# VELOSTER(FS) > 2012 > G 1.6 GDI > Engine Mechanical System

## Engine Mechanical System > General Information > Specifications

### Specifications

| Description | | Specifications | Limit |
|---|---|---|---|
| **General** | | | |
| Type | | In-line, DOHC | |
| Number of cylinders | | 4 | |
| Bore | | 77mm (3.0315in) | |
| Stroke | | 85.44mm (3.3638in) | |
| Total displacement | | 1,591 cc (97.09 cu.in) | |
| Compression ratio | | 11.0 : 1 | |
| Firing order | | 1-3-4-2 | |
| **Valve timing** | | | |
| Intake valve | Opens | ATDC 8°/BTDC 42° | |
| | Closes | ABDC 69°/ABDC 19° | |
| Exhaust valve | Opens | BBDC 50°/BBDC 10° | |
| | Closes | ATDC 5°/ATDC 45° | |
| **Cylinder head** | | | |
| Flatness of gasket surface | | Less than 0.05mm (0.0020in) for total area<br>Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in) | |
| **Camshaft** | | | |
| Cam height | Intake | 44.15mm (1.7382in) | |
| | Exhaust | 43.55mm (1.7146in) | |
| Journal outer diameter (Intake, Exhaust) | | 22.964 ~ 22.980mm (0.9041 ~ 0.9047in) | |
| Camshaft cap oil clearance | | 0.027 ~ 0.058mm (0.0011 ~ 0.0023in) | 0.1mm (0.0039in) |
| End play | | 0.10 ~ 0.20mm (0.0039 ~ 0.0079in) | |
| **Valve** | | | |
| Valve length | Intake | 93.15mm (3.6673in) | |
| | Exhaust | 92.60mm (3.6457in) | |
| Stem outer diameter | Intake | 5.465 ~ 5.480mm (0.2152 ~ 0.2157in) | |
| | Exhaust | 5.458 ~ 5.470mm (0.2149 ~ 0.2154in) | |
| **Face angle** | | 45.25° ~ 45.75° | |
| Thickness of valve head (margin) | Intake | 1.10mm (0.0433in) | 0.8mm (0.0315in) |
| | Exhaust | 1.26mm (0.0496in) | 1.0mm (0.0394in) |
| Valve stem to valve guide clearance | Intake | 0.020 ~ 0.047mm (0.0008 ~ 0.0019in) | 0.10mm (0.0039in) |
| | Exhaust | 0.030 ~ 0.054mm (0.0012 ~ 0.0021in) | 0.15mm (0.0059in) |

| | | | |
|---|---|---|---|
| **Valve guide** | | | |
| Length | Intake | 40.3 ~ 40.7mm (1.5866 ~ 1.6024in) | |
| | Exhaust | 40.3 ~ 40.7mm (1.5866 ~ 1.6024in) | |
| **Valve spring** | | | |
| Free length | | 45.1mm (1.7756in) | |
| Out of squareness | | Less than 1.5° | |
| **Cylinder block** | | | |
| Cylinder bore | | 77.00 ~ 77.03mm (3.0315 ~ 3.0327in) | |
| Flatness of gasket surface | | Less than 0.05mm (0.0020in) for total area<br>Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in) | |
| **Piston** | | | |
| Piston outer diameter | | 76.97 ~ 77.00mm (3.0303 ~ 3.0315in) | |
| Piston to cylinder clearance | | 0.020 ~ 0.040mm (0.0008 ~ 0.0016in) | |
| Ring groove width | No. 1 ring groove | 1.23 ~ 1.25mm (0.0484 ~ 0.0492in) | 1.26mm (0.0496in) |
| | No. 2 ring groove | 1.23 ~ 1.25mm (0.0484 ~ 0.0492in) | 1.26mm (0.0496in) |
| | Oil ring groove | 2.01 ~ 2.03mm (0.0791 ~ 0.0799in) | 2.05mm (0.0807in) |
| **Piston ring** | | | |
| Side clearance | No.1 ring | 0.04 ~ 0.08mm (0.0016 ~ 0.0031in) | 0.1 mm (0.0039in) |
| | No.2 ring | 0.04 ~ 0.08mm (0.0016 ~ 0.0031in) | 0.1 mm (0.0039in) |
| | Oil ring | 0.02 ~ 0.06mm (0.0008 ~ 0.0024in) | 0.2 mm (0.0079in) |
| End gap | No. 1 ring | 0.14 ~ 0.28mm (0.0055 ~ 0.0110in) | 0.30mm (0.0118in) |
| | No. 2 ring | 0.30 ~ 0.45mm (0.0118 ~ 0.0177in) | 0.50mm (0.0197in) |
| | Oil ring | 0.20 ~ 0.40mm (0.0079 ~ 0.0157in) | 0.80mm (0.0315in) |
| **Piston pin** | | | |
| Piston pin outer diameter | | 18.001 ~ 18.006mm (0.7087 ~ 0.7089in) | |
| Piston pin hole inner diameter | | 18.016 ~ 18.021mm (0.7093 ~ 0.7095in) | |
| Piston pin hole clearance | | 0.010 ~ 0.020mm (0.0004 ~ 0.0008in) | |
| Connecting rod small end hole inner diameter | | 17.974 ~ 17.985mm (0.7076 ~ 0.7081in) | |
| Piston pin press-in load | | 500~1,500 kg (1,102 ~ 3,306 lb) | |
| **Connecting rod** | | | |
| Connecting rod big end inner diameter | | 45.000 ~ 45.018mm (1.7717 ~ 1.7724in) | |
| Connecting rod bearing oil clearance | | 0.032 ~ 0.052mm (0.0013 ~ 0.0020in) | 0.060mm (0.0024in) |
| Side clearance | | 0.10 ~ 0.25mm (0.0039 ~ 0.0098in) | 0.35m (0.0138in) |
| **Crankshaft** | | | |
| Main bearing oil clearance | No. 1, 2, 3, 4, 5 | 0.021 ~ 0.042mm (0.0008 ~ 0.0017in) | 0.05mm (0.0020in) |
| End play | | 0.05 ~ 0.25mm (0.0020 ~ 0.0098in) | 0.3mm (0.0118in) |
| **Engine oil** | | | |

| | | | |
|---|---|---|---|
| Oil quantity | Total | 4.0L (4.22US qt, 3.51lmp qt) | When replacing a short engine or a block assembly |
| | Oil pan | 3.3L (3.48US qt, 2.90lmp qt) | |
| | Drain and refill | 3.6L (3.80US qt, 3.16lmp qt) | Including oil filter |
| Oil grade | Recommendation | 5W-20/GF4&SM | If not available, refer to the recommended API or ILSAC classification and SAE viscosity number. |
| | Classification | API SL, SM or above<br>ILSAC GF3, GF4 or above | Satisfy the requirement of the API or ILSAC classification. |
| | SAE viscosity grade | Recommended SAE viscosity number | Refer to the "Lubrication System" |
| Oil pressure (at 1000rpm) | | 100kPa (1.0kg/cm², 14.5psi) or above | Oil temperature in oil pan : 110±2°C (230± 36°F) |
| **Cooling system** | | | |
| Cooling method | | Forced circulation with cooling fan | |
| Coolant quantity | | MT :<br>5.0L (1.32 U.S.gal., 5.28 U,S,qt., 4.40lmp.qt)<br>AT :<br>5.2L (1.37 U.S.gal., 5.49 U,S,qt., 4.57lmp.qt) | |
| Thermostat | Type | Wax pellet type | |
| | Opening temperature | 82 ± 1.5°C (179.6 ± 2.7°F) | |
| | Full opening temperature | 95°C (203°F) | |
| Radiator cap | Main valve opening pressure | 93.16 ~ 122.58kpa<br>(0.95 ~ 1.25kgf/cm², 13.51 ~ 17.78psi) | |
| | Vacuum valve opening pressure | MAX. 6.86 kpa(0.07kgf/cm², 1.00 psi) | |
| **Water temperature sensor** | | | |
| Type | | Thermister type | |
| Resistance | 20°C (68°F) | 2.45±0.14 kΩ | |
| | 80°C (176°F) | 0.3222 kΩ | |

## Tightening Torques

| Item | Quantity | N.m | kgf.m | lb-ft |
|---|---|---|---|---|
| **Engine mounting** | | | | |
| Engine mounting bracket to body fixing bolt | 2 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |
| Engine mounting bracket to body fixing nut | 1 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |
| Engine mounting support bracket to engine mounting insulator fixing nut | 1 | 63.7 ~ 83.4 | 6.5 ~ 8.5 | 47.0 ~ 61.5 |
| Engine mounting support bracket to engine support bracket fixing bolt | 1 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |

| | | | | |
|---|---|---|---|---|
| Engine mounting support bracket to engine support bracket fixing nut | 2 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |
| Transaxle mounting bracket to body fixing bolt | 2 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |
| Transaxle mounting bracket to body fixing nut | 1 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |
| Transaxle mounting insulator to transaxle mounting support bracket fixing bolt | 2 | 88.3 ~ 107.9 | 9.0 ~ 11.0 | 65.1 ~ 79.6 |
| Roll rod bracket to sub frame fixing bolt | 2 | 49.0 ~ 63.7 | 5.0 ~ 6.5 | 36.2 ~ 47.0 |
| Roll rod insulator to roll rod mounting support bracket fixing nut | 1 | 107.9 ~ 127.5 | 11.0 ~ 13.0 | 79.6 ~ 94.0 |
| **Timing system** | | | | |
| Timing chain and oil pump assembly cover bolt (M6×20) | 10 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Timing chain and oil pump assembly cover bolt (M6×38) | 2 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Timing chain and oil pump assembly cover bolt (M6×70) | 1 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Timing chain and oil pump assembly cover bolt (M8×22) | 3 | 18.6 ~ 23.5 | 1.9 ~ 2.4 | 13.7 ~ 17.4 |
| Idler pulley assemlby bolt | 1 | 42.2 ~ 53.9 | 4.3 ~ 5.5 | 31.1 ~ 39.8 |
| Timing chain tensioner arm bolt | 1 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Timing chain guide bolt | 2 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Crankshaft pulley bolt | 1 | 127.5 ~ 137.3 | 13.0 ~ 14.0 | 94.0 ~ 101.3 |
| Timing chain tensioner bolt | 2 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| **Cylinder head** | | | | |
| Ignition coil bolt | 4 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| High pressure fuel pipe nut | 2 | 25.5 ~ 31.4 | 2.6 ~ 3.2 | 18.8 ~ 23.1 |
| High pressure fuel pump bolt | 2 | 12.7 ~ 14.7 | 1.3 ~ 1.5 | 9.4 ~ 10.8 |
| Cylinder head cover bolt | 19 | [3.9~5.9] + [7.8~9.8] | [0.4~0.6] + [0.8~1.0] | [2.9~4.3] + [5.8~7.2] |
| Camshaft bearing cap bolt (M6) | 18 | [5.9] + [11.8~13.7] | [0.6] + [1.2~1.4] | [4.3] + [8.7~10.1] |
| Camshaft bearing cap bolt (M8) | 4 | [9.8] + [18.6~22.6] | [1.0] + [1.9~2.3] | [7.2] + [13.7~16.6] |
| Cylinder head bolt | 10 | [29.4] + [90°] + [90°] | [3.0] + [90°] + [90°] | [21.7] + [90°] + [90°] |
| **Cylinder block** | | | | |
| Engine support bracket bolt | 4 | 29.4 ~ 41.2 | 3.0 ~ 4.2 | 21.7 ~ 30.4 |
| Ladder frame bolt | 13 | 18.6 ~ 23.5 | 1.9 ~ 2.4 | 13.7 ~ 17.4 |
| Connecting rod cap bolt | 8 | [17.7~21.6] + [88~92°] | [1.8~2.2] + [88~92°] | [13.0~15.9] + [88~92°] |
| Crankshaft main bearing cap bolt | 10 | [19.6] + [90°] | [2.0] + [90°] | [14.5] + [90°] |
| Flywheel bolts (M/T) | 6 | 71.6 ~ 75.5 | 7.3 ~ 7.7 | 52.8 ~ 55.7 |
| Drive plate bolts (A/T) | 6 | 71.6 ~ 75.5 | 7.3 ~ 7.7 | 52.8 ~ 55.7 |

| | | | | |
|---|---|---|---|---|
| **Lubrication system** | | | | |
| Oil filter | 1 | 11.8 ~ 15.7 | 1.2 ~ 1.6 | 8.7 ~ 11.6 |
| Oil pan bolt | 11 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Oil pan drain plug | 1 | 34.3 ~ 44.1 | 3.5 ~ 4.5 | 25.3 ~ 32.5 |
| Oil screen bolt | 2 | 19.6 ~ 26.5 | 2.0 ~ 2.7 | 14.5 ~ 19.5 |
| Oil pressure switch | 1 | 7.8 ~ 11.8 | 0.8 ~ 1.2 | 5.8 ~ 8.7 |
| Oil level gauge assembly mounting bolt | 1 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| **Cooling system** | | | | |
| Water pump pulley bolt | 4 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Water pump bolt | 5 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Water temperature control assembly mounting bolt | 3 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Water inlet fitting nut | 2 | 18.6 ~ 23.5 | 1.9~ 2.4 | 13.7 ~ 17.4 |
| Heater pipe mounting bolt (M6) | 1 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Heater pipe mounting nut | 2 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Heater pipe mounting bolt (M8) | 1 | 18.6 ~ 23.5 | 1.9 ~ 2.4 | 13.7 ~ 17.4 |
| Engine coolant temperature sensor (ECTS) | 1 | 29.4 ~ 39.2 | 3.0 ~ 4.0 | 21.7 ~ 28.9 |
| **Intake and exhaust system** | | | | |
| Air intake hose clamp bolt | 2 | 2.9 ~ 4.9 | 0.3 ~ 0.5 | 2.2 ~ 3.6 |
| Air cleaner asembly bolt | 2 | 7.8 ~ 9.8 | 0.8 ~ 1.0 | 5.8 ~ 7.2 |
| Electronic throttle control (ETC) module bolt | 4 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Intake manifold nut | 2 | 18.6 ~ 23.5 | 1.9 ~ 2.4 | 13.7 ~ 17.4 |
| Intake manifold bolt | 3 | 18.6 ~ 23.5 | 1.9 ~ 2.4 | 13.7 ~ 17.4 |
| Exhaust manifold heat protector bolt | 3 | 9.8 ~ 11.8 | 1.0 ~ 1.2 | 7.2 ~ 8.7 |
| Exhaust manifold stay bolt | 3 | 39.2 ~ 49.0 | 4.0 ~ 5.0 | 28.9 ~ 36.2 |
| Exhaust manifold nut | 9 | 29.4 ~ 41.2 | 3.0 ~ 4.2 | 21.7 ~ 30.4 |
| Oxygen sensor (Front/Rear) | 2 | 39.2 ~ 49.0 | 4.0 ~ 5.0 | 28.9 ~ 36.2 |
| Catalytic converter / muffler nut | 6 | 39.2 ~ 58.8 | 4.0 ~ 6.0 | 28.9 ~ 43.4 |

## Engine Mechanical System > General Information > Repair procedures

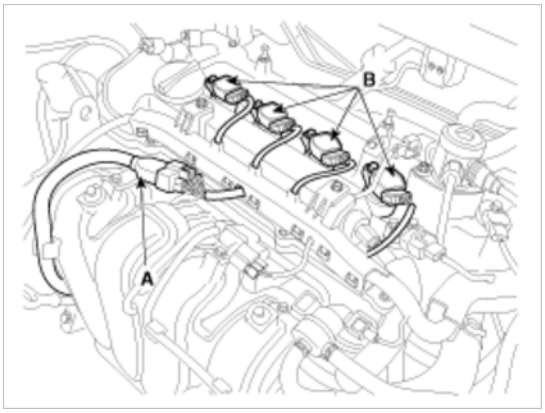
### Compession Pressure Inspection

NOTE

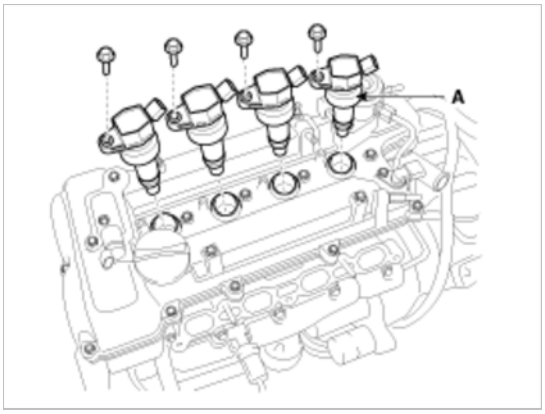
If the there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. Make sure the oil in the crankcase is of the correct viscosity and at the correct level and that the battery is correctly charged. Operate the vehicle until the engine is at normal operating temperature. Turn the ignition switch to the OFF position.
2. Remove the engine cover.

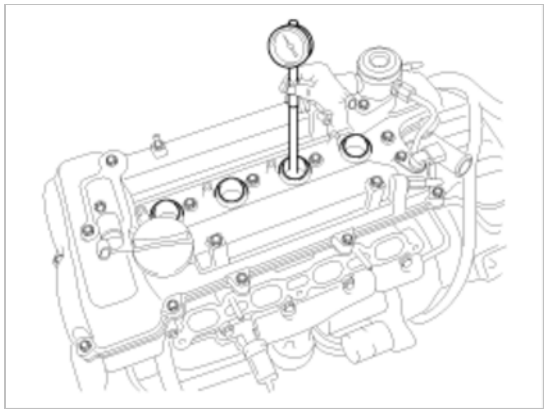
3. Disconnect the injector extension connector (A) and the ignition coil connectors (B).




4. Remove the ignition coils (A).




5. Remove the spark plugs.
   Using a 16mm plug wrench, remove the 4 spark plugs.
6. Check the cylinder compression pressure.
   (1) Insert a compression gauge into the spark plug hole.



   (2) Set the throttle plate in the wide-open position.
   (3) While cranking the engine, measure the compression pressure.

> NOTE
>
> Always use a fully charged battery to obtain engine speed of 250rpm or more.

   (4) Repeat step 1) through 3) for each cylinder.

> NOTE

This measurement must be done in as short time as possible.

**Compression pressure**
Standard : 1225.83kPa (12.5kg/cm², 177.79psi) (200~250 rpm)
Minimum : 1078.73kPa (11.0kg/cm², 156.46psi)
Difference between each cylinder :
98kPa (1.0kg/cm², 14psi) or less

(5) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat step 1) through 3) for cylinders with low compression.
A. If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
B. If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.

7. Install the spark plugs.

**Tightening torque :**
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

8. Install the ignition coil (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

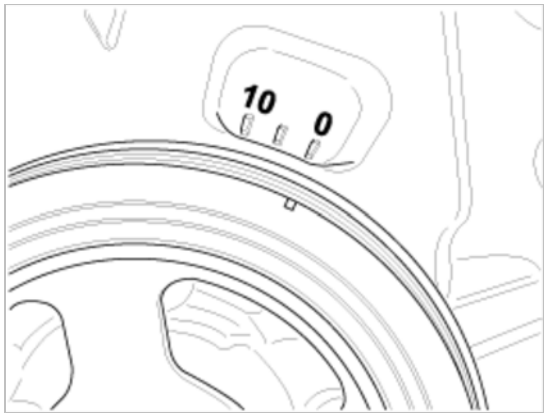
9. Connect the injector extension connector and the ignition coil connectors.
10. Install the engine cover.

## Valve Clearance Inspection And Adjustment

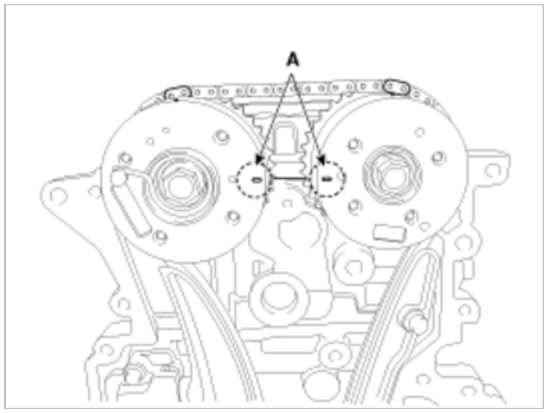
NOTE

Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C) and cylinder head is installed on the cylinder block.

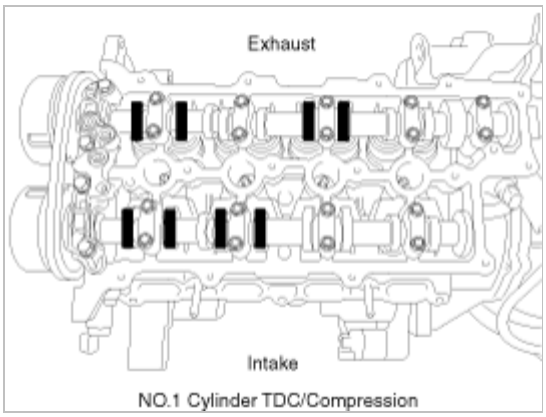
1. Remove the cylinder head cover. (Refer to Timing system)
2. Set No.1 cylinder to TDC/compression.
(1) Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover.




(2) Check that the marks of the intake and exhaust CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft one revolution (360°).




3. Inspect the valve clearance.
   (1) Check only the intake valves of the 1st and 2nd cylinders and exhaust valves of the 1st and 3rd cylinders for their clearance.
      A. Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.



NO.1 Cylinder TDC/Compression

      B. Record the out-of-specification valve clearance measurements. They will be used later to determine the required tappet for adjusting.

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Valve clearance specification (Engine coolant temperature : 20°C [68°F])
Limit
Intake : 0.17 ~ 0.23mm (0.0067 ~ 0.0091in.)
Exhaust : 0.22 ~ 0.28mm (0.0087 ~ 0.0110in.)

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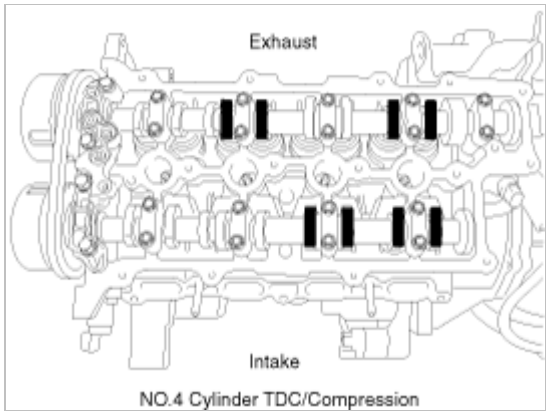
   (2) Turn the crankshaft pulley one revolution (clockwise 360°) and align its groove with timing mark of the timing chain cover.
   (3) Check the intake valves of the 3rd and 4th cylinders and exhaust valves of the 2nd and 4th cylinders for their clearance.



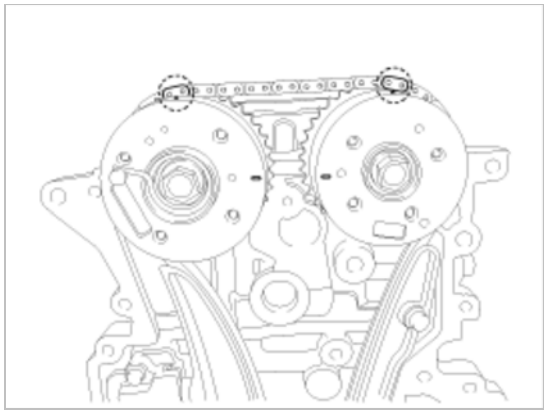
NO.4 Cylinder TDC/Compression

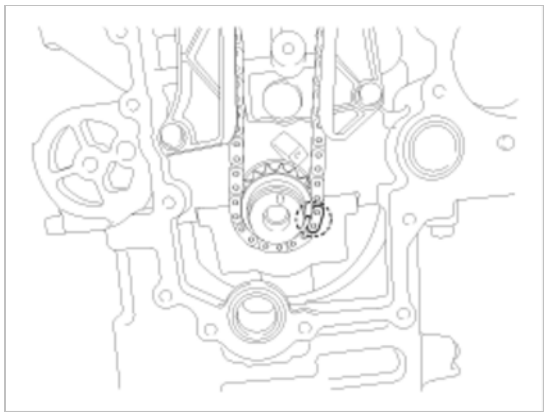
4. Adjust the intake and exhaust valve clearance.

(1) Set the No.1 cylinder to the TDC/compression position.

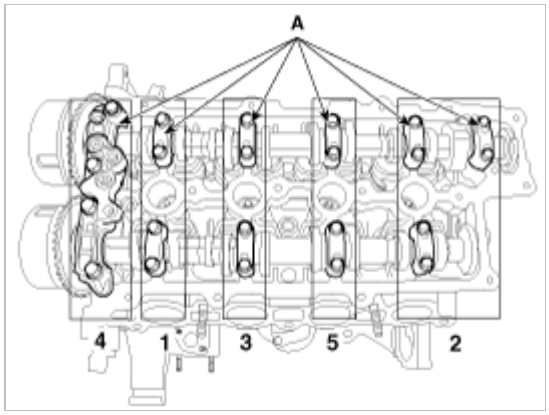
(2) Remove the timing chain. (Refer to Timing system)

> **CAUTION**
>
> Put paint marks on the timing chain links (2 places) that meet with the timing marks of the intake and exhaust CVVT sprockets.





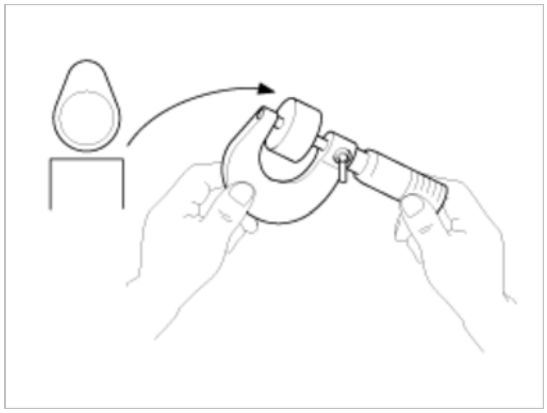
(3) Remove the camshaft bearing caps (A) with the order below.




(4) Remove the intake camshaft assembly.

(5) Remove the exhaust camshaft assembly.

(6) Measure the thickness of the removed tappet using a micrometer.



(7) Calculate the thickness of a new tappet so that the valve clearance comes within the specificified value.

Valve clearance (Engine coolant temperature : 20°C)
T : Thickness of removed tappet
A : Measured valve clearance
N : Thickness of new tappet
Intake : N = T + [A - 0.20mm(0.0079in.)]
Exhaust : N = T + [A - 0.25mm (0.0098in.)]

(8) Select a new tappet with a thickness as close as possible to the caculated value.

NOTE

Shims are available in 41 size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.690mm (0.1417in.)

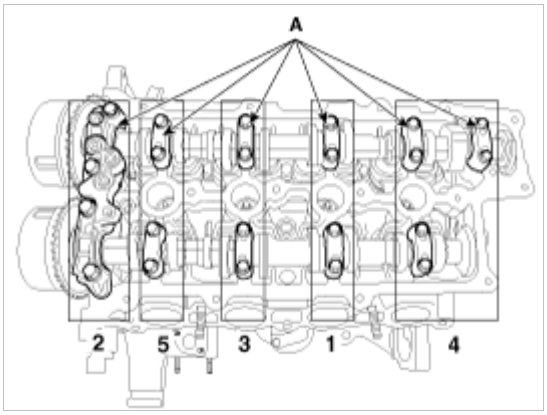
(9) Place a new tappet on the cylinder head.

(10) Install the exhaust camshaft assembly.

(11) Install the intake camshaft assembly.

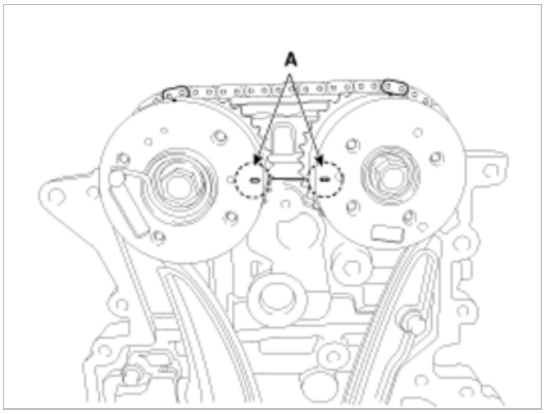
(12) Install the camshaft bearing caps with the order below.

**Tightening torque :**
1st step
M6 bolt :
5.9 N.m (0.6 kgf.m, 4.3 lb-ft)
M8 bolt :
9.8 N.m (1.0 kgf.m, 7.2 lb-ft)
2nd step
M6 bolts :
11.8 ~ 13.7N.m (1.2 ~ 1.4kgf.m, 8.7 ~ 10.1lb-ft)
M8 bolts :
18.6 ~ 22.6N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)




(13) Install the timing chain. (Refer to Timing system)

(14) Turn the crankshaft two turns in the operating direction(clockwise) and check that the marks of the intake and exhaust CVVT sprockets are in straight line on the cylinder head surface.




(15) Recheck the valve clearance.

Valve clearance (Engine coolant temperature : 20°C)
[Specification]
Intake : 0.17 ~ 0.23mm (0.0067 ~ 0.0091in.)
Exhaust : 0.22 ~ 0.28mm (0.0087 ~ 0.0110in.)

## Engine Mechanical System > General Information > Troubleshooting

### Troubleshooting

| Symptom | Suspect area | Remedy |
|---|---|---|
| Engine misfire with abnormal internal lower engine noises. | Loose or improperly installed engine flywheel. | Repair or replace the flywheel as required. |
| | Worn piston rings.<br>(Oil consumption may or may not cause the engine to misfire.) | Inspect the cylinder for a loss of compression . Repair or replace as required. |
| | Worn crankshaft thrust bearings. | Replace the crankshaft and bearings as required. |
| Engine misfire with abnormal valve train noise. | Stuck valves.<br>(Carbon buildup on the valve stem can cause the valve not to close properly.) | Repair or replace as required. |
| | Excessive worn or mis-aligned timing chain. | Replace the timing chain and sprocket as required. |

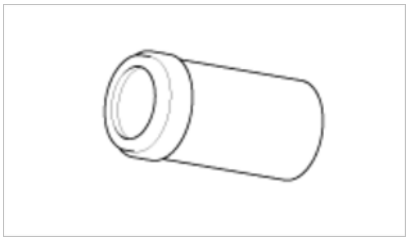
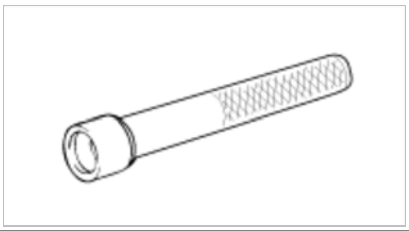
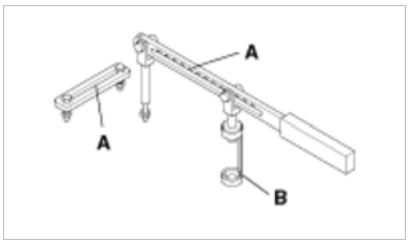
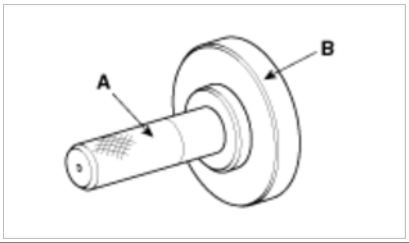
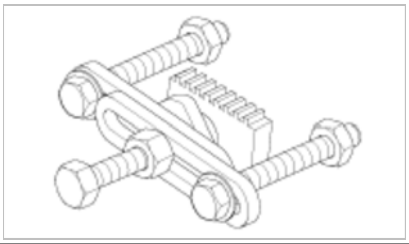
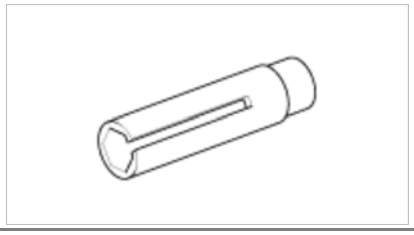
| | | |
|---|---|---|
| | Worn camshaft lobes. | Replace the camshaft and MLA. |
| Engine misfire with coolant consumption. | • Faulty cylinder head gasket and/or cracking or other damage to the cylinder head and engine block cooling system.<br>• Coolant consumption may or may not cause the engine to overheat. | • Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket.<br>• Repair or replace as required. |
| Engine misfire with excessive oil consumption. | Worn valves, valve guides and/or valve stem oil seals. | Repair or replace as required. |
| | Worn piston rings.<br>(Oil consumption may or may not cause the engine to misfire) | Inspection the cylinder for a loss of compression.<br>Repair or replace as required. |
| Engine noise on start-up, but only lasting a few seconds. | Incorrect oil viscosity. | Drain the oil.<br>Install the correct viscosity oil. |
| | Worn crankshaft thrust bearing. | Inspect the thrust bearing and crankshaft.<br>Repair or replace as required. |
| Upper engine noise, regardless of engine speed. | Low oil pressure. | Repair or replace as required. |
| | Broken valve spring. | Replace the valve spring. |
| | Worn or dirty valve lifters. | Replace the valve lifters. |
| | Stretched or broken timing chain and/or damaged sprocket teeth. | Replace the timing chain and sprockets. |
| | Worn timing chain tensioner, if applicable. | Replace the timing chain tensioner as required. |
| | Worn camshaft lobes. | Inspect the camshaft lobes.<br>Replace the camshaft and valve lifters as required. |
| | Worn valve guides or valve stems. | Inspect the valves and valve guides, then repair as required. |
| | Stuck valves. (Carbon on the valve stem or valve seat may cause the valve to stay open.) | Inspect the valves and valve guides, then repair as required. |
| Lower engine noise, regardless of engine speed. | Low oil pressure. | Repair or replace damaged components as required. |
| | Loose or damaged flywheel. | Repair or replace the flywheel. |
| | Damaged oil pan, contacting the oil pump screen. | Inspect the oil pan.<br>Inspect the oil pump screen.<br>Repair or replace as required. |
| | Oil pump screen loose, damaged or restricted. | Inspect the oil pump screen.<br>Repair or replace as required. |
| | Excessive piston-to-cylinder bore clearance. | Inspect the piston and cylinder bore.<br>Repair as required. |
| | Excessive piston pin-to-bore clearance. | Inspect the piston, piston pin and the connecting rod.<br>Repair or replace as required. |
| | Excessive connecting rod bearing clearance. | Inspect the following components and repair as required.<br>• The connecting rod bearings.<br>• The connecting rods. |

| | | |
|---|---|---|
| | | • The crankshaft.<br>• The crankshaft journal. |
| | Excessive crankshaft bearing clearance. | Inspect the following components and repair as required.<br>• The crankshaft bearings.<br>• The crankshaft journals. |
| | Incorrect piston, piston pin and connecting rod installation. | Verify the piston pins and connecting rods are installed correctly.<br>Repair as required. |
| Engine noise under load. | Low oil pressure. | Repair or replace as required. |
| | Excessive connecting rod bearing clearance. | Inspect the following components and repair as required.<br>• The connecting rod bearings.<br>• The connecting rods.<br>• The crankshaft. |
| | Excessive crankshaft bearing clearance. | Inspect the following components and repair as required.<br>• The crankshaft bearings.<br>• The crankshaft journals.<br>• The cylinder block crankshaft bearing bore. |
| Engine will not crank. (crankshaft will not rotate) | Hydraulically locked cylinder.<br>• Coolant/antifreeze in cylinder.<br>• Oil in cylinder.<br>• Fuel in cylinder. | Remove spark plugs and check for fluid.<br>Inspect for broken head gasket.<br>Inspect for cracked engine block or cylinder head.<br>Inspect for a sticking fuel injector and/or leaking fuel regulator. |
| | Broken timing chain and/or timing chain gears. | Inspect timing chain and gears.<br>Repair as required. |
| | Foreign material in cylinder.<br>• Broken valve.<br>• Piston material.<br>• Foreign material. | Inspect cylinder for damaged components and/or foreign materials.<br>Repair or replace as required. |
| | Seized crankshaft or connecting rod bearings. | Inspect crankshaft and connecting rod bearing.<br>Repair or replace as required. |
| | Bent or broken connecting rod. | Inspect connecting rods.<br>Repair or replace as required. |
| | Broken crankshaft. | Inspect crankshaft.<br>Repair or replace as required. |

## Engine Mechanical System > General Information > Special Service Tools

### Special Service Tools

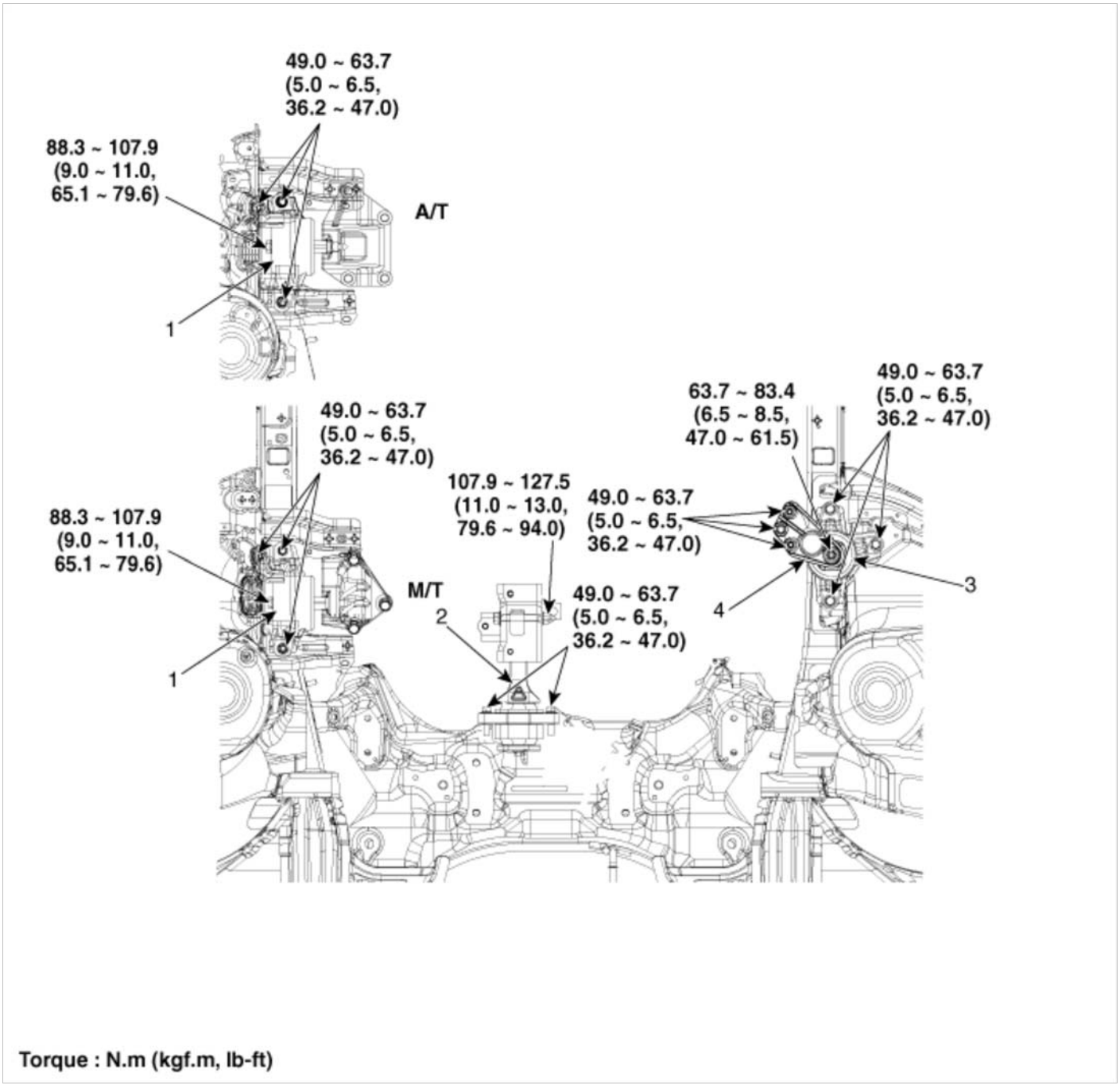
| Tool (Number and name) | Illustration | Use |
|---|---|---|

| | | |
|---|---|---|
| Crankshaft front oil seal installer<br>(09455-21200) |  | Installation of the front oil seal |
| Valve stem oil seal installer<br>(09222-2B100) |  | Installation of the valve stem oil seal |
| Valve spring compressor and holder<br>A : (09222-3K000)<br>B : (09222-3K100) |  | Removal and installation of the intake or exhaust valve |
| Crankshaft rear oil seal installer<br>A : (09231-H1100)<br>B : (09231-2B200) |  | Installation of the crankshaft rear oil seal |
| Ring gear stoppper<br>(09231-2B100) |  | Installation of crankshaft pulley bolt |
| Engine coolant temperature sensor socket wrench<br>(09221-25100) |  | Removal and installation of engine coolant sensor |
| Oil pan remover<br>(09215-3C000) |  | Removal of oil pan |

| | | |
|---|---|---|
| Torque angle adapter (09221-4A000) |  | Installation of bolts & nuts needing an angular method |

## Engine Mechanical System > Engine And Transaxle Assembly > Engine Mounting > Components and Components Location

### Components



| | |
|---|---|
| 1. Transaxle mounting bracket<br>2. Roll rod bracket | 3. Engine mounting bracket<br>4. Engine mounting support bracket |

## Engine Mechanical System > Engine And Transaxle Assembly > Engine And Transaxle Assembly > Repair procedures

### Removal

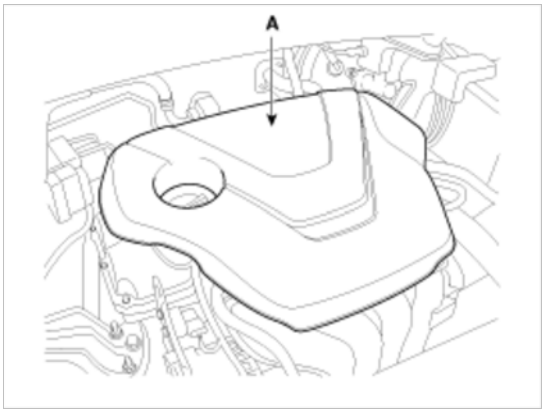
**CAUTION**

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

**NOTE**

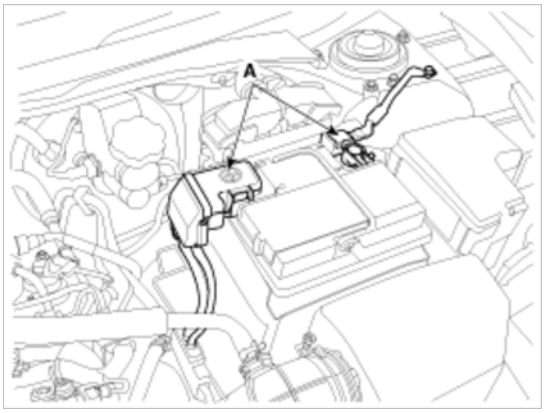
- Mark all wiring and hoses to avoid misconnection.
- To release the fuel system pressure before removing the engine assembly, start the engine with the fuel pump relay removed. And then turn off the ignition switch after engine stops.

1. Remove the engine cover (A).



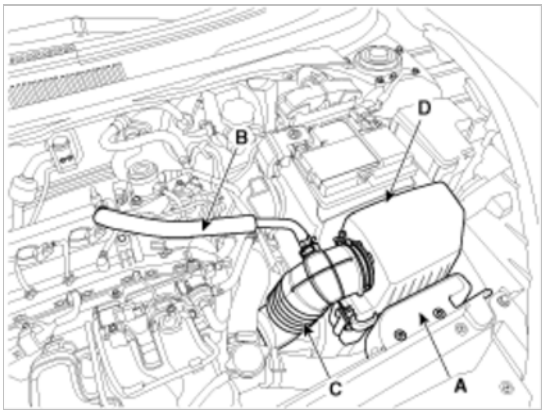

2. Disconnect the battery terminals (A). Disconnect the negative terminal first.

**Tightening torque :**
(+) terminal :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (without battery sensor):
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (with battery sensor):
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)



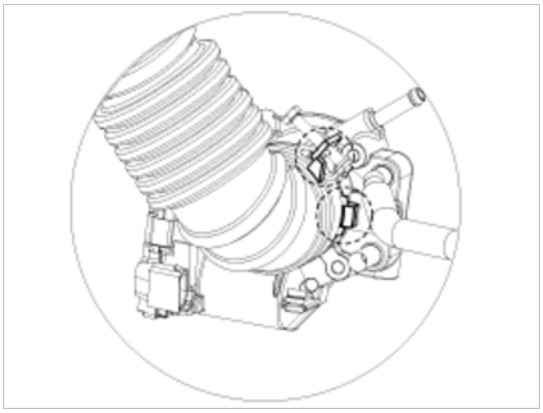

3. Remove the air cleaner assembly.
   (1) Remove the air duct (A).
   (2) Disconnect the breather hose (B).
   (3) Disconnect the air intake hose (C) and then remove the air cleaner assembly (D).

**Tightening torque**
Hose clamp bolt:
2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)
Air cleaner assembly bolts:
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



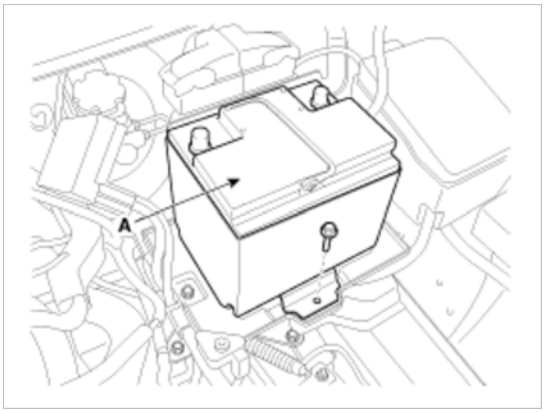

NOTE

- Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.
- Install the air intake hose while the groove of hose must be matched to the protrusion of the throttle body.



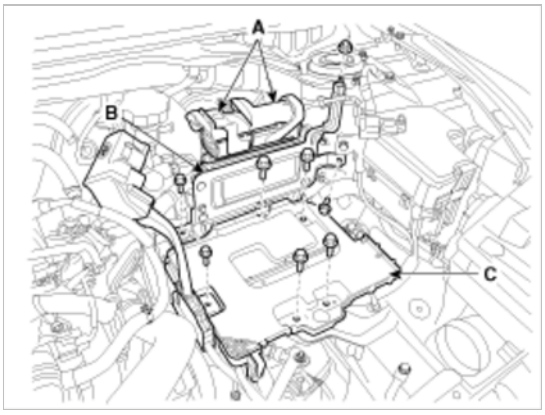
4. Remove the battery (A) after removing the mounting bracket.

