Chapter 4 Part C:
Fuel and exhaust systems - exhaust and emissions

Contents

Degrees of difficulty

Easy, suitable for novice with little experience 

Fairly easy, suitable for beginner with some experience 

Fairly difficult, suitable for competent DIY mechanic 

Difficult, suitable for experienced DIY mechanic 

Very difficult, suitable for expert DIY or professional 

Specifications

Torque wrench settings	Nm	lbf ft
AIR non-return valve to pipe	30	22
AIR pipe support bracket to manifold	8	6
AIR pipe to manifold	20	15
AIR pipe to support bracket	8	6
AIR pump bracket to protective shield	10	7
AIR pump to wheel arch	20	15
AIR pump to insulator	10	7
AIR valves to bracket	4	3
Carbon canister	4	3
EGR valve	20	15
Heat shield	8	6
Oxygen sensor	30	22

1 Emissions control systems - general

General

Multec system

1 An evaporative emissions control system is fitted to minimise the escape into the atmosphere of unburned hydrocarbons.

2 The fuel tank filler cap is sealed and a charcoal canister is mounted under the right-hand front wing to collect the petrol vapours generated in the tank when the vehicle is parked. It stores them until they can be purged from the canister into the inlet tract to be burned by the engine during normal combustion. The canister's control valve (on the top of the canister) is opened by a vacuum pipe from the front of the throttle body on C16 NZ, C16 NZ2 and C18 NZ engines. On X16 SZ it's opened by an electronically activated purge valve, mounted on the camshaft housing.

Motronic system

3 The system is as described in Chapter 4B, except that the charcoal canister is purged under the control of the fuel injection/ignition system module through the fuel tank vent valve. To ensure that the engine runs correctly when it is cold and/or idling, and to protect the catalytic converter from the effects of an over-rich mixture, the valve is not opened by the module until the engine is under partial or full load. The valve solenoid is then modulated on and off to allow the stored vapour to pass into the inlet tract.

4 Canister removal and refitting is as described in Section 11.

5 On C20 NE engines, the vent valve is mounted above the injectors for cylinders 2 and 4. To remove it, disconnect the battery negative lead and the valve wiring plug, then disconnect the two vent hoses having made note of their connections. Either remove the valve from its mounting bracket, or unbolt the bracket, as required.

6 On C20 XE engines, the vent valve is mounted on the left-hand end of the engine, underneath the end of the fuel injector wiring harness housing **(see illustration)**. Removal and refitting is as described in the previous paragraph.

Simtec system

7 For information refer to "General description", in Chapter 4B. Note that "AIR", is an abbreviation for the secondary Air Injection Reactor system used on this model.

1.6 Disconnecting the fuel tank vent valve wiring

2 Exhaust gas recirculation (EGR) system - general

The system reintroduces small amounts of exhaust gas into the combustion cycle to reduce the generation of oxides of nitrogen (NOx).

On C16 NZ, C16 NZ2 and C18 NZ engines, the volume of exhaust gas reintroduced is governed by manifold vacuum, through the EGR valve mounted on the inlet manifold. When the valve is opened small amounts of exhaust gas are allowed to enter the inlet tract, passing through ports in the cylinder head.

On X16 SZ engines the EGR valve is operated by an EGR module, mounted on the left-hand side of the engine compartment behind the battery. This module amplifies signals received from the fuel system ECU and operates the EGR valve electronically providing precise control of exhaust gas recirculation under all engine conditions.

3 EGR valve (Multec system models) - testing, removal and refitting

Testing

1 On C16 NZ, C16 NZ2 and C18 NZ engines, it is recommended that the system is checked annually, by checking the movement of the valve's diaphragm carrier plate as follows. Note that the carrier plate is visible only through the apertures in the underside of the valve, so a battery-operated torch and small mirror may be useful. On X16 SZ engines, Vauxhall test equipment is necessary to check the EGR system.

