General Information

Specifications

Description		Specifications	Limit
General			
Type		V-type, DOHC	
Number of cylinders		8	
Bore		92mm (3.6220in)	
Stroke		87mm (3.4252in)	
Total displacement		4,627 cc (282.4 cu.in)	
Compression ratio		10.4 : 1	
Firing order		1-2-7-8-4-5-6-3	
Valve timing			
Intake valve	Opens (ATDC)	8°	
	Closes (ABDC)	74°	
Exhaust valve	Opens (BBDC)	62°	
	Closes (ATDC)	4°	
Cylinder head			
Flatness of gasket surface		Less than 0.02mm (0.0008in) / 100 x 100	
Flatness of manifold mounting surface		Less than 0.01mm (0.0004in) / 110 x 110	
Camshaft			
Camheight	Intake	41.6mm (16.4in)	
	Exhaust	41.5mm (16.3in)	
Camshaft bearing oil clearance(Intake/Exhaust)	No. 1 journal	0.025 ~ 0.057mm (0.0010 ~ 0.0022in)	
	No. 2,3,4,5 journal	0.020 ~ 0.057mm (0.0008 ~ 0.0022in)	
Camshaft journal outer diameter(Intake/Exhaust)	No. 1 journal	35.964 ~ 35.980mm (1.4159 ~ 1.4165in)	
	No. 2,3,4,5 journal	25.964 ~ 25.980mm (1.0222 ~ 1.0228in)	
Camshaft journal bore inner diameter(Intake/Exhaust)	No. 1 journal	36.005 ~ 36.021mm (1.4175 ~ 1.4181in)	
	No. 2,3,4,5 journal	26.000 ~ 26.021mm (1.0236 ~ 1.0244in)	
End play		RH-In : 0.12 ~ 0.22mm (0.0047 ~ 0.0086in) RH-Ex. LH-In, LH-Ex : 0.12 ~ 0.22mm (0.0047 ~ 0.0086in)	
Valve			
Valve length	Intake	107.77mm (4.2429in)	
	Exhaust	107.75mm (4.2421in)	

Description		Specifications	Limit
Stem outer diameter	Intake	5.965 ~ 5.980mm (0.2348 ~ 0.2354in)	
	Exhaust	5.958 ~ 5.970mm (0.2346 ~ 0.2350in)	
Face angle (Intake/Exhaust)		45.25° ~ 45.75°	
Thickness of valve head (margin)	Intake	1.2mm (0.0472in)	
	Exhaust	1.2mm (0.0472in)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.0008 ~ 0.0018in)	
	Exhaust	0.030 ~ 0.054mm (0.0012 ~ 0.0021in)	
Valve guide			
Inner diameter	Intake	6.000 ~ 6.012mm (0.2362 ~ 0.2367in)	
	Exhaust	6.000 ~ 6.012mm (0.2362 ~ 0.2367in)	
Valve seat			
Width of seat contact	Intake	1.15 ~ 1.45mm (0.0453 ~ 0.0571in)	
	Exhaust	1.35 ~ 1.65mm (0.0531 ~ 0.0650in)	
Seat angle	Intake	44.75° ~ 45.10°	
	Exhaust	44.75° ~ 45.10°	
Valve spring			
Free length		47.8mm (1.8819in)	
Load		27.0±1.4kg/38mm(59.6±3.0 lb/1.496in)	
		69.3±2.4kg/28mm(152.85.4 lb/1.102in)	
Out of squareness		Less than 1.5°	
Cylinder block			
Cylinder bore		92.000 ~ 92.030mm (3.6220 ~ 3.6232in)	
Flatness of gasket surface		Total : Less than 0.05mm (0.0020in)	
		Bore to bore : Less than 0.02mm (0.0008in)	
Piston			
Piston outer diameter		91.945 ~ 91.975mm (3.6199 ~ 3.6211in)	
Piston to cylinder clearance		0.045 ~ 0.065mm (0.0018 ~ 0.0026in)	
Ring groove width	No. 1 ring groove	1.23 ~ 1.25mm (0.0484 ~ 0.0492in)	
	No. 2 ring groove	1.23 ~ 1.25mm (0.0484 ~ 0.0492in)	
	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in)	
Piston ring			
Ring width	No. 1 ring	1.17 ~ 1.19mm (0.0461 ~ 0.0469in)	
	No. 2 ring	1.17 ~ 1.19mm (0.0461 ~ 0.0469in)	
	Oil ring	1.88 ~ 1.95mm (0.0740 ~ 0.0768in)	

Description		Specifications	Limit
Side clearance	No. 1 ring	0.04 ~ 0.08mm (0.0016 ~ 0.0031in)	
	No. 2 ring	0.04 ~ 0.08mm (0.0016 ~ 0.0031in)	
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in)	
End gap	No. 1 ring	0.17 ~ 0.32mm (0.0067 ~ 0.0126in)	
	No. 2 ring	0.37 ~ 0.52mm (0.0146 ~ 0.0205in)	
	Oil ring	0.20 ~ 0.70mm (0.0079 ~ 0.0276in)	
Piston pin			
Piston pin outer diameter		21.995 ~ 22.000mm (0.8659 ~ 0.8661in)	
Piston pin hole inner diameter		22.004 ~ 22.010mm (0.8663 ~ 0.8665in)	
Piston pin hole clearance		0.004 ~ 0.015mm (0.0002 ~ 0.0006in)	
Connecting rod small end hole inner diameter		22.007 ~ 22.018mm (0.8664 ~ 0.8668in)	
Connecting rod small end hole clearance		0.007 ~ 0.023mm (0.0003 ~ 0.0009in)	
Connecting rod			
Connecting rod big end inner diameter		55.000 ~ 55.018mm (2.1654 ~ 2.1661in)	
Connecting rod bearing oil clearance		0.018 ~ 0.036mm (0.0007 ~ 0.0014in)	
Side clearance		0.1~ 0.3mm (0.0039 ~ 0.0118in)	
Crankshaft			
Main journal outer diameter		64.982 ~ 65.000mm (2.5583 ~ 2.5591in)	
Pin journal outer diameter		51.982 ~ 52.000mm (2.0465 ~ 2.0472in)	
Main bearing oil clearance		0.004 ~ 0.022mm (0.0002 ~ 0.0009in)	
End play		0.10 ~ 0.28mm (0.0039 ~ 0.0110in)	
Drive plate			
Runout		0.25mm (0.0098in)	
Oil pump			
Relief valve opening pressure		490±49.0kpa (5±0.5kg/cm², 71±7.1psi)	
Engine oil			
Oil quantity	Total	7.5L(7.92US qt, 6.59Imp qt)	When replacing a short engine or a block assembly
	Oil pan	6.2L(6.55US qt, 5.46Imp qt)	
	Drain and refill	6.7L(7.07US qt, 5.89Imp qt)	Including oil filter

Description		Specifications	Limit
Oil grade	Recommendation (except Middle East)	5W-20/GF4&SM	If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.
	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System"
Oil pressure (at 1000rpm)		156.91kPa (1.6kgf/cm², 22.76psi) or above	Oil temperature in oil pan : 110±2˚C (230 ±35.6˚F)
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		14L (14.79US qt, 12.31Imp qt)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2˚C(179.6±3.6˚F)	
	Pull opening temperature	95˚C(203˚F)	
Radiator cap	Main valve openingpressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi)	
	Vacuum valve openingpressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05kg/cm², 0.14 ~ 0.71 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20˚C(68˚F)	2.45±0.14 kΩ	
	80˚C(176˚F)	0.3222 kΩ	

Tightening Torques

Item	Quantity	Nm	kgf.m	lb-ft
Cylinder head				
Cylinder head cover bolt (RH)	17	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head cover bolt (LH)	18	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head bolt (long bolt) (LH/RH)	20	32.4 ~ 36.3+ 88˚ ~92˚+ 118˚~122˚	3.3 ~ 3.7+ 88˚~ 92˚+ 118˚~122˚	23.9 ~ 26.8+ 88˚ ~92˚+ 118˚~122˚
Cylinder head bolt (flange bolt) (LH/RH)	4	32.4 ~ 36.3	3.3 ~ 3.7	23.9 ~ 26.8
Camshaft bearing cap bolt (LH/RH)	44	13.7 ~ 14.7	1.4 ~ 1.5	10.1 ~ 10.8
Pressure relief valve (LH/RH)	2	21.6 ~ 25.	2.2 ~ 2.6	15.9 ~ 18.8
Ignition coil bolt (LH/RH)	8	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Spark plug (LH/RH)	8	24.5 ~ 29.4	2.5 ~ 3.0	18.1 ~ 21.7
Oil control valve bolt (LH/RH)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
OCV(oil control valve) filter (LH/RH)	2	53.9 ~ 63.7	5.5 ~ 6.5	39.8 ~ 47.0
CVVT assembly fixing bolt (LH/RH)	4	73.5 ~ 83.4	7.5 ~ 8.5	54.2 ~ 61.5
Water temperature sensor wiring bracket bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water temperature sensor	1	19.6 ~ 39.2	2.0 ~ 4.0	14.5 ~ 28.9
Oil pressure switch wiring bracket bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pressure switch	1	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Timing system				
Timing chain lower cover bolt	14	23.5 ~ 27.5	2.4 ~ 2.8	17.4 ~ 20.3
Timing chain upper cover (LH/RH)	14	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt (LH/RH)	2	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Tensioner adapter bolt	3	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Timing chain tensioner arm bolt (LH/RH)	2	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Timing chain guide mounting bolt (LH/RH)	2	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Timing chain tensioner bolt (LH/RH)	2	78.5 ~ 88.3	8.0 ~ 9.0	57.9 ~ 65.1
Cam to cam guide bolt (LH/RH)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Crankshaft pulley bolt	1	392.3 ~ 402.1	40.0 ~ 41.0	289.3 ~ 296.6
Drive belt tensioner bolt	2	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Alternator mounting bolt	2	29.4 ~ 41.2	3.0 ~ 4.2	21.7 ~ 30.4
Alternator bracket bolt (10X50)	4	29.4 ~ 41.2	3.0 ~ 4.2	21.7 ~ 30.4
Alternator bracket bolt (8X40)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Cooling fan clutch	1	58.8	6.0	43.4
Cooling fan bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder block				

Item	Quantity	Nm	kgf.m	lb-ft
Drain plug	1	96.1 ~ 100.0	9.8 ~ 10.2	70.9 ~ 73.8
Connecting rod cap bolt	16	22.6 ~ 26.5+ 98° ~102°	2.3 ~ 2.7+ 98°~ 102°	16.6 ~ 19.5+ 98° ~102°
Lower crankcase assembly bolt (main bearing cap bolt)	20	37.3 ~ 41.2+120°	3.8 ~ 4.2+120°	27.5 ~ 30.4+120°
Lower crankcase assembly bolt (flange bolt)	15	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Cylinder block rear cover bolt	12	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder block bank cover bolt	12	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Drive plate bolt	8	98.1 ~ 107.9	10.0 ~ 11.0	72.3 ~ 79.6
Cooling system				
Water pump pulley bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Cooling fan pulley bolt	1	76.5 ~ 80.4	7.8 ~ 8.2	56.4 ~ 59.3
Water pump bolt	9	19.6 ~ 24.5	2.0 ~ 2.5	14.5 ~ 18.1
Water temperature control assembly bolt	4	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water outlet fitting assembly bolt	2	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water inlet pipe bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water outlet pipe bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Lubrication system				
Oil level gauge guide bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil filter assembly bolt	5	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Oil cooler bolt	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Lower oil pan bolt	16	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Upper oil pan bolt	27	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump assembly bolt	4	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Oil pump sprocket bolt	1	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Intake and exhaust system				
Air cleaner assembly bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake manifold module nut	10	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Exhaust manifold nut (LH/RH)	24	49.0 ~ 53.9	5.0 ~ 5.5	36.2 ~ 39.8
Exhaust manifold heat protector bolt (LH/RH)	6	8.8 ~ 10.8	0.9 ~ 1.1	6.5 ~ 8.0
Front muffler nut (LH/RH)	8	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Main muffler nut	6	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Tail pipe nut	2	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Engine mounting				
Engine mounting bracket and engine fixing bolt (LH/RH)	8	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0

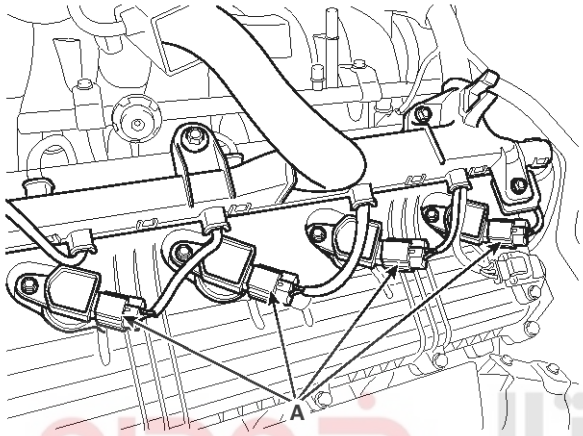
Item	Quantity	Nm	kgf.m	lb-ft
Engine mounting insulator and engine mounting bracket fixing nut (LH/RH)	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Engine mounting insulator and frame fixing nut (LH/RH)	6	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transmission mounting insulator and transmission fixing bolt	4	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transmission mounting insulator and frame fixing nut	4	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9

Compression Pressure Inspection

NOTICE

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

1. Warm up engine to normal operating temperature(80~95°C(176-203°F)).
2. Remove the ignition coil connectors (A) and ignition coils (B).



