Specifications

Description	Specifications	Limit
General		
Type	In-line, Double Overhead Camshaft	
Number of cylinder	4	
Bore	86mm (3.385in)	
Stroke	86mm (3.385in)	
Total displacement	1998cc (121.92cu.in.)	
Compression ratio	9.4 : 1	
Firing order	1-3-4-2	
Valve timing		
Intake valve		
Opens (ATDC / BTDC)	ATDC 11° ~ BTDC 34°	
Closes (ABDC)	ABDC 67° ~ 22°	
Exhaust		
Opens (BBDC)	BBDC 54° ~ 14°	
Closes (ATDC)	ATDC -10° ~ 30°	
Valve		
Valve length		
Intake	113.18mm (4.4559in.)	112.93mm (4.4460in)
Exhaust	105.79mm (4.1649in.)	105.59mm (4.1570in)
Stem O.D.		
Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)	
Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)	
Face angle	45.25° ~ 45.75°	
Margin		
Intake	1.02mm (0.0401in.)	
Exhaust	1.09mm (0.0429in.)	
Valve stem to valve guide clearance		
Intake	0.020 ~ 0.047mm (0.00078 ~ 0.00185in.)	0.07mm (0.00275in.)
Exhaust	0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)	0.09mm (0.00354in.)
Valve guide		
Length		
MLA		
MLA outer diameter	31.964 ~ 31.980mm (1.2584 ~ 1.2590in.)	
Cylinder head tappet bore inner diameter	32.000 ~ 32.025mm (1.2598 ~ 1.2608in.)	

MLA to tappet bore clearance	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.)
Valve seat		
Width of seat contact		
Intake	1.16 ~ 1.46mm (0.0457 ~ 0.0575in.)	
Exhaust	1.35 ~ 1.65mm (0.0531 ~ 0.0649in.)	
Seat angle	44.75° ~ 45.10°	
Valve guide		
Length	43.8 ~ 44.2mm (1.7244 ~ 1.7401in.)	
Inner diameter	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
Valve spring		
Free length	47.44mm (1.8677in.)	
Load	19.0 ± 0.6kg/35.0mm (41.88 ± 1.32lb/1.3779in.)	
Square	39.8 ± 1.2kg/26.0mm (87.74 ± 2.64lb/1.0236in.)	
	1.5° MAX.	
Valve clearance		
Cold (20°C[68°F])		
Intake	0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust	0.27 ~ 0.33mm (0.0106 ~ 0.0129in,)	0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)
Cylinder head		
Flatness of gasket surface	Max. 0.05mm (0.0019in.)	
Flatness of manifold mounting surface	Max. 0.10mm (0.0039in.)	
Cylinder block		
Cylinder bore	86.00 ~ 86.03mm (3.3853 ~ 3.3871in.)	
Out-of-round and taper of cylinder bore	Less than 0.05mm (0.0019in.)	
Clearance with piston (To set limits to new parts)	0.015 ~ 0.035mm (0.0005 ~ 0.0013in.)	
Piston		
O.D (To set limits to new parts)	87.975 ~ 88.005mm (3.4635 ~ 3.4647in.)	
Ring groove width		
No.1	1.235 ~ 1.250mm (0.0486 ~ 0.0492in.)	1.26mm (0.0496in.)
No.2	1.230 ~ 1.250mm (0.0484 ~ 0.0492in.)	1.26mm (0.0496in.)
Oil ring	2.01 ~ 2.03mm (0.0791 ~ 0.0799in.)	2.05mm (0.0807in.)
Piston ring		
Side clearance		
No.1	0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)	0.1mm (0.004in.)
No.2	0.04 ~ 0.08mm (0.0015 ~ 0.0031in.)	0.1mm (0.004in.)
Oil ring	0.06 ~ 0.13mm (0.0023 ~ 0.0051in.)	0.2mm (0.008in.)
End gap		

No.1			0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)	0.6mm (0.0236in.)
No.2			0.37 ~ 0.52mm (0.0145 ~ 0.0204in.)	0.7mm (0.0275in.)
Oil ring side rail			0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Piston pin				
Piston pin outer diameter			21.997 ~ 22.000mm (0.8660 ~ 0.8661in.)	
Piston pin hole inner diameter			22.030 ~ 22.070mm (0.8673 ~ 0.8688in.)	
Piston pin hole clearance			0.003 ~ 0.010mm (0.0001 ~ 0.0004in.)	
Connecting rod small end inner diameter			22.005 ~ 22.011mm (0.8663 ~ 0.8666in.)	
Connecting rod				
Bend			0.05mm (0.0020in.) or less	
Twist			0.1mm (0.004in.) or less	
Connecting rod big end to crankshaft side clearance			0.100 ~ 0.250mm (0.0039 ~ 0.010in.)	0.35mm (0.0138in.)
Connecting rod bearing				
Oil clearance (To seat limits to new parts)			0.025 ~ 0.043mm (0.0009 ~ 0.0016in.)	0.05mm (0.0078in.)
Camshaft				
Cam height	Intake		43.80mm (1.7244in.)	
	Exhaust		45.00mm (1.7716in.)	
Journal O.D	Intake	No.1	¢ 30mm (1.1811in.)	
		No.2, 3, 4, 5	¢ 24mm (0.9449in.)	
	Exhaust	No.1	¢ 36mm (1.4173in.)	
		No.2, 3, 4, 5	¢ 24mm (0.9449in.)	
Bearing oil clearance	Intake	No.1	0.022 ~ 0.057mm (0.0008 ~ 0.0022in.)	0.09mm (0.0035in.)
		No.2, 3, 4, 5	0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)	0.12mm (0.0047in.)
	Exhaust	No.1	0 ~ 0.032mm (0 ~ 0.0012in.)	
		No.2, 3, 4, 5	0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)	0.12mm (0.0047in.)
End play			0.04 ~ 0.16mm (0.0015 ~ 0.0062in.)	0.20mm (0.0047in.)
Crankshaft				
Pin O.D.			47.954 ~ 47.972mm (1.8879 ~ 1.8886in.)	
Journal O.D.			51.942 ~ 51.960mm (2.0449 ~ 2.0456in.)	
End play			0.07 ~ 0.25mm (0.0027 ~ 0.0098in.)	
Crankshaft bearing				
Oil clearance			0.020 ~ 0.038mm (0.0007 ~ 0.0014in.)	
Cooling method			Water-cooled, pressurized. Forced circulation with water pump	
Engine oil				
Oil quantity	Total		5.9L (6.23US qt, 5.19Imp qt)	When replacing a short engine or a block assembly
	Oil pan		5.0L (5.28US qt, 4.41Imp qt)	

	Drain and refill	5.3L (5.60US qt, 4.66Imp qt)	Including oil filter
Oil grade	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	5W-20, 5W-30, 5W-40	
Oil pressure (at 1000rpm)		127kPa (1.3kg/cm², 18.49psi) or above	Oil temperature in oil pan : 110±2°C (230±36°F)
Radiator			
Type		Pressurized corrugated fin type	
Radiator cap			
Main valve opening pressure		83 ~ 110kpa (12 ~ 16psi, 0.83 ~ 1.1kg/cm²)	
Vacuum valve opening pressure		-7kpa (-100psi, -0.07kg/cm²) or less	
Thermostat			
Type		Wax pellet type with jiggle valve	
Valve opening temperature		82°C (177°F)	
Full-opening temperature		95°C (201°F)	
Coolant pump		Centrifugal type impeller	
Drive belt			
Type		V-ribbed belt	
Engine coolant temperature sensor			
Type		Heat-sensitive thermistor type	
Resistance		2.31 ~ 2.59KΩ at 20°C (68°F)	
Air cleaner			
Type		Dry type	
Element		Paper type	
Exhaust pipe			
Muffler		Expansion resonance type	
Suspension system		Rubber hangers	

Service Standrds

Standard value	
Antifreeze	Mixture ratio of anti-freeze in coolant
ETHYLENE GLYCOL BASE FOR ALUMINUM	50%

Tightening Torques

Item	N.m	kgf.m	lb-ft
Ladder frame bolt (M8 x 55)	23.5 ~ 27.4	2.4 ~ 2.8	17.4 ~ 20.2
Oil pump bolt (BSM)	8.8 + 16.6 + 25.5	0.9 + 1.7 + 2.6	6.5 + 12.3 + 18.8
Timing chain cover bolt (M8)	18.6 ~ 22.5	1.9 ~ 2.3	13.7 ~ 16.6

Timing chain cover bolt (M6)	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Oil pan bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Engine support bracket bolt (LH/RH)	49.0 ~ 63.7	5.0 ~ 6.5	36.1 ~ 47.0
Camshaft bearing cap bolt (M6)	10.8 ~ 12.7	1.1 ~ 1.3	7.9 ~ 9.4
Camshaft bearing cap bolt (M8)	27.4 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder head bolt	(32.4~36.3) + (90~95°) + (90~95°)	(3.3~3.7) + (90~95°) + (90~95°)	(23.9~26.8) + (90~95°) + (90~95°)
Engine hanger bolt	27.5 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder head cover bolt	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Crankshaft pulley bolt	166.6 ~ 176.4	17.0 ~ 18.0	122.9 ~ 130.1
Connecting rod bearing cap bolt	(17.7~21.6) + (88~92°)	(1.8~2.2) + (88~92°)	(13.0~15.9) + (88~92°)
Main bearing cap bolt	14.7 + (27.5~31.4) + (120~125°)	1.5 + (2.8~3.2) + (120~125°)	10.8 + (20.3~23.1) + (120~125°)
Flywheel bolt	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Drive plate bolt	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Timing chain tensioner bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain tensioner arm bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
OCV bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
CVVT bolt	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
BSM chain tensioner arm bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain guide bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain tensioner bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
P/S pump bracket bolt	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Tensioner ASSY intergrated bracket bolt	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Water temp. control nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water inlet pipe nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water temp. control bolt	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.4
Oil level gauge assembly bolt	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Ignition coil bolt	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Intake manifold bolt	18.6 ~ 27.4	1.9 ~ 2.8	13.7 ~ 20.2
Intake manifold nut	18.6 ~ 27.4	1.9 ~ 2.8	13.7 ~ 20.2
Intake manifold stay bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust manifold heat protector bolt	18.6 ~ 27.4	1.9 ~ 2.8	13.7 ~ 20.2
Exhaust manifold nut	49.0 ~ 53.9	5.0 ~ 5.5	36.1 ~ 39.7
Exhaust manifold stay bolt (M8)	18.6 ~ 27.4	1.9 ~ 2.8	18.6 ~ 20.2
Exhaust manifold stay bolt (M10)	49.0 ~ 53.9	5.0 ~ 5.5	36.1 ~ 39.8
Muffler bolt	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4

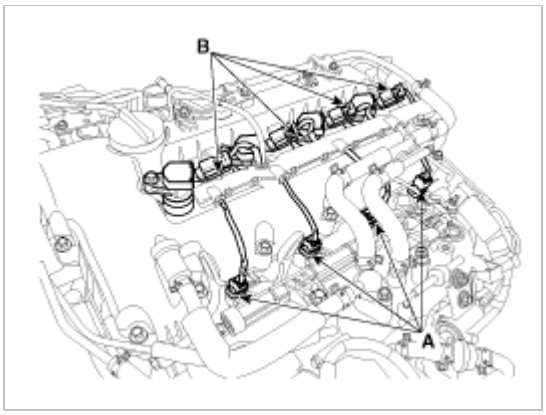
Crankshaft position sensor bolt	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Oxygen sensor	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.1
Knock sensor	16.7 ~ 25.5	1.7 ~ 2.6	12.3 ~ 18.8
Camshaft position sensor	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Oil pressure switch	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Oil filter	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6

Compression Pressure Inspection

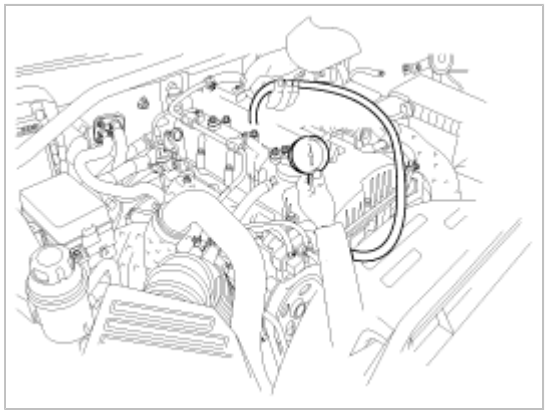
NOTE

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

1. Warm up and stop engine.
   Allow the engine to warm up to normal operating temperature.
2. Disconnect the injector connectors (A), ignition coil connectors (B) and ignition coils.



3. Remove spark plugs.
   Using a 16mm plug wrench, remove the 4 spark plugs.
4. Check cylinder compression pressure.
   A. Insert a compression gauge into the spark plug hole.



   B. Fully open the throttle.
   C. While cranking the engine, measure the compression pressure.

NOTE

Always use a fully charged battery to obtain engine speed of 200 rpm or more.

   D. Repeat steps (a) through (c) for each cylinder.

NOTE

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

Compression pressure :
1,283kPa (13.0kgf/cm², 185psi)

Minimum pressure :
1,135kPa (11.5kgf/cm², 164psi)
Difference between each cylinder :
100kPa (1.0kgf/cm², 15psi) or less

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

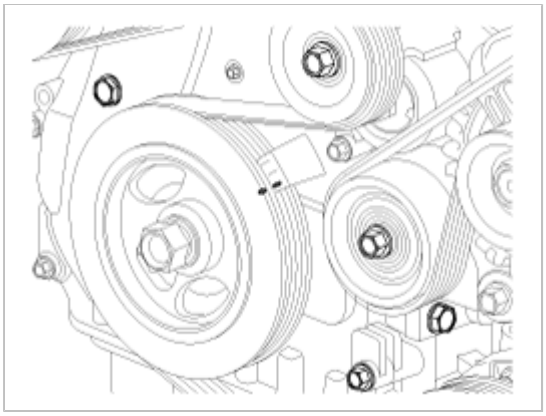
5. Reinstall spark plugs.
6. Connect the injector connectors and ignition coil connectors.

Valve Clearance Inspection And Adjustment

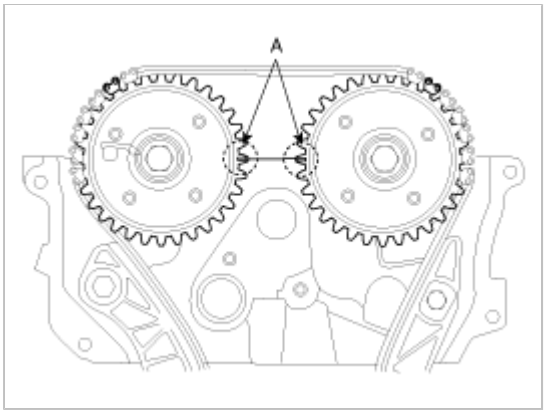
NOTE

Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C (68°F)) and cylinder head is installed on the cylinder block.

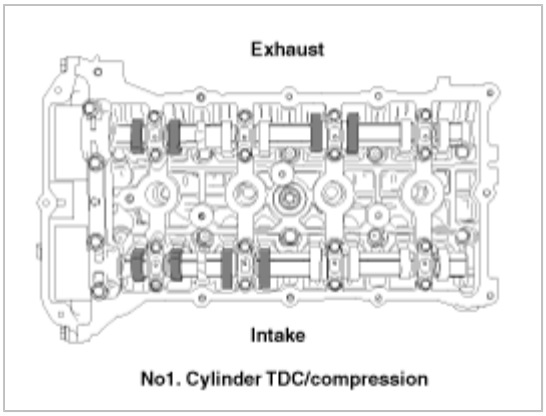
1. Remove the cylinder head cover. (Refer to Timing system)
2. Set No.1 cylinder to TDC/compression.
   A. Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.



   B. Check that the mark (A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.
   If not, turn the crankshaft one revolution (360°)



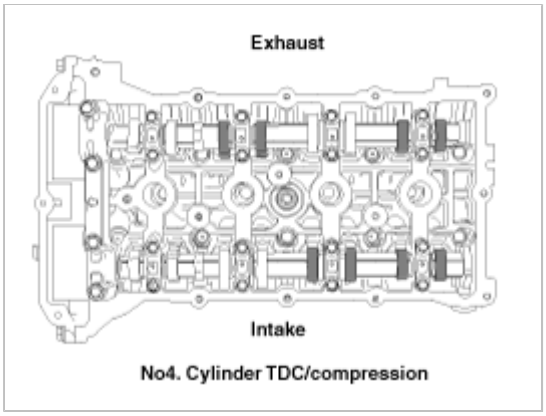
3. Inspect the valve clearance.
   A. Check only the valve indicated as shown. [No. 1 cylinder : TDC/Compression] measure the valve clearance.



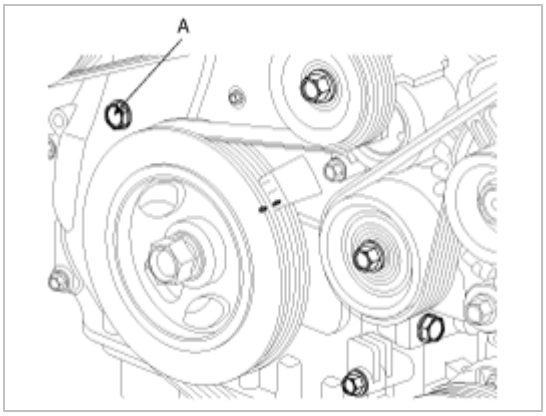
·Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.
·Record the out-of-specification valve clearance measurements. They will be used later to determine the required replacement adjusting tappet.

Valve clearance
Specification
Engine coolant temperature : 20°C [68°F]
Limit
Intake : 0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust : 0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)

B. Turn the crankshaft pulley one revolution (360°) and align the groove with timing mark "T" of the lower timing chain cover.
C. Check only valves indicated as shown. [NO. 4 cylinder : TDC/compression]. Measure the valve clearance.



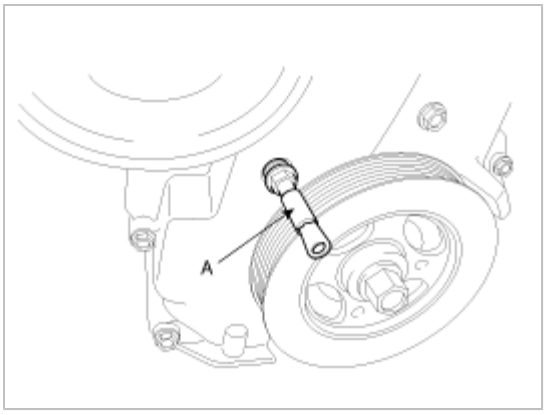
4. Adjust the intake and exhaust valve clearance.
   A. Set the No.1 cylinder to the TDC/compression.
   B. Marks on the timing chain and camshaft timing sprockets.
   C. Remove the service hole bolt(A) of the timing chain cover.



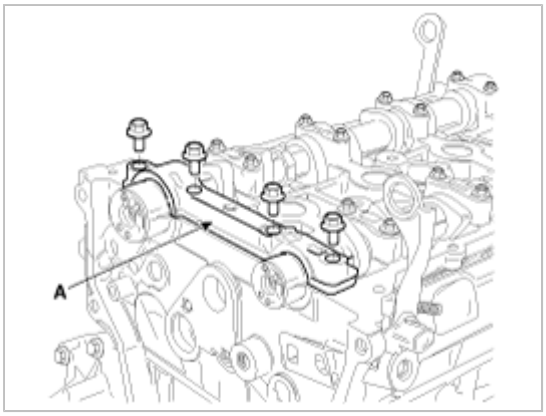
CAUTION

The bolt must not be reused once it has been assembled.

D. Insert the SST(A) (09240-2G000) in the service hole of the timing chain cover and release the ratchet.



E. Remove the front camshaft bearing cap(A).



F. Remove the exhaust camshaft bearing cap and exhaust camshaft.

G. Remove the intake camshaft bearing cap and intake camshaft.

CAUTION

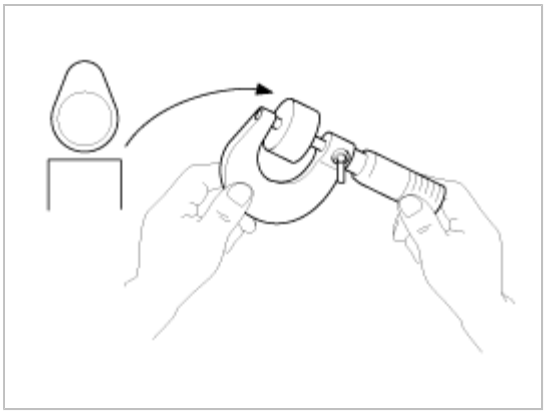
When disconnect the timing chain from the camshaft timing sprocket, hold the timing chain.

H. Tie down timing chain so that it dosen't move.

CAUTION

Be careful not to drop anything inside timing chain cover.

I. Measure the thickness of the removed tappet using a micrometer.



J. Calculate the thickness of a new tappet so that the valve clearance comes within the specified 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-0.30mm (0.0118in.)]

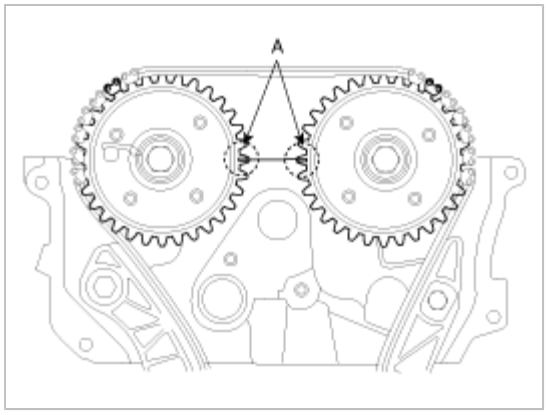
K. Select a new tappet with a thickness as close as possible to the calculated value.

> NOTE
>
> Shims are available in 47size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.690mm (0.1452in.)

L. Place a new tappet on the cylinder head.
M. Hold the timing chain, and install the intake camshaft and timing sprocket assembly.
N. Align the matchmarks on the timing chain and camshaft timing sprocket.
O. Install the intake and exhaust camshaft.
P. Install the front bearing cap.
Q. Install the sevice hole bolt.

Tightening torque :
11.8 ~ 14.7N.m (1.2 ~ 1.5kgf.m, 8.7 ~ 10.8lb-ft)

R. Turn the crankshaft two turns in the operating direction(clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks(A).



S. Recheck the valve clearance.

Valve clearance (Engine coolant temperature : 20°C)
[Specification]
Intake : 0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)
Exhaust : 0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)

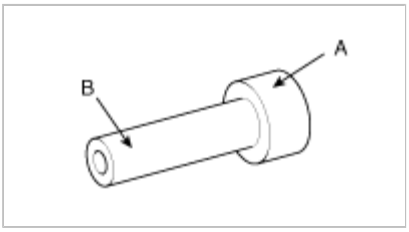
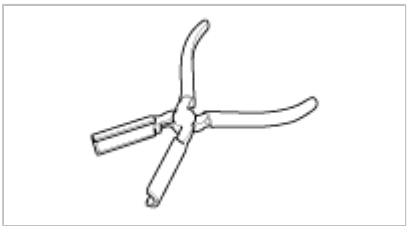
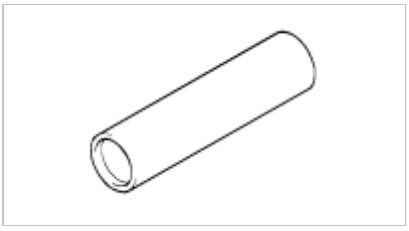
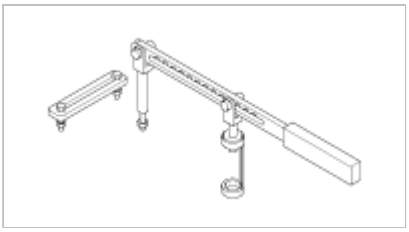
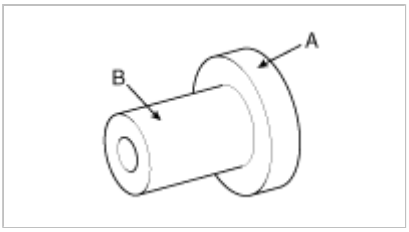
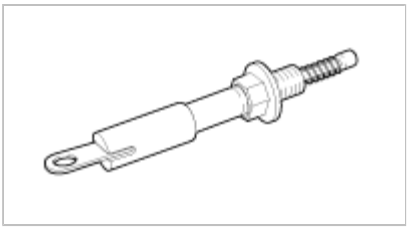
Troubleshooting

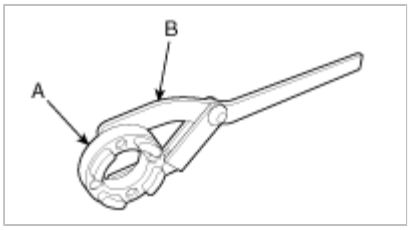
Symption	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings Loose or improperly engine filwheel	Replace the crankshaft and bearings as required. Repair or replace the flywheel as required.
	Worn piston rings (Oil consumption may or may not cause the 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. (Carbon buidup on the valve stem)	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 valve lifters.
Engine misfire with coolant consumption	• Faulty cylinder head gasket or other damage to the cylinder head and engine block cooling system. • 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. • Repair or replace as required.
Engine misfire with excessive oil consumption	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	• Inspect the cylinder for a loss of compression. • Repair or replace as required.
Engine noise on start-up, but only lasting a few seconds.	Incorrect oil viscosity	• Drain the oil. • Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	• Inspect the thrust bearing and crankshaft. • 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.
	Stetched 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. • Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair or replace as required.
	Stuck valves. (Carbon on the valve stem or valve seat may cause the valve to	Inspect the valves and valve guides, then repair or replace as required.

	stay open.	
	Worn drive belt, idler, tensioner and bearing.	Replace as required
Lower engine noise, regardless of engine speed	Low oil pressure	Repair or required.
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	• Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	• Inspect the oil pump screen. • Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	• Inspect the piston, piston pin and cylinder bore. • Repair or replace as required.
	Excessive piston pin-to-piston clearance	• Inspect the piston, piston pin and the connecting rod. • Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair or replace as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block
	Incorrect piston, piston pin and connecting rod installation	• Verify the piston pins and connecting rods are installed correctly. • 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 or replace as required : • The connecting rod bearings. • The connecting rods. • The crankshaft
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
Engine will not crank-crankshaft will not rotate	Hydraulically locked cylinder • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector and/or leaking fuel regulator.

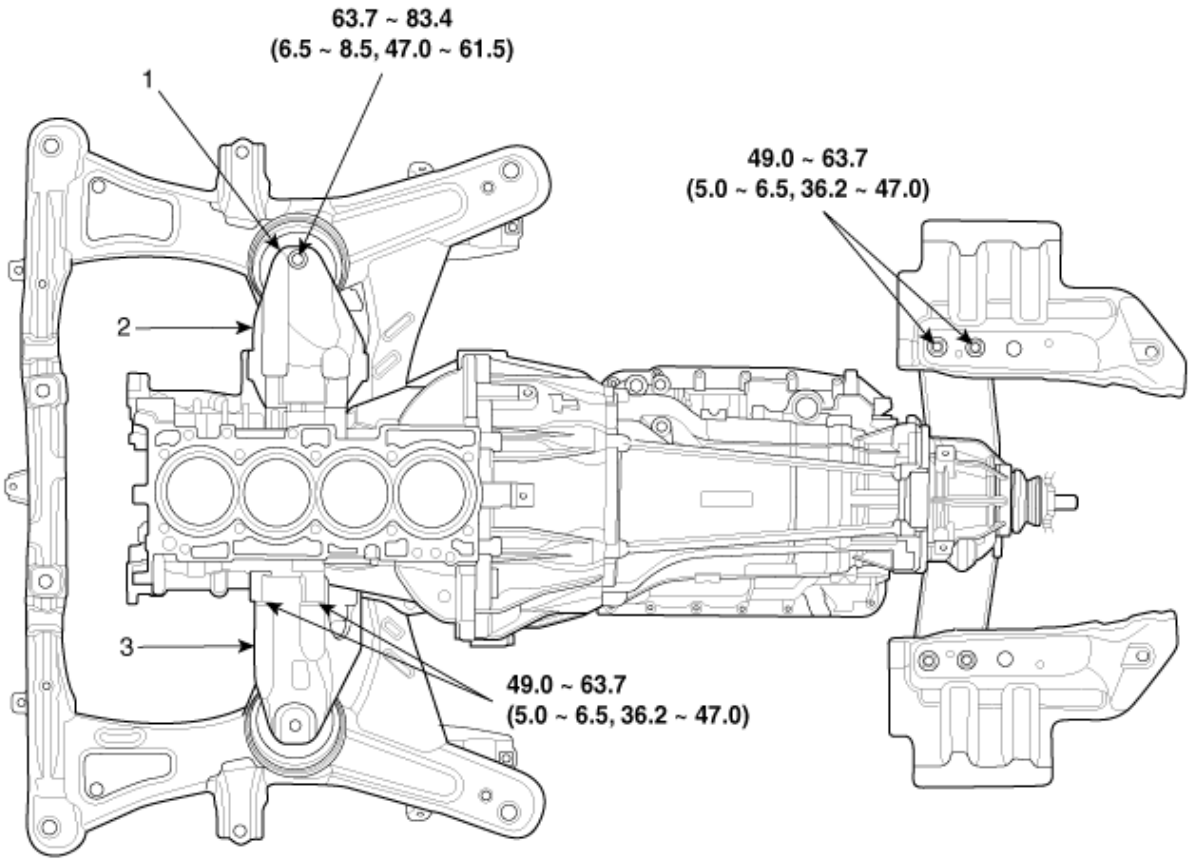
	Broken timing chain and/or timing chain and/or timing chain gears.	1. Inspect timing chain and gears. 2. Repair as required.
	Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	1. Inspect crankshaft and connecting rod bearing. 2. Repair as required.
	Bent or broken connecting rod.	1. Inspect connecing rods. 2. Repair as required.
	Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

Special Service Tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-3K000) (09231-H1100)		Installation of the front oil seal A : 09214-3K000 B : 09231-H1100
Valve stem seal		Removal of the valve stem seal
Torque angle adapter (09221-4A000)		Installtion of bolts & nuts needing an angular method of adjustment.
Valve stem oil seal installer (09222-4A000)		Installation of the valve stem oil seal
Valve spring compressor & holder (09222-3K000) (09222-3K100)		Removal and installation of the intake or exhaust valve 09222-3K100 (holder)
Crankshaft rear oil seal installer (09214-3K100) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09214-3K100 B : 09231-H1100
Timing chain tensioner ratchet holder (09240-2G000)		Timing chain tension release. In vehicle inspection and adjustment of valve clearance.

Crankshaft pulley adapter (09231-2M100) Crankshaft pulley adapter holder (09231-2J210)		Removal and installation of crankshaft pulley from the vehicle A : 09231-2M100 B : 09231-2J210 (Holder)

Components



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

1. Engine mounting bracket 2. Engine support bracket RH	3. Engine support bracket LH

Removal

CAUTION

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

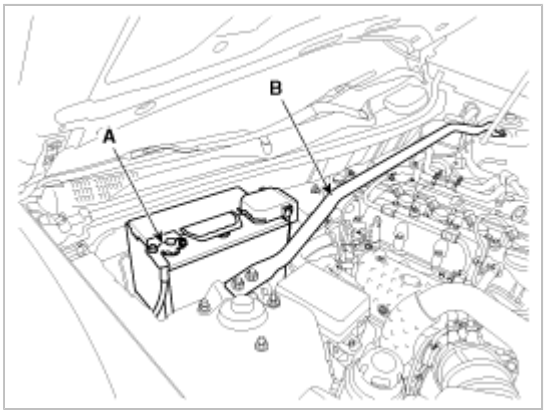
WARNING

For release the fuel pressure, start the engine and wait until fuel in fuel line is exhausted.
After the engine stop turn the ignition switch OFF.