**Tightening torque:**
8.8 ~ 13.7N.m (0.9 ~ 1.4kgf.m, 6.5 ~ 10.1lb-ft)



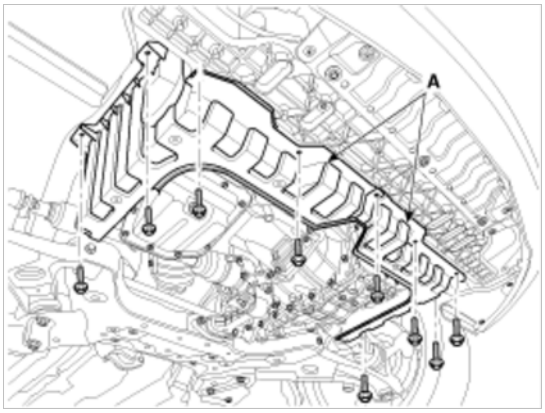

5. Disconnect the ECM connectors (A) and then remove the ECM (B) and the battery tray (C).

**Tightening torque**
ECM bracket bolts & nut :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
Battery tray bolts :
8.8 ~ 13.7N.m (0.9 ~ 1.4kgf.m, 6.5 ~ 10.1lb-ft)



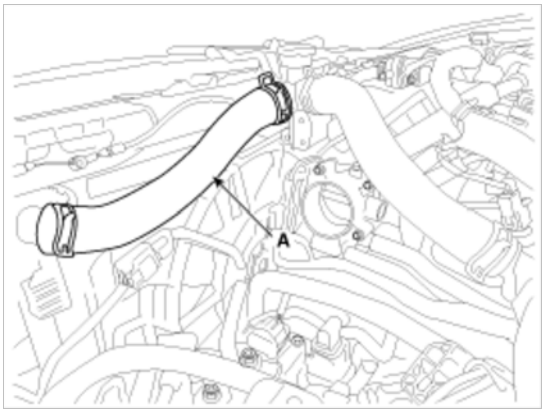

6. Remove the under cover (A).

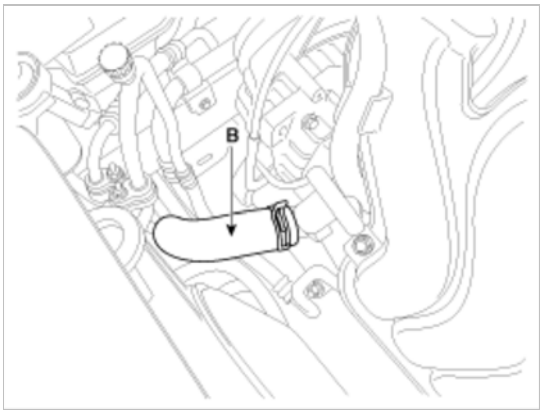
**Tightening torque:**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)




7. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to drain with speed. (Refer to Cooling system in this group)

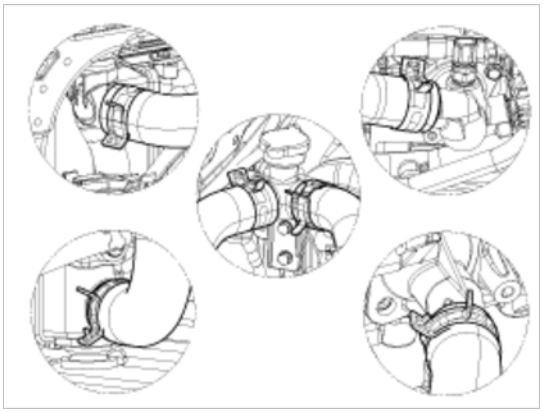
8. Disconnect the radiator upper hose (A) and lower hose (B).



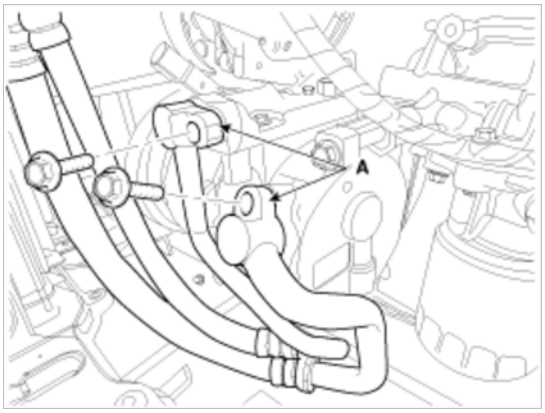




NOTE

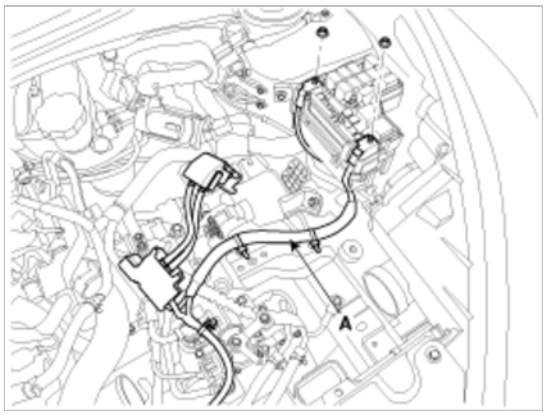
Install the radiator hoses as shown illustrations.



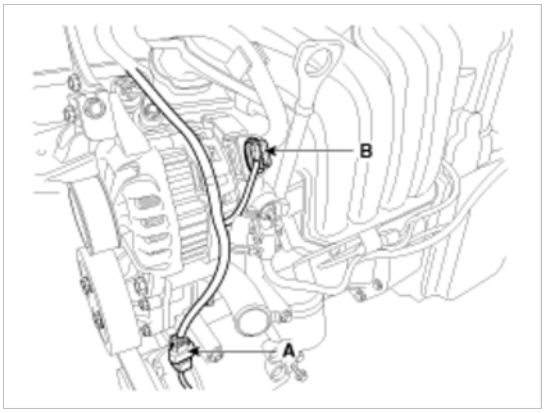
9. Recover the refrigerant and then remove the high pressure pipe and low pressure pipe (A). (Refer to Air conditioning system in HA Group.)



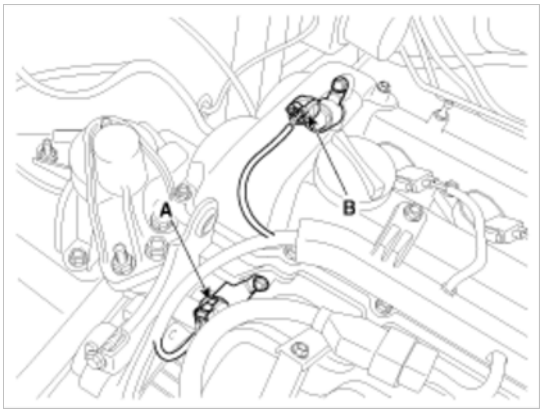

10. Disconnect the (+) cable (A) from the fuse/relay box.



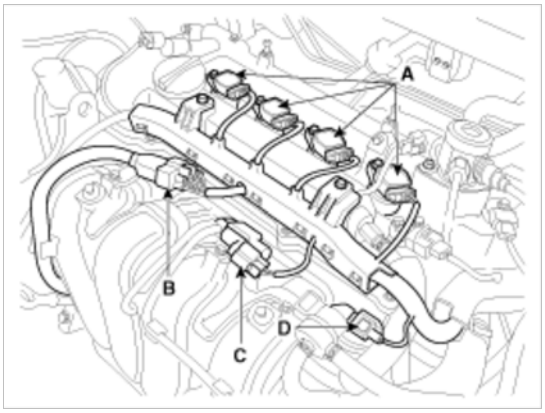

11. Disconnect the wiring connectors and harness clamps, and remove the wiring and protectors from the cylinder head and intake manifold.
    (1) The A/C compressor switch connector (A) and the alternator connector (B)



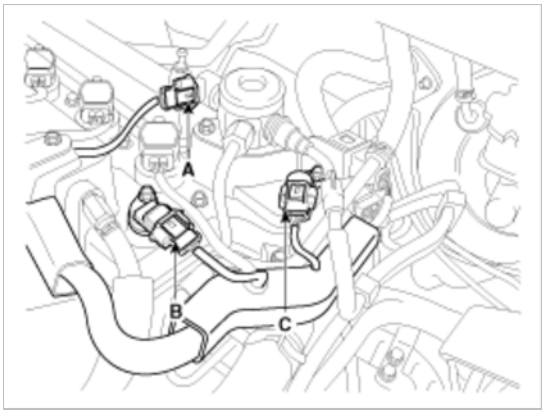

    (2) The intake OCV (Oil control valve) connector (A) and the exhaust OCV (Oil control valve) connector (B)



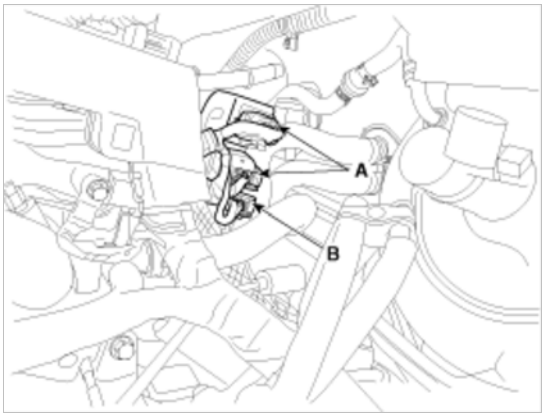
(3) The ignition coil connectors (A), the injector extension connector (B), the VIS (Variable intake system) connector (C) and the PCSV (Purge control solenoid valve) connector (D)



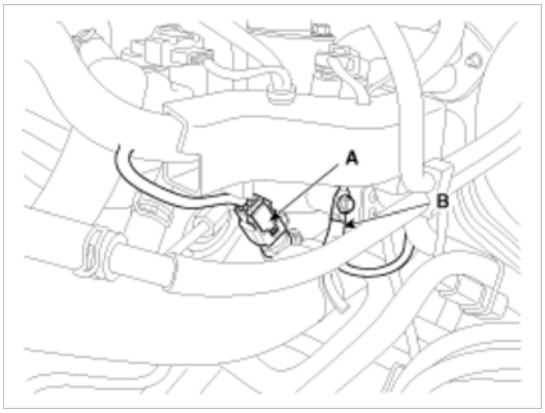

(4) The FPCV (Fuel pressure control valve) connector (A), the intake CMPS (Camshaft position sensor) connector (B) and the exhaust CMPS (Camshaft position sensor) connector (C)



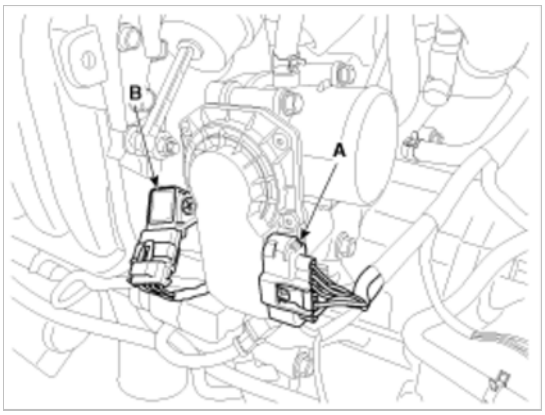

(5) The oxygen sensor connectors (A) and the condenser connector (B)



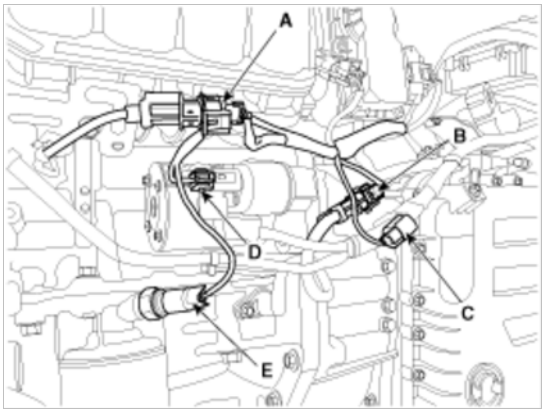

(6) The ECTS (Engine coolant temperature sensor) connector (A) and the ground line (B)



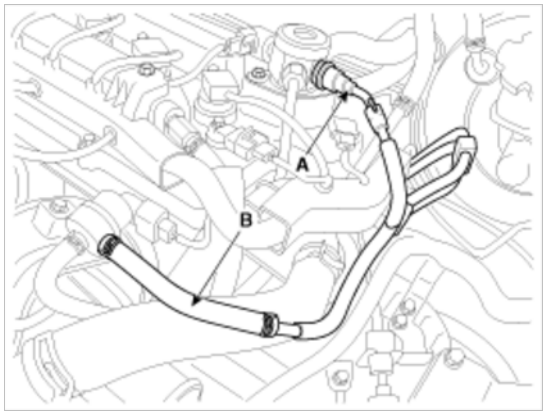

(7) The ETC (Electronic throttle control) connector (A) and the MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B)



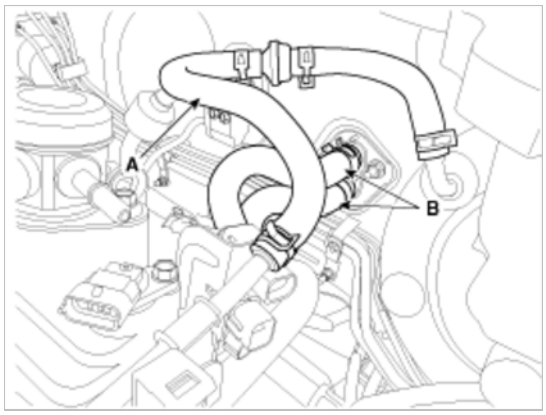

(8) The knock sensor connector (A), the CKPS (Crankshaft position sensor) connector (B), the front connector (C), the starter connector (D) and the oil pressure connector (E)




12. Remove the transaxle wire harness connectors and control cable from the transaxle. (Refer to AT or MT group).
13. Disconnect the fuel hose (A) and the PCSV (Purge control solenoid valve) hose (B).

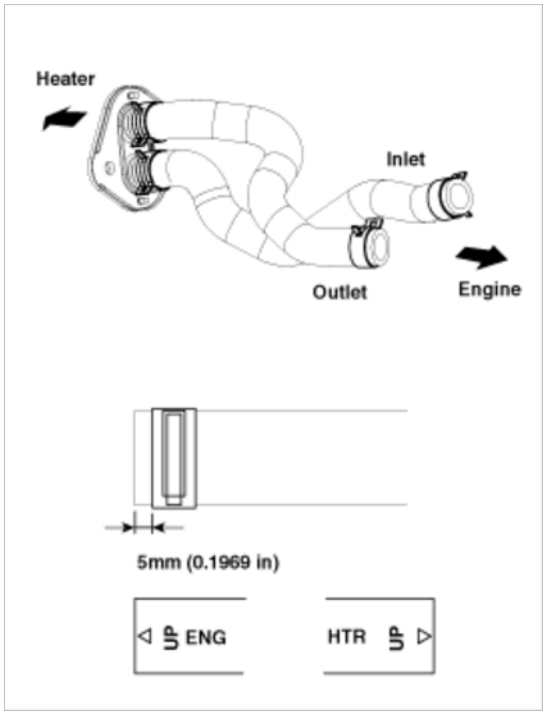



14. Disconnect the brake booster vacuum hose (A) and the heater hose (B).

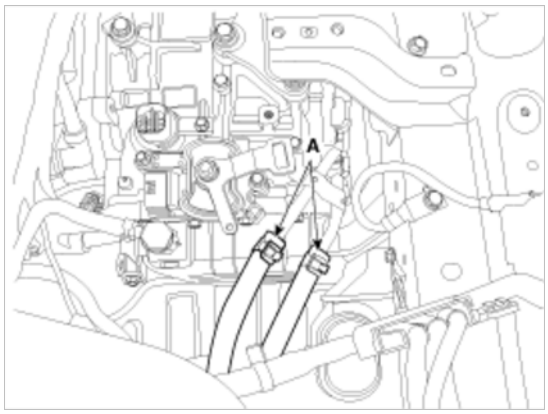



NOTE

Install the heater hoses as shown illustrations.

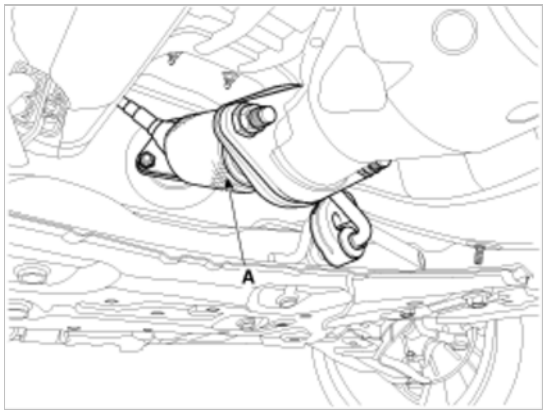



15. Disconnect the ATF cooler hoses (A). (Refer to AT group)

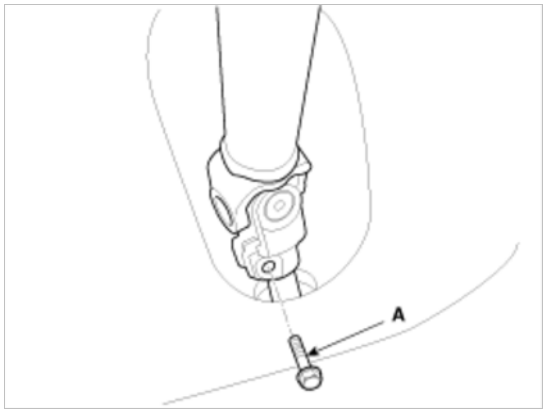



16. Remove the front muffler (A) after removing the rear oxygen sensor connector from the bracket.

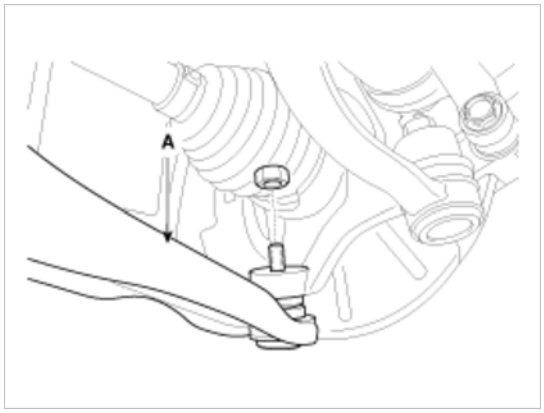
**Tightening torque:**
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)



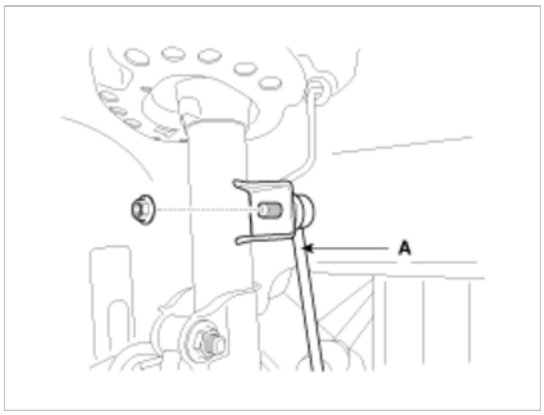

17. Remove the steering u-joint mounting bolt (A). (Refer to ST group)



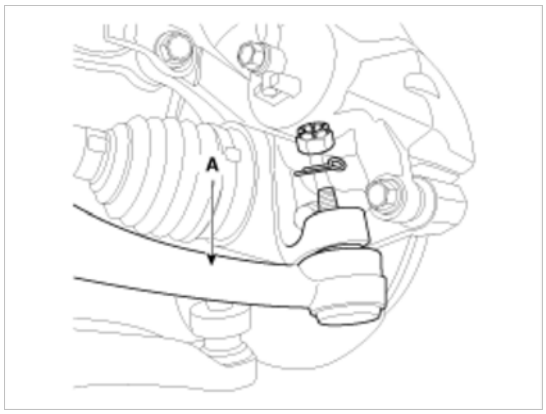

18. Remove the front wheels. (Refer to SS group)
19. Remove the lower arms (A). (Refer to SS group)




20. Remove the stabilizer bar links (A). (Refer to SS group)

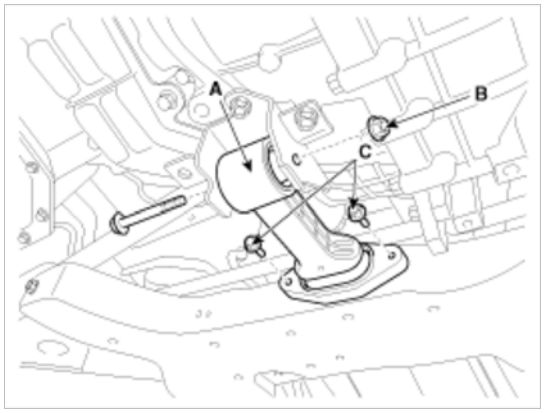



21. Remove the tie rod ends (A). (Refer to ST group)



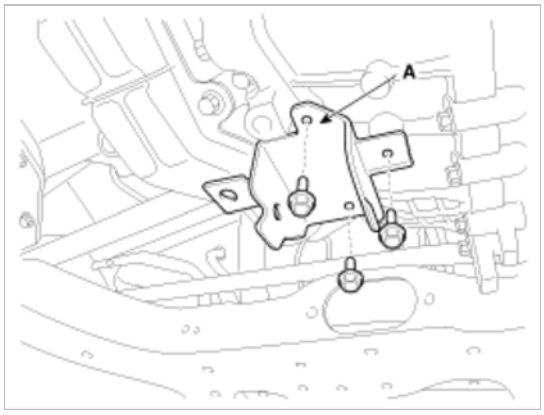

22. Disconnect the drive shafts from the axle hubs. (Refer to DS group)
23. Remove the roll rod bracket (A).

**Tightening torque**
Nut (B) :
107.9 ~ 127.5 N.m (11.0 ~ 13.0 kgf.m, 79.6 ~ 94.0 lb-ft)
Bolt (C) :
49.0 ~ 63.7 N.m (5.0 ~ 6.5 kgf.m, 36.2 ~ 47.0 lb-ft)



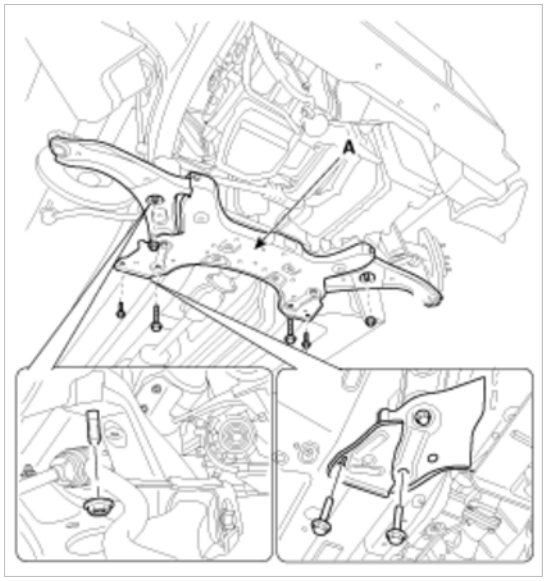

24. Remove the roll rod mounting support bracket (A).

**Tightening torque:**
49.0 ~ 68.6 N.m (5.0 ~ 7.0 kgf.m, 36.2 ~ 50.6 lb-ft)




25. Support the sub frame (A) with a floor jack, and then remove the sub frame mounting bolts and nuts. (Refer to SS group)

**Tightening torque**
Sub frame mounting bolts & nuts :
156.9 ~ 176.5 N.m (16.0 ~ 18.0 kgf.m, 115.7 ~ 130.2 lb-ft)
Sub frame stay mounting bolts :
44.1 ~ 53.9 N.m (4.5 ~ 5.5 kgf.m, 32.5 ~ 39.8 lb-ft)

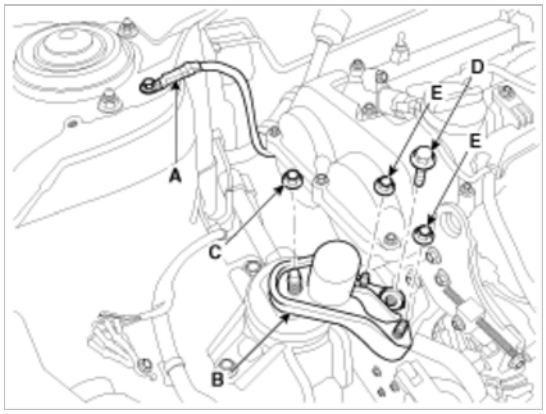


NOTE

- After removing the sub frame mounting bolts and nuts, the engine and transaxle assembly may fall downward, and so support them securely with floor jack.
- Verify that the hoses and connectors are disconnected before removing the engine and transaxle assembly.

26. Disconnect the ground line (A) and then remove the engine mounting support bracket (B).

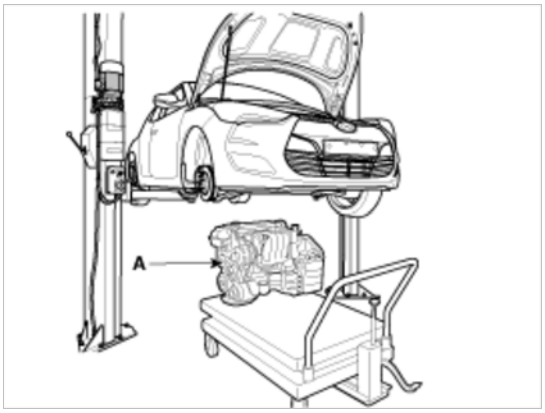
**Tightening torque**
Ground line bolt :
10.8 ~ 13.7 N.m (1.1 ~ 1.4 kgf.m, 8.0 ~ 10.1 lb-ft)
Nut (C) :
63.7 ~ 83.4 N.m (6.5 ~ 8.5 kgf.m, 47.0 ~ 61.5 lb-ft)
Bolt (D) and nuts (E) :
49.0 ~ 63.7 N.m (5.0 ~ 6.5 kgf.m, 36.2 ~ 47.0 lb-ft)




27. Disconnect the ground line (A), and then remove the transaxle mounting bracket bolts (B).

**Tightening torque:**
88.3 ~ 107.9 N.m (9.0 ~ 11.0 kgf.m, 65.1 ~ 79.6 lb-ft)


28. Remove the engine and transaxle assembly (A) by lifting vehicle.




CAUTION

When remove the engine and transaxle assembly, be careful not to damage any surrounding parts or body components.

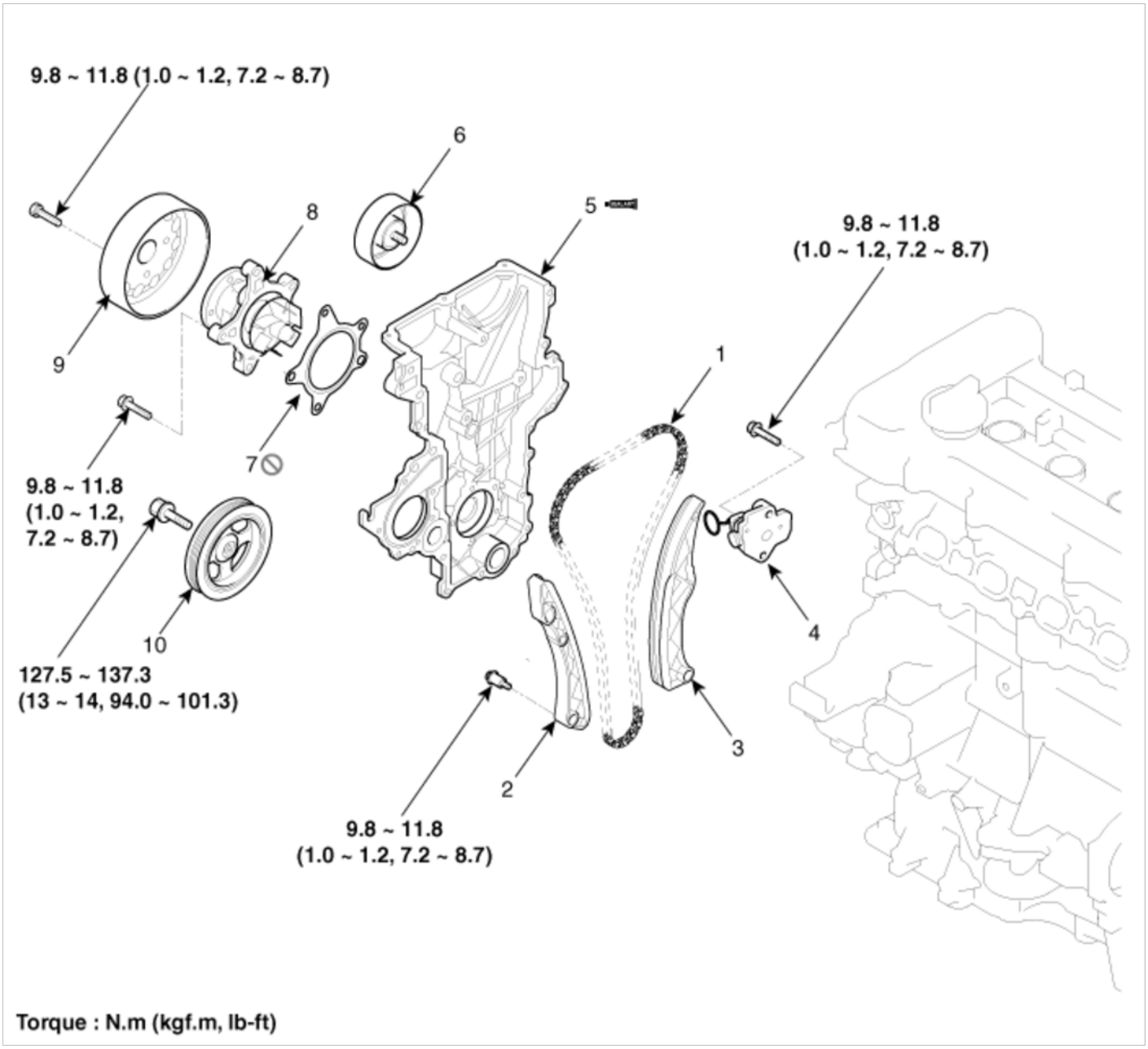
### Installation

Installation is in the reverse order of removal.
Perform the following :

- Adjust a shift cable.
- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill power steering fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- Clean battery posts and cable terminals and assemble.
- Inspect for fuel leakage.
  - After assemble the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
  - Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.
- Bleed air from the cooling system.
  - Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
  - Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
  - Put radiator cap on tightly, then run the engine again and check for leaks.

## Engine Mechanical System > Timing System > Timing Chain > Components and Components Location

### Components




| | |
|---|---|
| 1. Timing chain | 6. Drive belt idler |
| 2. Timing chain guide | 7. Water pump gasket |
| 3. Timing chain arm | 8. Water pump |
| 4. Timing chain auto tensionr | 9. Water pump pulley |
| 5. Timing chain cover | 10. Crank shaft pulley |

## Engine Mechanical System > Timing System > Timing Chain > Repair procedures

### Removal

Engine removal is not required for this procedure.

CAUTION

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

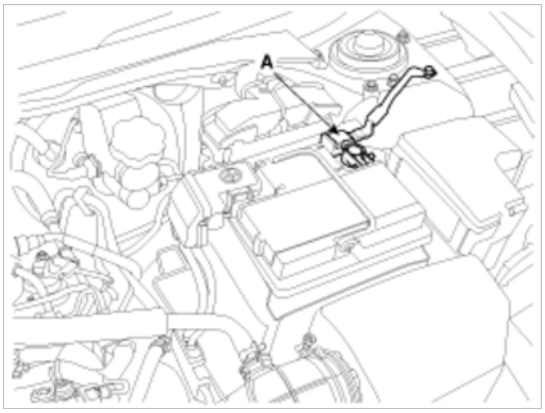
NOTE

Mark all wiring and hoses to avoid misconnection.

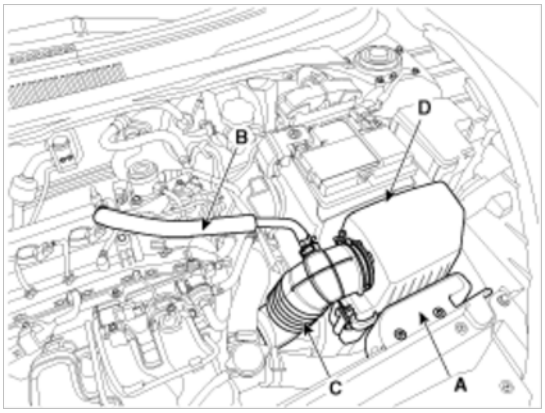
WARNING

In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

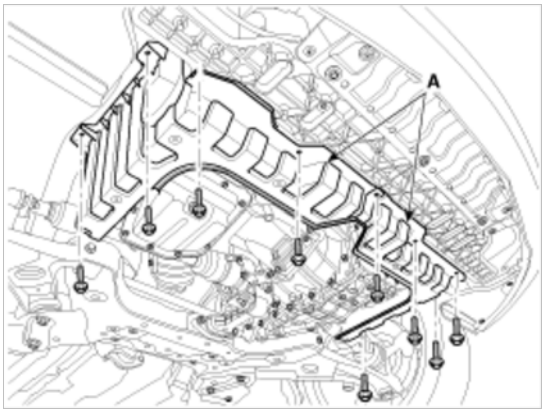
1. Remove the engine cover.
2. Disconnect the battery negative terminal (A).



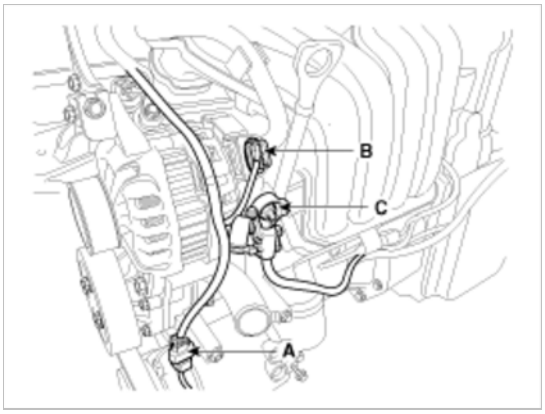

3. Remove the air cleaner assembly.
   (1) Remove the air duct (A).
   (2) Disconnect the breather hose (B).
   (3) Disconnect the air intake hose (C) and then remove the air cleaner assembly (D).



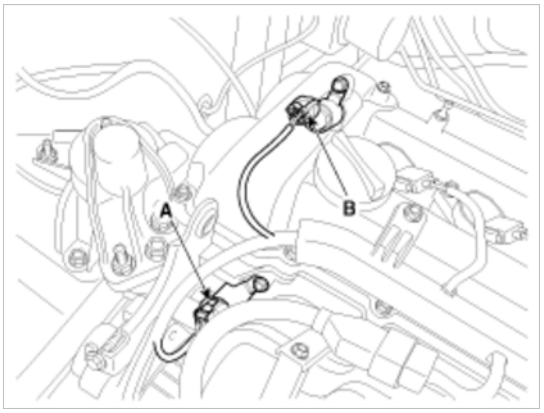

4. Remove the RH front wheel.
5. Remove the under covers (A).



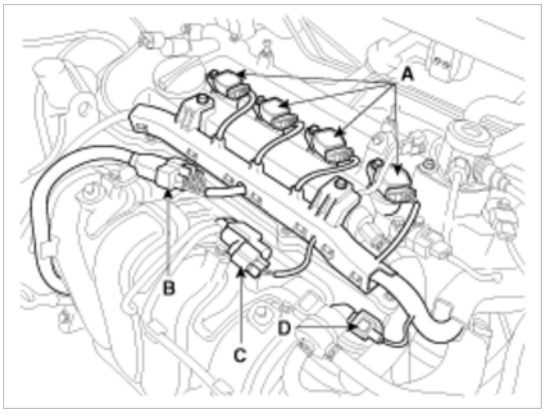

6. Disconnect the A/C compressor switch connector (A), the alternator connector (B) and the cable from the alternator “B” terminal (C).



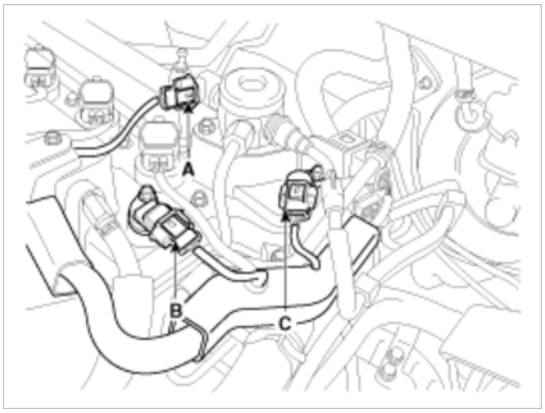

7. Disconnect the intake OCV (Oil control valve) connector (A) and the exhaust OCV (Oil control valve) connector (B).



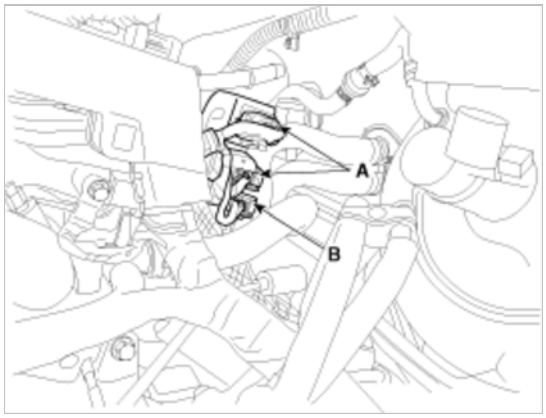

8. Disconnect the ignition coil connectors (A), the injector extension connector (B), the VIS (Variable intake system) connector (C) and the PCSV (Purge control solenoid valve) connector (D).



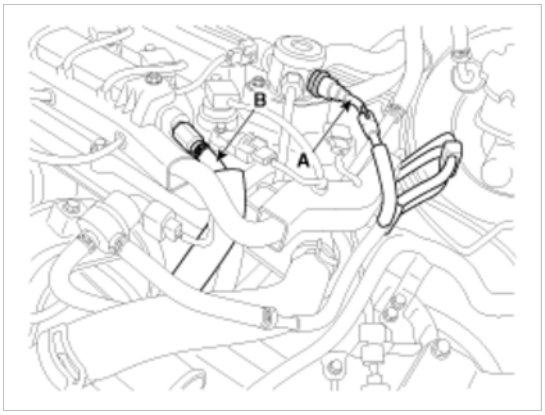
9. Disconnect the FPCV (Fuel pressure control valve) connector (A), the intake CMPS (Camshaft position sensor) connector (B) and the exhaust CMPS (Camshaft position sensor) connector (C).



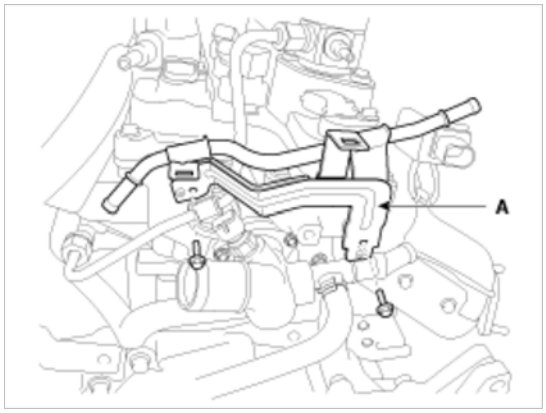

10. Disconnect the oxygen sensor connectors (A) and the condenser connector (B).



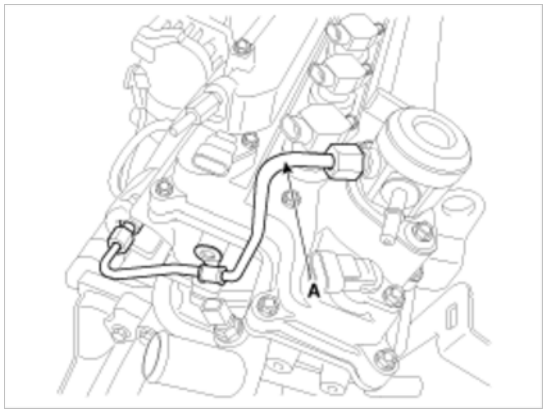

11. Disconnect the fuel hose (A) and the PCV (Positive crankcase ventilation) hose (B).



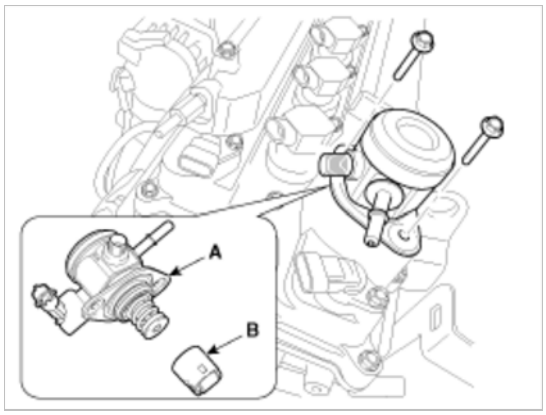

12. Remove the vacuum pipe assembly (A).



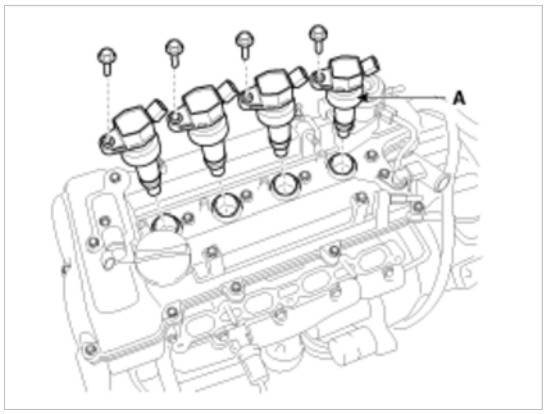
13. Remove the high pressure pipe (A). (Refer to FL group)



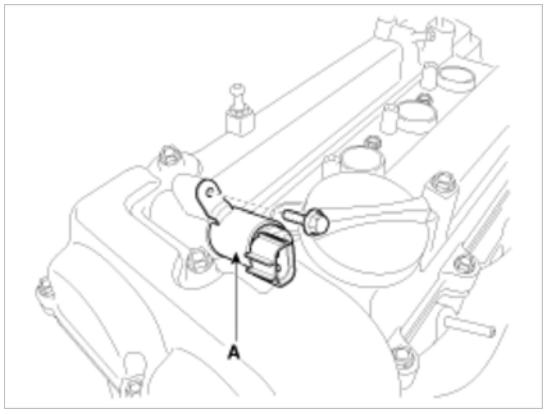

14. Remove the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)



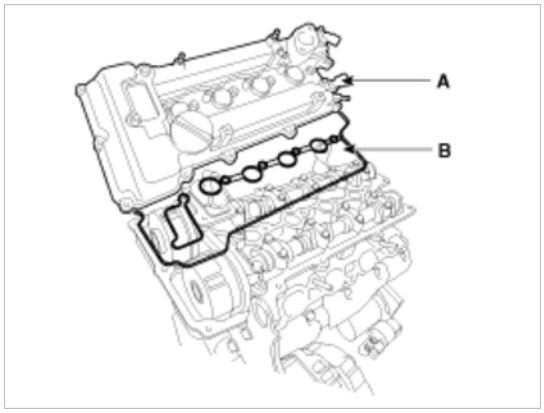

15. Remove the ignition coils (A).



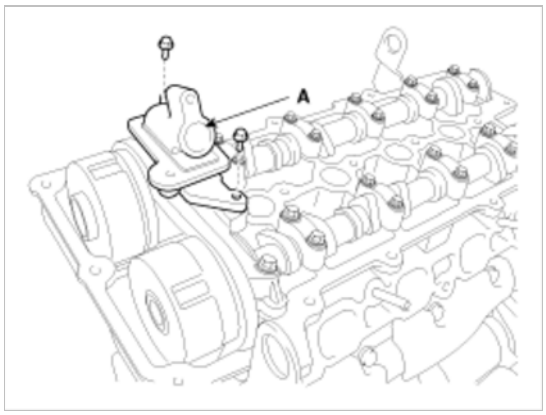

16. Remove the exhaust OCV (Oil control valve) (B).



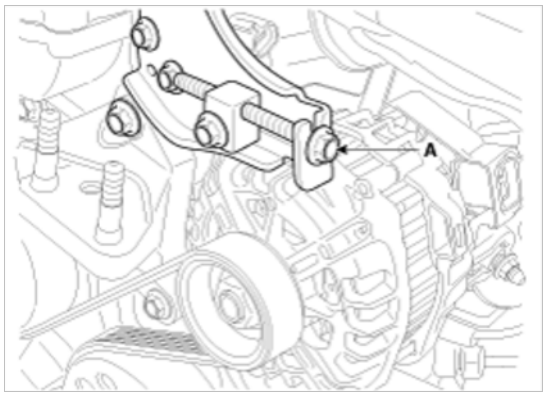

17. Remove the cylinder head cover (A) with gaskets (B).



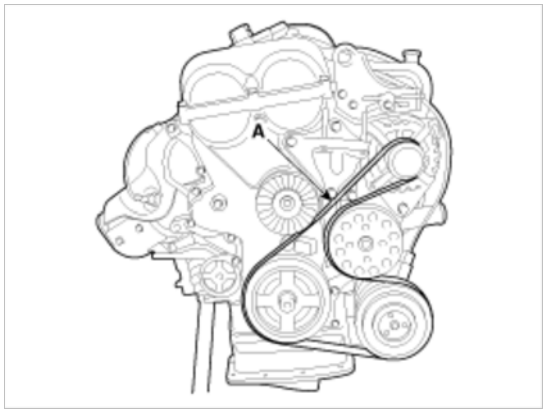

18. Remove the exhaust OCV (Oil control valve) adapter (A).



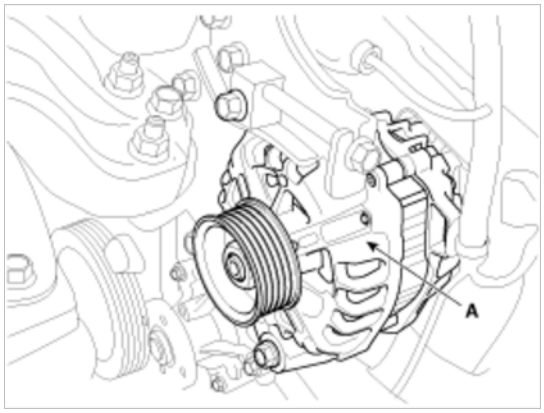

19. Loosen the water pump pulley bolt and the drive idler mounting bolt.
20. Loosen the alternator tension adjusting bolt (A) to loosen tension.



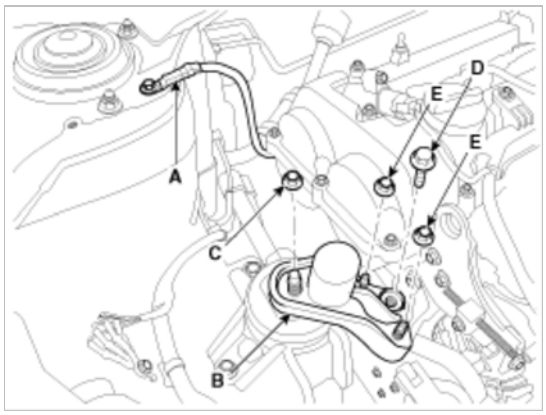

21. Remove the alternator drive belt (A).




22. Remove the alternator (A). (Refer to Altemator in EE Group).



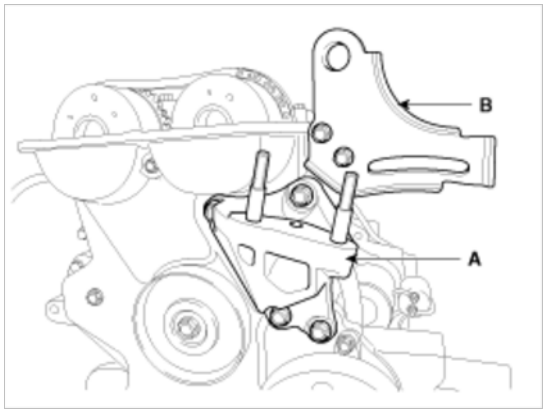

23. Disconnect the ground line (A) and then remove the engine mounting support bracket (A).



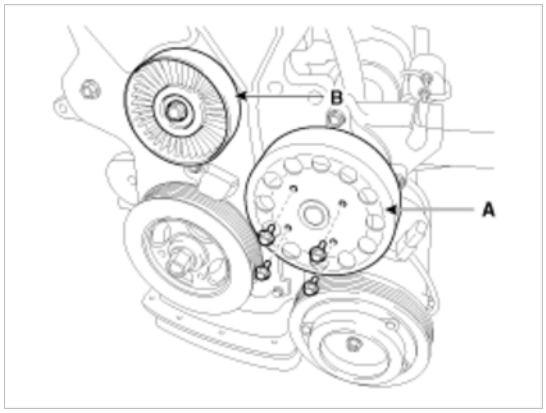

NOTE

Support the engine with a jack not to be tilted.

