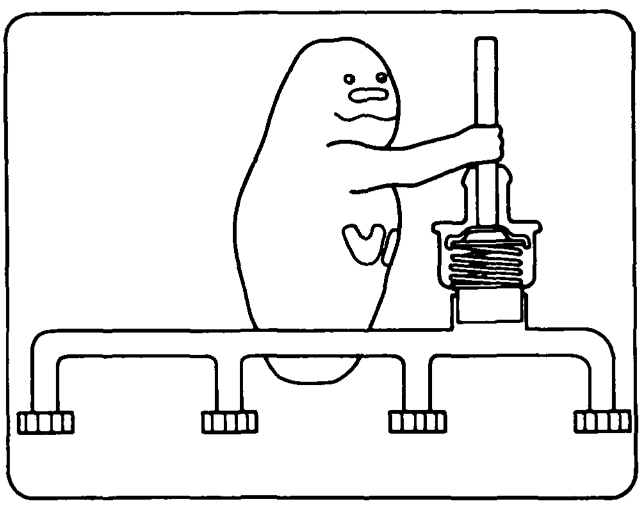


Figure 6-16

Notes:

6. A check valve is shown being tested in Figure 6-15. List the basic steps necessary to perform this test.

   a)

   b)

   c)

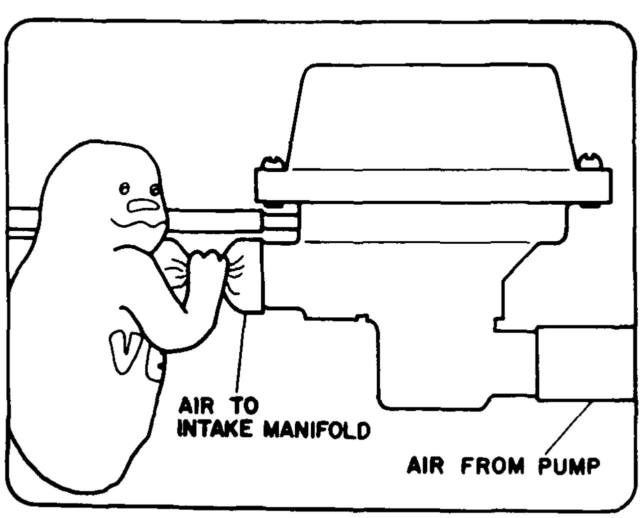


Figure 6-17

7. Figure 6-17 shows the gulp valve being tested. List the basic steps necessary to perform this test.

   a)

   b)

Fill out the following worksheet as you perform the checks.

AIR INJECTION SYSTEM WORKSHEET

Engine Speed	Test Condition	Pass	Fail
0	AIR PUMP DRIVE BELT		
0	CENTRIFUGAL FILTER		
0	AIR AND VACUUM HOSE CONDITION		
Idle and 1500 rpm	PUMP AIR FLOW AT DISCHARGE HOSE END		
Idle	DIVERTER VALVE TEST		
2000 rpm	DIVERTER VALVE DISCHARGE ON DECELERATION		
Idle	GULP VALVE TEST		
Idle	GULP VAVLE TEST		

STUDENT'S WORKBOOK

Fuel Evaporation Control

Unit 7

Introductory Notes:

A. List the main parts of the fuel evaporation control system.

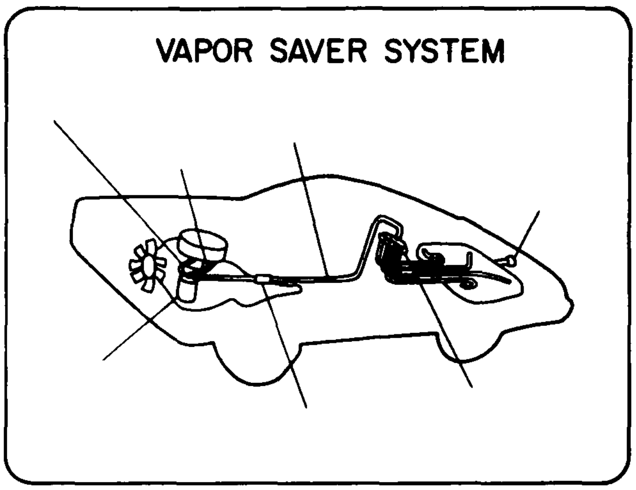


Figure 7-1

1.

2.

3.

4.

5.

6.

7.

Label each main part listed.

Notes:

B. Explain the operation of the following fuel evaporation system components.

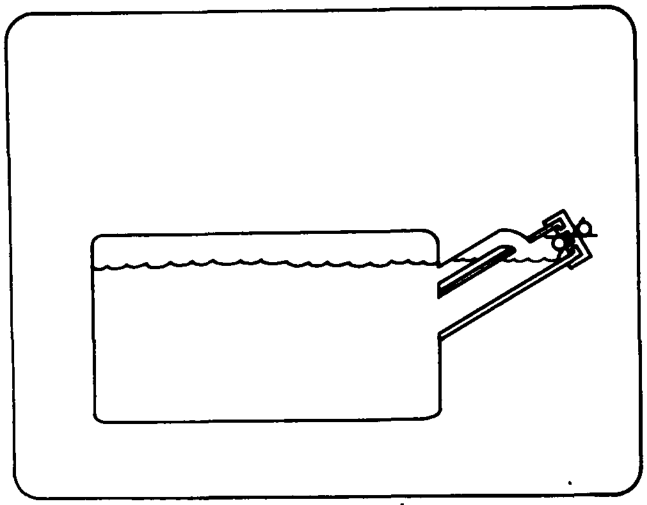


Figure 7-2

1. Fuel tanks and filler necks

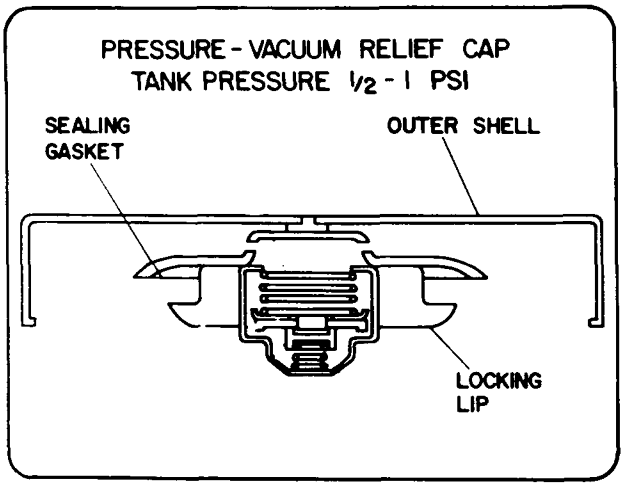


Figure 7-3

2. Fuel tank filler caps - (tank under pressure)

Show the flow path the fuel vapors.

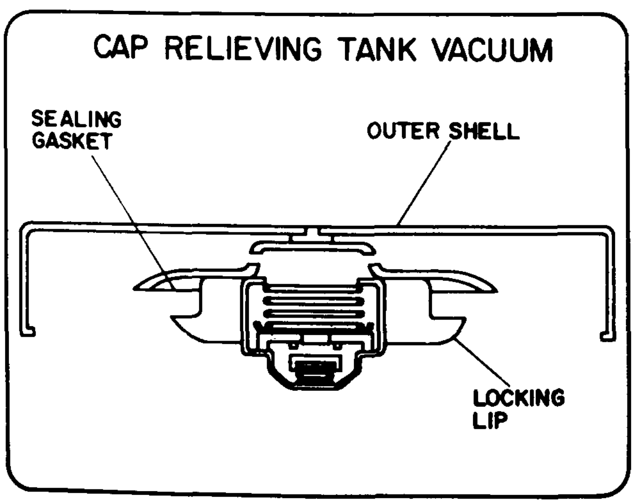


Figure 7-4

3. Fuel tank filler cap - (tank under vacuum)

Show the flow path for fuel vapors.

