

**15.40 Unscrew the union nuts and disconnect the fuel feed and return hoses from the manifold**

**41** Disconnect the injector wiring harness connector and the vacuum hose from the fuel pressure regulator (see illustration).

**42** Slacken and remove the retaining bolts then lift the manifold lower section away from the cylinder head. Remove the seals from the manifold flange recesses and discard them; new ones must be used on refitting (see illustrations).

**43** If necessary, undo the retaining bolts and remove the intake manifold flange from the top of the cylinder head (see illustration). Recover the flange seals and discard them; new ones must be used on refitting.

**Refitting**

**44** Refitting is the reverse of removal noting the following.

- a) Ensure all the mating surfaces are clean and dry and the new seals/sealing rings are correctly seated in their recesses (see illustration). Tighten all the manifold retaining bolts evenly and progressively to their specified torque settings.
- b) Ensure that all relevant hoses are reconnected to their original positions, and are securely held (where necessary) by their retaining clips.
- c) Tighten the fuel hose and vacuum servo hose union nuts to their specified torque settings.
- d) Ensure the EGR valve and pipe mating surfaces are clean and dry and apply a smear of high-temperature grease to the threads of the union nut (Vauxhall recommend the use of assembly paste 19 48 569 - available from your Vauxhall dealer).



**15.41 The injector wiring harness connector (arrowed) is clipped onto the engine rear lifting bracket (shown with engine removed)**

*Reconnect the pipe to the valve and tighten its union nut to the specified torque.*

e) On completion, adjust the accelerator cable as described in Section 3.

**16 Exhaust manifold - removal and refitting**



**Note:** New manifold nuts will be required on refitting.

**2.0 litre SOHC engine**

**Removal**

- 1** Firmly apply the handbrake then jack up the front of the vehicle and support it on axle stands. If necessary, to improve access undo the retaining bolts and remove the undercover from beneath the engine.
- 2** Slacken and remove the bolt(s) securing the exhaust system front pipe to its mounting bracket then unscrew the bolts securing the front pipe to the manifold. Free the pipe from the manifold taking care not to place any strain on the oxygen sensor wiring. Discard the front pipe gasket; a new one should be used on refitting.
- 3** Undo the retaining bolts and remove the heatshield from the exhaust manifold.
- 4** Remove the engine oil dipstick and pull the plug caps off from the centre (No 2 and 3) spark plugs. Unscrew the centre spark plug heatshields and remove them from the



**15.42a Remove the manifold lower section . . .**

manifold (a special socket, number KM-834, is available to ease removal of the heatshields).

**5** Undo the retaining nuts securing the manifold to the head. Manoeuvre the manifold out of the engine compartment, complete with the gasket. Discard both the gasket and retaining nuts; new ones should be used on refitting.

**Refitting**

- 6** Examine all the exhaust manifold studs for signs of damage and corrosion; remove all traces of corrosion, and repair or renew any damaged studs.
- 7** Ensure that the manifold and cylinder head sealing faces are clean and flat, and fit the new gasket.
- 8** Refit the manifold then fit the new retaining nuts and tighten them to the specified torque.
- 9** Apply a smear of high-temperature grease (Vauxhall recommend the use of assembly paste 19 48 569 - available from your Vauxhall dealer) to the threads of the spark plug heatshields then refit the shields and tighten them to the specified torque. Reconnect the plug caps and refit the dipstick.
- 10** Apply the high-temperature grease to the heatshield bolts then refit the heatshield to the manifold and securely tighten the bolts.
- 11** Fit a new gasket to the exhaust front pipe joint and lubricate the front pipe to manifold bolts with the high-temperature grease. Refit the bolts to the manifold, tightening them to the specified torque, then securely tighten the bolt(s) securing the front pipe to its mounting bracket.