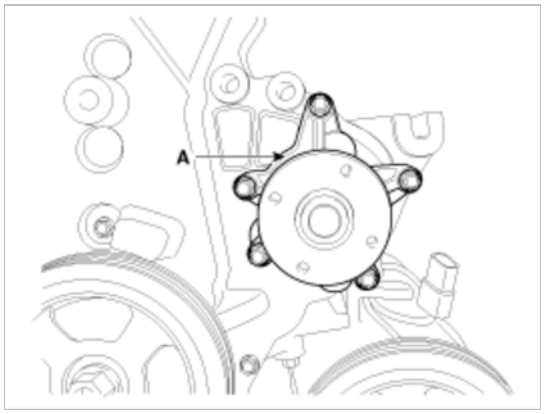
24. Remove the alternator bracket (B).
25. Remove the engine support bracket (A).



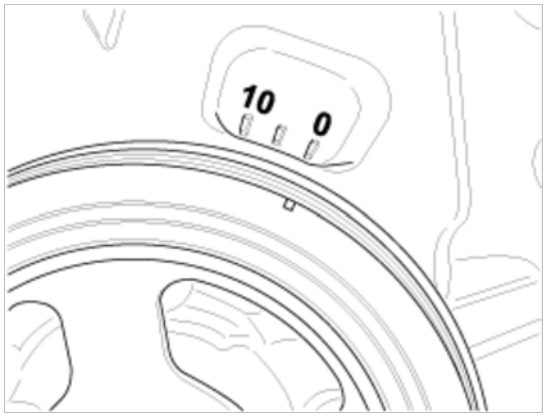

26. Remove the water pump pulley (A) and the drive belt idler (B).



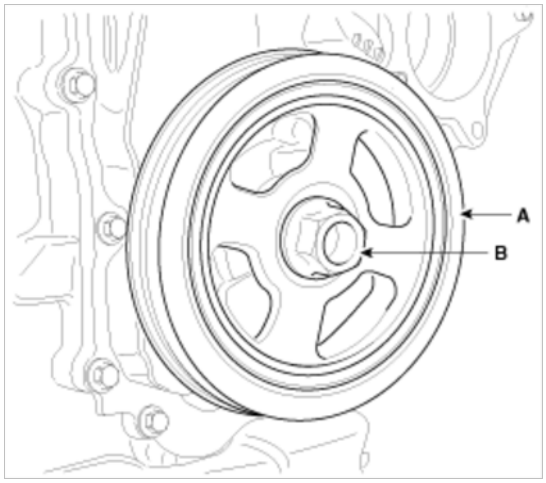

27. Remove the water pump (A).




28. Turn the crankshaft pulley clockwise, and align its groove with the timing mark of the timing chain cover.



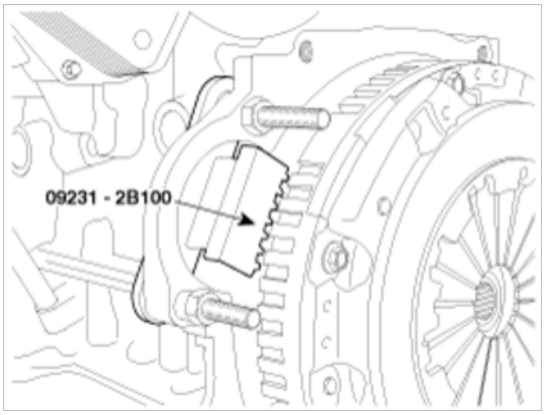

29. Remove the crankshaft bolt (B) and crankshaft pulley (A).



NOTE

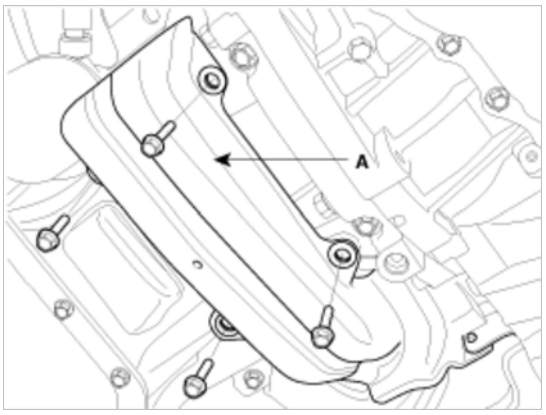
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

- Install the SST (09231-2B100) to hold the ring gear after removing the starter.

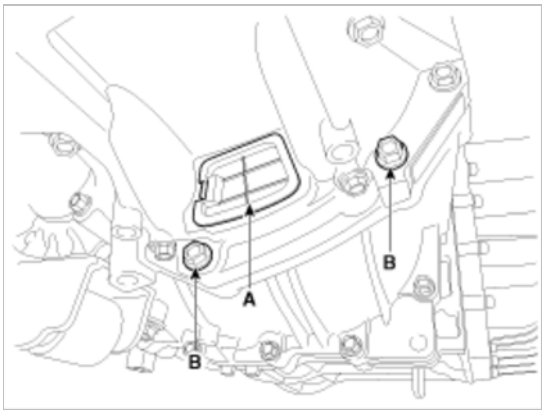



- Install the SST (09231-3D100) to hold the ring gear after removing the dust cover.

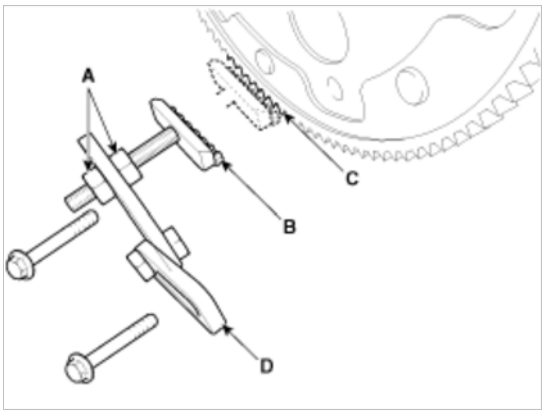
1. Remove the bracket (A).



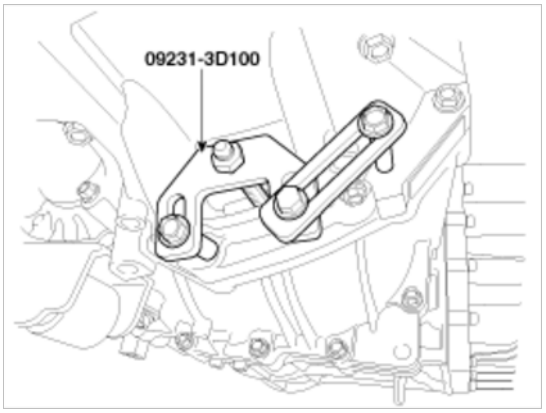

2. Remove the dust cover (A) and unfasten the transaxle mounting bolt (B).



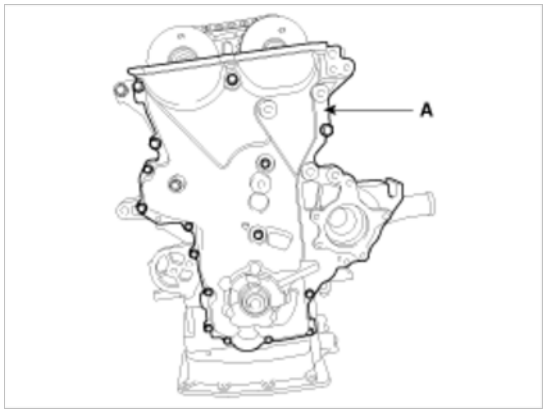

3. Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.
4. Adjust the angle of the links (D), and fasten the bolt 70mm(2.7559in) in the original mounted hole.




5. Tighten the bolts and nuts of the holder and links securely.



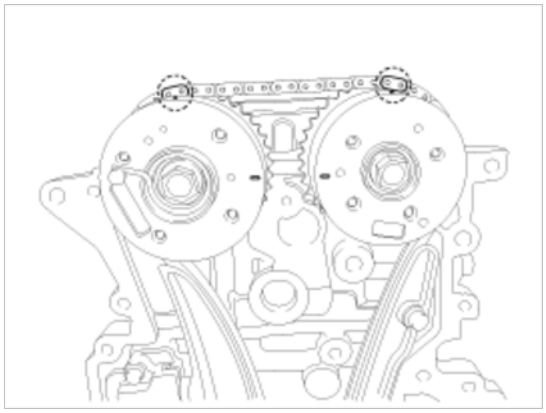

30. Remove the timing chain cover (A).

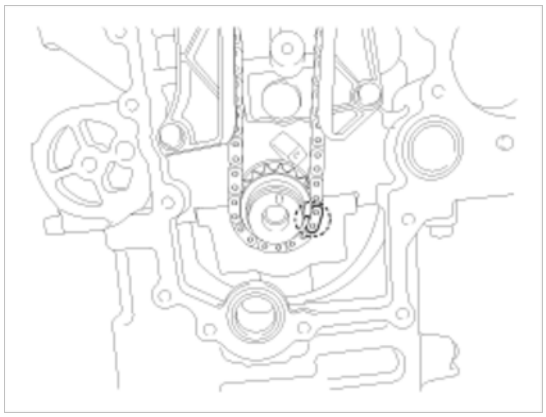



31. Align the timing marks of the CVVT sprockets with the upper surface of the cylinder head to make No.1 cylinder be positioned at TDC.
    (1) Check the dowel pin of the crankshaft for facing upside of the engine at this monent.

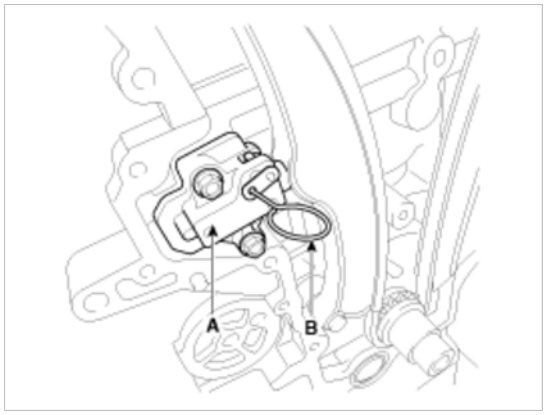
CAUTION

Put paint marks on the timing chain links(3 places) that meet with the timing marks of the CVVT sprockets(In, Ex : 2) and the CVVT sprocket.





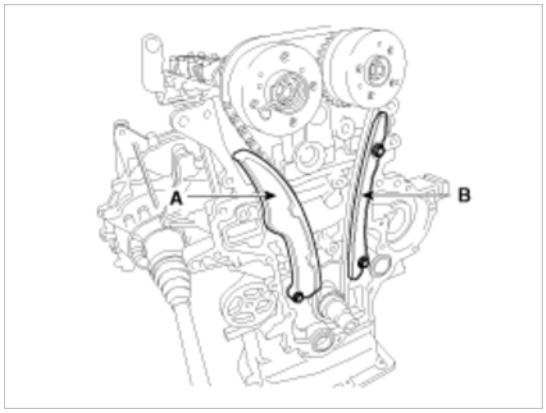
32. Remove the hydraulic tensioner (A).



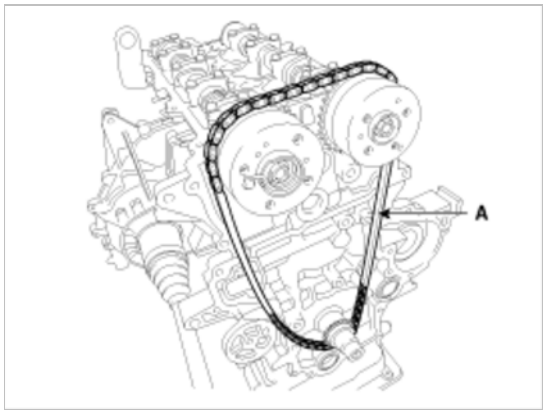

CAUTION

Before removing the tensioner, fix the piston of the tensioner with a pin through the hole(B) at compressed position.

33. Remove the timing chain tensioner arm (A) and guide (B).




34. Remove the timing chain (A).




## Inspection

**Sprockets, Hydraulic Tensioner, Chain Guide, Tensioner Arm, Timing Chain**

1. Check the CVVT sprocket, crankshaft sprocket teeth for abnormal wear, cracks or damage. Replace if necessary.
2. Check a contact surface of the chain tensioner arm and guide for abnormal wear, cracks or damage. Replace if necessary.
3. Check the hydraulic tensioner for its piston stroke and ratchet operation. Replace if necessary.
4. Check the timing chain for its elongation, abnormal wear or damage. Replace if necessary.

## Belt, Idler, Pulley

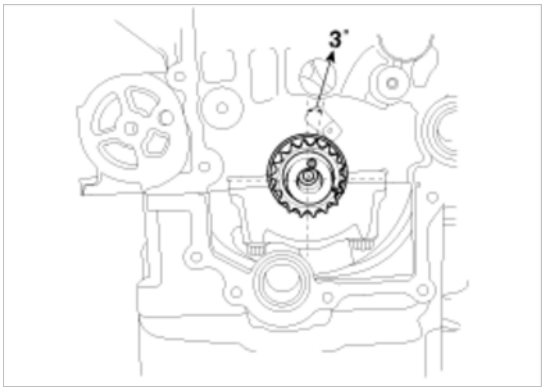
1. Check the idler for excessive oil leakage, abnormal rotation or vibration. Replace if necssery.
2. Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necssery.
3. Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necssery.

NOTE

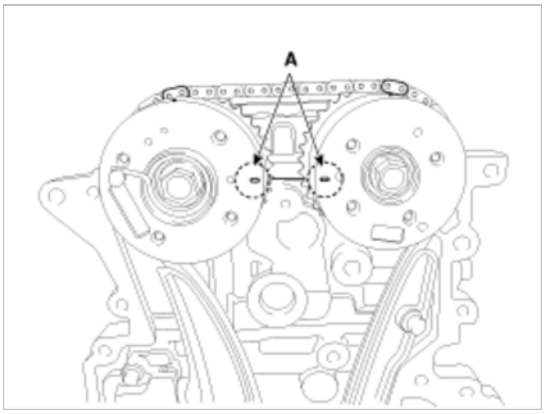
- Do not bend, twist or turn the timing chain inside out.
- Do not allow the timing chain to come into contact with oil, water and steam.

## Installation

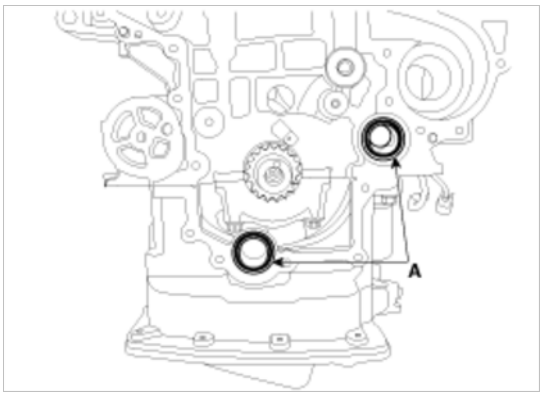
1. Dowel pin of crankshaft should be positioned at 3° in relation to vertical center line.




2. Align the TDC marks (A) of the CVVT sprockets with the upper surface of the cylinder head to make No.1 cylinder be positioned at TDC.

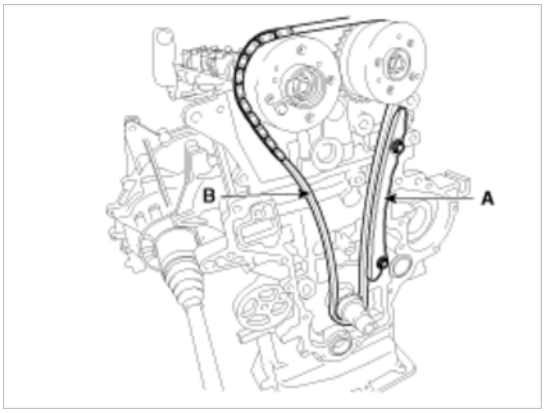



3. Install the new O-rings (A).




4. Install the timing chain guide (A) and the timing chain (B).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

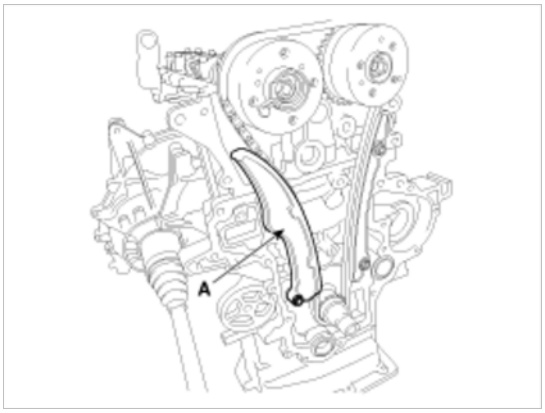



NOTE

When installing a timing chain, align the timing marks on the sprockets with paint marks of the chain.
Order : Crankshaft sprocket → Timing chain guide → Intake CVVT sprocket → Exhaust CVVT sprocket.

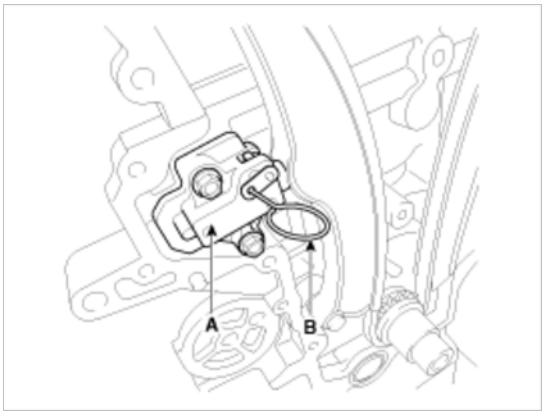
5. Install the chain tensioner arm (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)




6. Install the hydraulic tensioner (A) and remove the pin (B).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)




NOTE

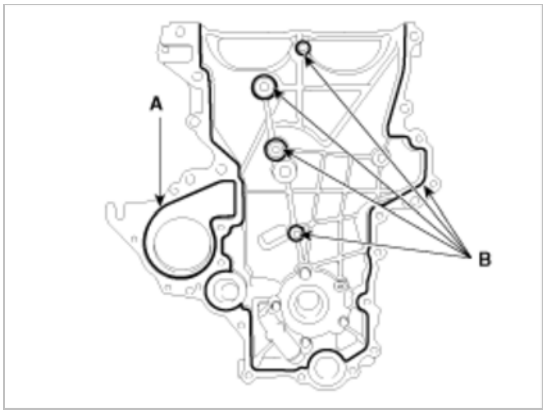
Recheck the top dead center (TDC) marks on the crankshaft and camshaft.

7. Install the timing chain cover.
   (1) Before installing, remove the hardened sealant from the cylinder block and ladder frame surface.
   (2) Apply the liquid gasket(TB 1217H or LOCTITE 5900H) on the surface between the cylinder head and the cylinder block.

   **Width :** 3 ~ 5mm (0.1181~0.1969in.)

   (3) Apply the liquid gasket, THREE BOND 1282B or THREE BOND 1216E on the water pump contact parts (A) of the timing chain cover and Hyundai Gray RTV or THREE BOND 1217H or LOCTITE 5900H on the rest parts (B). Reassemble the cover within 5 minutes.

   **Width :** 3.5 ~ 4.5 mm (0.1378 ~ 0.1772 in.)

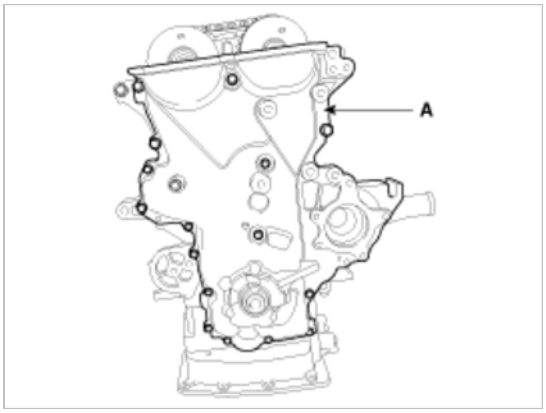



CAUTION

Remove oil or dust on the surface surely.

   (4) Align the dowel pin of the cylinder block and the holes of the oil pump.
   (5) Tighten the bolts to install the timing chain cover (A).

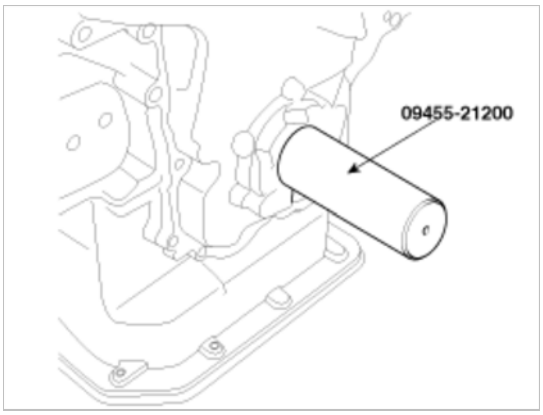
   **Tightening torque :**
   M8 bolts :
   18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)
   M6 bolts :
   9.8 ~ 11.8 Nm (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



CAUTION

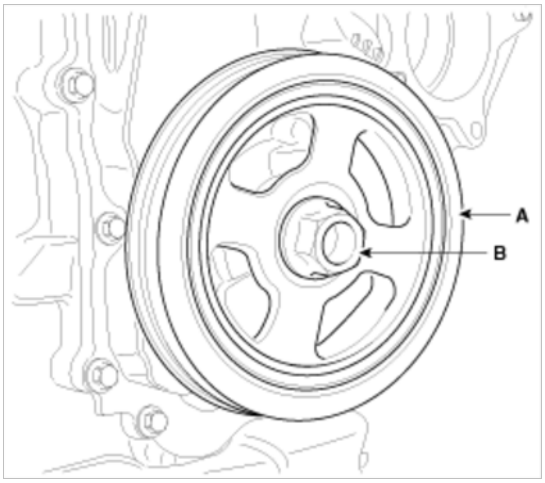
After the installation, do not crank engine or apply pressure on the cover for half an hour.

8. Using the SST(09455-21200), reassemble the timing chain cover oil seal.




9. Install the crankshaft pulley (A).

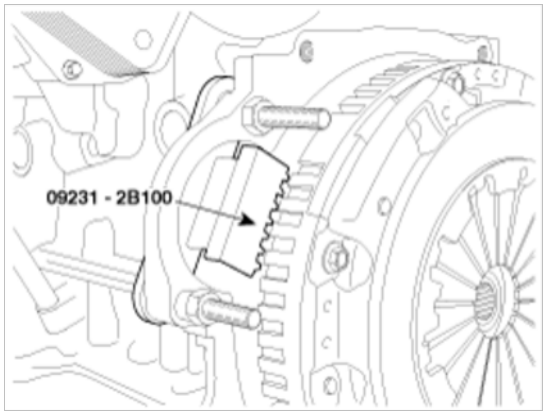
**Tightening torque :**
127.5 ~ 137.3 N.m (13.0 ~ 14.0 kgf.m, 94.0 ~ 101.3 lb-ft)




NOTE

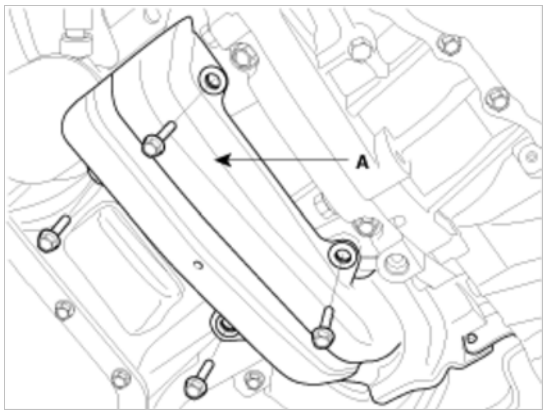
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

- Install the SST (09231-2B100) to hold the ring gear after removing the starter.

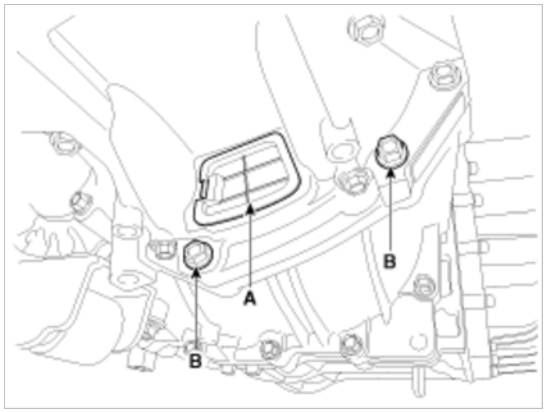



- Install the SST (09231-3D100) to hold the ring gear after removing the dust cover.

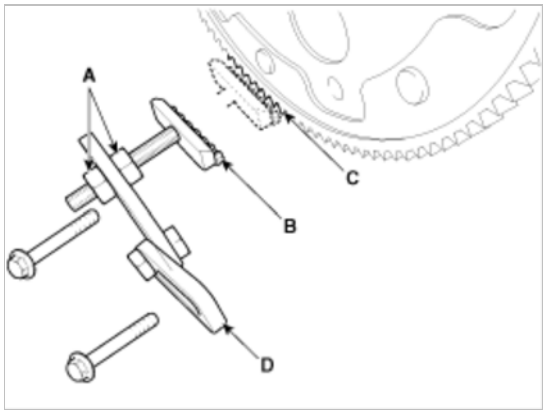
1. Remove the bracket (A).



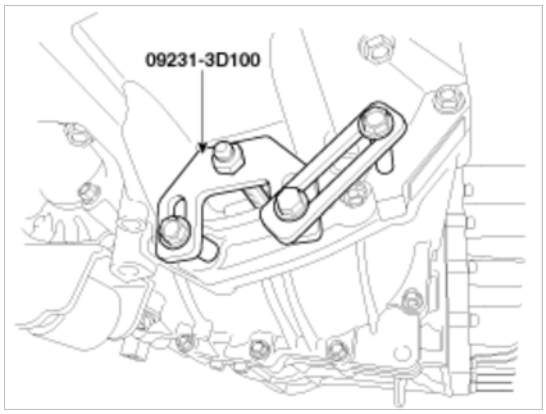

2. Remove the dust cover (A) and unfasten the transaxle mounting bolt (B).




3. Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.
4. Adjust the angle of the links (D), and fasten the bolt 70mm(2.7559in) in the original mounted hole.

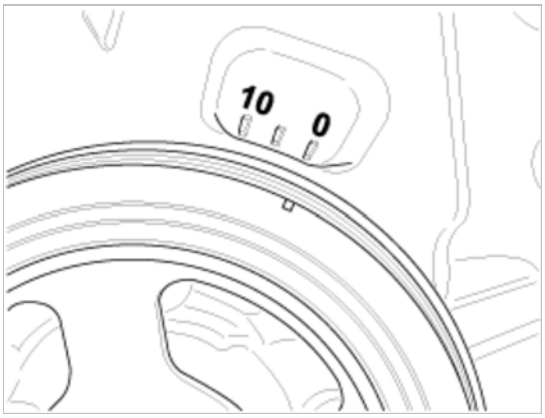



5. Tighten the bolts and nuts of the holder and links securely.



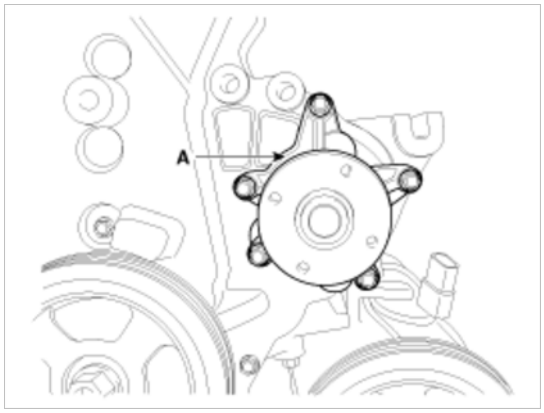
NOTE

When installing the pulley, the groove on the pulley should be positioned outside.



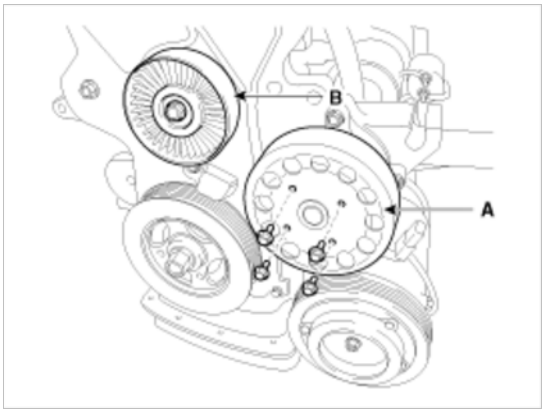

10. Install the water pump (A) with a gasket.

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)




11. Install the water pump pulley (A) and the drive belt idler (B).

**Tightening torque :**
A: 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
B: 42.2 ~ 53.9 N.m (4.3 ~ 5.5 kgf.m, 31.1 ~ 39.8 lb-ft)




CAUTION

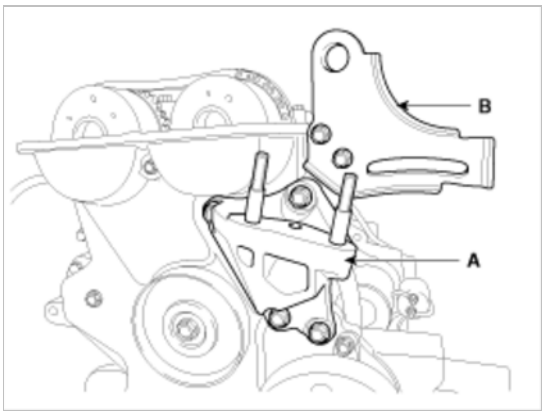
Tighten the bolts diagonally.

12. Install the engine support bracket (A).

**Tightening torque :**
29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)

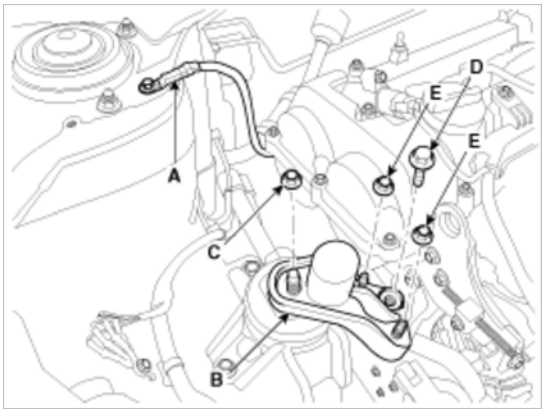
13. Install the alternator bracket (B).

**Tightening torque :**
19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)



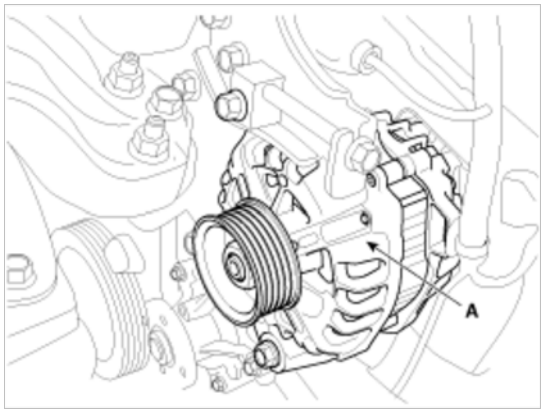

14. Install the engine mounting support bracket (B) and then connect the ground line (A).

**Tightening torque**
Ground line bolt :
10.8 ~ 13.7 N.m (1.1 ~ 1.4 kgf.m, 8.0 ~ 10.1 lb-ft)
Nut (C) :
63.7 ~ 83.4 N.m (6.5 ~ 8.5 kgf.m, 47.0 ~ 61.5 lb-ft)
Bolt (D) and nuts (E) :
49.0 ~ 63.7 N.m (5.0 ~ 6.5 kgf.m, 36.2 ~ 47.0 lb-ft)

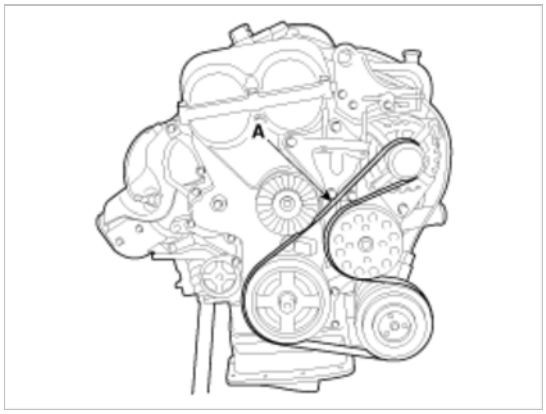



15. Install the alternator (A).

**Tightening torque :**
M8 bolt :
19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)
M10 bolt :
29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)

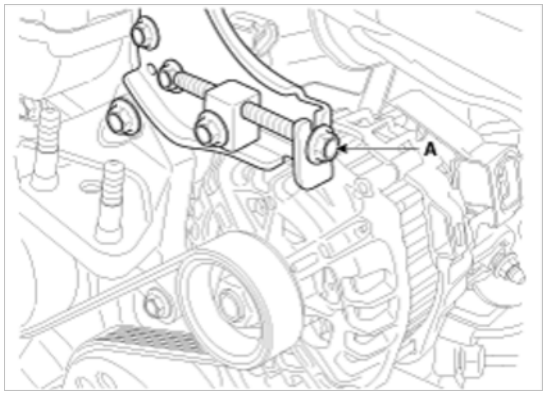



16. Install the drive belt (A).



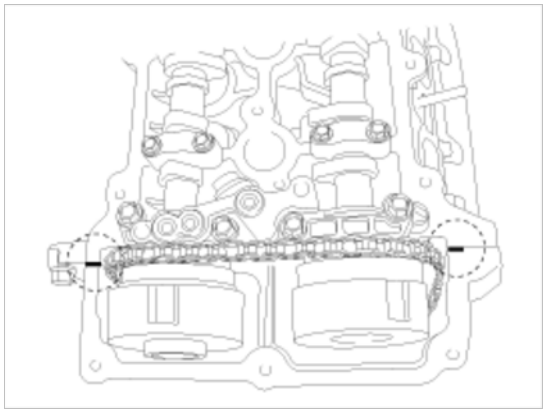

17. Adjust tension by tightening the alternator tension adjust bolt (A).(Refer to Charging system in EE Group).

**Tension**
New belt: 882.6 ~ 980.7N (90 ~ 100kg, 198.4 ~ 220.5lb)
Used belt: 637.4 ~ 735.5N (65 ~ 75kg, 143.3 ~ 165.3lb)



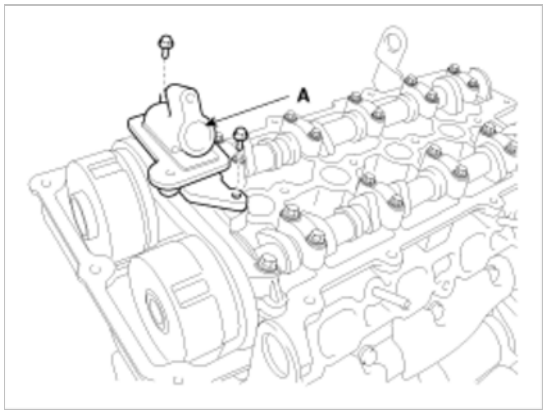

18. Before installing the cylinder head cover, remove oil, dust or hardened sealant from the timing chain cover and the cylinder head upper surface.
19. After applying the liquid gasket, Hyundai Gray RTV or THREE BOND 1217H or LOCTITE 5900H on the cylinder head cover, reassemble the cover within five minutes.

**Width :** 2.0 ~ 2.5mm(0.0787~0.0984in.)



20. Install the OCV (Oil Control Valve) adapter (A).

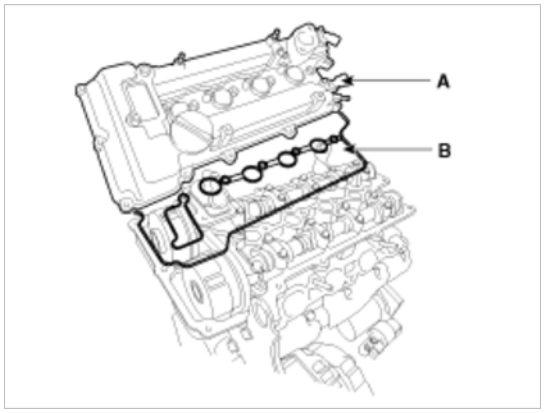
**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)




CAUTION

- Keep the OCV adapter clean.
- Make sure the O-rings on the front bearing cap are installed.

21. Install the cylinder head cover (A) with a new gasket (B).



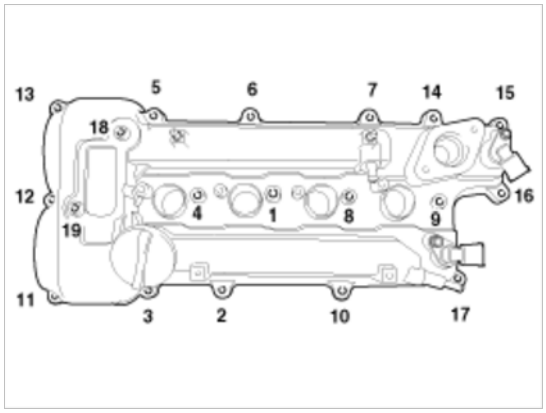

CAUTION

Do not reuse the disassembled gasket.

22. Tighten the cylinder head cover bolts with the order and steps.

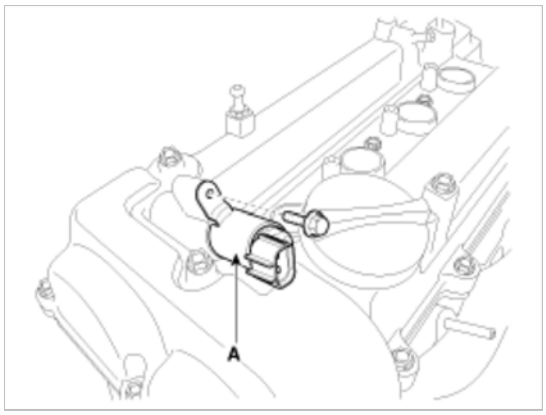
**Tightening torque :**

1st step: 3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)
2nd step: 7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)



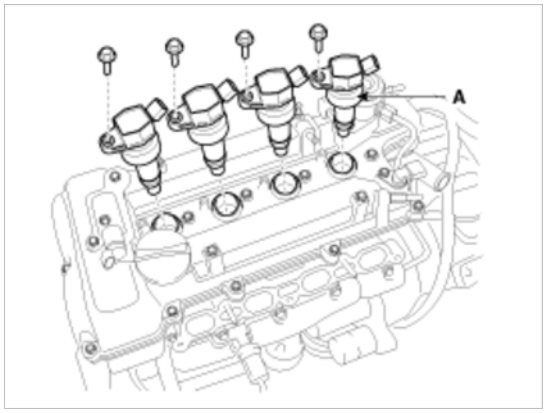

23. Install the exhaust OCV (Oil Control Valve) (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



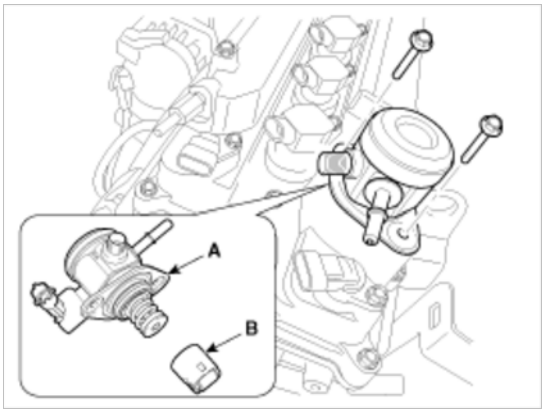

24. Install the ignition coils (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)




25. Install the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)

**Tightening torque :**
12.7 ~ 14.7N.m (1.3 ~ 1.5kgf.m, 9.4 ~ 10.8lb-ft)




**CAUTION**

Before installing the high pressure fuel pump, position the roller tappet in the lowest position (BDC) by rotating the crankshaft. Otherwise the installation bolts may be broken because of tension of the pump spring.

**NOTE**

Do not use already used bolt again.

**NOTE**

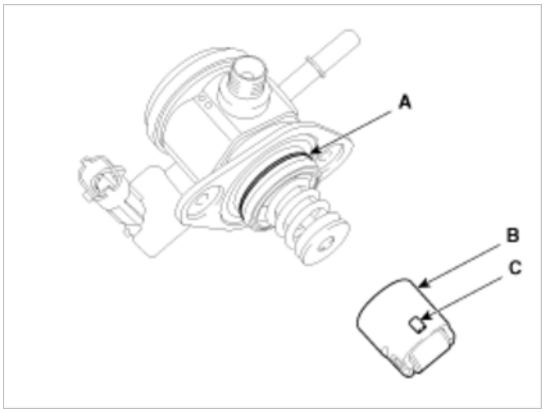
When tightening the installation bolts of the high pressure fuel pump, tighten in turn the bolts in small step (0.5 turns) after tightening them with hand-screwed torque.

**CAUTION**

Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

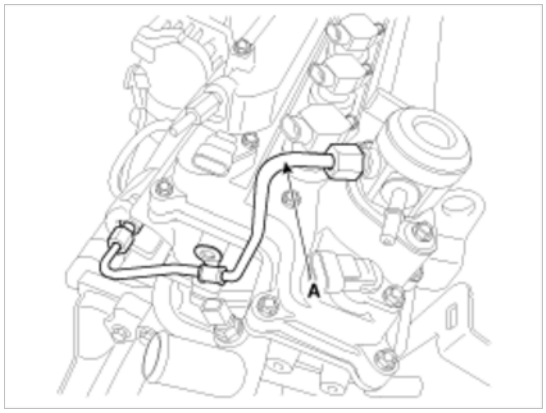
**CAUTION**

Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove where the protrusion is installed.




26. Install the high pressure pipe (A). (Refer to FL group)

**Tightening torque :**
25.5 ~ 31.4N.m (2.6 ~ 3.2kgf.m, 18.8 ~ 23.1lb-ft)

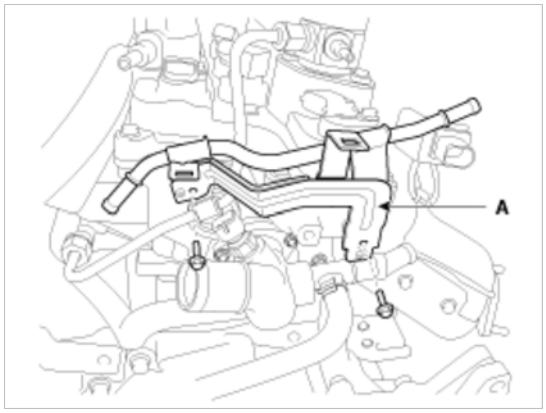



CAUTION

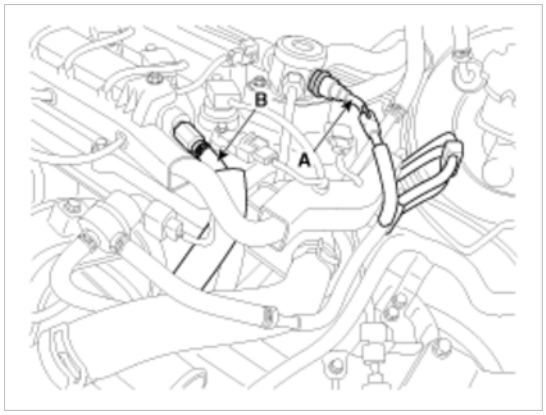
Do not reuse the high pressure pipe.

27. Install the vacuum pipe assembly (A).

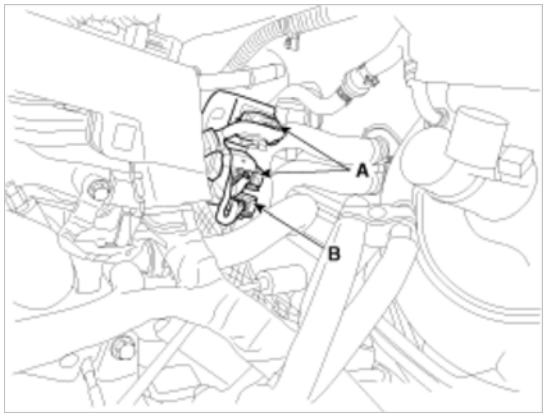
**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



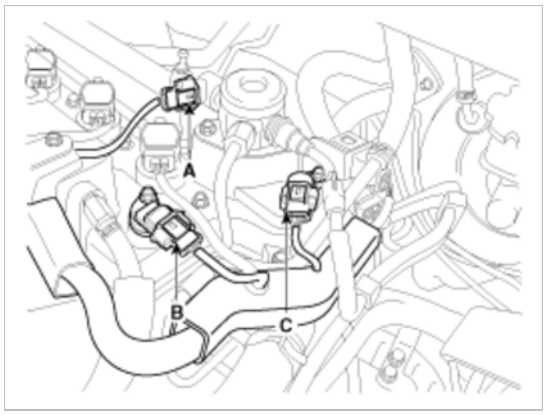

28. Connect the fuel hose (A) and the PCSV (Purge control solenoid valve) hose (B).



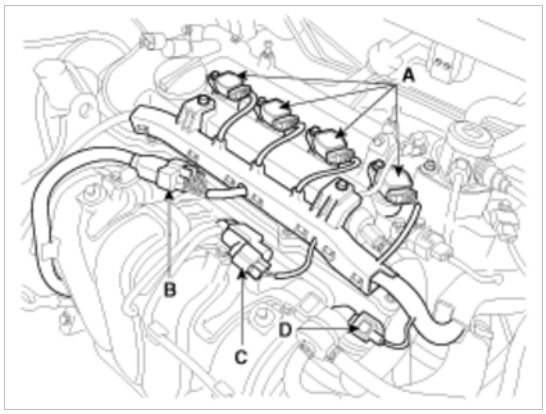

29. Connect the oxygen sensor connectors (A) and the condenser connector (B).



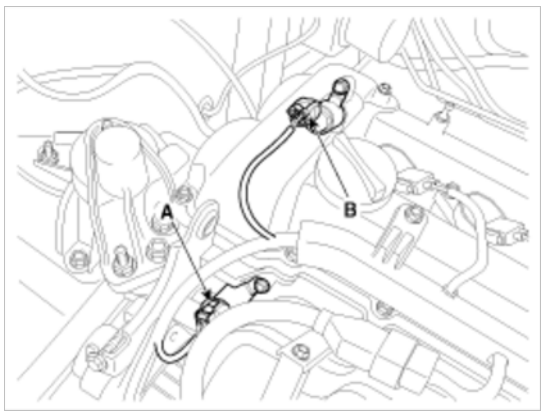

30. Connect the FPCV (Fuel pressure control valve) connector (A), the intake CMPS (Camshaft position sensor) connector (B) and the exhaust CMPS (Camshaft position sensor) connector (C).