4. Liquid-vapor separator - (separate from tank)

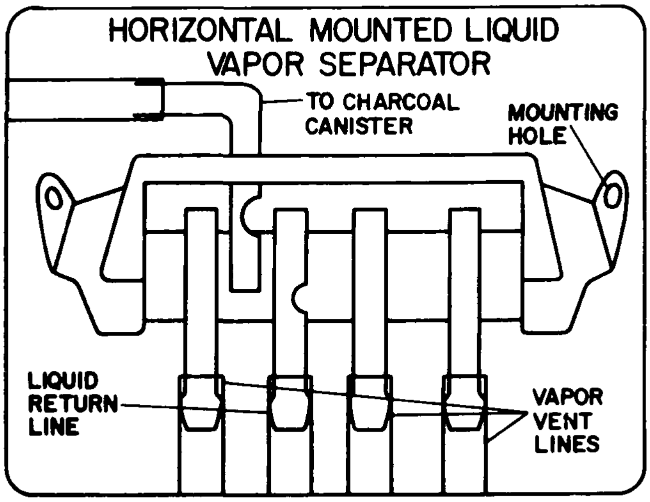


Figure 7-5

5. Liquid-vapor separator - (on tank)

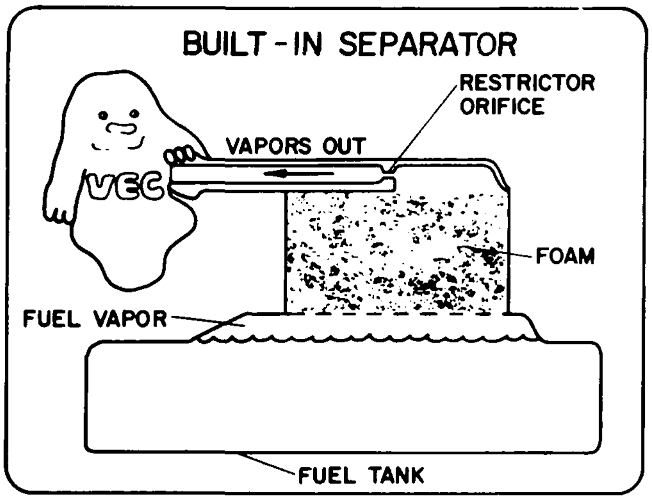


Figure 7-6

6. Charcoal canister

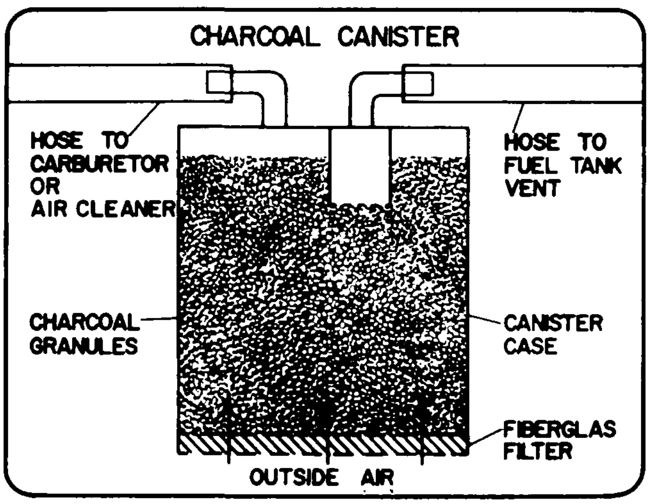


Figure 7-7

C. Explain the methods used to purge fuel vapors from the charcoal canister.

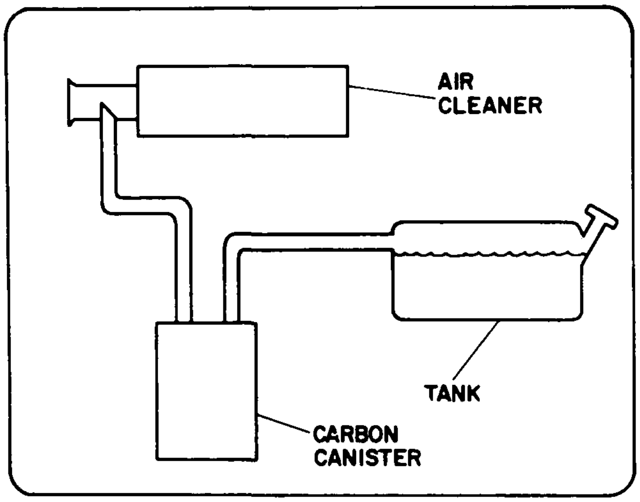


Figure 7-8

Show air and purged fuel vapor path.

1. Variable purge method -

   a) What causes this purge method to change or be variable?

   b) Explain how the fuel vapors are removed from the canister.

   c) What happens to the air and fuel vapors after they leave the canister?

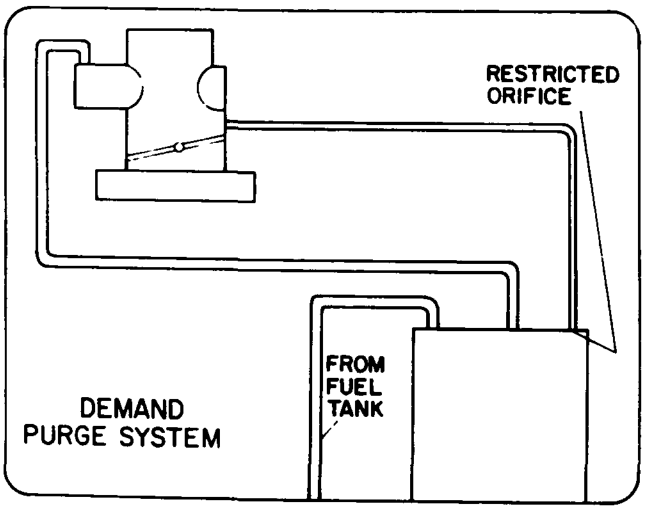


Figure 7-9

Show air and purged fuel vapor path.

2. Demand purge method -

   a) Where does the purge line connect to the carburetor?

   b) Does canister purging occur during idle or during off-idle operation?

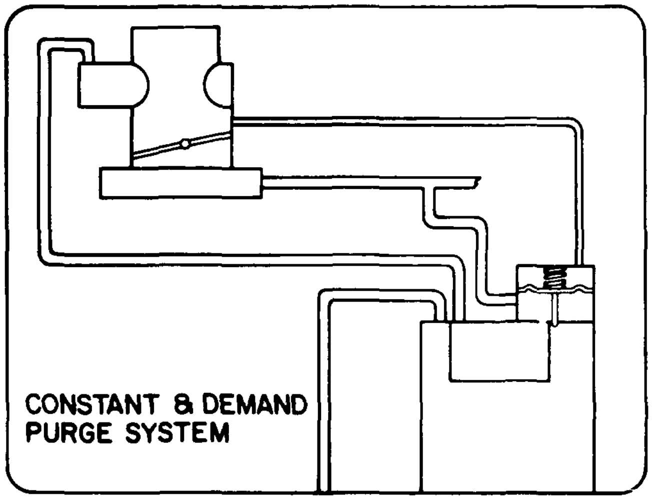


Figure 7-10

Label each part of the system.

3. Constant and demand purge -

   a) What system does the constant purge tie into?

   b) What limits the amount of fuel and air purged from the canister?

D. Explain the operation of carburetor fuel bowl vents.

Notes:

1. Engine shut off or idling.

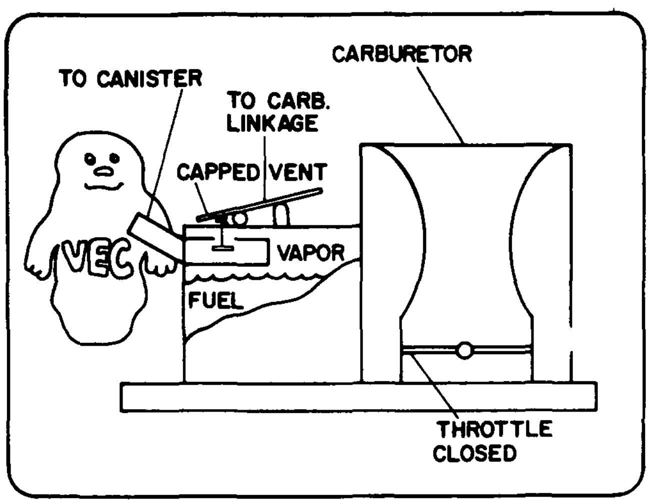


Figure 7-11

Show the fuel vapor path.

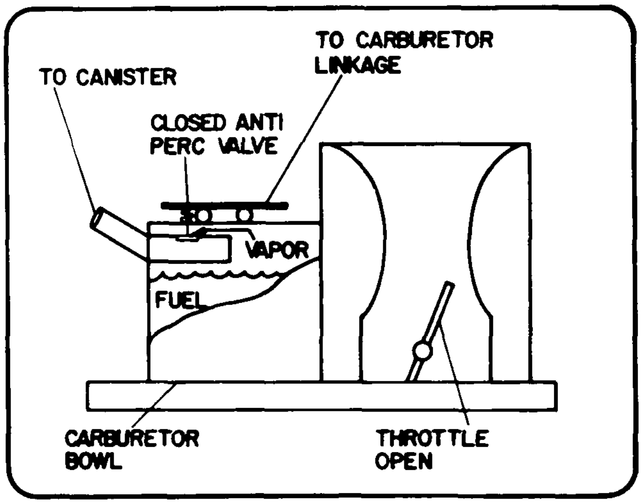


Figure 7-12

2. Engine running throttle open -

E. Explain the effect the fuel evaporation control system has on HC-CO emissions and driveability.

1. Explain how poor hose connections increase HC emissions to atmosphere.

2. Explain how torn or deteriorated fuel tank filter cap seals increase HC emissions to atmosphere.

3. Explain why it is necessary to follow the Vehicle Emissions Control Label during carburetor adjustment.

Notes:

F. Fuel Evaporation Control System Maintenance Checks

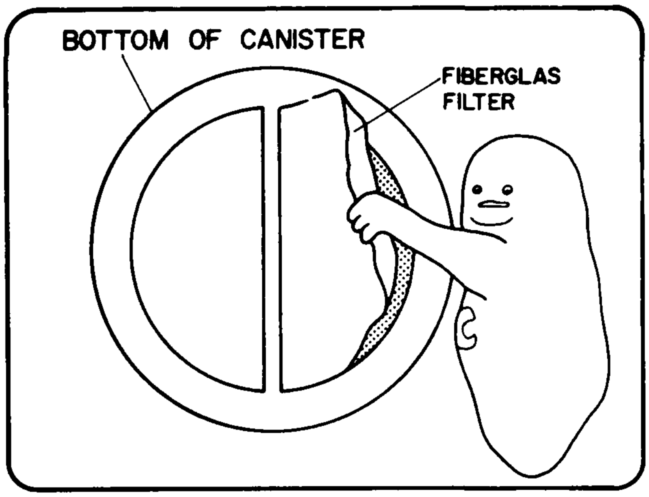


Figure 7-13

1. List the visual checks that should be performed on the fuel evaporation control systems.

a)

b)

c)

Notes:

Fill out the following worksheet as you perform the tests.