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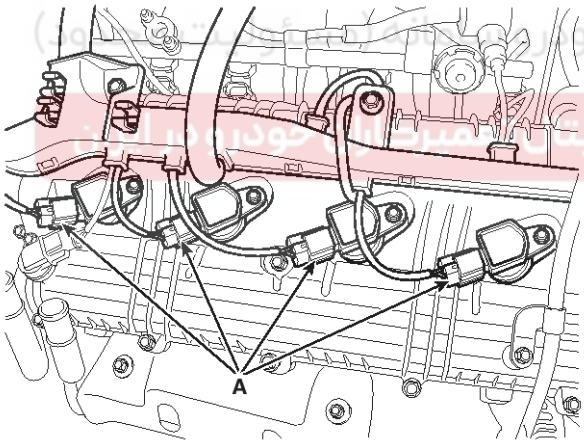

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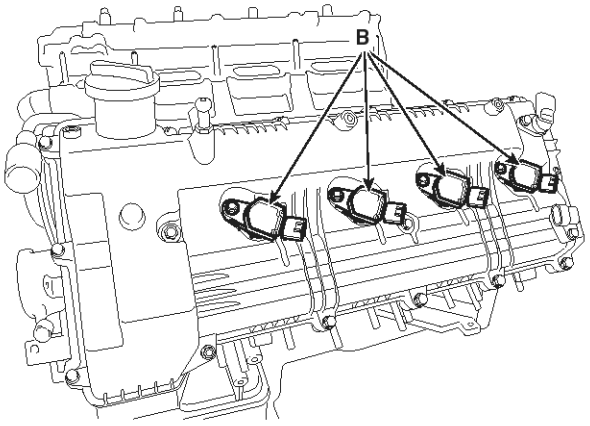

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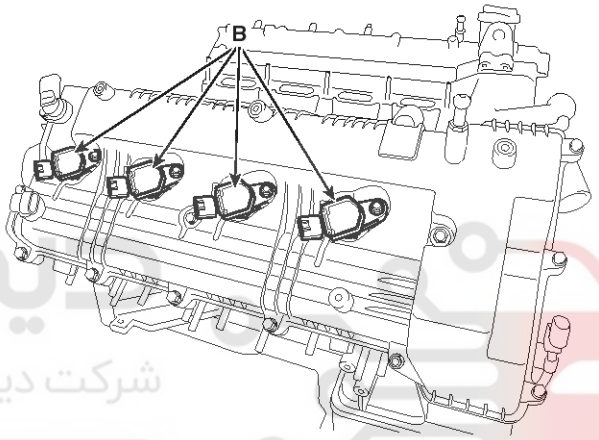

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3. Remove the spark plugs.

   Using a 16mm plug wrench, remove the 8 spark plugs.
4. Check cylinder compression pressure.
   1) Insert a compression gauge into the spark plug hole.
   2) Fully open the throttle.
   3) Crank the engine over 7 times to measure compression pressure.

      NOTICE

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

4) Repeat step 1) though 3) for each cylinder.

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

Compression pressure :
1,078kPa (11.0kg/cm², 156psi)
Minimum pressure :
931kPa (9.5kg/cm², 135psi)
Difference between each cylinder :
98kPa (1.0kg/cm², 14psi) or less

5) 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 step 1) through 3) 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 the spark plugs.
6. Install the ignition coils and ignition connectors.

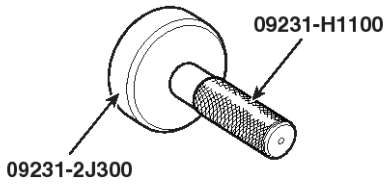
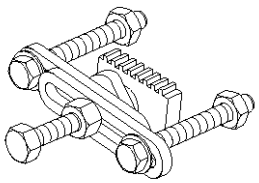
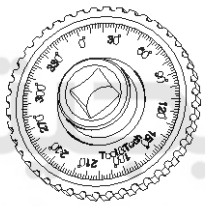
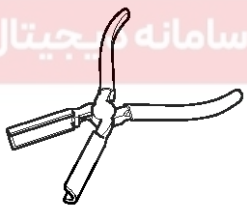
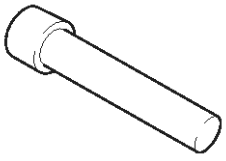
Troubleshooting

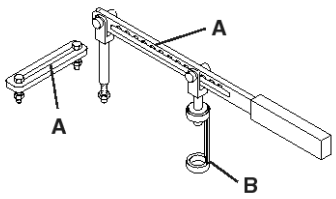
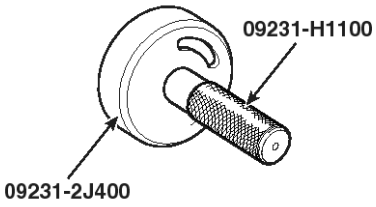
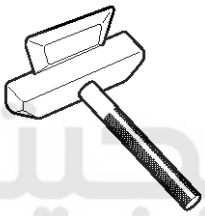
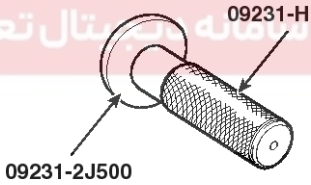
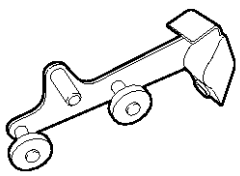
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or damaged engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause 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 buildup 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.
	HLA sponge	Run the engine at 2500~3000rpm within 15 minutes. If it dosen't disappear, refer to cylinder head assembly in this group.
Engine misfire with coolant consumption.	• Faulty cylinder head gasket and/or cranking 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.

Symptom	Suspect area	Remedy
Upper engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	• Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair as required.
	Stuck valves.Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the valves and valve guides, then repair as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required.
Lower engine noise, regardless of engine speed.	Low oil pressure.	Repair as required.
	Loose or damaged drive plate.	Repair or replace the drive plate.
	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 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 as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair 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.

Symptom	Suspect area	Remedy
Engine noise under load.	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance .	Inspect the following components and repair as required : • The connecting rod bearings. • The connecting rods. • The crankshaft.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair 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.	• Remove spark plugs and check for fluid. • Inspect for broken head gasket. • Inspect for cracked engine block or cylinder head. • Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain and/or timing chain gears.	• Inspect timing chain and gears. • Repair as required.
	Material in cylinder. • Broken valve • Piston material • Foreign material	• Inspect cylinder for damaged components and/or foreign materials. • Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	• Inspect crankshaft and connecting rod bearing. • Repair as required.
	Bent or broken connecting rod.	• Inspect connecting rods. • Repair as required.
	Broken crankshaft.	• Inspect crankshaft. • Repair as required.

Special Service Tools

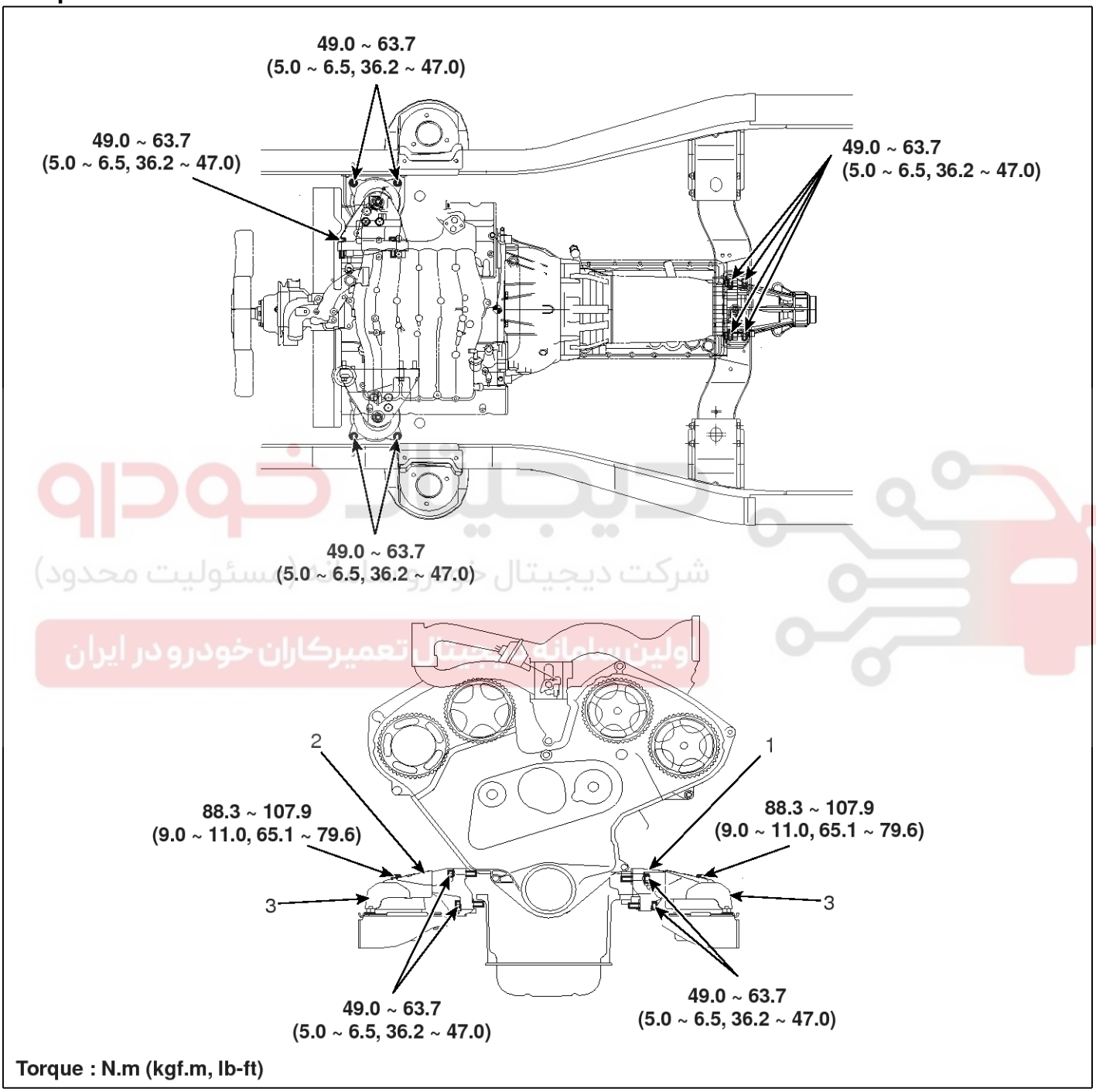
Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09231-2J300) (09231-H1100)	 SHMM19367N	Installation of the front oil seal
Flywheel stopper (09231-2B100)	 SHDEM6201D	Removal and installation of the flywheel and crankshaft pulley
Torque angle adapter (09221-4A000)	 LCAC030A	Installation of bolts & nuts needing an a-ngular method
Valve stem seal remover (09222-29000)	 KDRF232A	Removal of the valve stem seal
Valve stem seal installer (09222-28200)	 SHMM19368N	Installation of the valve stem seal

Tool (Number and name)	Illustration	Use
Valve spring compressor & holder (09222-3K000) (09222-3C300)	 ECRF003A	Removal and installation of the intake or exhaust valves A : 09222-3K000 B : 09222-3C300 (holder)
Crankshaft rear oil seal installer (09231-2J400) (09231-H1100)	 SHMM19369N	Installation of the crankshaft rear oil seal
Oil pan remover (09215-3C000)	 ACJF125A	Removal of oil pan
Oil seal installer (09231-2J500) (09231-H1100)	 SHMM19370N	Installation of the cylinder head cover oil seal & timing chain upper cover oil seal.
Timing chain locking tool (09231-2J600)	 SHMM19371N	Holds the timing chain with timing chain guide & timing chain tensioner arm durin-g installation.

Engine And Transaxle Assembly

Engine Mounting

Components



SHMM19372N

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

Engine And Transaxle Assembly

Removal

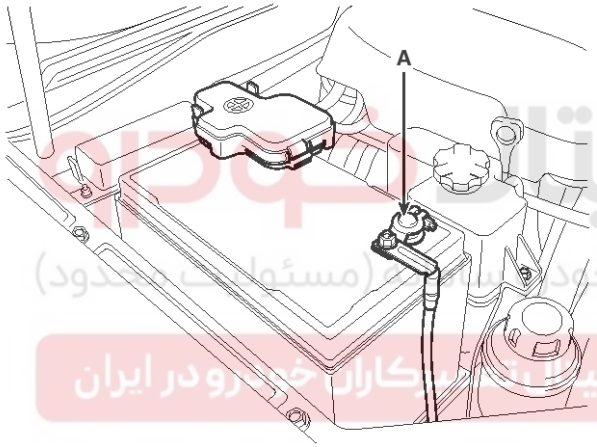
CAUTION

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

NOTICE

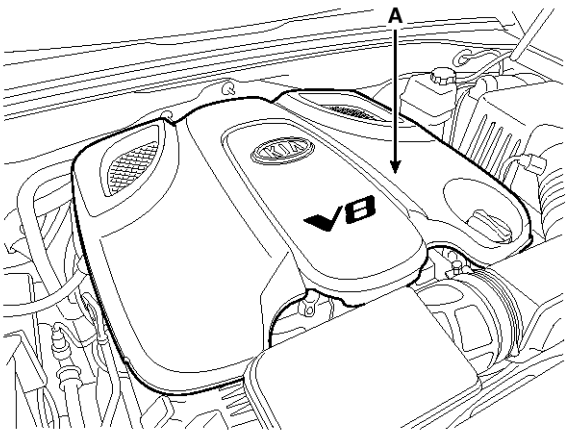
- *Mark all wiring and hoses to avoid misconnection.*

1. First, remove the transmission before removing the engine. (Refer to AT group)
2. Remove the bonnet. (Refer to BD group)
3. Remove the cowl cover and wiper arm. (Refer to BE group)
4. Disconnect the negative terminal from the battery.



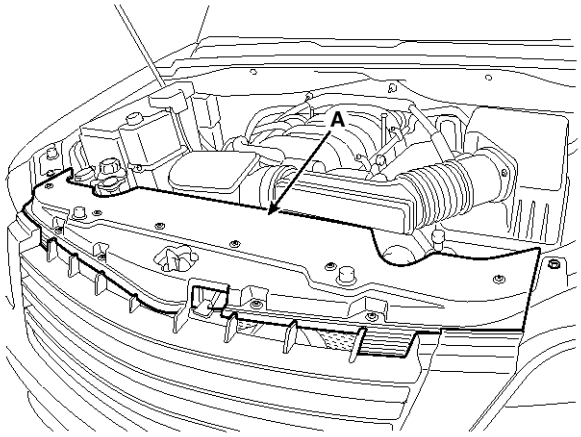
SHMM19043N

5. Remove the engine cover (A).



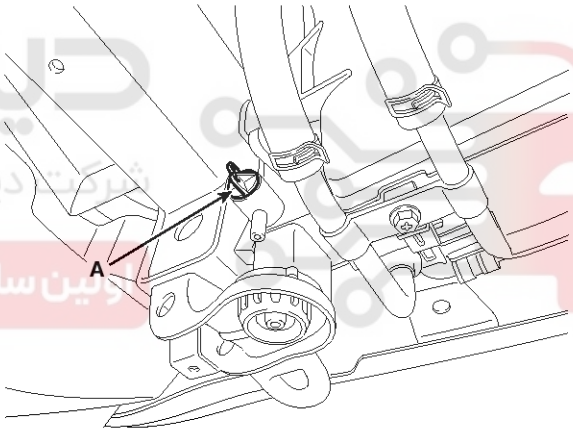
SHMM19044N

6. Remove the radiator grill upper guard (A).



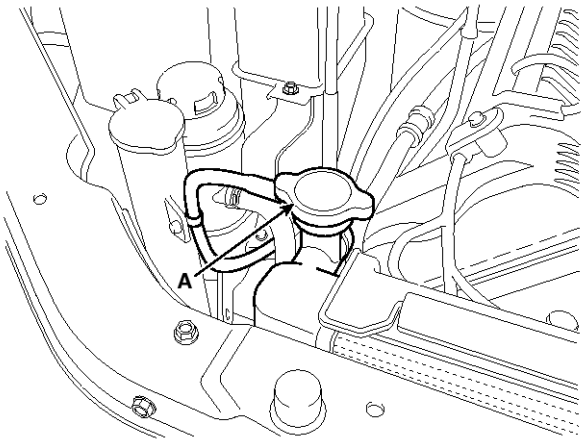
SHMM19045N

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



SHMM19046N

Remove the radiator cap (A) to speed draining.