31. Connect the ignition coil connectors (A), the injector extension connector (B), the VIS (Variable intake system) connector (C) and the PCSV (Purge control solenoid valve) connector (D).

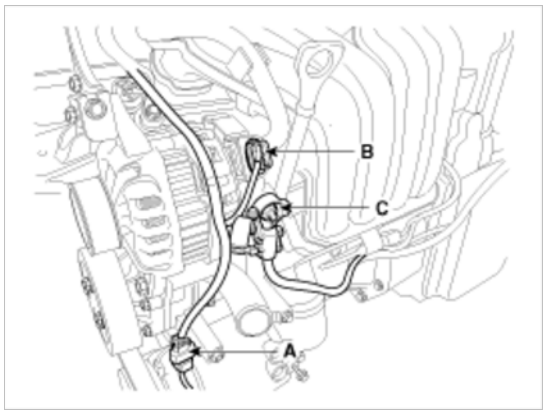



32. Connect the intake OCV (Oil control valve) connector (A) and the exhaust OCV (Oil control valve) connector (B).



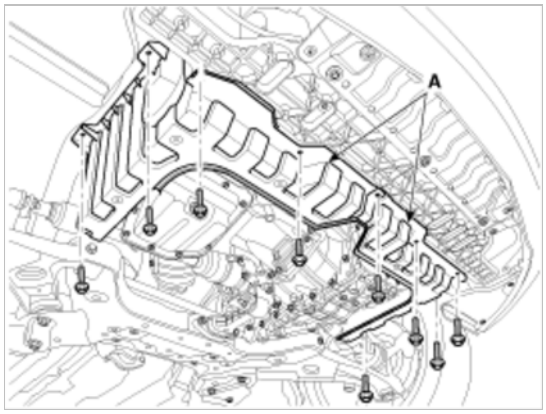
33. Connect the A/C compressor switch connector (A), the alternator connector (B) and the cable from the alternator “B” terminal (C).

**Tightening torque :**
9.8 ~ 14.7N.m (1.0 ~ 1.5kgf.m, 7.2 ~ 10.8lb-ft)




34. Install the under covers (A).

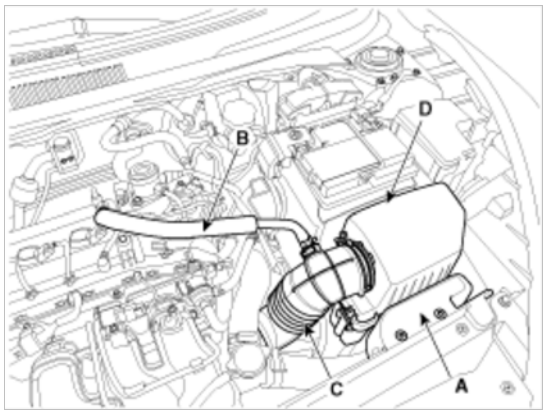
**Tightening torque :**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)




35. Install the RH front wheel.
36. Install the air cleaner assembly.
    (1) Install the air cleaner assembly (D) and then connect the air intake hose (C).

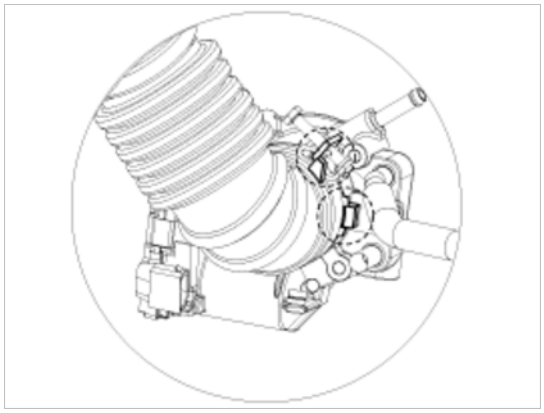
**Tightening torque :**
Hose clamp bolt :
2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)
Air cleaner assembly bolts :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

    (2) Connect the breather hose (B).
    (3) Install the air duct (A) .



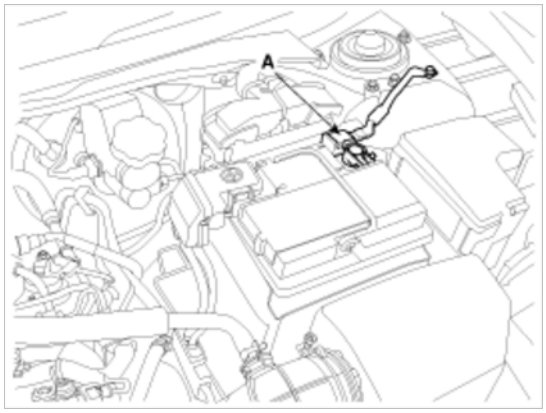

NOTE

- Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.
- Install the air intake hose while the groove of hose must be matched to the protrusion of the throttle body.



37. Connect the battery negative terminal (A).

**Tightening torque :**
Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)



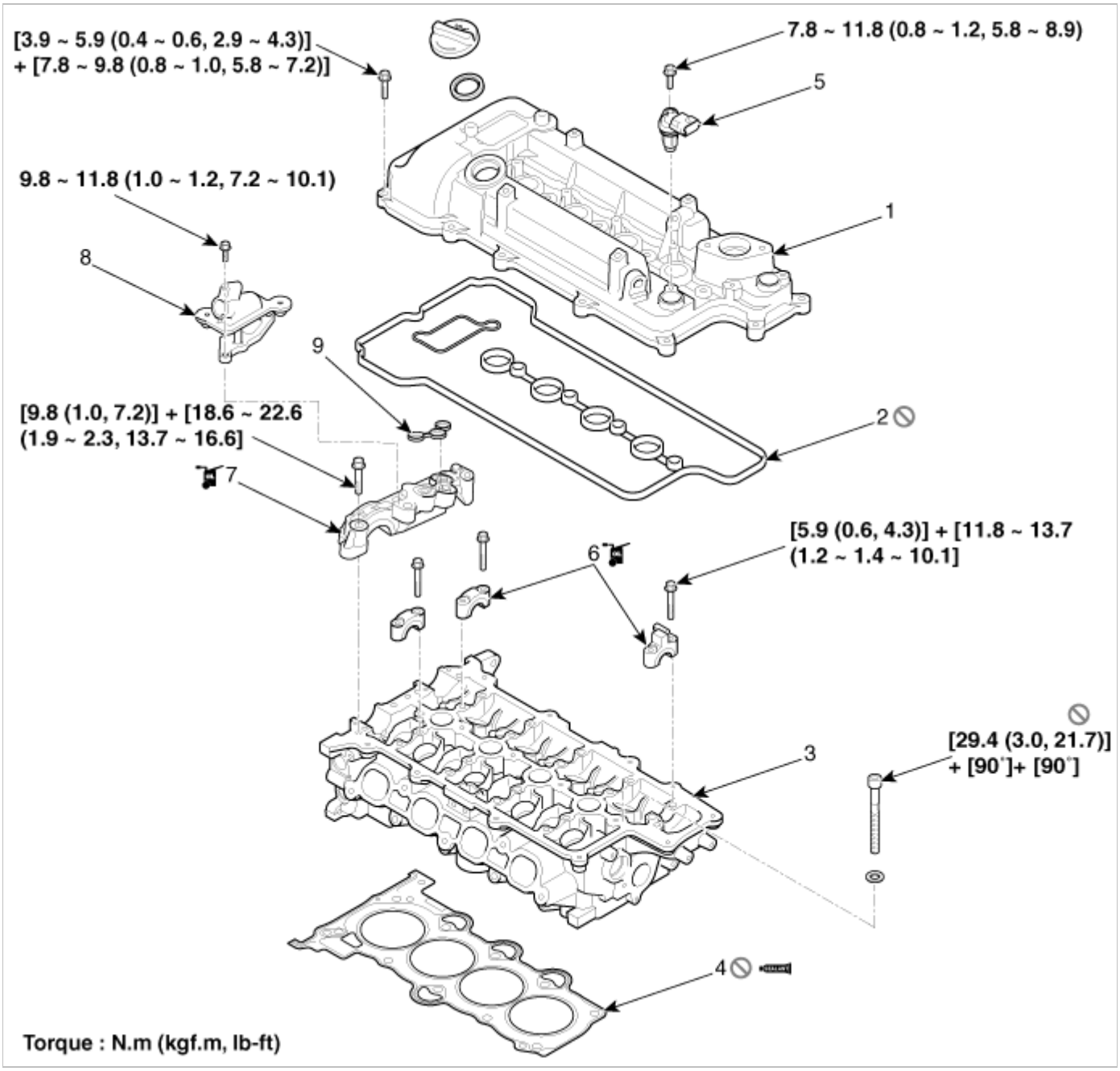

38. Install the engine cover.

CAUTION

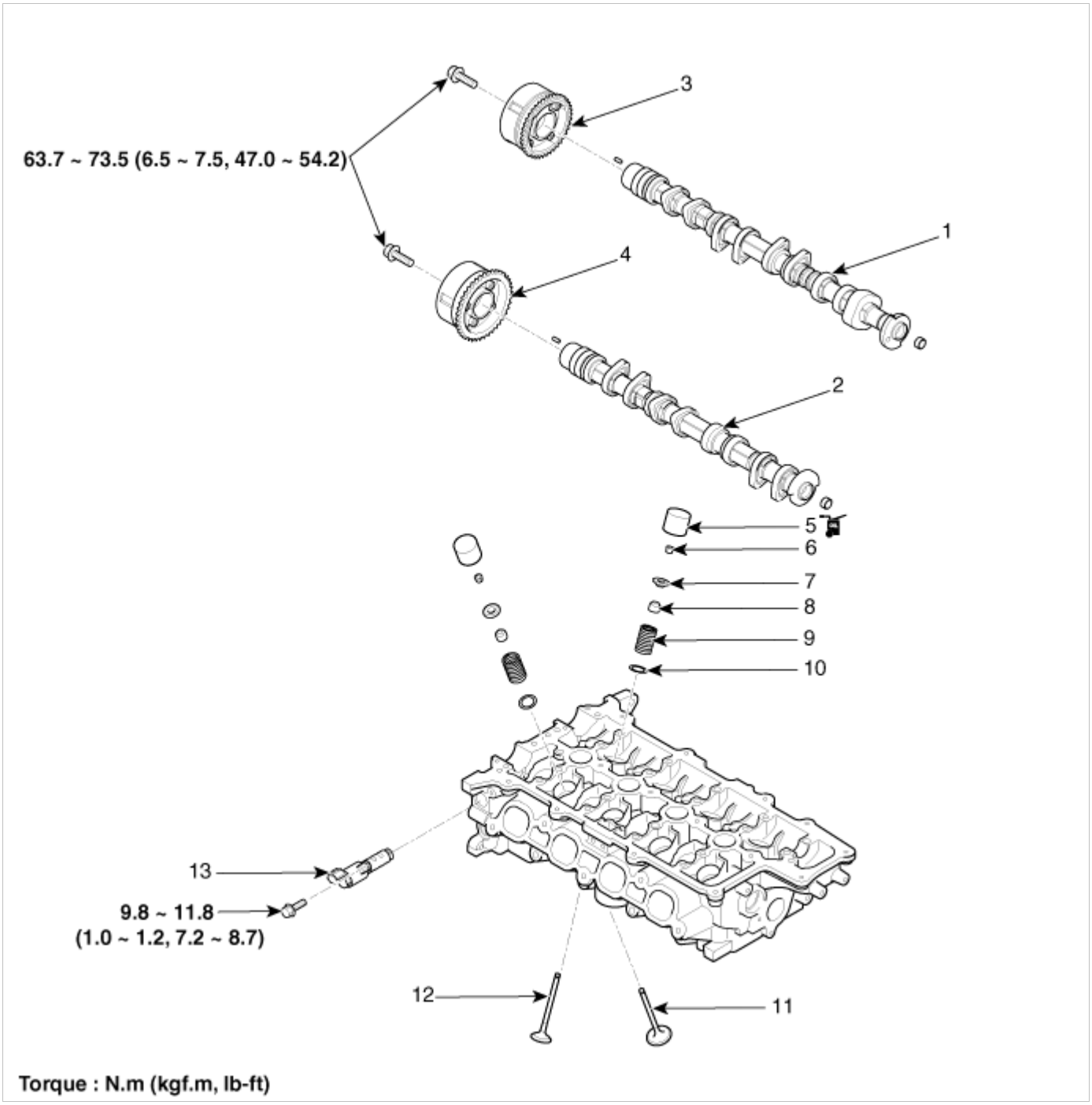
Make sure the engine cover is installed before driving.

# Engine Mechanical System > Cylinder Head Assembly > Cylinder Head > Components and Components Location

## Components




| | |
|---|---|
| 1. Cylinder head cover | 6. Camshaft bearing cap |
| 2. Cylinder head cover gasket | 7. Camshaft front bearing cap |
| 3. Cylinder head assembly | 8. OCV (Oil Control Valve) adapter |
| 4. Cylinder head gasket | 9. O-ring |
| 5. Camshaft position sensor | |




| | |
|---|---|
| 1. Exhaust camshaft | 8. Valve stem seal |
| 2. Intake camshaft | 9. Valve spring |
| 3. Exhaust CVVT assembly | 10. Valve spring seat |
| 4. Intake CVVT assembly | 11. Intake valve |
| 5. Mechanical Lash Adjuster (MLA) | 12. Exhaust valve |
| 6. Retainer lock | 13. Oil Control Valve (OCV) |
| 7. Retainer | |

## Engine Mechanical System > Cylinder Head Assembly > Cylinder Head > Repair procedures

### Removal

Engine removal is not required for this procedure.

**CAUTION**

- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature before removing it.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

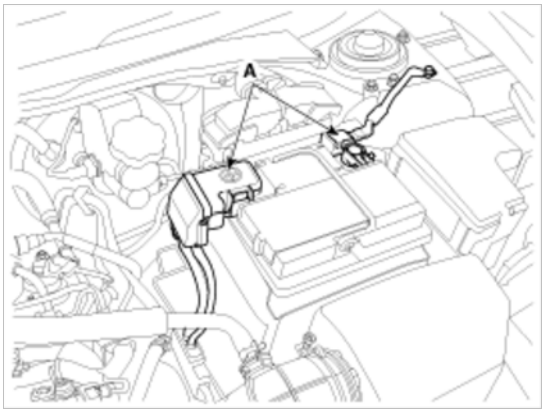
**NOTE**

Mark all wiring and hoses to avoid misconnection.

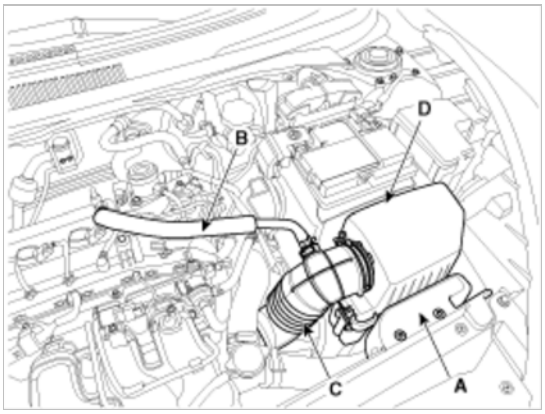
**WARNING**

In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

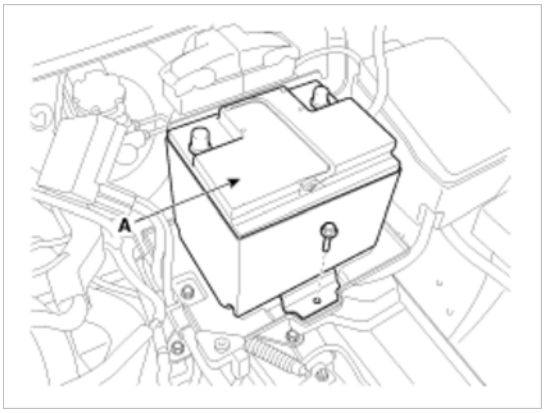
1. Remove the engine cover.
2. Disconnect the battery terminals (A).



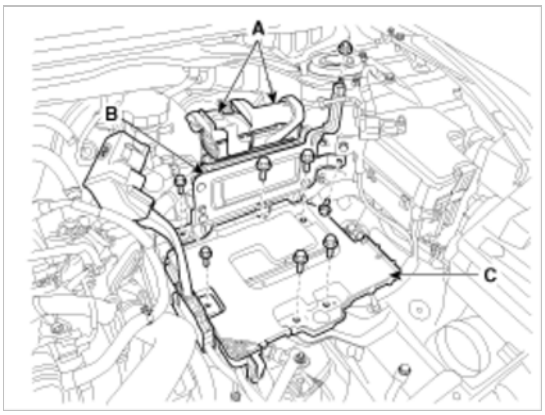

3. Remove the air cleaner assembly.
   (1) Remove the air duct (A)
   (2) Disconnect the breather hose (B) and the air intake hose (C)
   (3) Remove the air cleaner assembly (D)



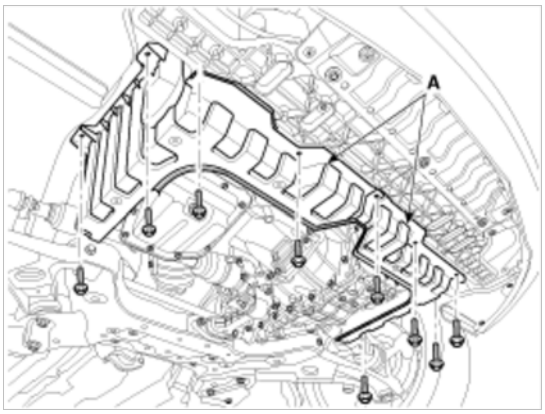

4. Remove the battery (A) after removing the mounting bracket.



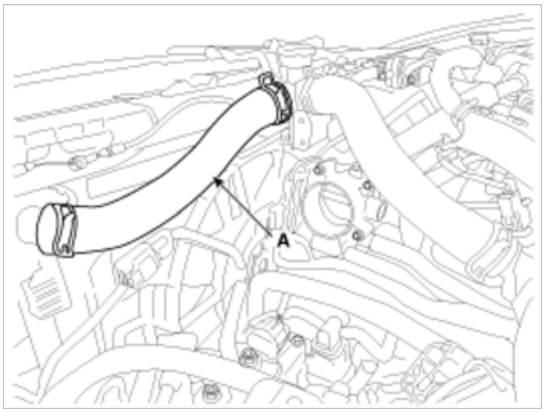

5. Disconnect the ECM connectors (A) and then remove the ECM (B) and battery tray (C).

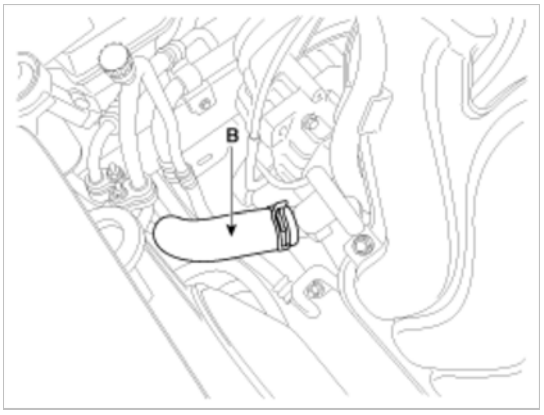



6. Remove the RH front wheel.
7. Remove the under covers (A).

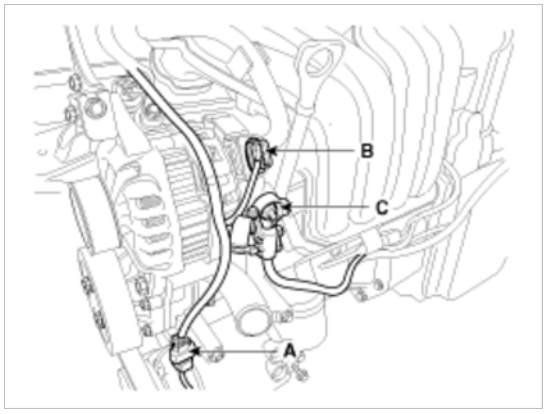



8. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to help drain the coolant faster. (Refer to Cooling system in this group)
9. Disconnect the radiator upper hose (A) and lower hose (B).

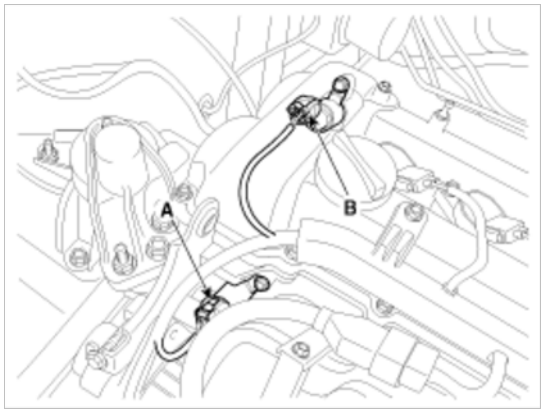


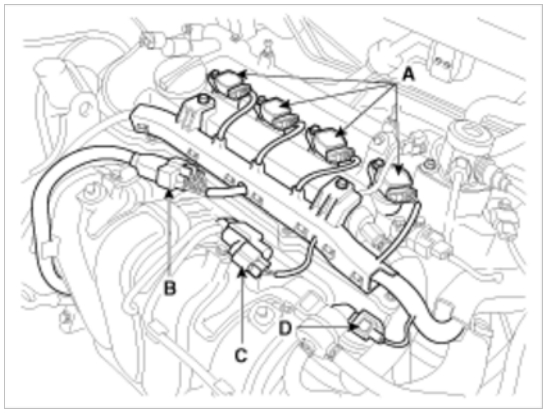

10. Disconnect the wiring connectors and harness clamps, and remove the wiring and protectors from the cylinder head and intake manifold.
    (1) The A/C compressor switch connector (A), the alternator connector (B) and the cable from the alternator “B” terminal (C)



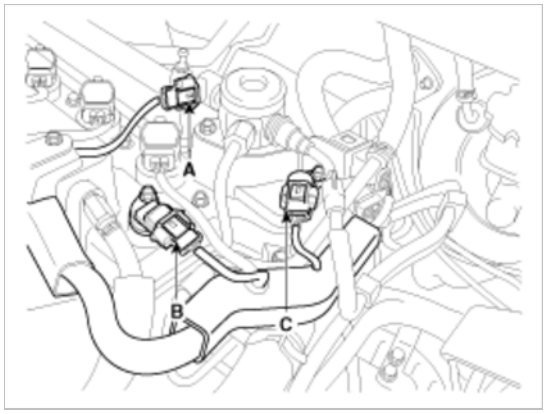

    (2) The intake OCV (Oil control valve) connector (A) and the exhaust OCV (Oil control valve) connector (B)



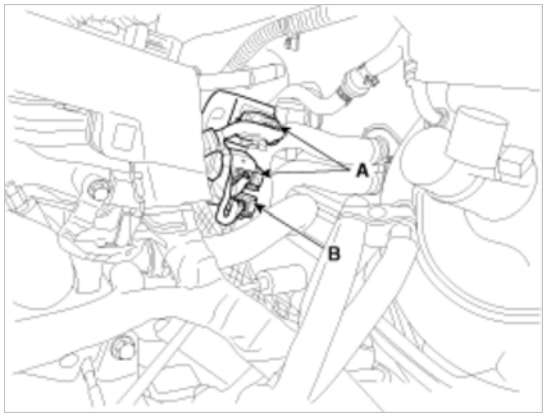
(3) The ignition coil connectors (A), the injector extension connector (B), the VIS (Variable intake system) connector (C) and the PCSV (Purge control solenoid valve) connector (D)



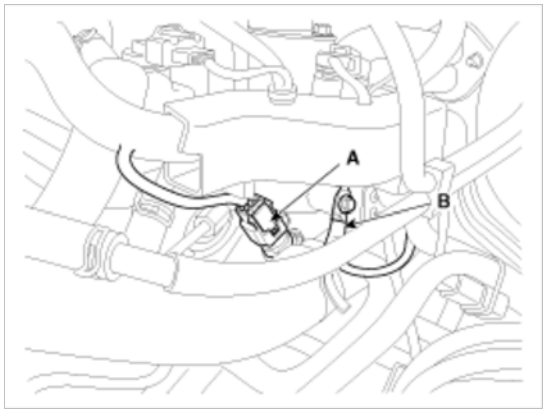

(4) The FPCV (Fuel pressure control valve) connector (A), the intake CMPS (Camshaft position sensor) connector (B) and the exhaust CMPS (Camshaft position sensor) connector (C)



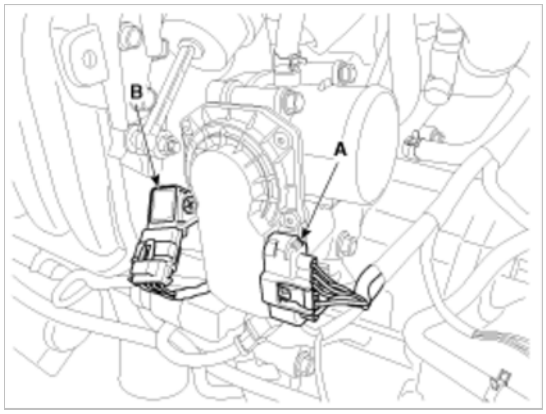

(5) Disconnect the oxygen sensor connectors (A) and the condenser connector (B)



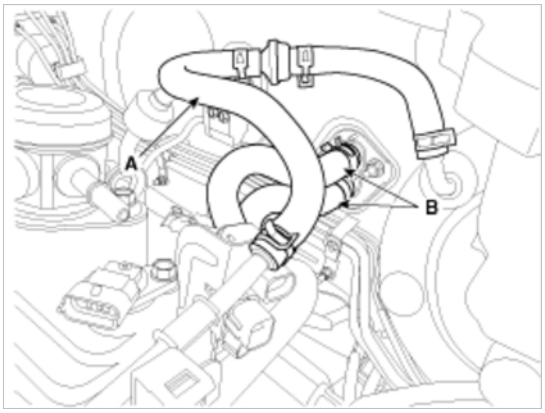

(6) The ECTS (Engine coolant temperature sensor) connector (A) and the ground line (B)



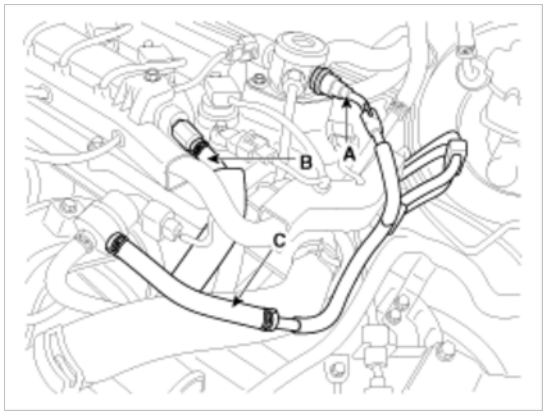

(7) The ETC (Electronic throttle control) connector (A) and the MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B)



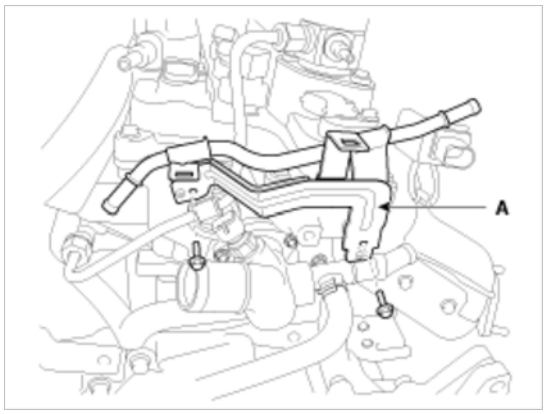

11. Disconnect the brake booster vacuum hose (A) and heater hose (B).



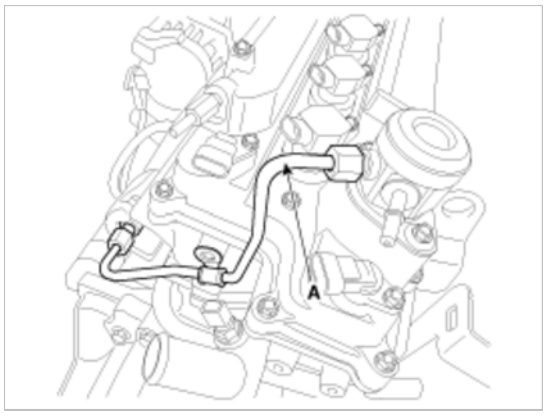

12. Disconnect the fuel hose (A), the PCV (Positive crankcase ventilation) hose (B) and the PCSV (Purge control solenoid valve) hose (C).



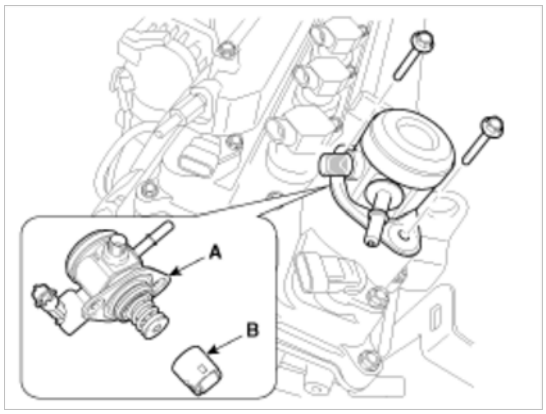
13. Remove the vacuum pipe assembly (A).



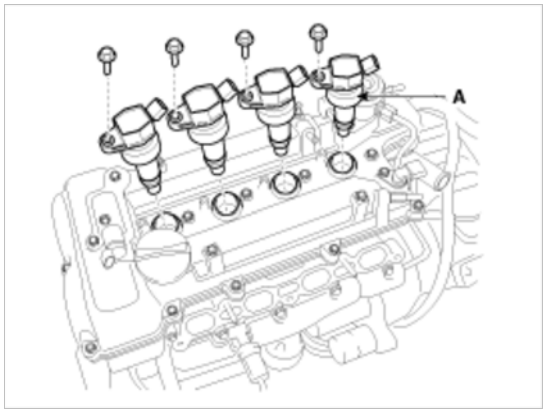

14. Remove the high pressure pipe (A). (Refer to FL group)



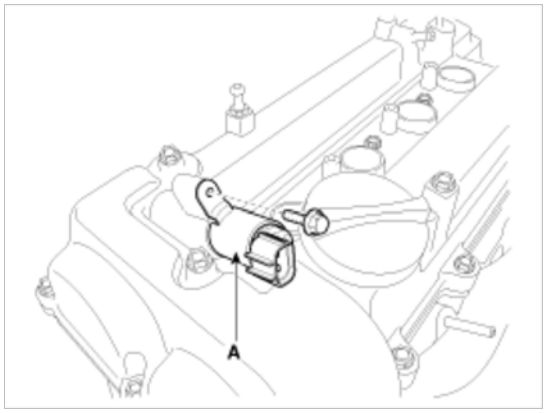

15. Remove the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)



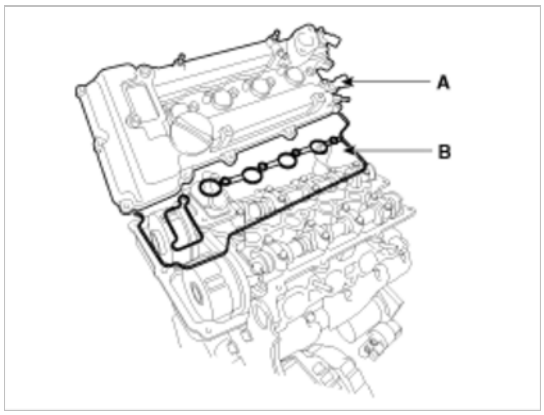

16. Remove the ignition coils (A).



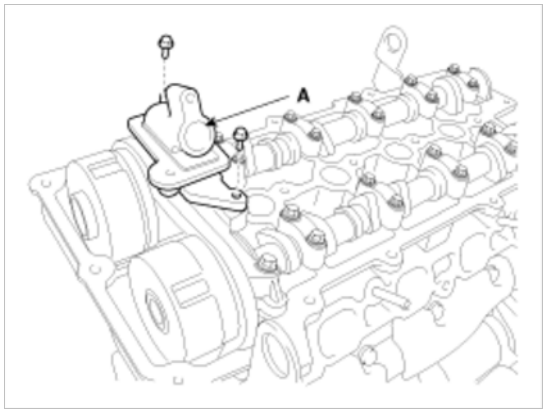

17. Remove the exhaust OCV (Oil control valve) (B).



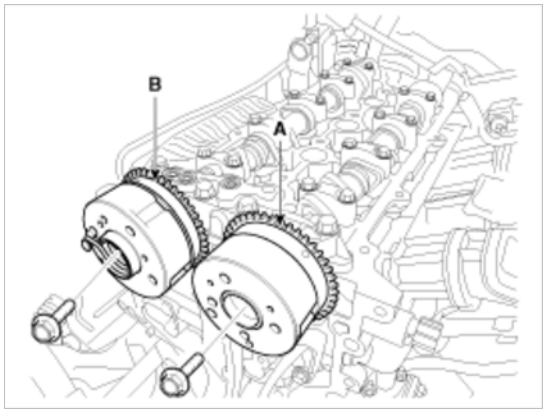

18. Remove the cylinder head cover (A) with gaskets (B).




19. Remove the exhaust OCV (Oil control valve) adapter (A).

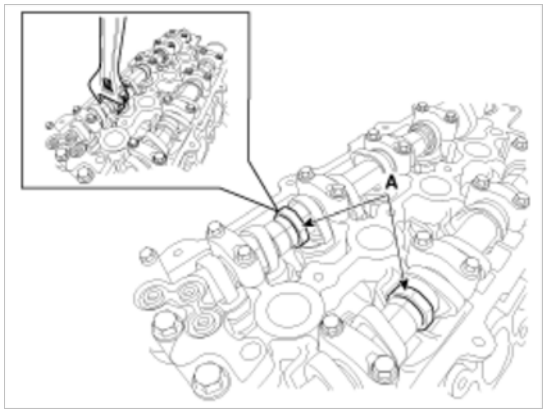



20. Remove the timing chain.
    (Refer to Timing system in this group)
21. Remove the exhaust manifold assembly. (Refer to Intake and exhaust system in this group)
22. Remove the intake manifold module assembly. (Refer to Intake and exhaust system in this group)
23. Remove the intake CVVT assembly (A) and exhaust CVVT assembly (B).

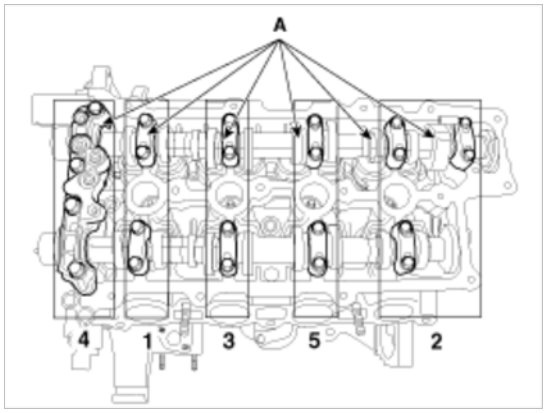



NOTE

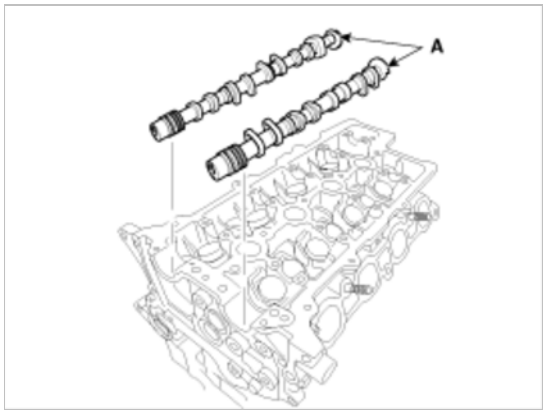
When removing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position (A).



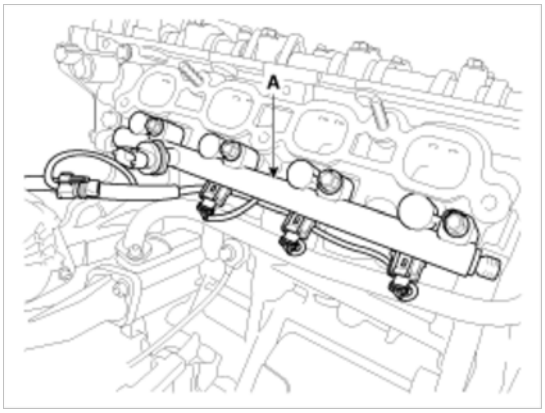

24. Remove the camshaft bearing caps (A) with the order below.



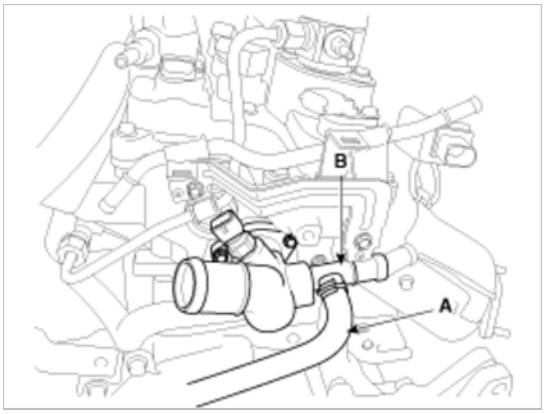

25. Remove the camshafts (A).



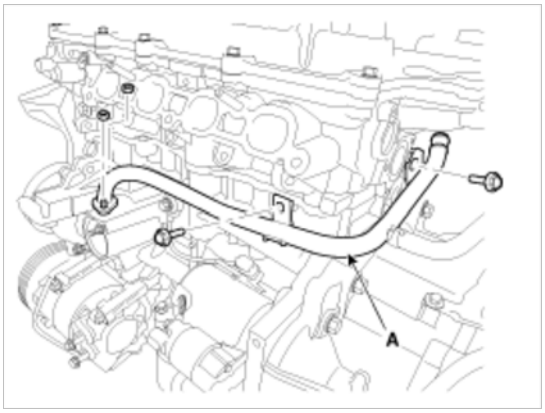
26. Remove the injector & rail assembly (A). (Refer to FL group)



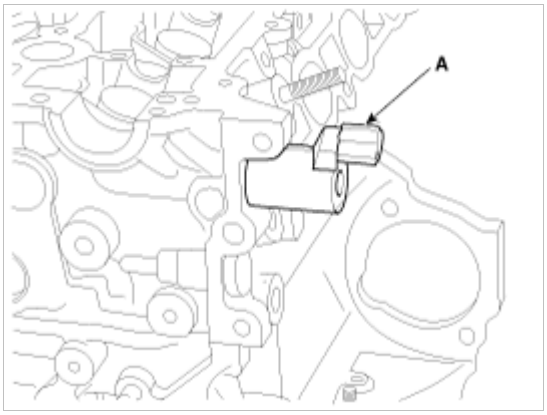

27. Remove the water temperature control assembly (B) after disconnecting the throttle body cooling hose (A).




28. Remove the heater pipe (A).




29. Remove the intake OCV (Oil Control Valve) (A).




30. Remove the cylinder head bolts, then remove the cylinder head.

(1) Uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown.


CAUTION

Head warpage or cracking could result from removing bolts in an incorrect order.

(2) Lift the cylinder head from the cylinder block and put the cylinder head on wooden blocks.

CAUTION

Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

## Disassembly

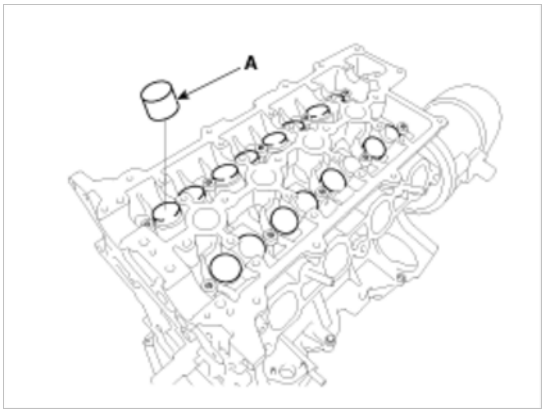
NOTE

Identify MLA(Mechanical lash adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

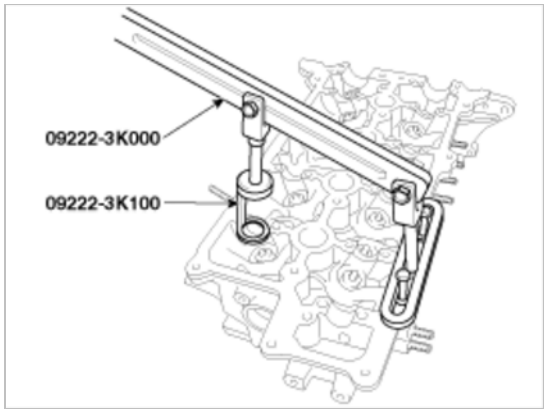
1. Remove the MLAs (A).

CAUTION

When removing MLAs, mark all the MLAs for their rearrangement.




2. Remove the valves.
   (1) Using the SST (09222 - 3K000, 09222 - 3K100), compress the valve spring and remove the retainer lock.




(2) Remove the spring retainer.

(3) Remove the valve spring.

(4) Remove the valve.

(5) Remove the valve stem seal.

(6) Using a magnetic pickup tool, remove the spring seat.

CAUTION

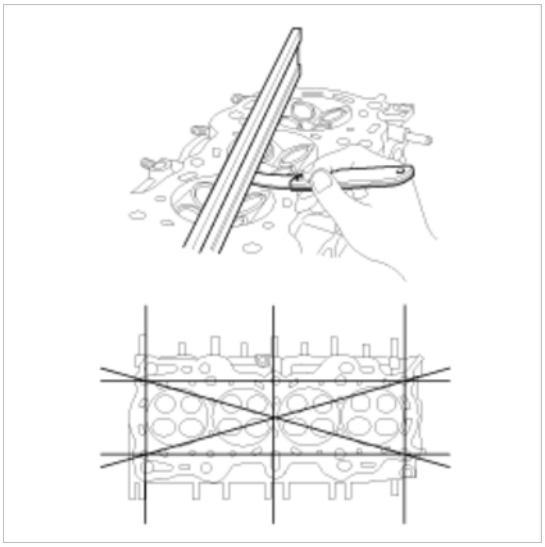
Do not reuse the valve stem seals.

## Inspection

### Cylinder Head

1. Inspect for flatness.
   Using a precision straight edge and feeler gauge, measure the surface the contacting the cylinder block and the manifolds for warpage.

**Flatness of cylinder head gasket surface**
Standard :
Less than 0.05mm (0.0020in) for total area
Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in)



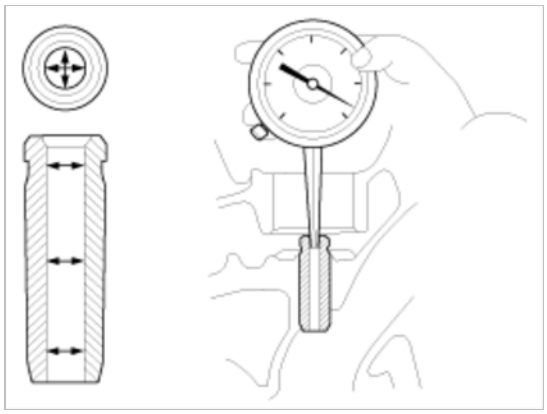
2. Inspect for cracks.
   Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace

the cylinder head.

## Valve And Valve Spring

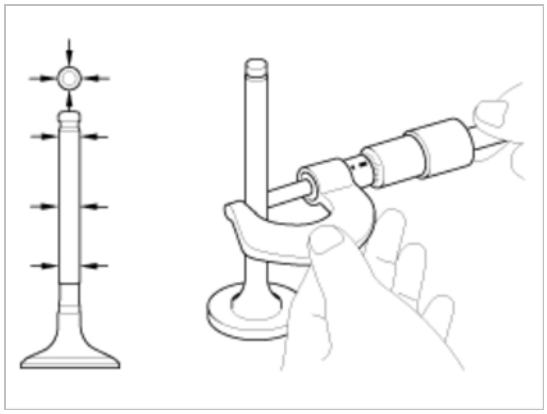
1. Inspect the valve stems and valve guides.
   (1) Using a caliper gauge, measure the inner diameter of valve guide.

   **Valve guide inner diameter :**
   5.500 ~ 5.512mm (0.2165 ~ 0.2170in)



   (2) Using a micrometer, measure the outer diameter of valve stem.

   **Valve stem outer diameter**
   Intake : 5.465 ~ 5.480mm (0.2152 ~ 0.2157in)
   Exhaust : 5.458 ~ 5.470mm (0.2149 ~ 0.2154in)



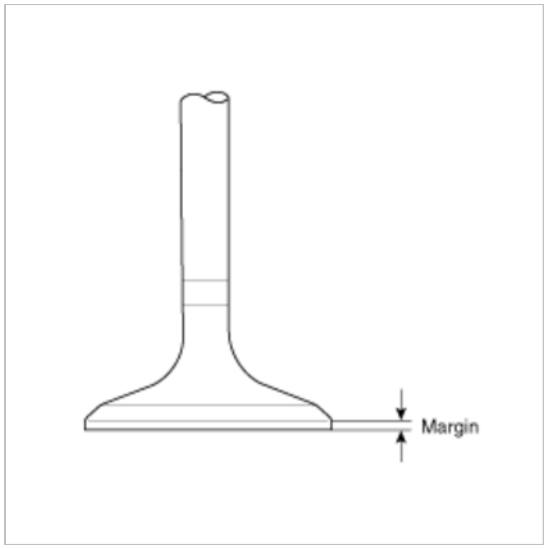
   (3) Subtract the valve stem outer diameter measurement from the valve guide inner diameter measurement.

   **Valve stem- to-guide clearance**
   Intake : 0.020 ~ 0.047mm (0.0008 ~ 0.0019in)
   Exhaust : 0.030 ~ 0.054mm (0.0012 ~ 0.0021in)

   If the clearance is greater than specification, replace the valve or the cylinder head.

2. Inspect the valves.
   (1) Check the valve is ground to the correct valve face angle.
   (2) Check that the surface of valve for wear.
   If the valve face is worn, replace the valve.
   (3) Check the valve head margin thickness.
   If the margin thickness is less than minimum, replace the valve.

**Margin**
**Standard**
Intake : 1.10mm (0.0433in)
Exhaust : 1.26mm (0.0496in)




(4) Check the length of valve.

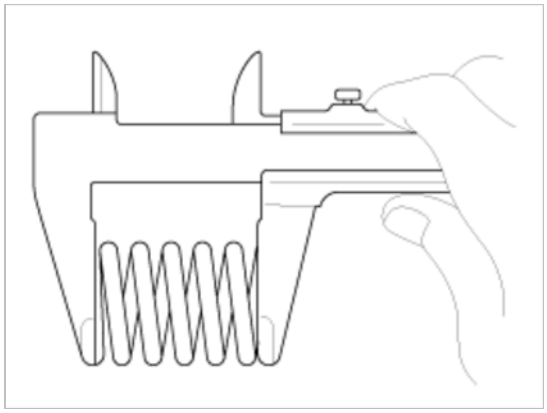
**Valve length**
Standard
Intake : 93.15mm (3.6673 in)
Exhaust : 92.60mm (3.6457 in)

(5) Check the surface of valve stem tip for wear.
If the valve stem tip is worn, replace the valve.