Engine Speed	Test Conditions	Pass	Fail
	VISUAL INSPECTION		
0	Fuel tank filler cap		
0	Fuel tank and hose connection condition		
0	Liquid vapor separator and/or check valve condition		
0	Type of purge system		
0	Canister line condition		
0	Filter condition		

STUDENT'S WORKBOOK

Exhaust Gas Recirculation

Unit 8

Introductory Notes:

A. Explain the purpose of the EGR valve.

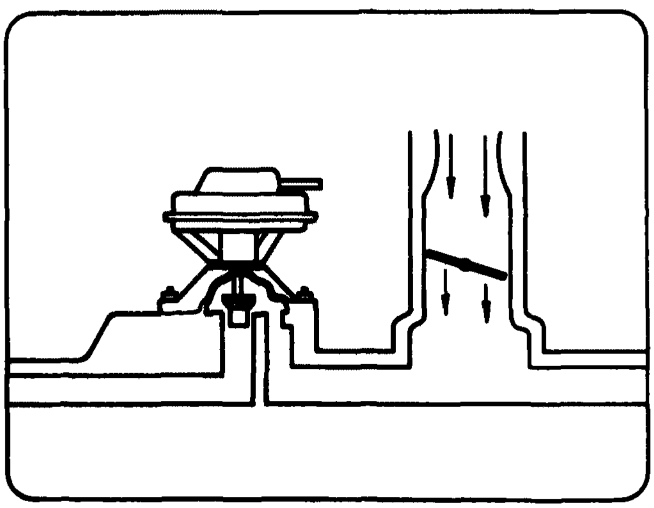


Figure 8-1

Label each part of the system.

1. What does the EGR valve control?

2. What happens as the EGR valve opens?

3. What opens the EGR valve?

B. Identify and explain the components that can be used to control the EGR valve.

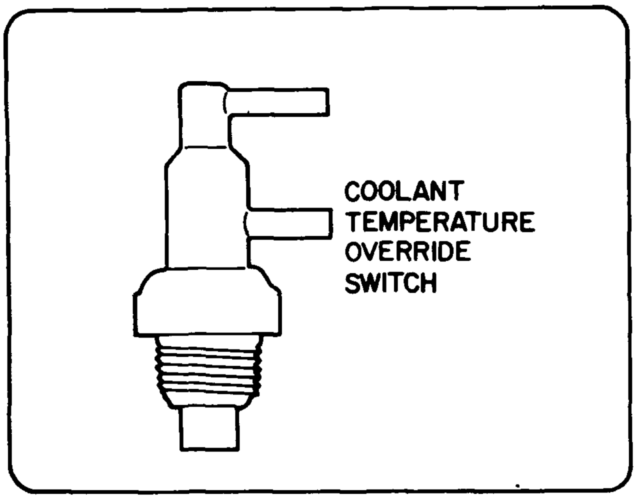


Figure 8-2

1. Explain the purpose of the Coolant Temperature Override switch (CTO).

   a) Where is the CTO switch normally located?

   b) What temperature is sensed by the CTO switch?

   c) Can vacuum pass through the switch at low coolant temperatures?

Notes:

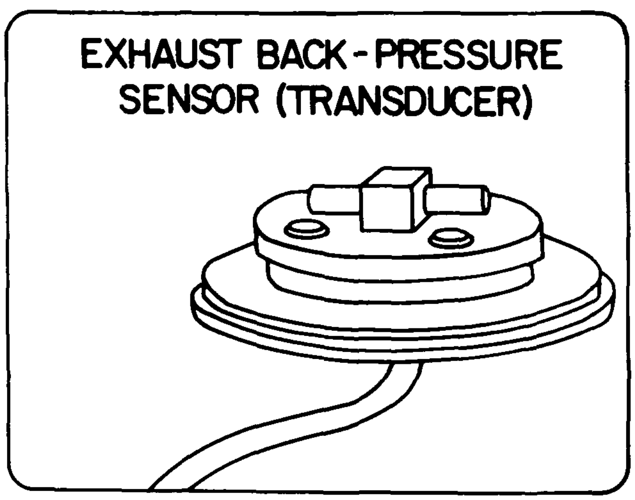


Figure 8-3

2. Explain the purpose of the exhaust back pressure sensor.

   a) What pressure is sensed by the back pressure sensor?

   b) Where is the back pressure sensor normally located in the EGR system?

   c) Does the back pressure sensor allow vacuum to reach the EGR valve under low exhaust back pressure conditions or high exhaust back pressure conditions?

3. Explain the purpose of the vacuum amplifier.

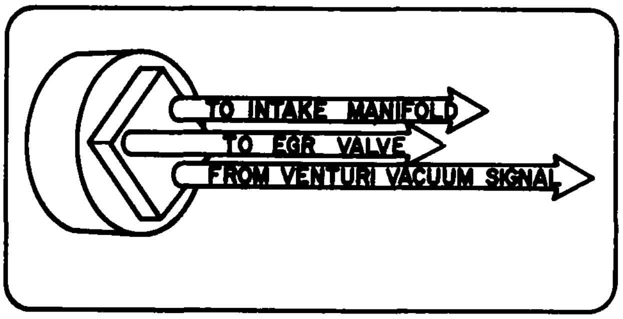


Figure 8-4

a) List the two vacuums that enter the amplifier.

1)

2)

b) What source of vacuum operates the EGR valve?

c) Where does the venturi vacuum signal come from?

C. Explain the operation of the ported vacuum EGR system with a CTO switch.

1. List the events that occur as the throttle is opened and coolant temperature is low.

a)

b)

c)

d)

e) Describe the effect this has on cold engine driveability.

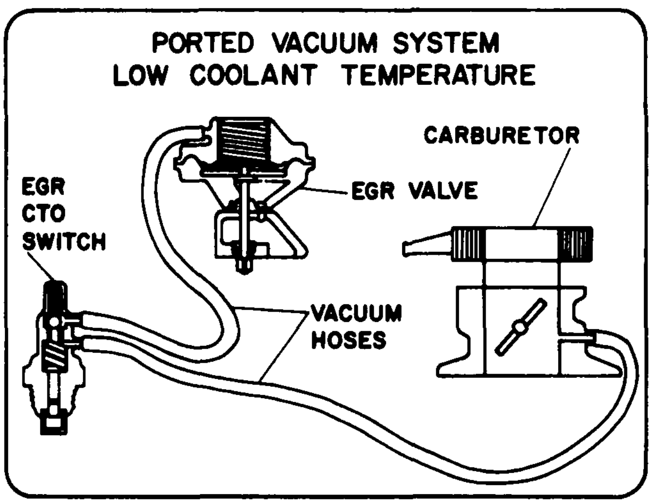


Figure 8-5

Show the vacuum path during this condition.

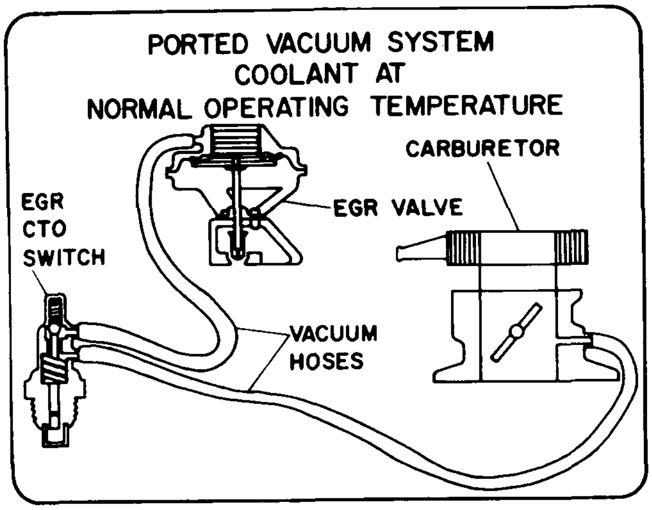


Figure 8-6

Show the vacuum path during this condition.

Notes:

2. List the events that occur as the throttle is opened and coolant temperature is normal.

   a)

   b)

   c)

D. Explain the operation of the venturi vacuum EGR system with a CTO switch.

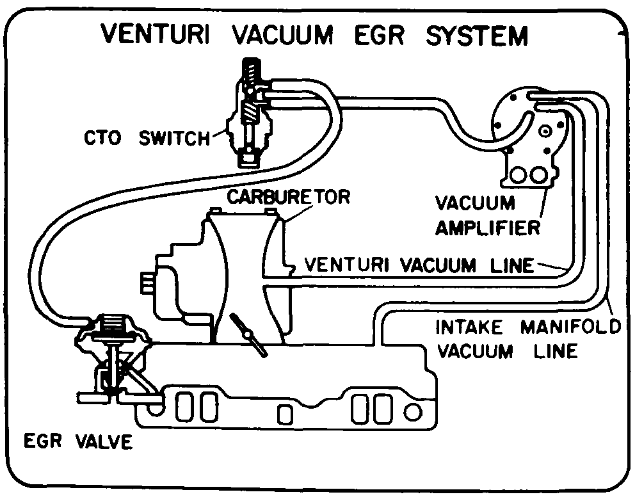


Figure 8-7

Show the path of the vacuum during this condition.

1. List the events that occur as the throttle is opened and coolant temperature is low.

   a)

   b)

   c)

   d)

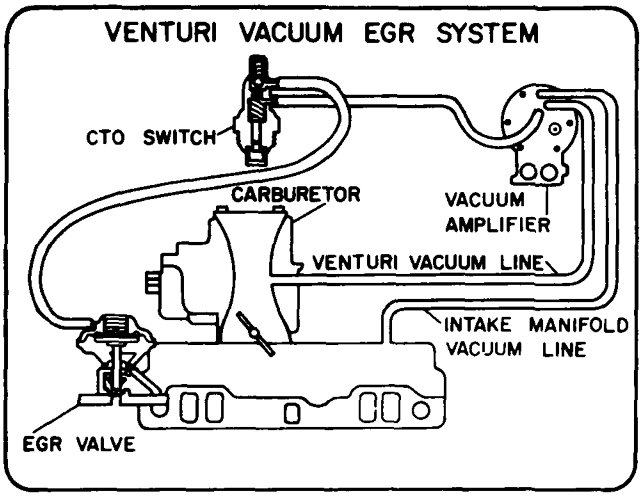


Figure 8-8

Show the path of vacuum during this condition.