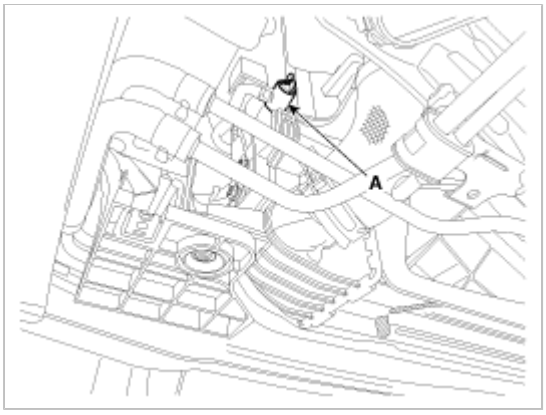
NOTE

Mark all wiring and hoses to avoid misconnection.

1. Disconnect the battery negative cable (A).
2. Remove the transmission system before removing the engine system. (Refer to MT, AT group)
3. Remove the strut bar (B).

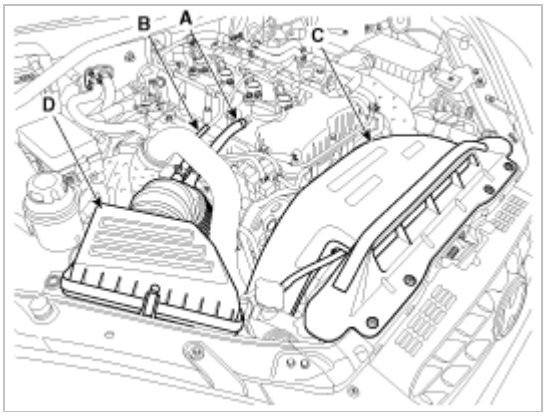


4. Remove the drain plug (A) and drain the engine coolant.

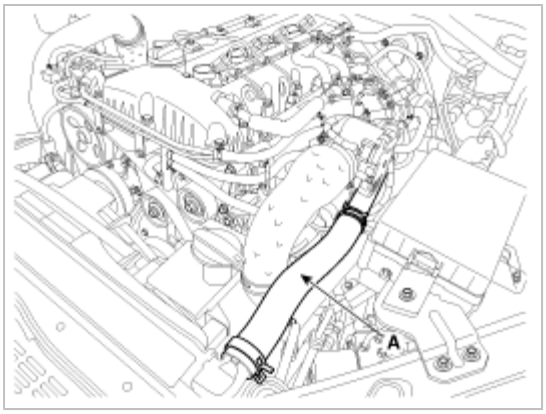


5. After recovering refrigerant, remove the high & low pressure pipe. (Refer to HA group)
6. Disconnect the breather hose (A), vacuum hose (B). And remove the air duct (C) and air cleaner assembly (D).

Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)

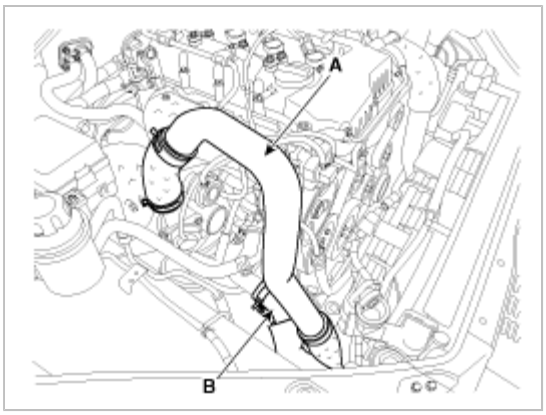


7. Remove the radiator upper hose (A) .

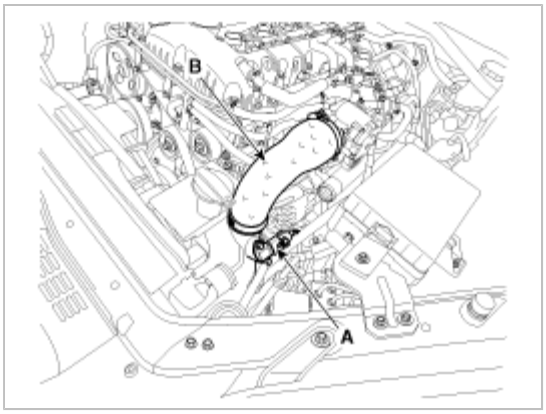


8. Remove the intercooler inlet hose (A) and radiator lower hose (B).

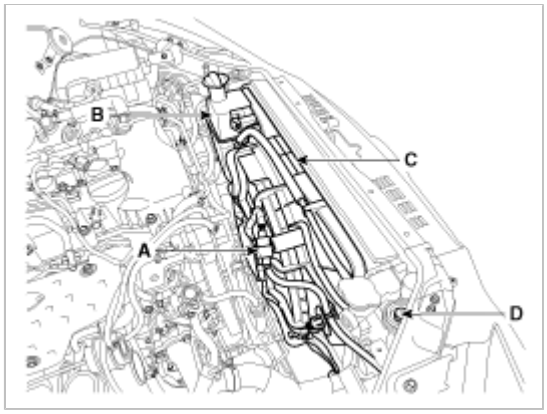
Tightening torque :
Bolt : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)
Clamp : 4.9 ~ 6.8 N.m (0.5 ~ 0.7kgf.m, 3.6 ~ 5.1lb-ft)



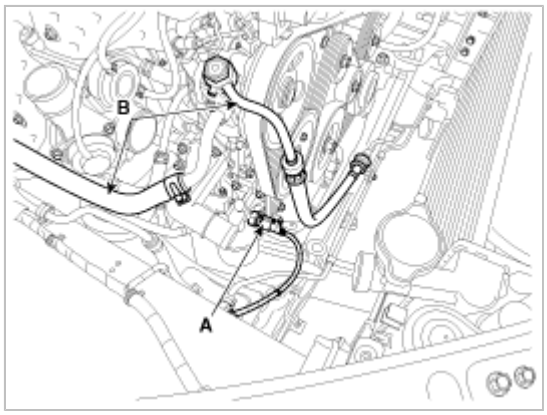
9. Remove the intercooler outlet hose (B) after disconnecting the BPS connector (A).



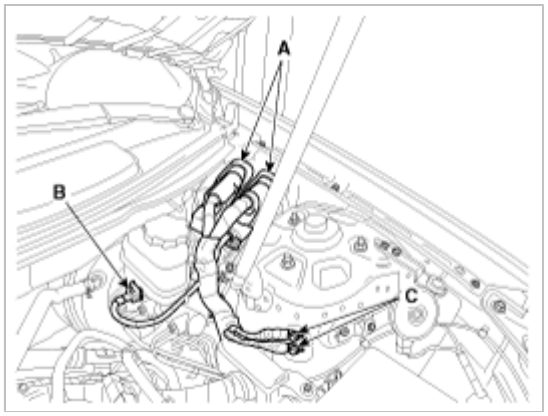
10. Remove the cooling fan.
    (1) Remove the cooling fan connector (A).
    (2) Remove the reservoir tank (B).
    (3) Remove the fan assembly (C).



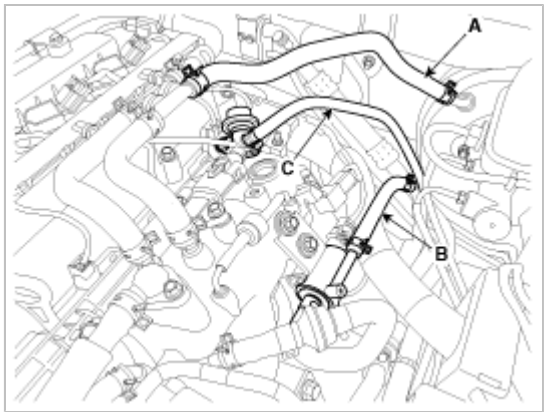
11. Disconnect the oil pressure (OPS) sensor (A) and remove the power steering oil hoses (B).



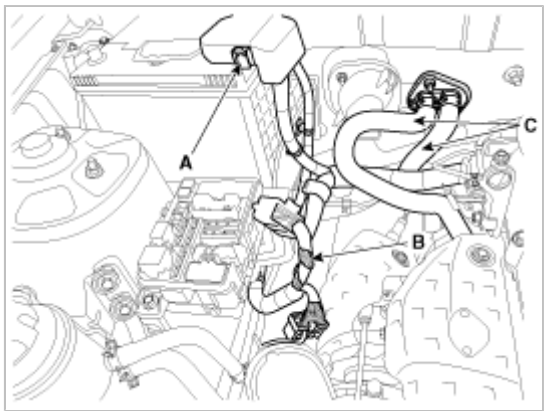
12. Disconnect the ECM connectors (A), brake oil level sensor connector (B) and ground (C).



13. Disconnect the brake booster vacuum hose (A), PCSV hose (B) and fuel hose (C).

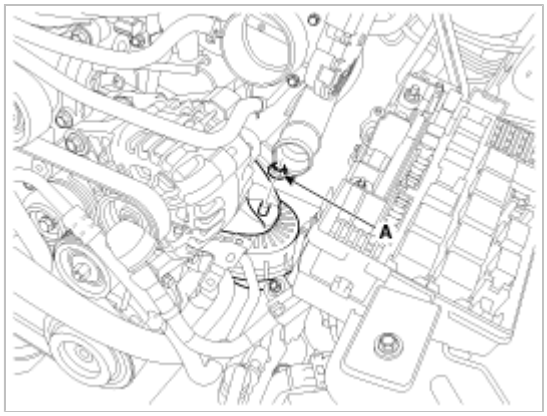


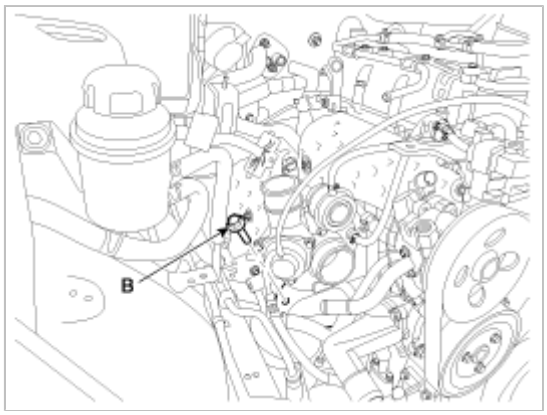
14. Remove the alternator cable. (Refer to EE group)
15. Disconnect the the battery (+) cable (A), wirings (B) and heater hoses (C).



16. Remove the engine mounting bracket nut (A) and bolt (B).

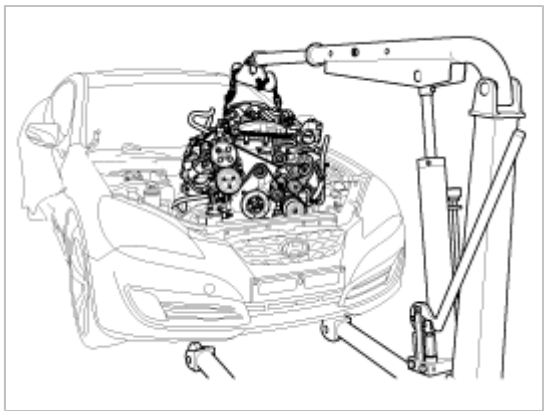
Tightening torque :
66.7 ~ 83.4N.m (6.8 ~ 8.5kgf.m, 49.2 ~ 61.5lb-ft)





17. Remove the hood. (Refer to BD group)
18. Remove the engine assembly by lifting the engine jack.

> CAUTION
>
> When removing the engine assembly, be careful not to damage any surrounding parts or body components.



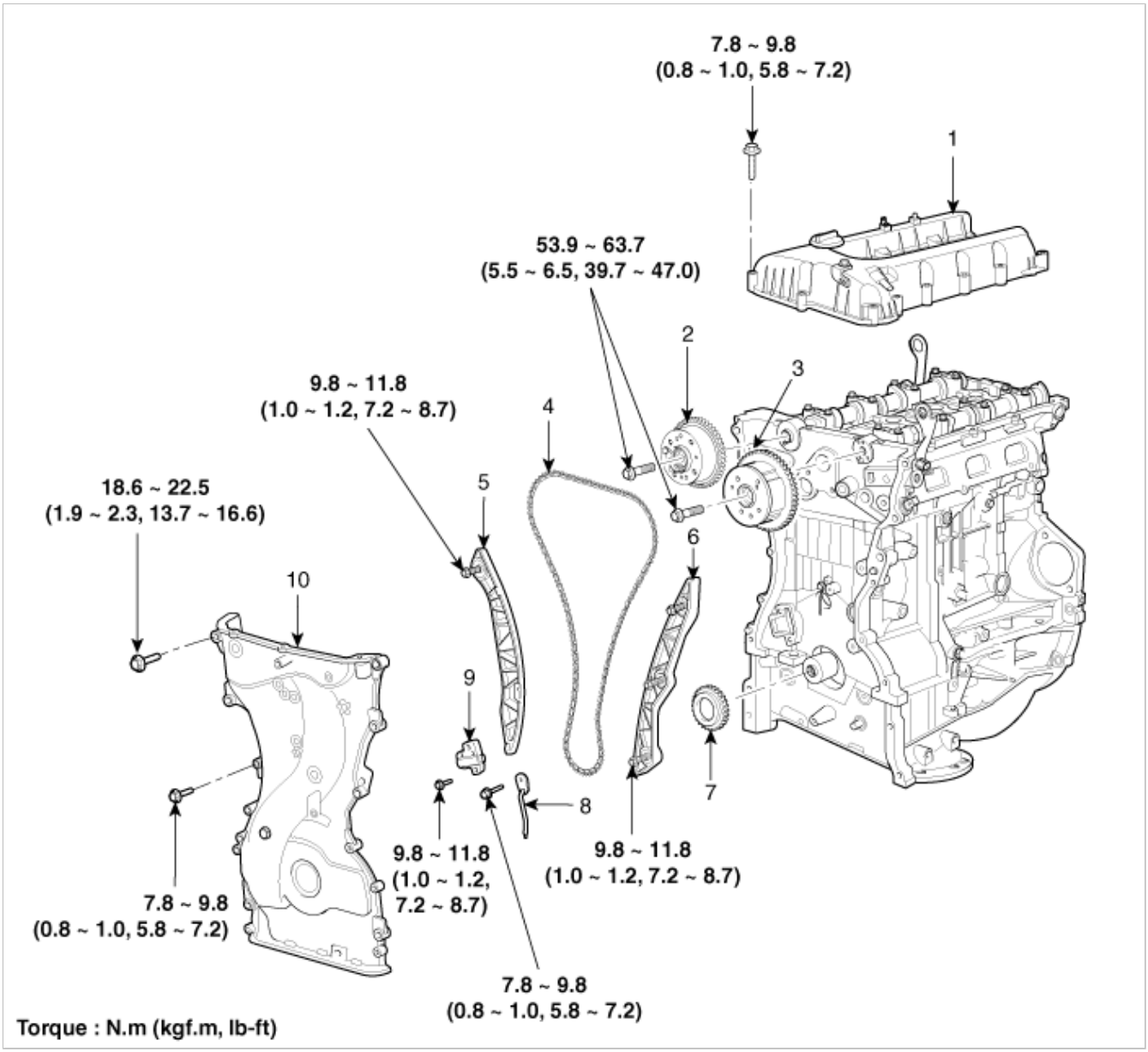
Installation

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

- Adjust a shift cable.
- Adjust a throttle 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.
- Place a heater control knob on "HOT" positon.

• 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.
• Clean battery posts and cable terminals and assemble.

Components



1. Cylinder head cover	5. Timing chain tensioner arm	8. Oil jet
2. Exhaust CVVT assembly	6. Timing chain tensioner guide	9. Timing chain tensioner
3. Intake CVVT assembly	7. Crankshaft sprocket	10. Timing chain cover
4. Timing chain		

Removal

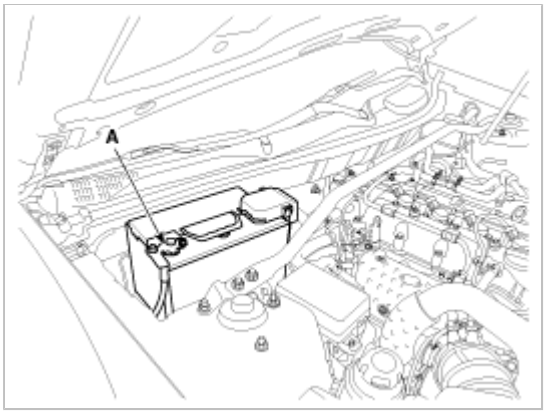
CAUTION

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

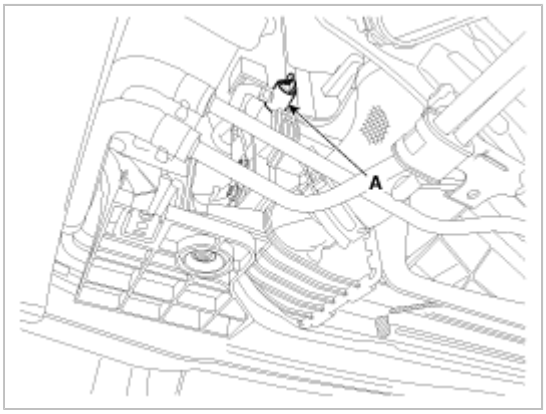
NOTE

Mark all wiring and hoses to avoid misconnection.

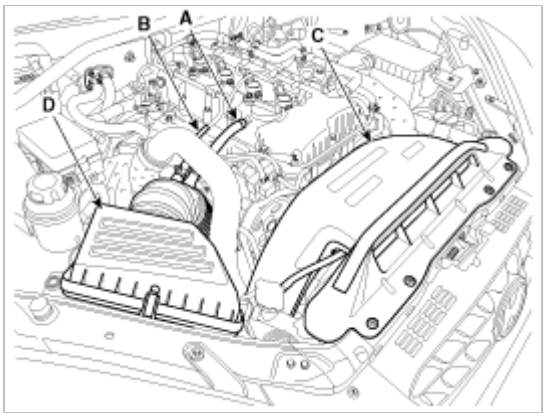
1. Disconnect the battery nagative cable (A).



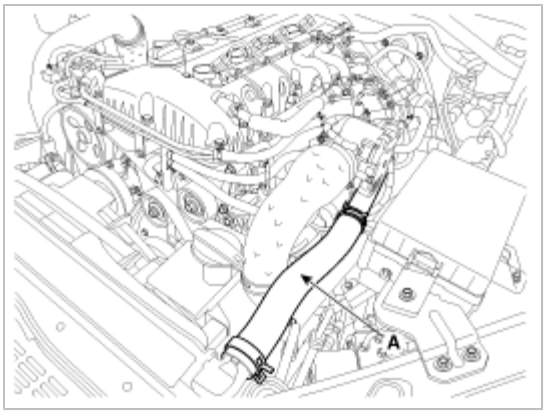
2. Loosen the drain plug (A) and drain the engine coolant.



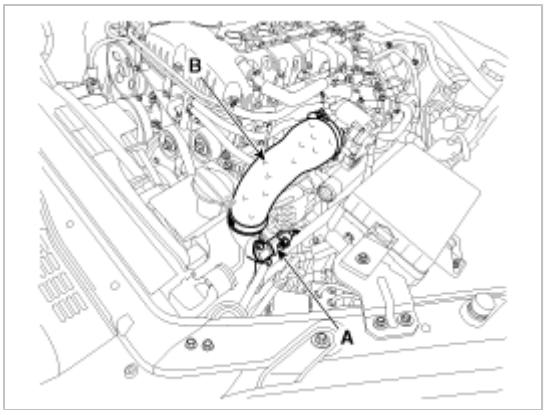
3. Disconnect the breather hose (A), vacuum hose (B). And remove the air duct (C) and air cleaner assembly (D).



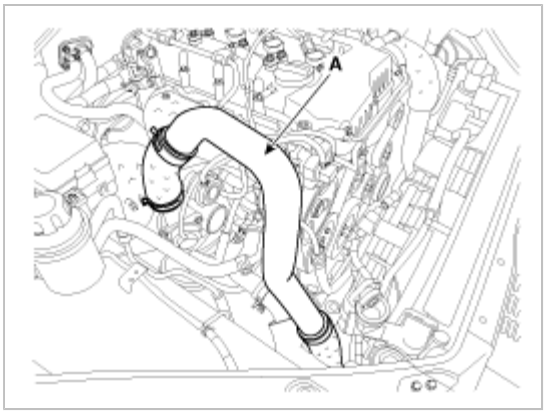
4. Remove the radiator upper hose (A).



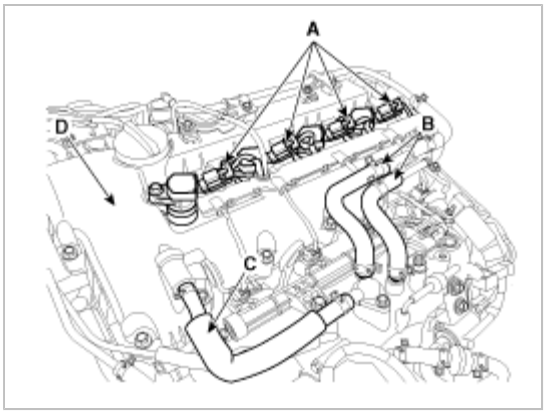
5. Remove the intercooler outlet hose (B) after disconnecting the BPS connector (A).



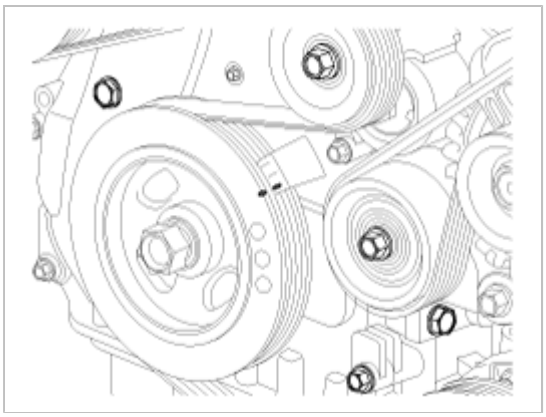
6. Remove the intercooler inlet hose (A).



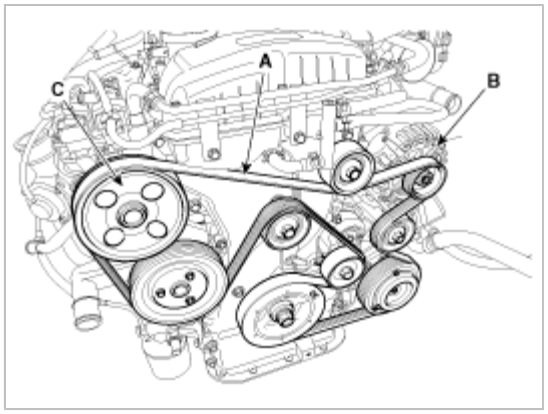
7. Disconnect the ignition coil connectors (A) and remove the ignition coils.
8. Remove the cylinder head cover (D) after removing the vacuum hoses (B) and PCV hose (C).



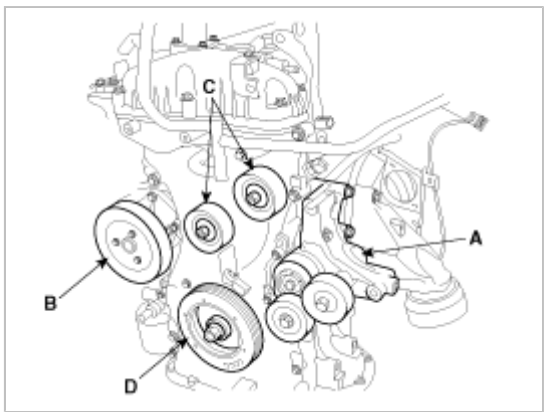
9. Set No.1 cylinder to TDC/compression.



10. Remove the drive belt (A), alternator (B) and power steering pump (C).



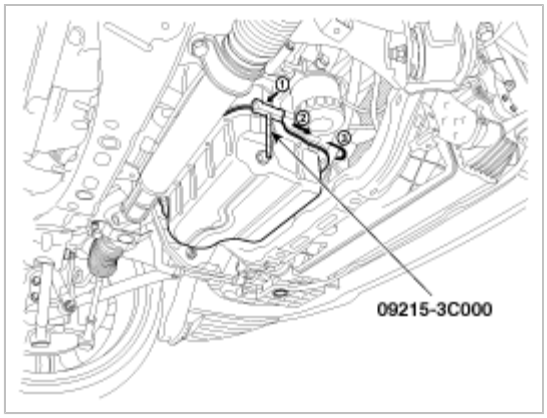
11. Remove the tensioner assembly (A), water pump assembly (B), idler (C) and crankshaft pulley (D).



NOTE

Use the SST (crankshaft pulley adapter and holder, 09231-2M100,09231-2J210,) to remove the crankshaft pulley bolt.

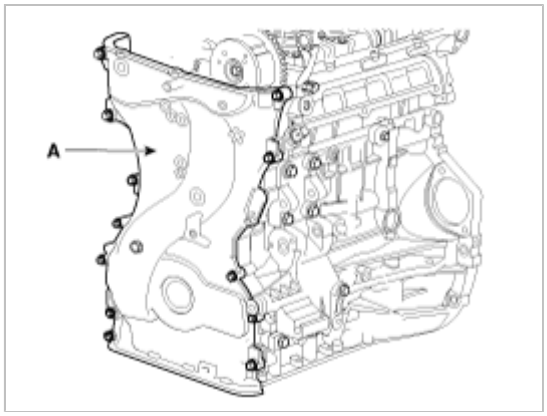
12. Remove the lower oil pan using the SST (09215-3C000).



NOTE

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of arrow #1.
- After tapping the SST with a plastic hammer along the direction of arrow #2 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.
- Be careful not to damage the contact surfaces of Upper oil pan and lower oil pan.

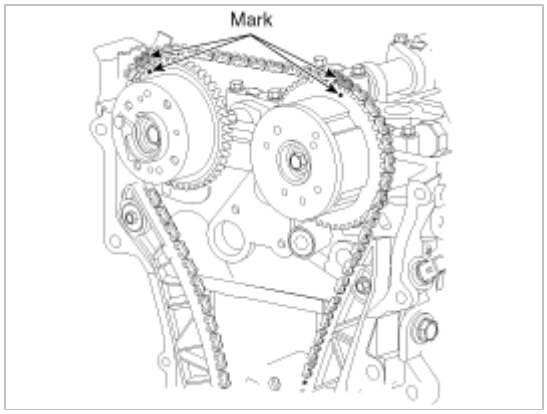
13. Remove the timing chain cover (A).

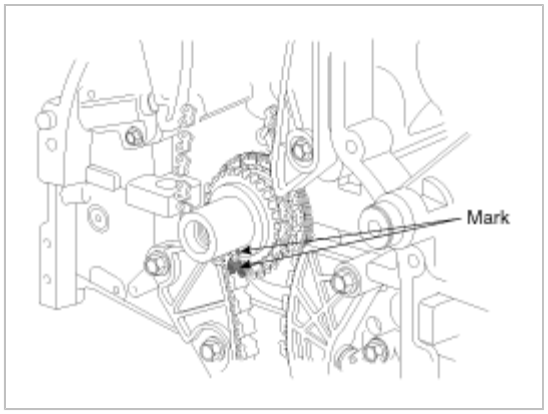


CAUTION

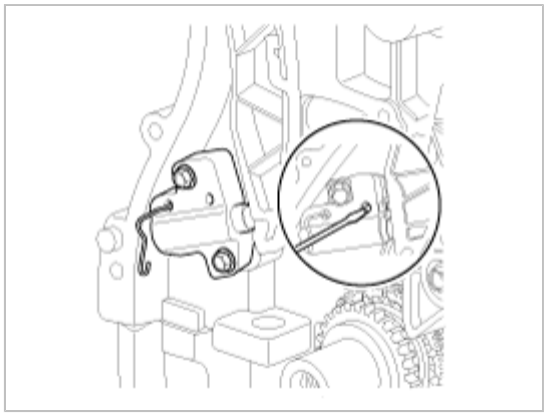
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

14. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.

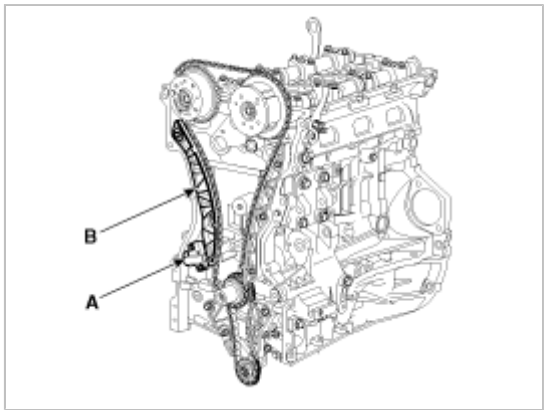




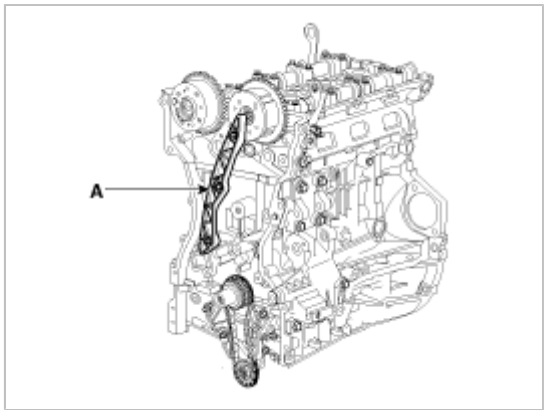
15. Install a set pin after compressing the timing chain tensioner.



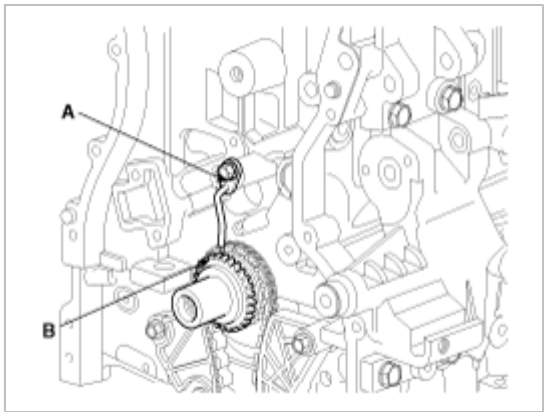
16. Remove the timing chain tensioner (A) and timing chain tensioner arm (B).



17. Remove the timing chain.
18. Remove the timing chain guide (A).



19. Remove the timing chain oil jet (A) and crankshaft sprocket (B).



20. Remove the balance shaft chain.
    (Refer to Lubrication system in this group)

Inspection

Sprockets, Hydraulic Tensioner, Chain Guide, Tensioner Arm

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.

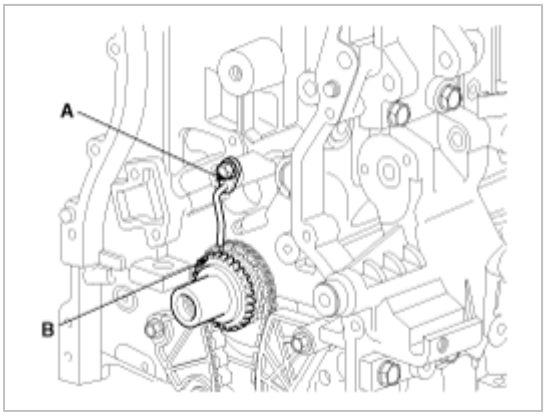
Belt, Idler, Pulley

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

Installation

1. Install the timing chain oil jet (A) and crankshaft sprocket (B).

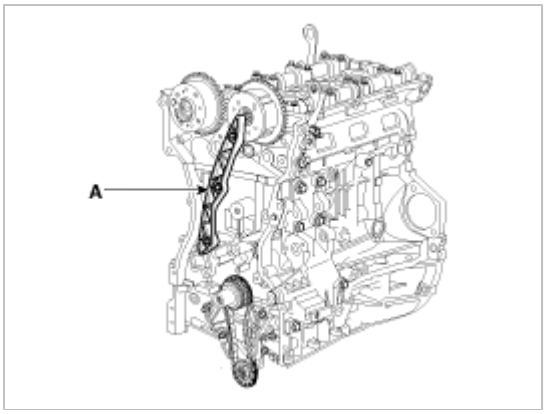
Tightening torque :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



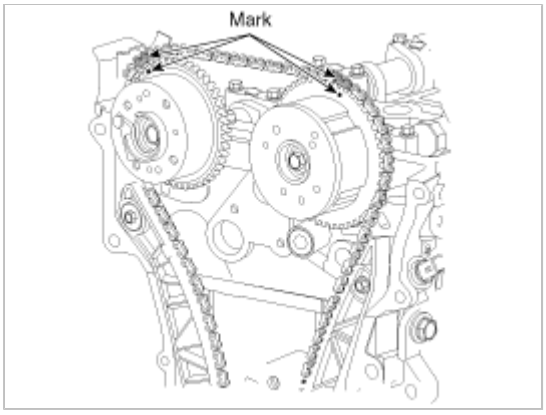
2. Set crankshaft that the key of crankshaft should be aligned with the mating surface of main bearing cap. Put the intake, exhaust camshaft assembly that the TDC mark of intake sprocket and exhaust sprocket should be aligned with the top surface of cylinder head. As a result of this, place the piston on No.1 cylinder at the top dead center on compression stroke.
3. Install the timing chain guide (A).