**15.42b . . . and recover the seals (arrowed) from the flange**



**15.43 Removing the manifold flange**



**15.44 On refitting be sure to renew all manifold seals and sealing rings**



16.20 Disconnect the wiring connectors from the coolant sensor and sender . . .

### 2.0 litre DOHC engine

#### Removal

12 Remove the secondary air injection system air valve and connecting pipe as described in Chapter 4B.

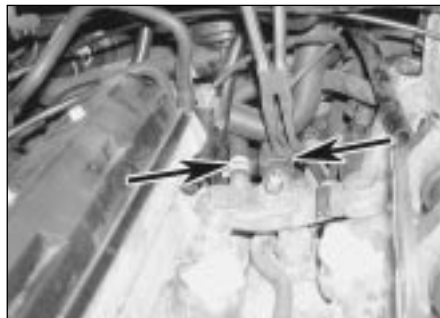
13 Carry out the operations described in paragraphs 1 and 2.

14 Undo the retaining nuts then remove the exhaust manifold and gasket from the cylinder head. Discard both the gasket and retaining nuts; new ones should be used on refitting.

#### Refitting

15 Refit the manifold as described in paragraphs 6 to 8.

16 Fit a new gasket to the exhaust front pipe joint and lubricate the front pipe to manifold bolts with high-temperature grease (Vauxhall recommend the use of assembly paste 19 48 569 - available from your Vauxhall dealer).



16.21 . . . then release the retaining clips and disconnect the coolant hoses

Refit the bolts to the manifold, tightening them to the specified torque, then securely tighten the bolt(s) securing the front pipe to its mounting bracket.

17 Refit the secondary air injection system connecting pipe and air valve as described in Chapter 4B.

### 2.5 and 3.0 litre engine

#### Right-hand cylinder bank

18 Remove the inlet manifold and flange as described in Section 15.

19 Drain the cooling system as described in Chapter 1.

20 Disconnect the wiring connectors from the coolant temperature gauge sender and the engine management system coolant temperature sensor which are screwed into the coolant outlet which links the rear of the cylinder heads (see illustration).



16.22 Unscrew the retaining bolts and remove the coolant outlet from the engine (sealing rings arrowed)

21 Slacken the retaining clips and disconnect the coolant hoses from the cylinder head outlet (see illustration).

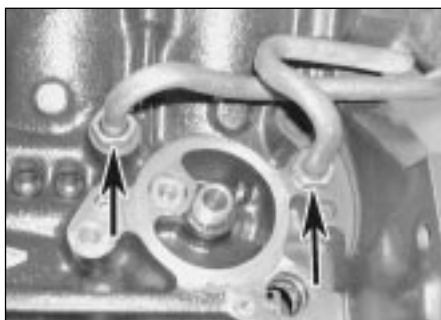
22 Unscrew the retaining bolts and remove the coolant outlet from the cylinder heads (see illustration). Recover the sealing rings and discard them; new ones must be used on refitting.

23 Position a container beneath the oil filter. Unscrew the filter using an oil filter removal tool if necessary, and drain the oil into the container. If the oil filter is damaged or distorted during removal, it must be renewed. Given the low cost of a new oil filter relative to the cost of repairing the damage which could result if a re-used filter springs a leak, it is probably a good idea to renew the filter in any case.

24 Unscrew the union nuts securing the oil cooler pipes to the cylinder block then unscrew the union bolts securing the pipes to the cooler. Recover the sealing washers from each side of the oil cooler unions and move the pipes to the rear (see illustrations).

25 Release the retaining clips and disconnect the radiator bottom hose, expansion tank hose and heater hose from the coolant pipe on the right-hand side of the engine. Slacken and remove the retaining bolts then remove the pipe from the engine (see illustration). Recover the sealing ring and discard it; a new one should be used on refitting. Note that it may be necessary to remove the camshaft cover from the right-hand cylinder head to gain the clearance required to remove the coolant pipe.

26 Undo the retaining bolts and remove the heatshields from the exhaust manifold (see illustrations).



16.24a Unscrew the union nuts securing the oil pipes to the block . . .