2 With the engine fully warmed up to normal operating temperature and idling, briefly open and close the throttle. The carrier plate should move upwards as the manifold vacuum changes. When the engine is idling smoothly again, press the carrier plate upwards (do this very carefully, so that the plate is not distorted or the diaphragm damaged). The idle speed should drop significantly (approximately 100 rpm).

3 If the valve does not respond as described, it must be cleaned.

Removal

4 Pull off the hose from the valve, then unbolt the valve and remove it **(see illustrations)**. Clean away all carbon using a wire brush and a pointed tool, but take care not to damage the valve seat. Renew the valve gasket to prevent induction leaks.

Refitting

5 Refit the valve and reconnect the hose, then recheck the system's performance; if there is no improvement, the valve must be renewed.

3.4 Disconnecting the vacuum hose from the exhaust gas recirculation valve

3.4B Withdrawing the exhaust gas recirculation valve

4 EGR valve (Simtec system) - testing, removal and refitting

Note: *A new gasket will be required when refitting the valve.*

Removal

1 Disconnect the battery negative lead.

2 Remove wiring harness and vacuum hose.

3 Mark position of the valve, to ensure correct relocation.

4 Undo the 3 bolts, and remove the valve from the dual spark ignition coil's coolant flange.

Refitting

5 Clean the sealing surfaces of the valve and flange.

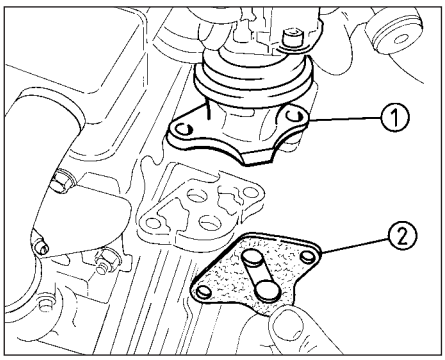
6 Refit the valve with a new gasket and line up the marks made before removal **(see illustration)**.

5 EGR module (X16 SZ models) - removal and refitting

Removal

1 Disconnect the knock module from its bracket (refer to Chapter 4B, if necessary), and place to one side.

2 Remove wiring plug from module. Remove module from bracket.



4.6 EGR valve
1 Valve 2 Gasket

Refitting

3 Refitting is a reversal of removal.

6 AIR pump assembly (Simtec system) - removal and refitting

Removal

1 Chock the rear wheels, jack up the front of the vehicle and support it on axle stands placed under the body side members (see "*Jacking and Vehicle Support*")

2 Remove the left hand front wheel and inner wheel arch lining.

3 Loosen the hose clamp and remove the air duct hose from the pump.

4 Disconnect the battery negative lead.

5 Undo the securing nuts and remove the pump assembly from its location. Disconnect the wiring plug.

6 Remove the wiring plug from the pump's bracket.

7 Mark the position of the pump on it's bracket before separating.

8 Remove the fixing bolts and disconnect the pump from it's insulator.

9 The insulator can also be checked by removing the 3 nuts, securing the protective shield. Before removing, mark the shield and insulator. Replace if necessary.

10 Check the pump's air cleaner for damage.

Refitting

11 Refitting is a reversal of removal. Ensure correct alignment of the components.

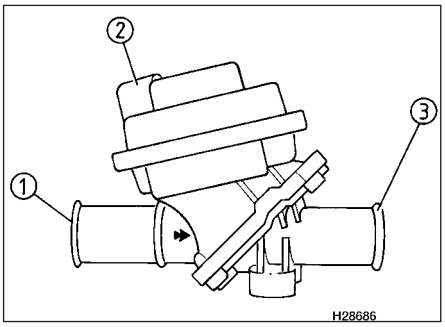
7 AIR cut-off valve - removal, testing and refitting

Removal

1 Before removal, mark on the cut-off valve, the direction of flow towards the non-return valve **(see illustration)**.

2 Disconnect and remove the air duct and vacuum hoses.

3 Undo the switchover valve's bolts and move to one side.



7.1 AIR cut-off valve

1 Connection to AIR pump
2 Connection to AIR switchover valve
3 Connection to AIR non-return valve

4 The cut-off valve can now be removed from the bracket.

Testing

5 To test the cut-off valve a vacuum hand pump with gauge will be required. If available, connect to the cut-off valve and ensure that air through-flow aperture is fully open.