2. List the events that occur as the throttle is opened and coolant temperature is normal.

   a)

   b)

   c)

   d)

E. Explain the operation of the ported vacuum EGR system with the back pressure sensor.

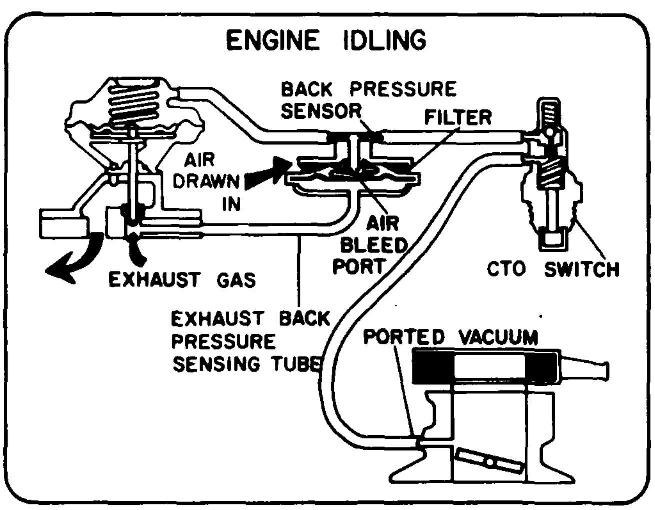


Figure 8-9

Show the path of vacuum during this condition.

1. List the events that occur with the engine at idle or very low speeds.

   a)

   b)

   c)

   d)

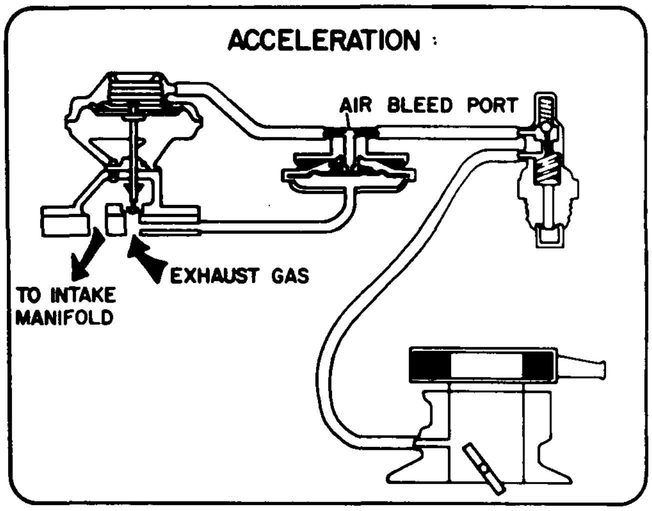


Figure 8-10

Show the path of vacuum during this condition.

2. List the events that occur during acceleration.

   a)

   b)

   c)

   d)

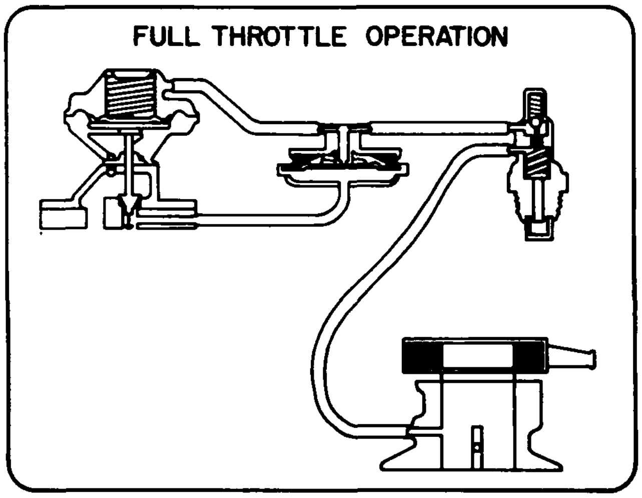


Figure 8-11

3. List the events that occur during wide open throttle acceleration.

   a)

   b)

   c)

   d)

Notes:

F. Explain the effect of the EGR system on HC-CO and NO_x emissions and driveability.

Notes:

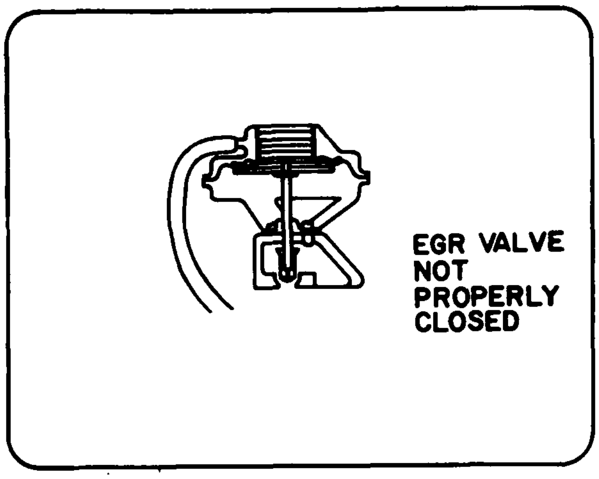


Figure 8-12

1. List the effects of an EGR valve that does not close properly.

   a)

   b)

   c)

   d)

2. List the conditions that can cause the EGR valve to open too soon or not completely close.

   a)

   b)

   c)

   d)

   e)

3. Explain what happens if the EGR valve base gasket leaks.

4. Explain what can happen with a CTO switch failure.

   a)

   b)

Notes:

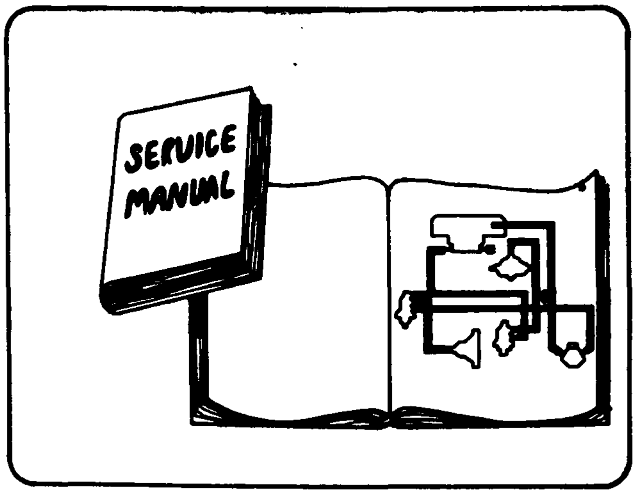


Figure 8-13

Describe the importance of Figure 8-13.

G. EGR System Operational Checks.

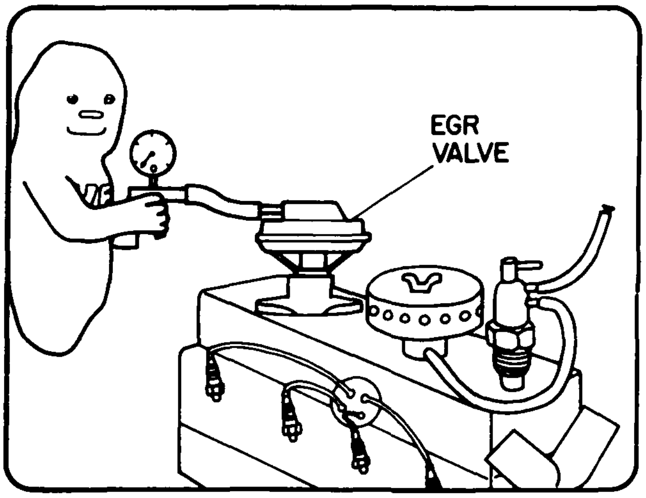


Figure 8-14

1. Figure 8-14 shows an EGR valve being tested. List the basic steps necessary to perform this test.

   a)

   b)

   c)

   d)

Notes:

2. Figures 8-15 and 8-16 show a ported vacuum and venturi vacuum EGR system. List the basic steps necessary to operationally test these systems with coolant temperature below 80°F.

a)

b)

c)

c)

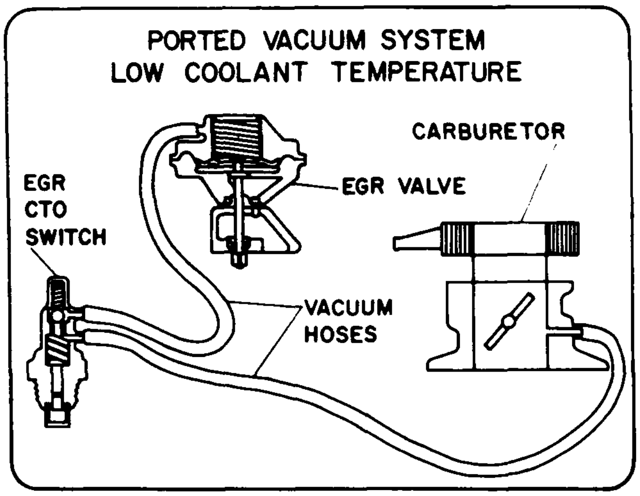


Figure 8-15

Show the path of vacuum during these conditions.