16.24b . . . then unscrew the union bolts and detach the pipes from the oil cooler (sealing washers arrowed)



16.25 Removing the engine coolant pipe



16.26a Undo the retaining bolts and remove the lower . . .



16.26b . . . and upper heatshields from the right-hand exhaust manifold

**27** Slacken and remove the bolt securing the exhaust system right-hand front pipe to its mounting bracket then unscrew the bolts securing the pipe to the manifold. Free the pipe from the manifold taking care not to place any strain on the oxygen sensor wiring, and recover the gasket. Discard the front pipe gasket; a new one should be used on refitting.

**28** Unscrew the union nuts and remove the pipe connecting the exhaust gas recirculation (EGR) valve to the manifold.

**29** Slacken the clip securing the connecting hose to the right-hand cylinder bank secondary air injection system pipe then unscrew the bolts securing the pipe to the manifold. Remove the pipe from the vehicle and discard its gaskets (see illustration).

**30** Undo the retaining nuts then remove the exhaust manifold and gasket from the cylinder head. Discard both the gasket and retaining nuts; new ones should be used on refitting.

**31** Refitting is the reverse of removal, noting the following points.

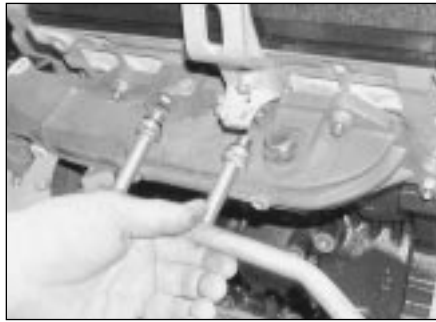
- a) Prior to refitting, check the manifold studs and renew any that are worn or damaged.
- b) Ensure all mating surfaces are clean and dry and use new gaskets, sealing rings and washers.
- c) Secure the manifold in position with new retaining nuts, tightening them evenly and progressively to the specified torque.
- d) Prior to refitting, lubricate the threads of the secondary air injection system pipe bolts, the EGR valve pipe nuts, the front pipe to manifold bolts and the heatshield bolts with a smear of high-temperature grease (Vauxhall recommend the use of assembly paste 19 48 569 - available from your Vauxhall dealer).
- e) Tighten all fixings to their specified torque setting (where given).
- f) Ensure that all relevant hoses are reconnected to their original positions, and are securely held (where necessary) by their retaining clips.
- g) Fit new sealing washers to each side of the oil cooler pipe unions and tighten the pipe union nuts and bolts to the specified torque.
- i) Fit a new oil filter and refill the cooling system as described in Chapter 1.
- j) On completion, check the engine oil level as described in Weekly checks.

#### Left-hand cylinder bank

**32** It is not possible to remove the exhaust manifold from the left-hand cylinder bank with the engine in the vehicle. This leaves two possible options, the first is to remove the engine unit from the vehicle and the second is to remove the cylinder head assembly. Decide on the course of action which is best suited then proceed as follows.

**33** Working as described in Chapter 2C, either remove the engine unit from the vehicle or alternatively remove the cylinder head assembly from the engine.

**34** If the engine has been removed, unscrew



**16.29** Undo the retaining bolts and remove the secondary air connecting pipe

the bolt and spacer securing the coolant pipe and engine lifting bracket to the cylinder head and remove the lifting bracket. Free the coolant pipe from the thermostat housing then manoeuvre it out of position then withdraw the dipstick and ease the dipstick tube out from the cylinder block. Discard the coolant pipe and dipstick tube sealing rings; new ones should be used on refitting.

**35** Undo the retaining bolts and remove the heatshields from the exhaust manifold.

**36** Unscrew the retaining bolts and remove the secondary air injection system pipe from the manifold. Recover the gaskets fitted between the pipe and manifold and discard them.

**37** Undo the retaining nuts then remove the exhaust manifold and gasket from the cylinder head. Discard both the gasket and retaining nuts; new ones should be used on refitting.