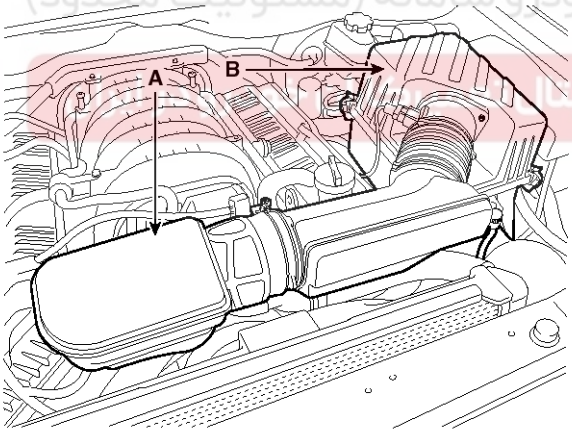


SHMM19047N

WARNING

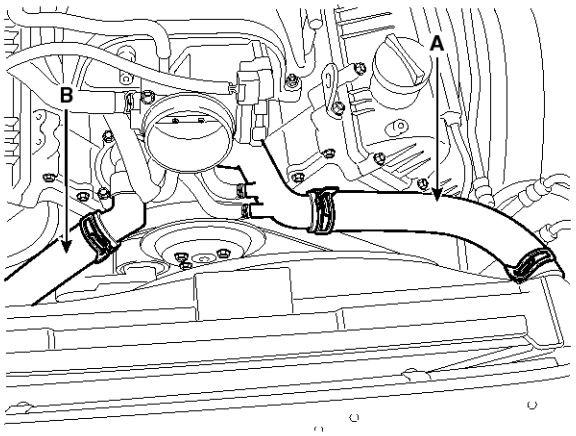
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

8. Recover refrigerant. (Refer to Air conditioner compressor in HA Group)
9. Remove the air duct (A) and the air cleaner assembly (B).



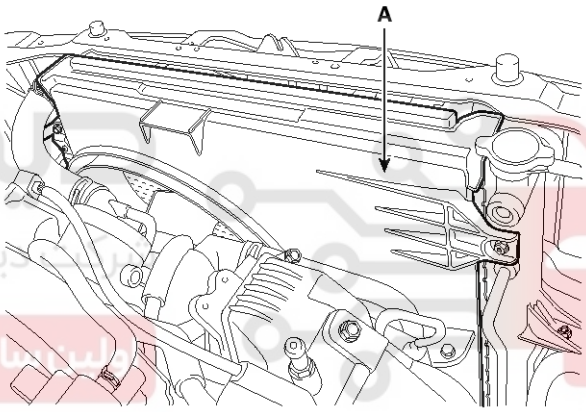
SHMM19048N

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



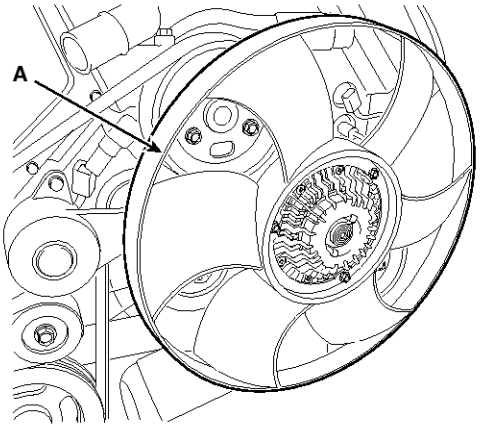
SHMM19049N

11. Remove the radiator upper shroud (A).



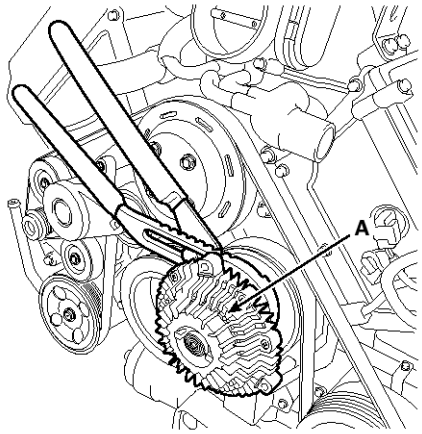
SHMM19050N

12. Remove the cooling fan (A).



SHMM19051N

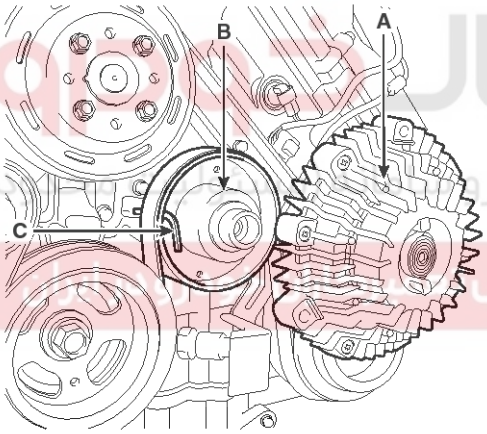
13. Remove the cooling fan clutch (A).



SHMM19052N

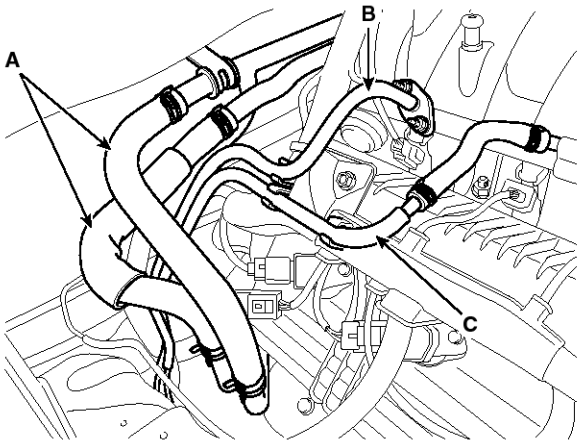
NOTICE

Remove the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



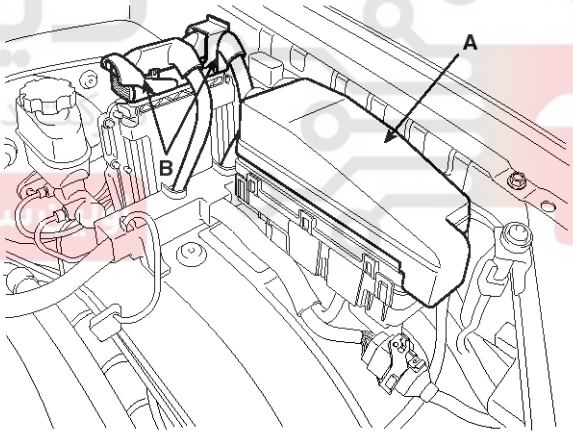
SHMM19053N

14. Disconnect the heater hoses (A), the fuel hose (B) and the purge control solenoid valve (PCSV) hose (C).



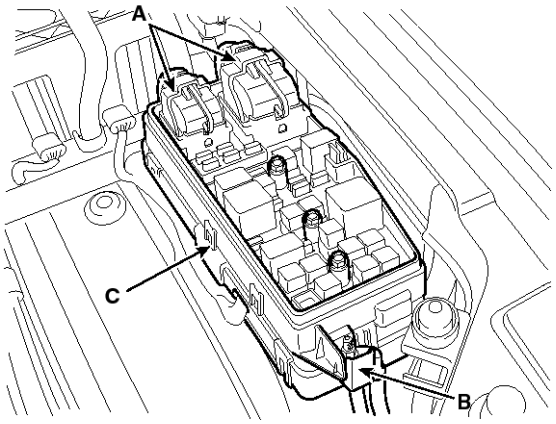
SHMM19054N

15. Remove the engine wire harness from the fuse and relay block.
    1) Remove the ECM connector (B) and the fuse and relay block cover (A).



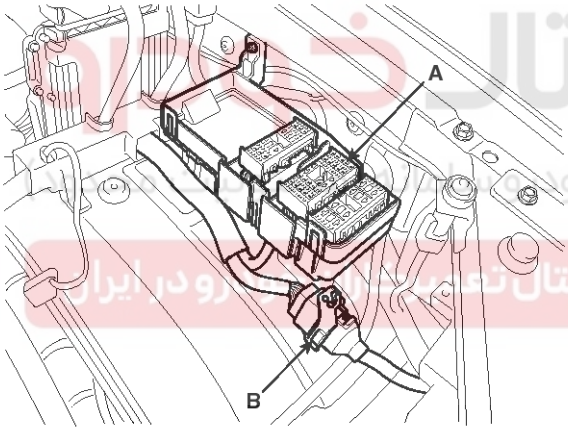
SHMEM8008D

2) Remove the connectors (A) and the cable (B) from the fuse and relay block (C).
3) Remove the fuse and relay block (C).



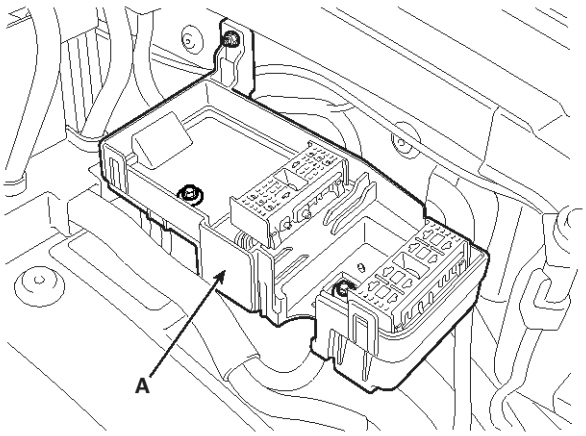
SHMM19055N

4) Remove the fuse and relay block connector (A) and the multi connector (B).



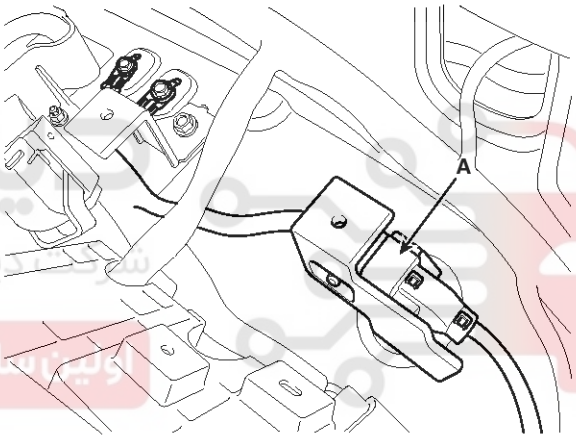
SHMM19310N

5) Remove the fuse and relay block lower cover (A).



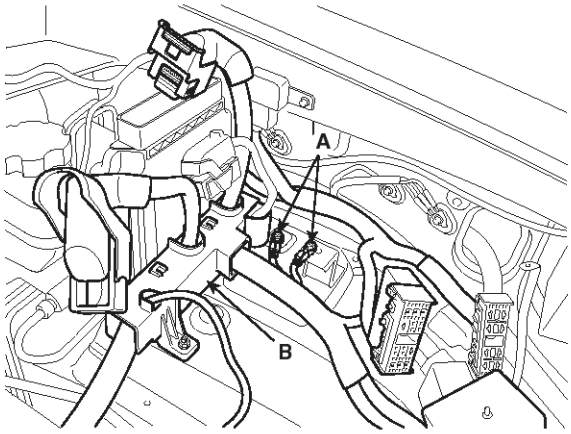
SHMM19056N

6) Remove the connector (A) from the fuse and relay block lower cover bracket.



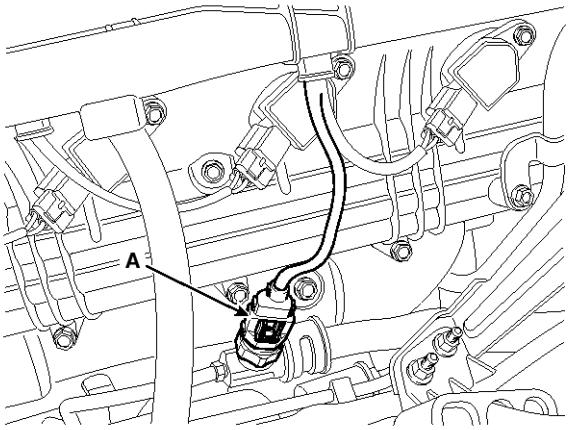
SHMM19057N

7) Remove the earth cable (A) and the harness protector (B).