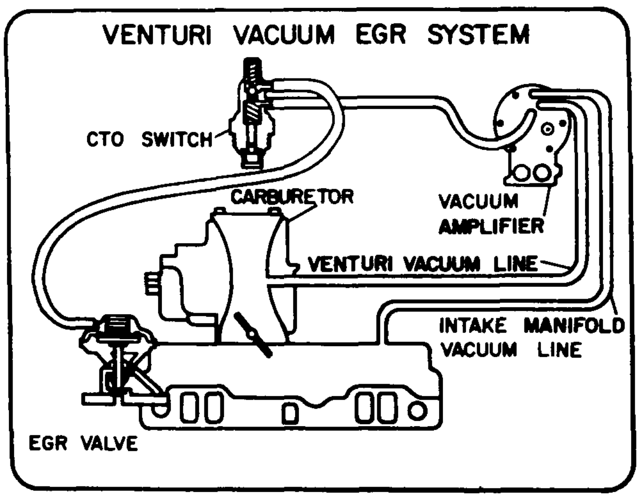


Figure 8-16

Notes:

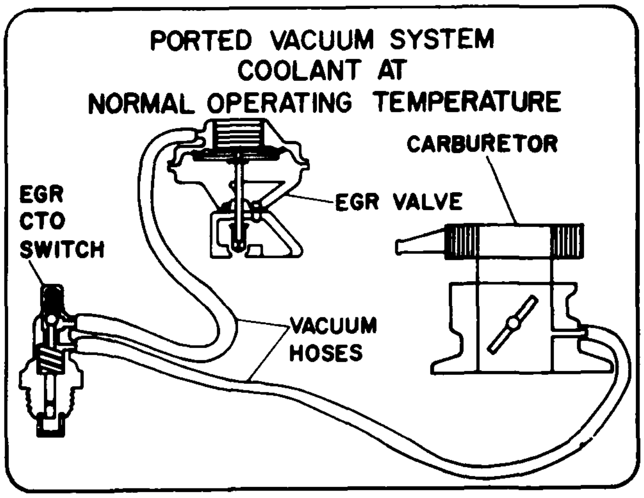


Figure 8-17

Show the path of vacuum during these conditions.

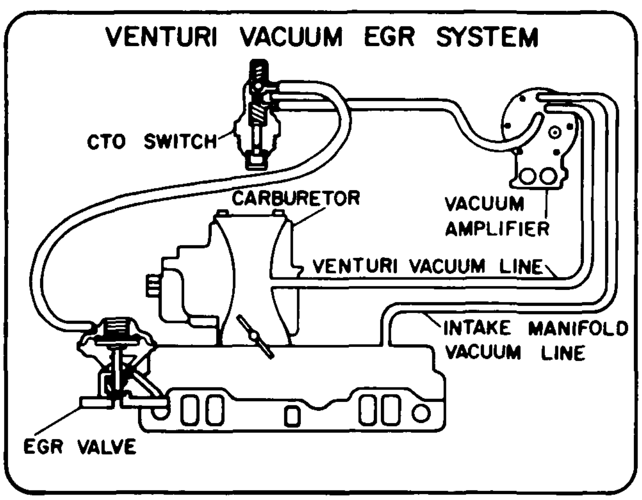


Figure 8-18

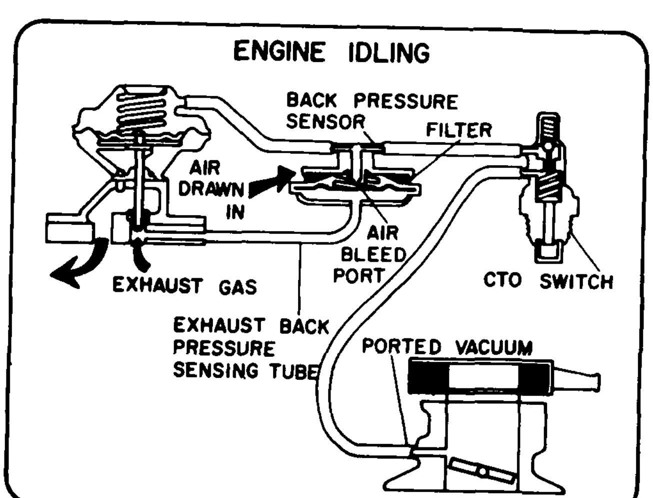


Figure 8-19

3. List the basic steps necessary to perform an operational test on the systems shown in Figures 8-17 and 8-18 when the engine is at operating temperature.

4. Figure 8-19 shows a ported vacuum EGR system with an exhaust back pressure sensor. List the basic steps necessary to operationally test this system with coolant temperature below 80°F and at normal operating temperature.

a)

b)

c)

d)

e)

f)

Notes:

Fill out the following worksheet as you perform the tests.

Engine Speed	Test Conditions	Pass	Fail	Vacuum Reading
Idle	EGR VALVE OPERATIONAL CHECK			
2000 rpm	Ported Vacuum or Venturi Vacuum EGR Systems Engine Cold Check EGR valve stem movement or vacuum to EGR valve			
2000 rpm	Engine Warm Check EGR valve stem movement or vacuum to EGR valve			
2000 rpm	Ported Vacuum EGR System with Back Pressure Sensor Engine Cold Check for valve stem movement or vacuum to EGR valve			
2000 rpm	Engine Warm Check EGR valve stem movement or or vacuum to EGR valve			

STUDENT'S WORKBOOK

Spark Control Systems

Unit 9

Introductory Notes:

A. Explain the purpose for retarded timing at idle.

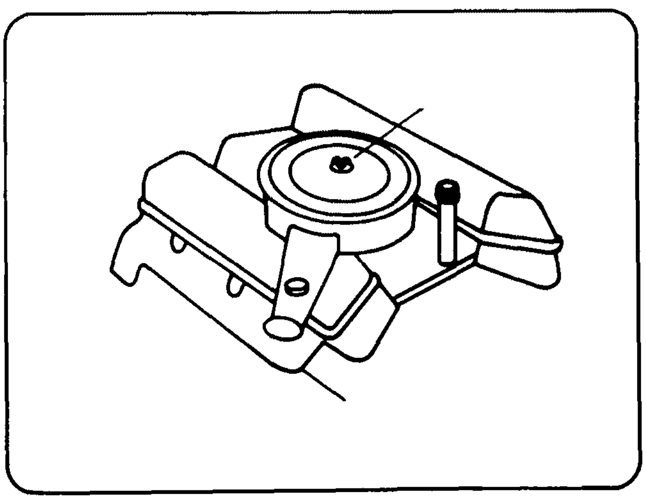


Figure 9-1

a)

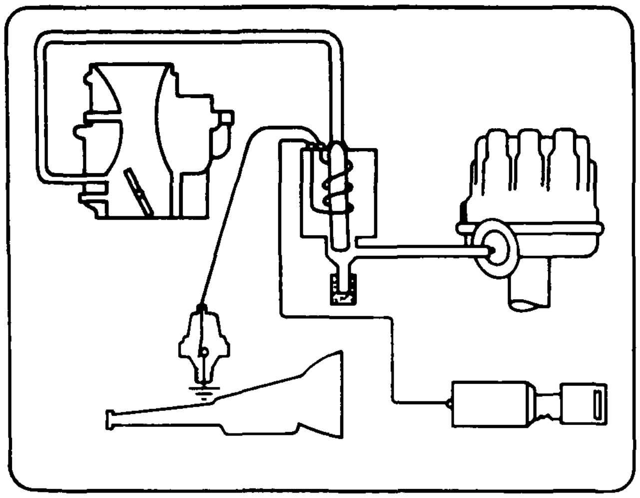
b)

c)

d)

e)

B. Identify the parts of a typical transmission controlled spark system.



1.

2.

3.

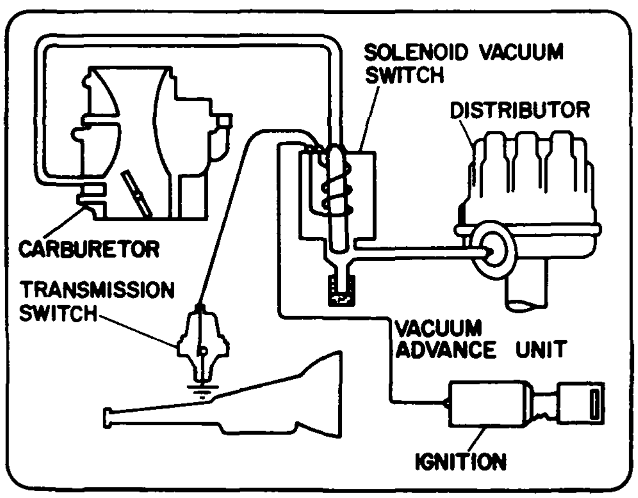
4.

Figure 9-2

Label each main part listed.

C. Explain the operation of the transmission controlled spark system.

1. Transmission in lower gears



a)

b)

c)

Figure 9-3

Show the vacuum path during this condition.

d)

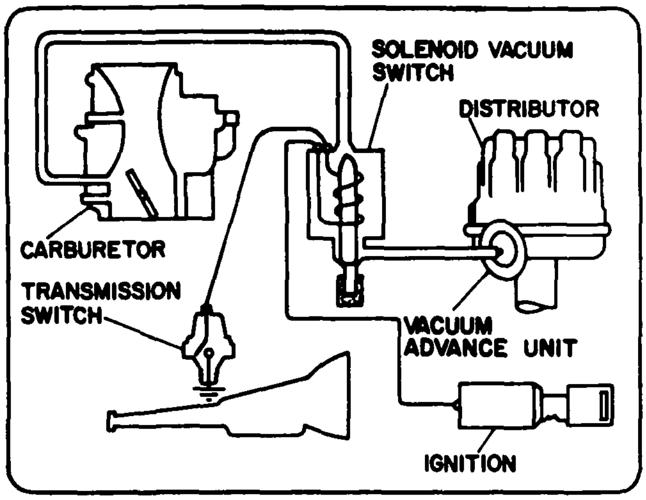


Figure 9-4

Show the vacuum path during this condition.