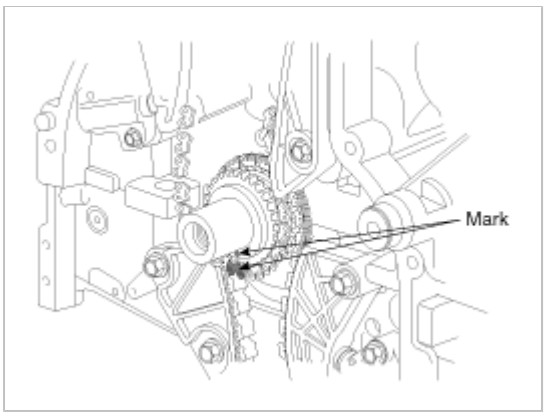
Tightening torque :

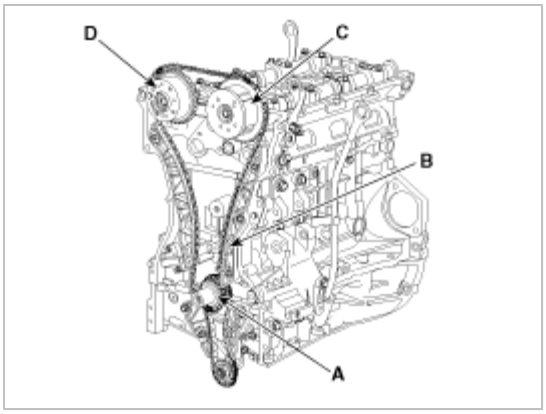
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



4. Install the timing chain.
   To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.Crankshaft sprocket (A) -> Timing chain guide (B) -> Intake CVVT assembly (C) -> Exhaust CVVT assembly (D).
   The timing mark of each sprockets should be matched with timing mark (color link) of timing chain at installing timing chain.





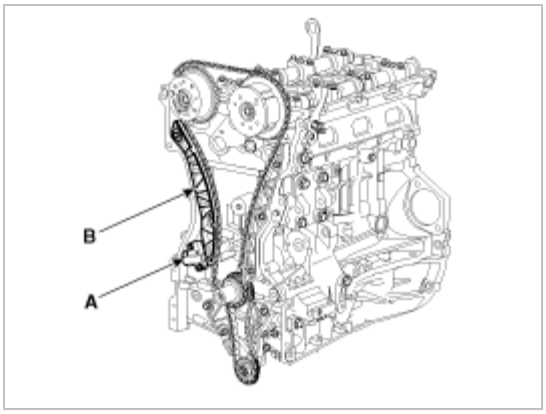


5. Install the timing chain tensioner arm (B).

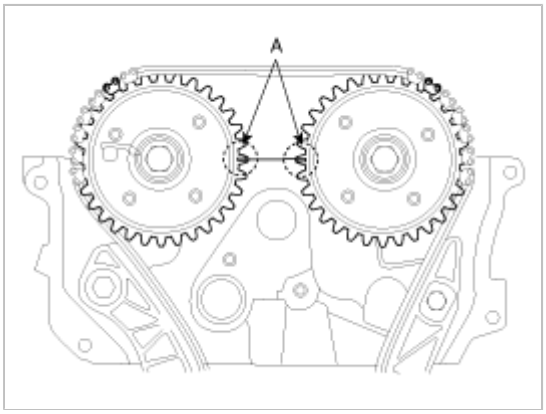
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

6. Install the timing chain auto tensioner (A) and remove the set pin.

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



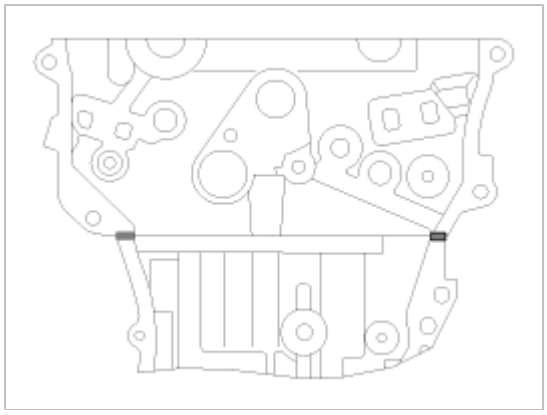
7. After rotating crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.



8. Install timing chain cover.
   A. Using a gasket scraper remove all the old packing meterial from the gasket surfaces.
   B. The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and ladder frame) must be free of engine oil and ETC.
   C. Before assembling the timing chain cover, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied on the gap between cylinder head and cylinder block.

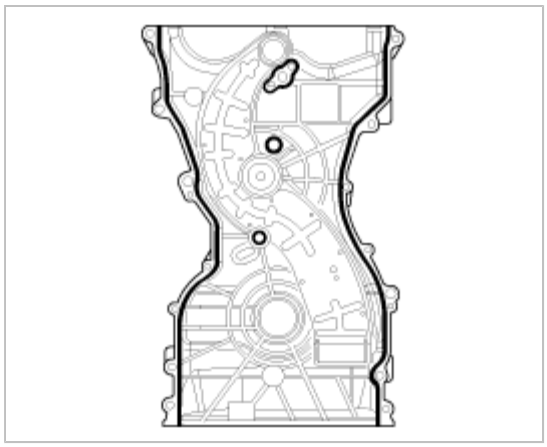
The part must be assembled within 5 minutes after sealant was applied.

Bead width : 2.5±0.5mm (0.098±0.019in.)



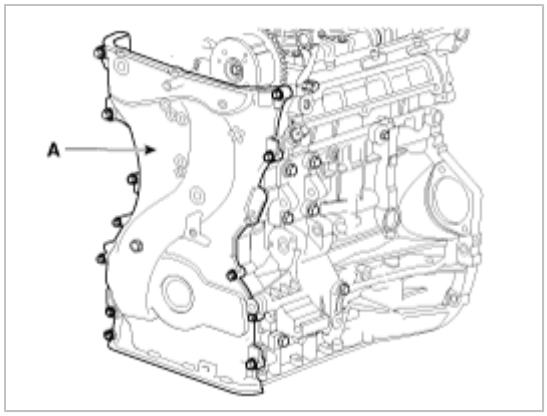
D. After applying liquid sealant Loctite 5900H on timing chain cover. The part must be assembled within 5 minutes after sealant was applied. Sealant should be applied without discontinuity.

Bead width : 3.0mm(0.12in.)



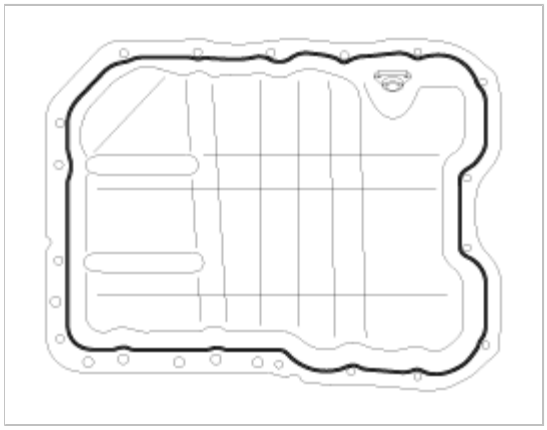
E. The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in order to assemble the timing chain cover to be in exact position.

Tightening torque :
M6 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
M8 : 18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



F. The firing and/or blow out test should not be performed within 30 minutes after the timing chain cover was assembled.

9. Install the oil pan.
   A. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
   B. Before assembling the oil pan, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.



CAUTION

- When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

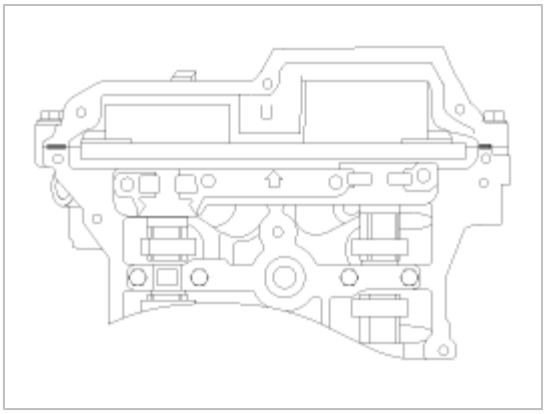
   C. Install the oil pan (A).
   Uniformly tighten the bolts in several passes.

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

   D. After assembly, wait at least 30 minutes before filling the engine with oil.

10. Install the cylinder head cover.
   A. The hardened sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
   B. After applying sealant (Loctite 5900H), it should be assembled within 5 minutes.

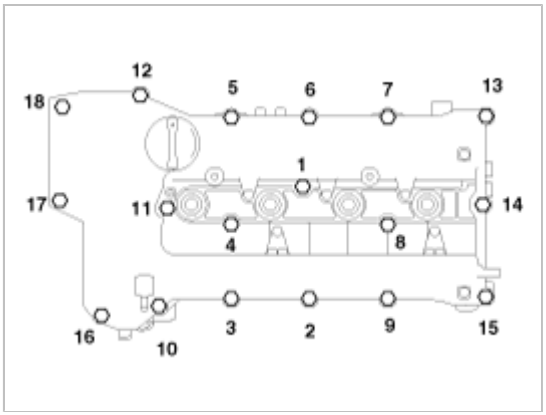
Bead width : 2.5±0.5mm (0.098±0.019in.)



   C. The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.
   D. Install the cylinder head cover bolts as following method.

Tightening torque :
Step 1 : 3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)

Step 2 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



CAUTION

Do not reuse cylinder head cover gasket.

11. Install the crankshaft pulley (D).

Tightening torque :
166.7 ~ 176.5N.m (17 ~ 18kgf.m, 122.9 ~ 130.2lb-ft)

NOTE

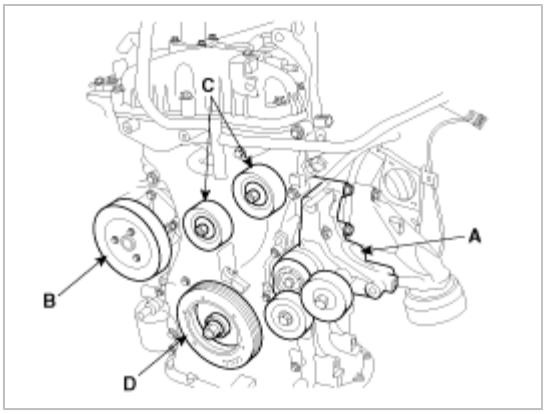
Fix the crankshaft using the SST (09231-2M000, 09231-2J210) when installing the crankshaft pulley bolt.

12. Install the water pump pulley (B) and Idler (C).

Tightening torque :
B: 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
C: 53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.8 ~ 47.0lb-ft)

13. Install the tensioner bracket assembly (A).

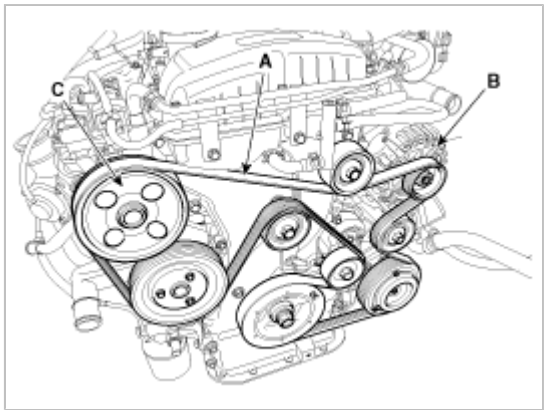
Tightening torque :
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)



14. Install the alternator (B), power steering pump (C) and drive belt (A).

Tightening torque :
B: 49.0 ~ 63.7N.m (5.0 ~ 6.5kgf.m, 36.1 ~ 47.0lb-ft)

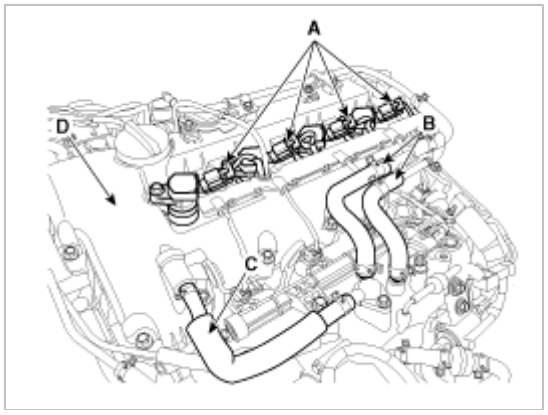
C: 16.6 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)



15. Install the ignition coil and connect the ignition coil connector (A).

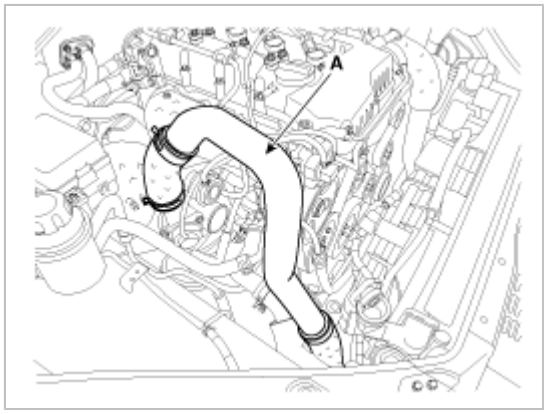
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

16. Install the vacuum hose (B) and PCV hose (C).

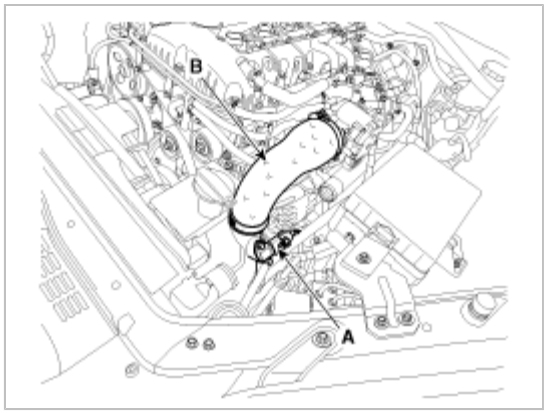


17. Install the intercooler inlet hose (A).

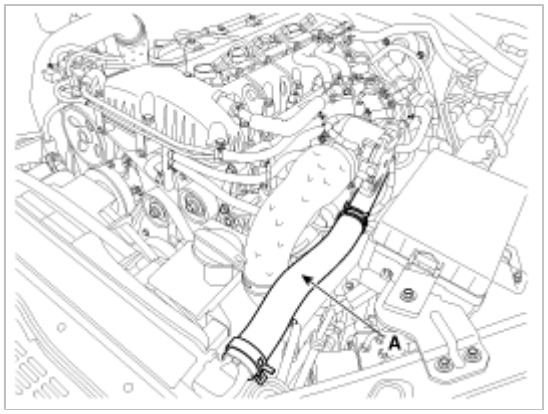
Tightening torque :
Bolt : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)
Clamp : 4.9 ~ 6.8N.m (0.5 ~ 0.7kgf.m, 3.6 ~ 5.1lb-ft)



18. Install the intercooler outlet hose (B) and connect the BPS connector (A).

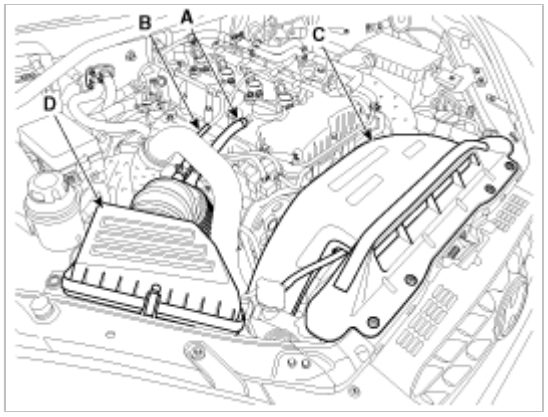


19. Install the radiator upper hose (A).

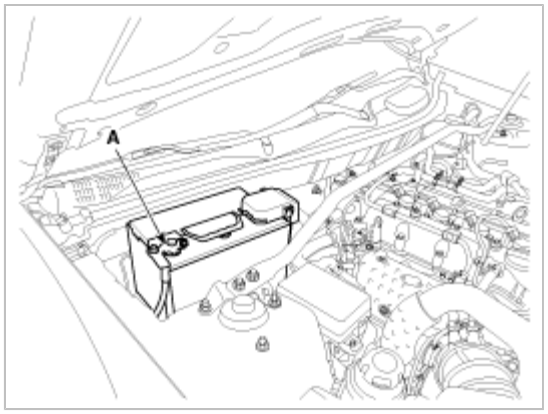


20. Install the air cleaner assembly (D) and air duct (C). And then connect the breather hose (A) and vacuum hose (B).

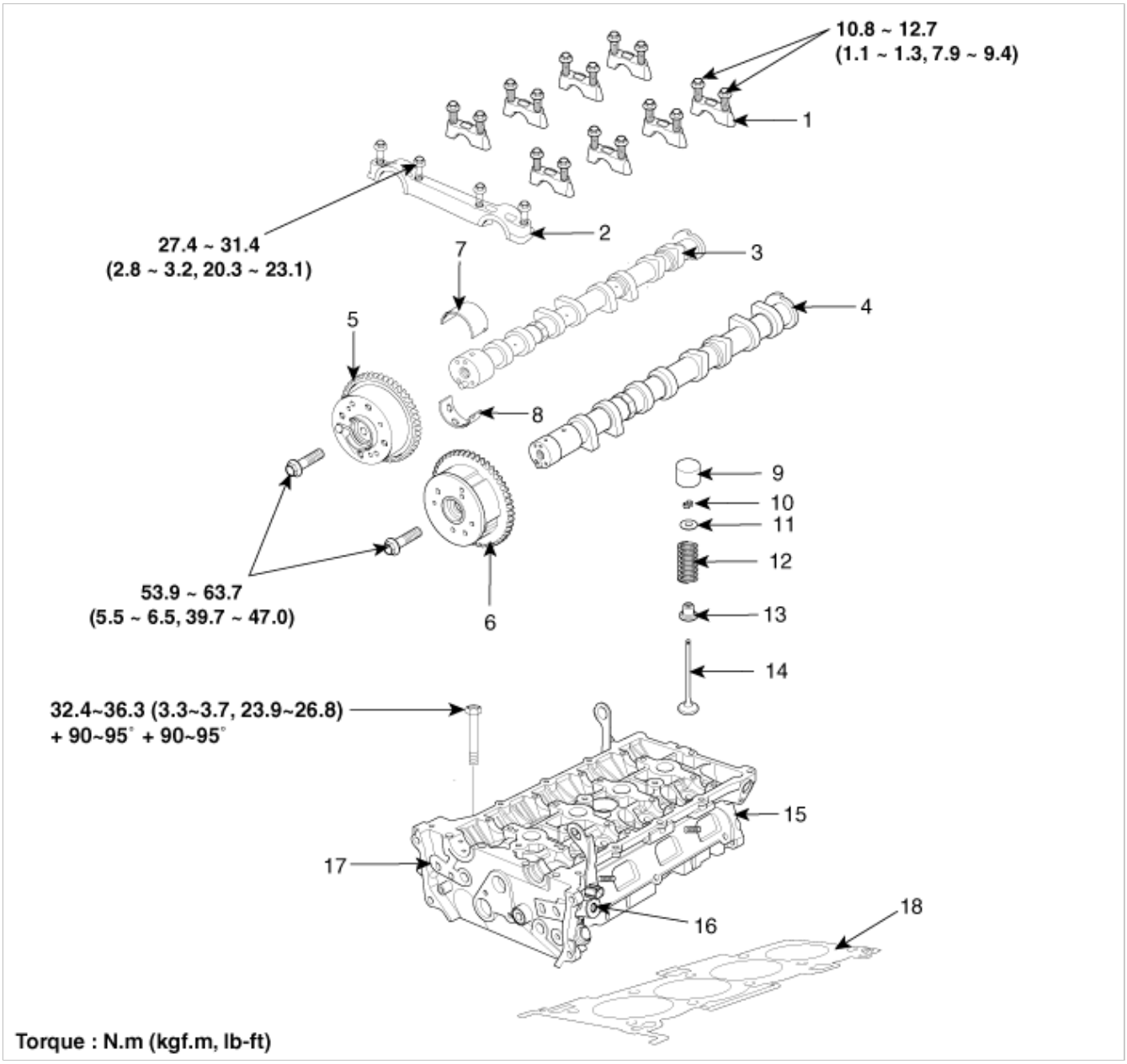
Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.1 ~ 3.6lb-ft)



21. Connect the battery negative cable (A).


A

Components



1. Camshaft bearing cap	7. Exhaust camshaft upper bearing	13. Valve stem seal
2. Camshaft front bearing cap	8. Exhaust camshaft lower bearing	14. Valve
3. Exhaust camshaft	9. MLA	15. Cylinder head
4. Intake camshaft	10. Retainer lock	16. Intake OCV
5. Exhaust CVVT assembly	11. Retainer	17. Exhaust OCV
6. Intake CVVT assembly	12. Valve spring	18. Cylinder head gasket

Removal

Engine removal is not required for this procedure.

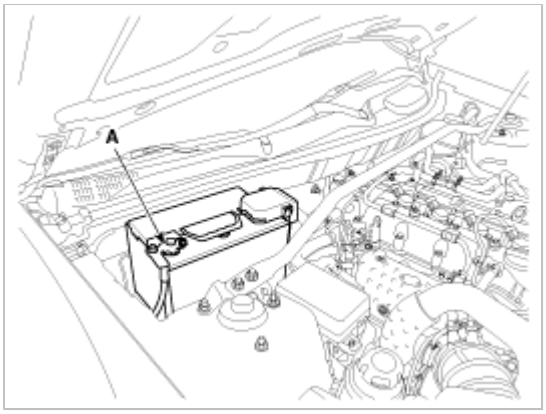
CAUTION

- 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.

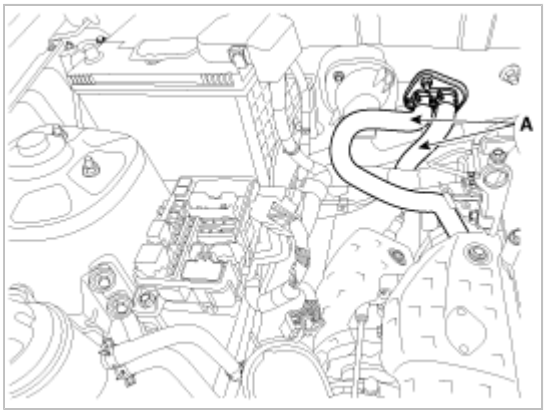
NOTE

Mark all wiring and hoses to avoid misconnection.

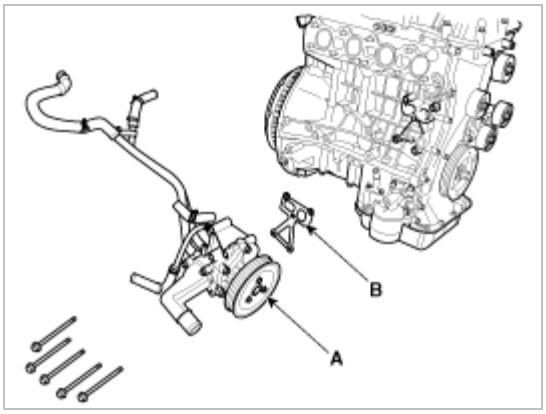
1. Disconnect the negative (-) battery terminal (A).



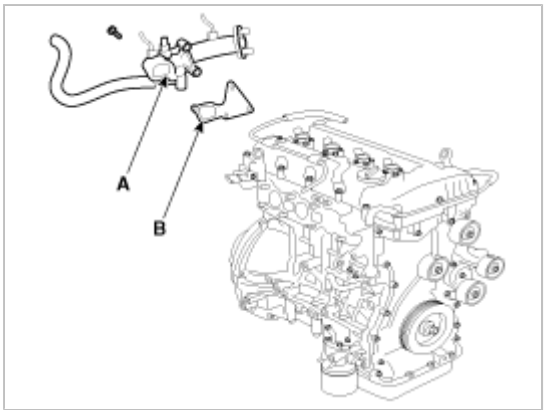
2. Remove the heater hoses (A).



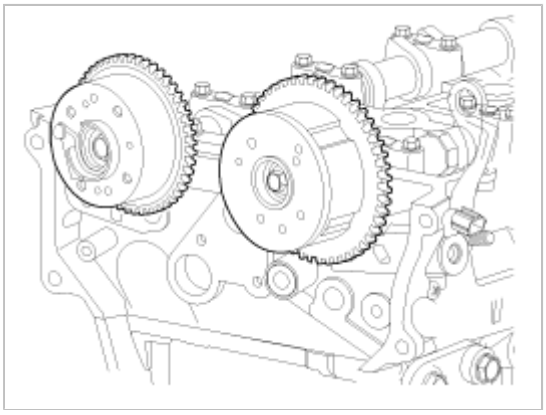
3. Remove the intake & exhaust manifold. (Refer to Intake and exhaust system in this group)
4. Remove the water pump (A) and gasket (B).



5. Remove the water temperature control assembly (A) and gasket (B).

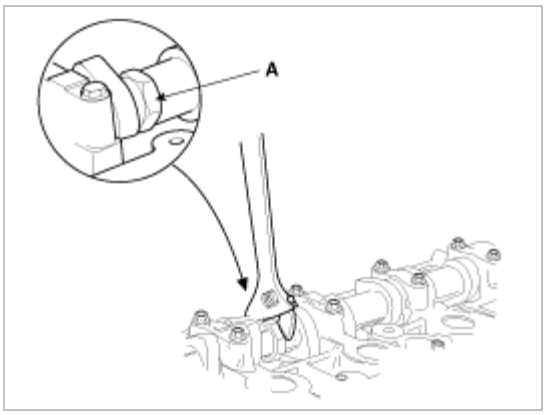


6. Remove the intake & exhaust CVVT assembly. (Refer to Timing system in this group)
7. Remove the intake & exhaust CVVT assembly.

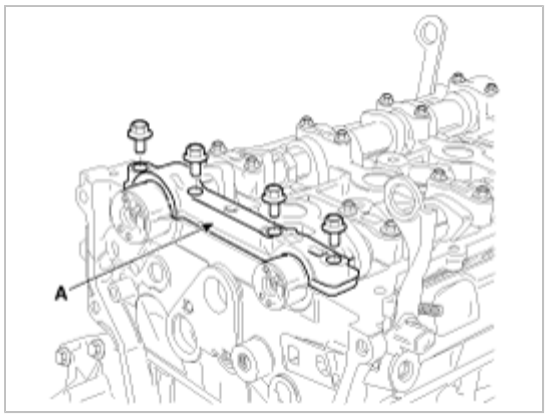


NOTE

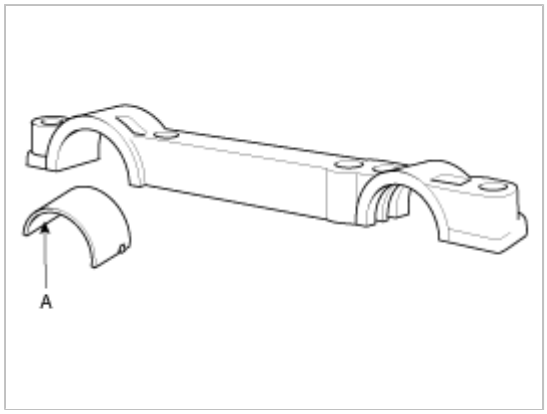
Fix the cam shaft (A) with a wrench when removing the CVVT assembly.



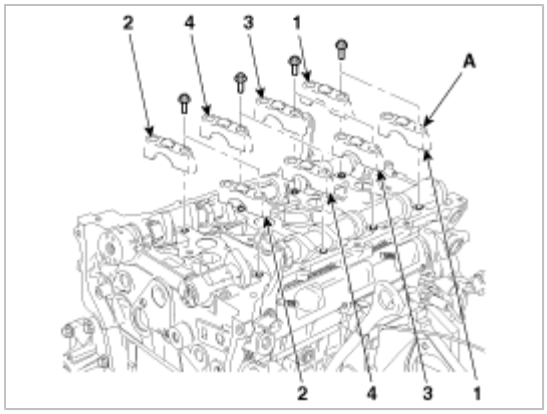
8. Remove the cam shaft.
   A. Remove the front cam shaft bearing cap (A).



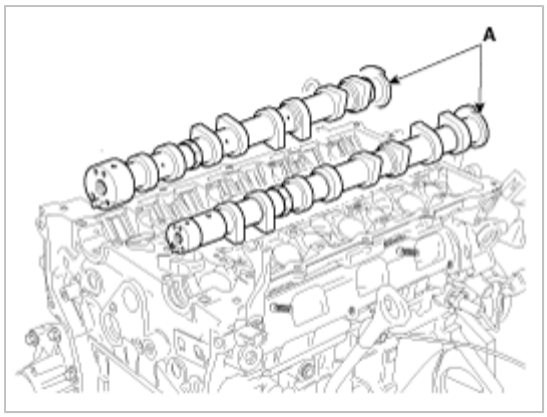
   B. Remove the exhaust cam shaft upper bearing (A).



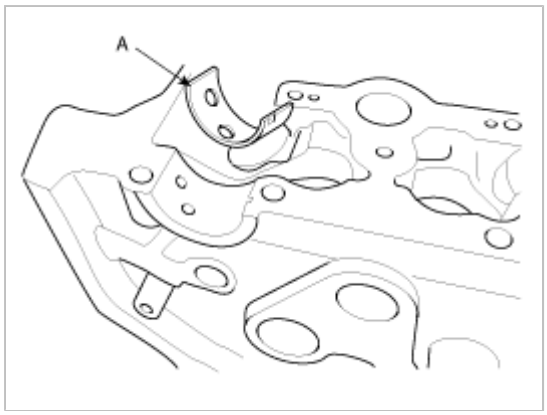
   C. Remove camshaft bearing cap (A), in the sequence shown.



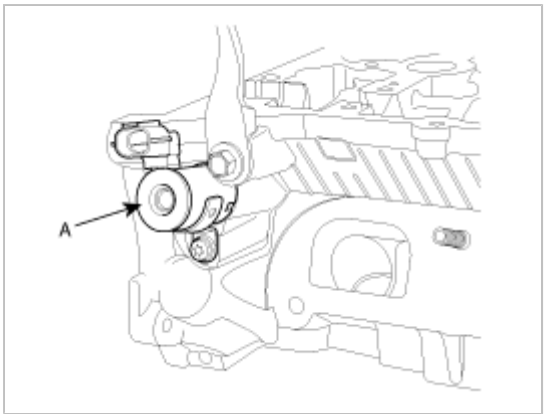
   D. Remove the cam shaft (A).



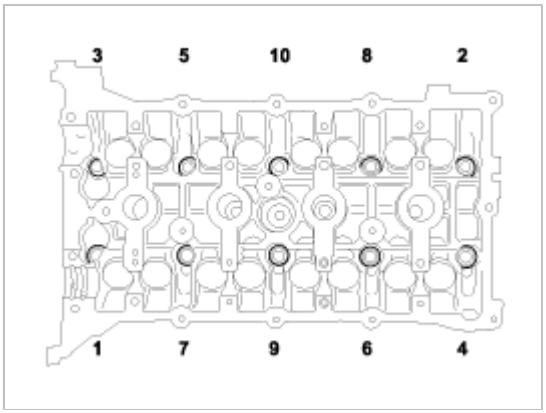
E. Remove the exhaust cam shaft lower bearing (A).



9. Use a torx wrench, remove the intake OCV (A).



10. Remove the exhaust OCV.
11. Remove the cylinder head bolts, then remove the cylinder head.
    A. Using triple square wrench, 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.