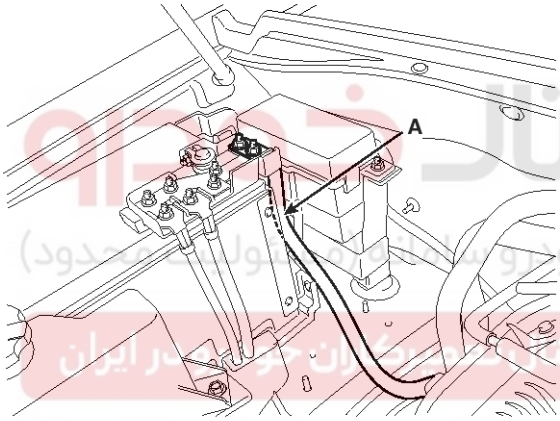
SHMM19311N

16. Remove the power steering pump pressure switch connector (A).



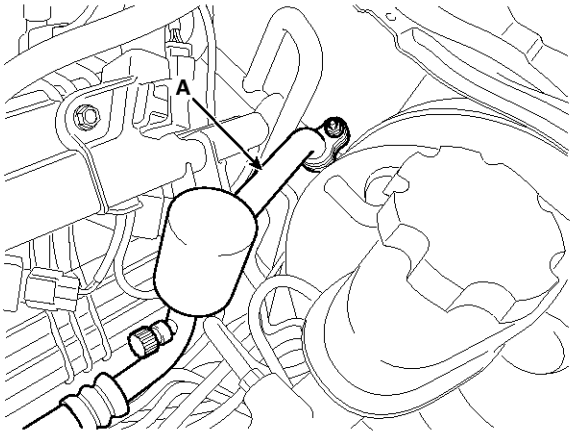
SHMM19058N

17. Remove the cable (A) from the battery.

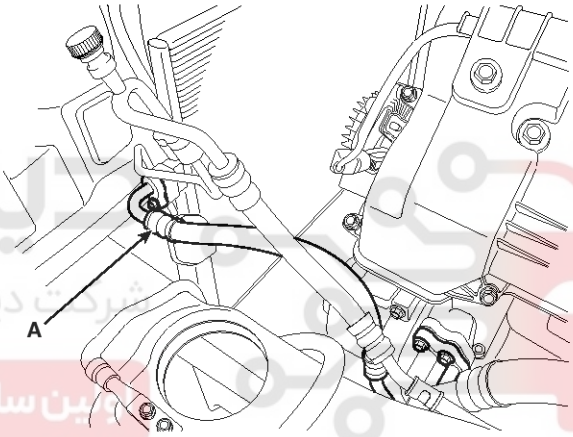


SHMM19155N

18. Remove the air conditioner high pressure pipe (A). (Refer to HA group)

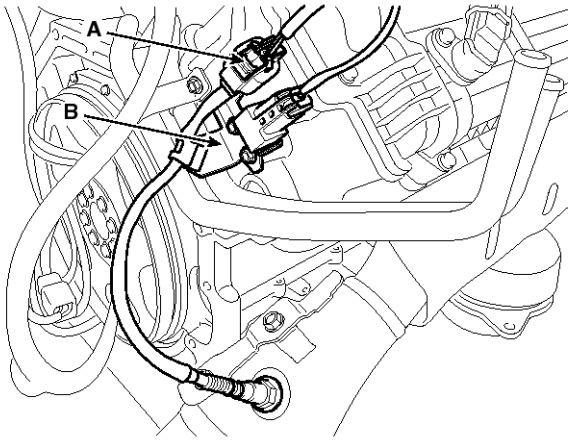


SHMM19059N

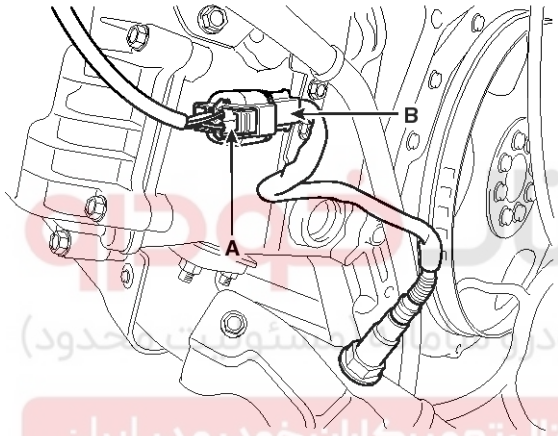


SHMM19060N

19. Remove the oxygen sensor connector (A).

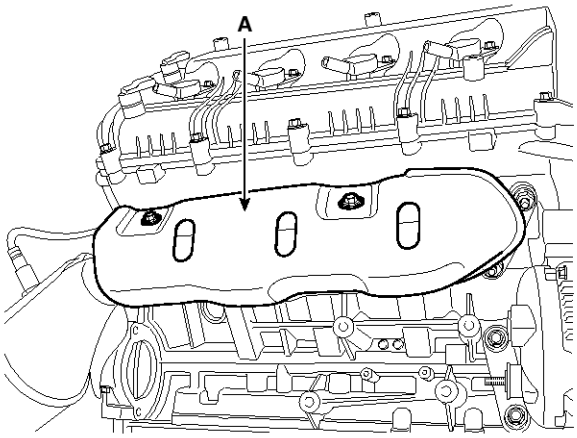


SHMM19080N

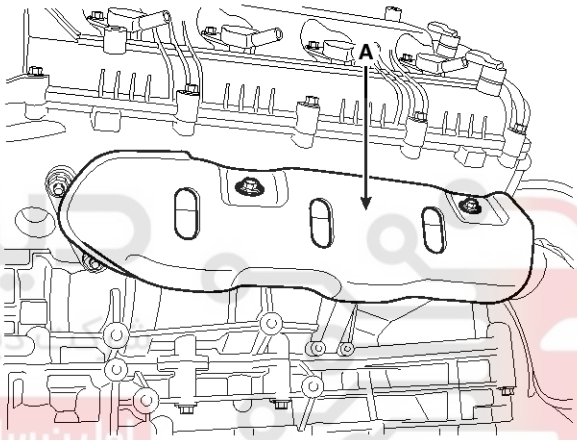


SHMM19079N

20. Remove the exhaust manifold heat protector (A).

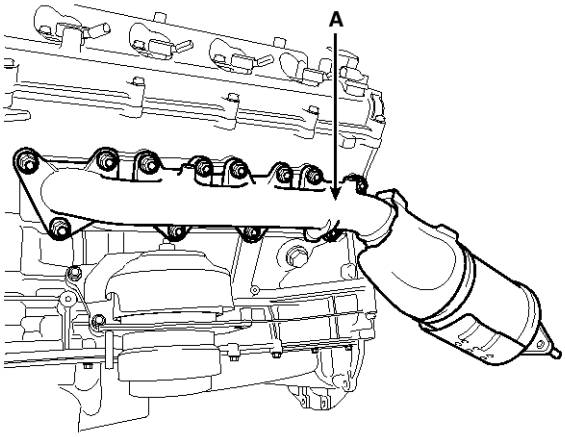


SHMM19002N

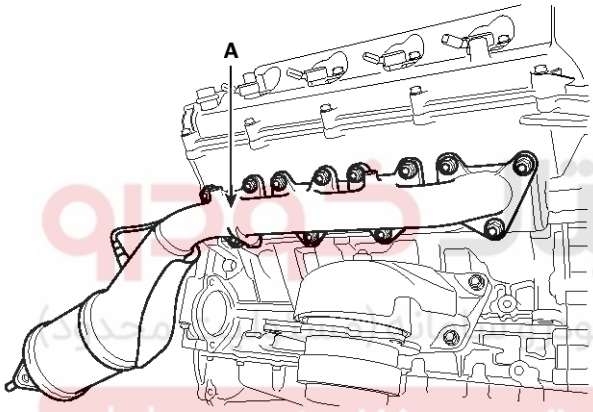


SHMM19003N

21. Remove the exhaust manifold (A).



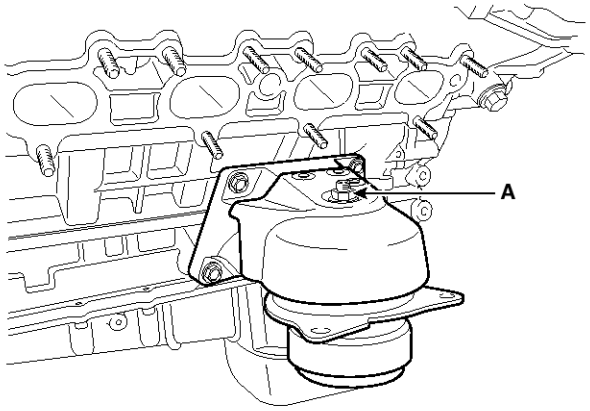
SHMM19063N



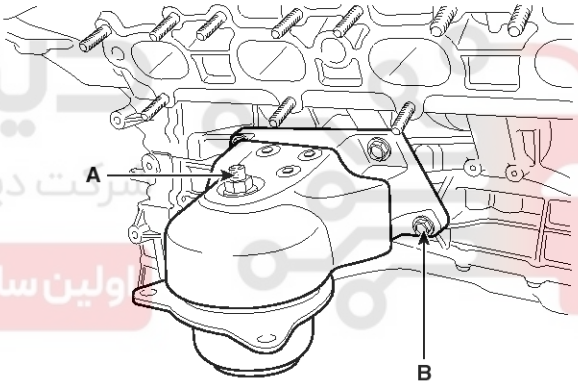
SHMM19064N

22. Remove the engine mounting bracket nuts (A) and the earth cable (B).

Tightening torque :
49.0 ~ 63.7Nm (5.0 ~ 6.5kgf.m, 36.2 ~ 47.0lb-ft)



SHMM19065N



SHMM19066N

23. Remove the engine assembly from the vehicle by using hoist.

NOTICE
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 :

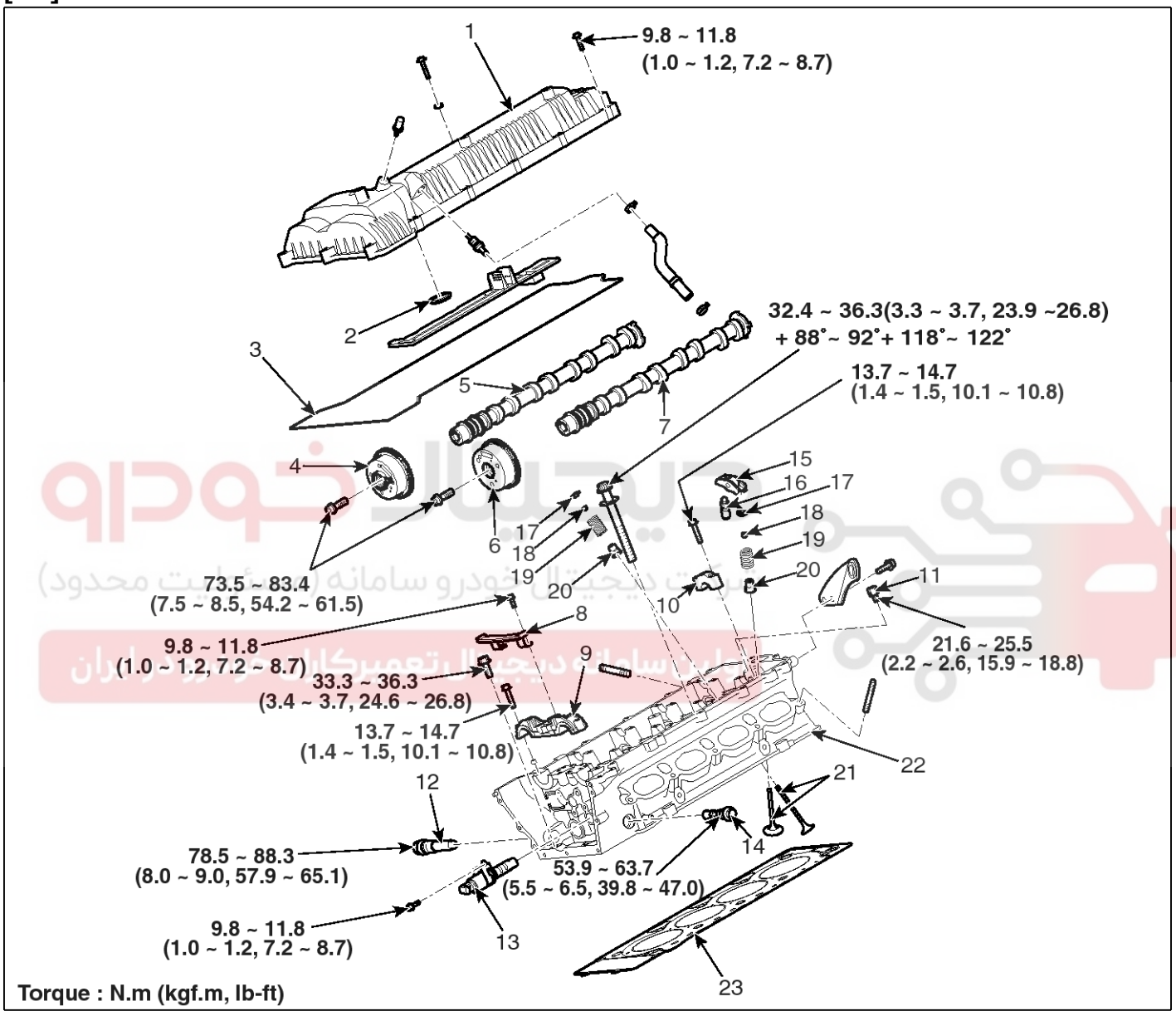
- Adjust the shift cable.
- Refill engine with engine oil.
- Refill transaxle with fluid.
- Clean the battery posts and cable terminals with sandpaper assemble them, then apply grease to prevent corrosion.
- Inspect for fuel leakage.
  - After assembling the fuel line, turn on the ignition switch (do 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 lines.
- Refill radiator with engine coolant.
- 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.

Cylinder Head Assembly

Cylinder Head

Components

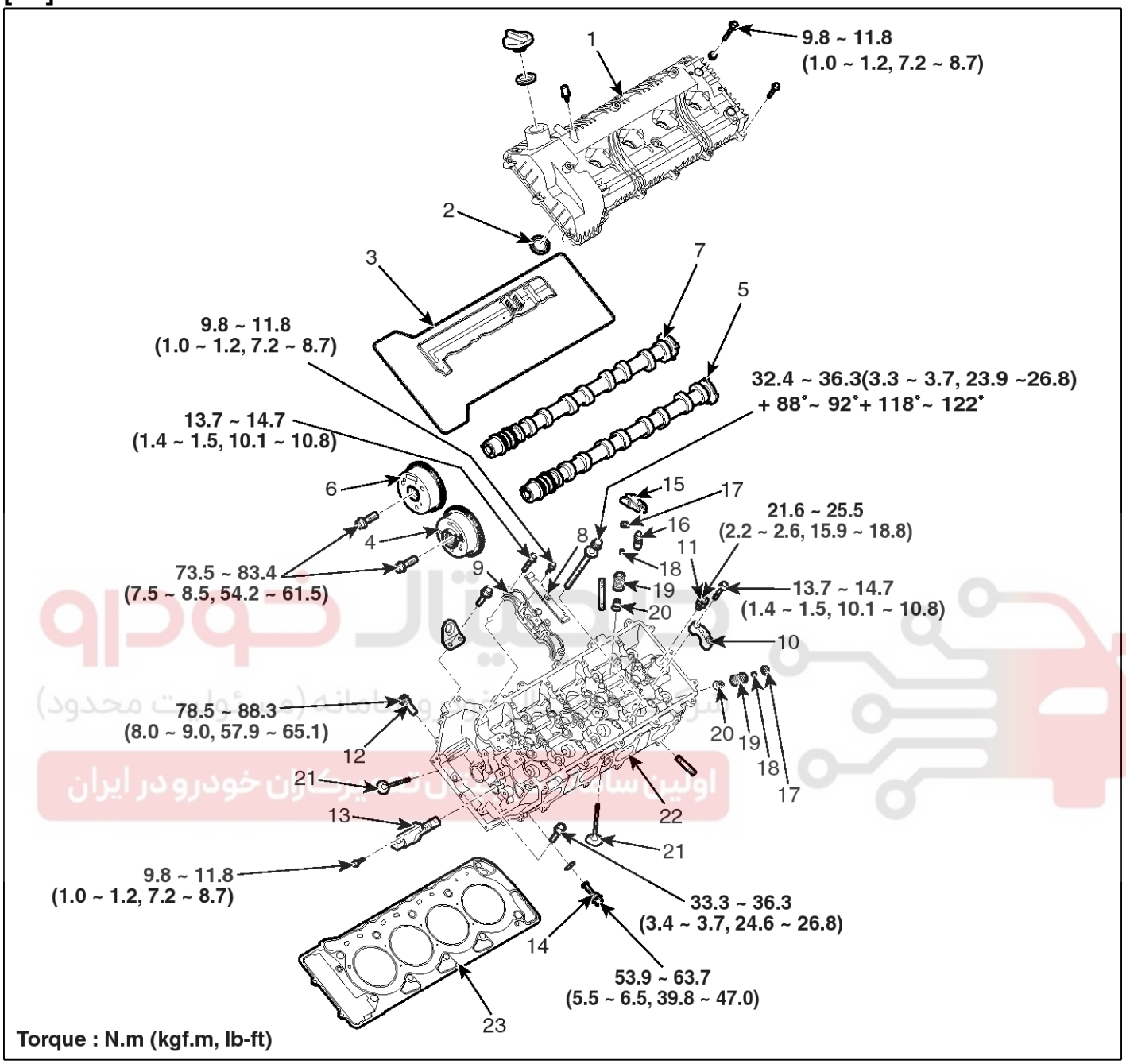
[RH]