Notes:

2. Transmission in high gear.

a)

b)

c)

d)

D. Explain the operation of a transmission controlled spark system with a coolant temperature override (CTO) switch.

Notes:

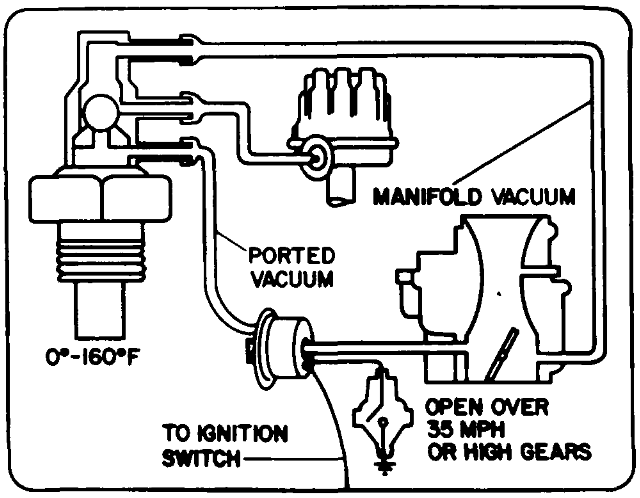


Figure 9-5

Show the vacuum path during this condition.

1. Coolant temperature below approximately 160°F.

   a)

   b)

   c)

   d)

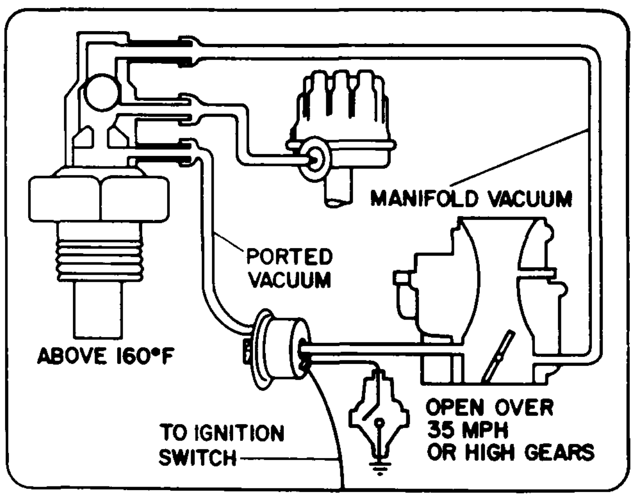


Figure 9-6

Show the vacuum path during this condition.

2. Coolant temperature above approximately 160°F.

   a)

   b)

   c)

E. Explain the operation of a transmission controlled spark system with HOT and COLD coolant temperature override (CTO) switch.

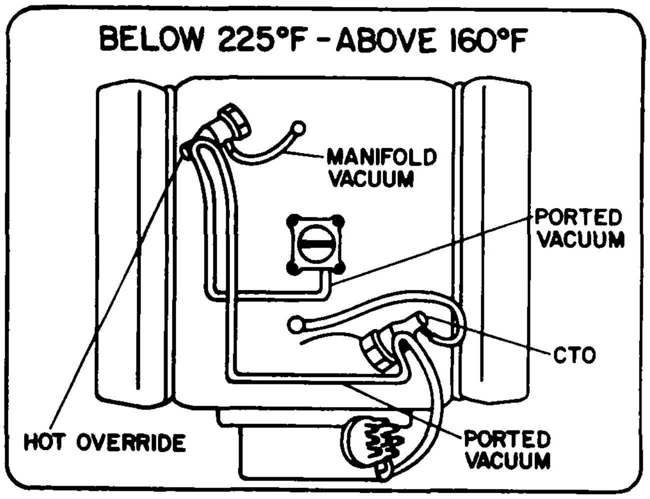


Figure 9-7

Show the vacuum path during this condition.

1. Coolant temperature above approximately 160°F.

   a)

   b)

   c)

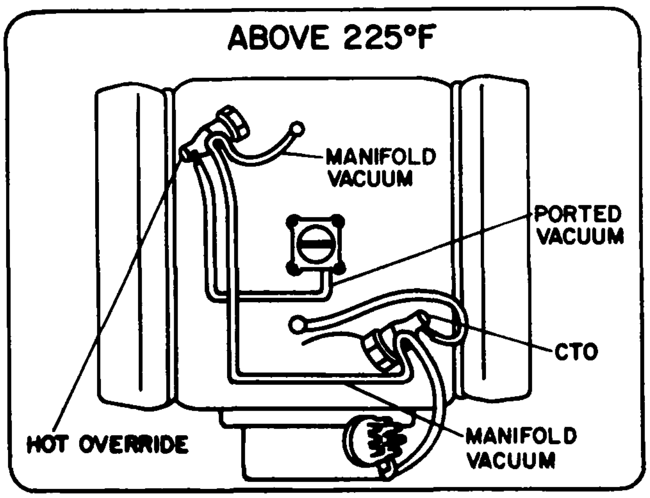


Figure 9-8

Show the vacuum path during this condition.

2. Coolant temperature above approximately 225°F.

   a)

   b)

   c)

   d)

   e)

F. Explain the operation of the spark delay valve.

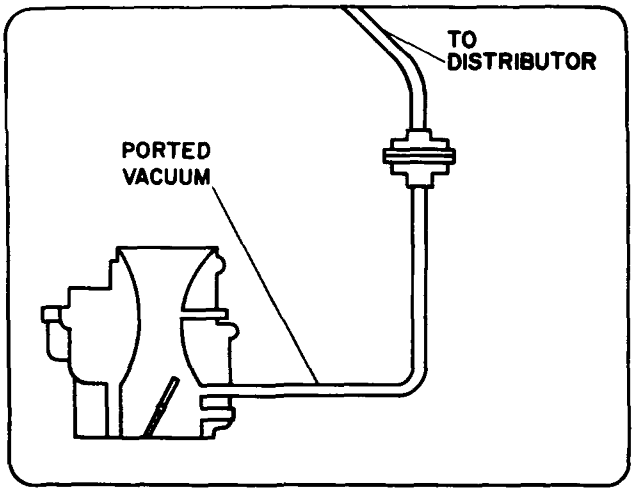


Figure 9-9

1.

2.

3.

4.

G. Explain the operation of the OSAC valve.

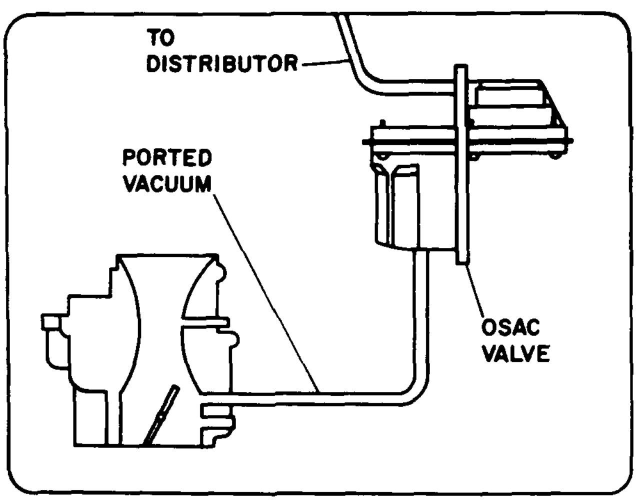


Figure 9-10

1. What do the letters OSAC stand for?

a)

b)

c)

d)

e)

H. Explain how spark control systems can affect HC, CO, NO_x and driveability.

1. Over advancing spark timing.

   a)

   b)

   c)

2. Failure of transmission controlled spark system.

   a)

   b)

3. Failure of CTO switch (hot or cold).

   a)

   b)

4. Improper spark delay valve or OSAC valve operation.

   a)

   b)

I. Spark Control Systems Operational Checks.

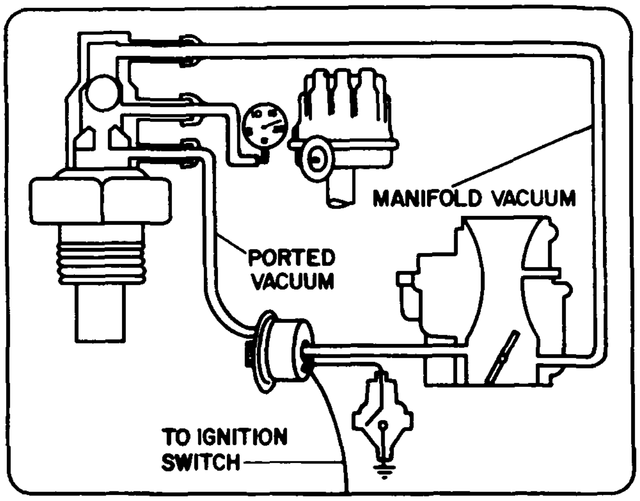


Figure 9-11

1. Figure 9-11 shows an operational test on a vehicle with automatic transmission. List the basic steps necessary to perform this test.

a)

b)

c)

d)

e)

f)

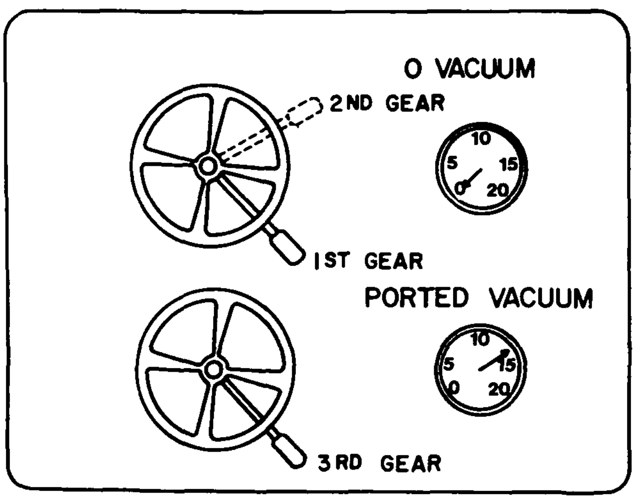


Figure 9-12

2. Figure 9-12 shows an operational test on a vehicle with a standard transmission. List the basic steps necessary to perform this test.

a)

b)

c)

d)