3. Inspect the valve seats.
(1) Check the valve seat for evidence of overheating and improper contact with the valve face. If the valve seat is worn, replace the cylinder head.
(2) Check the valve guide for wear. If the valve guide is worn, replace the cylinder head.

4. Inspect the valve springs.
(1) Using a steel square, measure the out-of-square of valve spring.
(2) Using a vernier calipers, measure the free length of valve spring.

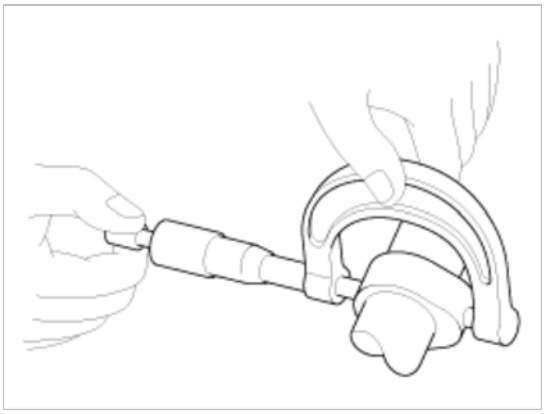
**Valve spring**
**Standard**
Free height : 45.1mm (1.7756in)
Out of square : Less than 1.5°



## Camshaft

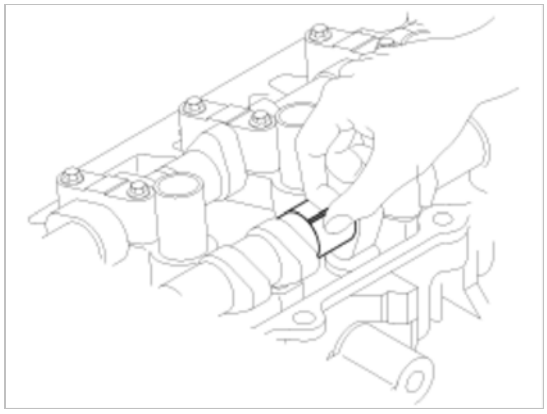
1. Inspect the cam height.
   Using a micrometer, measure the cam height.

**Cam height**
Intake : 44.15mm (1.7382in)
Exhaust : 43.55mm (1.7146in)



If the cam lobe height is less than specified, replace the camshaft.

2. Check the cranshaft journal for wear.
   If the journal is worn excessively, replace the camshaft.
3. Inspect the camshaft journal clearance.
   (1) Clean the bearing caps and camshaft journals.
   (2) Place the camshafts on the cylinder head.
   (3) Lay a strip of plastigage across each of the camshaft journal.



(4) Install the bearing caps and tighten the bolts with specified torque.

**Tightening torque :**
1st step
M6 bolt :
5.9 N.m (0.6 kgf.m, 4.3 lb-ft)
M8 bolt :
9.8 N.m (1.0 kgf.m, 7.2 lb-ft)
2nd step
M6 bolts :
11.8 ~ 13.7N.m (1.2 ~ 1.4kgf.m, 8.7 ~ 10.1lb-ft)
M8 bolts :
18.6 ~ 22.6N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)

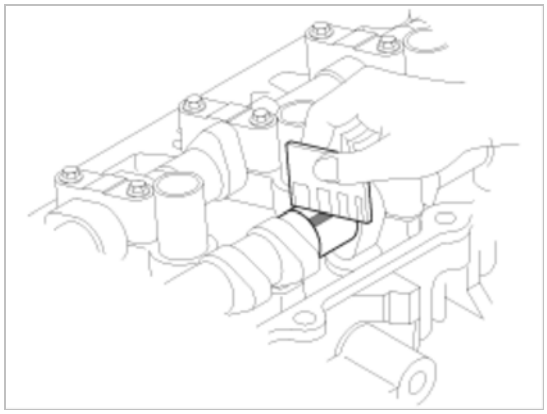
CAUTION

Do not turn the camshaft.

(5) Remove the bearing caps.

(6) Measure the plastigage at its widest point.

**Bearing oil clearance**
Standard : 0.027 ~ 0.058mm (0.0011 ~ 0.0023in)
Limit : 0.1mm ( 0.0039in)

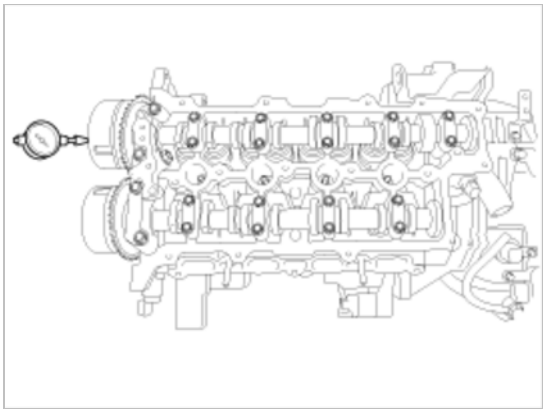


If the oil clearance is greater than specified, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

4. Inspect the camshaft end play.
(1) Install the camshafts.

(2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

**Camshaft end play**
Standard : 0.1 ~ 0.2mm (0.0039 ~ 0.0079in)



If the end play is greater than specified, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(3) Remove the camshafts.

## Continuous Variable Valve Timing (CVVT) Assembly

1. Inspect the Continuous variable valve timing (CVVT) assembly.
   (1) Fix the Continuous variable valve timing (CVVT ) with its camshaft in a vice.
   (2) Check that the CVVT assembly will not turn. If it is not turned, it is in normal condition.
   (3) Apply vinyl tape to all the parts except the one hole.
   (4) Using an air gun, apply the pressure, 147.10kpa (1.5kg/cm², 21.33psi) in the hole. This makes the lock pin in maximum retarded state released.

> NOTE
>
> • Wrap around it with a shop rag, because the oil can splash out.
> • After releasing the pin, you can turn the CVVT assembly for advance by hand.
> • If there was too much air leakage, the pin can not be released.

   (5) Under the condition of 3), turn the CVVT assembly to the advance angle side with your hand.
   Depending on the air pressure, the CVVT assembly will turn to the advance side.
   Also, if the air pressure that was applied was insufficient because of the air leakage from the port, the lock pin may not release properly.
   (6) Except the position where the lock pin meets at the maximum delay angle, let the CVVT assembly turn back and forth and check the movable range and that there is no interference.

**Standard :** Movable smoothly in the range about 25°

   (7) Turn the CVVT assembly with your hand counterclockwise and lock it at the maximum delay angle position.

## Reassembly

> NOTE
>
> • Thoroughly clean all parts to be assembled.
> • Before installing the parts, apply fresh engine oil to all sliding and rotating surface.
> • Replace oil seals with new ones.

1. Install the valves.
   (1) Install the spring seats.

(2) Using the SST (09222 - 2B100), push in a new oil seal.

NOTE

Do not reuse old valve stem oil seals.
Incorrect installation of the seal could result in oil leakage past the valve guides.

CAUTION

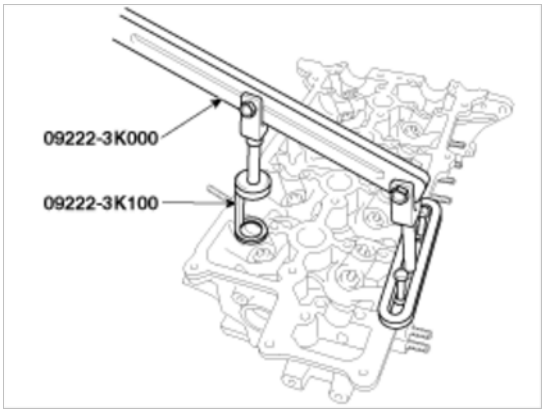
Intake valve stem seals are different from exhaust ones in type. Do not reassembly ones in the other's places.

(3) Install the valve, valve spring and spring retainer, after applying engine oil at the end of each valve.

NOTE

When installing valve springs, the enamel coated side should face the valve spring retainer.

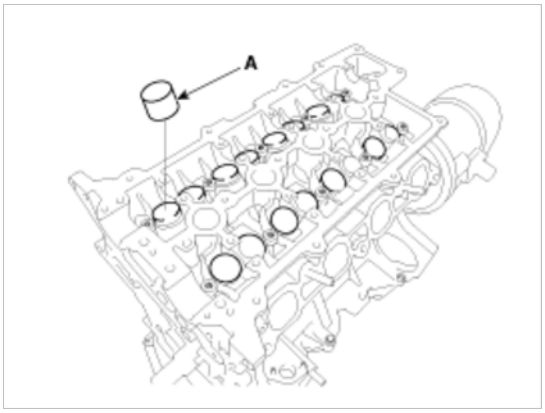
2. Using the SST(09222 - 3K000, 09222 - 3K100), compress the spring and install the retainer locks.
   After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.




CAUTION

When installing the SST, use the torque, 1.2kgf.m or less.

3. Lightly tap the end of each valve stem two or three times with the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.
4. Install the MLA(Mechanical lash adjuster)s.
   Check that the MLA (A) rotates smoothly by hand.




NOTE

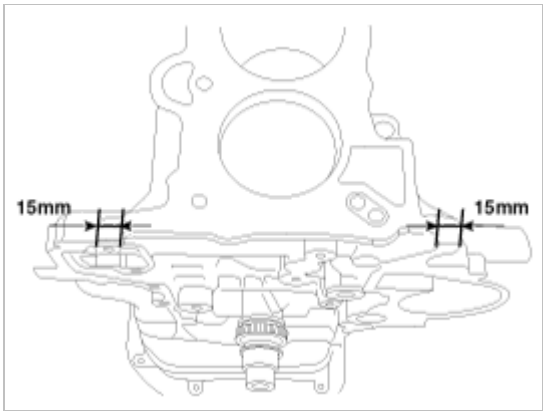
All the MLAs must be installed in its original position.

## Installation

NOTE

- Thoroughly clean all parts to be assembled.
- Always use a new cylinder head and manifold gasket.
- Always use a new cylinder head bolt.
- The cylinder head gasket is a metal gasket. Take care not to bend it.
- Rotate the crankshaft, set the No.1 piston at TDC.

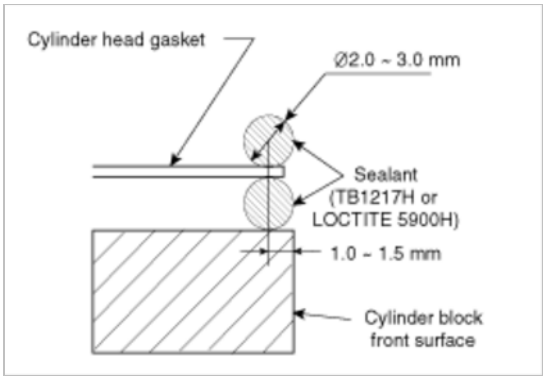
1. Install the cylinder head assembly.
   (1) Before installing, remove the hardened sealant from the cylinder block and cylinder head surface.
   (2) Before installing the cylinder head gasket, apply sealant on the upper surface of the cylinder block and reassemble the gasket within five minutes.




NOTE

Refer to the illustration for applying sealant.

**Width :** 2.0 ~ 3.0mm(0.0787~0.1181in.)
**Position :** 1.0 ~ 1.5mm(0.0394~0.0591in.)
**Specification :** Hyundai Gray RTV or TB 1217H or LOCTITE 5900H

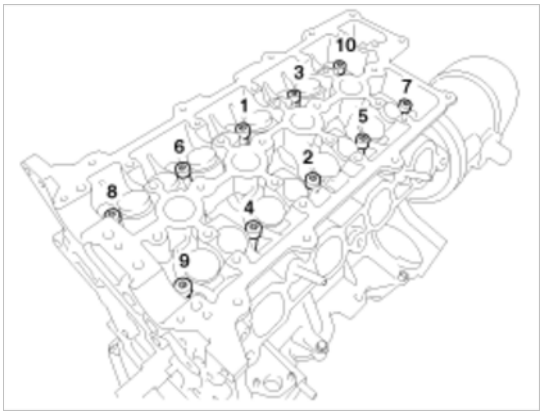



   (3) After installing the cylinder head gasket on the cylinder block, apply sealant on the upper surface of the cylinder head gasket and reassemble in five minutes.

2. Place the cylinder head carefully not to damage the gasket.

3. Install the cylinder head bolts with washers.
   (1) Tighten the 10 cylinder head bolts, in several passes, in the sequence shown.

**Tightening torque :**
29.4Nm (3.0kgf.m, 21.7lb-ft) + 90° + 90°

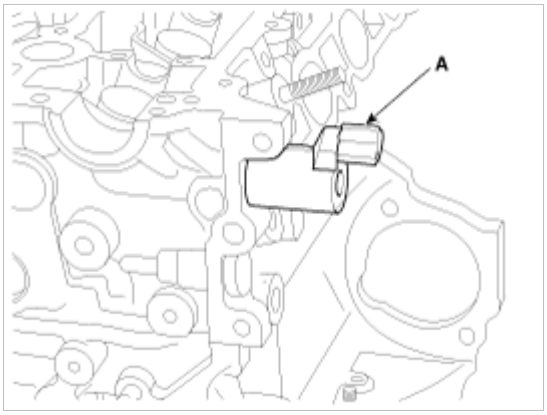



CAUTION

Always use new cylinder head bolts.

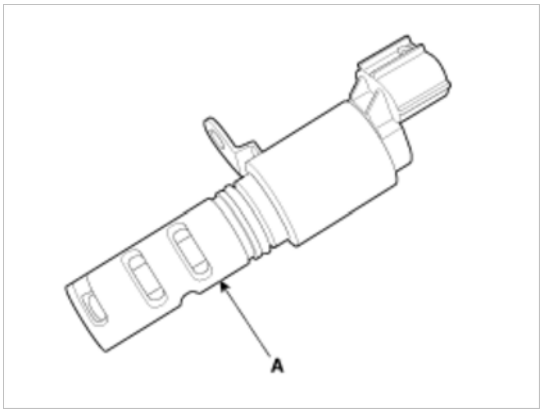
4. Install the oil control valve (OCV) (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



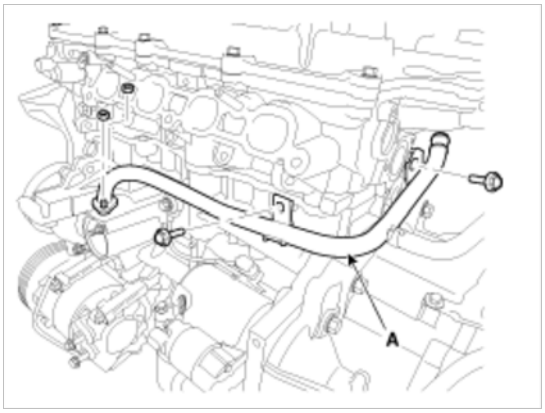

CAUTION

- Do not reuse the OCV when dropped.
- Keep the OCV filter clean.
- Do not hold the OCV sleeve (A) during servicing.
- When the OCV is installed on the engine, do not move the engine with holding the OCV yoke.



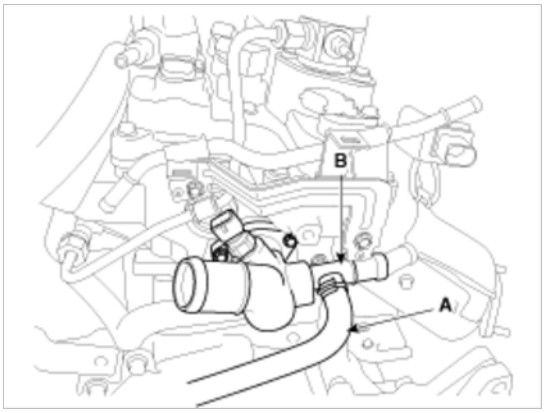

5. Install the heater pipe (A).

**Tightening torque**
M6 bolt and nuts :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
M8 bolts :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



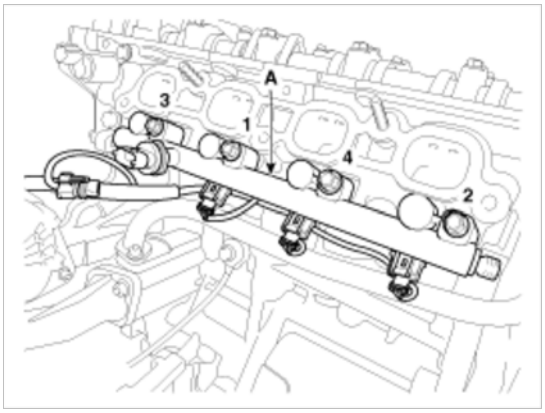

6. Install the water temperature control assembly (A) after connecting the throttle body cooling hose (A).

**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)




7. Install the injector & rail assembly (A).

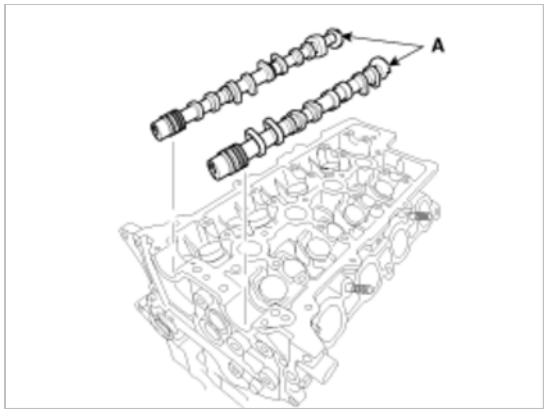
**Tightening torque :**
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)




8. Install the intake and exhaust manifold.
   (Refer to Intake and Exhaust system in this group)
9. Install the camshafts (A).
   (1) Before installing, apply engine oil on journals.

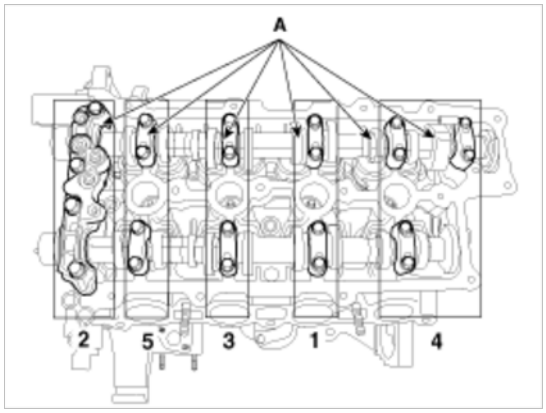
> **CAUTION**
>
> Do not make oil flow down to the front side of the cylinder head.

   (2) After installing, check the valve clearance.



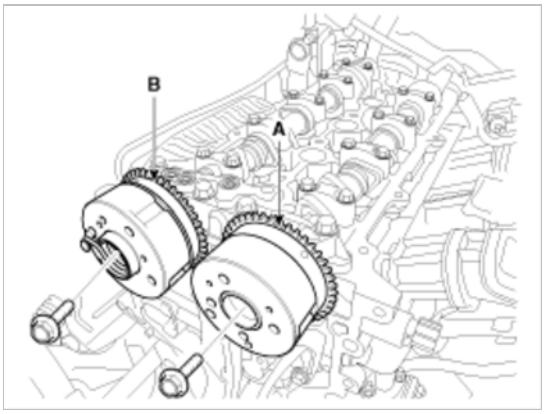

10. Install the camshaft bearing caps with the order below.

**Tightening torque :**
1st step
M6 bolt :
5.9 N.m (0.6 kgf.m, 4.3 lb-ft)
M8 bolt :
9.8 N.m (1.0 kgf.m, 7.2 lb-ft)
2nd step
M6 bolts :
11.8 ~ 13.7N.m (1.2 ~ 1.4kgf.m, 8.7 ~ 10.1lb-ft)
M8 bolts :
18.6 ~ 22.6N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



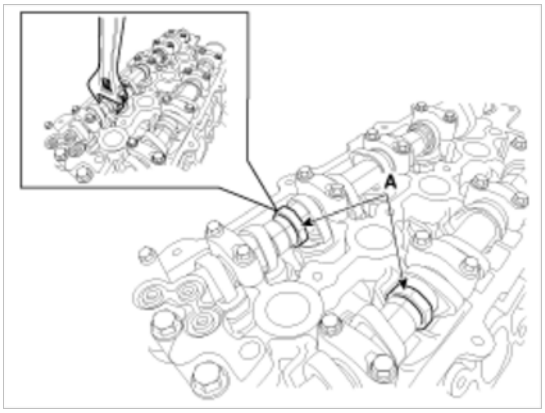

11. Install the intake CVVT assembly (A) and exhaust CVVT assembly (B).

**Tightening torque :**
63.7 ~ 73.5N.m (6.5 ~ 7.5kgf.m, 47.0 ~ 54.2lb-ft)



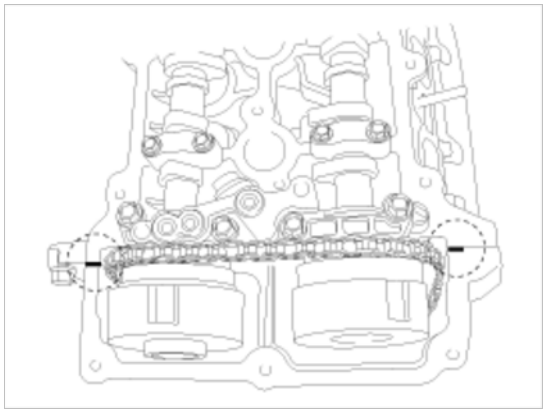

NOTE

When installing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position (A).



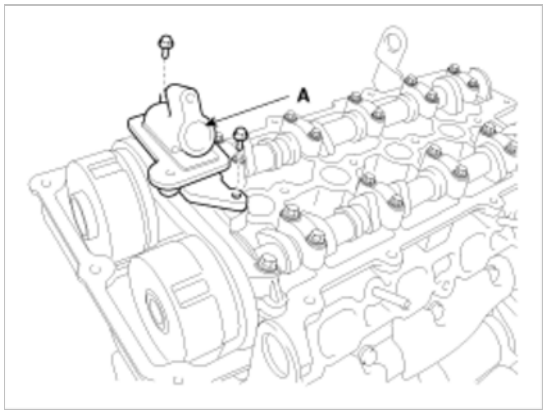

12. Install the timing chain.
(Refer to Timing system in this group)
13. Before installing the cylinder head cover, remove oil, dust or hardened sealant from the timing chain cover and the cylinder head upper surface.
14. After applying the liquid gasket, Hyundai Gray RTV or THREE BOND 1217H or LOCTITE 5900H on the cylinder head cover, reassemble the cover within five minutes.

**Width :** 2.0 ~ 2.5mm(0.0787~0.0984in.)



15. Install the OCV (Oil Control Valve) adapter (A).

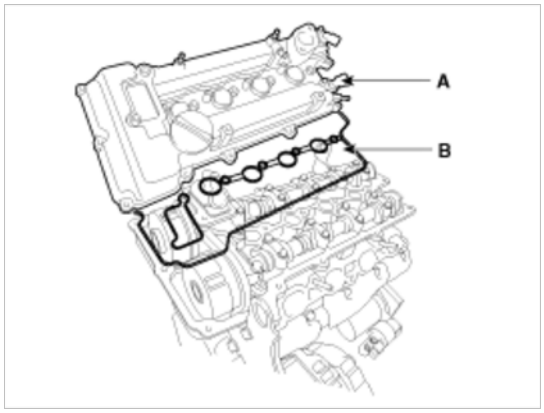
**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)




CAUTION

- Keep the OCV adapter clean.
- Make sure the O-rings on the front bearing cap are installed.

16. Install the cylinder head cover (A) with a new gasket (B).



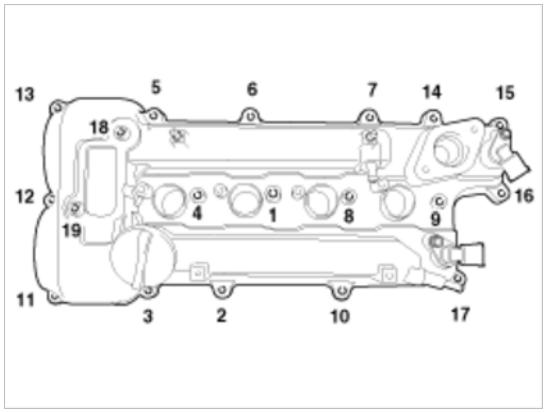

CAUTION

Do not reuse the disassembled gasket.

17. Tighten the cylinder head cover bolts (A) with the order and steps.

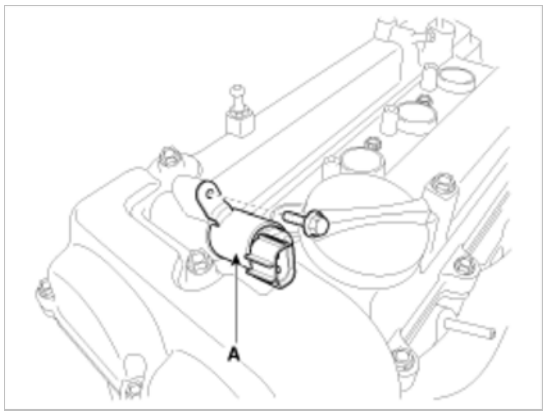
**Tightening torque :**

1st step: 3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)
2nd step: 7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)



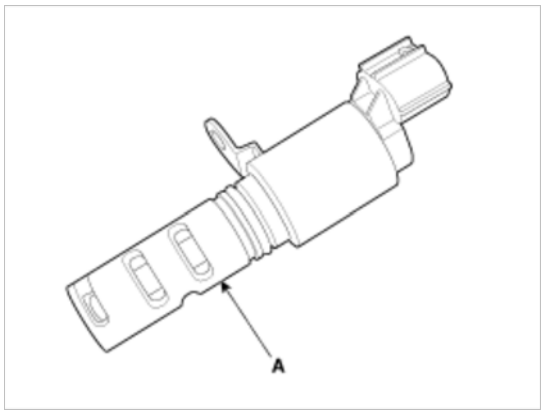

18. Install the exhaust OCV (Oil control valve) (A).

**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)




CAUTION

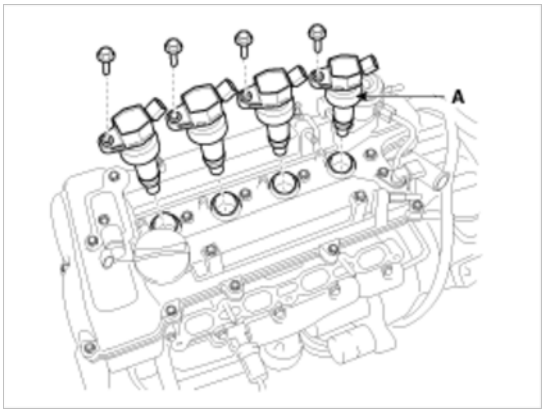
- Do not reuse the OCV when dropped.
- Keep the OCV filter clean.
- Do not hold the OCV sleeve (A) during servicing.
- When the OCV is installed on the engine, do not move the engine with holding the OCV yoke.




19. Install the ignition coils (A).

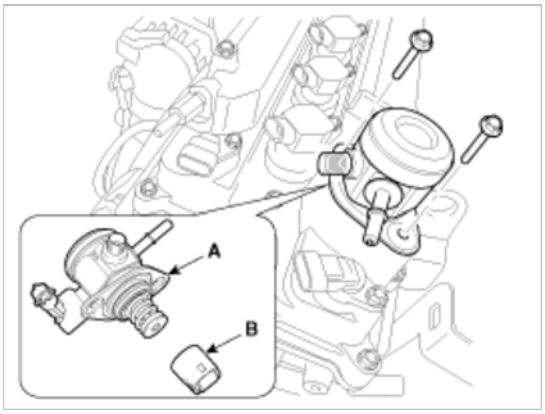
**Tightening torque :**

9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)




20. Install the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)

**Tightening torque :**
12.7 ~ 14.7N.m (1.3 ~ 1.5kgf.m, 9.4 ~ 10.8lb-ft)




CAUTION

Before installing the high pressure fuel pump, position the roller tappet in the lowest position (BDC) by rotating the crankshaft. Otherwise the installation bolts may be broken because of tension of the pump spring.

NOTE

Do not use already used bolt again.

NOTE

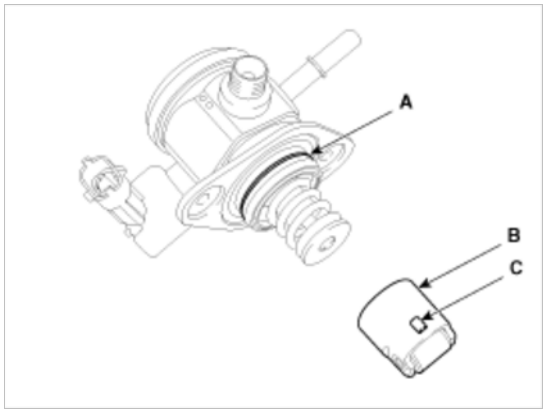
When tightening the installation bolts of the high pressure fuel pump, tighten in turn the bolts in small step (0.5 turns) after tightening them with hand-screwed torque.

CAUTION

Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

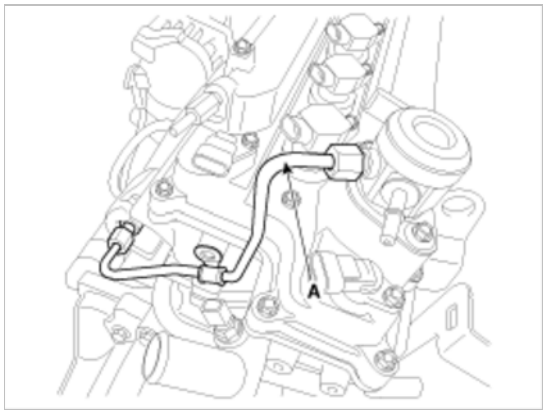
CAUTION

Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove where the protrusion is installed.




21. Install the high pressure pipe (A). (Refer to FL group)

**Tightening torque :**
25.5 ~ 31.4N.m (2.6 ~ 3.2kgf.m, 18.8 ~ 23.1lb-ft)

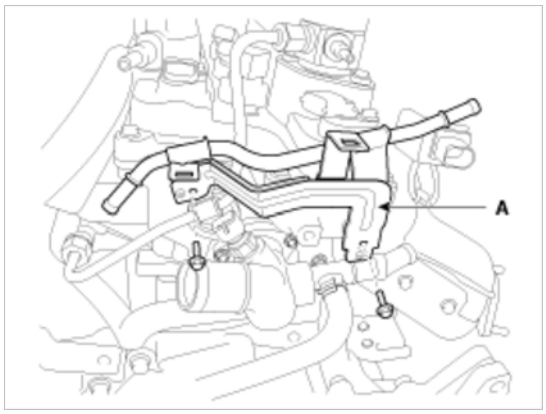



CAUTION

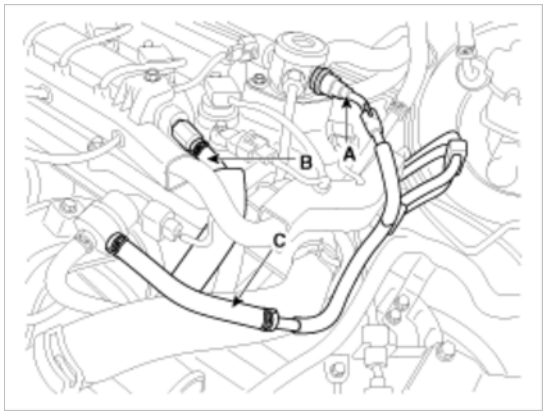
Do not reuse the high pressure pipe.

22. Install the vacuum pipe assembly (A).

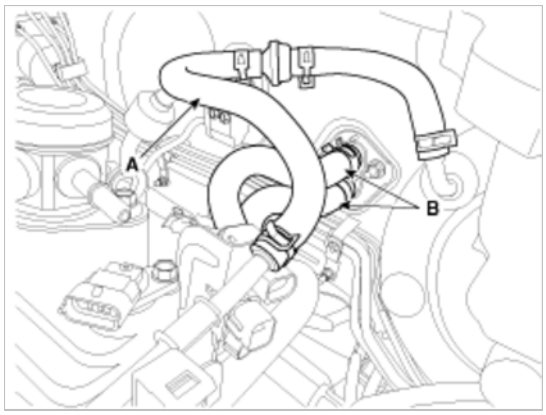
**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)




23. Connect the fuel hose (A), the PCV (Positive crankcase ventilation) hose (B) and the PCSV (Purge control solenoid valve) hose (C).

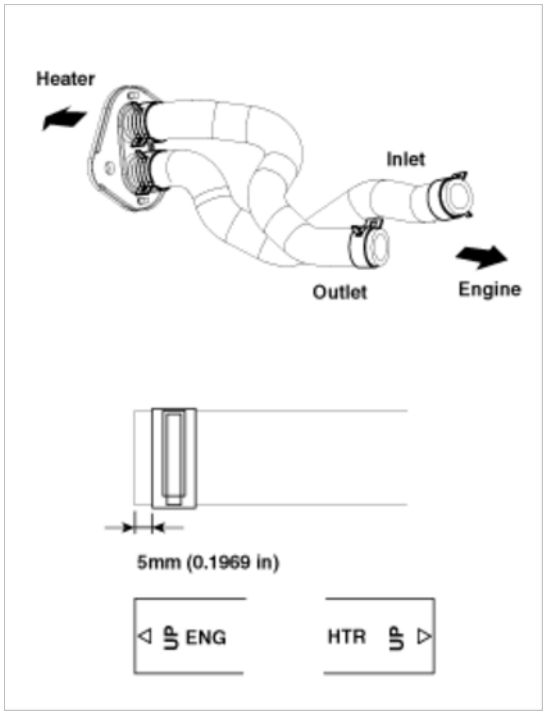



24. Connect the brake booster vacuum hose (A) and heater hose (B).



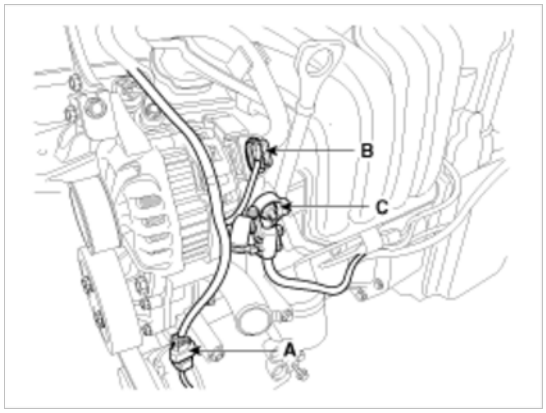

NOTE

Install the heater hoses as shown illustrations.

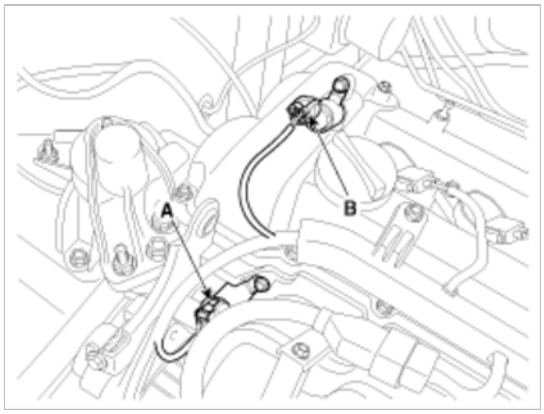



25. Connect the wiring connectors and harness clamps, and remove the wiring and protectors from the cylinder head and intake manifold.
    (1) The A/C compressor switch connector (A), the alternator connector (B) and the cable from the alternator “B” terminal (C)

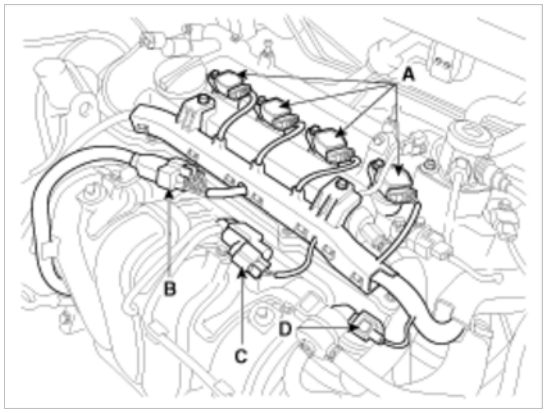
**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



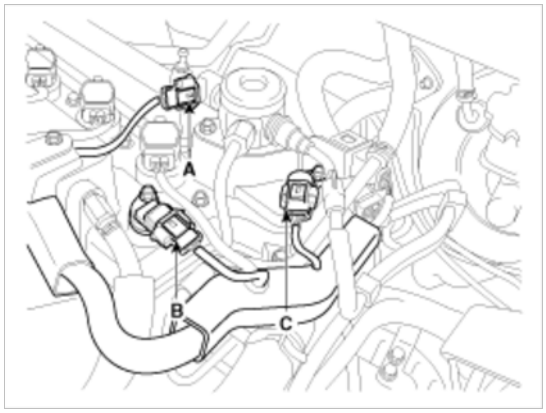

(2) The intake OCV (Oil control valve) connector (A) and the exhaust OCV (Oil control valve) connector (B)



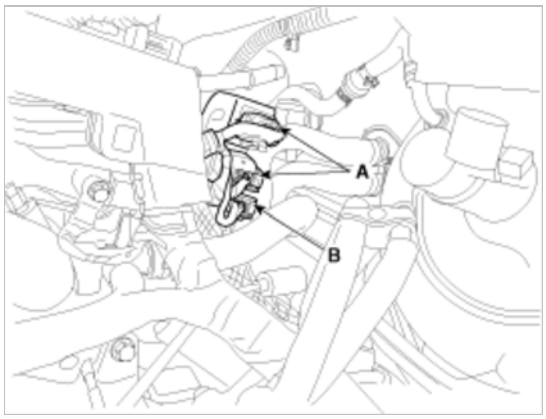

(3) The ignition coil connectors (A), the injector extension connector (B), the VIS (Variable intake system) connector (C) and the PCSV (Purge control solenoid valve) connector (D)



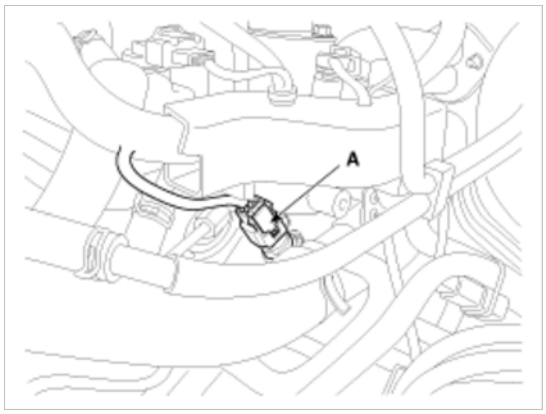

(4) The FPCV (Fuel pressure control valve) connector (A), the intake CMPS (Camshaft position sensor) connector (B) and the exhaust CMPS (Camshaft position sensor) connector (C)



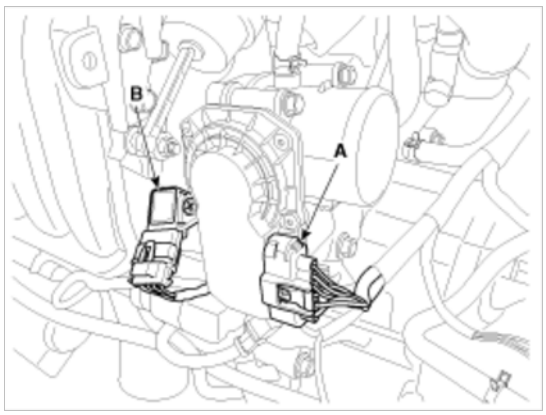

(5) The oxygen sensor connectors (A) and the condenser connector (B).



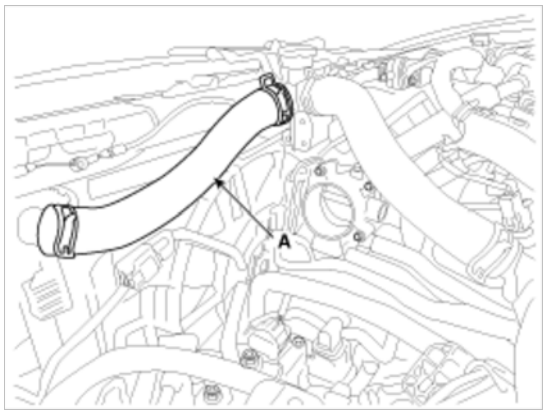

(6) The ECTS (Engine coolant temperature sensor) connector (A) and the ground line

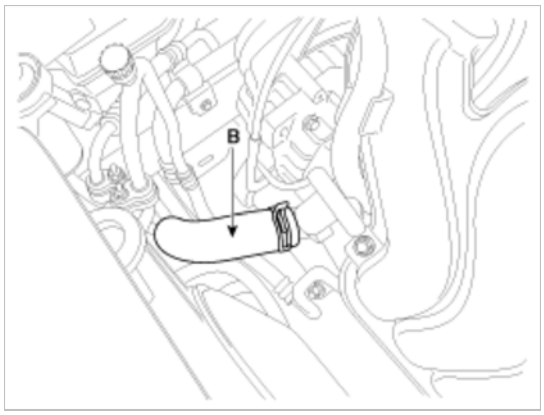



(7) The ETC (Electronic throttle control) connector (A) and the MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B)



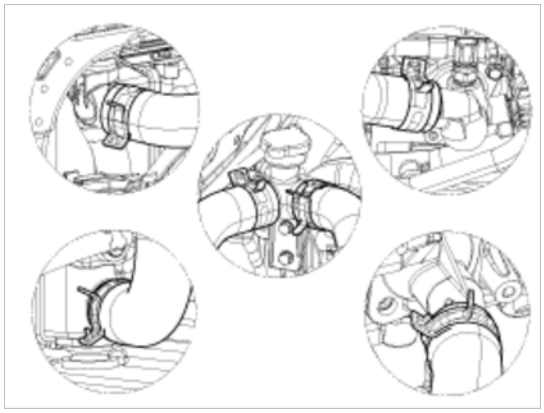

26. Connect the radiator upper hose (A) and lower hose (B).



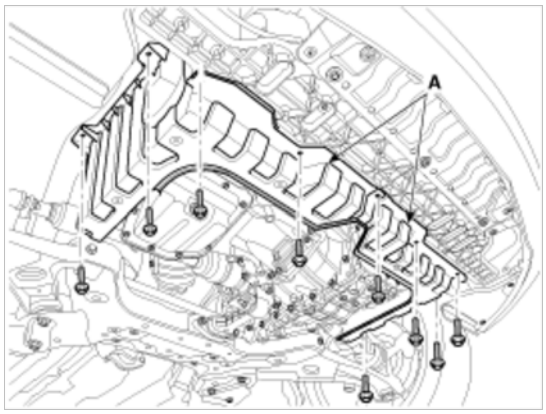

NOTE

Install the radiator hoses as shown illustrations.



27. Install the under covers (A).

**Tightening torque :**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)

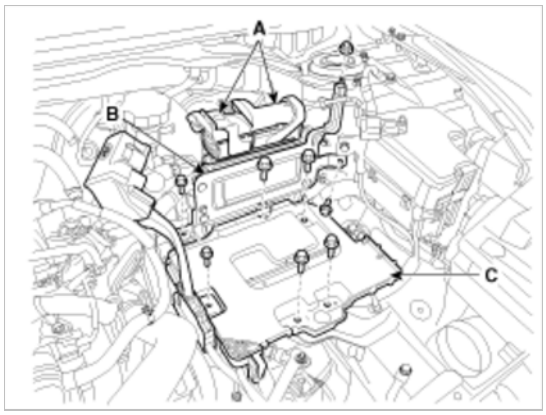



28. Install the battery tray (C).

**Tightening torque :**
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

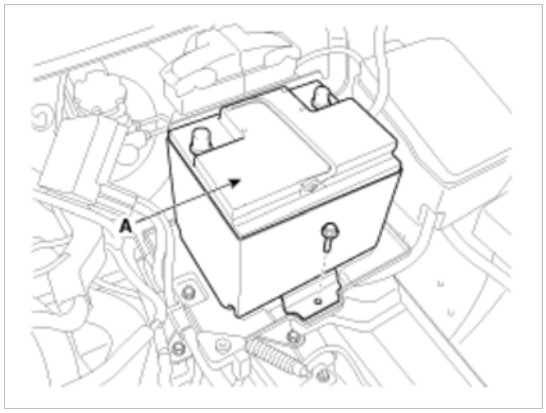
29. Install the ECM (B) and then connect the ECM connectors (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)




30. Install the battery (A) after removing the mounting bracket.

**Tightening torque :**
8.8 ~ 13.7 N.m (0.9 ~ 1.4 kgf.m, 6.5 ~ 10.1 lb-ft)

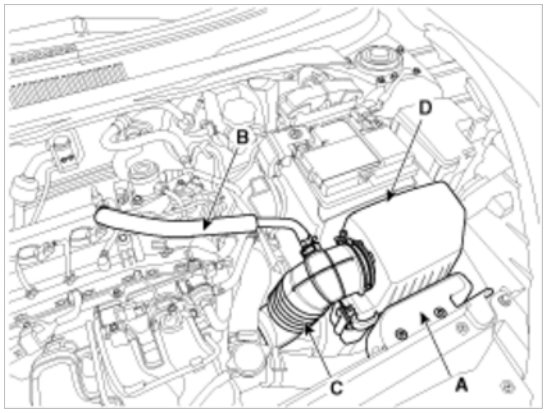



31. Install the RH front wheel.
32. Install the air cleaner assembly.
    (1) Install the air cleaner assembly (D) and the air intake hose (C).

**Tightening torque**
Hose clamp bolt :
2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)
Air cleaner assembly bolts :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

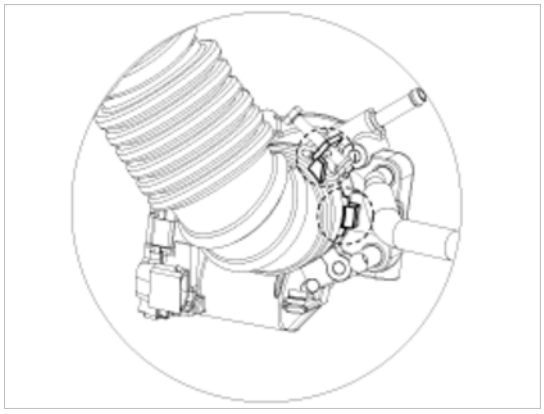
(2) Connect the breather hose (B).

(3) Install the air duct (A).



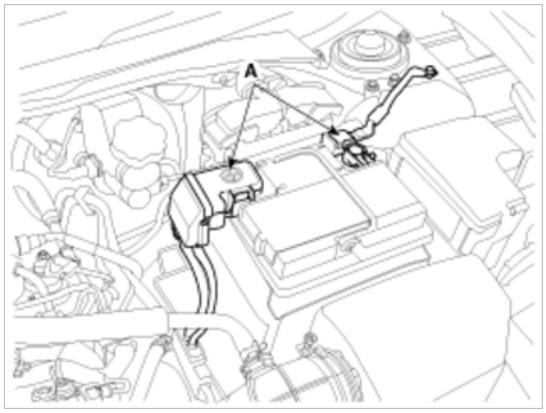

NOTE

- Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.
- Install the air intake hose while the groove of hose must be matched to the protrusion of the throttle body.



33. Connect the battery negative terminals (A).

**Tightening torque**
(+) terminal :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (without battery sensor) :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal (with battery sensor) :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)




34. Install the engine cover.

CAUTION

Install the engine cover.