**38** Refitting is the reverse of removal, noting the following points.

- a) Prior to refitting, check the manifold studs and renew any that are worn or damaged.
- b) Ensure the manifold and cylinder head mating surfaces are clean and dry then fit the new gasket. Refit the manifold then fit the new retaining nuts, tightening them evenly and progressively to the specified torque.
- c) Lubricate the threads of the secondary air injection system pipe bolts with a smear of high-temperature grease (Vauxhall recommend the use of assembly paste 19 48 569 - available from your Vauxhall dealer). Fit



**17.4** The intake duct switchover valve solenoid valve (arrowed) is mounted on the rear of the pre-volume chamber (shown with chamber removed)

new gaskets to the pipe unions then refit the pipe to the cylinder head and tighten the retaining bolts to the specified torque (see Chapter 4B).

- d) Lubricate the manifold heatshield bolts with the high-temperature grease before installation.
- e) If the engine was removed, fit new sealing rings to the dipstick tube and thermostat housing coolant pipe. Ensure the coolant pipe, dipstick tube and lifting bracket are correctly positioned before refitting the retaining bolt and spacer and tightening to the specified torque.

## 17 Multi-ram air intake system - information and component removal and refitting



### Information

**1** All 2.5 and 3.0 litre engines are fitted with a multi-ram air intake system to help increase torque output at all engine speeds. The system consists of the pre-volume chamber, which splits the air cleaner intake duct into two separate ducts, and two valves, one linking the intake ducts in between the pre-volume chamber and throttle housing, and the second linking the left- and right-hand chambers of the inlet manifold upper section. Each valve is controlled the engine management ECU via a solenoid valve and vacuum diaphragm unit.

**2** There are four possible combinations of valve position, each of which is suited to a particular engine speed range, they are as follows.

- a) Idle speed - intake duct valve closed, manifold valve open
- b) Full load at low engine speeds - intake duct and manifold valves both closed.
- c) Full load at medium engine speeds - intake duct valve open, manifold valve closed.
- d) Full load at high engine speeds - intake valve and manifold valve both open.

**3** Testing of the system can only be carried out using the special electronic diagnostic test unit which is plugged into the system's diagnostic connector (see Section 6). The multi-ram intake system components can be removed and refitted as follows.

### Component removal and refitting

#### Intake duct switchover valve solenoid valve

**4** The intake duct switchover valve solenoid valve is mounted onto the rear of the pre-volume chamber (see illustration).

**5** Ensure the ignition is switched off then disconnect the wiring connector from the valve.

**6** Disconnect the vacuum pipes from the valve, noting their correct fitted locations,



17.11 Undo the retaining screws (arrowed) and remove the switchover valve assembly from its housing

then undo the retaining screws and remove the valve from the engine compartment.

7 Refitting is the reverse of removal ensuring the vacuum hoses are correctly reconnected.

#### Intake duct switchover valve housing

8 Slacken the retaining clip and disconnect the idle speed adjuster hose from the intake duct.

9 Slacken the retaining clips securing the intake ducts to the throttle housing and valve housing and remove both ducts from the engine compartment.

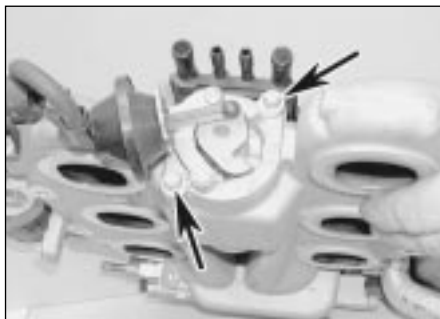
10 Disconnect the vacuum hose from the switchover valve diaphragm then slacken the lower retaining clips and remove the housing from the vehicle.

11 If necessary, slacken the retaining screws and remove the valve assembly from its housing, along with its sealing ring (see illustration).