B. Lift the cylinder head from the dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.

CAUTION

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

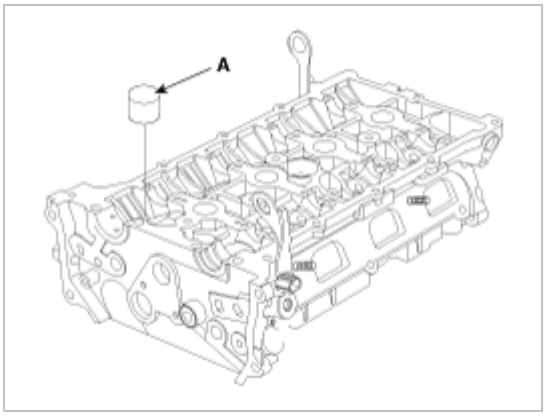
12. Remove the cylinder head gasket.

Disassembly

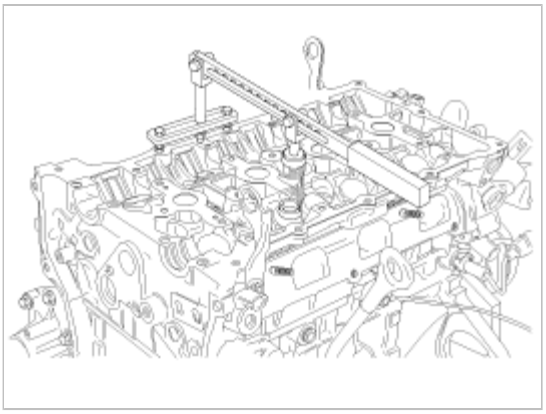
NOTE

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 MLAs(A).



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

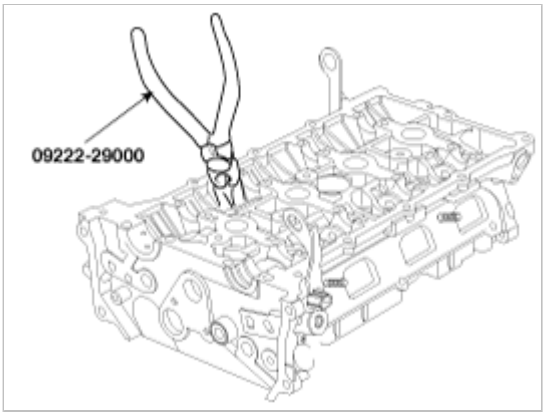


(2) Remove the spring retainer.

(3) Remove the valve spring.

(4) Remove the valve.

(5) Using valve stem seal remover (09222-29000), remove the valve stem seal.

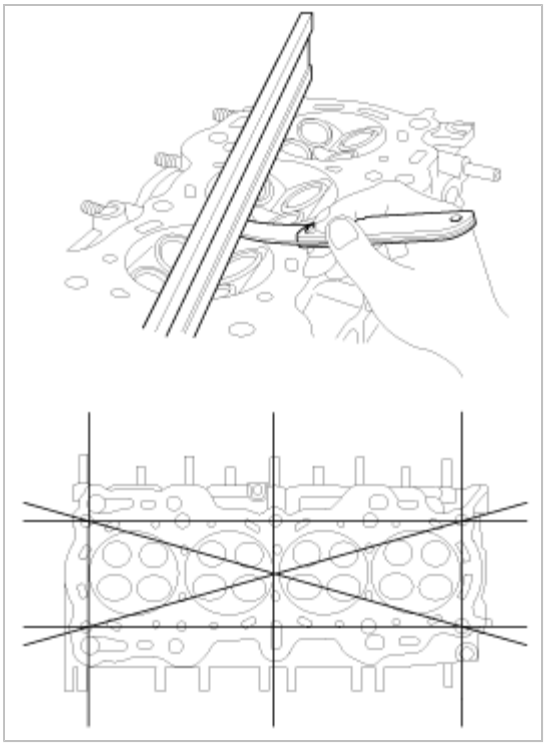


Inspection

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(0.002in.)

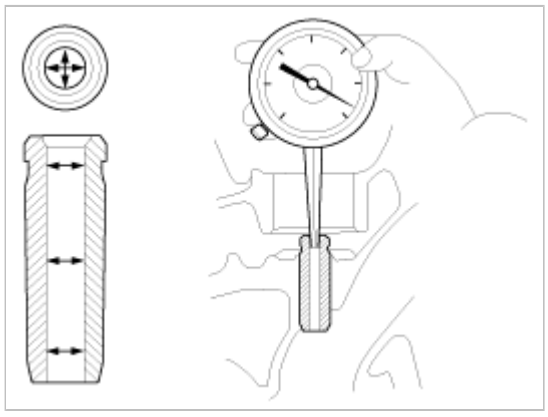


2. Inspect for cracks.
   Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

Valve And Valve Spring

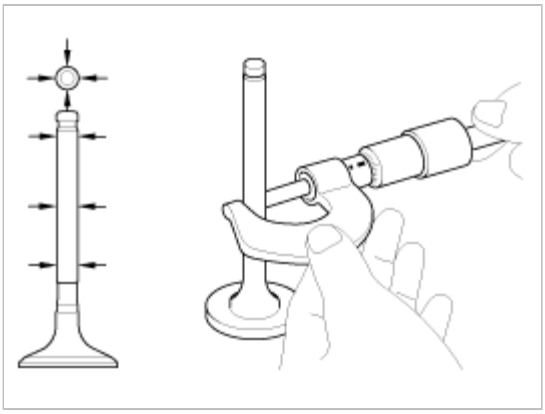
1. Inspect valve stems and valve guides.
   (1) Using a caliper gauge, measure the inside diameter of the valve guide.

Valve guid I.D.
Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)



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

Valve stem O.D.
Intake : 5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)
Exhaust : 5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)



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

Valve stem-to-guide clearance
[Standard]
Intake : 0.020 ~ 0.047mm (0.0008 ~ 0.0018in.)
Exhaust : 0.030 ~ 0.054mm (0.0012 ~ 0.0021in.)
[Limit]
Intake : 0.07mm (0.0027in.)
Exhaust : 0.09mm (0.0035in.)

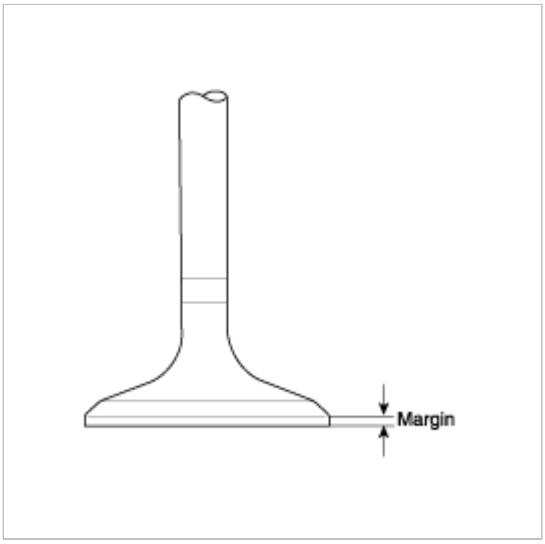
If the clearance is greater than maximum, replace the valve and valve guide.

2. Inspect valves.
(1) Check the valve is ground to the correct valve face angle.

(2) Check that the surface of the 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 : 1.02mm(0.0401in.)
Exhaust : 1.09mm(0.0429in.)



(4) Check the valve length.

Valve length
[Standard]
Intake : 113.18mm (4.456in.)
Exhaust : 105.84mm (4.167in.)
[Limit]
Intake : 112.93mm (4.446in.)
Exhaust : 105.59mm (4.157in.)

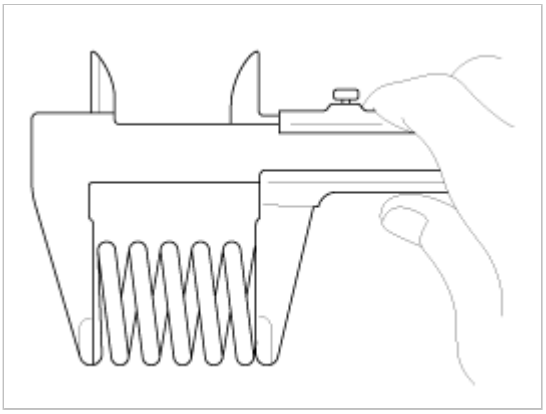
(5) Check the surface of the valve stem tip for wear.
If the valve stem tip is worn, replace the valve.

3. Inspect valve seats
Check the valve seat for evidence of overheating and improper contact with the valve face.
Replace the seat if necessary.
Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace it, then recondition the seat. Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.

4. Inspect valve springs.
(1) Using a steel square, measure the out-of-square of the valve spring.

(2) Using a vernier calipers, measure the free length of the valve spring.

Valve spring
[Standard]
Free height : 47.44mm (1.8677in.)
Out-of-square : 1.5°



If the free length is not as specified, replace the valve spring.

MLA

1. Inspect MLA.
Using a micrometer, measure the MLA outside diameter.

MLA O.D.
Intake/Exhaust :
31.964~31.980mm(1.2584 ~ 1.2590in.)

2. Using a caliper gauge, measure MLA tappet bore inner diameter of cylinder head.

Tappet bore I.D.
Intake/Exhaust :
32.000~32.025mm(1.2598 ~ 1.2608in.)

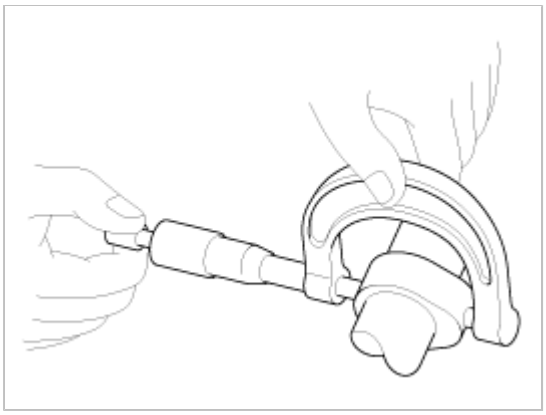
3. Subtract MLA outside diameter measurement from tappet bore inside diameter measurement.

MLA to tappet bore clearance
[Standard]
Intake/Exhaust : 0.020 ~ 0.061mm(0.0008 ~ 0.0024in.)
[Limit]
Intake/Exhaust : 0.07mm(0.0027in.)

Camshaft

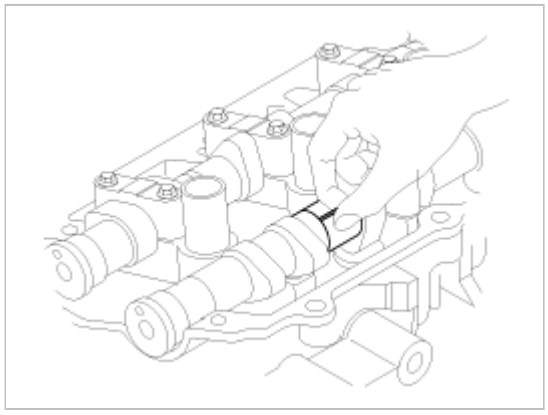
1. Inspect cam lobes.
   Using a micrometer, measure the cam lobe height.

Cam height
[Standard value]
Intake : 43.70 ~ 43.90mm (1.7204 ~ 1.7283in.)
Exhaust : 44.90 ~ 45.10mm (1.7677 ~ 1.7756in.)



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

2. Inspect 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.

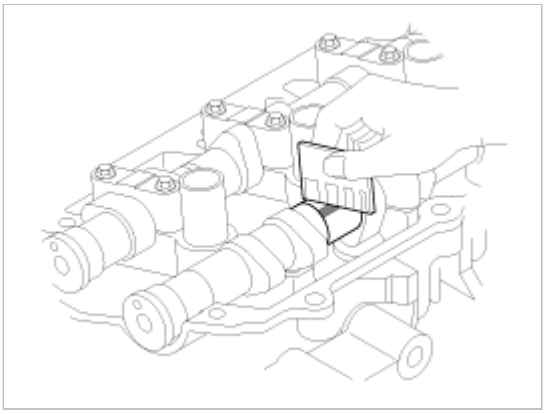
CAUTION

Do not turn the camshaft.

   (5) Remove the bearing caps.

(6) Measure the plastigage at its widest point.

Bearing oil clearance
[Standard value]
Intake
No.1 journal : 0.022 ~ 0.057mm (0.0008 ~ 0.0022in.)
No.2,3,4,5, journal : 0.045 ~ 0.082mm (0.0018 ~ 0.0032in.)
Exhaust
No.1 journal : 0 ~ 0.032mm (0 ~ 0.0012in.)
No.2,3,4,5, journal : 0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)
[Limit] :
Intake
No.1 journal : 0.09mm (0.0035in.)
No.2,3,4,5 journal : 0.12mm (0.0047in.)
Exhaust : 0.12mm (0.0047in.)



If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

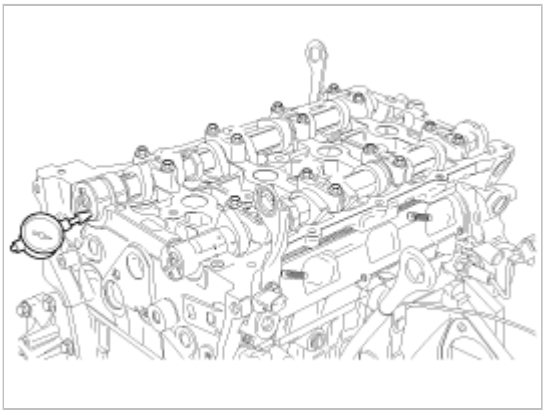
(7) Completely remove the plastigage.

(8) Remove the camshafts.

3. Inspect 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 value] : 0.04 ~ 0.16mm(0.0015 ~ 0.0062in.)
[Limit] : 0.20mm (0.0078in.)



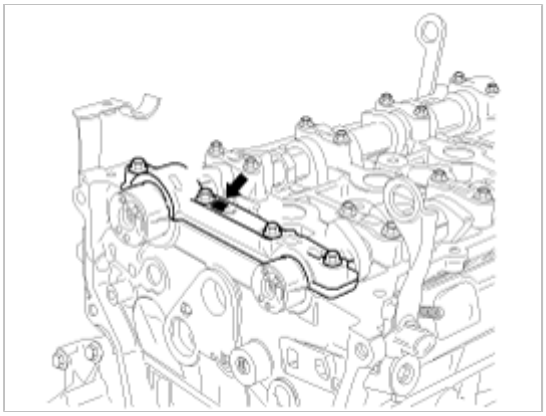
If the end play is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

(3) Remove the camshafts.

Exhaust Cam Shaft Bearing

1. Check the cylinder head bore mark.

Location Of Cylinder Head Bore Mark

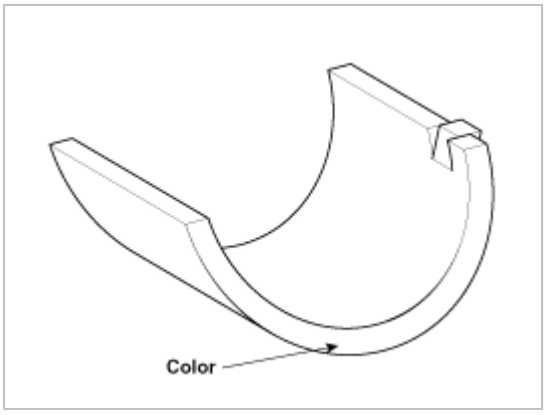


Discrimination Of Cylinder Head

Class	Mark	Exhaust No.1 Inside Diameter Of Cylinder Head Bore
a	A	40.000 ~ 40.008 mm (1.5748 ~ 1.5751 in.)
b	B	40.008 ~ 4.016 mm (1.5751 ~ 1.5754 in.)
c	C	40.016 ~ 40.024 mm (1.5754 ~ 1.5757 in.)

2. Select class of camshaft bearing same as class of cylinder head as shown on the table below.

Place Of Exhaust Cam Shaft Bearing Identification Mark



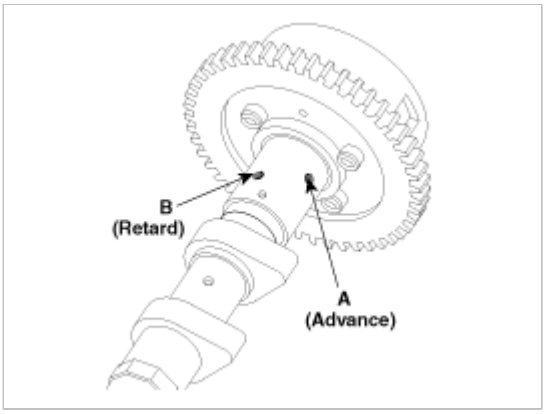
Discrimination Of Exhaust Camshaft Bearing

Cylinder Head Bore Class	Bearing Class For Installing (Color)	Thickness Of Bearing
a (A)	C (Green)	1.996~2.000mm (0.0785~0.0787in.)
b (B)	B (None color)	2.000~2.004mm (0.0787~0.0788in.)
c (C)	A (Black)	2.004~2.008mm (0.0788~0.0790in.)

Oil clearance : 0 ~ 0.032mm (0 ~ 0.0012in.)

CVVT Assembly

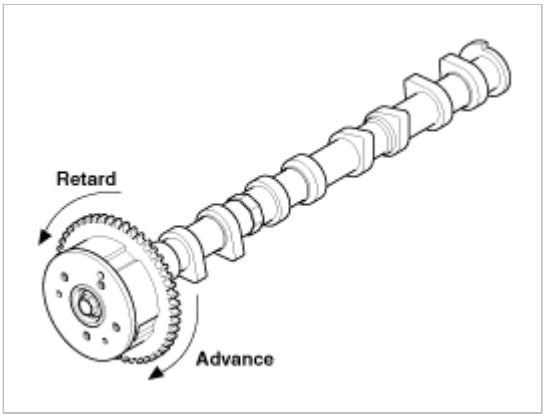
1. Inspect CVVT assembly.
   (1) Check that the CVVT assembly will not turn.
   (2) Apply vinyl tape to the retard hole except the one indicated by the arrow in the illustration.
   Verify the hold to tape and the hole to put air in.



   (3) Wind tape around the tip of the air gun and apply air of approx. 150kpa(1.5kgf/cm², 21psi) to the port of the camshaft.
   (Perform this in order to release the lock pin.)

> NOTE
>
> When the oil splashes, wipe it off with a shop rag and the likes.

   (4) With air applied, as in step(3), turn the CVVT assembly to the advance angle side (the arrow marked direction in the illustration) with your hand.
   Depending on the air pressure, the CVVT assembly will turn to the advance side without applying force by hand. Also, under the condition that the pressure can be hardly applied because of the air leakage from the port, there may be the case that the lock pin could be hardly released.



   (5) Turn the CVVT assembly back and forth and check the movable range and that there is no disturbance.

Standard:
Should move smoothly in a range from about
22.5° (Intake) / 20.0° (Exhaust)

   (6) Turn the CVVT assembly with your hand and lock it at the maximum delay angle position (counter clockwise).

Reassembly

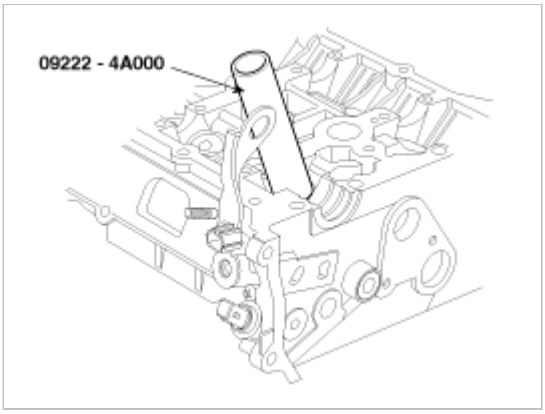
NOTE

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

1. Install valves.
   (1) Using SST(09222-4A000), push in a new oil seal.

   NOTE

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

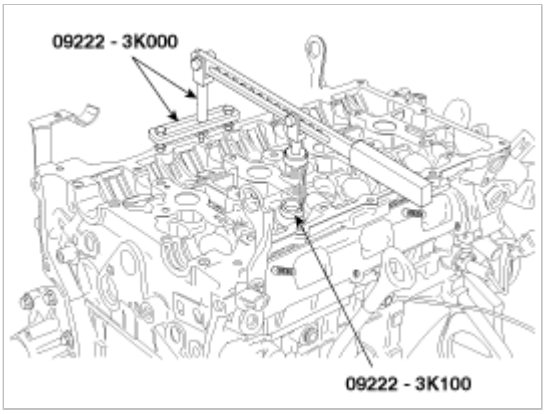
   

   (2) Install the valve, valve spring and spring retainer.

   NOTE

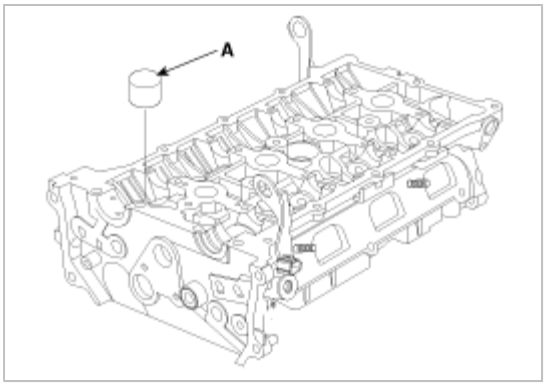
   Place valve springs so that the side coated with enamel faces toward the valve spring retainer and then installs the retainer.

   (3) 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.

   (4) 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.

2. Install MLAs.
   Check that the MLA rotates smoothly by hand.



NOTE

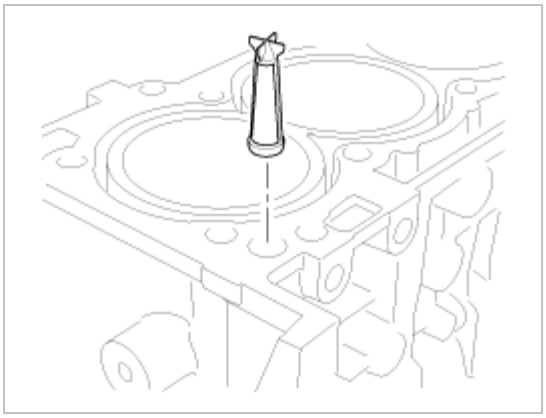
MLA can be reinstalled in its original position.

Installation

NOTE

- Thoroughly clean all parts to be assembled.
- Always use a new head and manifold gasket.
- 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 OCV filter.



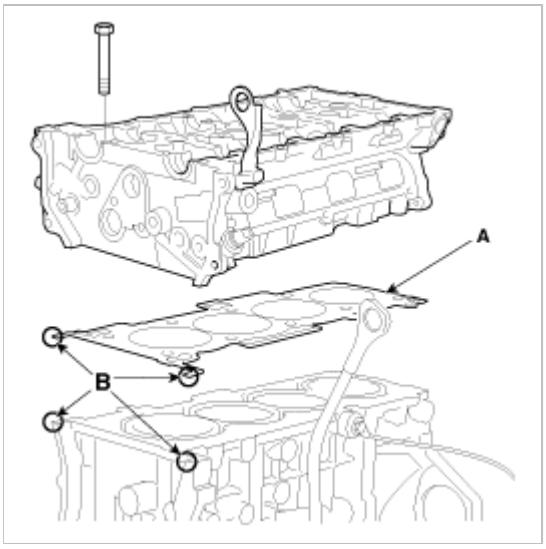
CAUTION

Keep the OCV filter clean.

2. Install the cylinder head gasket(A) on the cylinder block.

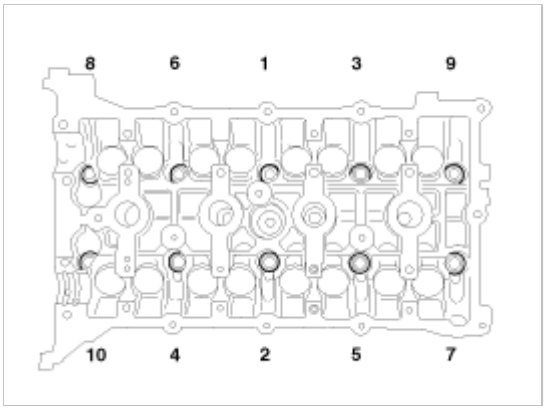
NOTE

- Be careful of the installation direction.
- Apply liquid gasket (Loctite 5900H) on the edge of cylinder head gasket upside and downside. (At the position 'B')
- After applying sealant, assemble the cylinder head in five minutes.



3. Place the cylinder head carefully in order not to damage the gasket with the bottom part of the end.
4. Install cylinder head bolts.
   A. Apply a light coat if engine oil on the threads and under the heads of the cylinder head bolts.
   B. Using hexagon wrench, install and tighten the 10 cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :
32.4~36.3Nm (3.3~3.7kgf.m, 23.9~26.8lb-ft) + (90~95°) + (90~95°)

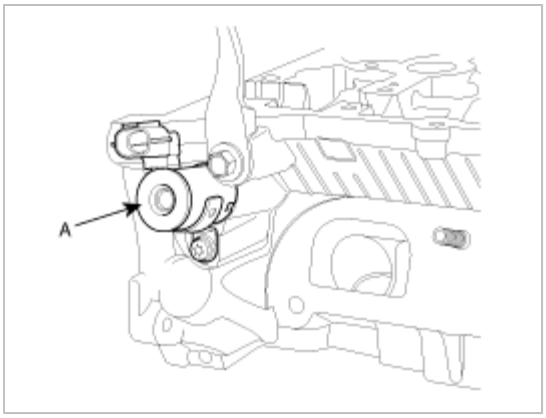


NOTE

Always use new cylinder head bolt.

5. Install the OCV(A).

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



CAUTION

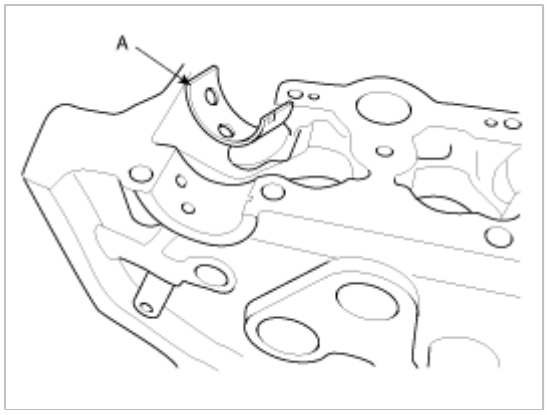
- Do not reuse the OCV when dropped.
- Keep the OCV filter clean.
- Do not hold the OCV sleeve during servicing.
- When the OCV is installed on the engine, do not move the engine with holding the OCV yoke.

6. Install the camshafts.

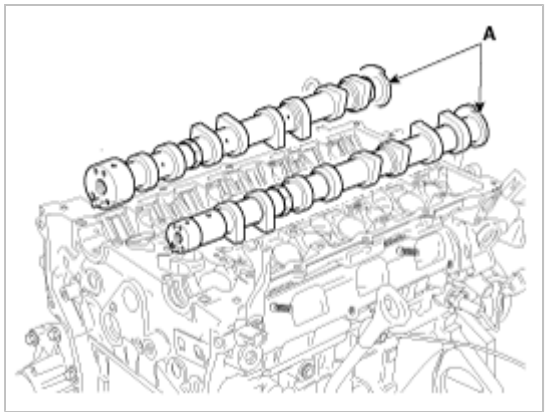
NOTE

Apply a light coat of engine oil on camshaft journals.

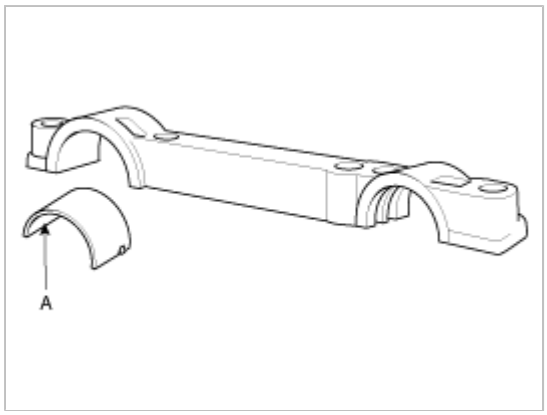
A. Install the exhaust camshaft lower bearing (A).



B. Install the camshafts (A).

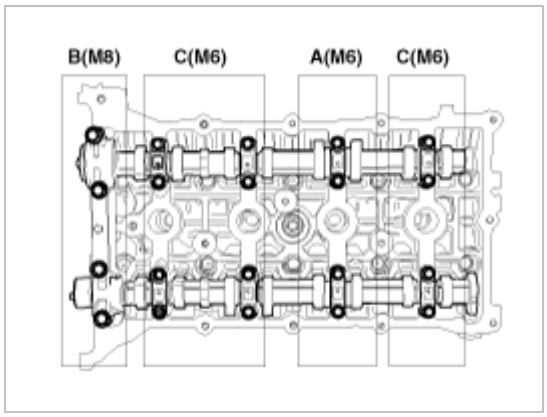


C. Install the exhaust camshaft upper bearing (A).



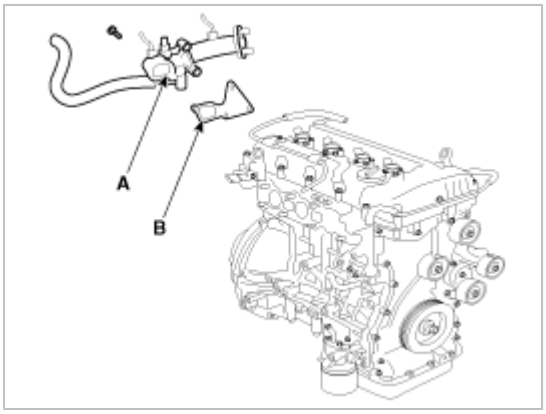
D. Install camshaft bearing caps in their proper locations.
Tightening order.
Group A → Group B → Group C.

Tightening torque
Step 1
M6 : 5.9N.m(0.6kgf.m, 4.3lb-ft)
M8 : 14.7N.m(1.5kgf.m, 10.8lb-ft)
Step 2
M6 : 10.8 ~ 12.7N.m(1.1 ~ 1.3kgf.m, 7.9 ~ 9.4lb-ft)
M8 : 27.5 ~ 31.4N.m(2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



7. Install the water temperature control assembly (A) with a new gasket (B).

Tightening torque :
Bolts : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)
Nut : 18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

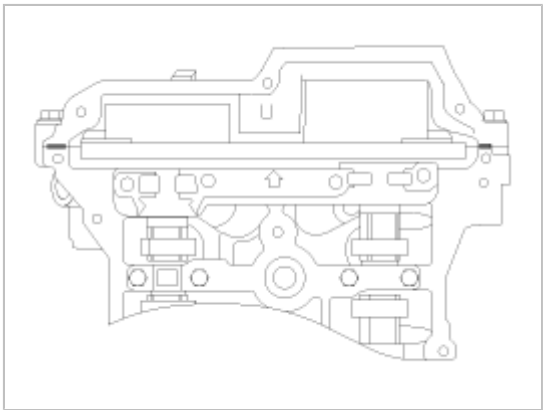


CAUTION

- Assemble water temp control assembly and water inlet pipe to water pump assembly before nuts for assembling of water inlet pipe to be tightened.
- Always use a new O-ring.

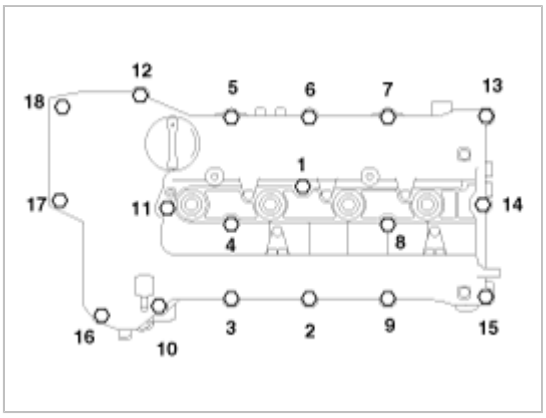
8. Install the timing chain.
9. Check and adjust valve clearance.
10. Install the cylinder head cover.
    A. The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
    B. After applying sealant, it should be assembled within 5 minutes.