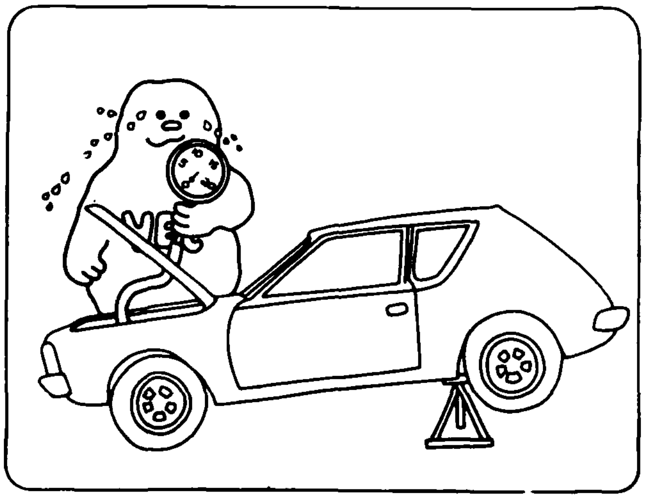


Figure 9-13

3. Figure 9-13 shows an operational test on a vehicle with a speed controlled spark system. List the basic steps necessary to perform this test.

a)

b)

c)

d)

e)

f)

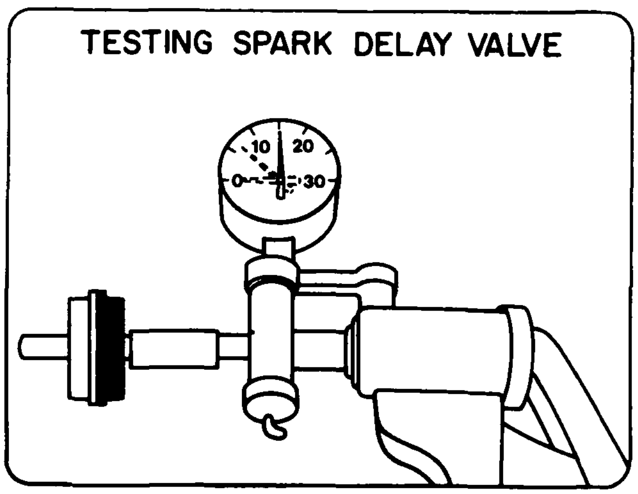


Figure 9-14

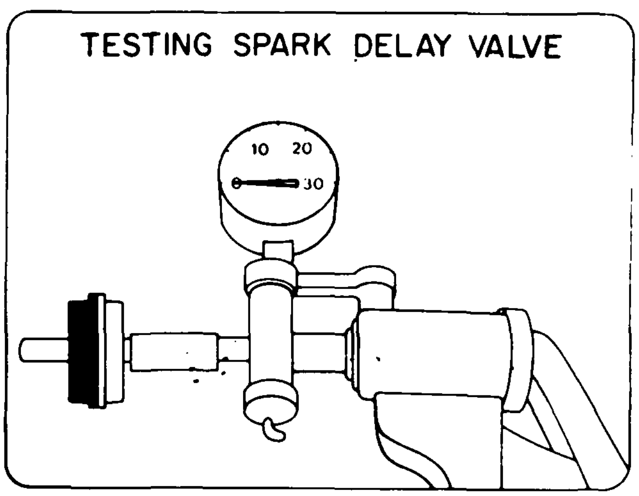


Figure 9-15

4. Figures 9-14 and 9-15 show a spark delay valve being tested. List the basic steps necessary to perform this test.

a)

b)

c)

d)

e)

a)

b)

c)

Notes:

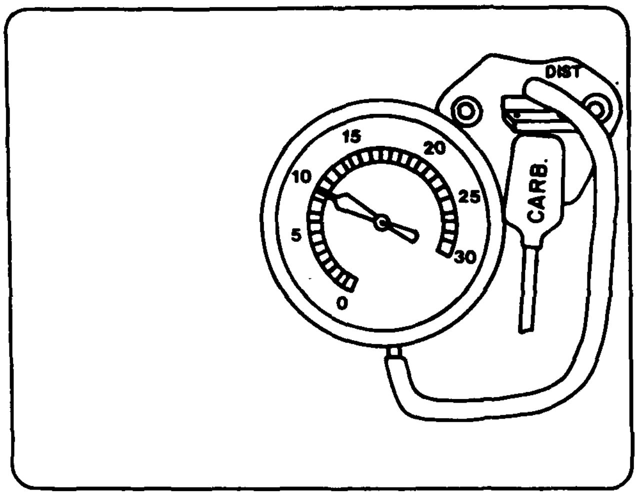


Figure 9-16

5. Figure 9-16 shows an OSAC valve being tested. List the basic steps necessary to perform this test.

a)

b)

c)

d)

e)

Fill out the following worksheet as you perform the checks.

SPARK CONTROL SYSTEM WORKSHEET

Engine Speed	Test Conditions	Pass	Fail	Vacuum Readings
TRANSMISSION CONTROLLED SPARK (AUTOMATIC)				
Approximately 1500 rpm	Engine at operating temperature Transmission selector in reverse			
TRANSMISSION CONTROLLED SPARK (STANDARD)				
Approximately 1500 rpm	Engine at operating temperature 1st gear (clutch depressed)			
	2nd gear (clutch depressed)			
	3rd or high gear (clutch depressed)			
SPEED CONTROLLED SPARK SYSTEM				
Slowly increase to 40 mph	Engine at operating temperature Rear wheels raised/jack stands Increase speed to approximately 40 mph			
SPARK DELAY VALVE				
Approximately 1500-2000 rpm or use hand pump				
OSAC VALVE				
1500-2000 rpm	Engine at operating temperature.			
throttle closed				

STUDENT'S WORKBOOK

Catalytic Converter Systems

Unit 10

Introductory Notes:

A. Explain the purpose of the catalytic converter.

1. List the functions of the catalytic converter.

a)

b)

c)

d)

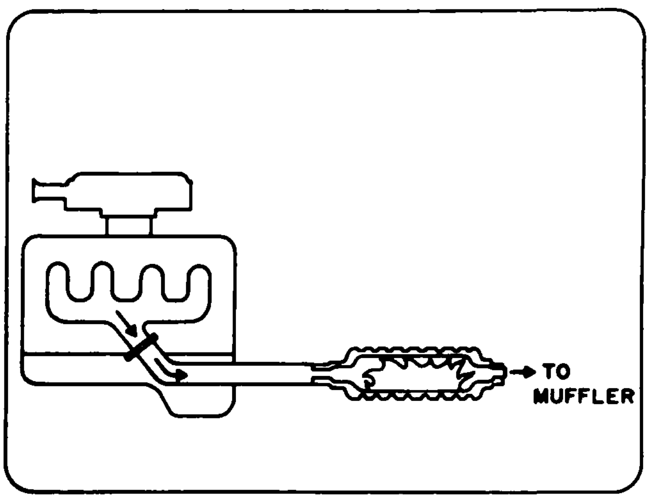


Figure 10-1

B. Explain the construction of monolith and pellet type converters.

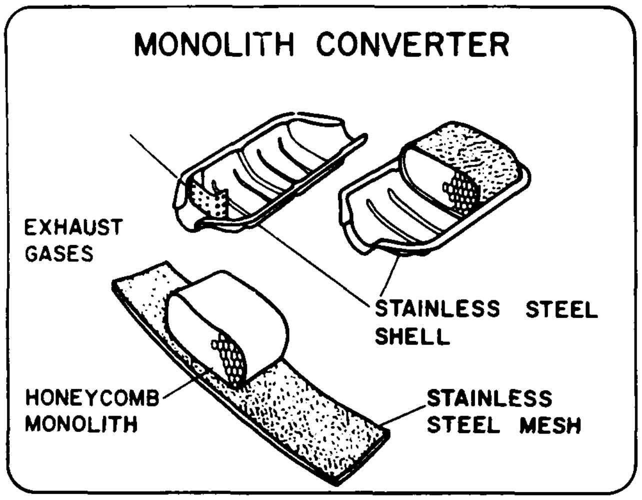


Figure 10-2

Label the components and show the flow path.

1. Monolith converters

a)

b)

c)

d)

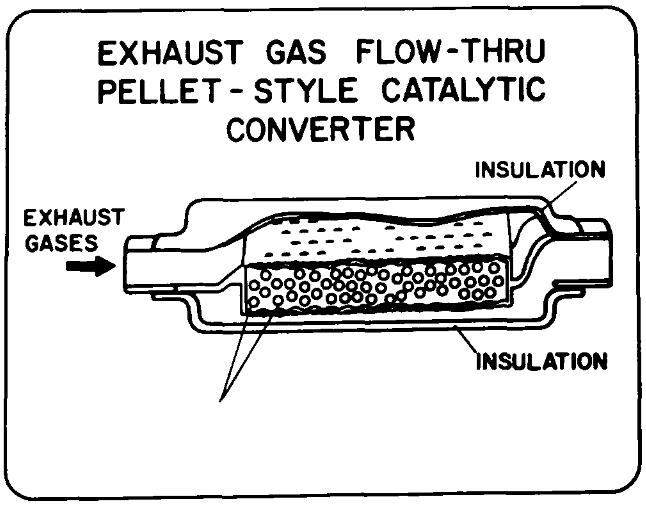


Figure 10-3

Label the components and show the flow path.