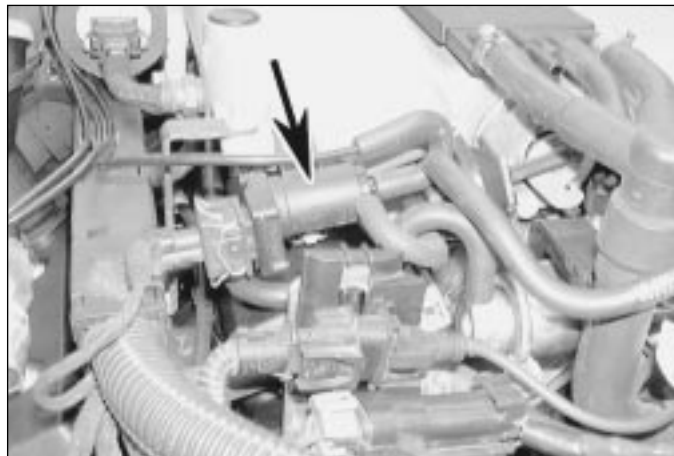
12 Refitting is the reverse of removal ensuring all the intake ducts are securely reconnected.

#### Manifold switchover valve solenoid valve

13 The manifold switchover valve solenoid valve is mounted onto the rear of the inlet manifold upper section on the left-hand side (see illustration).



17.19 Undo the retaining bolts (arrowed) and withdraw the switchover valve assembly from the manifold upper section



17.13 The manifold switchover valve solenoid valve (arrowed) is mounted onto the rear of the inlet manifold (shown with engine removed)

14 To gain access to the valve, remove the windscreen wiper arms and the water deflector panel from the base of the windscreen (see Chapter 12, Sections 15 and 16).

15 Ensure the ignition is switched off then disconnect the wiring connector from the valve.

16 Disconnect the vacuum pipes from the valve, noting their correct fitted locations, then undo the retaining screws and remove the valve from the manifold.

17 Refitting is the reverse of removal ensuring the vacuum hoses are correctly reconnected.

#### Manifold switchover valve assembly

18 Remove the upper section of the inlet manifold as described in Section 15.

19 Disconnect the vacuum hose from the diaphragm unit then undo the retaining bolts and remove the valve assembly from the manifold (see illustration). Recover the sealing ring and discard it; a new one should be used on refitting.

20 On refitting fit a new sealing ring to the valve assembly then refit the valve to the manifold. Securely tighten the valve retaining bolts then refit the manifold upper section (see Section 15).



17.25 Removing the pre-volume chamber assembly

#### Pre-volume chamber assembly

21 Remove the airflow meter as described in Section 14.

22 Slacken the retaining clip and disconnect the idle speed adjuster hose from the intake duct.

23 Slacken the retaining clips securing the intake ducts to the throttle housing and switchover valve and remove both ducts from the engine compartment.

24 Disconnect the wiring connector and vacuum hose from the intake duct switchover valve solenoid valve on the rear of the chamber.

25 Unscrew the mounting nuts then free the chamber assembly from its lower mounting rubber and manoeuvre it out of position (see illustration).

26 Refitting is the reverse of removal ensuring the chamber is correctly engaged with its lower mounting rubber.

#### 18 Exhaust system - general information, removal and refitting



#### General information

1 On 2.0 litre engine models, the exhaust system consists of three sections: the front pipe which incorporates the catalytic converter, the intermediate pipe and centre silencer, and the tailpipe and main silencer box.

2 On 2.5 and 3.0 litre engine models the exhaust system consists of five sections; there is a separate front pipe (incorporating a catalytic converter) and intermediate pipe (incorporating a centre silencer) for each bank of cylinders with both exhaust sections being joined to a single tailpipe and main silencer.

3 The front pipe joints are flange joints which are secured by bolts and the tailpipe is secured to the intermediate pipe by a clamping ring. The system is suspended throughout its entire length by rubber mountings.

## Removal

4 Each exhaust section can be removed individually, or alternatively, the complete system can be removed as a unit. Even if only one part of the system needs attention, it is often easier to remove the whole system and separate the sections on the bench.