Bead width : 2.5mm(0.1in.)
Sealant : LOCTITE 5900H



    C. The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.
    D. Install the cylinder head cover bolts as following method.

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

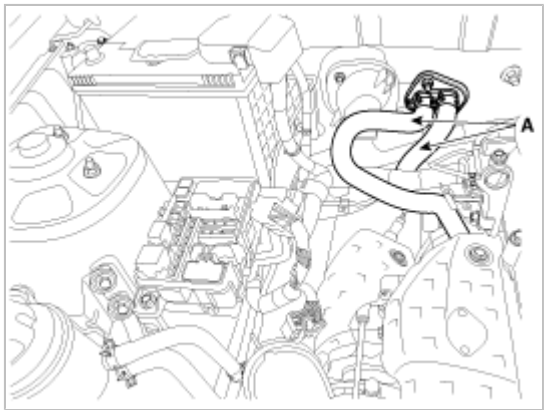


CAUTION

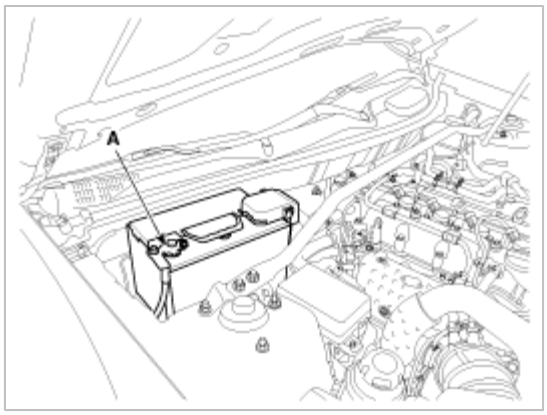
Do not reuse cylinder head cover gasket.

11. Install the intake & exhaust manifold. (Refer to Intake and exhaust system in this group)

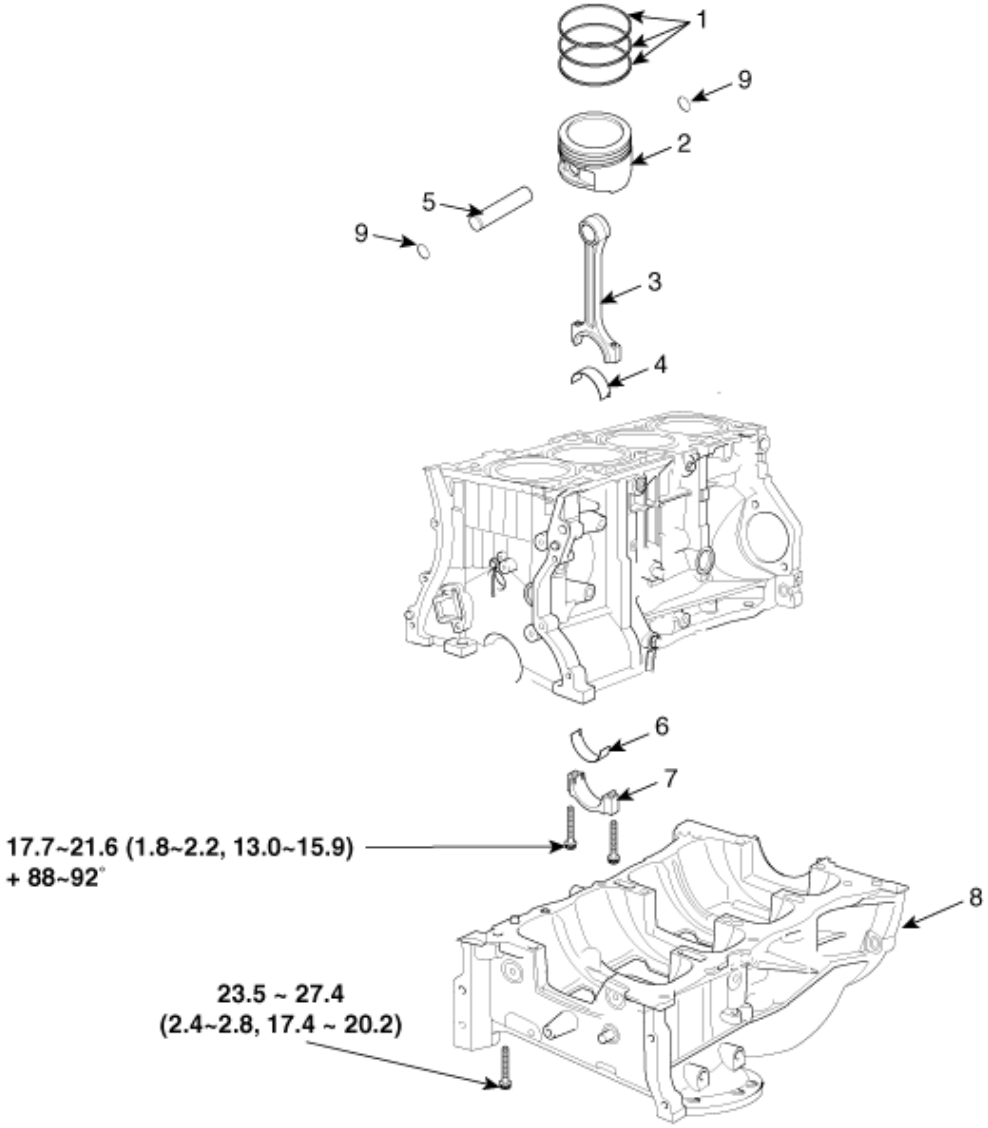
12. Install the heater hoses (A).



13. Connect the negative (-) battery terminal (A).

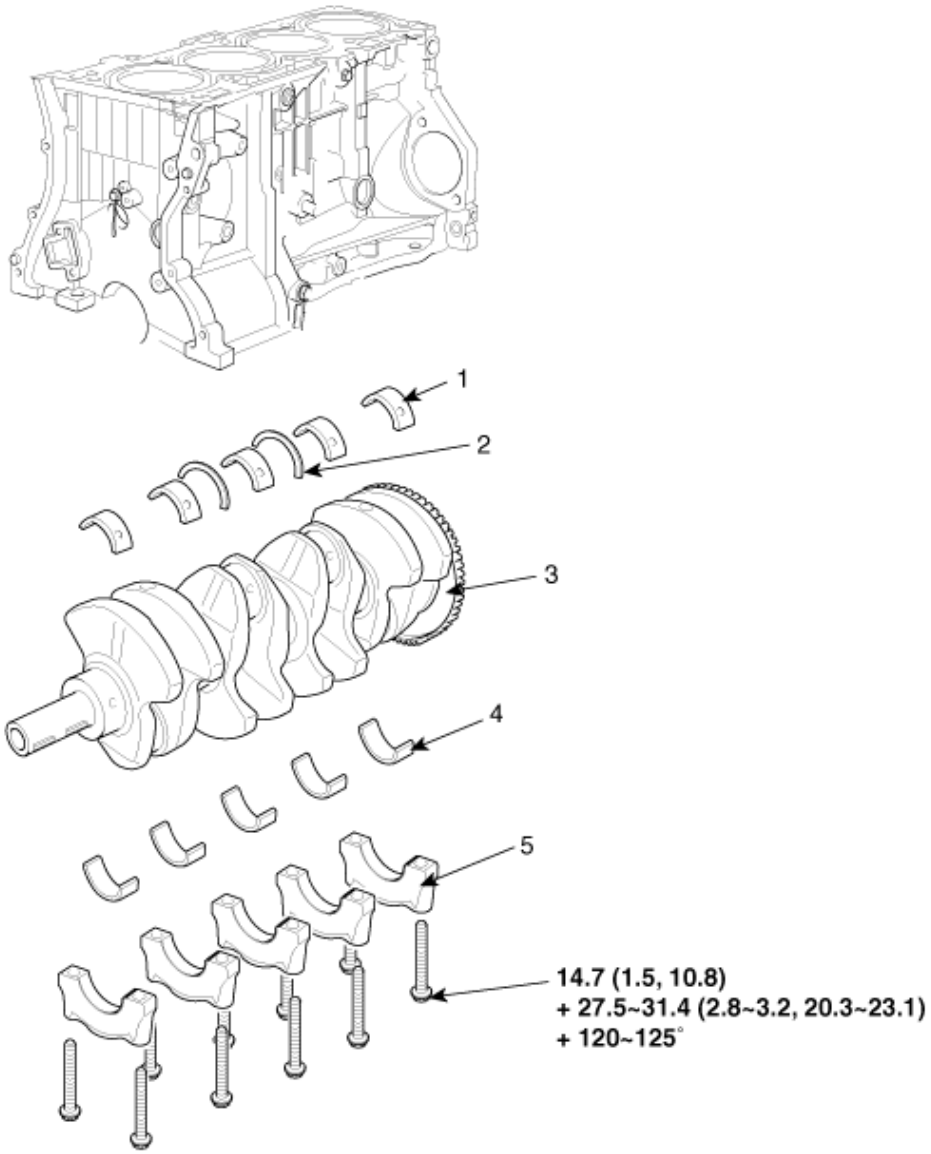


Components



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

1. Piston ring	5. Piston pin
2. Piston	6. Connecting rod lower bearing
3. Connecting rod	7. Connecting rod bearing cap
4. Connecting rod upper bearing	8. Ladder frame
	9. Snap ring

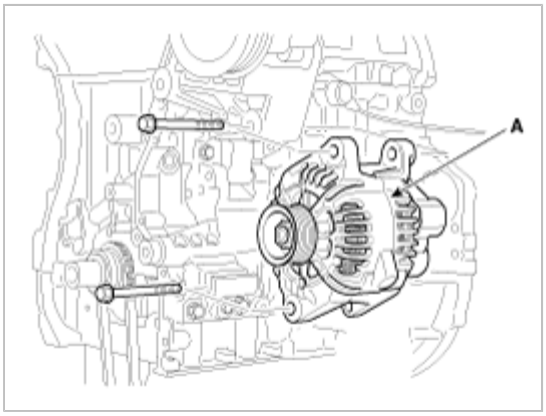


Torque : N.m (kgf.m, lb-ft)

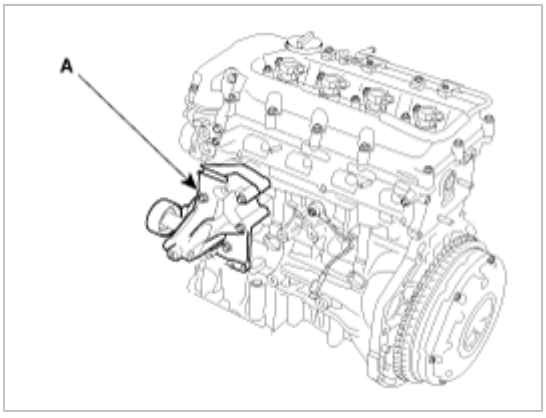
1. Crankshaft upper bearing 2. Thrust bearing 3. Crankshaft	4. Crankshaft lower bearing 5. Main bearing cap

Disassembly

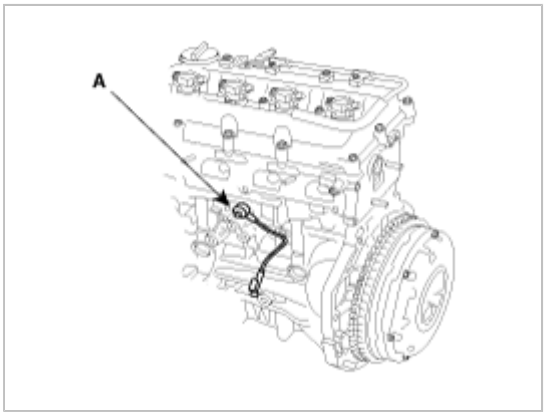
1. M/T : remove the flywheel.
2. A/T : remove the drive plate.
3. Install the engine to the engine stand for disassembly.
4. Remove the timing chain. (Refer to Timing system in this group)
5. Remove the cylinder head. (Refer to Cylinder block in this group)
6. Remove the alternator(A) from engine.



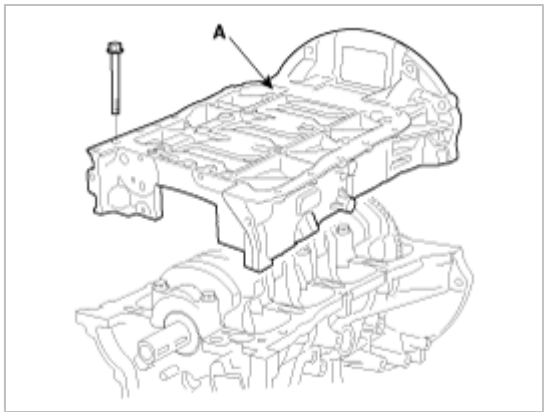
7. Remove the tensioner assembly integrated bracket(A).



8. Remove the knock sensor(A).



9. Remove the water pump.
10. Remove the oil pump.
11. Remove the ladder frame(A).

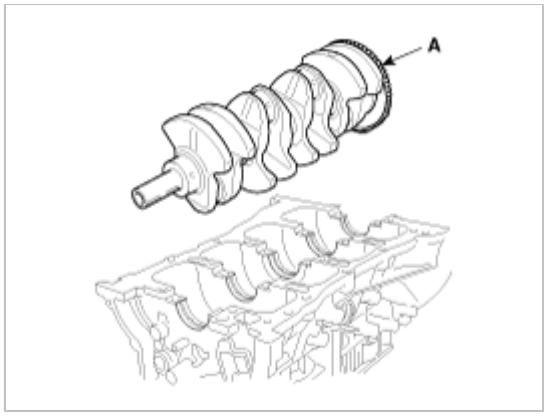


12. Check the connecting rod end play.
13. Remove the connecting rod caps and check oil clearance.
14. Remove the piston and the connecting rod assemblies.
    (1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
    (2) Push the piston, connecting rod assembly and upper bearing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

15. Remove the crankshaft bearing cap and check oil clearance.
16. Check the crankshaft end play.
17. 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.



18. 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.
19. Remove the piston rings.
    (1) Using a piston ring expender, remove the 2 compression rings.
    (2) Remove 2 side rails and the spacer by hand.

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

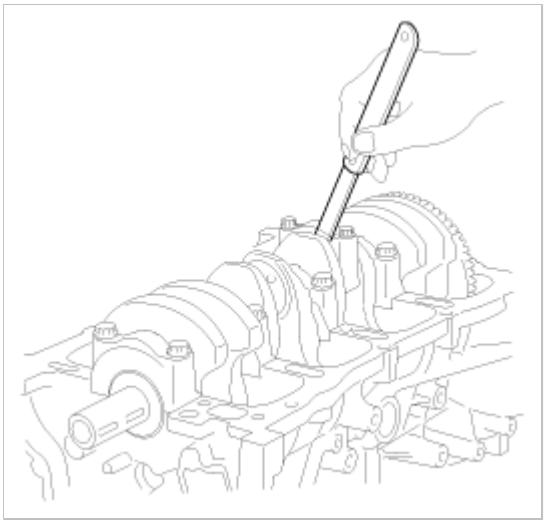
20. Disconnect the connecting rod from piston.

Inspection

Connecting Rod And Crankshaft

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

Standard end play : 0.1~ 0.25mm(0.004 ~ 0.010in.)
Maximum end play : 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 road bearing oil clearance.
   (1) Check the matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.
   (2) Remove 2 connecting rod cap bolts.
   (3) Remove the connecting rod cap and bearing half.
   (4) Clean the crank pin and bearing.
   (5) Place plastigage across the crank pin.
   (6) Reinstall the bearing half and cap, and torque the bolts.

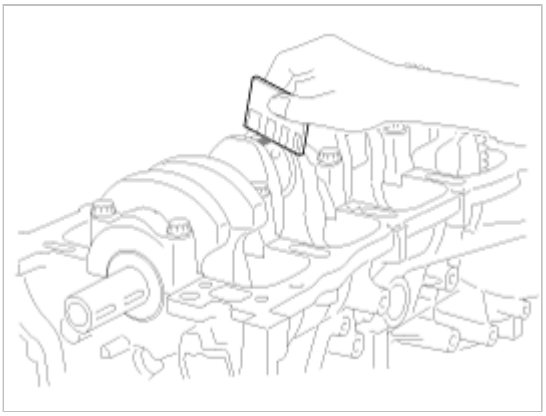
Tightening torque
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

NOTE

Do not turn the crankshaft.

   (7) Remove 2 bolts, connecting rod cap and bearing half.
   (8) Measure the plastigage at its widest point.

Standard oil clearance
0.025 ~ 0.043mm(0.0009 ~ 0.0016in.)



(9) If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

> **CAUTION**
>
> Do not file, shim, or 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 (the color listed above or below that one), and check clearance again.

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

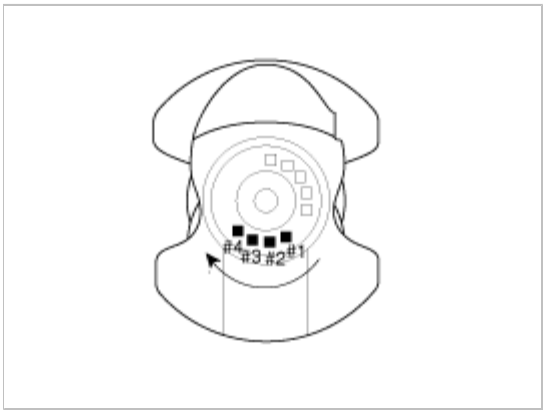
> **CAUTION**
>
> If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

Connecting Rod Mark Location

Discrimination Of Connecting Rod

Class	Mark	Inside Diameter
A	A	51.000 ~ 51.006mm (2.0079 ~ 2.0081in.)
B	B	51.006 ~ 51.012mm (2.0081 ~ 2.0083in.)
C	C	51.012 ~ 51.018mm (2.0083 ~ 2.0085in.)

Crankshaft Pin Mark Location Discrimination Of Crankshaft



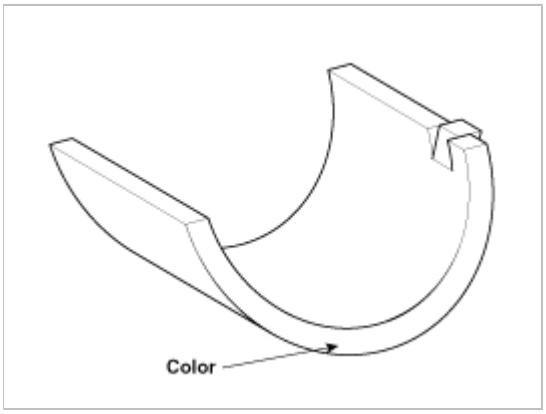
NOTE

Conform to read stamping order as shown arrow direction from #1.

Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Pin
I	1	47.966 ~ 47.972mm (1.8884 ~ 1.8886in.)
II	2	47.960 ~ 47.966mm (1.8881 ~ 1.8884in.)
III	3	47.954 ~ 47.960mm (1.8879 ~ 1.8881in.)

Place Of Identification Mark (Connecting Rod Bearing) Discrimination Of Connecting Rod Bearing



Discrimination Of Connecting Rod Bearing

Class	Mark	Thickness Of Bearing
AA	Blue	1.517 ~ 1.520mm (0.0597 ~ 0.0598in.)
A	Black	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
B	None	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
		1.508 ~ 1.511mm

C	Green	(0.0594 ~ 0.0595in.)
D	Yellow	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)

(11) Selection

Crankshaft Indentification Mark	Connecting Rod Identification Mark	Assembing Classification Of Bearing
I (1)	a (A)	D (Yellow)
	b (B)	C (Green)
	c (C)	B (None)
II (2)	a (A)	C (Green)
	b (B)	B (None)
	c (C)	A (Black)
III (3)	a (A)	B (None)
	b (B)	A (Black)
	c (C)	AA (Blue)

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

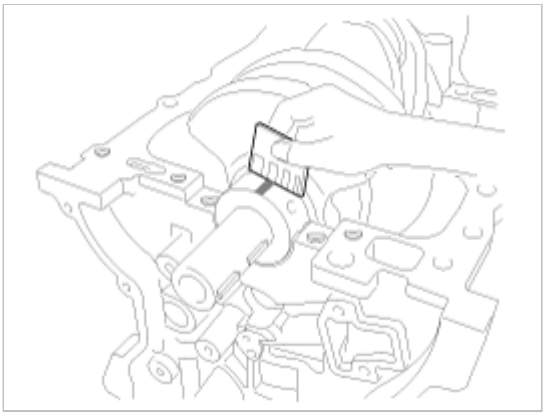
Tightening torque
14.7Nm (1.5kgf.m, 10.8lb-ft) + 27.5~31.4Nm (2.8~3.2kgf.m, 20.3~23.1lb-ft) + 120~125°

NOTE

Do not turn the crankshaft.

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

Standard oil clearance
0.020 ~ 0.038mm (0.0008 ~ 0.0015in.)



(6) If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

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

(7) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing (the color listed above or below that one), and check clearance again.

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

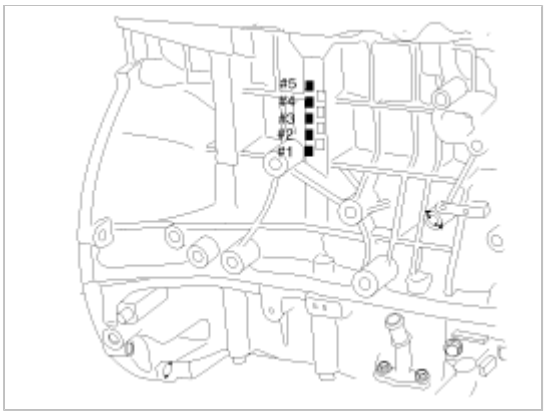
> CAUTION
>
> If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

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 (0.0020 in./3.94 in.) or less
Allowable twist of connecting rod :
0.1mm / 100mm (0.0039 in./3.94 in.) or less

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

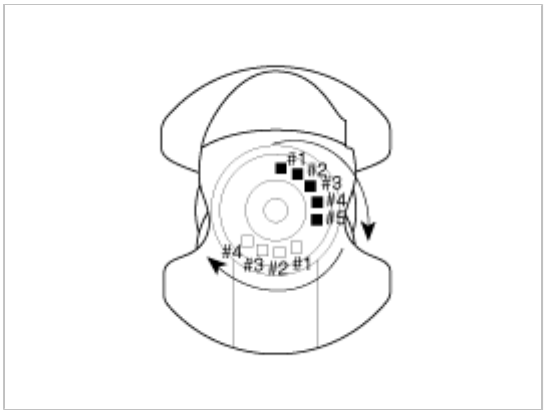


Discrimination Of Cylinder Block

Calss	Mark	Inside Diameter
a	A	56.000 ~ 56.006mm

		(2.2047 ~ 2.2049in.)
b	B	56.006 ~ 56.012mm (2.2049 ~ 2.2052in.)
c	C	56.012 ~ 56.018mm (2.2052 ~ 2.2054in.)

Crankshaft Journal Mark Location Discrimination Of Crankshaft



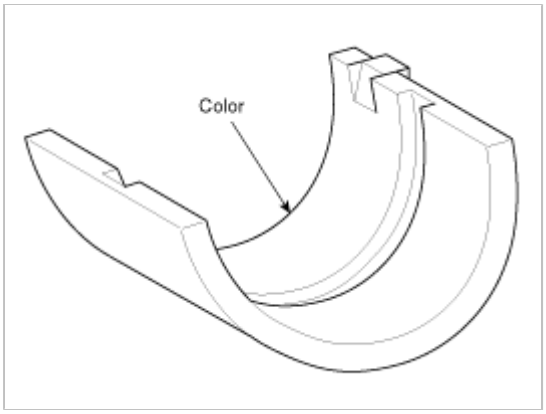
NOTE

Conform to read stamping order as shown arrow direction from #1.

Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Journal
I	1	51.954 ~ 51.960mm (2.0454 ~ 2.0456in.)
II	2	51.948 ~ 51.954mm (2.0452 ~ 2.0454.)
III	3	51.942 ~ 51.948mm (2.0449 ~ 2.0452in.)

Place Of Identification Mark (Crankshaft Bearing) Discrimination Of Crankshaft Bearing



Discrimination Of Crankshaft Bearing

Class	Mark	Thickness Of Bearing
AA	Blue	2.026 ~ 2.029mm (0.0797 ~ 0.0798in.)

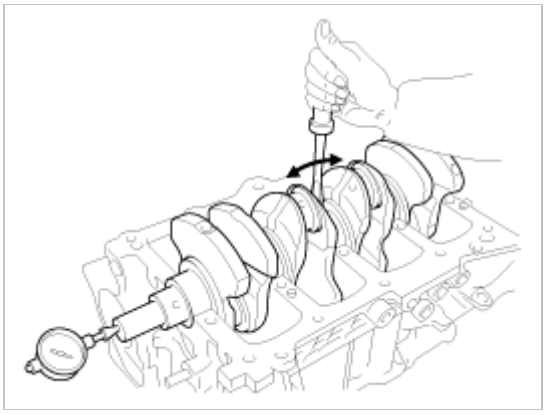
A	Black	2.023 ~ 2.026mm (0.0796 ~ 0.0797in.)
B	None	2.020 ~ 2.023mm (0.0795 ~ 0.0796in.)
C	Green	2.017 ~ 2.020mm (0.0794 ~ 0.795in.)
D	Yellow	2.014 ~ 2.017mm (0.0793 ~ 0.0794in.)

Selection

Crankshaft Identification Mark	Crankshaft Bore Identification Mark	Assembling Classification Of Bearing
I (1)	a (A)	D (Yellow)
	b (B)	C (Green)
	c (C)	B (None)
II (2)	a (A)	C (Green)
	b (B)	B (None)
	c (C)	A (Black)
III (3)	a (A)	B (None)
	b (B)	A (Black)
	c (C)	AA (Blue)

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

Standard end play
0.07 ~ 0.25mm (0.0027 ~ 0.0098in.)
Limit : 0.30mm (0.0118in.)

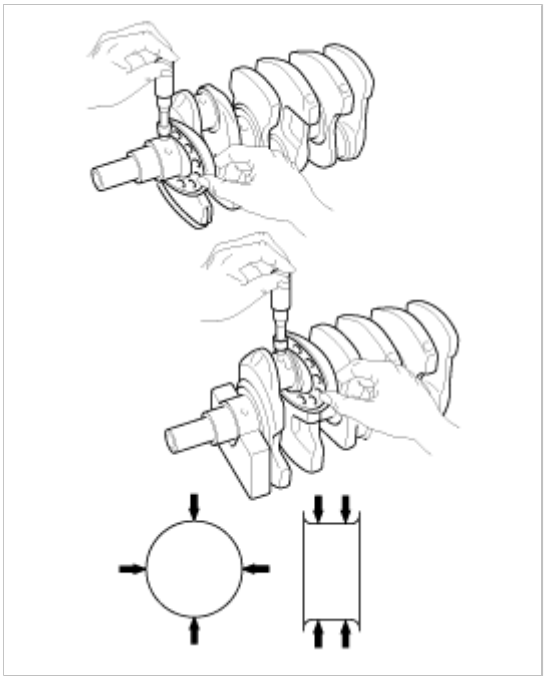


If the end play is greater than maximum, replace the thrust bearings as a set.

Thrust bearing thickness
1.925 ~ 1.965mm(0.0758 ~ 0.07736in.)

5. Inspect main journals and crank pins
   Using a micrometer, measure the diameter of each main journal and crank pin.

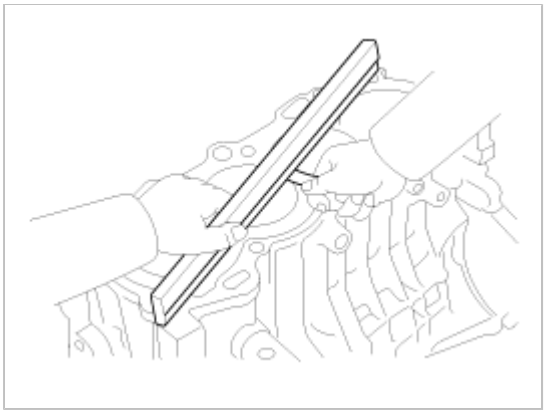
Main journal diameter :
51.942 ~ 51.960mm (2.0449 ~ 2.0456in.)
Crank pin diameter :
47.954 ~ 47.972mm (1.8879 ~ 1.8886in.)



Cylinder Block

1. Remove gasket material.
   Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
2. Clean cylinder block
   Using a soft brush and solvent, thoroughly clean the cylinder block.
3. Inspect 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.

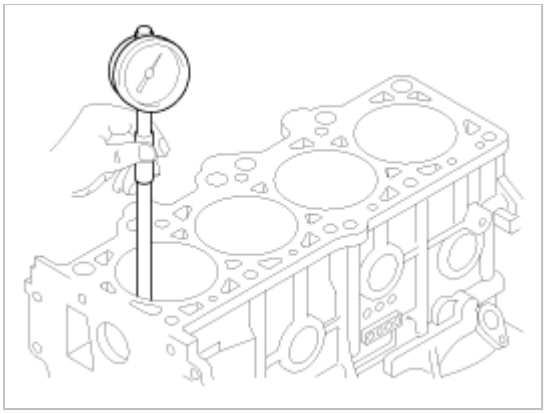
Flatness of cylinder block gasket surface
Standard : Less than 0.05mm(0.0020 in.)



4. Inspect cylinder bore diameter
   Visually check the cylinder for vertical scratchs.
   If deep scratches are present, replace the cylinder block.

5. Inspect cylinder bore diameter
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

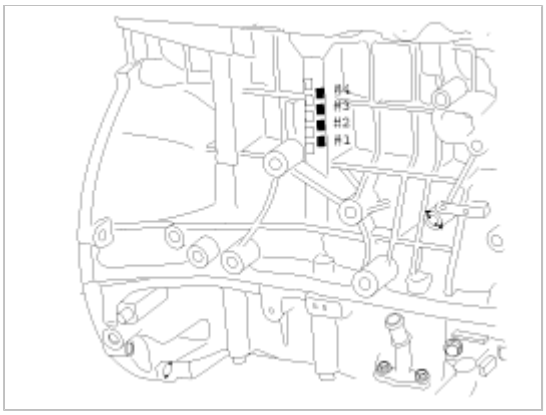
Standard diameter
86.00 ~ 86.03mm (3.3858 ~ 3.3870in.)



NOTE

Measure position(from the bottom of the cylinder block)
: 110.7mm(4.3582in.) / 160mm (6.2992in.) / 210mm (8.2677in.)

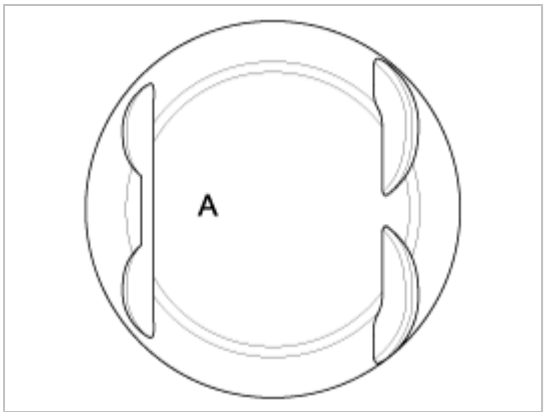
6. Check the cylinder bore size code on the cylinder block.



Cylinder Bore Inner Diameter

Size Code	Inner Diameter
A	86.00 ~ 86.01mm (3.3853 ~ 3.3862in.)
B	86.01 ~ 86.02mm (3.3862 ~ 3.3866in.)
C	86.02 ~ 86.03mm (3.3866 ~ 3.3870in.)

7. Check the piston size code on the piston top face.



NOTE

Stamp the grade mark of basic diameter with rubber stamp.

Piston Outer Diameter

Size Code	Outer Diameter
A	85.975 ~ 85.985mm (3.3848 ~ 3.3852in.)
B	85.985 ~ 85.995mm (3.3852 ~ 3.3856in.)
C	85.995 ~ 86.005mm (3.3856 ~ 3.3860in.)

8. Select the piston related to cylinder bore class.

Clearance : 0.015 ~ 0.035mm (0.00059 ~ 0.00137in.)