SHMM19326N

1. Cylinder head cover
2. Cylinder head cover oil seal
3. Cylinder head cover gasket
4. Exhaust CVVT assembly
5. Exhaust camshaft
6. Intake CVVT assembly
7. Intake camshaft
8. Cam to cam guide
9. Camshaft thrust bearing cap
10. Camshaft bearing cap
11. Pressure relief valve
12. Timing chain tensioner
13. Oil control valve
14. OCV filter
15. Roller finger follower
16. Hydraulic lash adjuster assembly
17. Valve spring retainer
18. Valve spring retainer lock
19. Valve spring
20. Valve stem seal
21. Valve
22. Cylinder head
23. Cylinder head gasket

[LH]



SHMM19327N

1. Cylinder head cover
2. Cylinder head cover oil seal
3. Cylinder head cover gasket
4. Exhaust CVVT assembly
5. Exhaust camshaft
6. Intake CVVT assembly
7. Intake camshaft
8. Cam to cam guide
9. Camshaft thrust bearing cap
10. Camshaft bearing cap
11. Pressure relief valve
12. Timing chain tensioner
13. Oil control valve
14. OCV filter
15. Roller finger follower
16. Hydraulic lash adjuster assembly
17. Valve spring retainer
18. Valve spring retainer lock
19. Valve spring
20. Valve stem seal
21. Valve
22. Cylinder head
23. Cylinder head gasket

Removal

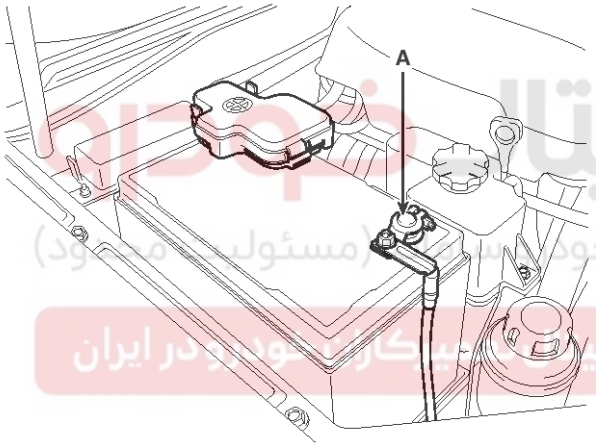
CAUTION

- **Use fender covers to avoid damaging painted surfaces.**
- **To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal operating 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.**

NOTICE

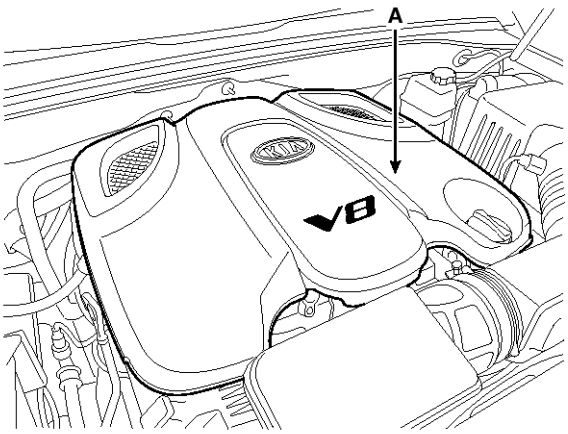
- *Mark all wiring and hoses to avoid misconnection.*
- *Turn the crankshaft pulley so that the No. 1 piston is at top dead center.*

1. Disconnect the negative terminal from the battery.



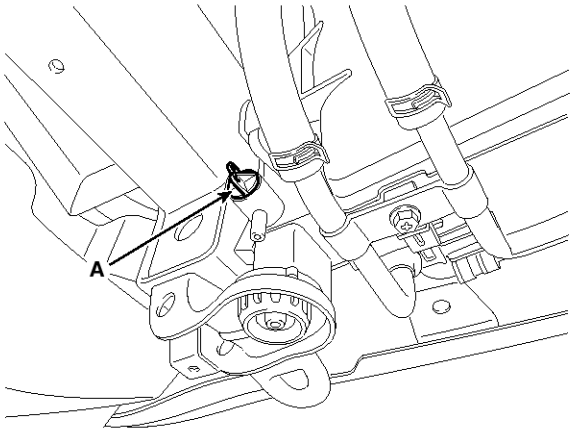
SHMM19043N

2. Remove the engine cover (A).



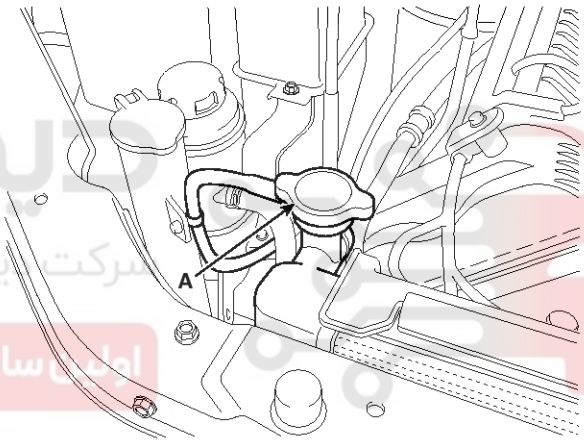
SHMM19044N

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



SHMM19046N

Remove the radiator cap (A) to speed draining.

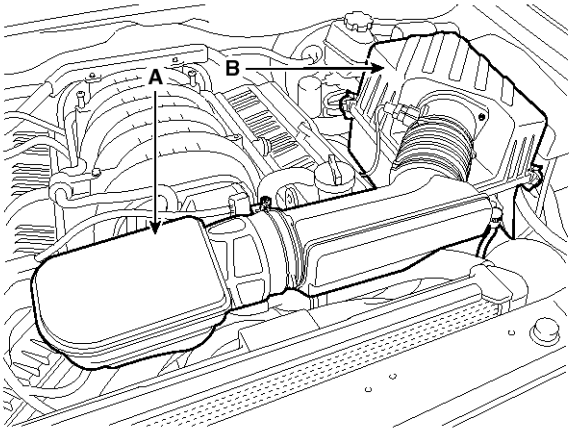


SHMM19047N

WARNING

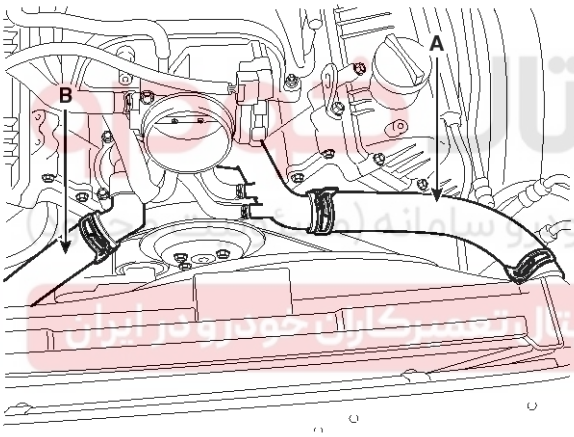
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

4. Remove the air duct (A) and the air cleaner assembly (B).



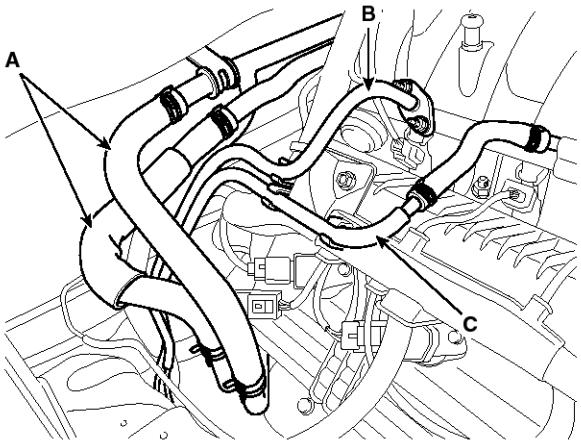
SHMM19048N

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



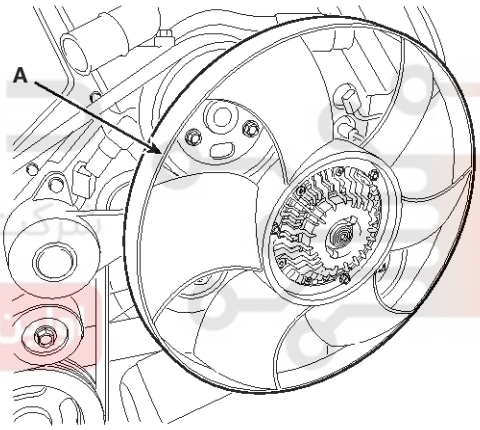
SHMM19049N

6. Disconnect the heater hoses (A), the fuel hose (B) and the purge control solenoid valve (PCSV) hose (C).



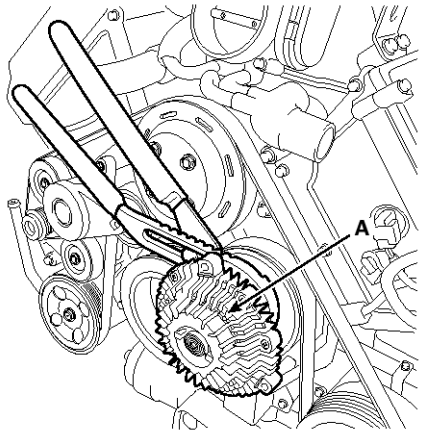
SHMM19054N

7. Remove the cooling fan (A).



SHMM19051N

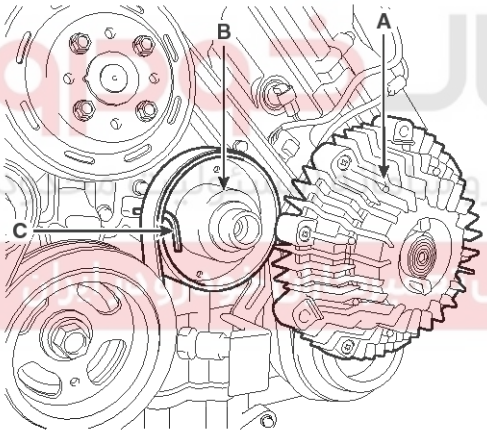
8. Remove the cooling fan clutch (A).



SHMM19052N

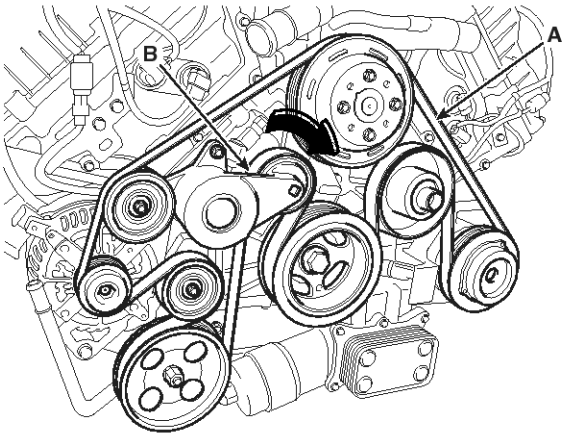
NOTICE

Remove the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



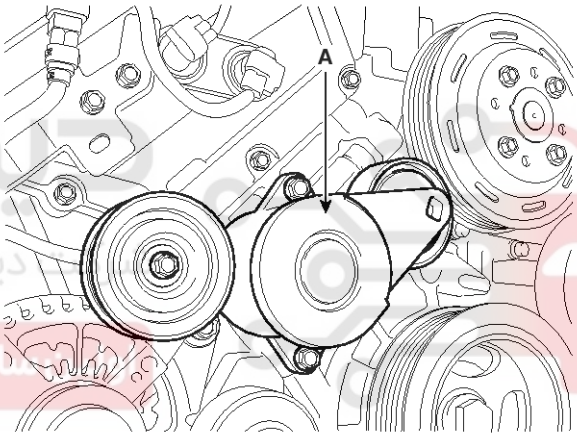
SHMM19053N

9. Turn the tensioner (B) clockwise and loosen, then remove the drive belt (A).



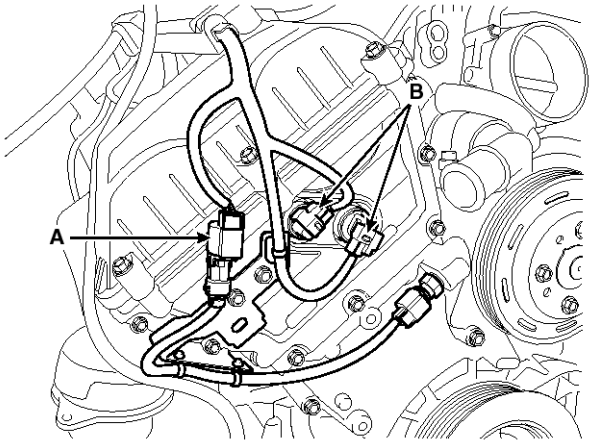
SHMM19067N

10. Remove the drive belt tensioner (A).



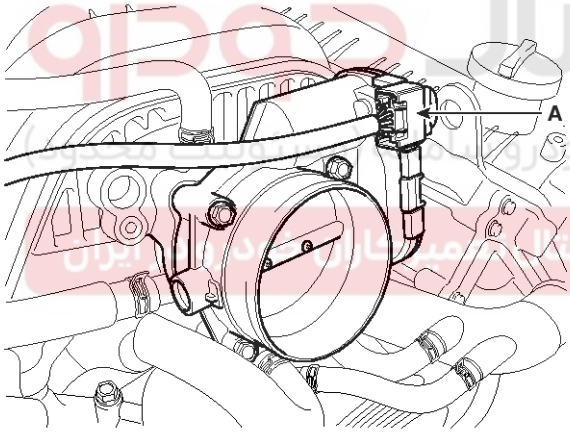
SHMM19068N

11. Remove the engine wiring harness from the cylinder head.
    1) Disconnect the water temperature sensor connector (A) and the CVVT oil control valve connectors (B).