5 To remove the system or part of the system, first jack up the front or rear of the car and support it securely on axle stands. Alternatively, position the car over an inspection pit or on car ramps.

### Front pipe

6 Trace the wiring back from the oxygen sensor, noting its correct routing, and disconnect its wiring connector (see illustration). Free the wiring from any clips so the sensor is free to be removed with the front pipe.

7 Slacken and remove the bolts securing the front pipe flange joint to the manifold.

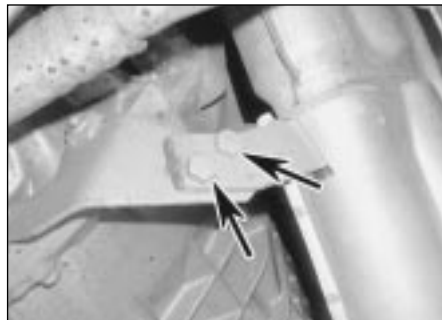
8 Unscrew the bolt(s) securing the front pipe to its mounting bracket(s) (see illustration).

9 Slacken and remove the bolts securing the front pipe to the intermediate pipe and remove the front pipe from the vehicle (see illustration). Recover the gasket from the front pipe to manifold joint.

### Intermediate pipe

10 Slacken and remove the bolts securing the intermediate pipe to the front pipe. On 2.5 and 3.0 litre engines also remove the bolts securing the other intermediate pipe to its front pipe.

11 Slacken the clamp securing the pipe to the tailpipe then free the intermediate pipe from its mounting rubbers. Ease the intermediate pipe out from the tailpipe and remove it from underneath the vehicle.



18.8 Front pipe-to-mounting bracket bolts - 2.0 litre DOHC engine

### Tailpipe

12 Slacken the clamp(s) securing the tailpipe to the intermediate pipe(s) (as applicable) (see illustration).

13 Free the tailpipe from its mounting rubbers then disengage it from the intermediate pipe(s) and remove it from the underneath the vehicle.

### Complete system

14 Trace the wiring back from the oxygen sensor(s), noting its correct routing, and disconnect the wiring connector(s). Free the wiring from any clips so the sensor(s) is free to be removed with the front pipe.

15 Unscrew the bolts securing the front pipe(s) to the mounting bracket.

16 Slacken and remove the bolts securing the front pipe flange joint(s) to the manifold(s) and recover the gasket(s).

17 Free the exhaust system from all its mounting rubbers and lower it from underneath the vehicle.

### Heat shield(s)

18 The heat shields are secured to the underside of the body by various nuts and bolts. Each shield can be removed once the relevant exhaust section has been removed. If a shield is being removed to gain access to a component located behind it, it may prove sufficient in some cases to remove the retaining nuts and/or bolts, and simply lower the shield, without disturbing the exhaust system.

### Refitting

19 Each section is refitted by reversing the removal sequence, noting the following points:



18.6 The oxygen sensor wiring connector (arrowed) is clipped to the side of the transmission unit

- Ensure that all traces of corrosion have been removed from the flanges.
- Inspect the rubber mountings for signs of damage or deterioration, and renew as necessary.
- Always renew the front pipe manifold gasket whenever it is disturbed.
- Where no gasket is fitted to a joint, apply a smear of exhaust system jointing paste to ensure a gas-tight seal.
- Prior to refitting, lubricate the threads of the front pipe to manifold bolts with a smear of high-temperature grease (Vauxhall recommend the use of assembly paste 19 48 569 - available from your Vauxhall dealer).
- Prior to tightening the exhaust system fasteners to the specified torque, ensure that all rubber mountings are correctly located, and that there is adequate clearance between the exhaust system and vehicle underbody.