Piston And Rings

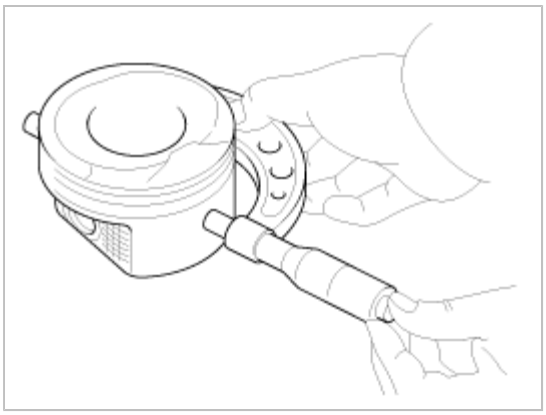
1. Clean piston
   (1) Using a gasket scraper, remove the carbon from the piston top.
   (2) Using a groove cleaning tool or broken ring, clean the piston ring grooves.
   (3) Using solvent and a brush, thoroughly clean the piston.

   NOTE

   Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 14 mm (0.55 in.) from the top land of the piston.

Standard diameter
85.975 ~ 86.005mm (3.3848 ~ 3.3860in.)

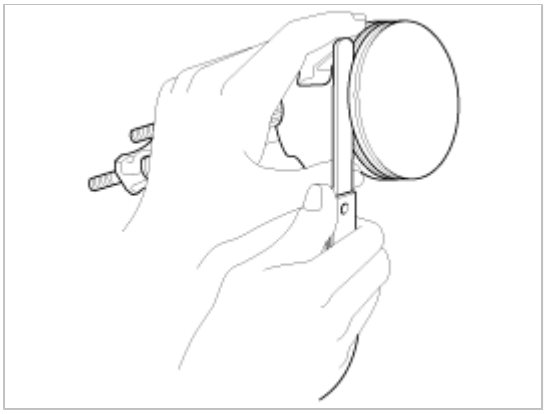


3. Calculate the difference between the cylinder bore diameter and the piston diameter.

Piston-to-cylinder clearance
0.015 ~ 0.035mm(0.00059 ~ 0.00137in.)

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

Piston ring side clearance
Standard
No.1 : 0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)
No.2 : 0.04 ~ 0.08mm (0.0015 ~ 0.0031in.)
Oil ring : 0.06 ~ 0.15mm (0.0023 ~ 0.0059in.)
Limit
No.1 : 0.1mm (0.004in.)
No.2 : 0.1mm (0.004in.)
Oil ring : 0.2mm (0.008in.)

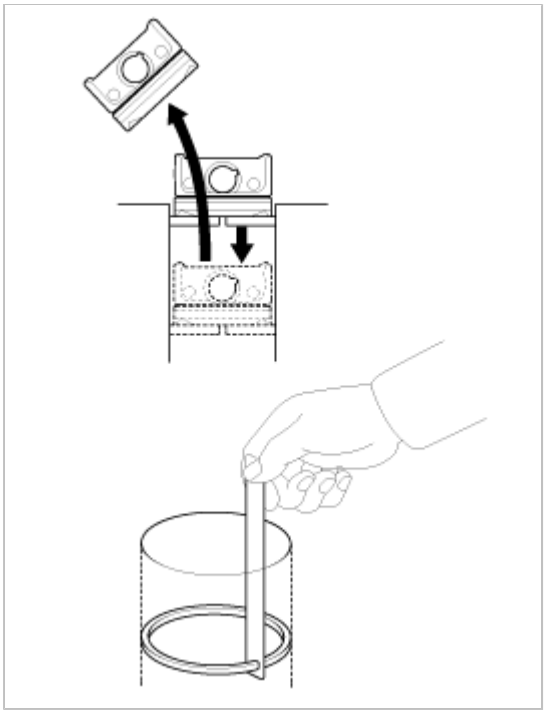


If the clearance is greater than maximum, replace the piston.

5. Inspect 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 ring. If the gap is too large, recheck the cylinder bore diameter against the wear limits, If the bore is over the service limit, the cylinder block must be rebored.

Piston ring end gap
Standard
No.1 : 0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)
No.2 : 0.37 ~ 0.52m (0.0145 ~ 0.0204in.)
Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0275in.)

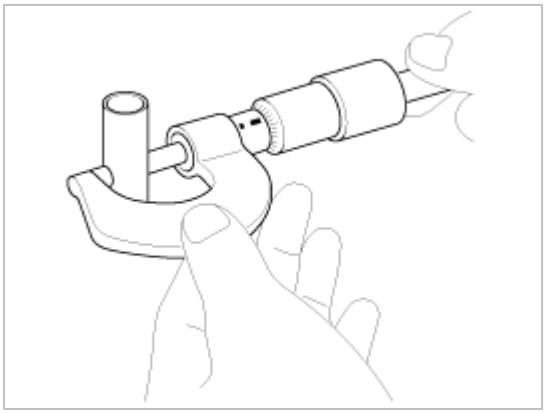
Limit
No.1 : 0.6mm (0.0236in.)
No.2 : 0.7mm (0.0275in.)
Oil ring : 0.8mm (0.0315in.)



Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter
21.997 ~ 22.000mm (0.8660 ~ 0.8661in.)

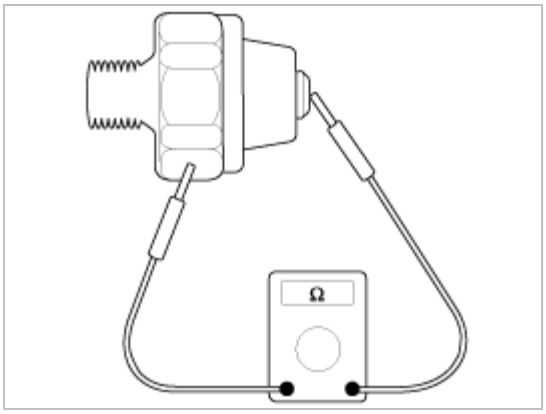


2. Measure the piston pin-to-piston clearance.

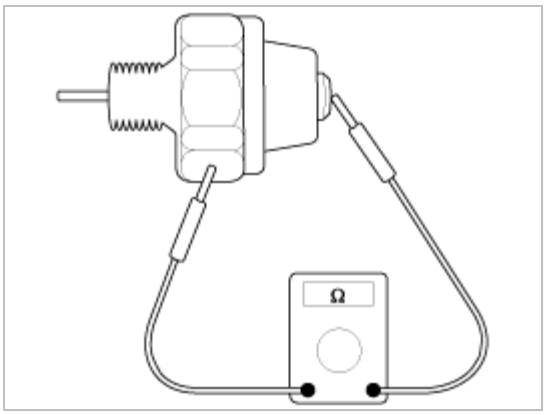
Piston pin-to-piston clearance
0.003 ~ 0.010mm (0.00011 ~ 0.00039in.)

Oil Pressure Switch

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.



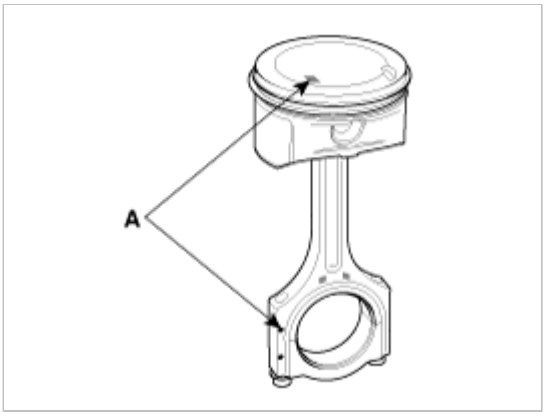
3. If there is no continuity when a 50kpa (7psi) is applied throgh the oil hole, the switch is operaing properly. Check for air leakage. If air leaks, the diaphragm is broken. Replace it.

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) The piston front mark and the connecting rod front mark must face the timing belt side of the engine.



   (2) Before pressing the piston pin, apply a coat of lubricant oil to the piston pin outer and connecting rod.

CAUTION

- Apply heat to the piston (70°C) and then install the piston pin.
- Take care that piston pin is not to be damaged during pressing process.

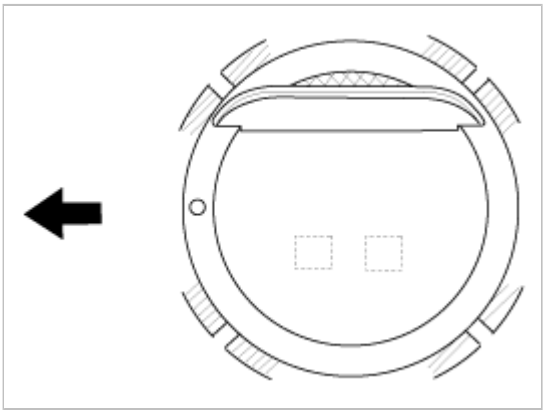
- When replace the piston pin, check the piston pin outer diameter and connecting rod small end inner diameter as below.

Piston pin outer DIA. :
21.997mm ~ 22.000mm (0.8660 ~ 0.8661 in)
Connecting rod S/END inner DIA. :
22.005mm ~ 22.011mm (0.8663 ~ 0.8665 in)

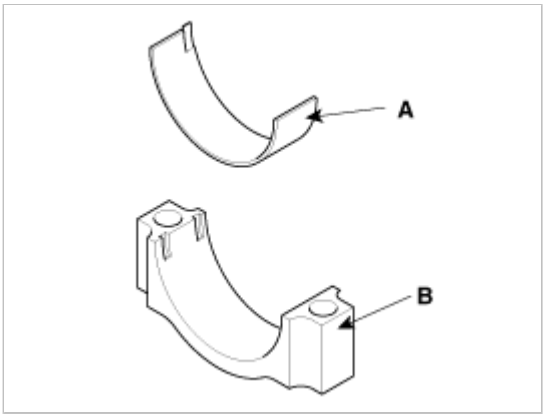
- Take care that piston is not to be damaged during installing process. When replace the piston pin, check the gap as below.

Connecting rod bushing gap :
0.005mm ~ 0.014mm (0.00019 ~ 0.00055 in)
Piston pin BOSS gap :
0.003mm ~ 0.010mm (0.00012 ~ 0.00039 in) - Heat to 70°C

2. Install the piston rings.
   (1) Install the oil ring spacer 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.



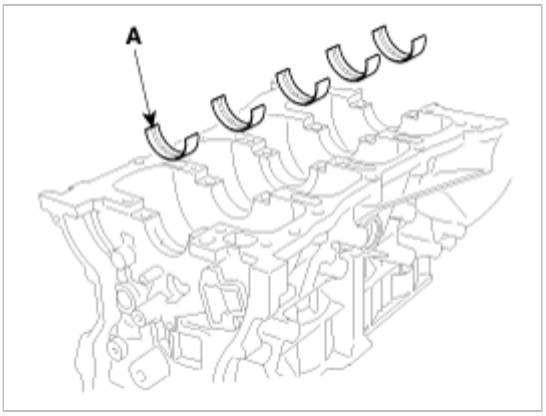
3. Install the connecting rod bearings.
   (1) Align the bearing claw with the groove of the connecting rod or connecting rod cap.
   (2) Install the bearings(A) in the connecting rod and connecting rod cap(B).



4. Install the main bearings.

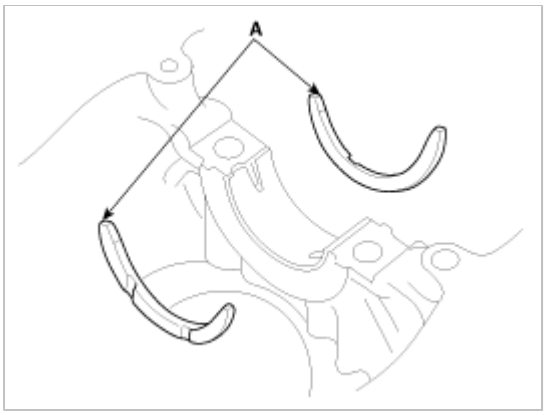
> NOTE
>
> Upper bearings have an oil groove of oil holes; Lower bearings do not.

(1) Align the bearing claw with the claw groove of the cylinder block, push in the 5 upper bearings(A).

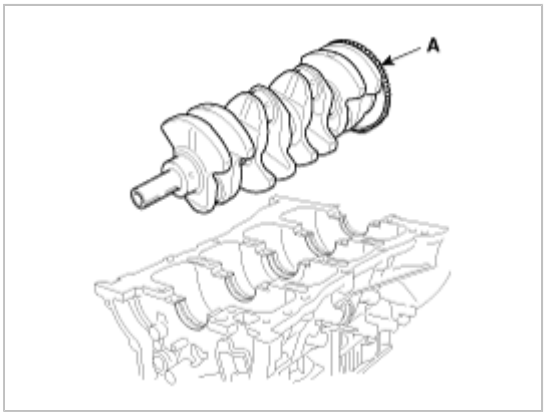


(2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

5. Install the thrust bearings.
Install the 2 thrust bearings(A) under the No.3 journal position of the cylinder block with the oil grooves facing outward.



6. Place the crankshaft(A) on the cylinder block.



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

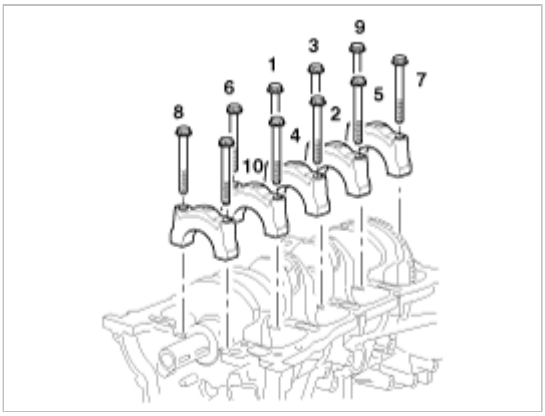
Tightening torque
14.7Nm (1.5kgf.m, 10.8lb-ft) + 27.5~31.4Nm (2.8~3.2kgf.m, 20.3~23.1lb-ft) + 120~125°

NOTE

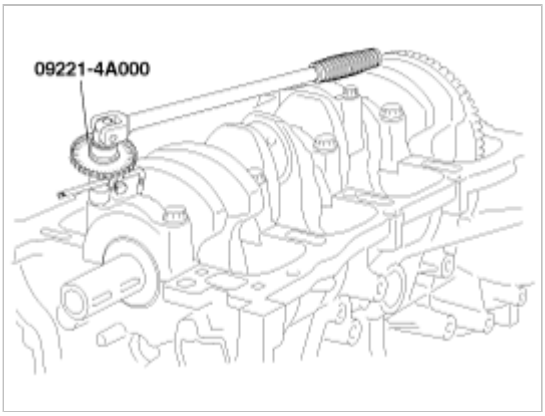
- The main bearing cap bolts are tightened in 2 progressive steps.
- If any of the bearing cap bolts in broken or deformed, replace it.

(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(A), in several passes, in the sequence shown.



(3) Retighten the bearing cap bolts by 120° in the numerical order shown. (Using the SST (09221-4A000))



(4) Check that the crankshaft turns smoothly.

9. Check crankshaft end play.

10. Install the piston and connecting rod assemblies.

NOTE

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

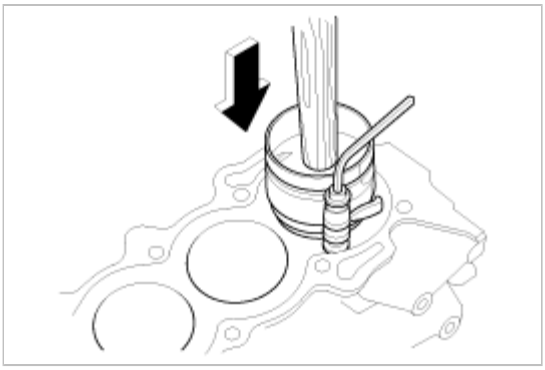
(1) Remove the connecting rod caps, and slip short sections of rubber hose over the threaded ends of the connecting rod bolts.

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

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

NOTE

Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.

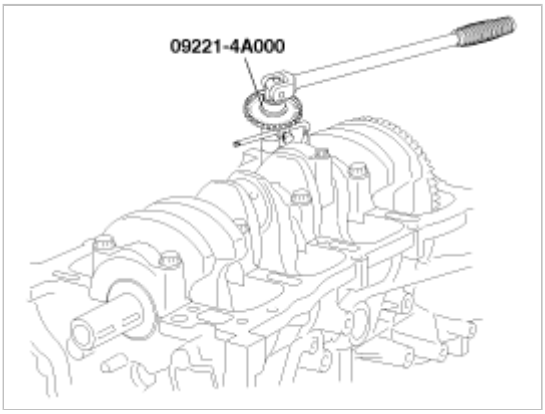


(4) Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

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

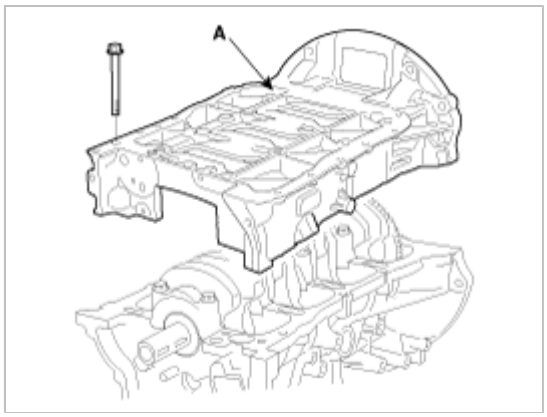
NOTE

Always use new connecting rod bolt.



11. Install the ladder frame (A).

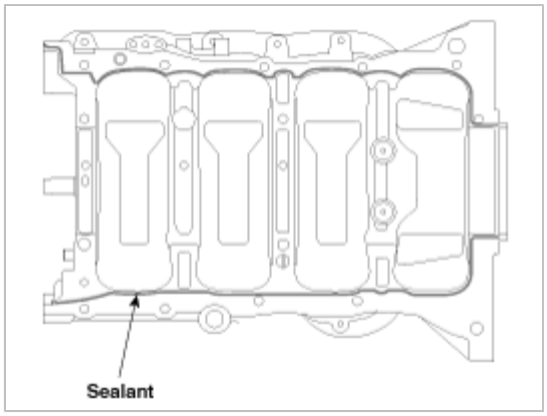
Tightening torque :
23.5 ~ 27.5N.m(2.4 ~ 2.8kgf.m, 17.4 ~ 20.2lb-ft)



NOTE

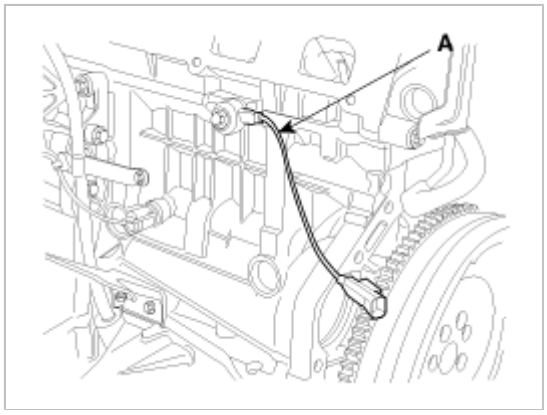
- Before assembling ladder frame, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied ladder frame.

- The part must be assembled within 5 minutes after sealant was applied.
- Apply sealant to the inner threads of the bolt holes.



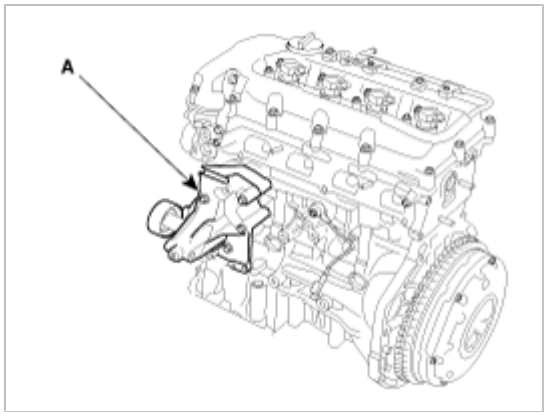
12. Install the rear oil seal.
    (1) Apply engine oil to a new oil seal lip.
    (2) Using SST (09231-H1100, 09214-3K100) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
13. Install the oil pump.
14. Install the water pump.
15. Install the knock sensor(A).

Tightening torque
16.7 ~ 25.5N.m (1.7 ~ 2.6kgf.m, 12.3 ~ 18.8lb-ft)



16. Install the tensioner assembly integrated bracket(A).

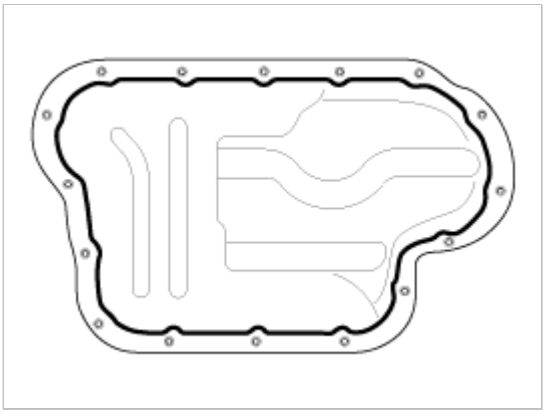
Tightening torque
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)



17. Install the power steering pump bracket and power steering pump.
18. Install the alternator.
19. Install the A/C compressor.
20. Install the cylinder head.
21. Install the timing chain.
22. Install the oil pan.
    (1) Using a razor blade and gasket scraper, remove all the old gasket material from the gasket surfaces.

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

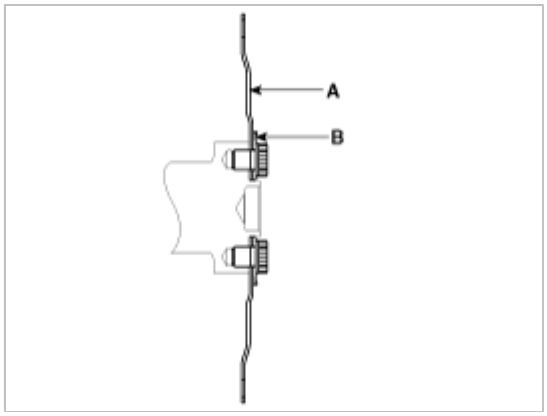
    (2) Apply liquid gasket as an even bead, centered between the edges of the mating surface.
    Use liquid gasket LOCTITE5900H or THREEBOND 1217H equivalent (MS721-40).



> **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.

23. Remove the engine stand.
24. A/T : Install the drive plate (A) with washer (B).

Tightening torque
117.7 ~ 127.5N.m (12 ~ 13kgf.m, 86.8 ~ 94.0lb-ft)



25. M/T : Install the flywheel.

Tightening torque
117.7 ~ 127.5N.m (12 ~ 13kgf.m, 86.8 ~ 94.0lb-ft)

NOTE

- Always use new flywheel(drive plate) bolts.

Engine Coolant 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.
3. Loosen the drain plug, 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

Pressure can blow water back out the radiator cap-pour water slowly while intermittently squeezing the radiator hoses.

7. After warming up the engine until the cooling fan operates several times, accelerate it at idle.
8. Wait until the engine is cool.
9. Repeat the step 1 to 8 until the drained water is clean.
10. Fill fluid mixture with coolant and water(5 : 5) (Tropical region – 4:6) 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 35% minimum.
  Coolant concentrations less than 35% 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.

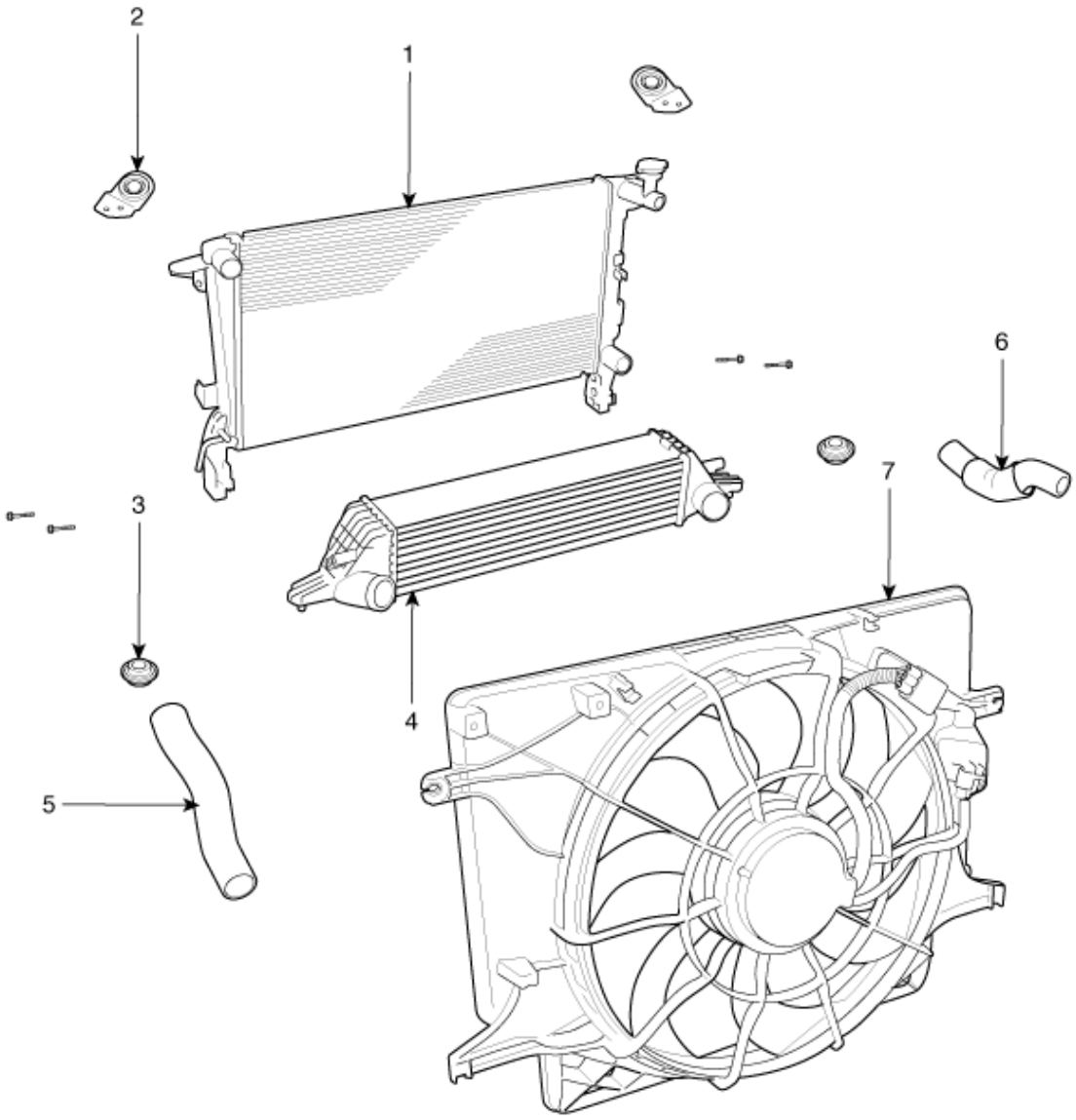
11. Start the engine and run coolant circulates.
    When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
12. Repeat 11 until the cooling fan 3 ~ 5times and bleed air sufficiently out of the cooling system.
13. Install the radiator cap and fill the reservoir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

NOTE

As it is to bleed air out to the cooling system and refill coolant when coolant gets cool completely, recheck the coolant level in the reservoir tank for 2 ~ 3 days after replacing coolant.

Coolant capacity : 5.5 L

Components

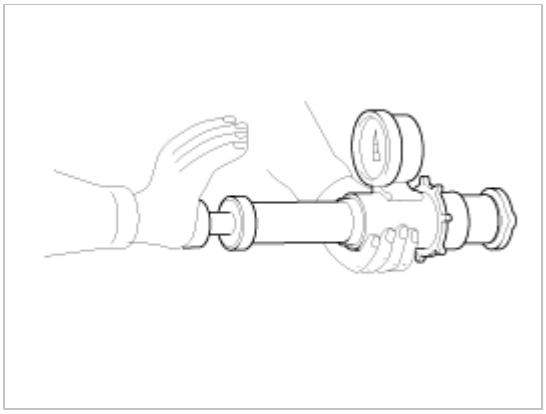


1. Radiator assembly	5. Radiator upper hose
2. Radiator mounting bracket	6. Radiator lower hose
3. Mounting insulator	7. Cooling fan assembly
4. Intercooler	

Inspection

Radiator Cap Test

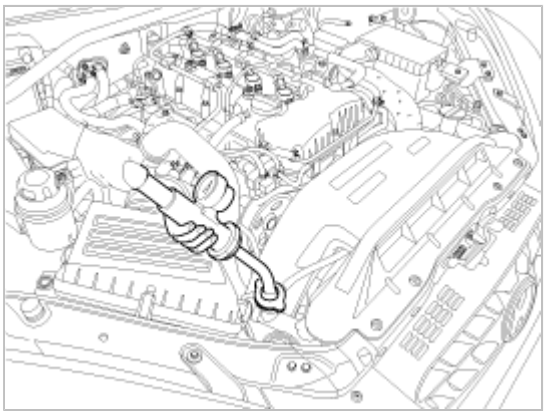
1. Remove the radiator cap, wet its seal with engine coolant, then install it no pressure tester.



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 it on the pressure tester.

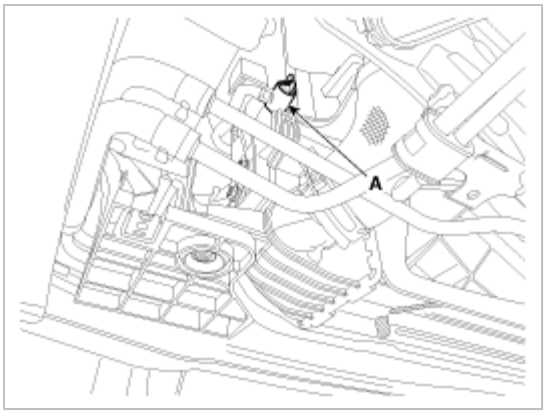


2. Apply a pressure tester to the radiator and apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm² 14 ~18 psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. Remove the tester and reinstall the radiator cap.

> NOTE
>
> Check for engine oil in the coolant and/or coolant in the engine oil.