Refitting

6 Refitting is a reversal of removal. Ensure valve is fitted in the correct direction.

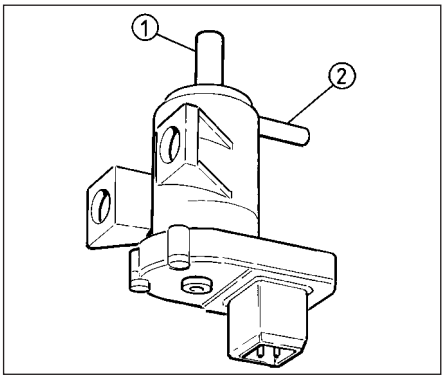
8 AIR switchover valve - removal and refitting

Removal

1 Disconnect the battery negative lead.
2 Disconnect wiring plug from the valve.
3 Mark the location of the vacuum hoses before removing them from the valve.
4 After disconnecting the hoses undo the two bolts, and remove them from its bracket.

Refitting

5 Refitting is a reversal of removal. Ensure hoses are fitted correctly **(see illustration).**



8.5 AIR switchover valve

1 Connection to brake servo vacuum hose
2 Connection to cut-off valve

9 AIR pipe and non-return valve - removal and refitting

Note: *New air pipe washers will be required when refitting.*

Removal

1 Remove the non-return valve air duct hose.
2 Undo the bolts engine lifting eye bracket, and turn the bracket on to its left hand side.
3 Remove the pipe support bracket by releasing its three bolts.
4 Remove the heat shield that is secured by two bolts.
5 The air pipe can now be removed by releasing the two securing bolts.
6 If necessary the non-return valve can now be disconnected.
7 Carefully clamp the pipe using a vice with protective jaws. Unbolt the valve from the pipe, clean and inspect for damage.

Refitting

8 Before refitting, coat the threads of the non-return valve with sealing compound (i.e. Vauxhall part no. 90094714).
9 Use new washers when refitting the pipe, (take care as the washers have sharp edges). Coat the pipe mounting bolts with assembly paste (i.e. Vauxhall part no. 90513210), before refitting.
10 Refitting is a reversal of removal. Retighten to correct torque as shown in Specifications.

10 Catalytic converter - description, general and precautions

Note: *The catalytic converter is not a filter. It creates a chemical reaction, but it is not affected by that reaction.*

Description

1 Certain models are available with a catalytic converter, to reduce exhaust emissions. These models can be identified by a 'C' or 'X', prefixing the engine code.
2 The purpose of the catalytic converter is to change potentially harmful hydrocarbon and carbon monoxide exhaust gases into harmless gases and water vapour. The converter consists of a stainless steel canister containing a catalyst-coated honeycomb ceramic. The catalyst is a mixture of three precious metals, platinum, palladium and rhodium.

10.9 The catalytic converter is protected by heat shields

3 The exhaust gases pass freely through the honeycomb, where the catalyst speeds up the chemical change of the exhaust gases, without being permanently altered itself.
4 To avoid damage to the catalyst, the engine must be kept properly tuned, and unleaded petrol must always be used. Normal leaded petrol will "poison" the catalyst, and must not be used.
5 To enable the Motronic engine management system to achieve complete combustion of the fuel mixture, and thus to minimise exhaust emissions, an oxygen sensor is fitted in the exhaust gas stream. The sensor monitors the oxygen level in the exhaust gas, and sends a signal to the Motronic module. The module constantly alters the fuel/air mixture within a narrow band to reduce emissions, and to allow the catalytic converter to operate at maximum efficiency. No adjustment of idle mixture is therefore possible on models fitted with a catalytic converter.