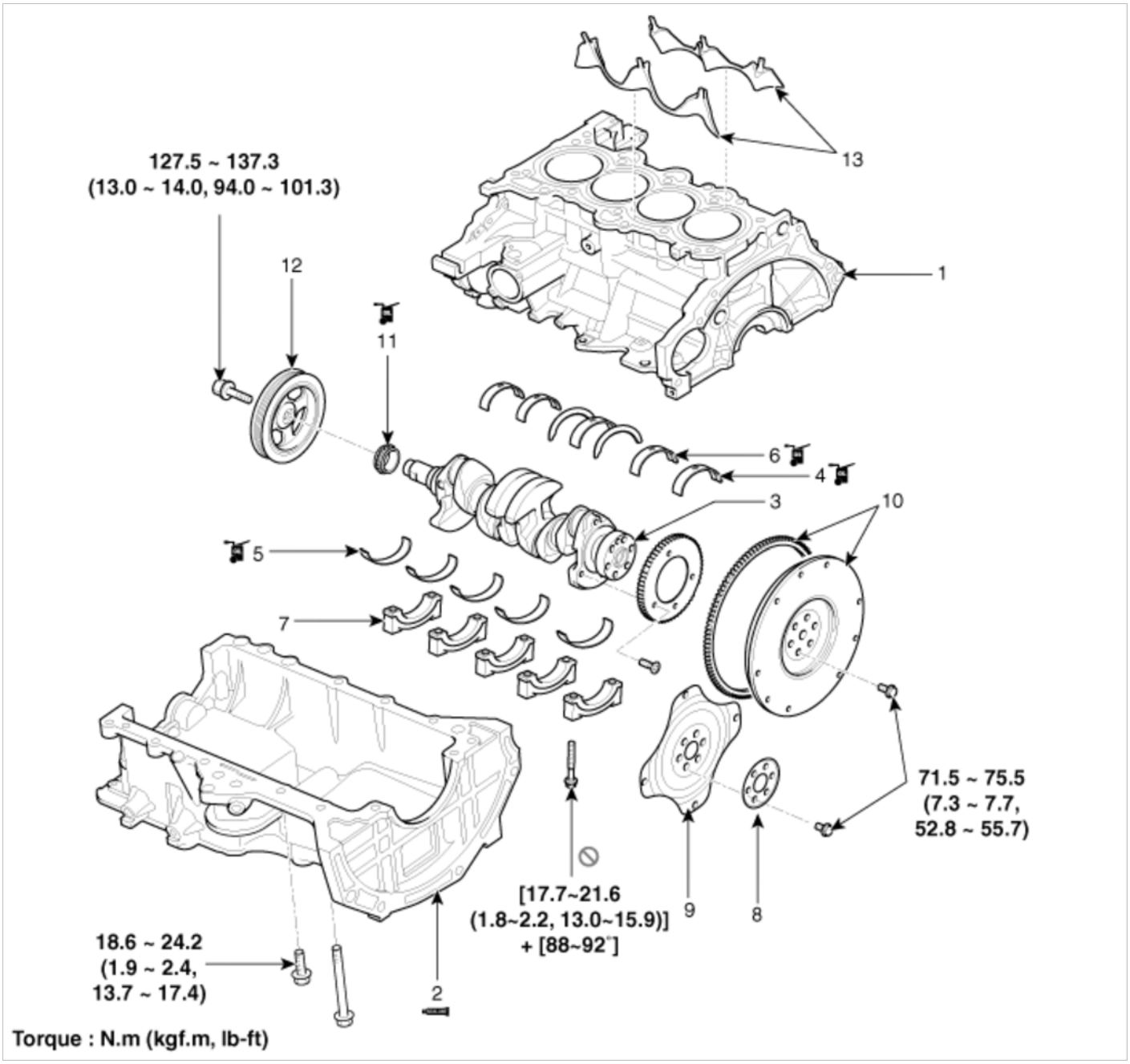
NOTE

Perform the following :

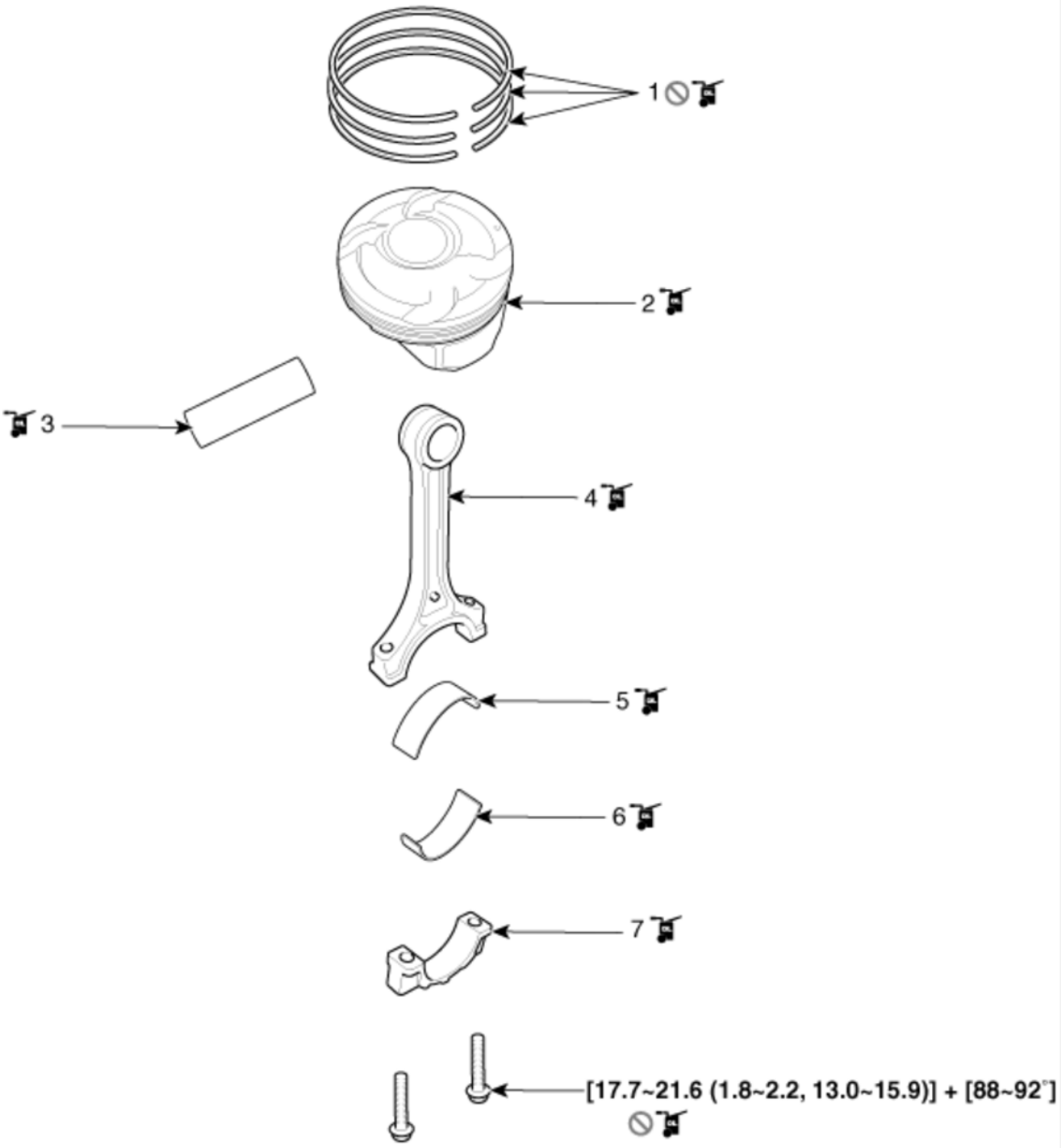
- Adjust a shift cable.
- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- Clean battery posts and cable terminals and assemble.
- Inspect for fuel leakage.
  - After assemble the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
  - Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.
- Bleed air from the cooling system.
  - Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
  - Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
  - Put radiator cap on tightly, then run the engine again and check for leaks.

## Engine Mechanical System > Cylinder Block > Cylinder Block > Components and Components Location

### Components




| | | |
|---|---|---|
| 1. Cylinder block | 5. Crankshaft lower bearing | 9. Drive plate |
| 2. Ladder frame | 6. Thrust bearing | 10. Fly wheel |
| 3. Crankshaft | 7. Main bearing cap | 11. Crankshaft sproket |
| 4. Crankshaft upper bearing | 8. Adapter plate | 12. Crankshaft pulley |
| | | 13. Water jacket insert |




Torque : N.m (kgf.m, lb-ft)

| | |
|---|---|
| 1. Piston ring<br>2. Piston<br>3. Piston pin<br>4. Connecting rod | 5. Connecting rod upper bearing<br>6. Connecting rod lower bearing<br>7. Connecting rod bearing cap |

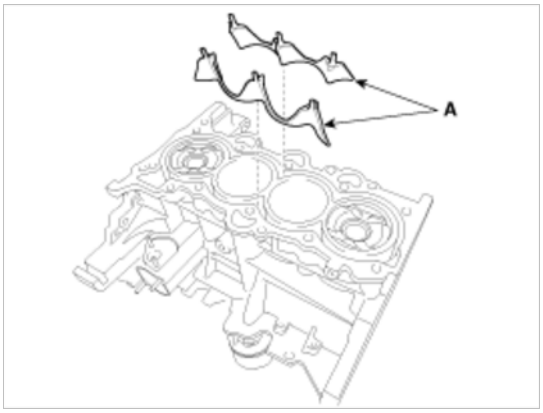
## Engine Mechanical System > Cylinder Block > Cylinder Block > Repair procedures

### Disassembly

Engine removal is required for this procedure. (Refer to Engine and transaxle assembly removal in this group)

1. M/T : Remove the fly wheel.
2. A/T : Remove the drive plate.

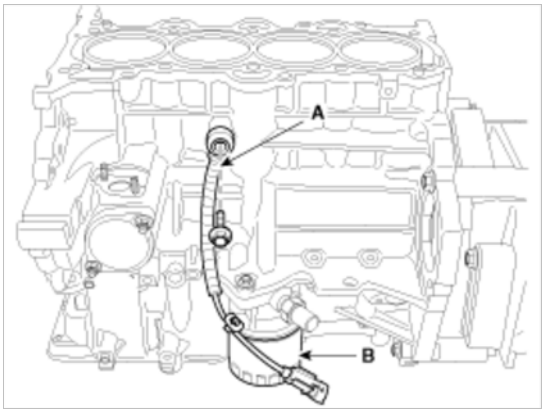
3. Install the engine to engine stand for disassembly.
4. Remove the timing chain. (Refer to Timing chain in this group)
5. Remove the cylinder head. (Refer to Cylinder head in this group)
6. Remove the water jacket insert (A).



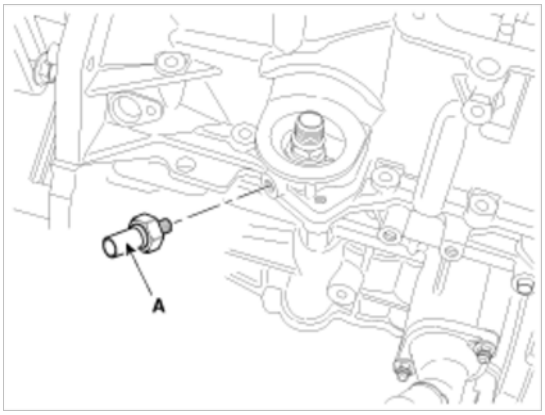

CAUTION

Be careful not to deform or damage it when removing.

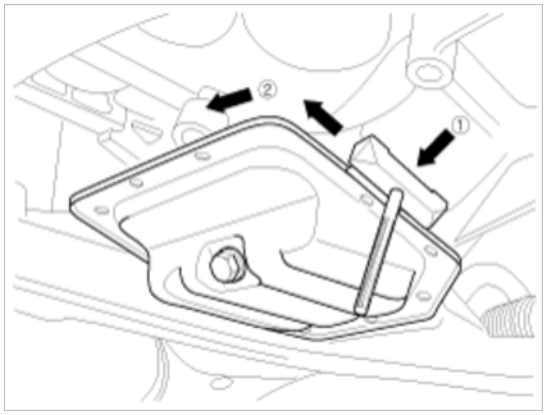
7. Remove the oil level gauge tube.
8. Remove the knock sensor (A) and the oil filter (B).




9. Remove the oil pressure switch (A).



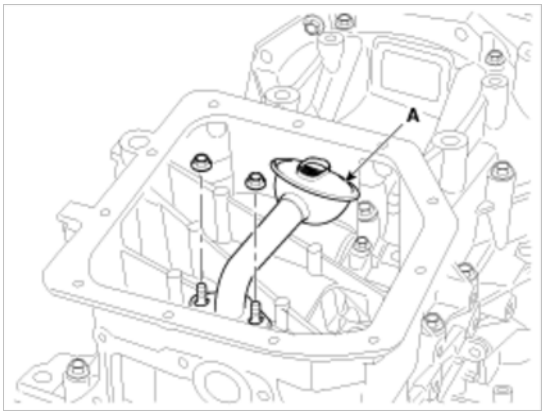

10. Using the SST (09215-3C000), remove the oil pan (A).



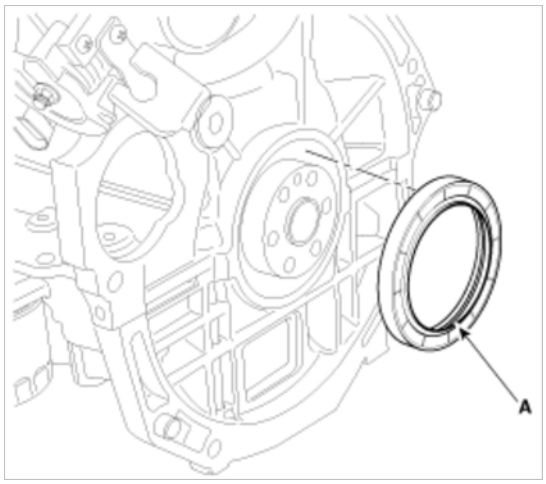

**CAUTION**

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of ① arrow.
- After tapping the SST with a plastic hammer along the direction of ② arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.
- Do not turn over the SST abruptly without tapping. It is result in damage of the SST.

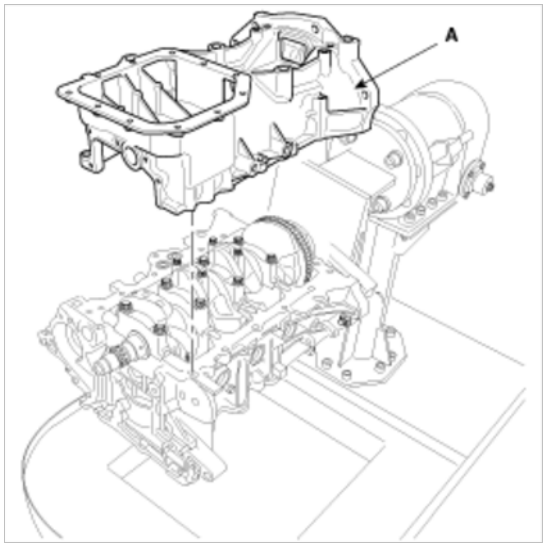
11. Remove the oil screen (A).




12. Remove the rear oil seal (A).




13. Remove the ladder frame (A).

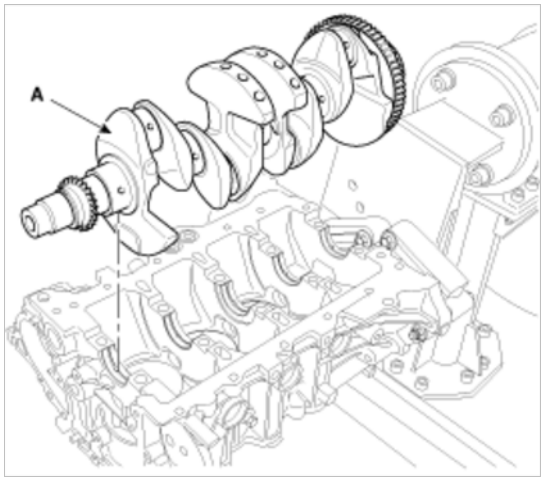



14. Check the connecting rod end play.
15. Remove the connecting rod caps and check oil clearance.
16. Remove the piston and connecting rod assemblies.
    (1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
    (2) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

> NOTE
>
> • Keep the bearings, connecting rod and cap together.
> • Arrange the piston and connecting rod assemblies in the correct order.

17. Remove the crankshaft bearing cap and check oil clearance.
18. Check the crankshaft end play.
19. Lift the crankshaft (A) out of the engine, being careful not to damage journals.

> NOTE
>
> Arrange the main bearings and thrust bearings in the correct order.




20. Check fit between piston and piston pin.
    Try to move the piston back and forth on the piston pin.
    If any movement is felt, replace the piston and pin as a set.
21. Remove the piston rings.

(1) Using a piston ring expander, remove the 2 compression rings.

(2) Remove the 2 side rails and coil spring.

> NOTE
>
> Arrange the piston rings in the correct order only.

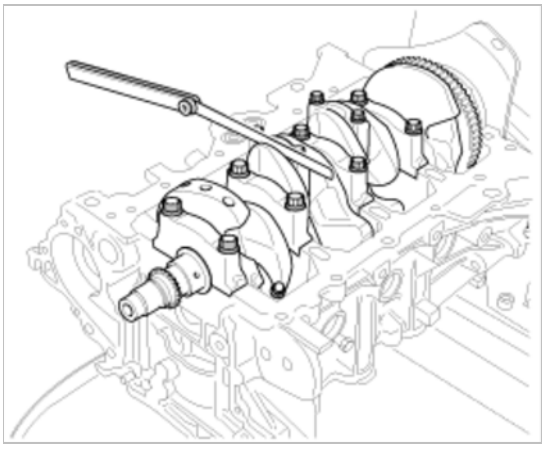
22. Remove the connecting rod from the piston.
    Using a press, remove the piston pin from piston.
    (Press-in load : 500 ~ 1,500kg(1,102 ~ 3,306lb))

## Inspection

### Connecting Rod And Crankshaft

1. Check the connecting rod end play.
   Using feeler gauge, measure the end play while moving the connecting rod back and forth.

**End play**
Standard : 0.10 ~ 0.25mm (0.0039 ~ 0.0098in)
Maximum : 0.35mm (0.0138in)



A. If out-of-tolerance, install a new connecting rod.

B. If still out-of-tolerance, replace the crankshaft.

2. Check the connecting rod bearing oil clearance.

(1) Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.

(2) Remove the 2 connecting rod cap bolts.

(3) Remove the connecting rod cap and lower bearing.

(4) Clean the crankshaft pin journal and bearing.

(5) Place a plastigage across the crankshaft pin journal.

(6) Reinstall the lower bearing and cap, and tighten the bolts. Do not reuse the bolts.

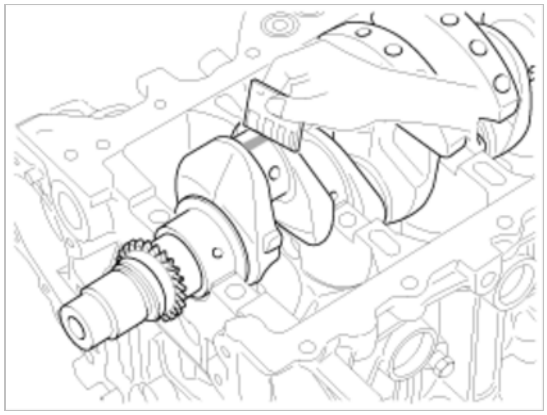
**Tightening torque :**
17.7 ~ 21.6N.m (1.8 ~ 2.2kgf.m, 13.0 ~ 15.9lb-ft) + 88 ~ 92°

> NOTE
>
> Do not turn the crankshaft.

(7) Remove the 2 bolts, connecting rod cap and lower bearing .

(8) Measure the plastigage at its widest point.

**Standard oil clearance**
0.032 ~ 0.052mm (0.0013 ~ 0.0020in)



(9) If the measurement from the plastigage is too wide or too narrow, remove the upper and lower bearing and then install a new bearings with the same color mark.
Recheck the oil clearance.

CAUTION

Do not file, shim, of scrape the bearings or the caps to adjust clearance.

(10) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing.
Recheck the oil clearance.

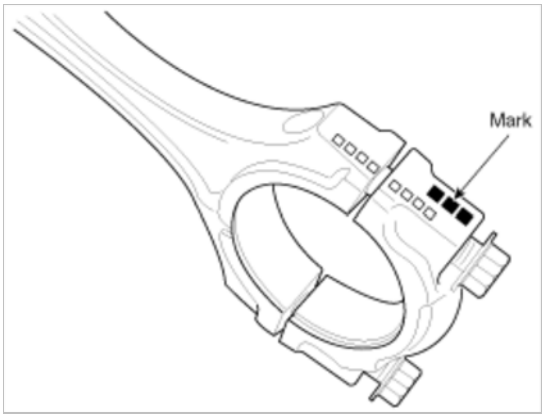
NOTE

If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and restart over.

CAUTION

If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

## Connecting Rod Mark Location

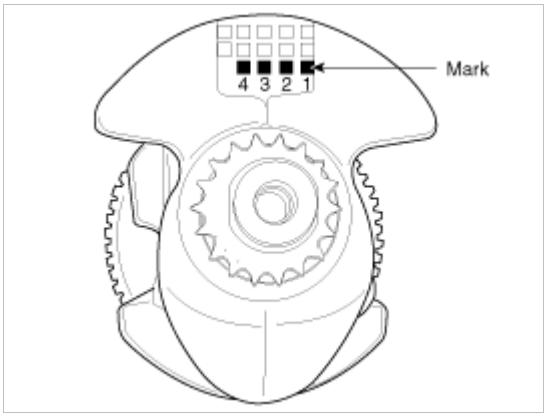



**Discrimination Of Connecting Rod**

| Mark | Connecting rod big-end inner diameter |
|---|---|

| | |
|---|---|
| A, 0 | 45.000 ~ 45.006mm (1.7717 ~ 1.7719in) |
| B, 00 | 45.006 ~ 45.012mm (1.7719 ~ 1.7721in) |
| C, 000 | 45.012 ~ 45.018mm (1.7721 ~ 1.7724in) |

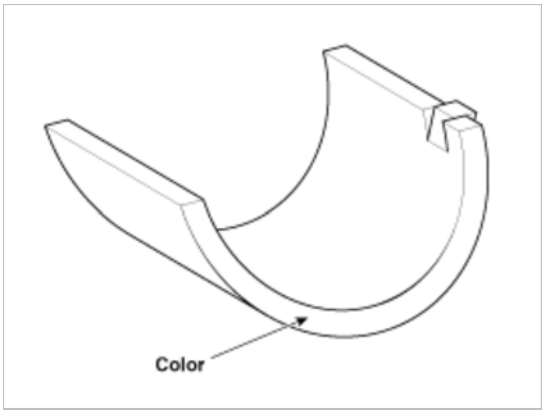
## Crankshaft Pin Diameter Mark Location




**Discrimination Of Crankshaft Pin Diameter**

| Mark | Crankshaft pin outer diameter |
|---|---|
| 1 | 41.972 ~ 41.966mm (1.6524 ~ 1.6522in) |
| 2 | 41.966 ~ 41.960mm (1.6522 ~ 1.6520in) |
| 3 | 41.960 ~ 41.954mm (1.6520 ~ 1.6517in) |

## Connecting Rod Bearing Color Location




**Discrimination Of Connecting Rod Bearing**

| Mark | Color | Connecting rod bearing thickness |
|---|---|---|
| A | Blue | 1.514 ~ 1.517mm (0.0596 ~ 0.0597in) |
| B | Black | 1.511 ~ 1.514mm (0.0595 ~ 0.0596in) |
| C | None | 1.508 ~ 1.511mm (0.0594 ~ 0.0595in) |
| D | Green | 1.505 ~ 1.508mm (0.0593 ~ 0.0594in) |
| E | Red | 1.502 ~ 1.505mm (0.0591 ~ 0.0593in) |

(11) Select the bearing by using selection table.
**Connecting Rod Bearing Selection Table**

| | | Connecting rod mark | | |
|---|---|---|---|---|
| | | A, 0 | B, 00 | C, 000 |
| **Crank shaft pin journal mark** | 1 | E (Red) | D (Green) | C (None) |
| | 2 | D (Green) | C (None) | B (Black) |
| | 3 | C (None) | B (Black) | A (Blue) |

3. Check the connecting rods.
   (1) When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the notches for holding the bearing in place are on the same side.
   (2) Replace the connecting rod if it is damaged on the thrust faces at either end. Also if step wear or a severely rough surface of the inside diameter of the small end is apparent, the rod must be replaced as well.
   (3) Using a connecting rod aligning tool, check the rod for bend and twist. If the measured value is close to the repair limit, correct the rod by a press. Any connecting rod that has been severely bent or distorted should be replaced.

**Allowable bend of connecting rod :**
0.05mm / 100mm (0.0020in / 3.94in ) or less
**Allowable twist of connecting rod :**
0.10mm / 100mm (0.0039in / 3.94in) or less

NOTE

When the connecting rods installed without bearings, there should be no difference on side surface.

4. Check the crankshaft bearing oil clearance.
   (1) To check main bearing-to-journal oil clearance, remove the main bearing caps and lower bearings.
   (2) Clean each main journal and lower bearing with a clean shop towel.
   (3) Place one strip of plastigage across each main journal.
   (4) Reinstall the lower bearings and caps, then tighten the bolts.

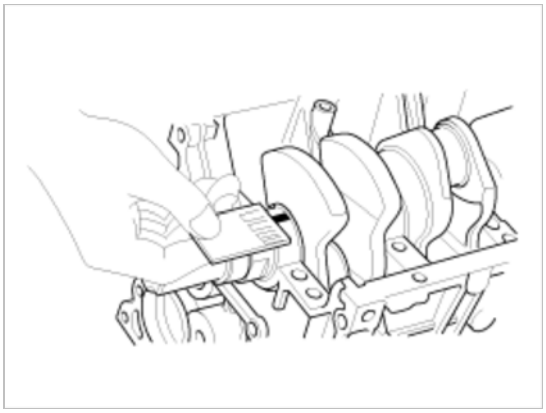
**Tightening torque :**
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

NOTE

Do not turn the crankshaft.

   (5) Remove the cap and lower bearing again, and measure the widest part of the plastigage.

**Standard oil clearance :**
No.1, 2, 3, 4, 5 : 0.021 ~ 0.042mm (0.0008 ~ 0.0017in)



(6) If the plastigage measures too wide or too narrow, remove the upper and lower bearing and then install a new bearings with the same color mark. (Refer to crankshaft main bearing selection table in this Group).
Recheck the oil clearance.

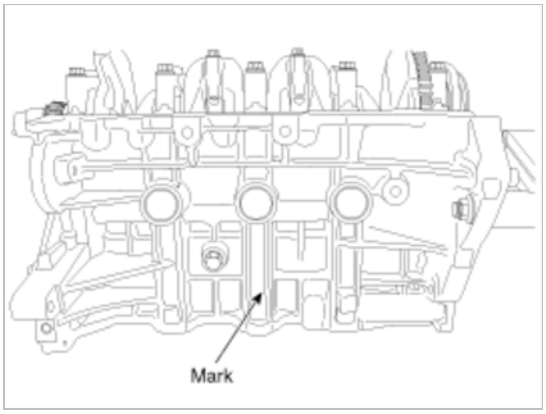
> **CAUTION**
>
> Do not file, shim, or scrape the bearings or the cap to adjust clearance.

(7) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing. (Refer to crankshaft main bearing selection table in this Group).
Recheck the oil clearance.

> **NOTE**
>
> If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

> **CAUTION**
>
> If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

**Cylinder block crankshaft journal bore mark location**
Letters have been stamped on the side surface of the block as a mark for the size of each of the 5 main journal bores.
Use them, and the numbers or letters stamped on the crank (marks for main journal size), to choose the correct bearings.

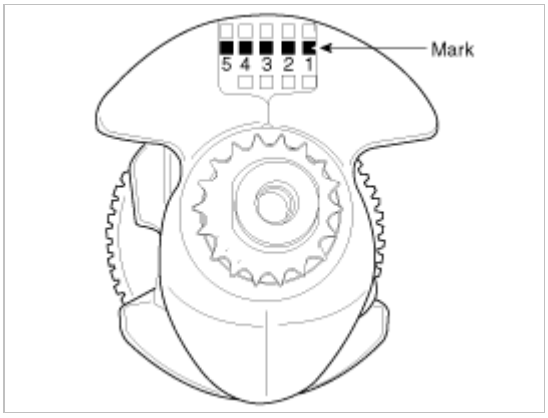



**Discrimination Of Cylinder Block Crankshaft Journal Bore**

| Mark | Cylinder block crankshaft journal bore inner diameter |
|---|---|
| A | 52.000 ~ 52.006mm (2.0472 ~ 2.0475in) |

| | |
|---|---|
| B | 52.006 ~ 52.012mm (2.0475 ~ 2.0477in) |
| C | 52.012 ~ 52.018mm (2.0477 ~ 2.0479in) |

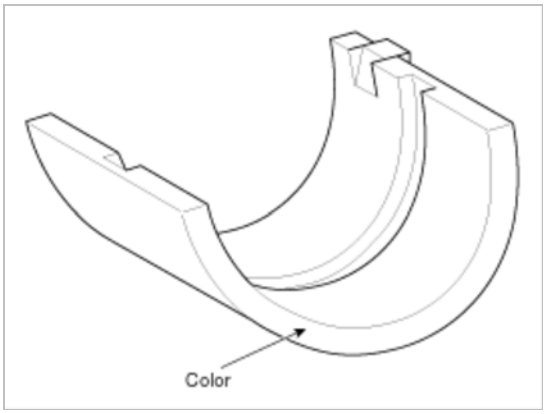
## Crankshaft Main Journal Mark Location




**Discrimination Of Crankshaft Main Journal**

| Mark | Crankshaft main journal outer diameter |
|---|---|
| 1 | 47.960 ~ 47.954mm (1.8882 ~ 1.8879in) |
| 2 | 47.954 ~ 47.948mm (1.8879 ~ 1.8877in) |
| 3 | 47.948 ~ 47.942mm (1.8877 ~ 1.8875in) |

## Crankshaft Main Bearing Color Location




**Discrimination Of Crankshaft Main Bearing**

| Mark | Color | Crankshaft main bearing thickness |
|---|---|---|
| | | No.1, 2, 3, 4, 5 |
| A | Blue | 2.026 ~ 2.029mm (0.0798 ~ 0.0799in) |
| B | Black | 2.023 ~ 2.026mm (0.0796 ~ 0.0798in) |
| C | None | 2.020 ~ 2.023mm (0.0795 ~ 0.0796in) |
| D | Green | 2.017 ~ 2.020mm (0.0794 ~ 0.0795in) |
| E | Red | 2.014 ~ 2.017mm (0.0793 ~ 0.0794in) |

(8) Select the bearing by using selection table.

**Crankshaft Main Bearing Selection Table**

| | | Cylinder block crankshaft journal bore mark | | |
|---|---|---|---|---|
| | | A | B | C |
| **Crank shaft main journal mark** | 1 | E (Red) | D (Green) | C (None) |
| | 2 | D (Green) | C (None) | B (Black) |
| | 3 | C (None) | B (Black) | A (Blue) |

5. Check the crankshaft end play.
   Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

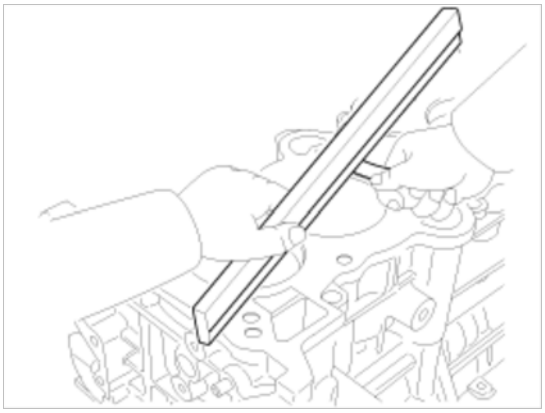
   **End play**
   Standard: 0.05 ~ 0.25mm (0.0020 ~ 0.0098in)
   Limit : 0.30mm (0.0118in)

   If the end play is greater than maximum, replace the center bearing.

## Cylinder Block

1. Remove the gasket material.
   Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
2. Clean the cylinder block
   Using a soft brush and solvent, thoroughly clean the cylinder block.
3. Inspect the top surface of cylinder block for flatness.
   Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

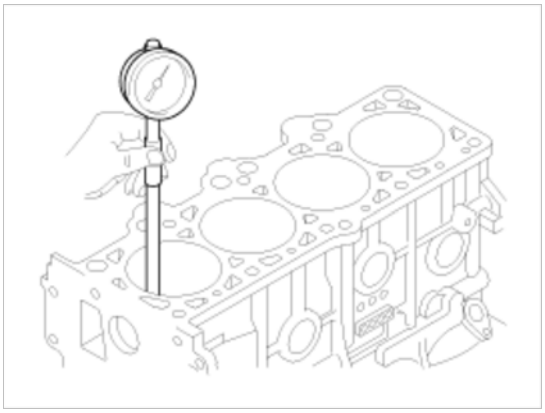
   Flatness of cylinder block gasket surface
   Standard :
   Less than 0.05mm (0.0020in) for total area
   Less than 0.02mm (0.0008in) for a section of 100mm (3.9370in) X 100mm (3.9370in)



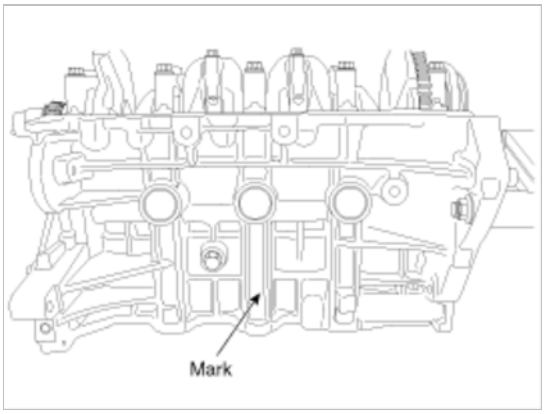
4. Inspect the cylinder bore.
   Visually check the cylinder for vertical scratchs.
   If deep scratchs are present, replace the cylinder block.
5. Inspect the cylinder bore diameter.
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial direction.

   **Standard diameter :**

77.00 ~ 77.03mm (3.0315 ~ 3.0327in)



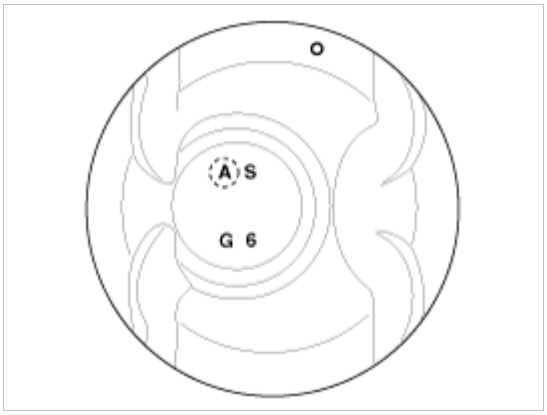
6. Check the cylinder bore size code on the cylinder block side surface.




**Discrimination Of Cylinder Bore Size**

| Mark | Cylinder bore inner diameter |
|---|---|
| A | 77.00 ~ 77.01mm (3.0315 ~ 3.0319in) |
| B | 77.01 ~ 77.02mm (3.0319 ~ 3.0323in) |
| C | 77.02 ~ 77.03mm (3.0323 ~ 3.0327in) |

7. Check the piston size mark (A) on the piston top face.




A : Grade
S : ISG type
G : Gasoline engine
6 : 1.6L

**Discrimination Of Piston Outer Diameter**

| Mark | Piston outer diameter |
|---|---|

| | |
|---|---|
| A | 76.97 ~ 76.98mm (3.0303 ~ 3.0307in) |
| B | 76.98 ~ 76.99mm (3.0307 ~ 3.0311in) |
| C | 76.99 ~ 77.00mm (3.0311 ~ 3.0315in) |

8. Select the piston related to cylinder bore class.

**Piston -to-cylinder clearance :**
0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

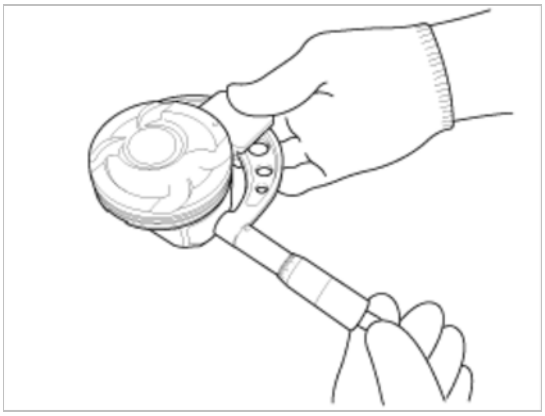
## Piston And Piston Rings

1. Clean the piston.
   (1) Using a gasket scraper, remove the carbon from the piston top.
   (2) Using a groove cleaning tool or broken ring, clean the piston ring grooves.
   (3) Using solvent and a brush, thoroughly clean the piston.

> NOTE
>
> Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 12mm(0.4724in) from bottom land of the piston.

**Standard diameter :**
76.97 ~ 77.00mm (3.0303 ~ 3.0315in)



3. Calculate the difference between the cylinder bore inner diameter and the piston outer diameter.

**Piston-to-cylinder clearance :**
0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

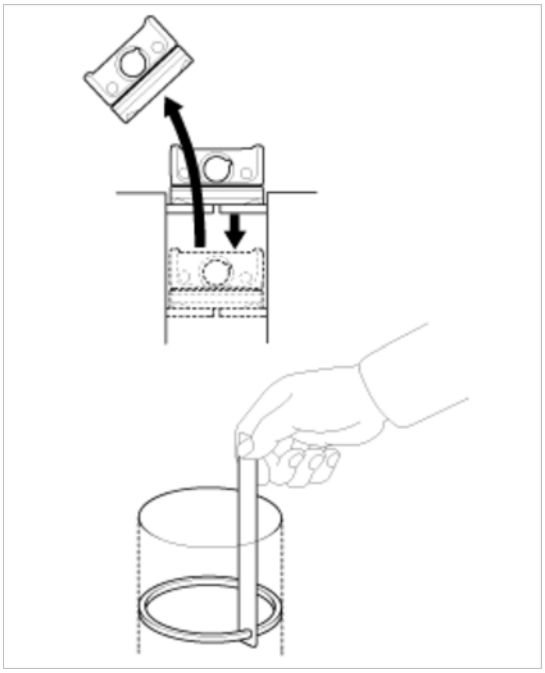
4. Inspect the piston ring side clearance.
   Using a feeler gauge, measure the clearance between new piston ring and the wall of ring groove.

**Piston ring side clearance**
No.1 ring : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)
No.2 ring : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)
Oil ring : 0.02 ~ 0.06mm (0.0008 ~ 0.0024in)
Limit
No.1 ring : 0.1mm (0.0039in)
No.2 ring : 0.1mm ( 0.0039in)
Oil ring : 0.2mm ( 0.0079in)

If the clearance is greater than maximum, replace the piston.

5. Inspect the piston ring end gap.
   To measure the piston ring end gap, insert a piston ring into the cylinder bore. Position the ring at right angles to the cylinder wall by gently pressing it down with a piston. Measure the gap with a feeler gauge. If the gap exceeds the service limit, replace the piston rings. If the gap is too large, recheck the cylinder bore inner diameter. If the bore is over the service limit, the cylinder block must be rebored.

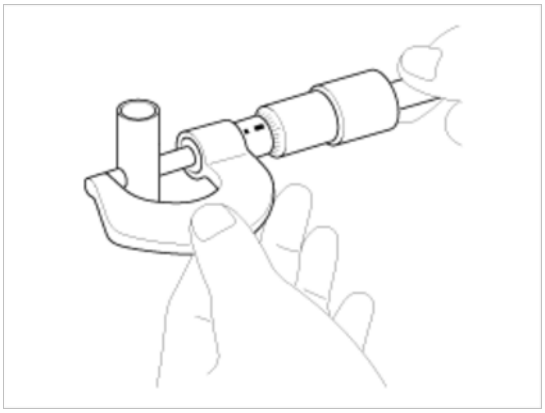
**Piston ring end gap**
Standard
No.1 ring : 0.14 ~ 0.28mm (0.0079 ~ 0.0138in)
No.2 ring : 0.30 ~ 0.45mm (0.0118 ~ 0.0177in)
Oil ring : 0.20 ~ 0.40mm(0.0079 ~ 0.0157in)
Limit
No.1 ring : 0.3mm(0.0118in)
No.2 ring : 0.5mm(0.0197in)
Oil ring : 0.8mm(0.0315in)



## Piston Pins

1. Measure the outer diameter of piston pin

**Piston pin diameter :**
18.001 ~ 18.006mm (0.7087 ~ 0.7089in)



2. Measure the piston pin-to-piston clearance.

**Piston pin-to-piston clearance :**
0.010 ~ 0.020mm (0.0004 ~ 0.0008in)

3. Check the difference between the piston pin outer diameter and the connecting rod small end inner diameter.

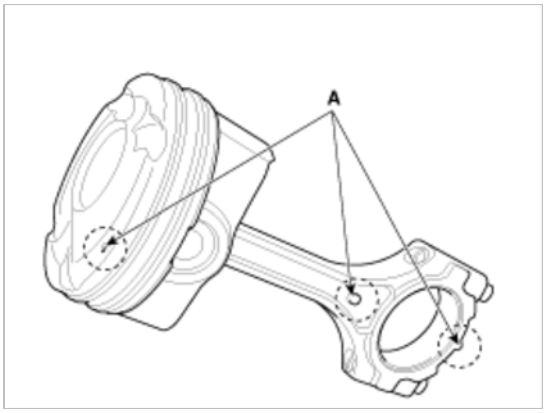
**Piston pin-to-connecting rod interference :**
-0.032 ~ -0.016mm (-0.0013 ~ -0.0006in)

## Reassembly

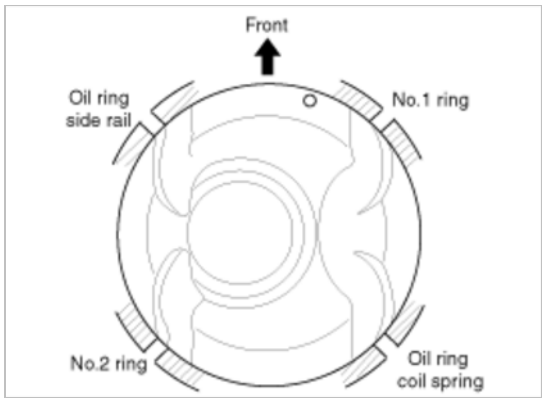
NOTE

- Thoroughly clean all parts to assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

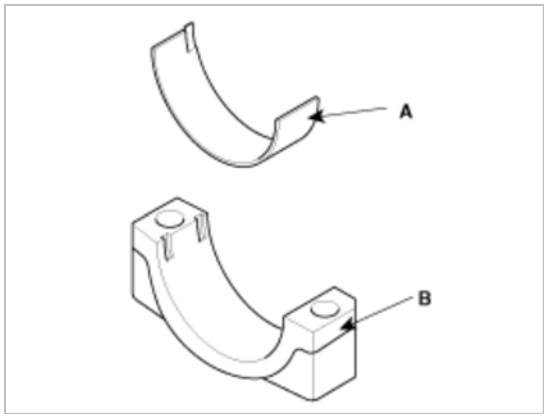
1. Assemble the piston and connecting rod.
   (1) Use a hydraulic press for installation
   (2) The piston front mark (A) and the connecting rod front mark (A) must face the timing chain side of the engine.




2. Install the piston rings.
   (1) Install the oil ring coil spring and 2 side rails by hand.
   (2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
   (3) Position the piston rings so that the ring ends are as shown.



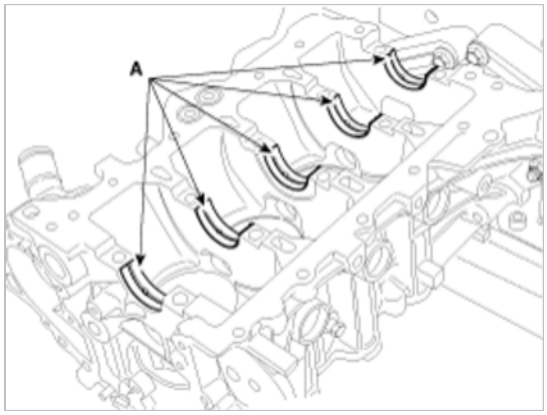

3. Install the connecting rod bearings.
   (1) Align the bearing (A) claw with the groove of the connecting rod or connecting rod cap (B).
   (2) Install the bearings (A) in the connecting rod and connecting rod cap (B).




4. Install the crankshaft main bearings.

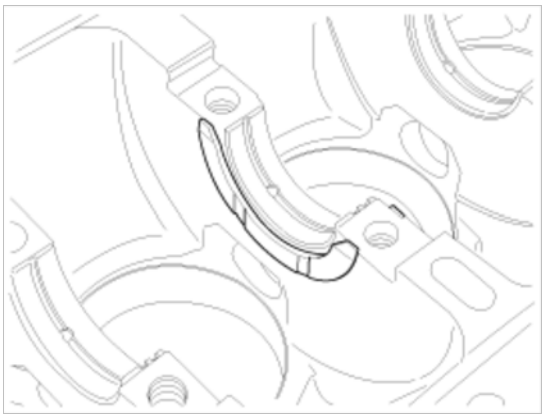
> NOTE
>
> Upper bearings have an oil groove of oil holes ; Lower bearings do not.

   (1) Align the bearing claw with the claw groove of the cylinder block, push in the five upper bearings(A).




   (2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

5. Install the thrust bearing.
   Install the thrust bearing (A) on the No.3 journal position of the cylinder block with the oil grooves facing outward.



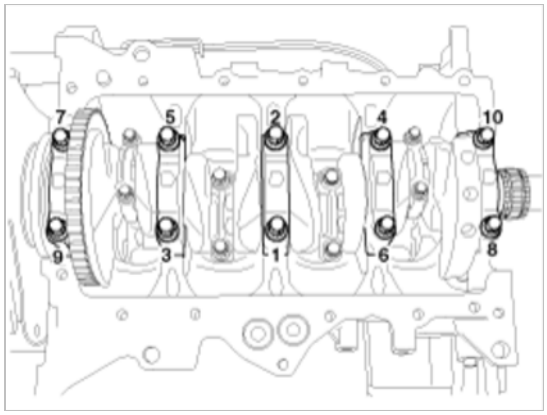
6. Place the crankshaft on the cylinder block.
7. Place the main bearing caps on the cylinder block.
8. Install the main bearing cap bolts.

> NOTE
>
> The main bearing cap bolts are tightened in 2 progressive steps.
> If any of the bearing cap bolts in broken or deformed, replace it.

(1) Apply a light coat of engine oil on the threads and under the bearing cap bolts.

(2) Install and uniformly tighten the 10 bearing cap bolts, in several passes, in the sequence shown.

**Tightening torque :**
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°




> CAUTION
>
> Do not reuse the main bearing cap bolts.

(3) Check that the crankshaft turns smoothly.

9. Check the crankshaft end play.
10. Install the piston and connecting rod assemblies.

> NOTE
>
> Before installing the piston, apply a coat of engine oil to the ring grooves and cylinder bores.

(1) Install the ring compressor, check that the rings are securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.