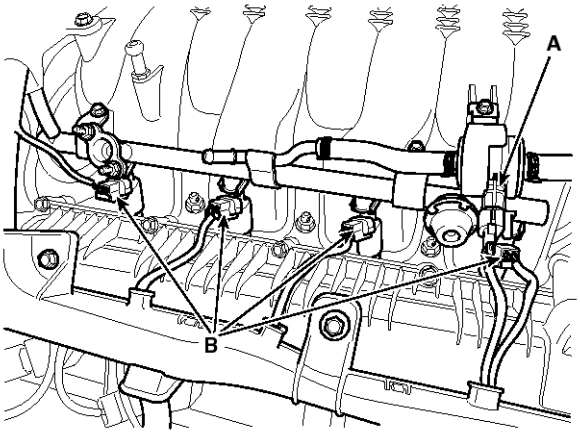
SHMM19069N

    2) Disconnect the ETC module connector (A).



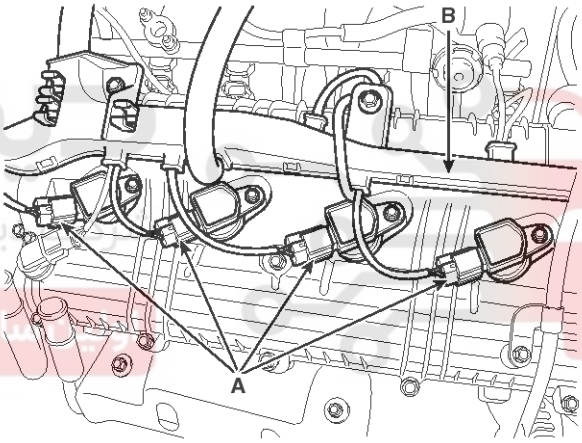
SHMM19070N

    3) Disconnect the PCSV connector (A) and the injector connectors (B).



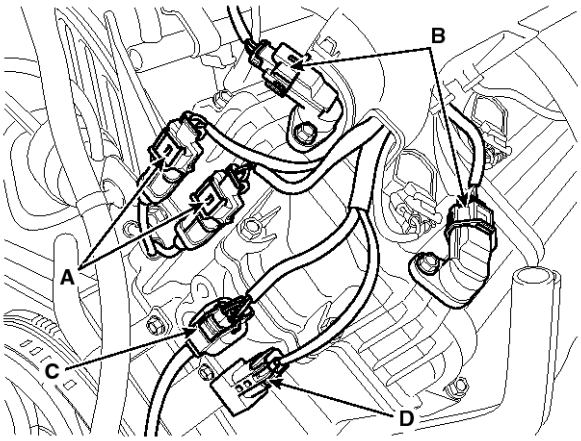
SHMM19071N

    4) Disconnect the ignition coil connectors (A) and the wiring harness protector (B).



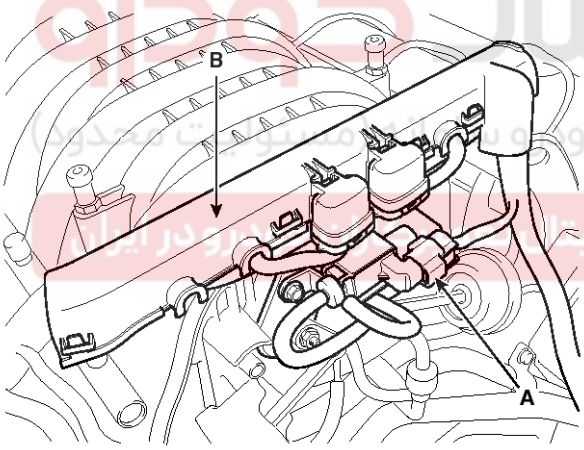
SHMM19072N

5) Disconnect the knock sensor connectors (A), the camshaft position sensor connectors (B), the oxygen sensor connector (C) and the condenser connector (D).



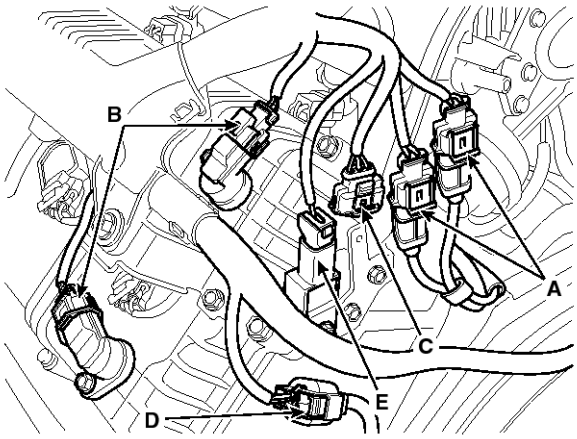
SHMM19073N

6) Disconnect the variable intake system solenoid valve connector (A) and the wiring harness protector (B).



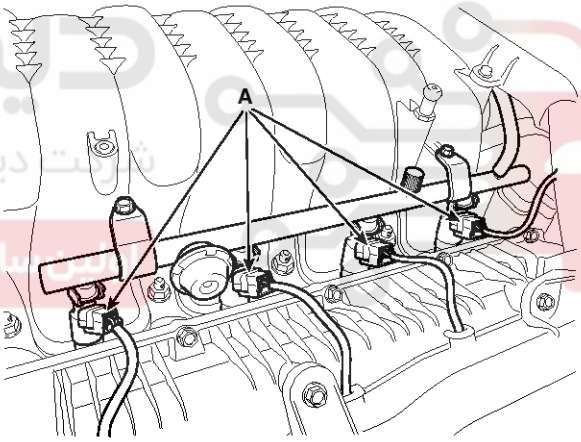
SHMM19074N

7) Disconnect the knock sensor connectors (A), the camshaft position sensor connectors (B), the crankshaft position sensor connector (C), the oxygen sensor connector (D) and the condenser connector (E).



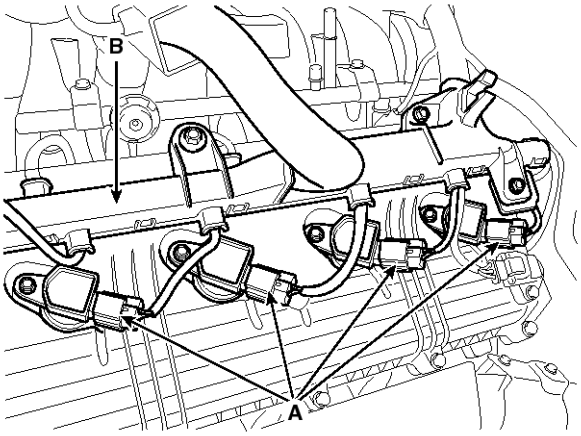
SHMM19075N

8) Disconnect the injector connectors (A).



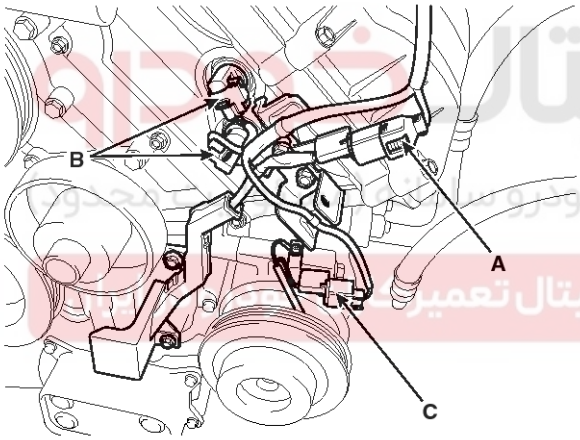
SHMM19076N

9) Disconnect the ignition coil connectors (A) and the wiring harness protector (B).



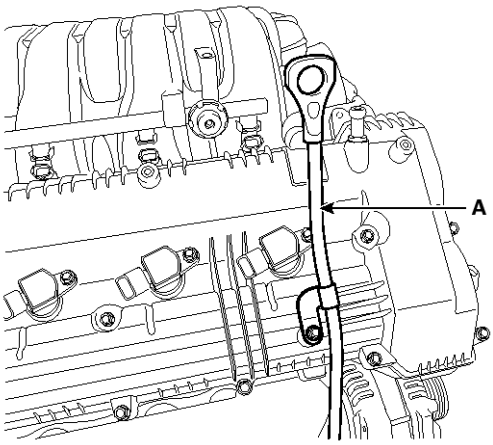
SHMM19077N

10) Disconnect the oil pressure switch connector (A), the CVVT oil control valve connectors (B) and the air conditioner compressor switch connector (C).