General

6 Ninety-nine per cent of exhaust gases, from a petrol engine (however efficient or well tuned), consists of nitrogen (N_2), carbon dioxide (CO_2), oxygen (O_2), other inert gases and water vapour (H_2O). The remaining 1% is made up of the noxious materials that are currently seen (except CO_2), as the major polluters of the environment. Carbon monoxide (CO), unburned hydrocarbons (HC), oxides of nitrogen (NOx) and some solid matter, including a small lead content.
7 The device most commonly used to clean up vehicle exhausts is the catalytic converter. It is fitted into the vehicle's exhaust system and uses precious metals (platinum and palladium or rhodium) as catalysts to speed up the reaction between the pollutants and the oxygen in the exhaust gases. CO and HC being oxidised to form H_2O and CO_2 and (in the three-way type of catalytic converter) NOx being reduced to N_2.
8 The converter consists of an element of ceramic honeycomb, coated with a combination of precious metals in such a way as to produce a vast surface area over which the exhaust gases must flow. The three-way closed-loop type converter fitted to these models can remove over 90% of pollutants.
9 The catalytic converter is a reliable and simple device that needs no maintenance. However there are some facts that an owner should be aware if the converter is to function properly for its full service life **(see illustration)**.

a) DO NOT use leaded petrol in a vehicle equipped with a catalytic converter. The lead will coat the precious metals, reducing their converting efficiency and will eventually destroy the converter.

b) Always keep the ignition and fuel systems well maintained according to the manufacturers schedule (see "Routine maintenance" and the relevant Chapter). In particular, ensure that the air cleaner filter element, the fuel filter and the spark plugs are renewed at the correct intervals. If the inlet air/fuel mixture is allowed to become too rich due to neglect, the unburned surplus will enter and burn in the catalytic converter, overheating the element and eventually destroying the converter.

c) If the engine develops a misfire, do not drive the vehicle at all (or at least as little as possible) until the fault is cured. The misfire will allow unburned fuel to enter the converter, which will result in its overheating, as noted above.

d) The engine control indicator (the outline of an engine with a lightning symbol superimposed), will light when the ignition is switched on and the engine is started, then it will go out. While it may light briefly while the engine is running, it should go out again immediately and stays unlit. If it lights and stays on while the engine is running, seek the advice of a Vauxhall dealer as soon as possible. A fault has occurred in the fuel injection/ignition system that, apart from increasing fuel consumption and impairing the engine's performance, may damage the catalytic converter.

e) DO NOT push or tow-start the vehicle. This will soak the catalytic converter in unburned fuel causing it to overheat when the engine does start see (b) above.

f) DO NOT switch off the ignition at high engine speeds. If the ignition is switched off at anything above idle speed, unburned fuel will enter the (very hot) catalytic converter, with the possible risk of its igniting on the element and damaging the converter.

g) DO NOT use fuel or engine oil additives. These may contain substances harmful to the catalytic converter.

h) DO NOT continue to use the vehicle if the engine burns oil to the extent of leaving a visible trail of blue smoke. The unburned carbon deposits will clog the converter passages and reduce its efficiency; in severe cases the element will overheat.

i) Remember that the catalytic converter operates at very high temperatures hence the heat shields on the vehicle's under-body and the casing will become hot enough to ignite combustible materials that brush against it. DO NOT, therefore, park the vehicle in dry undergrowth, over long grass or over piles of dead leaves.

j) Remember that the catalytic converter is FRAGILE. Do not strike it with tools during servicing work. Take great care when working on the exhaust system. Ensure that the converter is well clear of any jacks or other lifting gear used to raise the vehicle. Do not drive the vehicle over rough ground, road humps, etc., in such a way as to ground the exhaust system.