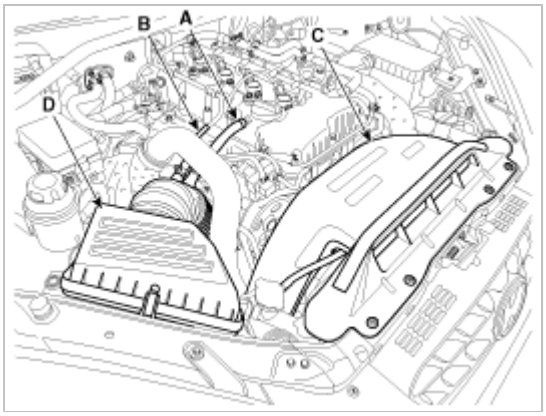
Removal

1. Remove the drain plug and drain the engine coolant.

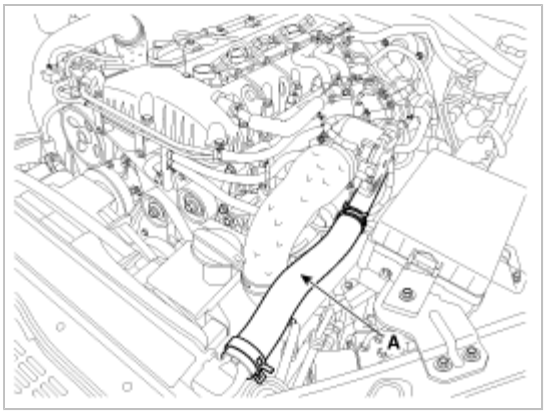


2. Disconnect the breather hose (A), vacuum hose (B) and remove the air duct (C), air cleaner assembly (D).

Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.9 ~ 1.1kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.1 ~ 3.6lb-ft)

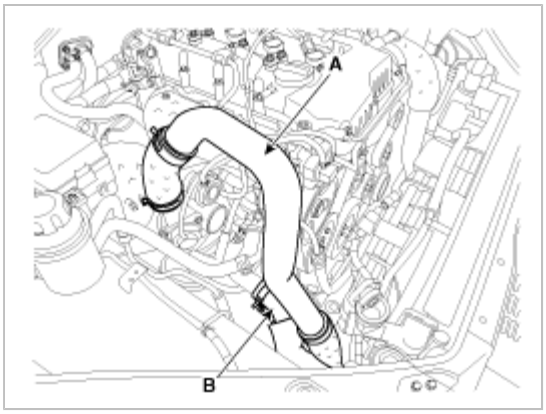


3. Remove the radiator upper hose (A).

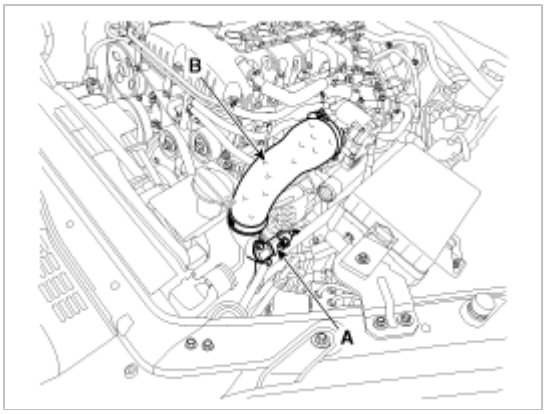


4. Disconnect the intercooler inlet hose (A), radiator lower hose (B).

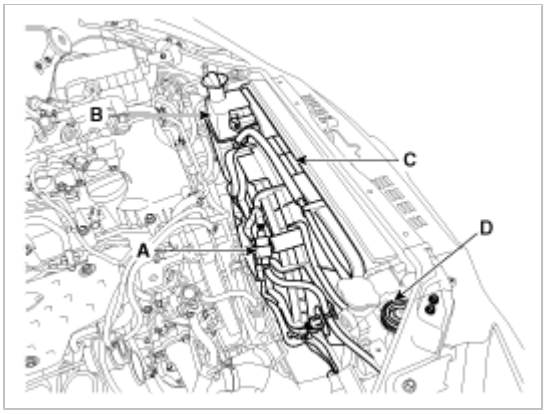
Tightening torque :
Bolt : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)
Clamp : 4.9~ 6.8N.m (0.5 ~ 0.7kgf.m, 3.6 ~ 5.0lb-ft)



5. Disconnect the BPS connector (A) and intercooler outlet hose (B).

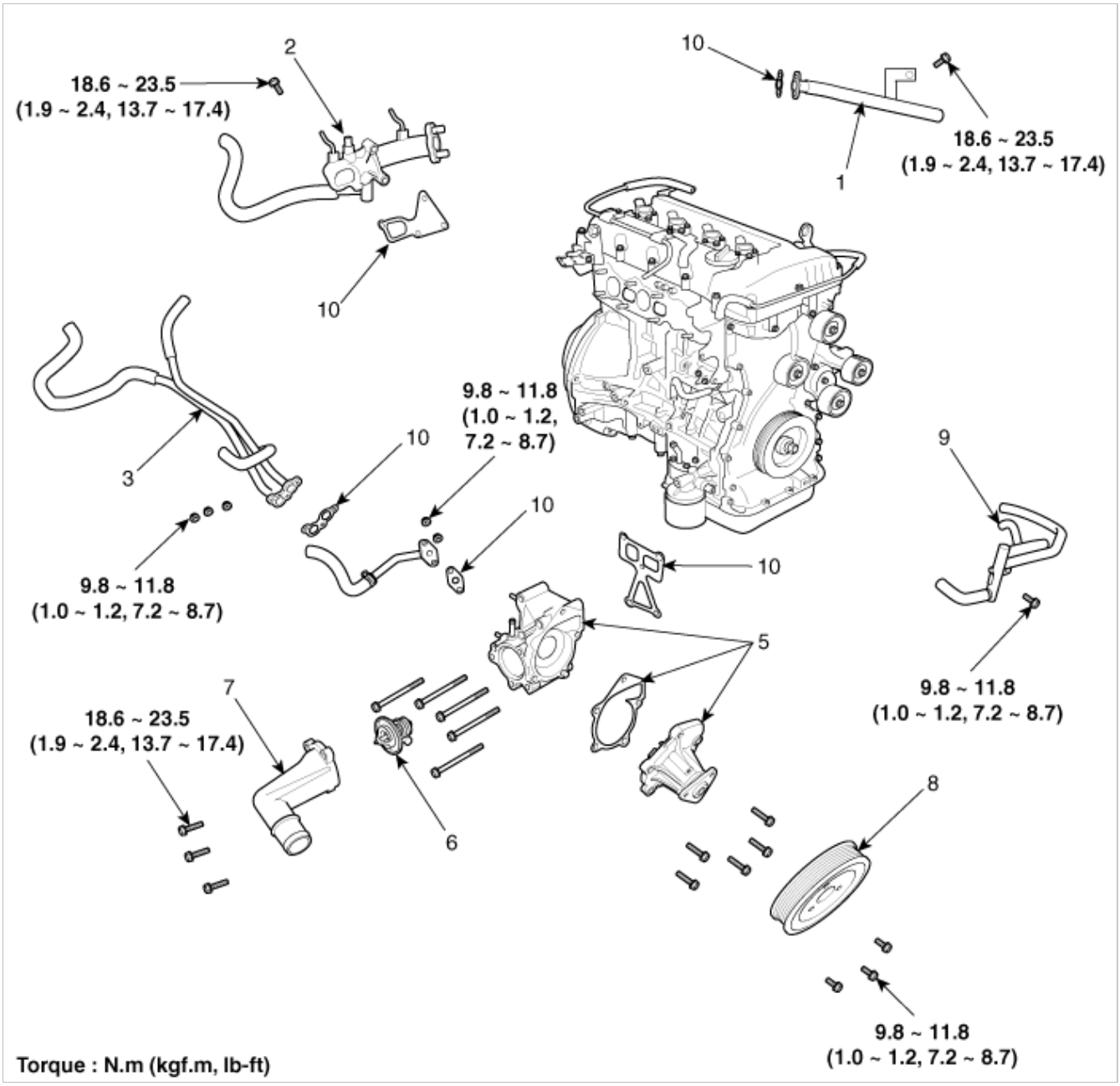


6. Remove the radiator.
   (1) Remove the cooling fan connector(A).
   (2) Remove the reservoir tank(B).
   (3) Remove the fan assembly(C).
   (4) Remove the radiator after removing the radiator upper mounting bracket(D).



7. Installation is the reverse of removal.
8. Fill the engine coolant.
9. Start the engine and check for leaks.
10. Recheck the coolant level.

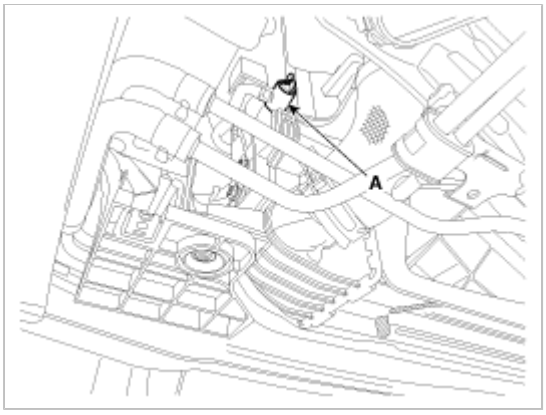
Components



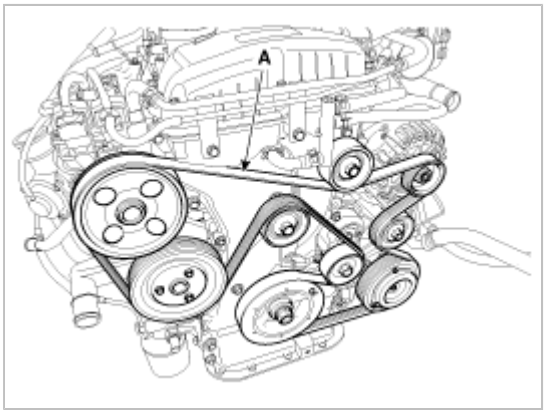
1. Water outlet pipe assembly	6. Thermostat
2. Water temp. control assembly	7. Water inlet fitting
3. Heater bypass pipe & hose assembly	8. Water pump pulley
4. Turbo charger water pipe	9. Air vent hose & pipe
5. Water pump	10. Gasket

Removal

1. Remove the drain plug (A) and drain the engine coolant.

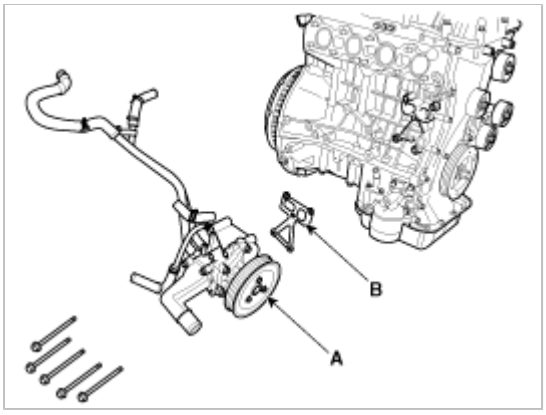


2. Remove the drive belt (A).



3. Remove the water pump (A) and water pump gasket (B).

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



4. Installation is the reverse of removal with a new water pump gasket.
5. Fill the engine coolant.
6. Start the engine and check for leaks.
7. Recheck the coolant level.

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.

> **NOTE**
>
> A small amount of 'weeping' from the bleed hole is normal.

Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	• From the bleed hole of the water pump	Naked eye observation	• 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 pump		• Check the material or any cracks of the water pump.	• Poor material. If any crack found, replace the water pump.
Noise	• From bearings • From mechanical seals • 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 • Loosened impeller	Loosened impeller	• Corrosion of the impeller wing	• Check engine coolant. • Poor coolant quality / Maintenance check
			• Impeller seperation from the shaft	• Replace the water pump.

Removal

NOTE

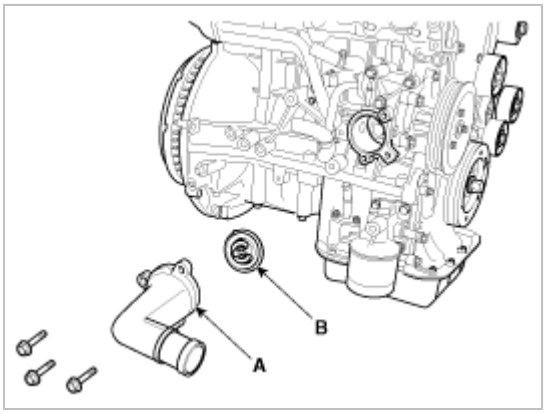
Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. Drain the engine coolant so its level is below the thermostat.
2. Remove the water inlet fitting (A) and thermostat (B).

Tightening torqe :
18.6 ~ 23.5Nm (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

NOTE

Install the thermostat with jiggle valve upward.



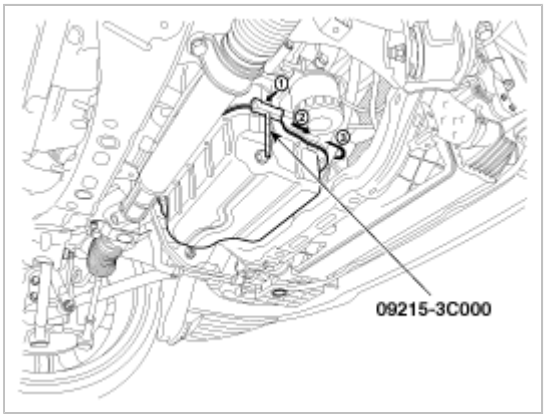
3. Installation is the reverse of removal.
4. Fill the engine coolant.
5. Start the engine and check for leaks.
6. Recheck the coolant level.

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) • Thermogauge indicates 'LOW'	Visually check observation after removing the radiator cap.	• Insufficient coolant or leakage.	• After refilling coolant, recheck.
		GDS check & Starting engine	• Check DTCs • Check connection of the fan clutch or the fan motor. ※ If the fan clutch is always connected, there will be a noise at idle.	• Check the engine coolant sensor, wiring and connectors. • Replace the componants.
		Remove the thermostat and inspect	• Check if there are dusts or chips in the thermostat valve. • Check adherence of the thermostat.	• Clean the thermostat valve and reuse the thermostat. • Replace the thermostat, if it doesn't work properly.
Heated excessively	• Engine overheated • Thermogauge indicates 'HI'	Naked eyes observation after removing the radiator cap.	• Insufficient coolant or leakage. ※ Be careful when removing a radiator cap of the overheated vehicle. • Check air in cooling system.	• After refilling coolant, recheck. • Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts.
		GDS check & Starting engine	• Check DTCs • Check the fan motor performance as temperature varies. • Check if the fan clutch slips. • Check the water pump adherence or impeller damaged.	• Check the engine coolant sensor, wiring and connectors. • Check the fan motor, the relay and the connector. • Replace the fan clutch, if it doesn't work properly. • 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. ※ Check the thermostat opens at the valve opening temperature.	• Replace the thermostat, if it doesn't work properly.

Removal

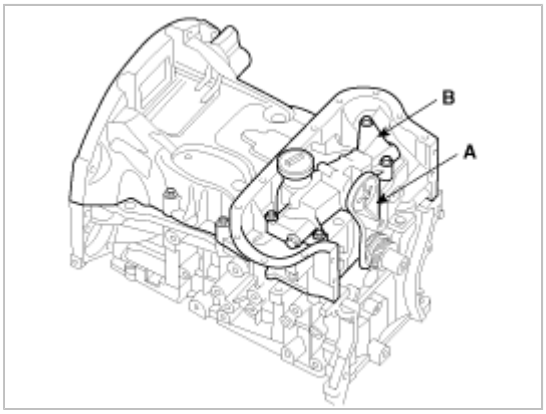
1. Drain the engine oil.
2. Remove the oil pan.
   Insert the blade of SST(09215-3C000) between the ladder frame and the oil pan. Cut off applied sealer and remove the lower oil pan.



NOTE

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of arrow (1).
- After tapping the SST with a plastic hammer along the direction of arrow (2) 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.
- Be careful not to damage the contact surfaces of Upper oil pan and lower oil pan.

3. Remove the timing chain.
   (Refer to Timing system in this group)
4. Remove the oil pump (B), oil pump chain (A) and sprocket.

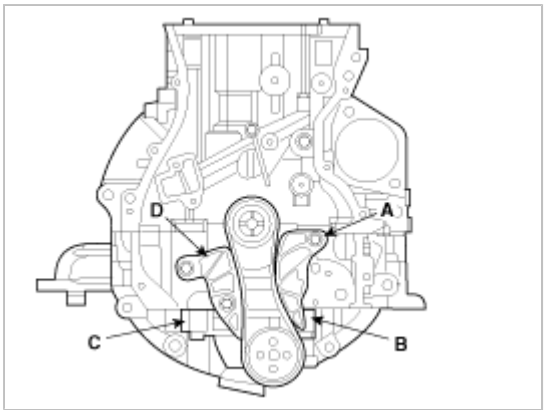


Installation

1. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.
2. Assemble the crankshaft sprocket on the crankshaft as the front mark on the crankshaft sprocket to be outward.
3. Tighten the oil pump tensioner bolt 'A' after placing the tensioner spring on the dowel pin located in ladder frame and then insert stopper pin to fix the oil pump chain tensioner 'B'.

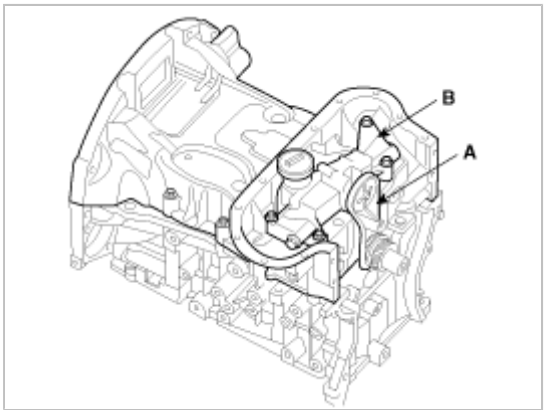
Tightening torque :

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



4. Assemble the oil pump chain on the crankshaft sprocket.
5. Assemble the oil pump assembly (B) as placing oil pump sprocket in to oil pump chain (A).

Tightening torque :
7.8 + 16.6 + 25.5 N.m (0.9 + 1.7 + 2.6kgf.m, 5.8+ 12.3 + 18.8 lb-ft)



Bolting order

A. Assemble the bolts with seting torque 25.5 N.m (2.6kgf.m,18.8 lb-ft)
B. Loosen the bolts as reverse bolting order.
C. Assemble the bolts (4EA) with seting torque 0.9 N.m (7.8kgf.m, 5.8 lb-ft)
D. Assemble the bolts (4EA) with seting torque 1.7 N.m (16.6kgf.m, 12.3 lb-ft)
E. Assemble the bolts with seting torque 25.5 N.m (2.6kgf.m,18.8 lb-ft) as bolting order.

6. Remove the tensioner pin after installing the oil pump chain guide (D).

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

7. Install the timing chain.
(Refer to Timing system in this group)

Engine Oil And Filter Replacement

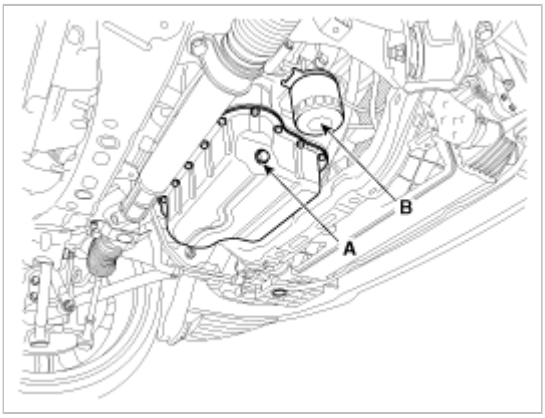
CAUTION

- 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 : 5.9L (6.23US qt, 5.19Imp qt)

Oil pan : 5.0L (5.28US qt, 4.41Imp qt)
Drain and refill including oil filter : 5.3L (5.60US qt, 4.66Imp qt)

(3) Install the oil filler cap.

4. Start engine and check for oil leaks and check the oil gauge or light for an indication of oil pressure.
5. Recheck the engine oil level.

Inspection

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 engine warm up stop the engine wait 5 minutes then check the oil level. Oil level should be between the "L" and "F" marks on the dipstick. If low check for leakage and add oil up to the "F" mark.

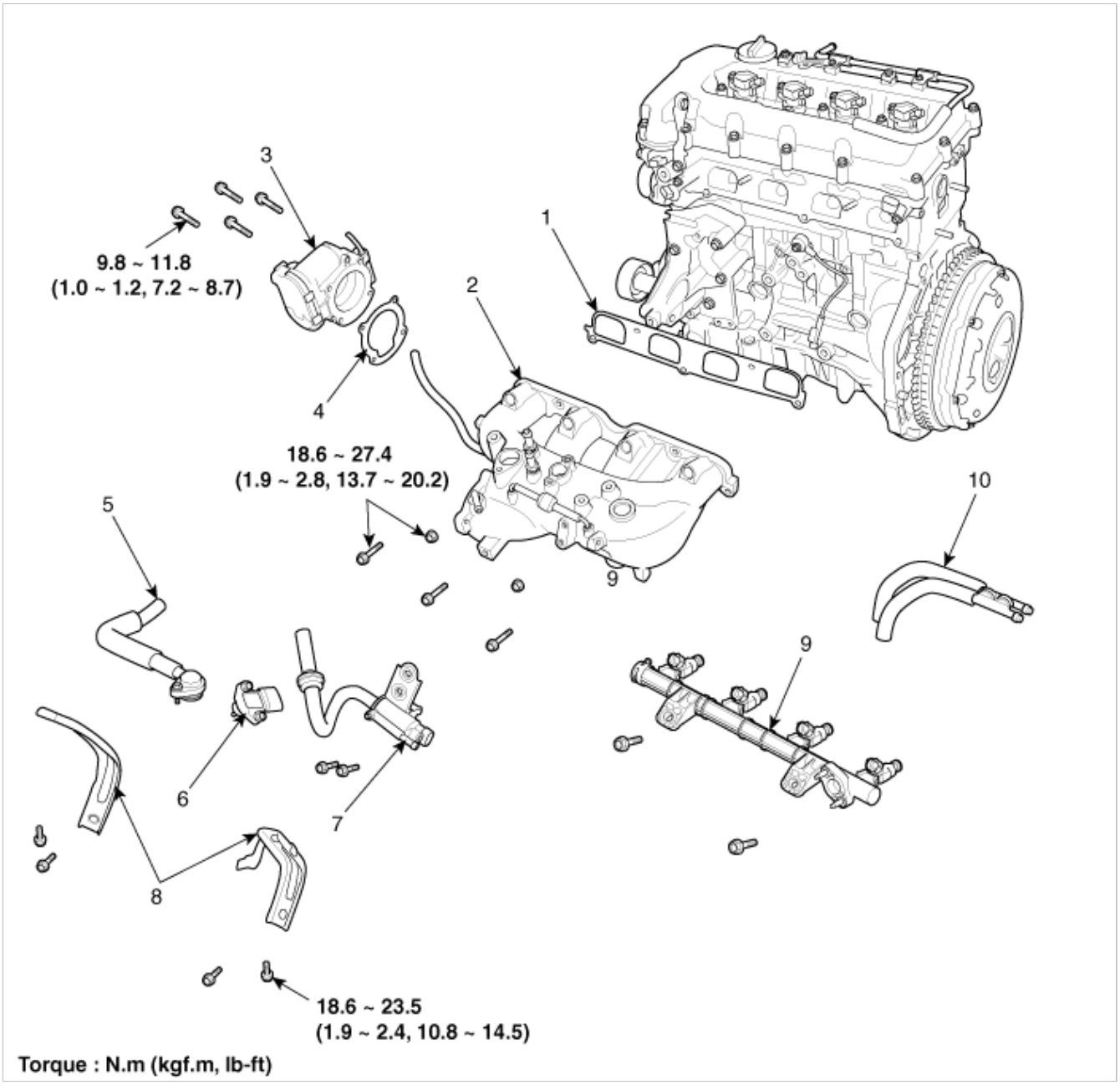
> NOTE
>
> Do not fill with engine oil above the "F" mark.

Selection Of Engine Oil

API classification : SL, SM or above
ILSAC classification : GF3, GF4 or above
SAE viscosity grade : 5W-20, 5W-30, 5W-40

> 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. Lubricants that do not have both an SAE grade number and API or ILSAC service classification on the container should not be used.

Components

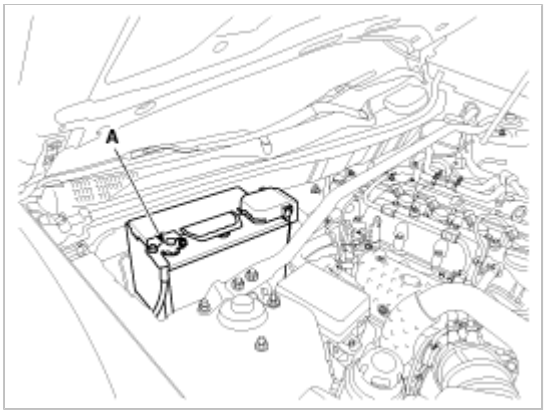


Torque : N.m (kgf.m, lb-ft)

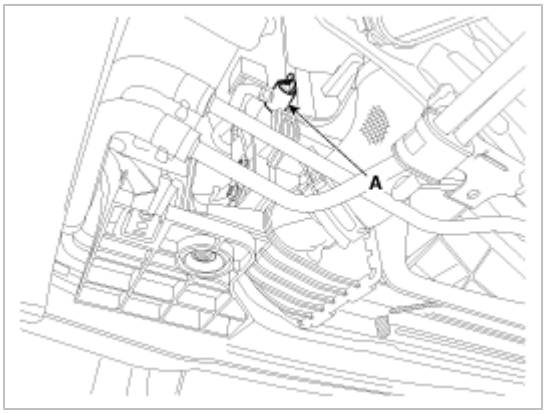
1. Intake manifold gasket	5. PCV hose assembly	8. Intake manifold stay
2. Intake manifold assembly	6. MAP sensor	9. Delivery pipe
3. Electronic throttle body	7. PCSV	10. Vaccum hose
4. Throttle body gasket		

Removal

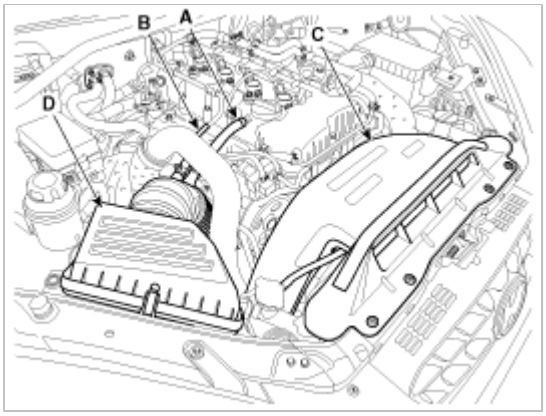
1. Disconnect the negative (-) battery terminal (A).



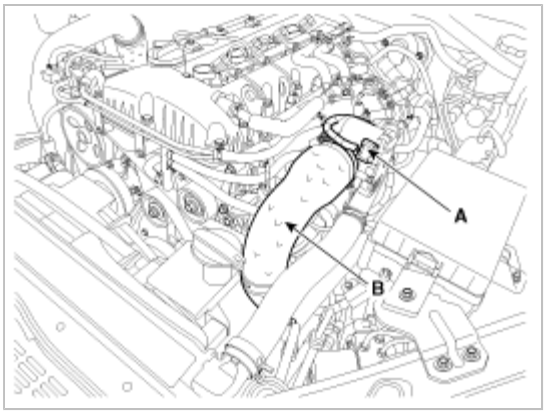
2. Remove the drain plug (A) and drain the engine coolant.



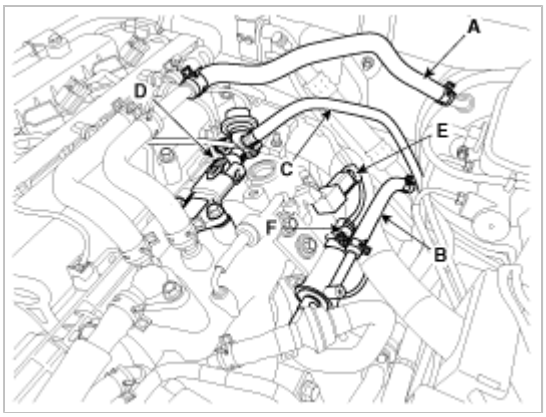
3. Remove the air duct (C).



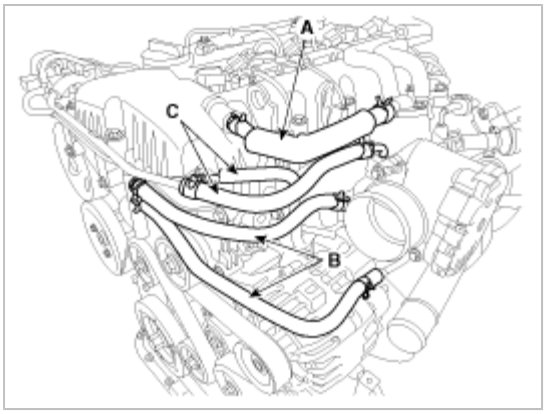
4. Remove the ETC connector (A) and intercooler outlet hose (B).



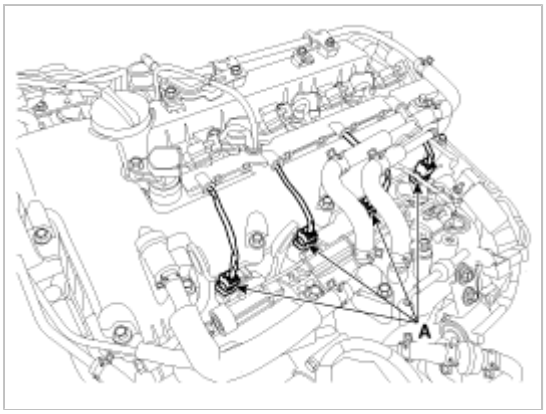
5. Disconnect the vacuum hose (A), PCSV hose (B), fuel hose (C), MAP sensor connector (D), condenser connector (E) and PCSV connector (F).



6. Remove the PCV hose (A), coolant hoses (B) and vacuum hoses (C).

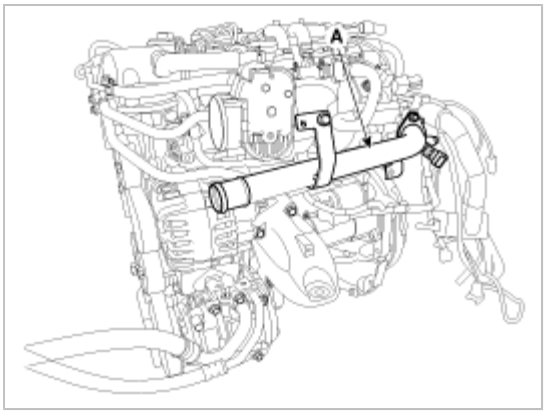


7. Remove the injector connectors (A).



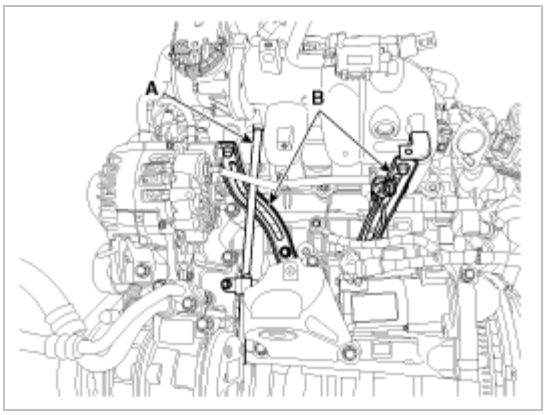
8. Remove the water outlet pipe (A).

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



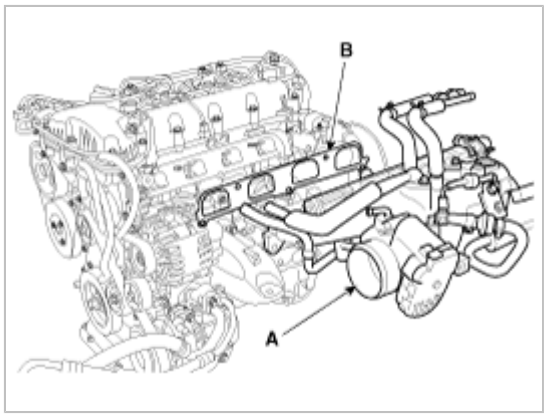
9. Remove the oil level gauge (A) and intake manifold stay (B) bolt.