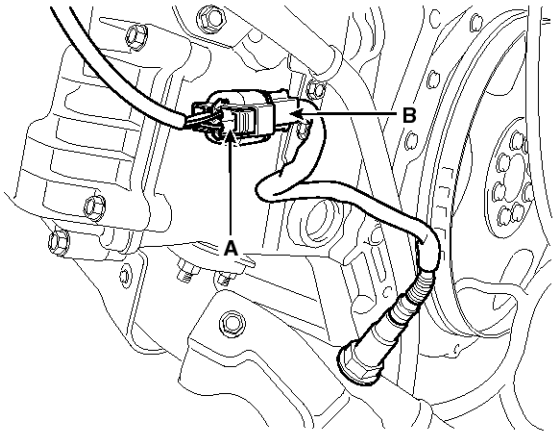
SHMM19078N

12. Remove the oil level gauge (A).

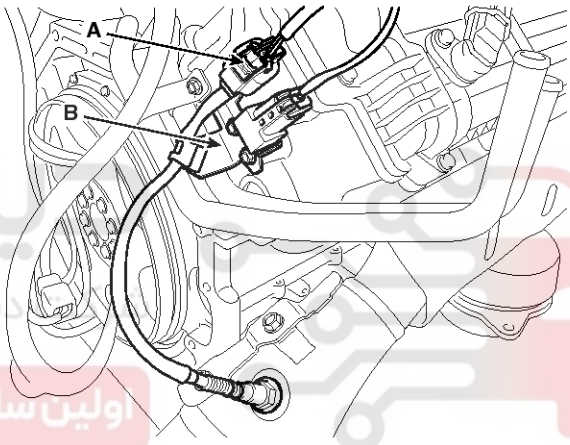


SHMM19001N

13. Disconnect the oxygen sensor connector (A) and remove the oxygen sensor connector bracket (B).

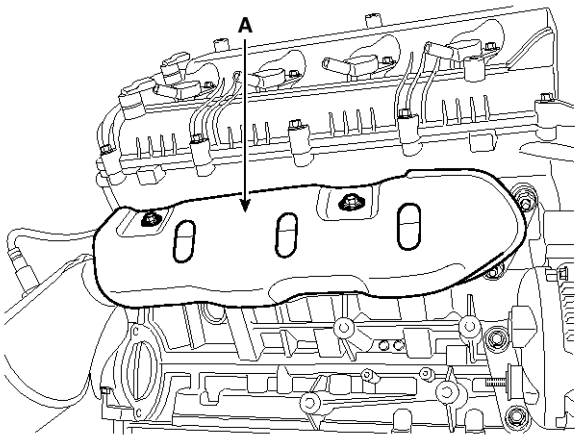


SHMM19079N

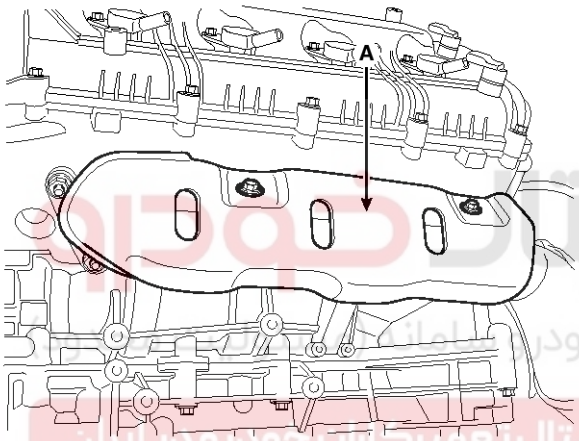


SHMM19080N

14. Remove the exhaust manifold heat protector (A).

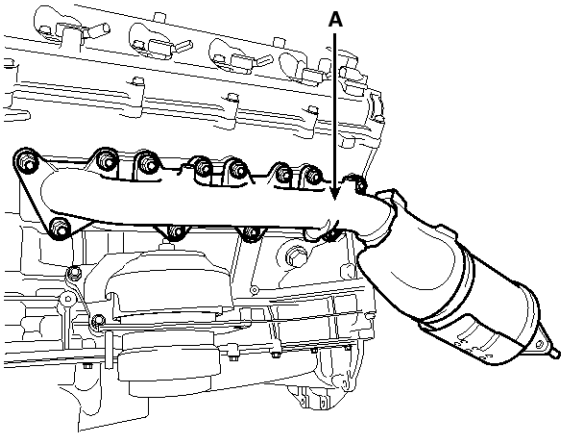


SHMM19002N

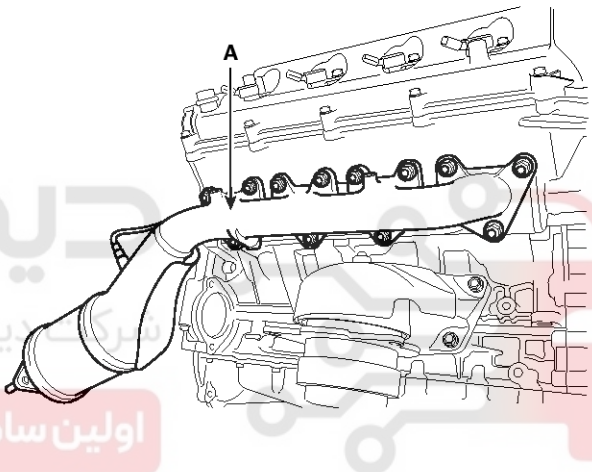


SHMM19003N

15. Remove the exhaust manifold (A).

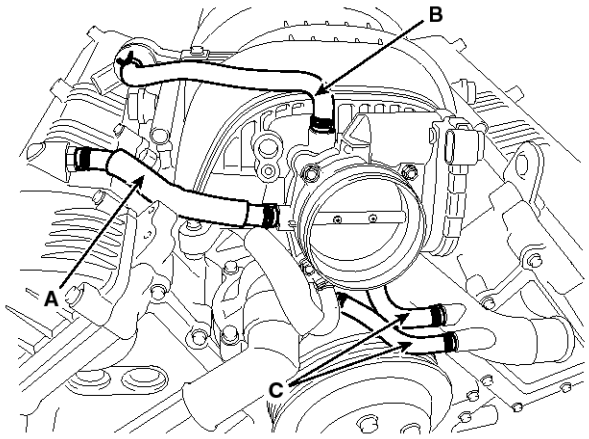


SHMM19063N



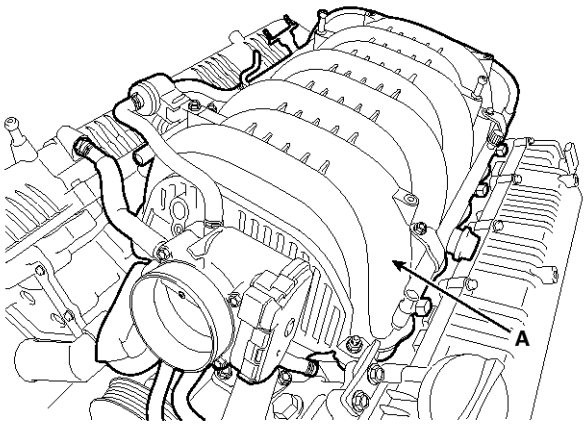
SHMM19064N

16. Disconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) from the intake manifold module and the throttle body.



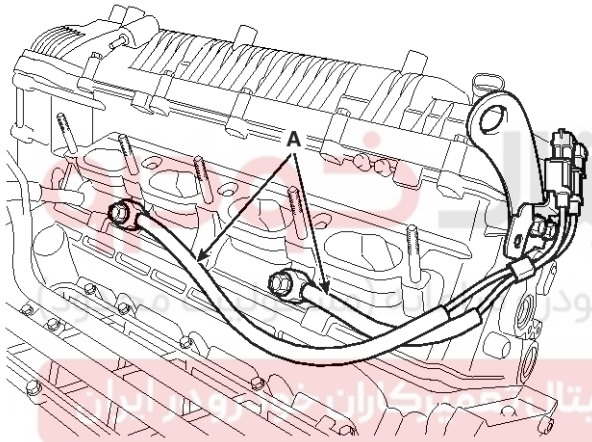
SHMM19081N

17. Remove the intake manifold module (A).

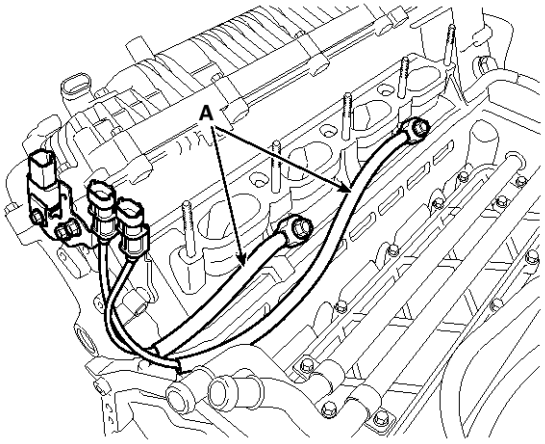


SHMM19082N

18. Remove the knock sensors (A).

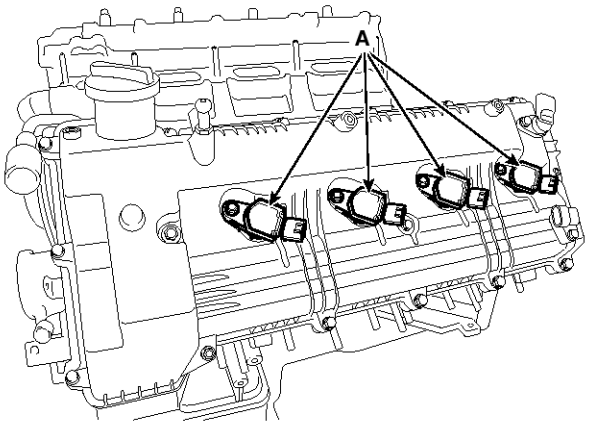


SHMM19008N

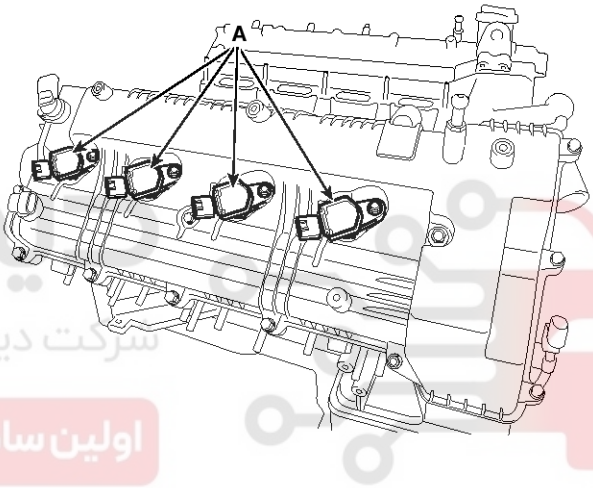


SHMM19009N

19. Remove the ignition coils (A).

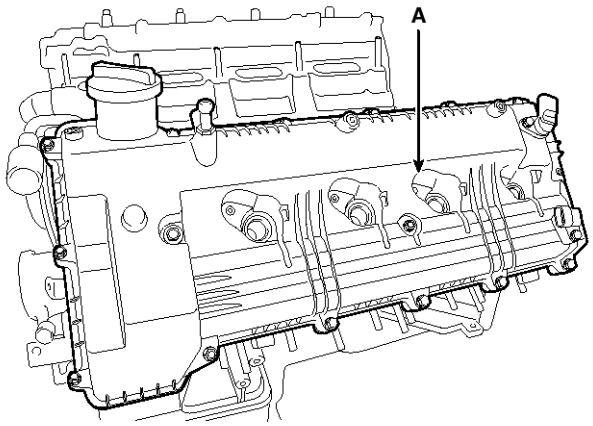


SHMM19010N

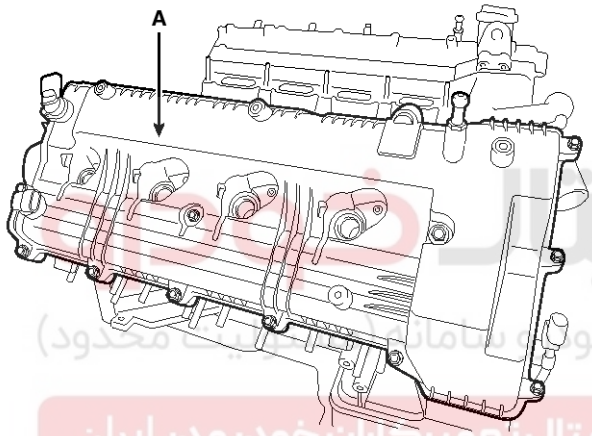


SHMM19011N

20. Remove the cylinder head cover (A).

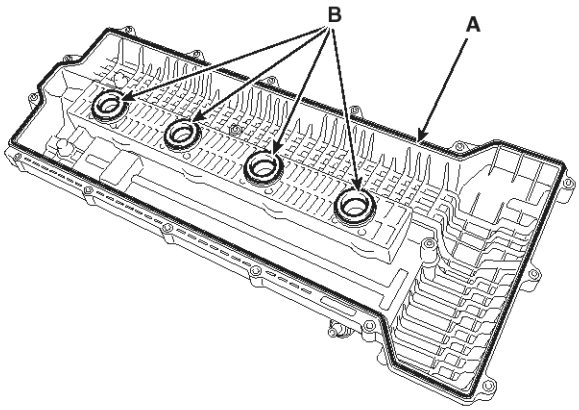


SHMM19012N

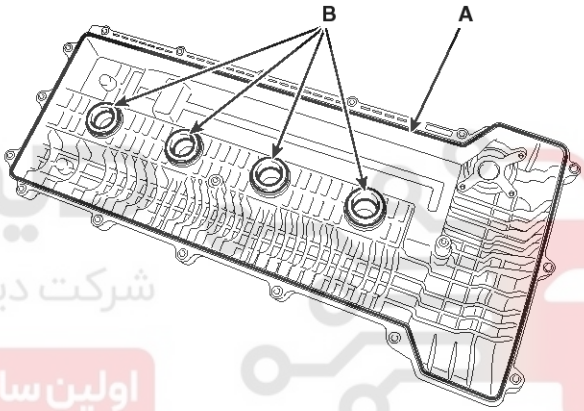


SHMM19013N

21. Remove the cylinder head cover gasket (A) and oil seal (B).

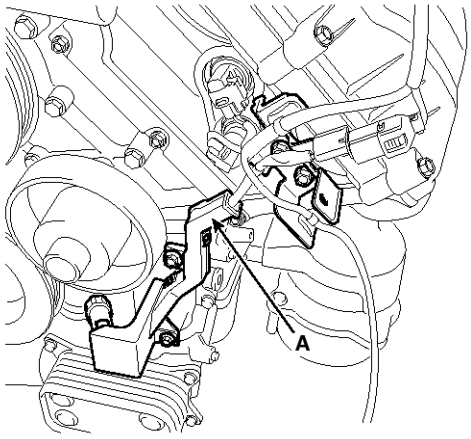


SHMM19016N



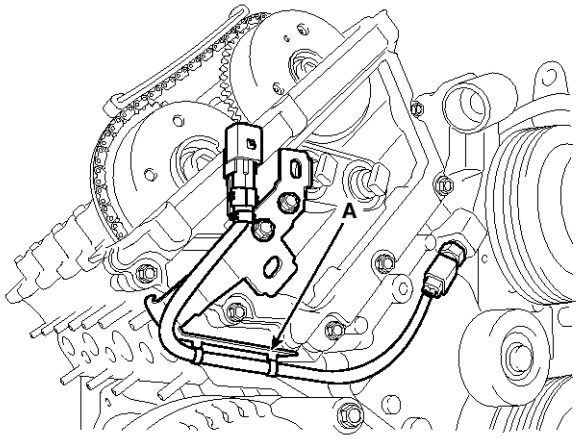
SHMM19017N

22. Remove the oil pressure switch wiring assembly and bracket (A).



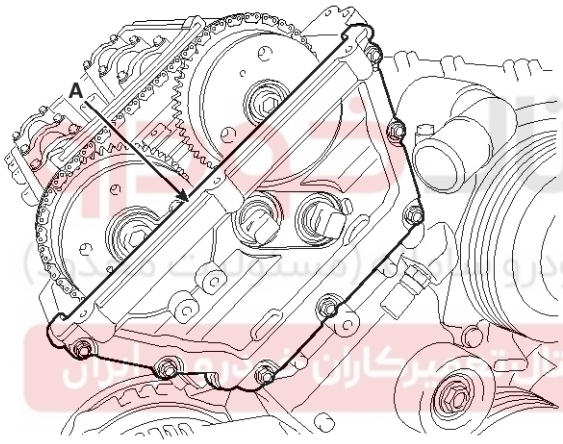
SHMM19083N

23. Remove the water temperature sensor wiring assembly and bracket (A).

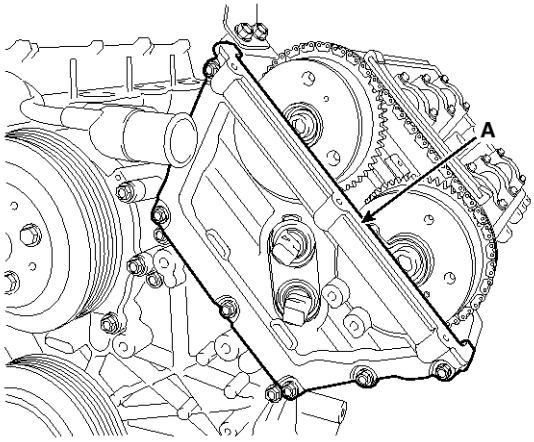


SHMM19019N

24. Remove the timing chain upper cover (A).

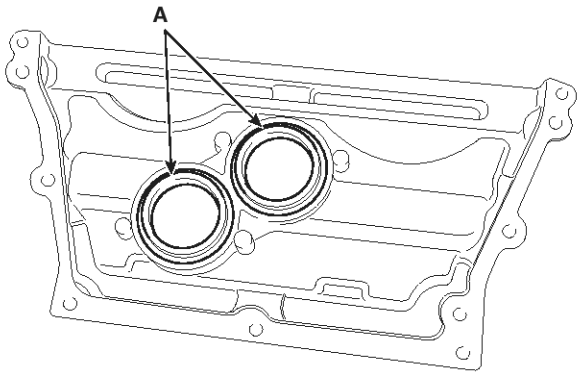


SHMM19020N

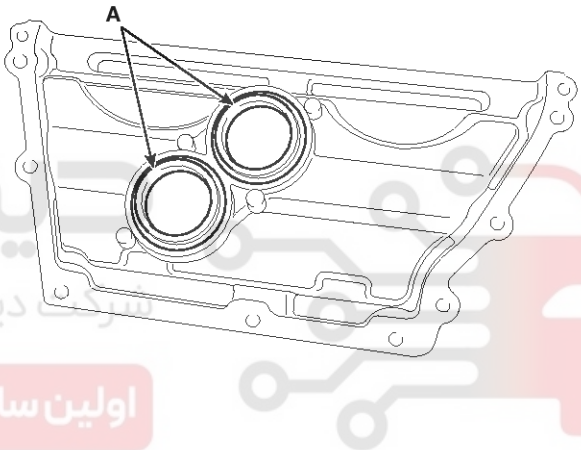


SHMM19021N

25. Remove the timing chain upper cover oil seal (A).

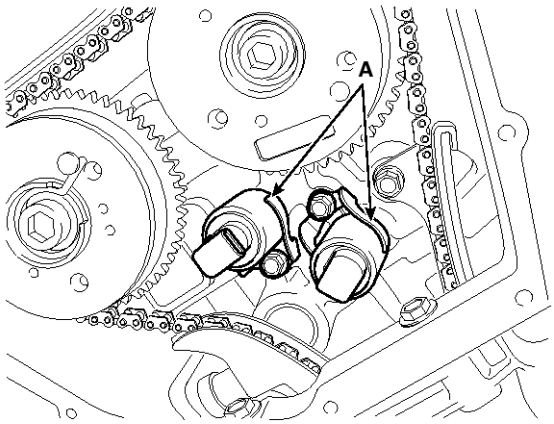


SHMM19022N

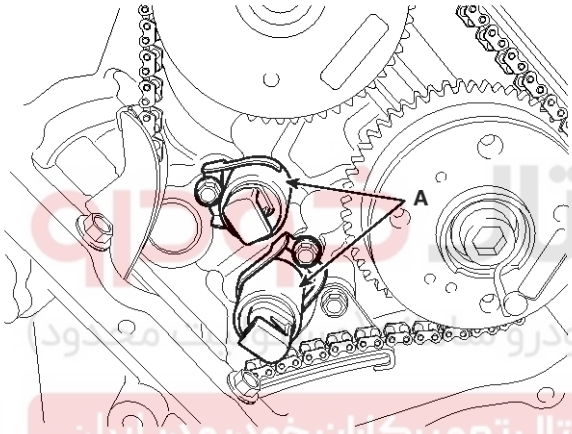


SHMM19023N

26. Remove the oil control valve (A).