(2) Stop after the ring compressor pops free, and check the connecting rod-to-crank journal alignment before pushing the piston into place.

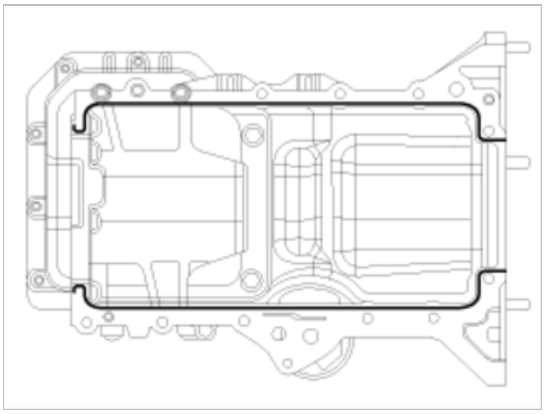
(3) Install the rod caps with bearings, and tighten the bolts.

**Tightening torque :**
17.7~21.8Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

CAUTION

Do not reuse the connecting rod cap bolts.

11. Apply the sealant on the ladder frame.

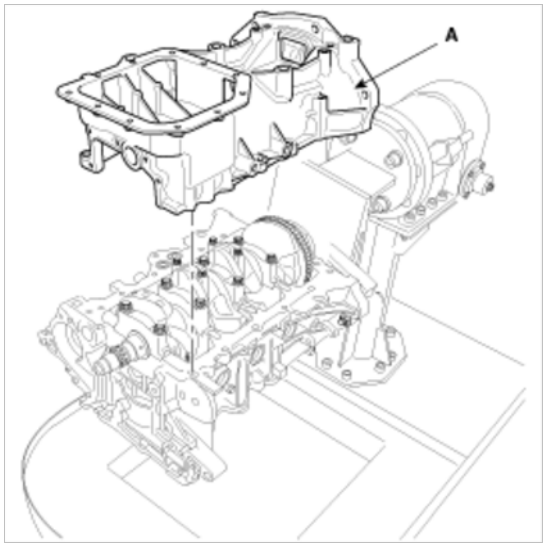


NOTE

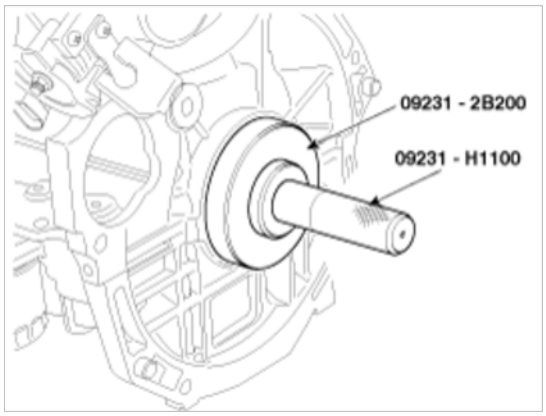
- Apply the sealant, Hyundai Gray RTV or TB 1217H or LOCTITE 5900H on the ladder frame rail portion and install it with in five minutes.
  If when sealant is applied to cylinder block bottom position, sealant position to be same with positon that is applied to ladder frame rail position.
- Apply sealant along the inner line of the bolt holes.

12. Install the ladder frame (A).

**Tightening torque :**
18.6 ~ 24.2N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

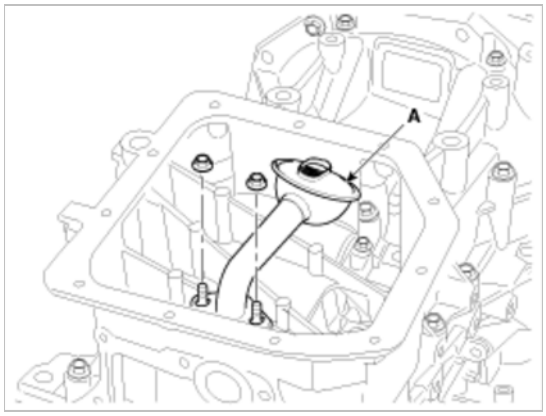


13. Install the rear oil seal.
    (1) Apply engine oil to a new oil seal lip.
    (2) Using the SST(09231-H1100, 09231-2B200) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.




14. Install the oil screen (A).
    Install a new gasket and oil screen with 2 bolts.

**Tightening torque :**
19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)



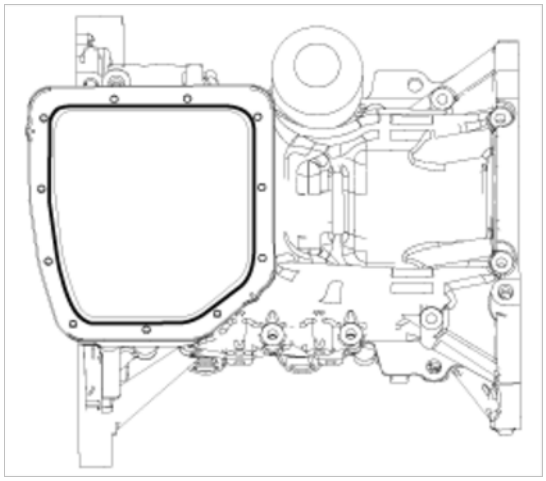

15. Install the oil pan.
    (1) Using a razor blade and gasket scraper, remove all the old packing material from the gasket surfaces.

NOTE

Check that the mating surfaces are clean and dry before applying liquid gasket.

    (2) Apply liquid gasket with the width of Ø3mm, starting 1mm-away position from the inner rounding of the oil pan rail.

**Liquid gasket :** Hyundai Gray RTV or TB 1217H or LOCTITE 5900H

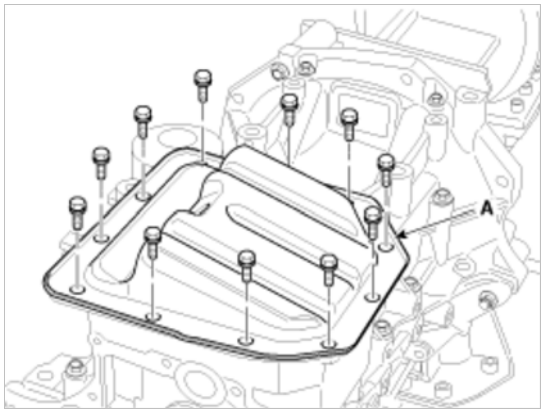


NOTE

- To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.
- Do not install the parts if five minutes or more have elapsed since applying the liquid gasket. Instead, reapply liquid gasket after removing the residue.
- After assembly, wait at least 30 minutes before filling the engine with oil.

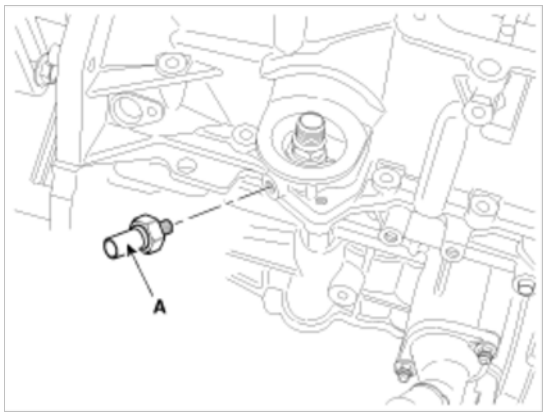
(3) Install the oil pan (A) with the bolts.
Uniformly tighten the bolts in several passes.

**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



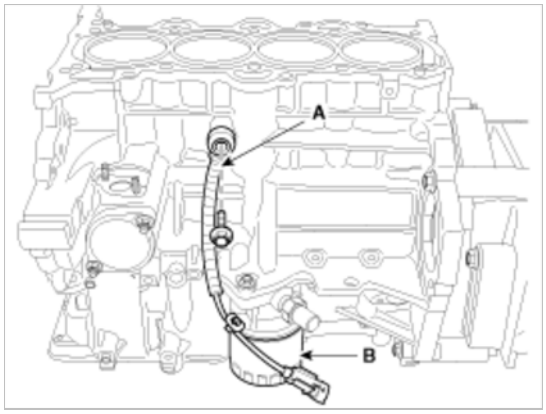

16. Install the oil pressure switch.
(1) Apply adhesive to 2 or 3 threads.
(2) Install the oil pressure switch (A).

**Tightening torque :**
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)




17. Install the knock sensor (A) and the oil filter (B).

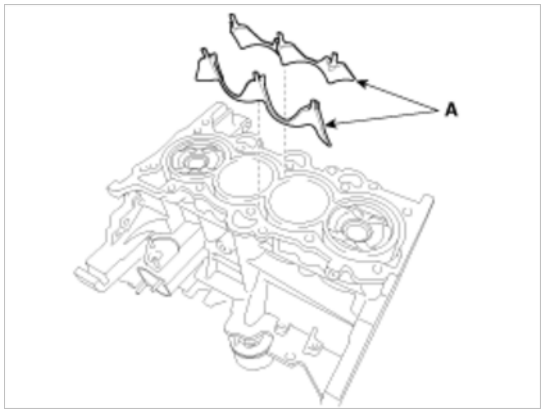
**Tightening torque :**
16.7 ~ 26.5N.m (1.7 ~ 2.7kgf.m, 12.3 ~ 19.5lb-ft)




18. Install the oil level gauge tube.
    (1) Install a new O-ring on the oil level gauge tube.
    (2) Apply engine oil on the O-ring.
    (3) Install the oil level gauge tube with the bolt.

**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

19. Install the water jacket insert (A).

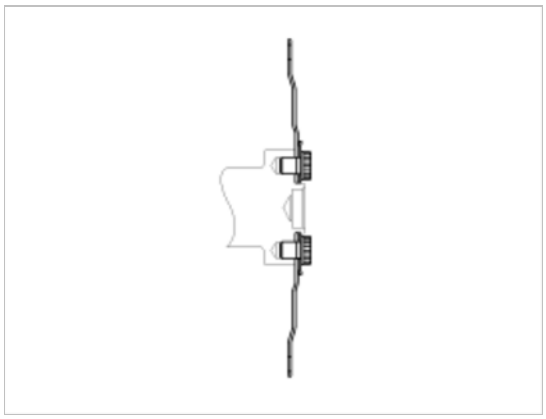



CAUTION

Maximum height of installed water jacket insert must be below top surface of cylinder block.

20. Install the cylinder head. (Refer to Cylinder head in this group)
21. Install the timing chain. (Refer to Timing chain in this group)
22. Remove the engine stand.
23. A/T :install the drive plate.

**Tightening torque :**
71.6 ~ 75.5N.m (7.3 ~ 7.7kgf.m, 52.8 ~ 55.7lb-ft)



24. M/T :install the fly wheel.

**Tightening torque :**
71.6 ~ 75.5N.m (7.3 ~ 7.7kgf.m, 52.8 ~ 55.7lb-ft)

25. Install the engine. (Refer to Engine and transaxle assembly in this group)

## Engine Mechanical System > Cooling System > Coolant > Repair procedures

### Refilling And Bleeding

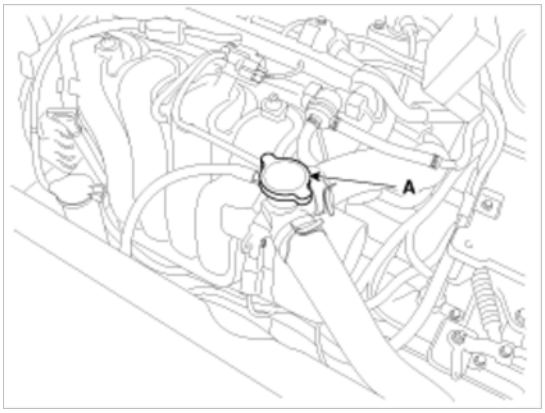
WARNING

Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

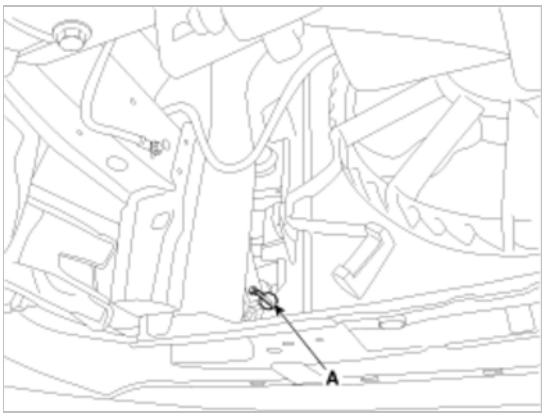
CAUTION

When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

1. Make sure the engine and radiator are cool to the touch.
2. Remove radiator cap (A).




3. Loosen the drain plug (A), and drain the coolant.




4. Tighten the radiator drain plug securely.
5. After draining engine coolant in the reservoir tank, clean the tank.
6. Fill the radiator with water through the radiator cap and tighten the cap.

> **NOTE**
>
> To most effectively bleed the air, pour the water slowly and press on the upper/lower radiator hoses.

7. Start the engine and allow to come to normal operating temperature. Wait for the cooling fans to turn on several times. Accelerate the engine to aid in purging trapped air. Shut engine off.
8. Wait until the engine is cool.
9. Repeat steps 1 to 8 until the drained water runs clear.
10. Fill fluid mixture with coolant and water (55~60%) (except for North America, Europe and China : 45~50%) slowly through the radiator cap. Push the upper/lower hoses of the radiator so as bleed air easily.

> **NOTE**
>
> - Use only genuine antifreeze/coolant.
> - For best corrosion protection, the coolant concentration must be maintained year-round at 55% (except for North America, Europe and China : 45%) minimum.
>   Coolant concentrations less than 55% (except for North America, Europe and China : 45%) may not provide sufficient protection against corrosion or freezing.
> - Coolant concentrations greater then 60% will impair cooling efficiency and are not recommended.

> **CAUTION**
>
> - Do not mix different brands of antifreeze/coolants.

• Do not use additional rust inhibitors or antirust products; they may not be compatible with the coolant.

11. Start the engine and run until coolant circulates.
    When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
12. Repeat 11 until the cooling fan 3 ~ 5 times and bleed air sufficiently out of the cooling system.
13. Install the radiator cap and fill the reservoir tank to the "MAX" (or "F") line with coolant.
14. Run the vehicle under idle until the cooling fan operates 2 ~ 3 times.
15. Stop the engine and wait coolant gets cool.
16. Repeat 10 to 15 until the coolant level doesn't fall any more, bleed air out of the cooling system.

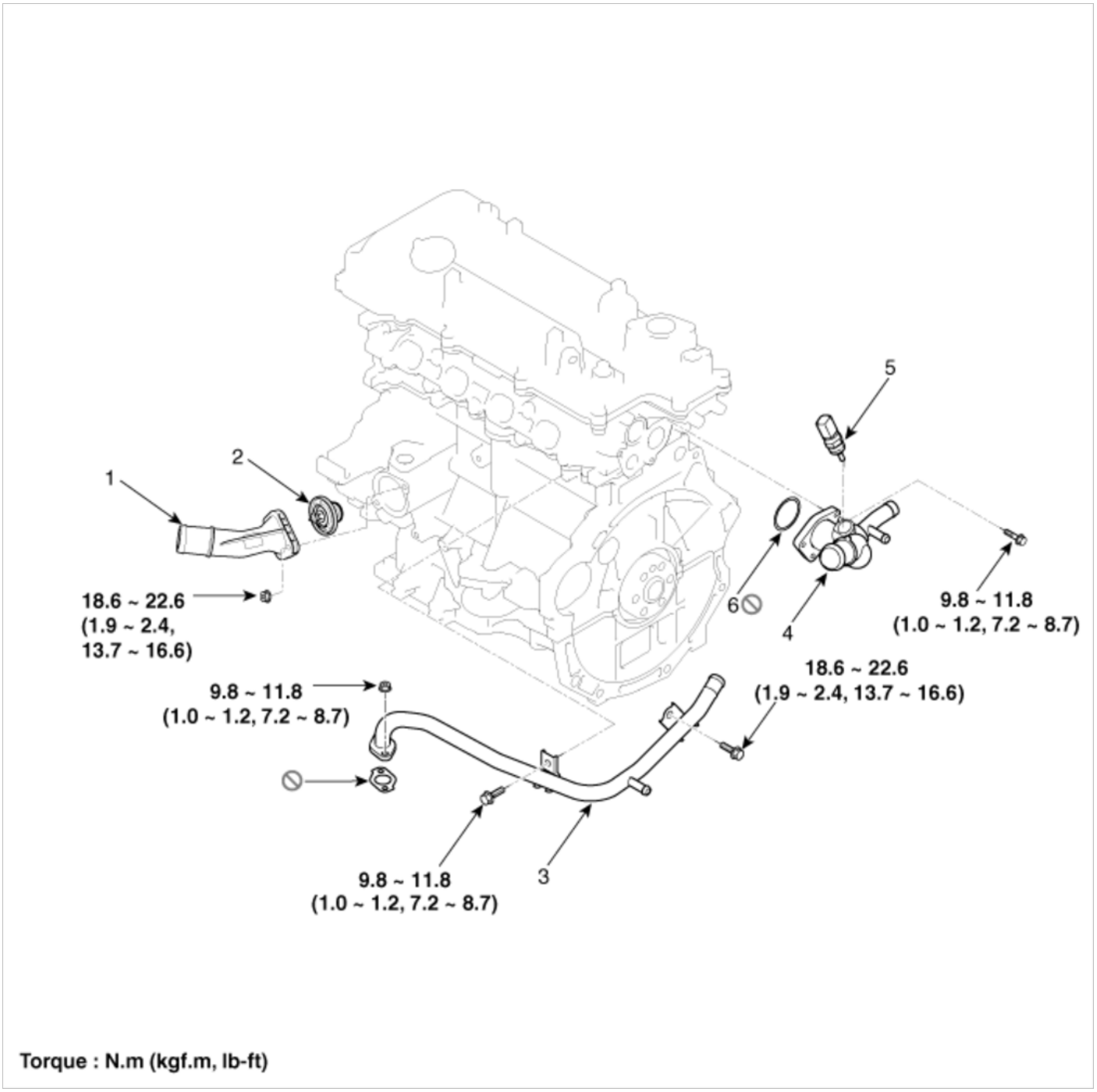
NOTE

It takes time to bleed out all the air in the cooling system. Refill coolant when coolant gets cool completely, when recheck the coolant level in the reservoir tank for 2~3 days after replacing coolant.

**Coolant capacity :**
MT : 5.0L (1.32 U.S.gal., 5.28 U,S,qt., 4.40lmp.qt)
AT : 5.2L (1.37 U.S.gal., 5.49 U,S,qt., 4.57lmp.qt)

## Engine Mechanical System > Cooling System > Thermostat > Components and Components Location

### Components




| | |
|---|---|
| 1. Water inlet fitting<br>2. Thermostat<br>3. Heater pipe | 4. Water temp control assembly<br>5. Water temperature sensor<br>6. Gasket |

## Engine Mechanical System > Cooling System > Thermostat > Repair procedures

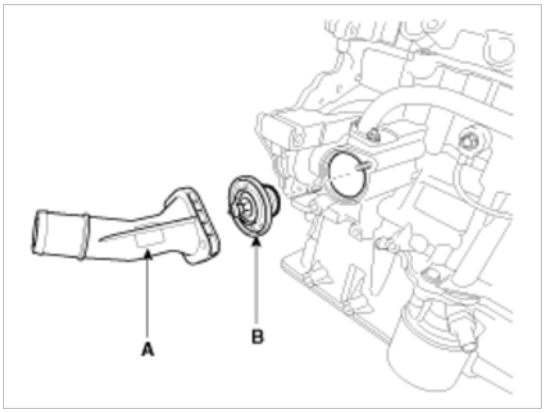
### Removal

NOTE

Disassembly of the thermostat would have an adverse effect, causing a lowering of cooling efficiency.

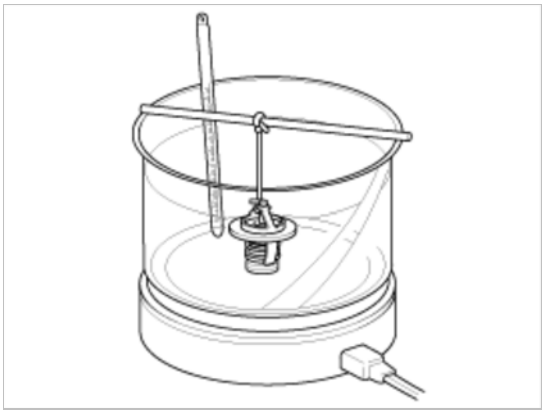
1. Drain engine coolant so that its level would be under the thermostat height.

2. Remove the radiator lower hose.
3. Remove the water inlet fitting (A) and thermostat (B).




## Inspection

1. Immerse the thermostat in water and gradually heat the water.



2. Check the valve opening temperature.

**Valve opening temperature :** 82±1.5°C (179.6±2.7°F)
**Full opening temperature :** 95°C (203°F)

If the valve opening temperature is not as specified, replace the thermostat.

3. Check the valve lift.

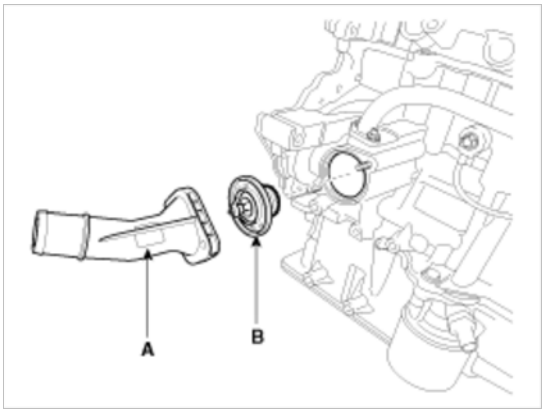
**Valve lift :** 8mm(0.3in) or more at 95°C (203°F)

If the valve lift is not as specified, replace the thermostat.

## Installation

1. Place the thermostat in the block.
   Install the thermostat (B) with the jiggle valve upward.
2. Install the water inlet fitting (A).

**Tightening torque :**
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)




3. Fill with engine coolant.
4. Start engine and check for leaks.

## Engine Mechanical System > Cooling System > Thermostat > Troubleshooting

### Troubleshooting

| Symptoms | | Possible Causes | | Remedy |
|---|---|---|---|---|
| Coolant leakage | • From the thermostat gasket | Check the mounting bolts | • Check the torque of the mounting bolts | • Retighten the bolts and check leakage again. |
| | | Check the gasket for damage | • Check gasket or seal for damage | • Replace gaskets and reuse the thermostat. |
| Cooled excessively | • Low heater performance (cool air blowed-out)<br>• Temperature gauge indicates 'LOW' | Visually check after removing the radiator cap. | • Insufficient coolant or leakage. | • After refilling coolant, recheck. |
| | | GDS check&Starting engine | • Check DTCs<br>• Check connection of the fan clutch or the fan motor.<br>※ If the fan clutch is always connected, there will be a noise at idle. | • Check the engine coolant sensor, wiring and connectors.<br>• Replace the componants. |
| | | Remove the thermostat and inspect | • Check if there are dusts or chips in the thermostat valve.<br>• Check adherence of the thermostat. | • Clean the thermostat valve and reuse the thermostat.<br>• Replace the thermostat, if it doesn't work properly. |
| Heated excessively | • Engine overheated<br>• Temperature gauge indicates 'HI' | Visually check after removing the radiator cap. | • Insufficient coolant or leakage.<br>※ Be careful when removing a radiator cap of the overheated vehicle.<br>• Check air in cooling system. | • After refilling coolant, recheck.<br>• Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts. |
| | | GDS check&Starting engine | • Check DTCs<br>• Check the fan motor performance as | • Check the engine coolant sensor, wiring and connectors. |

| | | | | |
|---|---|---|---|---|
| | | | temperature varies.<br>• Check if the fan clutch slips.<br>• Check the water pump adherence or impeller damaged. | • Check the fan motor, the relay and the connector.<br>• Replace the fan clutch, if it doesn't work properly.<br>• Replace the water pump, if it doesn't work properly. |
| | | Immerse the thermostat in boiling water and inspection. | • After removing the thermostat, check it works properly.<br>※ Check the thermostat opens at the valve opening temperature. | • Replace the thermostat, if it doesn't work properly. |

## Engine Mechanical System > Cooling System > Water pump > Repair procedures

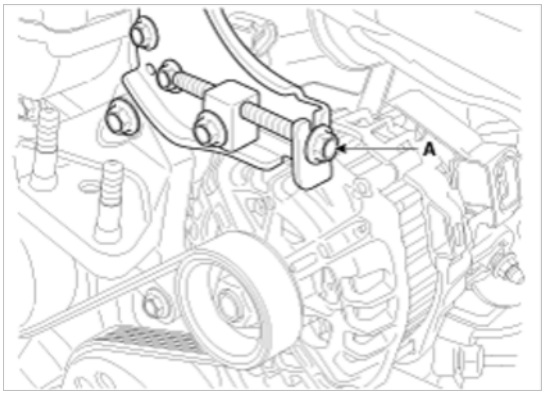
### Removal and Installation

**Water Pump**

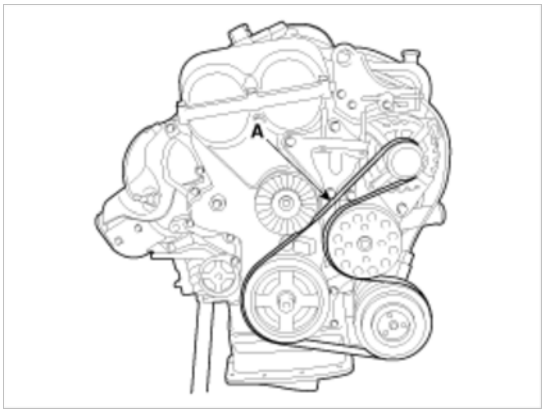
1. Drain engine coolant.

> WARNING
>
> System is under high pressure when the engine is hot.
> To avoid danger of releasing scalding engine coolant, remove the cap only when the engine is cool.

2. Loosen the alternator tension adjusting bolt (A) to loosen tension.

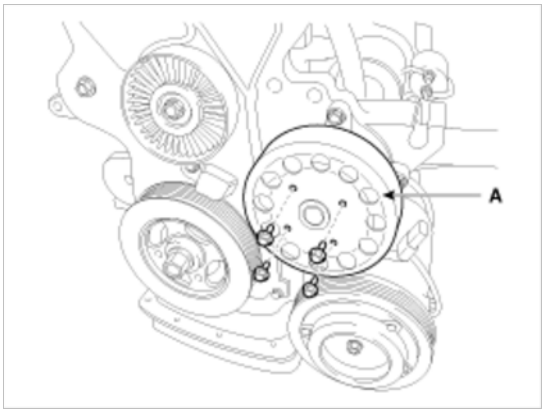



3. Remove the drive belt (A).




4. Remove the water pump pulley (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

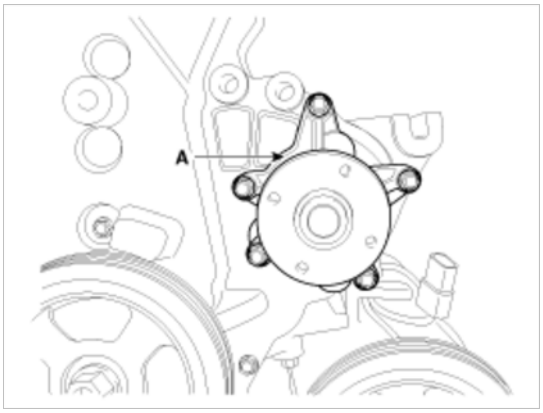



CAUTION

Tighten the bolts diagonally when installing.

5. Remove the water pump (A).

**Tightening torque :**
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



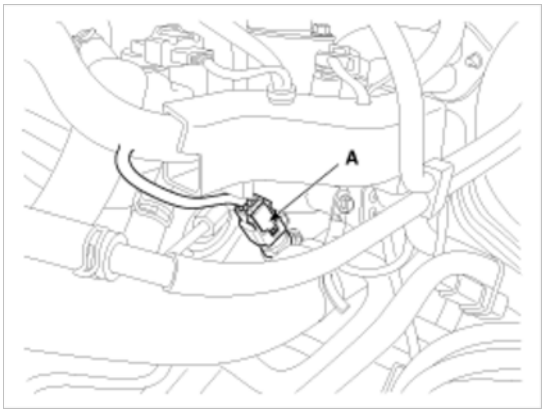

NOTE

Install the water pump with a new gasket.

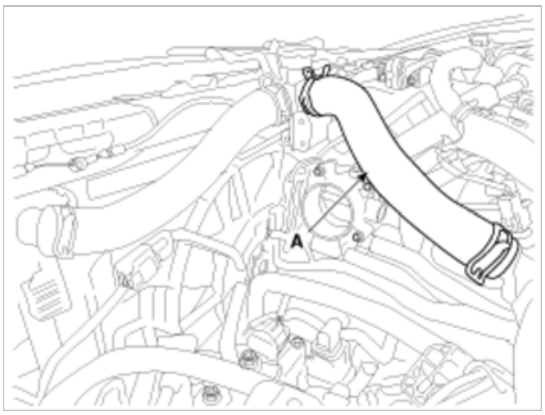
6. To install, reverse the removal orders.
7. Fill with engine coolant.
8. Start engine and check for leaks.
9. Recheck engine coolant level.

## Water Temperature Control Assembly

1. Drain engine coolant.
2. Disconnect the battery negative terminal.
3. Remove the air duct and air cleaner assembly. (Refer to Engine and transaxle assembly)
4. Disconnect the engine coolant temperature sensor connector (A).

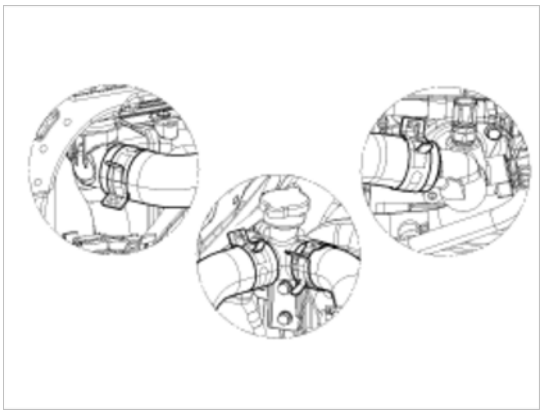



5. Disconnect the radiator upper hose (A).

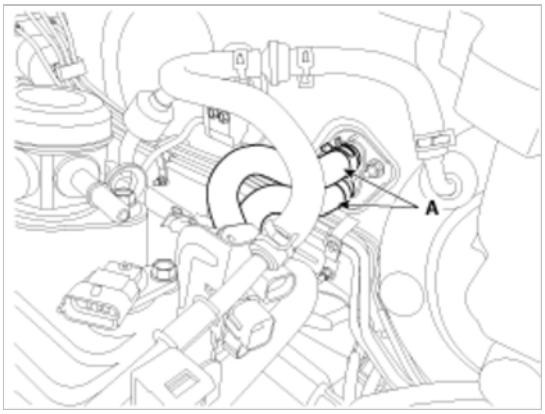



NOTE

Install the radiator hoses as shown illustrations.

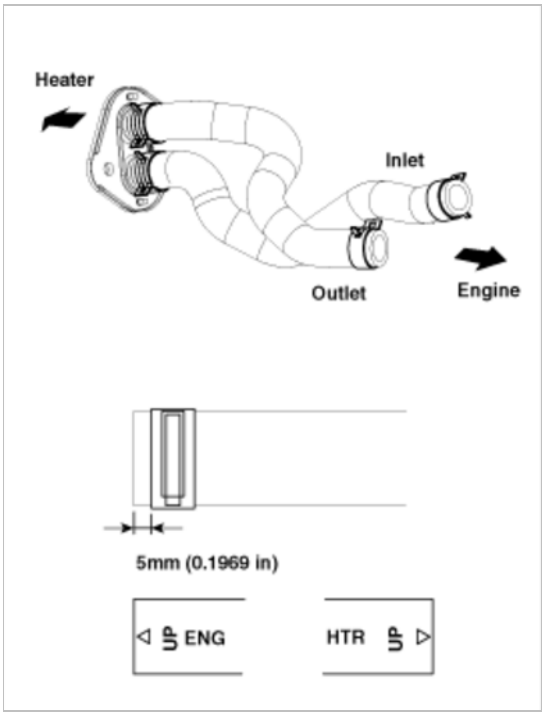


6. Disconnect the heater hoses (A).



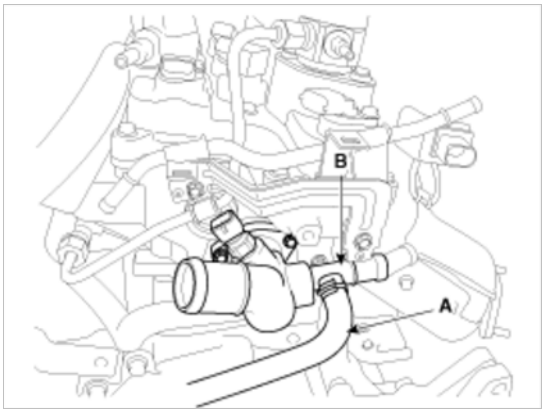
NOTE

Install the heater hoses as shown illustrations.



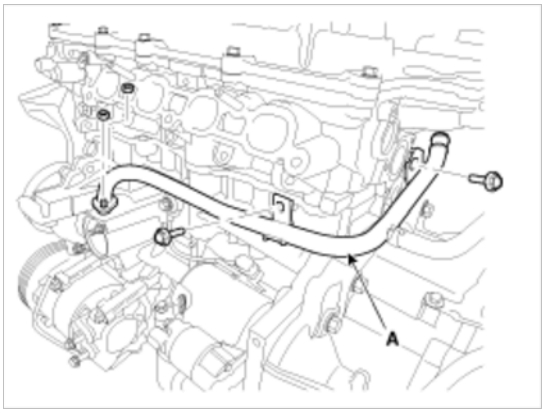

7. Remove the water temperature control assembly (B) after disconnecting the throttle body cooling hose (A).

**Tightening torque :**
9.8 ~ 11.7N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)




8. Remove the intake manifold. (Refer to Intake and exhaust system)
9. Remove the heater pipe (A).

**Tightening torque**
M6 bolt and nuts :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
M8 bolt :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)




10. To install, reverse the removal orders.

CAUTION

Clean the surface of the water temperature control assembly before installing.

### Inspection

1. Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.
3. Check for coolant leakage. If coolant leaks from hole, the seal is defective. Replace the coolant pump assembly and gasket.

NOTE

A small amount of “weeping” from the bleed hole is normal.

## Engine Mechanical System > Cooling System > Water pump > Troubleshooting

### Troubleshooting

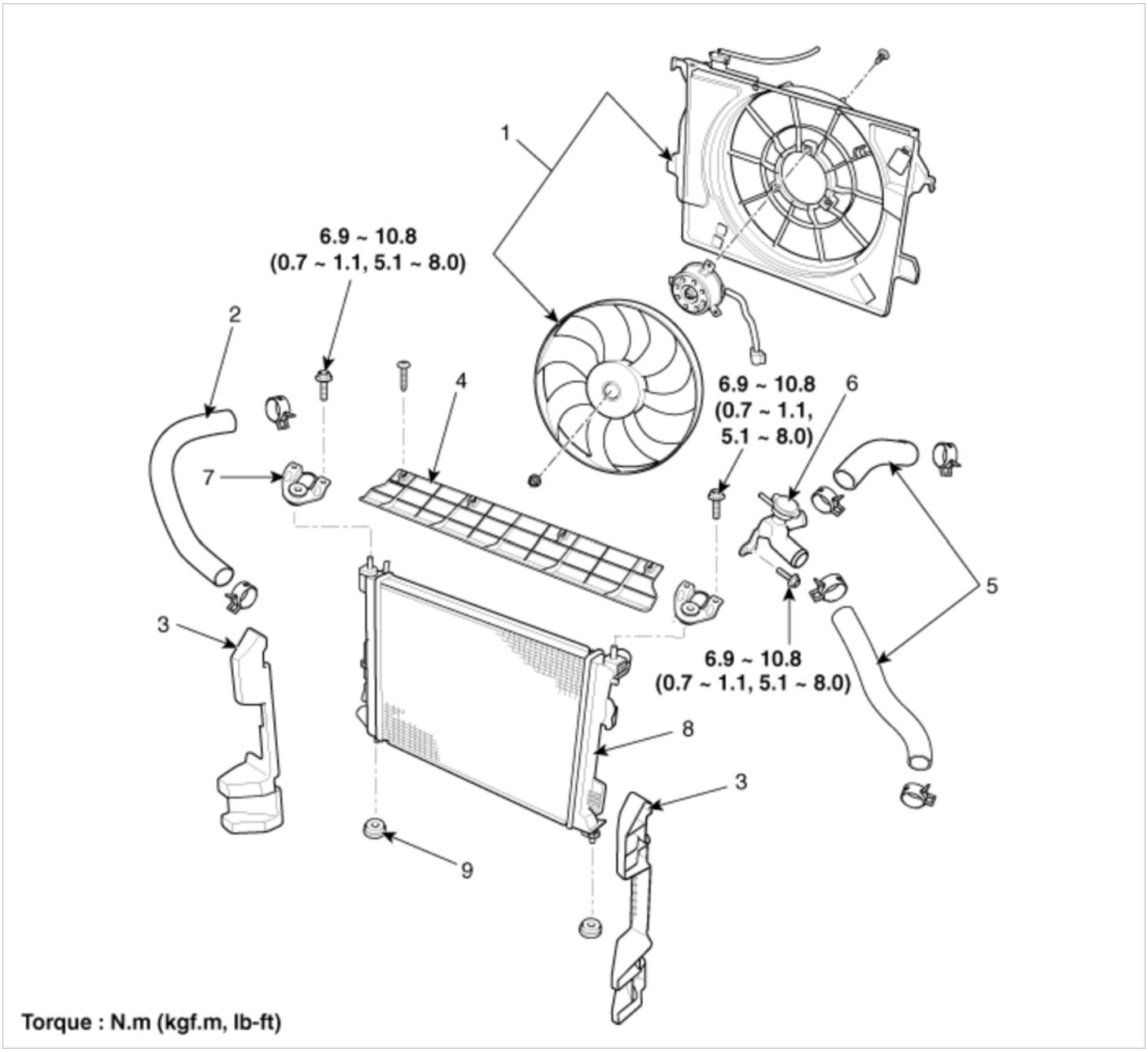
**Water Pump**

| Symptoms | | Possible Causes | | Remedy |
|---|---|---|---|---|
| Coolant leakage | • From the bleed hole of the water pump | Visually check | • Check leaks after about ten-minute warming up. | • If coolant still leaks, replace a water pump. |
| | | | | • If leakage stops, reuse the water pump (Do not replace the pump with a new one). |
| | • From gaskets or bolts | | • Check the tightening of the water pump mounting bolts. | • Retighten the mounting bolts. |
| | | | • Check damage of gaskets or inflow of dust. | • Replace the gasket and clean dust off. |
| | • From outer surface of water | | • Check the material or any cracks of the | • Poor material. If any crack found, replace the water |

| | | | | |
|---|---|---|---|---|
| | pump | | water pump. | pump. |
| Noise | • From bearings<br>• From mechanical seals<br>• Impeller interference | Inspection with a stethoscope | • After starting the engine, check noise with a stethoscope. | • If there is no noise, reuse the water pump(do not replace it). |
| | | | | • If there is any noise from the water pump, remove the drive belt and recheck. |
| | | Inspection after removing a drive belt | • After removing a water pump and a drive belt, check noise again. | • If there is noise, reuse the water pump. Check other drive line parts. |
| | | | | • If there is no noise, replace the water pump with a new one. |
| | | Inspection after removing a water pump | • After removing a water pump and a drive belt, check noise again. | • If there is any interference between them, replace the water pump with a new one. |
| Overheating | • Damaged impeller<br>• Loosened impeller | Loosened impeller | • Corrosion of the impeller wing | • Check engine coolant.<br>• Poor coolant quality / Maintenance check |
| | | | • Impeller seperation from the shaft | • Replace the water pump. |

## Engine Mechanical System > Cooling System > Radiator > Components and Components Location

### Components



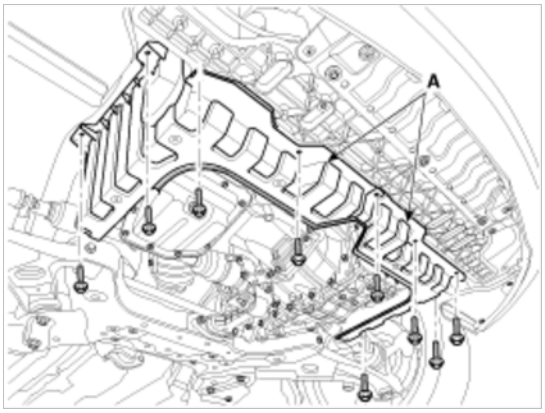

| | |
|---|---|
| 1. Cooling fan & reservoir tank assembly | 6. Filler neck |
| 2. Radiator lower hose | 7. Radiator mounting bracket |
| 3. Air guard | 8. Radiator assembly |
| 4. Upper cover | 9. Mounting insulator |
| 5. Radiator upper hose | |

## Engine Mechanical System > Cooling System > Radiator > Repair procedures

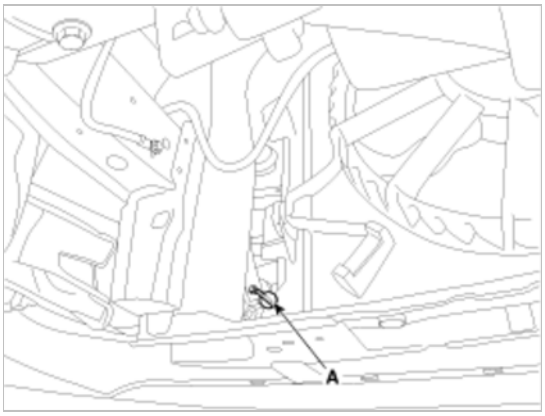
### Removal and Installation

1. Disconnect the battery negative terminal.
2. Remove the air cleaner assembly. (Refer to Intake and exhaust system in this group)
3. Remove the under cover (A).

**Tightening torque:**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)



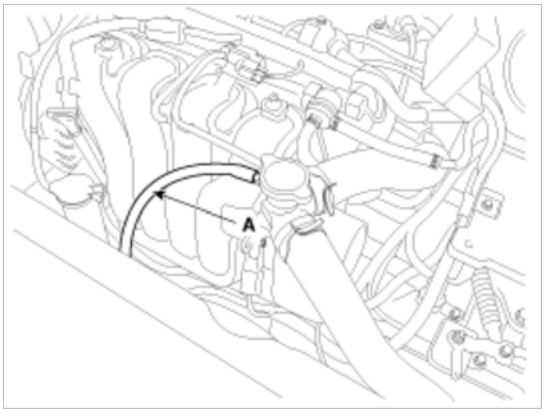

4. Loosen the drain plug (A), and drain the coolant.
   Remove the radiator cap to speed draining.



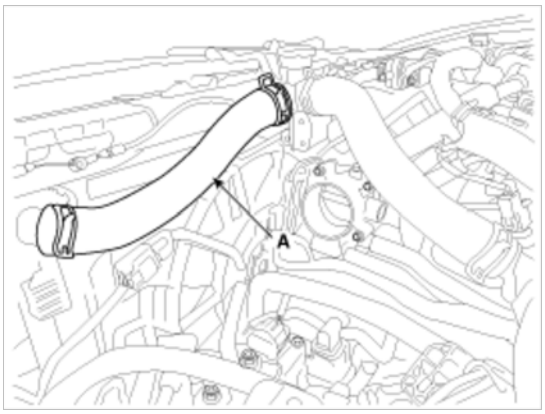

WARNING

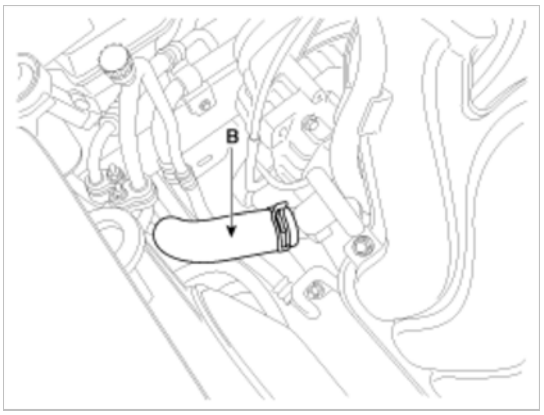
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

5. Disconnect the over flow hose (A) from the radiator.



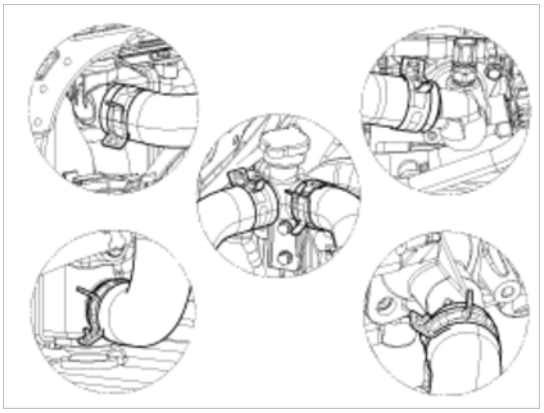

6. Remove the radiator upper hose (A) and the lower hose (B).



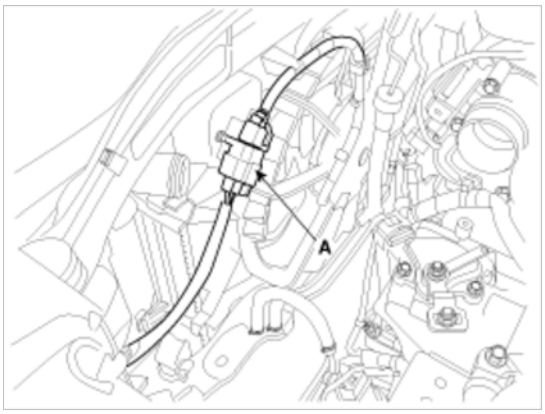

NOTE

Install the radiator hoses as shown illustrations.

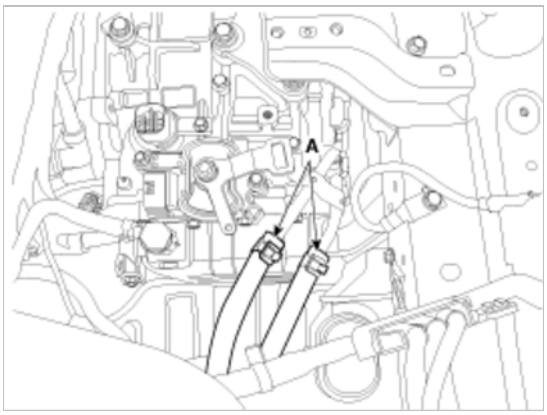


7. Disconnect the fan motor connector (A).

**Tightening torque:**
8.8 ~ 10.8 N.m (0.9 ~ 1.1 kgf.m, 6.5 ~ 7.9 lb-ft)




8. Disconnect the ATF cooler hoses (A). (Refer to AT group)

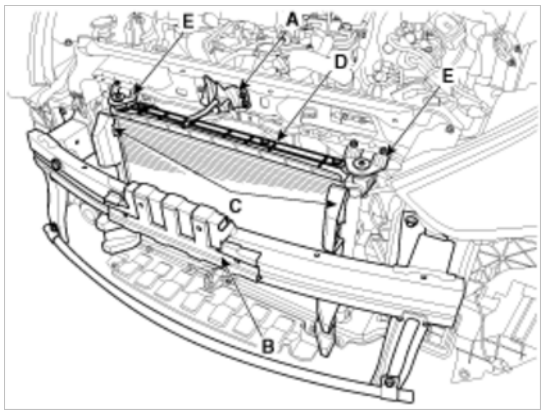



9. Remove the front bumper. (Refer to BD group)
10. Remove the hood latch (A). (Refer to BD group)
11. Remove the rail (B) and the air guard (C).