18.9 Front pipe-to-intermediate pipe bolts - 2.0 litre DOHC engine



18.12 Tailpipe-to-intermediate pipe clamp - 2.0 litre DOHC engine






# Chapter 4 Part B:

## Emission control systems

### Contents

Catalytic converter - general information and precautions . . . . .	7	Exhaust gas recirculation (EGR) system components - removal and refitting . . . . .	5
Emission control system testing - general information . . . . .	2	General information . . . . .	1
Evaporative emission control system components - removal and refitting . . . . .	4	Secondary air injection system components - removal and refitting . .	6
Exhaust emission control system components - removal and refitting . . . . .	3		

### Degrees of difficulty

<b>Easy</b> , suitable for novice with little experience 	<b>Fairly easy</b> , suitable for beginner with some experience 	<b>Fairly difficult</b> , suitable for competent DIY mechanic 	<b>Difficult</b> , suitable for experienced DIY mechanic 	<b>Very difficult</b> , suitable for expert DIY or professional 
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### Specifications

Torque wrench settings	Nm	lbf ft
EGR valve bolts . . . . .	20	15
EGR pipe union nuts - 2.5 and 3.0 litre engine . . . . .	25	18
EGR valve adaptor bolts - 2.5 and 3.0 litre engine . . . . .	8	6
Exhaust manifold shroud bolts . . . . .	8	6
Oxygen sensor . . . . .	30	22
Roadwheel bolts . . . . .	110	81
Secondary air injection system:		
Connecting pipe bolts:		
M6 bolt . . . . .	8	6
M8 bolt . . . . .	20	15
Non-return valve . . . . .	30	22
Pump assembly:		
Pump/mounting rubber nuts/bolts . . . . .	10	7
Mounting bracket-to-body nuts . . . . .	20	15
Air filter retaining clamp nut . . . . .	4	3

4B

#### 1 General information

1 All UK models use unleaded petrol and also have various other features built into the fuel system to help minimise harmful emissions. All models are equipped with a crankcase emission-control system, a catalytic converter, an exhaust gas recirculation (EGR) system and an evaporative emission control system to keep fuel vapour/exhaust gas emissions down to a minimum. All models except those with a 2.0 litre SOHC engine are also fitted with the secondary air injection system to further improve the exhaust gas emissions during engine warm-up.

#### Crankcase emission control

2 To reduce the emission of unburned hydrocarbons from the crankcase into the atmosphere, the engine is sealed and the blow-by gases and oil vapour are drawn from

inside the crankcase, through a wire mesh oil separator, into the inlet tract to be burned by the engine during normal combustion.

3 Under conditions of high manifold depression (idling, deceleration) the gases will be sucked positively out of the crankcase. Under conditions of low manifold depression (acceleration, full-throttle running) the gases are forced out of the crankcase by the (relatively) higher crankcase pressure; if the engine is worn, the raised crankcase pressure (due to increased blow-by) will cause some of the flow to return under all manifold conditions.

#### Exhaust emission control

**Note:** All 2.5 and 3.0 litre engines have two catalytic converters and two oxygen sensors; one for each bank of cylinders.

4 To minimise the amount of pollutants which escape into the atmosphere, all models are fitted with a catalytic converter in the exhaust system. The system is of the closed-loop type, in which a oxygen sensor in the exhaust

system provides the engine management (fuel-injection/ignition) system ECU with constant feedback, enabling the ECU to adjust the mixture to provide the best possible conditions for the converter to operate.

5 The oxygen sensor's tip is sensitive to oxygen and sends the ECU a varying voltage depending on the amount of oxygen in the exhaust gases; if the intake air/fuel mixture is too rich, the exhaust gases are low in oxygen so the sensor sends a low-voltage signal, the voltage rising as the mixture weakens and the amount of oxygen rises in the exhaust gases. Peak conversion efficiency of all major pollutants occurs if the intake air/fuel mixture is maintained at the chemically-correct ratio for the complete combustion of petrol of 14.7 parts (by weight) of air to 1 part of fuel (the stoichiometric ratio). The sensor output voltage alters in a large step at this point, the ECU using the signal change as a reference point and correcting the intake air/fuel mixture accordingly by altering the fuel injector pulse width.