Tightening torque :
A: 7.8~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)
B: 18.6~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



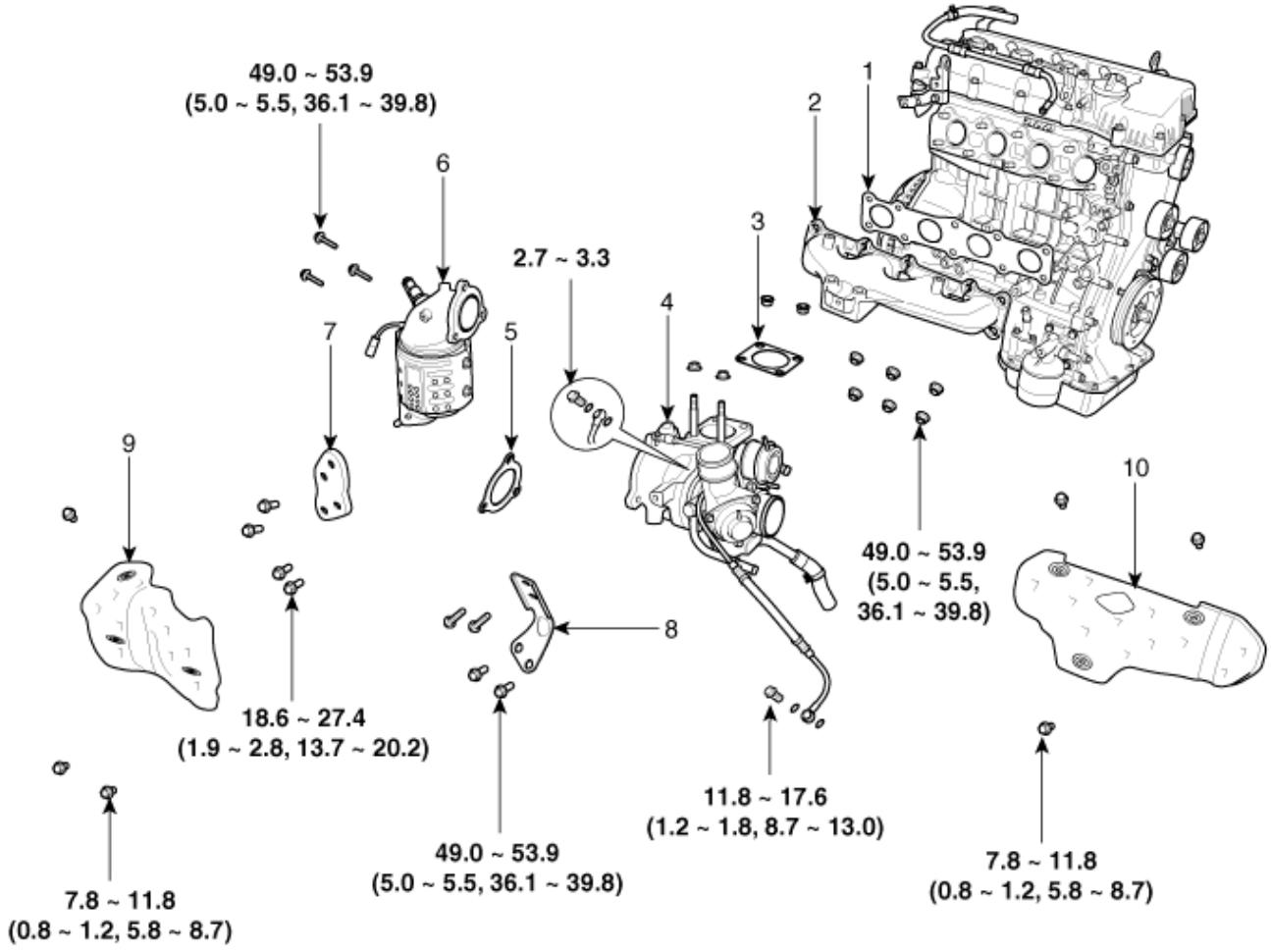
10. Remove the intake manifold (A) and gasket (B).

Tightening torque :
18.6~ 27.4N.m (1.9 ~ 2.8kgf.m, 13.7 ~ 20.2lb-ft)



11. Installation is the reverse of removal.

Components



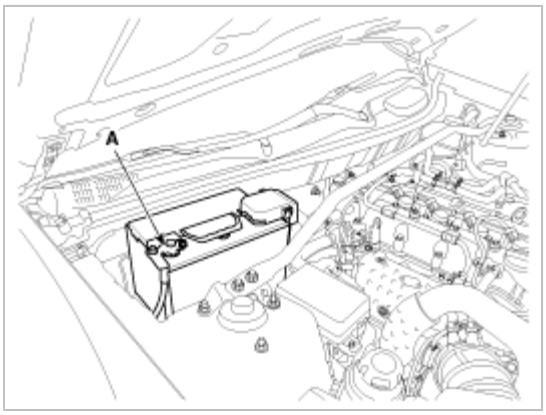
1. Exhaust manifold gasket	4. Turobcharger assembly	7. Turbocharger stay
2. Exhaust manifold	5. WCC gasket	8. Turobcharger heat protector
3. Turobcharger gasket	6. Warm-up catalytic converter (WCC)	9. Exhaust manifold heat protector

Removal

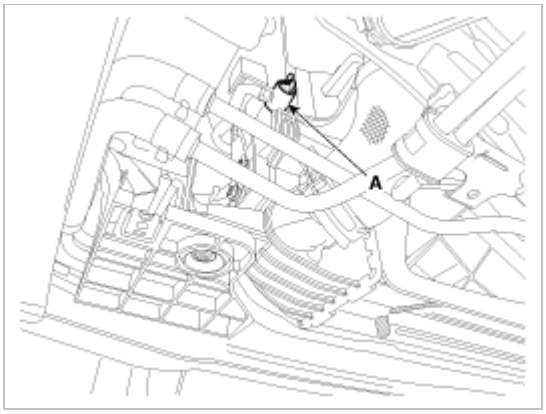
CAUTION

Check that engine is cool enough to work.

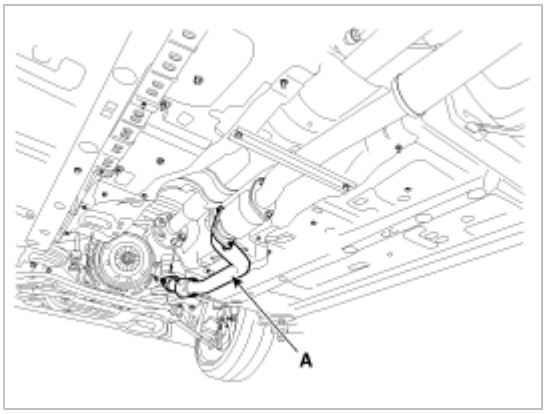
1. Disconnect the negative (-) battery terminal (A).



2. Remove the drain plug (A) and drain the engine coolant.

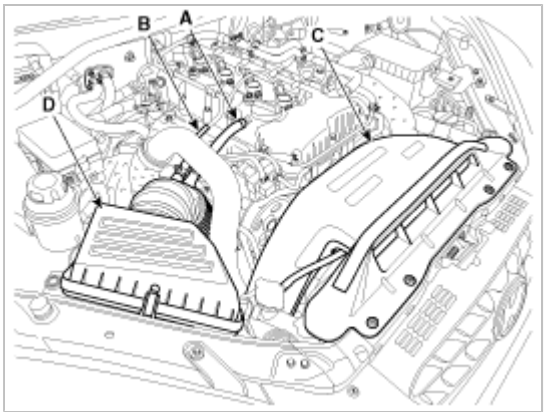


3. Remove the front muffler (A).



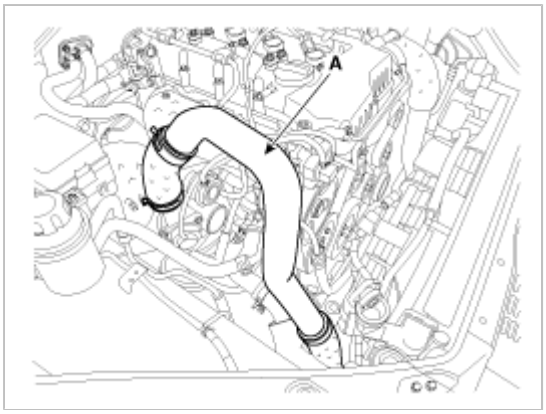
4. Disconnect the breather hose (A), vacuum hose (B). And remove the air duct (C) and air cleaner assembly (D).

Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.1 ~ 3.6lb-ft)

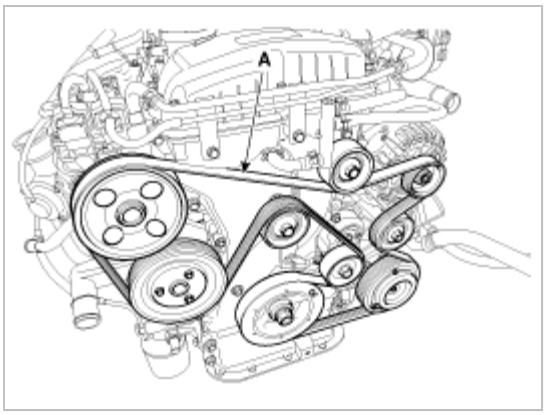


5. Disconnect the intercooler inlet hose (A).

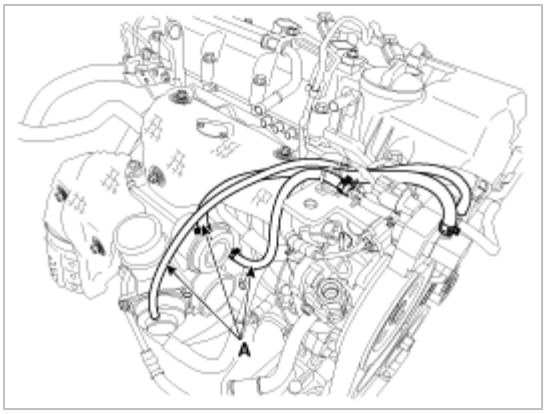
Tightening torque :
Bolt : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)
Clamp : 4.9~ 6.8N.m (0.5 ~ 0.7kgf.m, 3.6 ~ 5.0lb-ft)



6. Remove the drive belt (A).

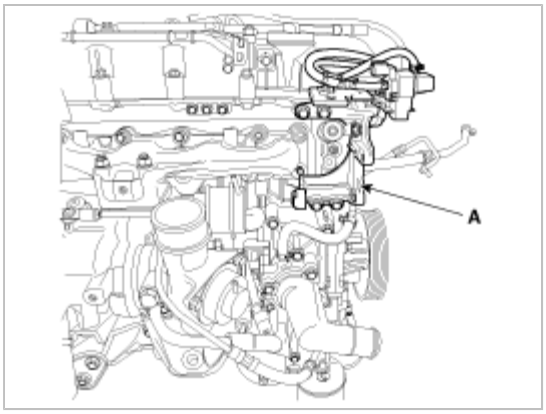


7. Remove the turbo control hoses (A).



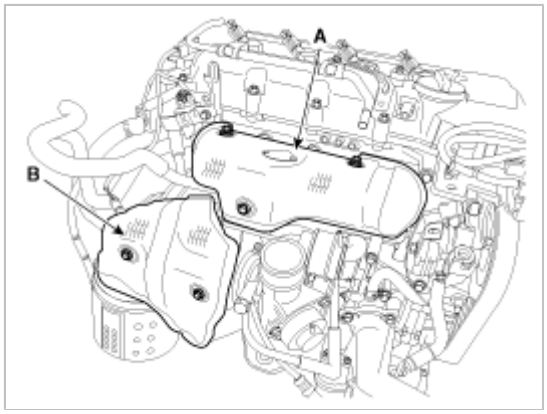
8. Remove the power steering pump. (Refer to steering group)
9. Remove the steering pump bracket (A).

Tightening torque :
19.6~ 23.5N.m (2.0 ~ 2.4kgf.m, 13.4 ~ 17.4lb-ft)



10. Remove the exhaust manifold heat protector (A) and turbocharger heat protector (B).

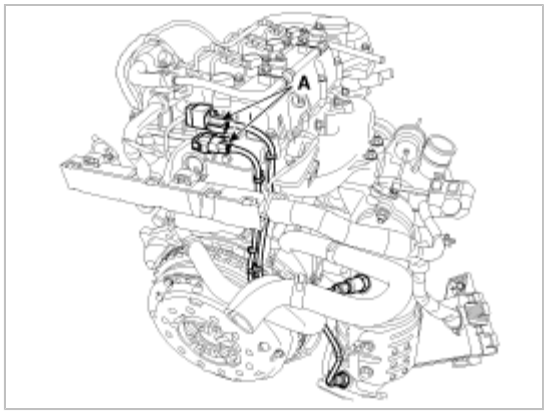
Tightening torque :
7.8~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



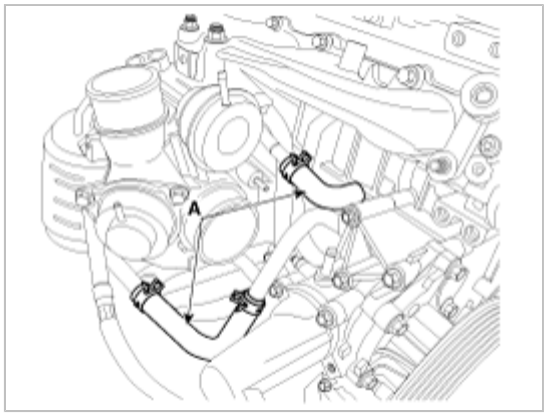
CAUTION

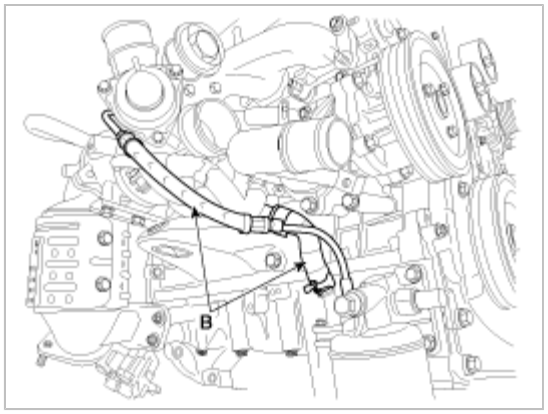
Check that engine is cool enough to work.

11. Remove the oxygen sensor connectors (A).



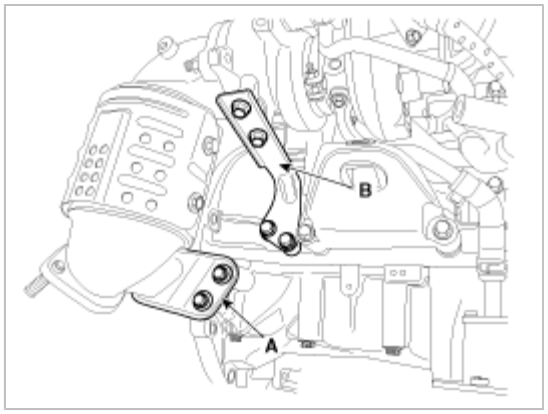
12. Remove the coolant hoses (A) and oil hoses (B) from turbocharger.





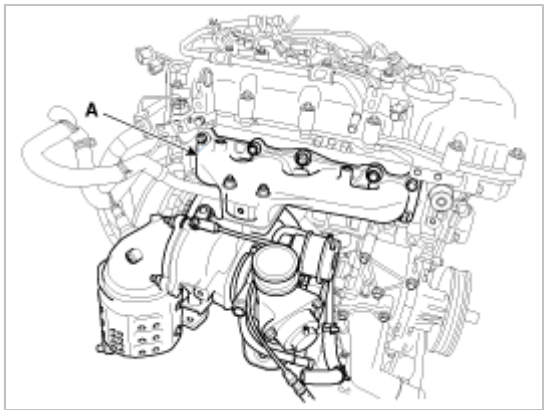
13. Remove the turbocharger stay bolt (A) and WCC stay bolt (B).

Tightening torque :
A: 49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.1 ~ 39.8lb-ft)
B: 8.6~ 27.4N.m (1.9 ~ 2.8kgf.m, 13.7 ~ 20.2lb-ft)



14. Remove the exhaust manifold & turbocharger assembly (A) and gasket.

Tightening torque :
49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.1 ~ 39.8lb-ft)

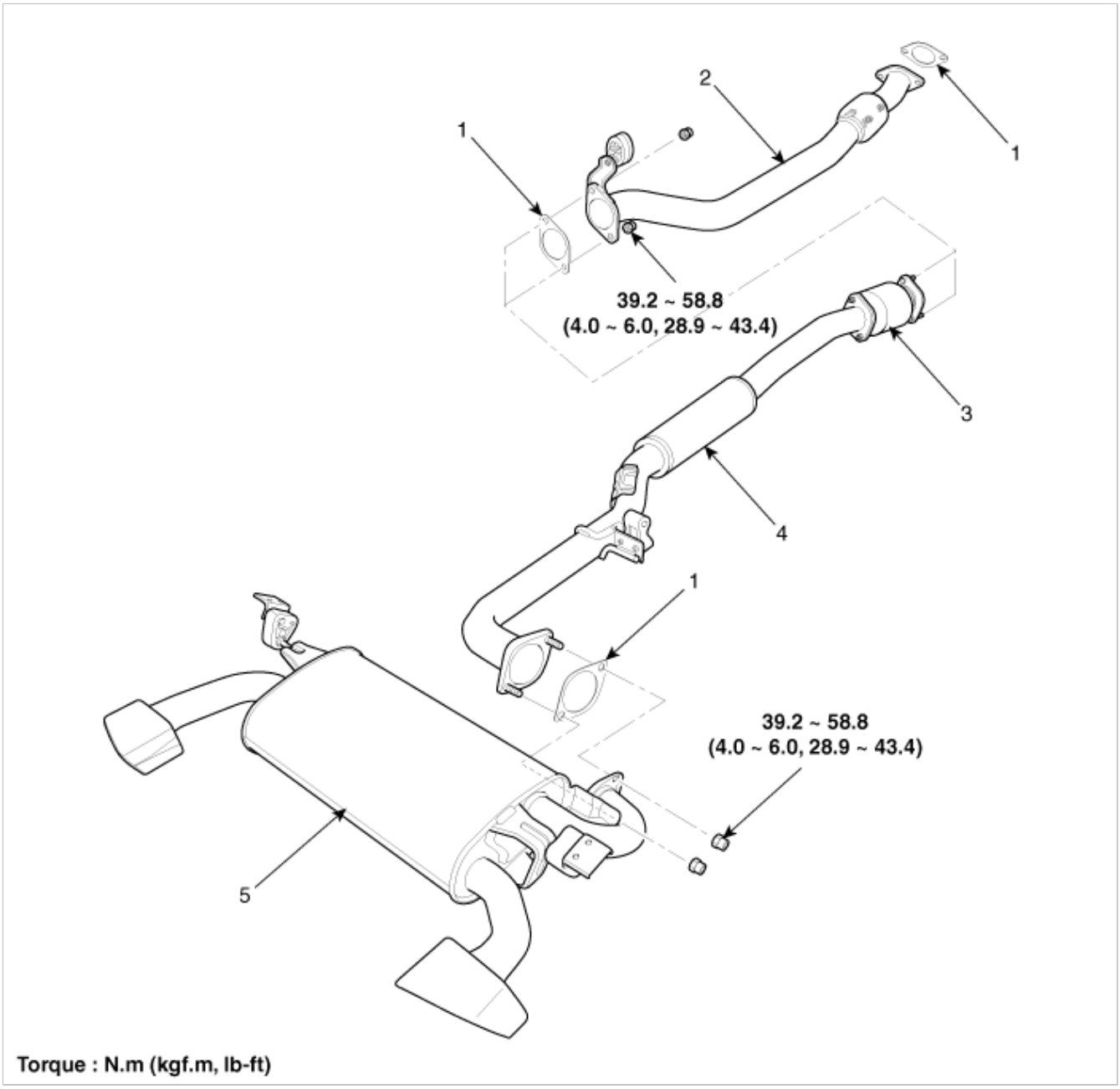


15. Installation is the reverse of removal.

NOTE

- Always use the new turbocharger, exhaust manifold and WCC gaskets when replacing.
- Always use a new turbocharger nuts and, exhaust manifold nuts when it is removed.
- Check that turbo control hose is installed in the right position to avoid interference with another parts (Heat protector, air hose etc.).
- Take care whether the turbocharger coolant hose is interfered with heat protector and exhaust manifold.

Components



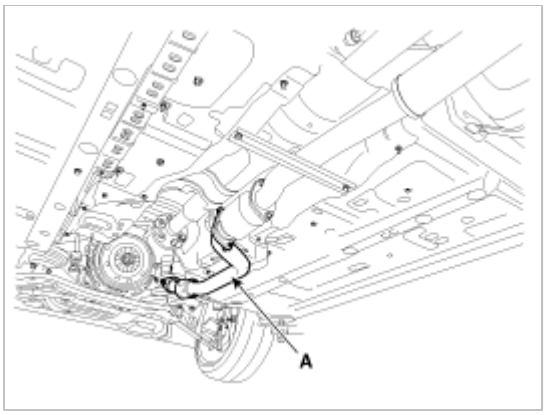
Torque : N.m (kgf.m, lb-ft)

1. Gasket 2. Front muffler 3. Catalytic converter	4. Center muffler 5. Main muffler

Removal

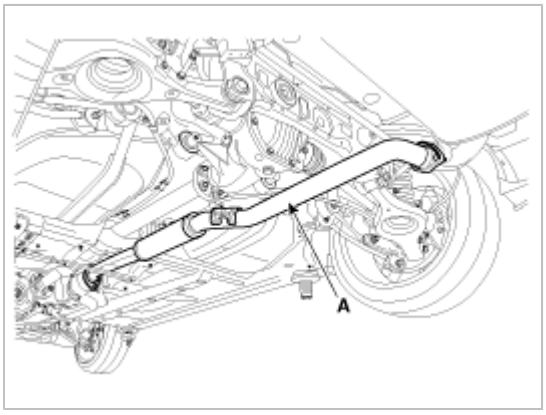
1. Remove the front muffler (A).

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



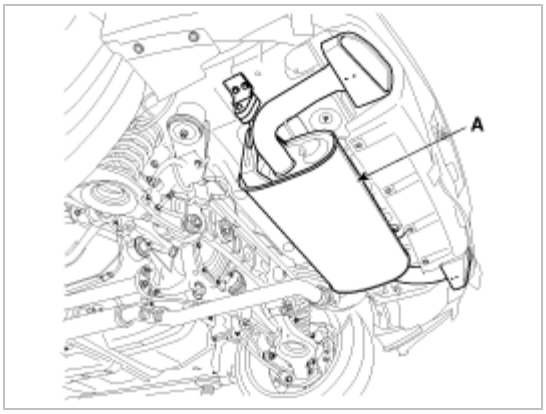
2. Remove the center muffler (A).

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

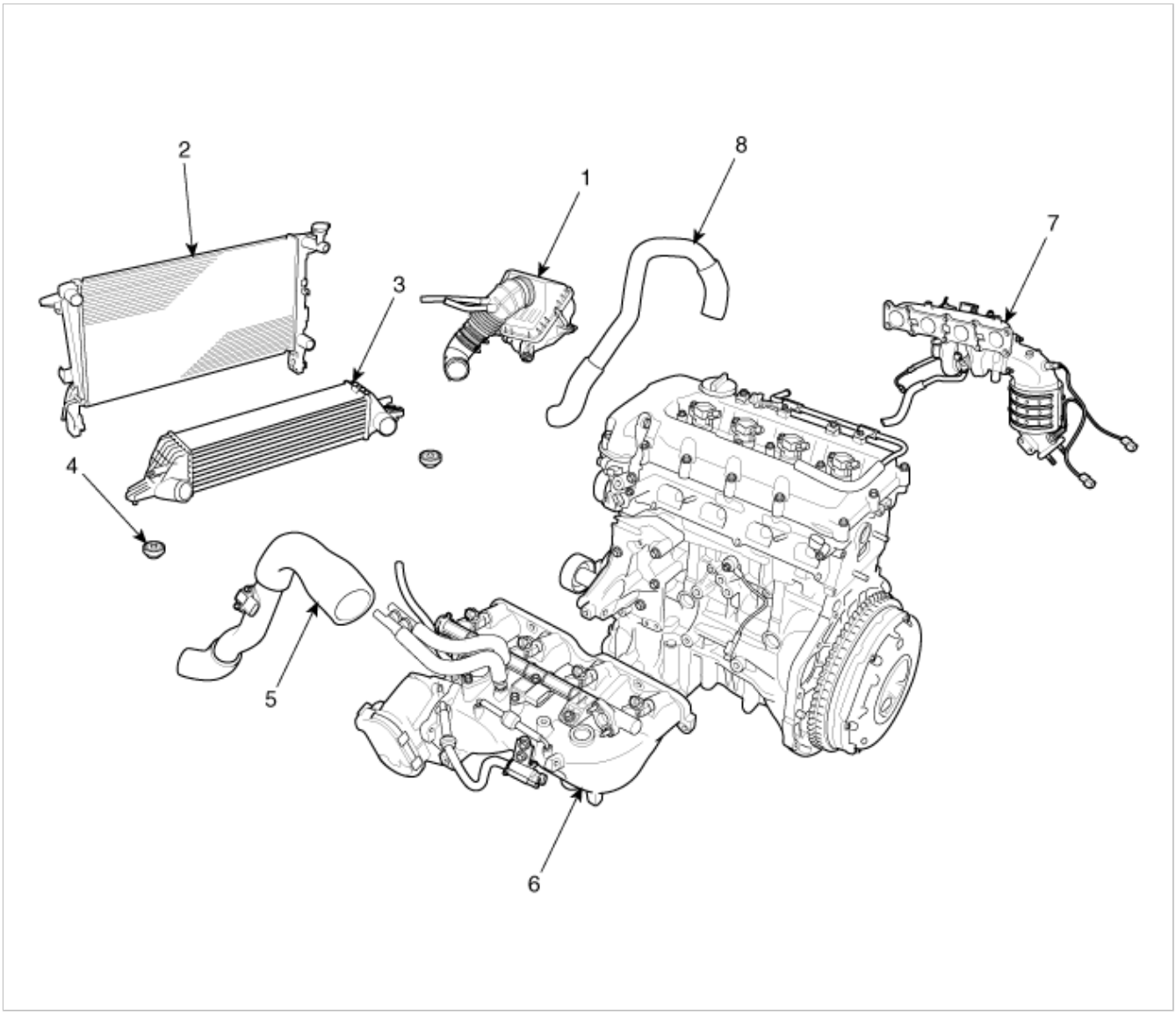


3. Remove the main muffler (A).

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


A

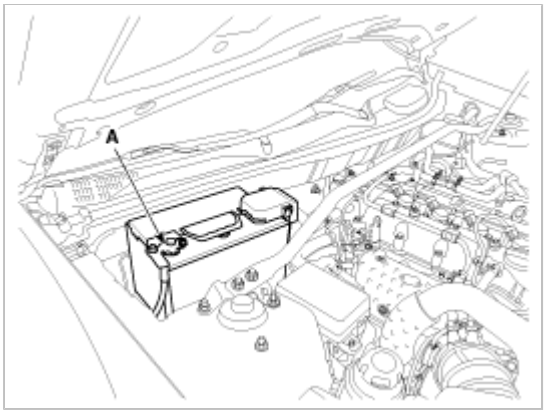
Components



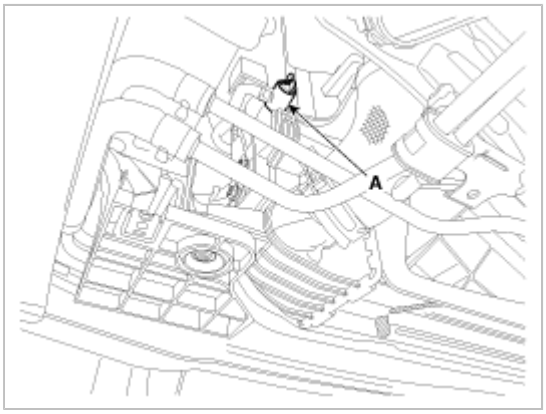
1. Air cleaner assembly	5. Intercooler outlet hose
2. Radiator	6. Intake manifold
3. Intercooler	7. Exhaust manifold
4. Mounting insulator	8. Intercooler inlet hose

Removal

1. Disconnect the negative (-) battery terminal (A).

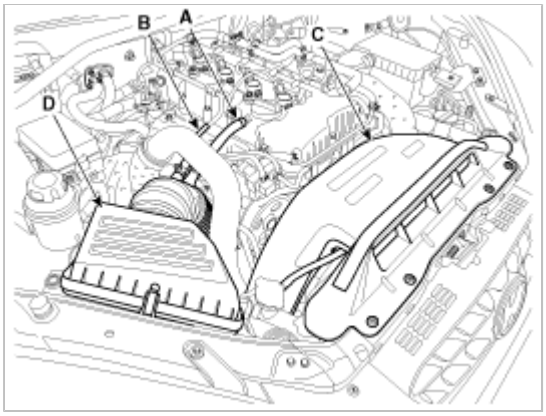


2. Remove the drain plug (A) and drain the engine coolant.

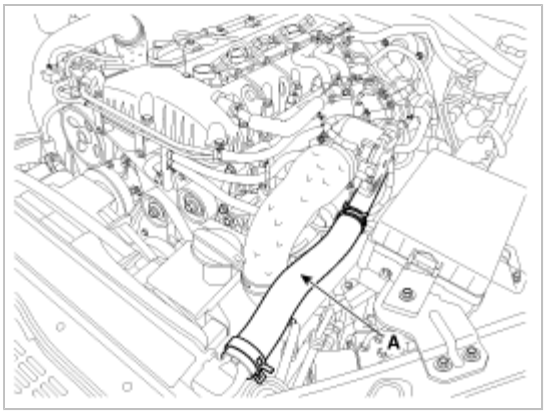


3. Disconnect the breather hose (A) and vacuum hose (B). And remove the air duct (C) and air cleaner assembly (D).

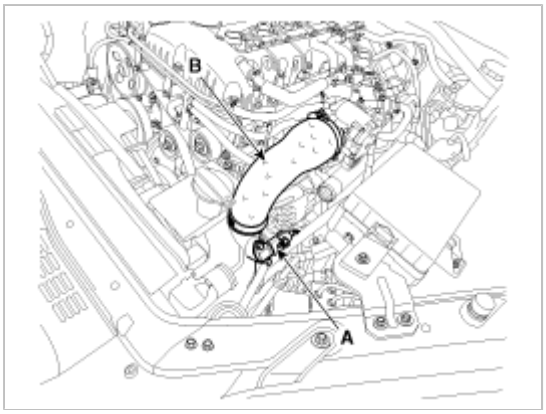
Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.1 ~ 3.6lb-ft)



4. Remove the radiator upper hose (A).

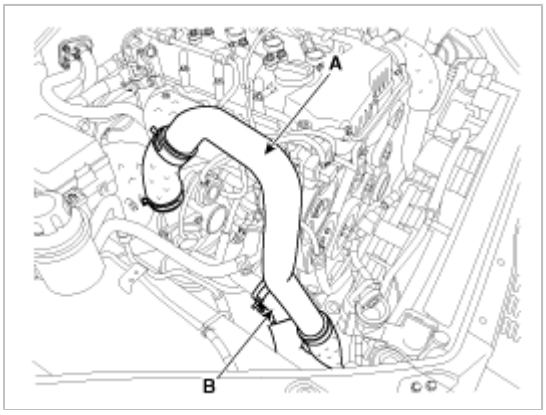


5. Remove the BPS connector (A) and intercooler outlet hose (B).



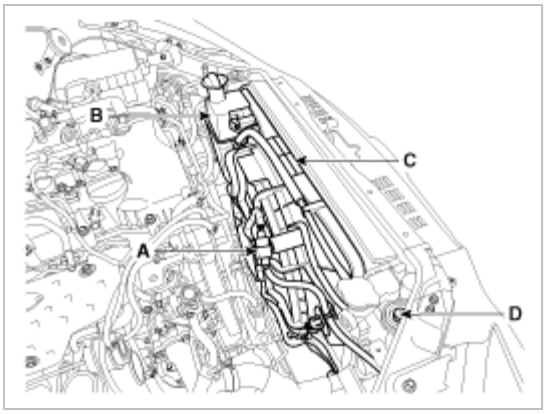
6. Disconnect the intercooler inlet hose (A) and radiator lower hose (B).

Tightening torque :
Bolt : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)
Clamp : 4.9~ 6.8N.m (0.5 ~ 0.7kgf.m, 3.6 ~ 5.0lb-ft)

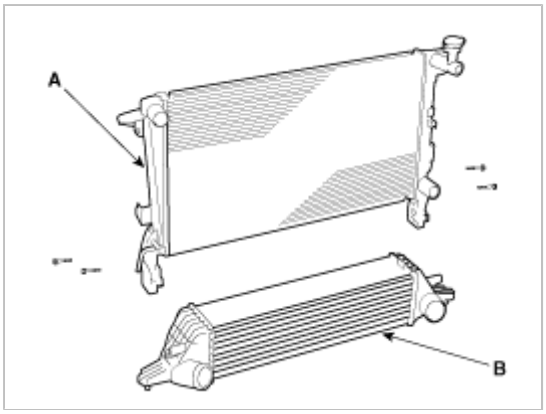


7. Remove the radiator assembly.
   (1) Remove the cooling fan connector(A).
   (2) Remove the reservoir tank(B).
   (3) Remove the fan assembly(C).
   (4) Remove the radiator after removing the radiator upper mounting bracket(D).

Tightening torque :
7.8 ~ 13.7N.m (0.9 ~ 1.4kgf.m, 5.8 ~ 10.1lb-ft)



8. Remove the radiator (A) and intercooler (B).



9. Installation is the reverse of removal.