k) In some cases, particularly when the vehicle is new and/or is used for stop/start driving, a sulphurous smell (like that of rotten eggs) may be noticed from the exhaust. This is common to many catalytic converter-equipped vehicles and seems to be due to the small amount of sulphur found in some petrol's reacting with hydrogen in the exhaust to produce hydrogen sulphide (CS) gas. While this gas is toxic, it is not produced in sufficient amounts to be a problem. Once the vehicle has covered a few thousand miles the problem should disappear. In the meanwhile a change of driving style or of the brand of petrol may effect a solution.

l) The catalytic converter, used on a well-maintained and well-driven vehicle, should last for between 50 000 and 100 000 miles. From this point on, careful checks should be made at all specified service intervals of the CO level to ensure that the converter is still operating efficiently. If the converter is no longer effective it must be renewed.

11 Carbon canister - removal and refitting

Removal

1 Apply the handbrake, then jack up the front of the vehicle, and support securely on axle stands placed under the body side members (see "*Jacking and Vehicle Support*").

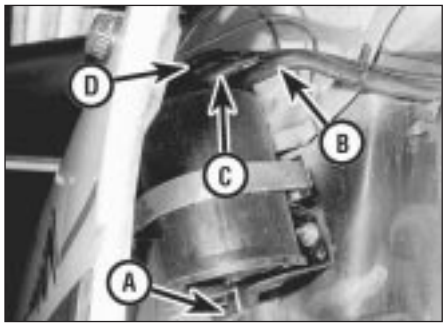
2 Remove the front right hand wheel and wheel arch liner.

3 Note the hose and pipe connections to the canister, or label them, to ensure that they are reconnected to their original unions, then disconnect them **(see illustration)**. Unscrew the two nuts securing the canister mounting bracket to the vehicle body.

Refitting

4 Refitting is a reversal of removal, however ensure correct fitment of hose and pipes.

12.6 Oxygen sensor location in front section of exhaust system - DOHC models



11.3 Charcoal canister

A Vent to atmosphere
B Vapour feed hose from filler pipe
C Vapour exhaust hose to inlet tract
D Control valve vacuum pipe from throttle body

12 Oxygen sensor (catalytic converter models) - removal and refitting

Note: *This sensor is also known as a Lambda sensor.*

Removal

1 Disconnect the battery negative lead.

2 Disconnect the oxygen sensor wiring plug, which is located behind the coolant expansion tank.

3 Apply the handbrake, then jack up the front of the vehicle, and support securely on axle stands placed under the body side members.

4 On DOHC models, remove the engine undershield, as described in Chapter 11.

5 On models fitted with Multec injection system, the sensor is screwed into the exhaust manifold. Trace the wiring from the sensor itself to the connector (either clipped to the radiator cooling fan shroud or behind the coolant expansion tank). Release it from any clips or ties; disconnect the wiring before unscrewing the sensor.

6 On other models, unscrew the oxygen sensor from the front section of the exhaust system **(see illustration)**. It is advisable to wear gloves, as the exhaust system will be extremely hot.

7 Withdraw the oxygen sensor and its wiring, taking care not to burn the wiring on the exhaust system. If the sensor is to be re-used, take care that the sealing ring is not lost, and that the sensor is not dropped.

Refitting

8 If a new sensor is being fitted, it will be supplied with the threads coated in a special grease to prevent it seizing in the exhaust system.

9 If the original sensor is being refitted, ensure that the screw thread is clean. Coat the thread with a lithium based copper grease (i.e. Vauxhall Part No. 90295397).