2. Pellet type converters

a)

b)

c)

d)

Notes:

C. Explain how engine operation affects catalytic converter operation.

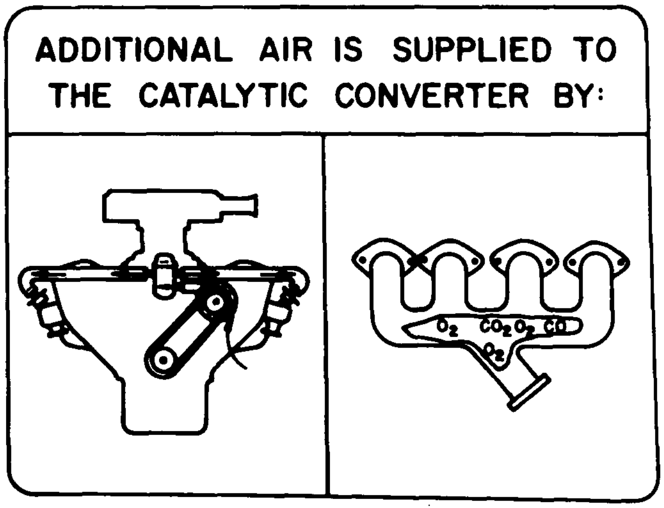


Figure 10-4

1.

a)

b)

Notes:

D. Explain the purpose of catalytic converter protection systems.

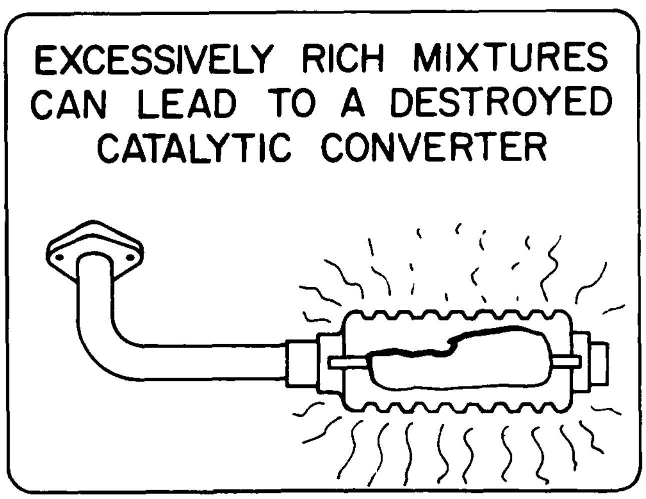


Figure 10-5

1.

2.

3.

a)

b)

c)

4.

E. Explain the operation of a catalytic converter protection system.

Notes:

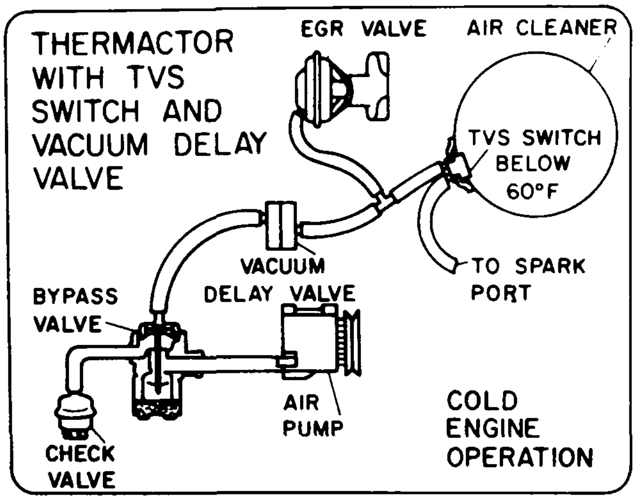


Figure 10-6

Show the vacuum path and AIR pump flow path.

1. Protection system operation when the engine is cold.

   a)

   b)

   c)

   d)

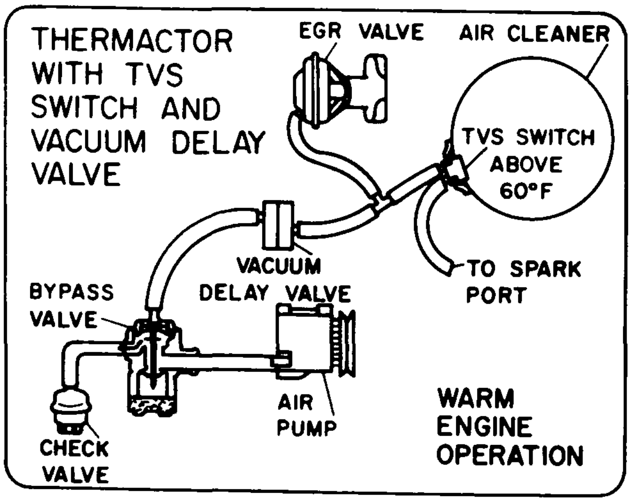


Figure 10-7

Show the vacuum path and AIR pump flow path.

2. Protection system operation at normal operating temperature.

   a)

   b)

   c)

   d)

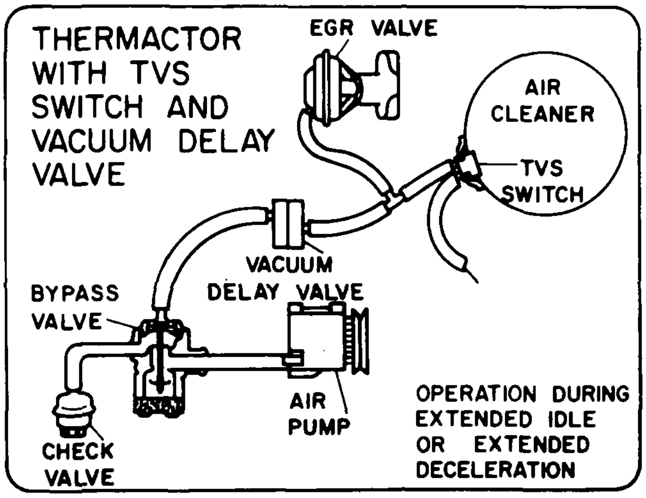


Figure 10-8

Show the vacuum path and AIR pump flow path

Notes:

3. Protection system operation during extended idle or extended deceleration.

a)

b)

c)

d)

F. Explain the purpose of exhaust system heat shields.

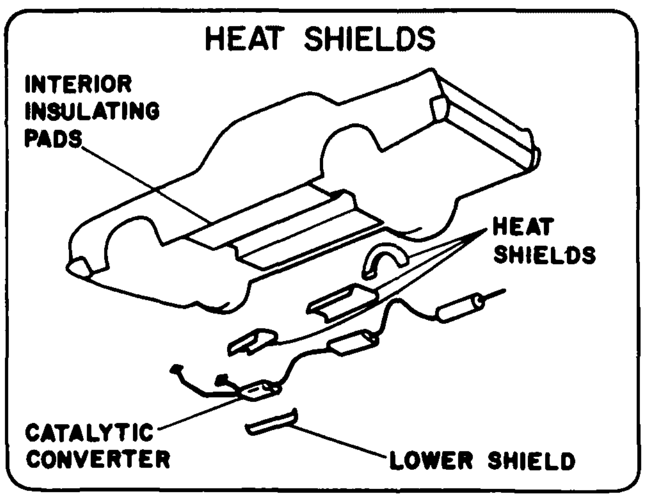


Figure 10-9

1.

2.

G. Explain why unleaded fuel must be used in catalytic converter equipped cars.

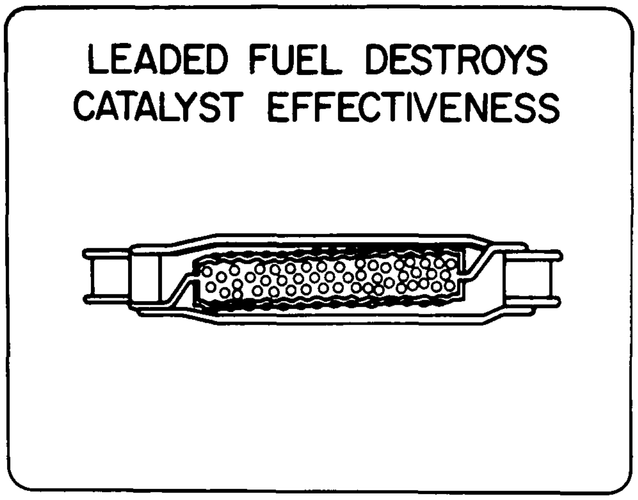


Figure 10-10

1.

a)

b)

H. Explain how catalytic converters can affect HC, CO and NO_x emissions and driveability.

1.

2.

3.

4.

I. List the basic steps for operationally checking a catalytic converter.

Notes:

1. Visual Inspection

   a)

   b)

   c)

2. Operational Checks

   a)

   b)

   c)

   d)

Notes:

Fill out the following worksheet as you perform the tests.

Engine Speed	Test Conditions	Pass	Fail	HC (PPM)	CO (%)
	VISUAL INSPECTION				
0	a) Catalytic Converter(s) b) AIR Pump c) Protection Systems d) Hose Condition e) Hose Connections f) Hose Routing				
	OPERATIONAL CHECKS				
Idle	Tailpipe Analyzer Reading				
2000 rpm	Tailpipe Analyzer Reading				

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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4. TITLE AND SUBTITLE Student's Workbook for Vehicle Emissions Control Training		5. REPORT DATE November 1977
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) B.D. Hayes, R.A. Ragazzi, M.T. Maness		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Industrial Seiences, Colorado State University, Fort Collins, Colorado 80523		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. T900621-01-0
12. SPONSORING AGENCY NAME AND ADDRESS Control Programs Development Bivision, Office of Air Quality Planning and Standards, Office of Air and Waste Management, U.S. Environmental Protection Agency, Research Triangle Park, N.C. 27711		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14. SPONSORING AGENCY CODE EPA 200/04
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

It is the intent of this book to explain each basic emissions control system and some of the more common devices found on today's car. Since it is a student's workbook it is designed to allow the student to proceed through the key points of each emissions control system.

Each basic emissions control system presented has the following information provided:

Part Identification
System Operation
System Control
System Effects on HC-CO and Driveability
Worksheets

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Hydrocarbons Carbon Monoxide Oxides of Nitrogen Infrared Exhaust Gas Analyzer Ignition Carburetion	Positive Crankcase Ventilation Thermostatic Air Cleaners Air Injection Systems Fuel Evaporation Control		

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