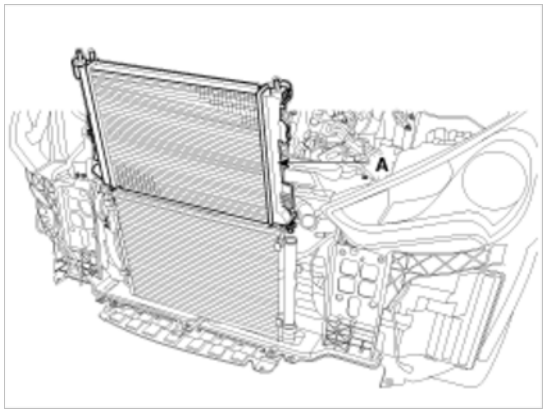
**Tightening torque**
Rail bolts :
16.7 ~ 25.5 N.m (1.7 ~ 2.6 kgf.m, 12.3 ~ 18.8 lb-ft)
Rail nuts :
3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

12. Remove the upper cover (D) and the upper mounting bracket (E).

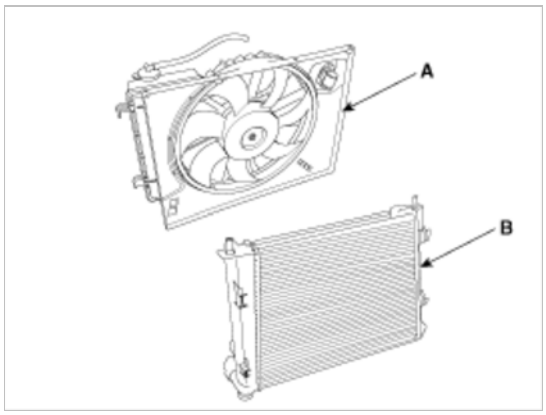
**Tightening torque :**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)




13. Separate the condenser from the radiator and then pull the radiator (A) upper from vehicle.




14. Remove the cooling fan & reservior tank (A) from the radiator (B).




15. Installation is in the reverse order of removal.
16. Fill the radiator with coolant and check for leaks.

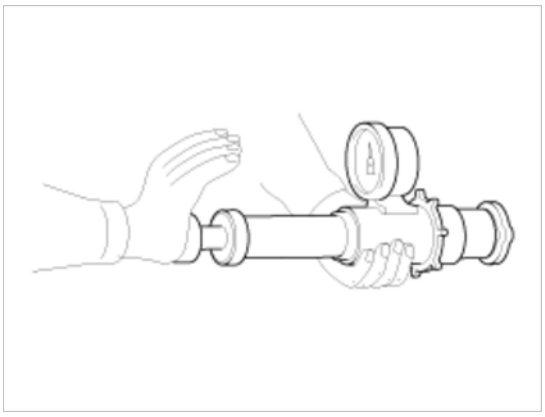
NOTE

- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
- Turn off engine and let it cool dwon. Check the coolant level and add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put the radiator cap on tightly, then run engine again and check for leaks.

## Inspection

## Radiator Cap Testing

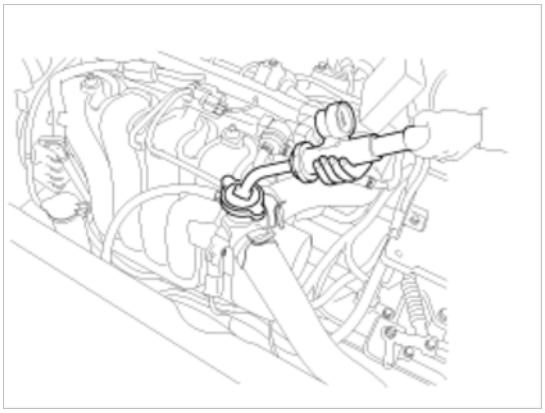
1. Remove the radiator cap, wet its seal with engine coolant, then install it to pressure tester.



2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm², 14 ~ 19psi).
3. Check for a drop in pressure.
4. If the pressure drops, replace the cap.

### Radiator Leakage Test

1. Wait until engine is cool, then carefully remove the radiator cap and fill the radiator with engine coolant, then install a pressure tester on it.



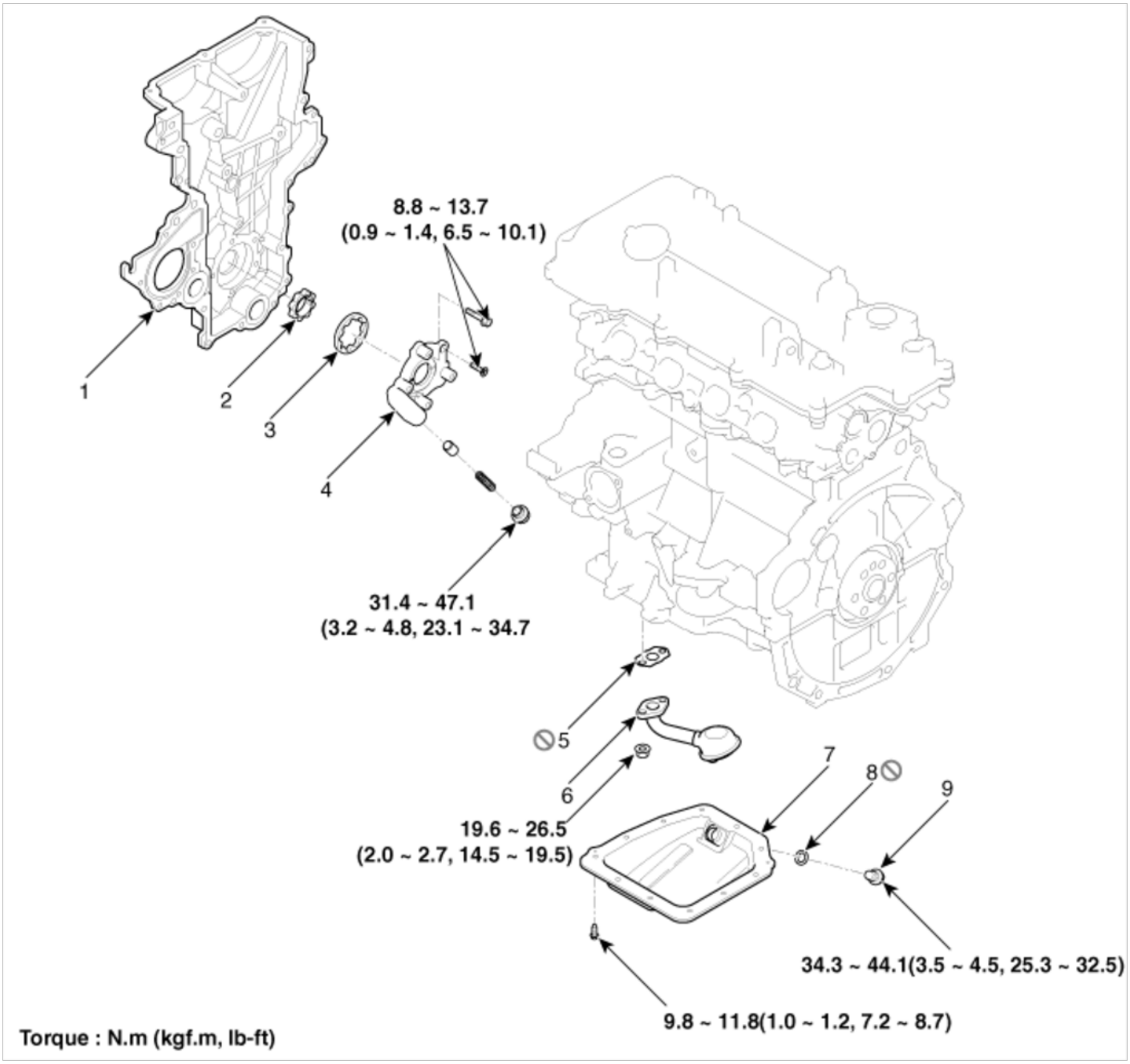
2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm², 14 ~ 19psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. If the pressure drops, check hoses, the radiator and the water pump for leakage. If there is no leakage, inspect the heater core, the cylinder block and the cylinder head.
5. Remove the tester and reinstall the radiator cap.

NOTE

Check for engine oil in coolant and/or coolant in engine oil.

## Engine Mechanical System > Lubrication System > Oil Pump > Components and Components Location

### Components




| | |
|---|---|
| 1. Timing chain cover | 6. Oil screen |
| 2. Inner roter | 7. Oil pan |
| 3. Outer roter | 8. Drain plug gasket |
| 4. Pump cover | 9. Oil drain plug |
| 5. Gasket | |

## Engine Mechanical System > Lubrication System > Engine Oil > Repair procedures

### Oil And Filter Replacement

CAUTION

- Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may

cause skin cancer.
- Exercise caution in order to minimize the length and frequency of contact of your skin to used oil. Wear protective clothing and gloves. Wash your skin thoroughly with soap and water, or use water-less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.
- In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.

1. Drain the engine oil.
   (1) Remove the oil filler cap.
   (2) Remove the oil drain plug, and drain the oil into a container.
2. Replace the oil filter.
   (1) Remove the oil filter.
   (2) Check and clean the oil filter installation surface.
   (3) Check the part number of the new oil filter is as same as old one.
   (4) Apply clean engine oil to the gasket of a new oil filter.
   (5) Lightly screw the oil filter into place, and tighten it until the gasket contacts the seat.
   (6) Tighten it with the torque below.

   **Tightening torque :**
   11.8 ~ 15.7N.m (1.2 ~ 1.6kgf.m, 8.7 ~ 11.6lb-ft)

3. Refill with engine oil.
   (1) Clean and install the oil drain plug with a new gasket.

   **Tightening torque :**
   34.3 ~ 44.1N.m (3.5 ~ 4.5kgf.m, 25.3 ~ 32.5lb-ft)

   (2) Fill with fresh engine oil.

   **Capacity**
   Total : 4.0L (4.22US qt, 3.51lmp qt)
   Oil pan : 3.3L (3.48US qt, 2.90lmp qt)
   Drain and refill in cluding oil filter :
   3.6L (3.80US qt, 3.16lmp qt)

   (3) Install the oil filler cap.
4. Start engine and check for oil leaks.
5. Recheck the engine oil level.

## Inspection

### Engine Oil

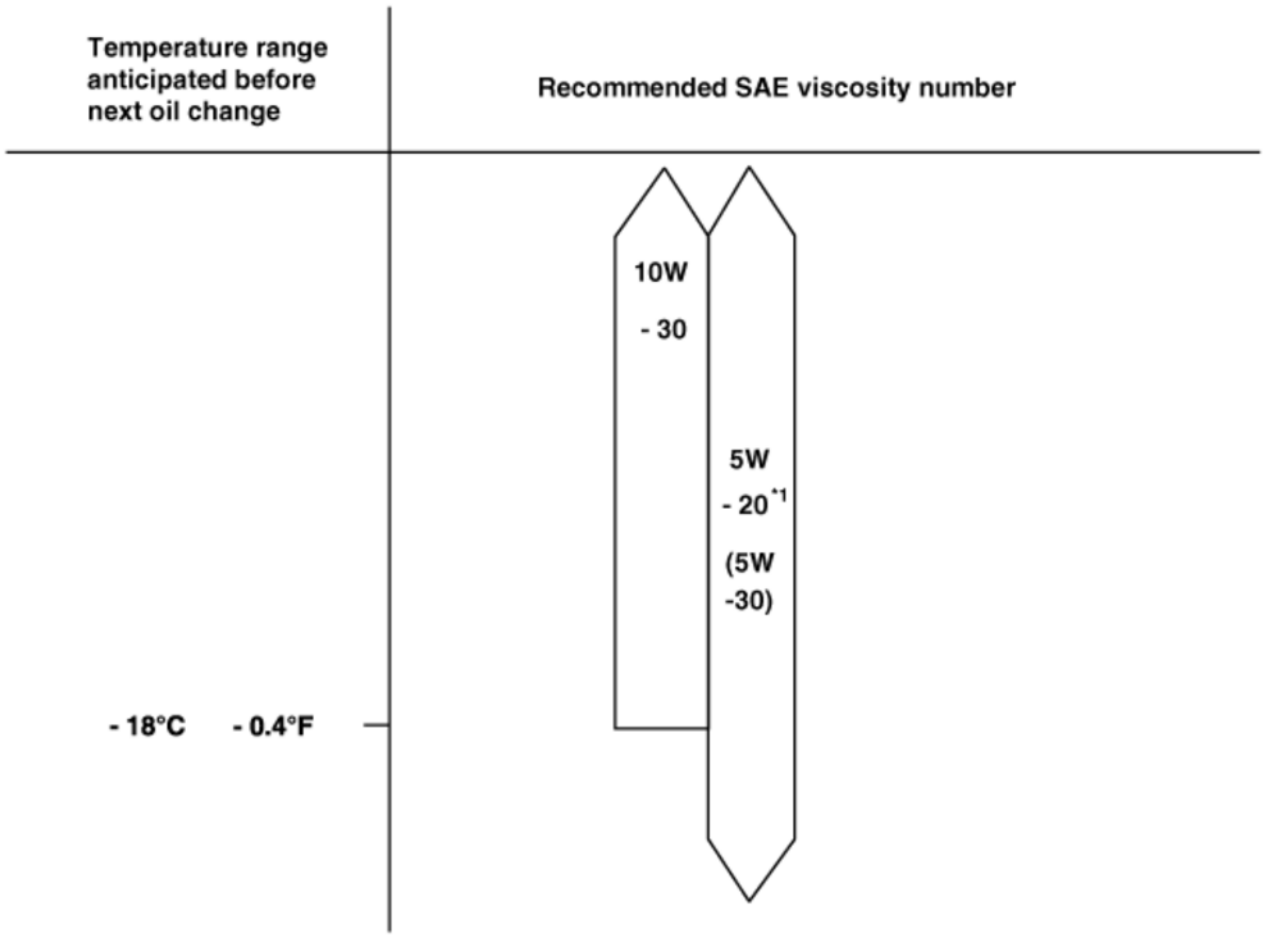
1. Check the engine oil quality.
   Check the oil deterioration, entry of water, discoloring of thinning.
   If the quality is visibly poor, replace the oil.
2. Check the engine oil level.
   After warning up the engine and then 5 minutes after the engine stop, oil level should be between the "L" and "F" marks in the dipstick.
   If low, check for leakage and add oil up to the "F" mark.

NOTE

Do not fill with engine oil above the "F" mark.

## Selection Of Engine Oil

Recommendation : 5W-20/GF4&SM (If not available, refer to the recommended API or ILSAC classification
API classification: SL, SM or above
ILSAC classification : GF3, GF4 or above
SAE viscosity grade : Refer to the recommended SAE viscosity number




*1 If 5W-20 / GF4 engine oil is not available, 5W-30 or secondary recommended engine oil for corresponding temperature range can be used.

NOTE

For best performance and maximum protection of all types of operation, select only those lubricants which :

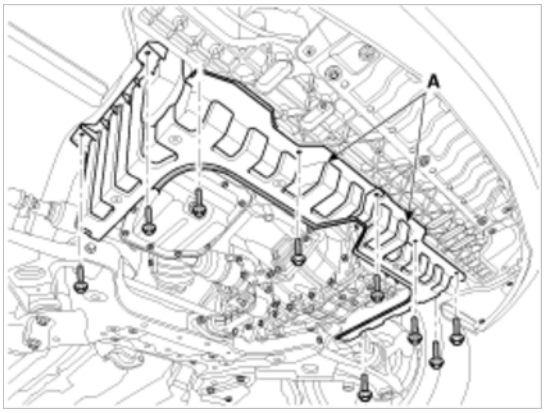
1. Satisfy the requirement of the API or ILSAC classification.
2. Have proper SAE grade number for expected ambient temperature range.
3. Lubricants that do not have both an SAE grade number and API or ILSAC service classification on the container should not be used.

# Engine Mechanical System > Lubrication System > Oil Pan > Repair procedures

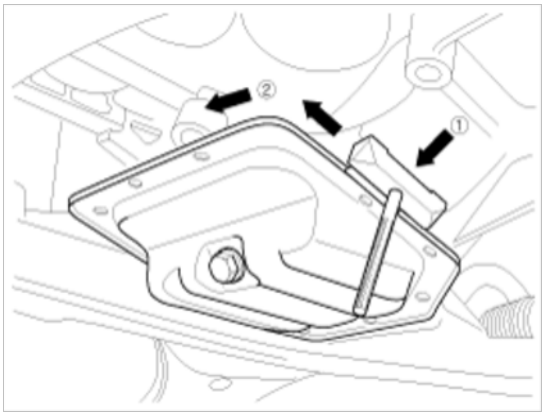
## Removal

1. Remove the under covers (A).

**Tightening torque:**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)




2. Drain engine oil.
3. Using the SST(09215-3C000) and remove the oil pan.




CAUTION

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of ① arrow.
- After tapping the SST with a plastic hammer along the direction of ② arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.
- Do not turn over the SST abruptly without tapping. It be result in damage of the SST.

## Installation

1. Install the oil pan.
   (1) Using a razor blade and gasket scraper, remove all the old packing material from the gasket surfaces.

   NOTE

   Check that the mating surfaces are clean and dry before applying liquid gasket.

   (2) Apply liquid gasket as an even bead, centered between the edges of the mating surface.

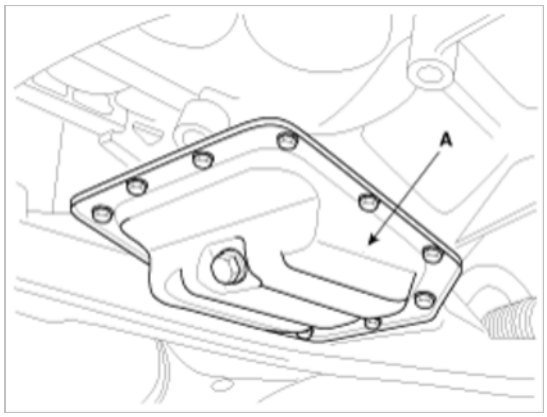
   **Liquid gasket :** TB 1217H or LOCTITE 5900H

NOTE

- To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.
- Do not install the parts if five minutes or more have elapsed since applying the liquid gasket. Instead, reapply liquid gasket after removing the residue.
- After assembly, wait at least 30 minutes before filling the engine with oil.

(3) Install the oil pan (A) with the bolts.
Uniformly tighten the bolts in several passes.

**Tightening torque :**
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

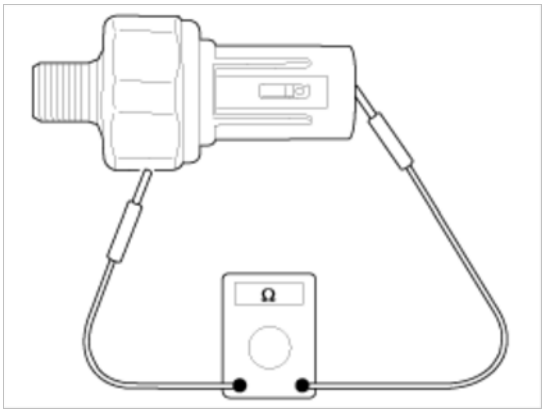



2. Refill engine oil.

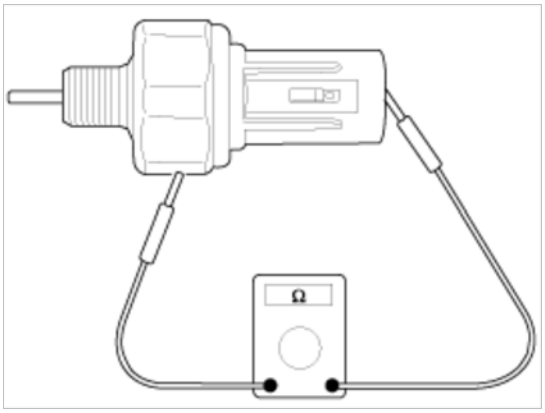
## Engine Mechanical System > Lubrication System > Oil Pressure Switch > Repair procedures

### Inspection

1. Check the continuity between the terminal and the body with an ohmmeter. If there is no continuity, replace the oil pressure switch.



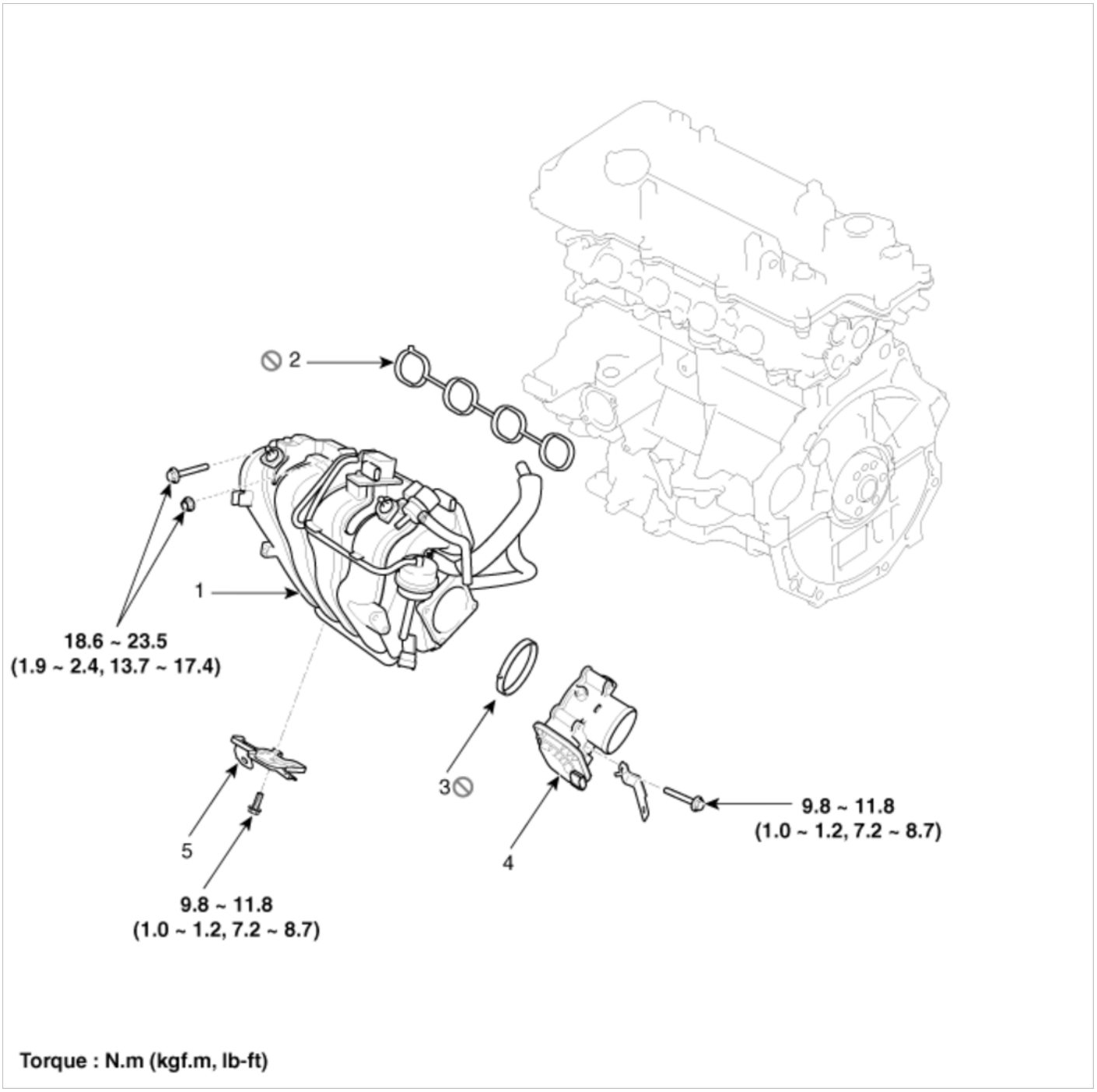

2. Check the continuity between the terminal and the body when the fine wire is pushed. If there is continuity even when the fine wire is pushed, replace the switch.




3. If there is no continuity when a 49.0kpa (0.5kg/cm², 7.1psi) is applied through the oil hole, the switch is operating properly.
   Check for air leakage. If air leaks, the diaphragm is broken. Replace it.

## Engine Mechanical System > Intake And Exhaust System > Intake Manifold > Components and Components Location

### Components




| | |
|---|---|
| 1. Intake manifold<br>2. Intake manifold gasket<br>3. Electronic throttle body gasket | 4. Electronic throttle body<br>5. Bracket |

## Engine Mechanical System > Intake And Exhaust System > Intake Manifold > Repair procedures

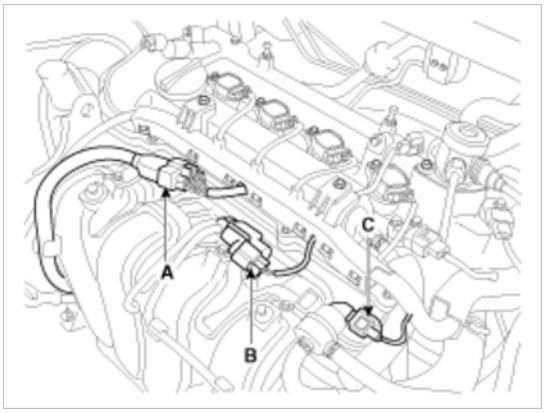
### Removal and Installation

1. Remove the engine cover.
2. Disconnect the battery negative terminal.

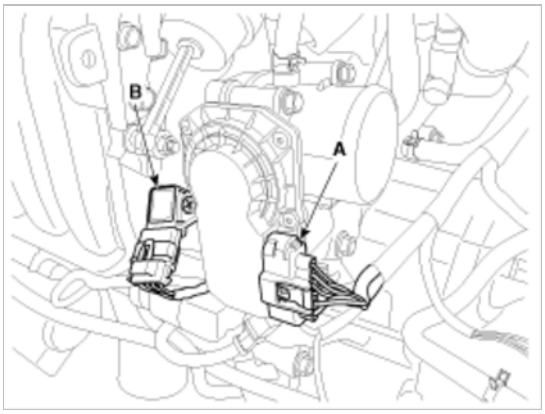
**Tightening torque :**

Without battery sensor :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

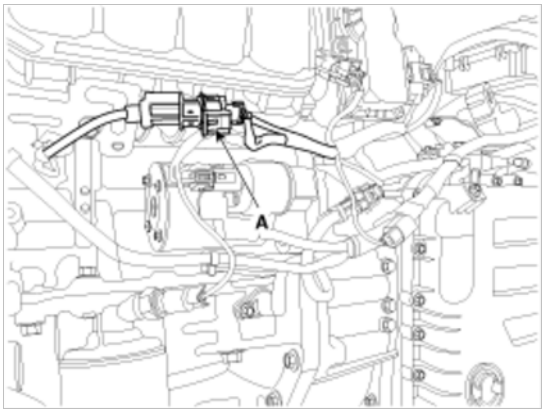
3. Remove the air duct and the air cleaner assembly.
   (Refer to Engine and transaxle assembly)
4. Disconnect the injector extension connector (A), the VIS (Variable intake system) connector (B) and the PCSV (Purge control solenoid valve) connector (C).



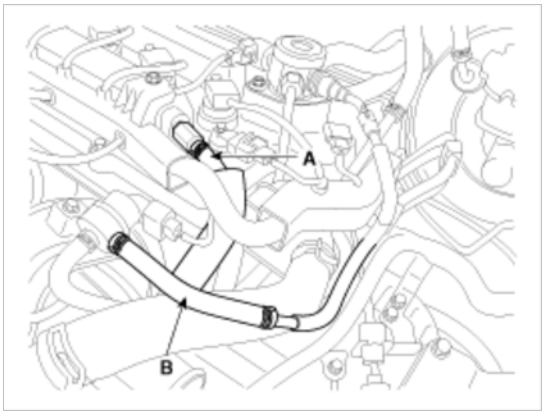

5. Disconnect the ETC (Electronic throttle control) connector (A) and the MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B).



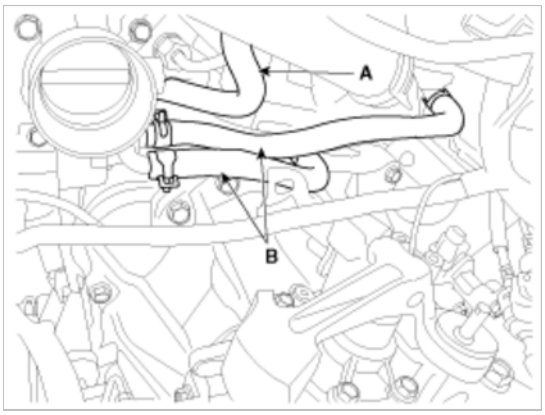

6. Disconnect the knock sensor connector (A).




7. Disconnect the PCV (Positive crankcase ventilation) hose (A) and the PCSV (Purge control solenoid valve) hose (B).

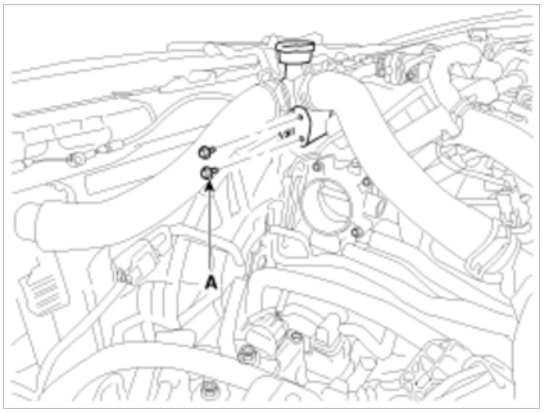



8. Disconnect the vacuum hose (A) and the throttle body coolant hoses (B).



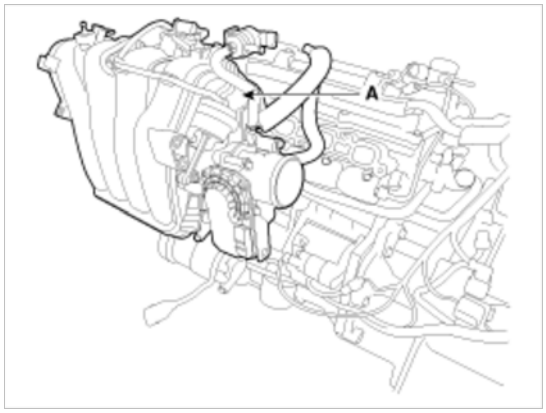

9. Unfasten the filler neck assembly mounting bolts (A).

**Tightening torque :**
6.9 ~ 10.8 N.m (0.7 ~ 1.1 kgf.m, 5.1 ~ 8.0 lb-ft)



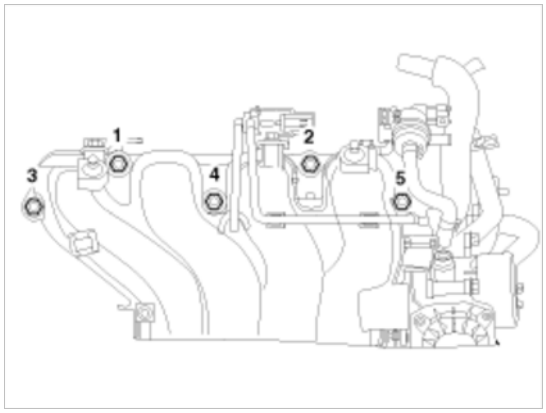

10. Remove the intake manifold (A) with the gasket (B).

**Tightening torque :**
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)




NOTE

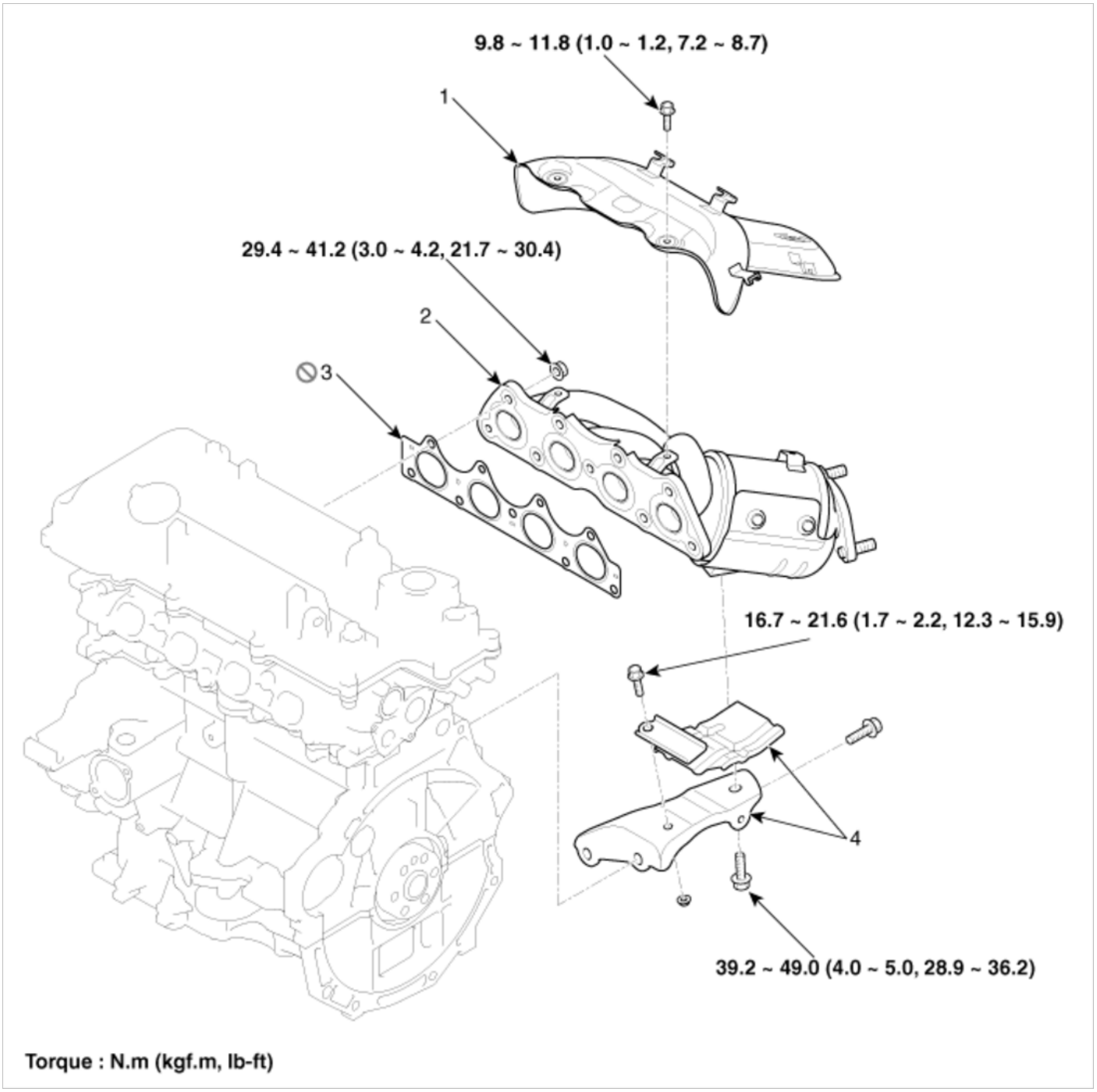
When installing, replace with new gaskets.
When installing the intake manifold, tighten the bolts and nuts with pre-torque first, and then tighten the bolts and nuts with specified torque in the sequence shown.




11. Installation is reverse order of removal.

## Engine Mechanical System > Intake And Exhaust System > Exhaust Manifold > Components and Components Location

### Components




| | |
|---|---|
| 1. Heat protector<br>2. Exhaust manifold | 3. Exhaust manifold gasket<br>4. Exhaust manifold stay |

## Engine Mechanical System > Intake And Exhaust System > Exhaust Manifold > Repair procedures

### Removal and Installation

1. Remove the engine cover.
2. Disconnect the battery negative terminal.

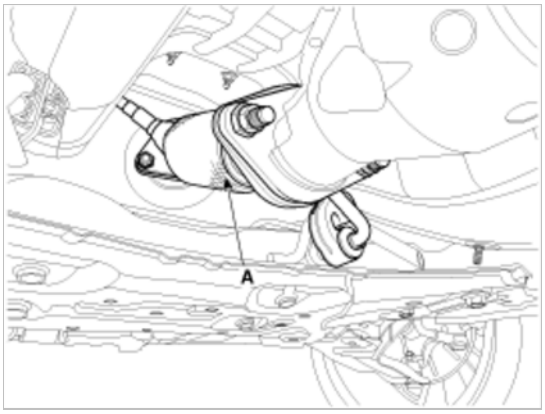
**Tightening torque :**
Without battery sensor :

7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
With battery sensor :
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

3. Disconnect the front and rear oxygen sensor connectors (A).

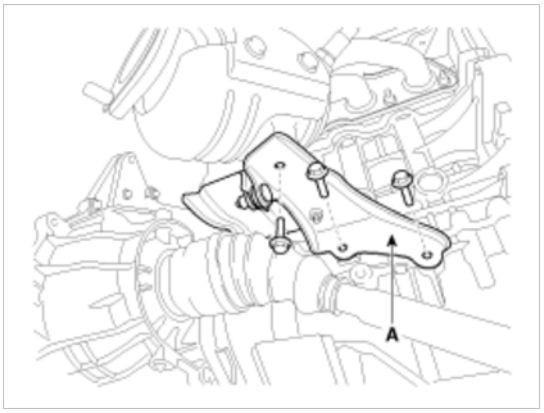

4. Remove the front muffler (A).

**Tightening torque:**
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)




5. Remove the exhaust manifold stay (A).

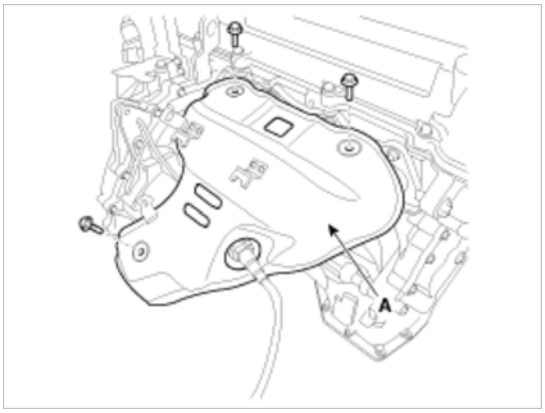
**Tightening torque:**
39.2 ~ 49.0N.m (4.0 ~ 5.0kgf.m, 28.9 ~ 36.2lb-ft)




6. Remove the heat protector (A).

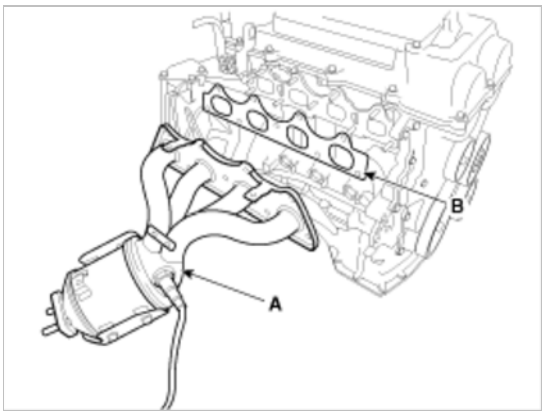
**Tightening torque:**

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



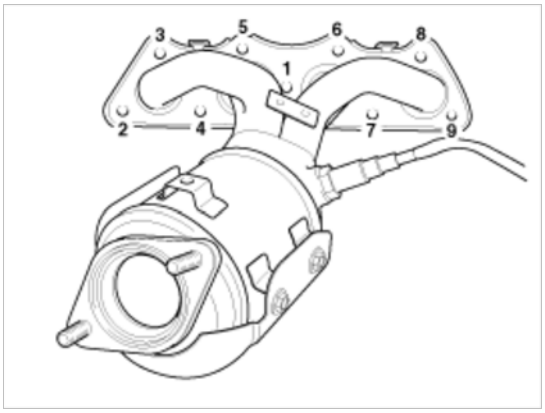

7. Remove the exhaust manifold (A).

**Tightening torque:**
29.4 ~ 41.2N.m (3.0 ~ 4.2kgf.m, 21.7 ~ 30.4lb-ft)




NOTE

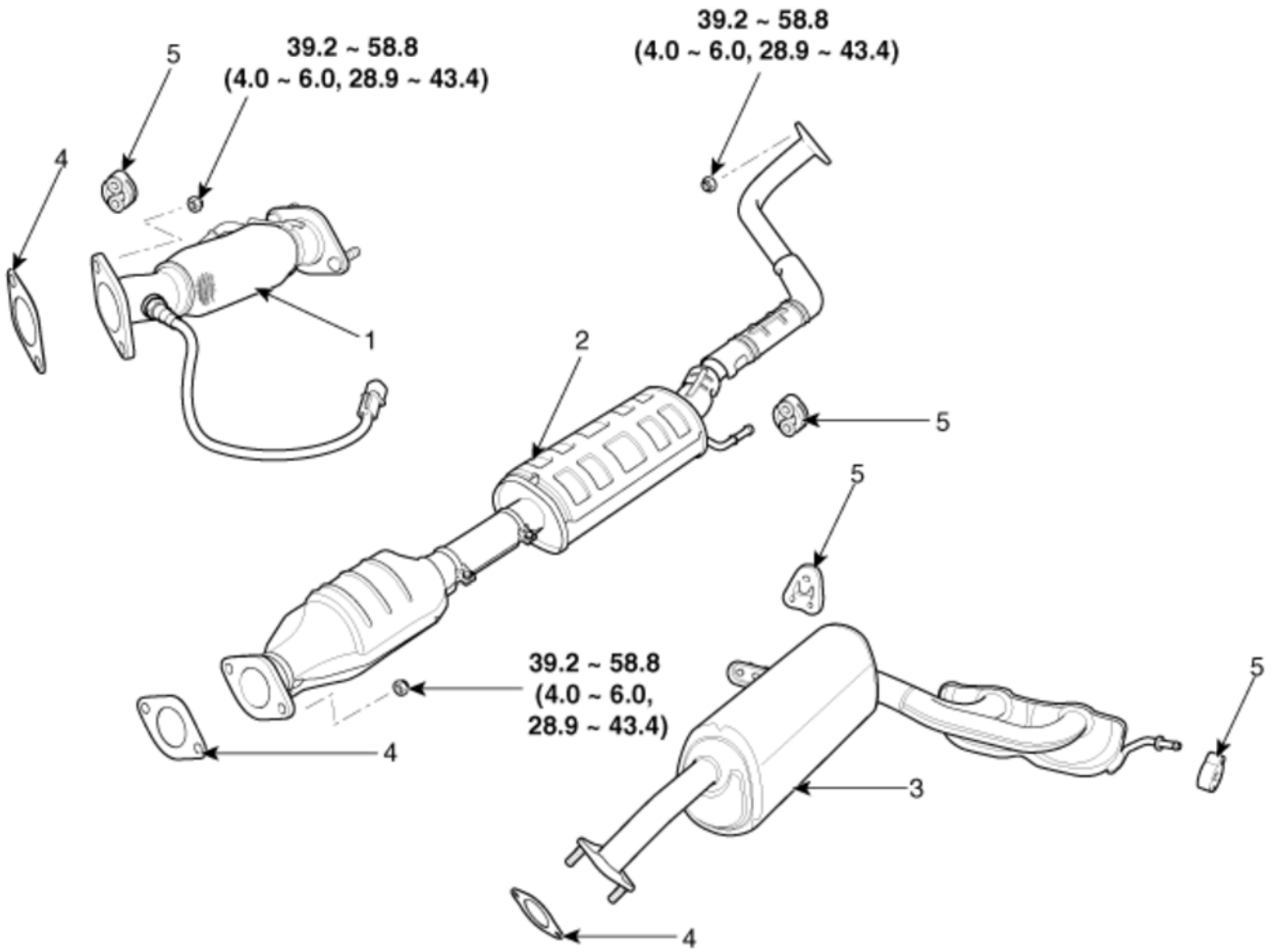
When installing, replace with a new gasket.
When installing the intake manifold, tighten the nuts with pre-torque first, and then tighten the nuts with specified torque in the sequence shown.




8. Installation is reverse order of removal.

## Engine Mechanical System > Intake And Exhaust System > Muffler > Components and Components Location

## Components




| | |
|---|---|
| 1. Front muffler<br>2. Catalytic converter & Center muffler assembly<br>3. Main muffler | 4. Gasket<br>5. Hanger |

## Engine Mechanical System > Intake And Exhaust System > Muffler > Repair procedures

### Removal and Installation

1. Disconnect the battery negative terminal.

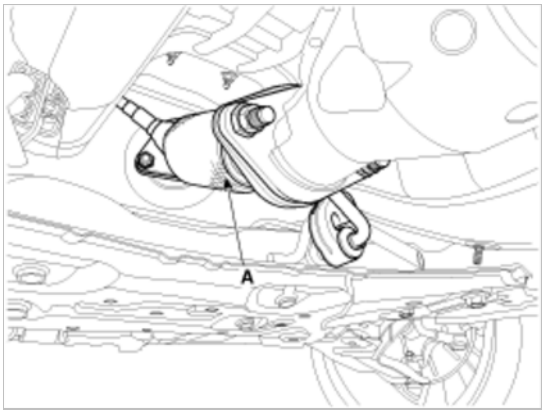
**Tightening torque**
Without battery sensor :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)
With battery sensor :

4.0 ~ 6.0 N.m (0.4 ~ 0.6 kgf.m, 3.0 ~ 4.4 lb-ft)

2. Disconnect the rear oxygen sensor connector (A).

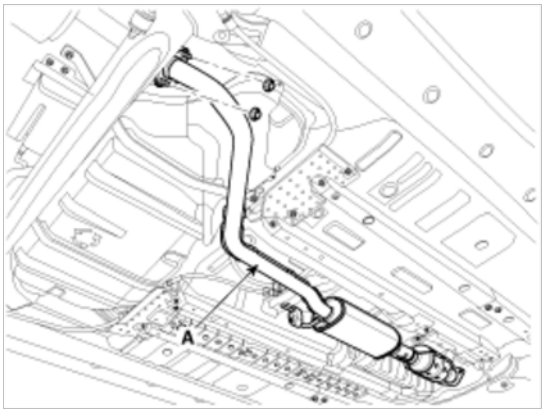

3. Remove the front muffler (A).

**Tightening torque:**
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)

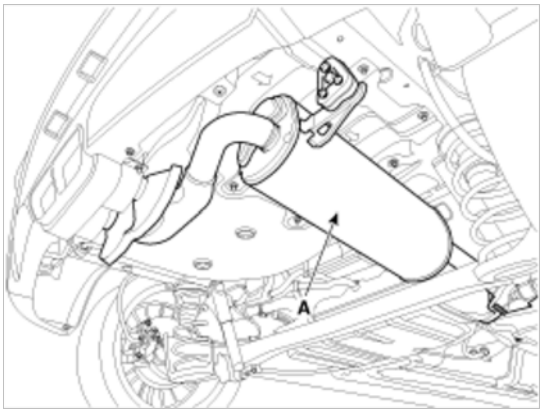



4. Remove the center muffler (A).

**Tightening torque:**
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)




5. Remove the main muffler (A).




6. Installation is the reverse order of removal.

NOTE

When installing, replace with new gaskets.