10 Refitting is a reversal of removal. Check the exhaust system for leakage when the engine is re-started.

13.7 Unscrewing an exhaust manifold securing nut - SOHC models

14.9 Exhaust front section flexible joint - SOHC models

14.10 Exhaust front section support bracket - SOHC models

13 Exhaust manifold - removal and refitting

Note: *New manifold-to-cylinder head, and manifold-to-downpipe, gaskets must be used on refitting. Exhaust manifolds on DOHC models are of tubular design, which form part of the front section of the exhaust.*

Removal

1 Disconnect the battery negative lead.
2 Disconnect the HT leads from the spark plugs, if necessary labelling them to ensure refitting to the correct cylinders.
3 Loosen the clamp screw and disconnect the air cleaner hot air tube from the shroud on the manifold, if fitted. Remove the securing screws and withdraw the hot air shroud from the manifold.
4 Working under the manifold, unscrew and remove the four bolts securing the exhaust downpipe to the manifold.
5 If fitted, disconnect the oxygen sensor wiring
6 Separate the downpipe from the manifold, and support with wire or string. Do not allow the front section of the exhaust system to hang under its own weight. Recover the gasket.
7 Unscrew the securing nuts, and withdraw the manifold from the cylinder head **(see illustration)**. Recover the gasket.
8 It is possible that some of the manifold studs may be unscrewed from the cylinder head when the manifold securing nuts are unscrewed. In this event, the studs should be screwed back into the cylinder head once the manifold has been removed, using two manifold nuts locked together.

Refitting

9 Refit the manifold using a new gasket, and tighten the securing nuts to the specified torque.
10 Reconnect the exhaust downpipe to the manifold, using a new gasket and tighten the securing bolts to the specified torque.
11 Further refitting is a reversal of removal.

14 Exhaust system - checking, removal and refitting

Note: *All relevant gaskets and/or sealing rings should be renewed on refitting*

Checking

1 Periodically, the exhaust system should be checked for signs of leaks or damage. Also inspect the exhaust system rubber mountings, and renew if necessary.
2 Small holes or cracks can be repaired using proprietary exhaust repair products, but where more serious corrosion or damage is evident, renewal will be necessary.

Removal

3 The original factory-fitted exhaust system consists of four separate sections, all of which can be renewed individually.
4 On models fitted with a catalytic converter, an oxygen sensor is fitted to the front section of the exhaust. The catalytic converter is fitted in place of the front expansion box in the conventional exhaust system. The manufacturers do not specify any renewal intervals for the catalytic converter.
5 Before renewing an individual section of the exhaust system, it is wise to inspect the remaining sections. If corrosion or damage is evident on more than one section of the system, it may prove more economical to renew the entire system.
6 Individual sections of the exhaust system can be removed as follows.

Front section - SOHC models

7 On models with a catalytic converter, disconnect the battery negative lead, and disconnect the oxygen sensor wiring plug, which is located behind the coolant expansion tank.
8 Raise the vehicle, and support securely on axle stands placed under the body side members (see "*Jacking and Vehicle Support*").
9 Unscrew the two securing bolts, and disconnect the exhaust front section from the front expansion box or catalytic converter (as applicable) at the flexible joint. Recover the sealing ring and the springs **(see illustration)**.
10 Unbolt the exhaust front section from the bracket on the cylinder block **(see illustration)**.
11 Unscrew and remove the four bolts securing the downpipe to the exhaust manifold, and withdraw the exhaust front section **(see illustration)**. Recover the downpipe-to-manifold gasket.

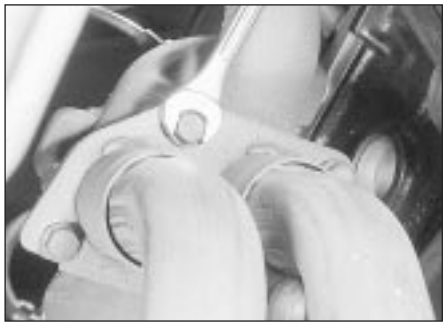
Refitting

12 Refitting is a reversal of removal, but use a new gasket when reconnecting the downpipe to the manifold, and a new sealing ring when connecting the flexible joint. Tighten all fixings to the specified torque.

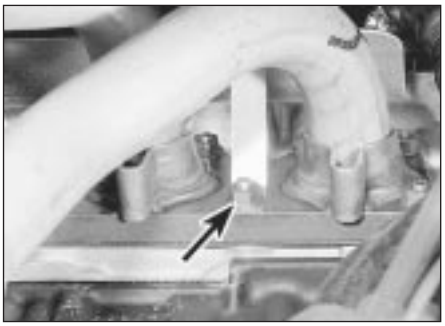
Front section - DOHC models

Removal

13 Proceed as described in paragraphs 7 and 8.
14 Remove the engine undershield, as described in Chapter 11.
15 Proceed as described in paragraphs 9 and 10.
16 Working in the engine compartment, remove the bolts securing the exhaust manifold heat shield to the cylinder head.
17 Unscrew the two lower exhaust manifold securing nuts that also secure the heat shield brackets, and withdraw the heat shield **(see illustration)**.
18 Unscrew the remaining manifold securing nuts, then withdraw the manifold/exhaust front section from the vehicle. Recover the manifold gasket.



14.11 Unscrewing a downpipe-to-exhaust manifold bolt - SOHC models



14.17 Exhaust manifold nut (arrowed) securing exhaust heat shield - DOHC models

19 It is possible that some of the manifold studs may be unscrewed from the cylinder head when the manifold securing nuts are unscrewed. In this event, the studs should be screwed back into the cylinder head once the manifold has been removed, using two manifold nuts locked together.

Refitting

20 Refitting is a reversal of removal, but use a new manifold gasket, and use a new sealing ring when reconnecting the flexible joint. Tighten all fixings to the specified torque.

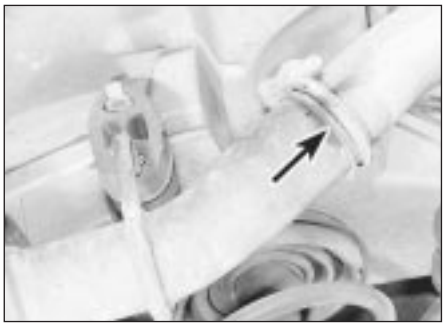
Front expansion box/catalytic converter

Removal

21 Proceed as described in paragraphs 8 and 9.

22 Unscrew the three securing nuts and bolts, and disconnect the expansion box/catalytic converter from the exhaust centre section flanged joint. Recover the gasket.

23 Withdraw the expansion box/catalytic converter from the vehicle.



14.26 Exhaust centre section-to-rear section clamp (arrowed) - SOHC model

Refitting

24 Refitting is a reversal of removal, but use a new sealing ring when reconnecting the flexible joint, and a new gasket when reconnecting the flanged joint. Tighten all fixings to the specified torque.

Centre section

Removal

25 Raise the vehicle, and support securely on axle stands placed under the body side members.

26 Unscrew the clamp bolt, and disconnect the exhaust centre section from the rear section **(see illustration)**. If necessary, tap around the joint with a hammer to break the seal, and gently prise the two sections apart. Note that the end of the centre section fits inside the rear section, to form a sleeve joint.

27 Proceed as described in paragraph 22.

28 Release the exhaust centre section from its rubber mountings on the underbody, and withdraw it from the vehicle **(see illustration)**.

14.28 Exhaust centre section forward rubber mountings - DOHC models

Refitting

29 Refitting is a reversal of removal, but use a new gasket when reconnecting the flanged joint, and lubricate the pipes with exhaust assembly paste when connecting the centre section to the rear section. Tighten all fixings to the specified torque.

Rear section

Removal

30 Proceed as described in paragraphs 25 and 26.

31 Release the exhaust rear section from its rubber mountings on the underbody, and withdraw it from the vehicle.

Refitting

32 Refitting is a reversal of removal, but lubricate the pipes with exhaust assembly paste when connecting the rear section to the centre section. Tighten the clamp bolt to the specified torque.