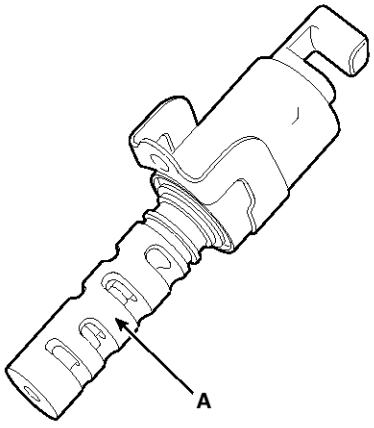
SHMM19024N



SHMM19025N

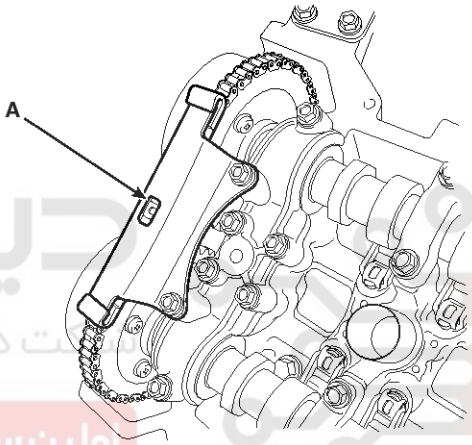
NOTICE

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

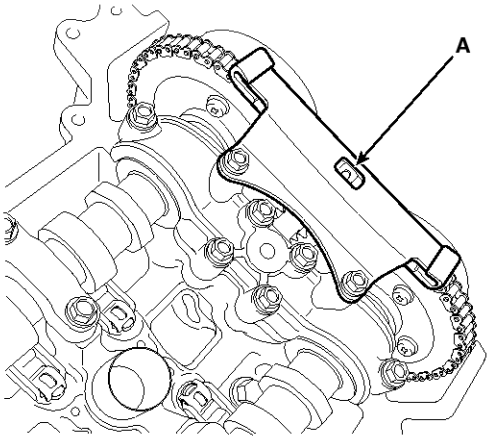


SVIM19146D

27. Remove the cam to cam guide (A).



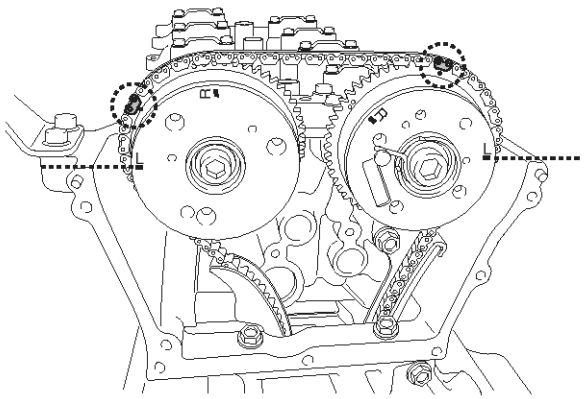
SHMM19026N



SHMM19027N

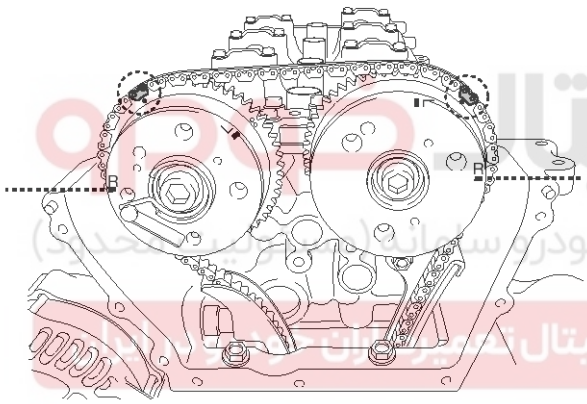
28. Align the timing mark of camshaft sprocket.

[LH]



SHMM19028N

[RH]

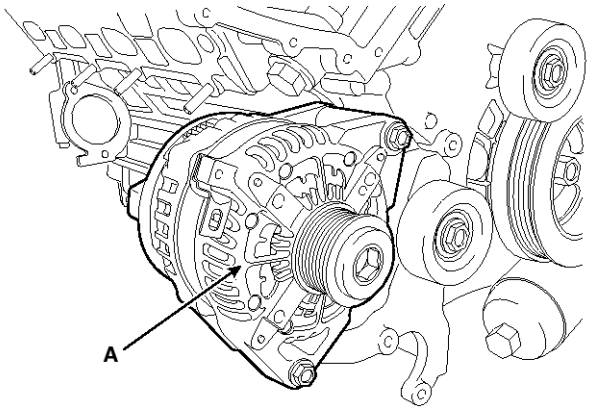


SHMM19029N

NOTICE

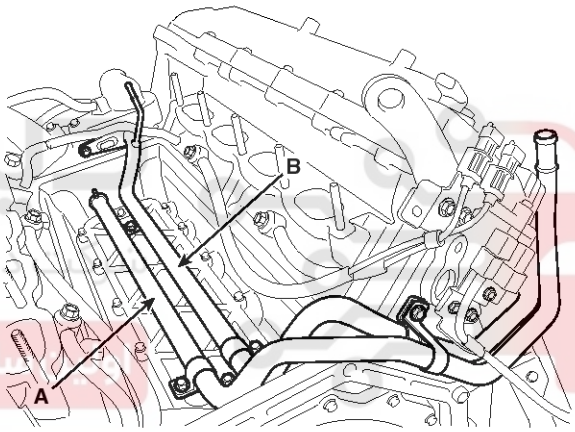
In case that the timing system has been disassembled wholly, the timing chain can be installed with all of chain installation mark of the sprocket and timing marked chain links aligned without additional marking. However, in case of on-vehicle repair (for cylinder head assembly, timing chain tensioner, CVVT, camshaft, HLA or etc.), which is not necessary to remove the timing chain completely, mark the timing chain links corresponding to the chain installation marks on the sprocket with an identification when the No.1 piston is at TDC position because it is very difficult to align all of the chain installation mark of the sprocket and the timing marked chain links.

29. Remove the alternator (A).



SHMM19030N

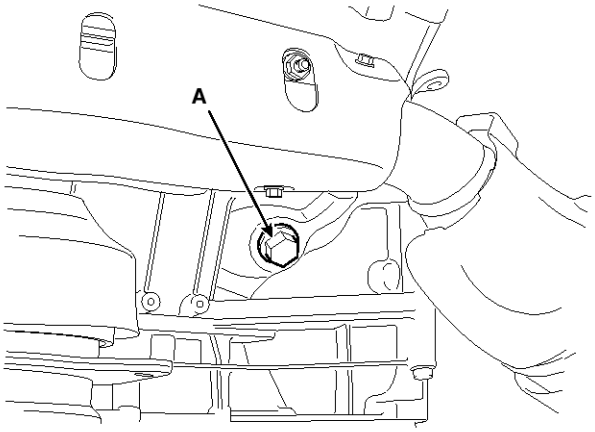
30. Remove the water outlet pipe (A) and the water inlet pipe (B).



SHMM19084N

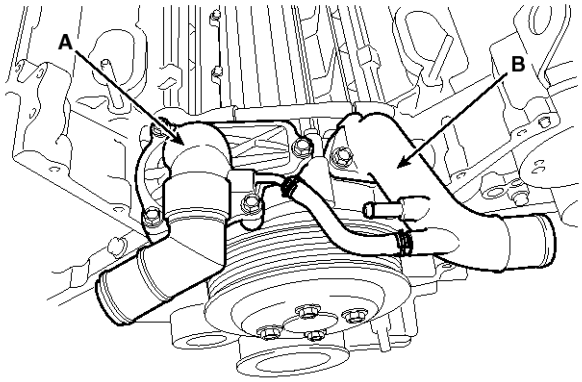
NOTICE

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



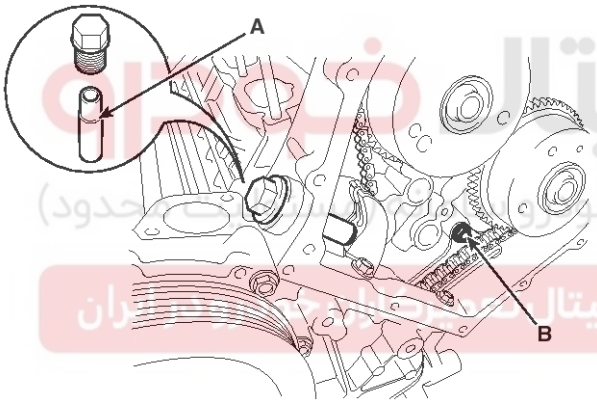
SHMM19085N

31. Remove the water temperature control assembly (A) and the water outlet fitting assembly (B).

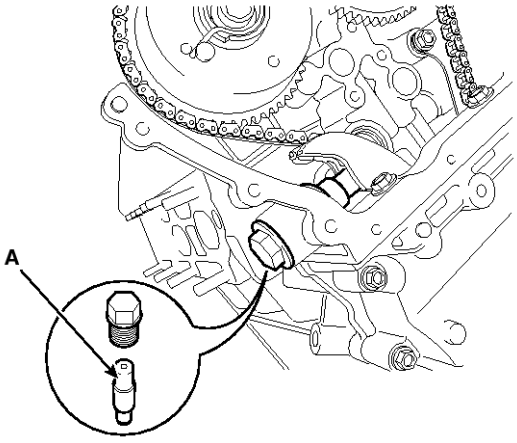


SHMM19033N

32. Remove the timing chain tensioner (A).

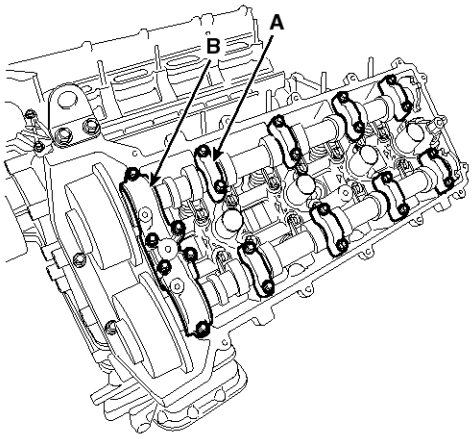


SHMM19034N

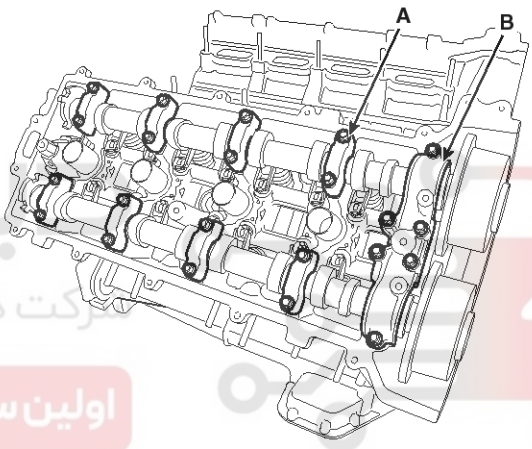


SHMM19035N

33. Remove the camshaft bearing caps (A) and the camshaft thrust bearing cap (B).

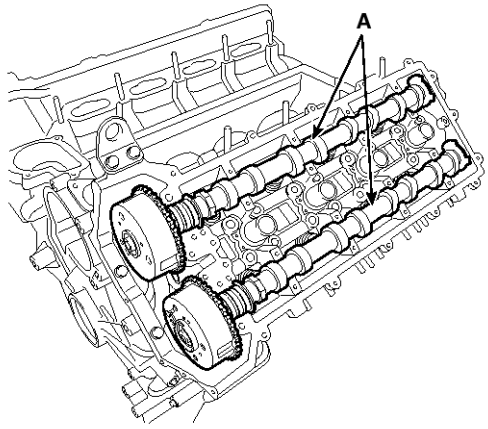


SHMM19036N

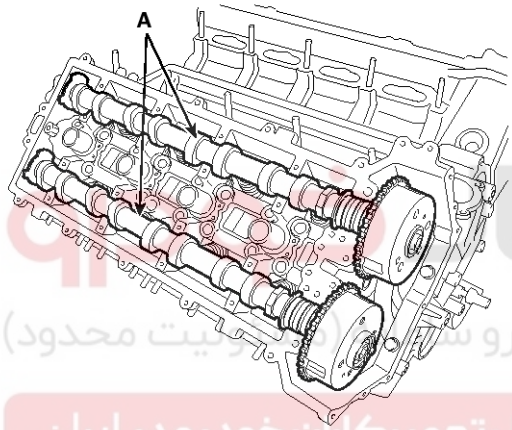


SHMM19037N

34. Remove the camshaft and CVVT assembly (A).

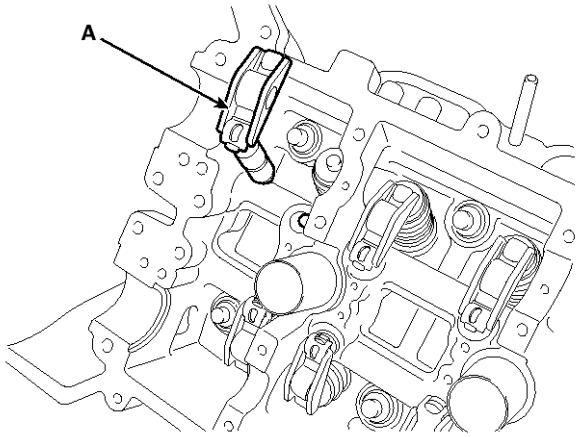


SHMM19160N



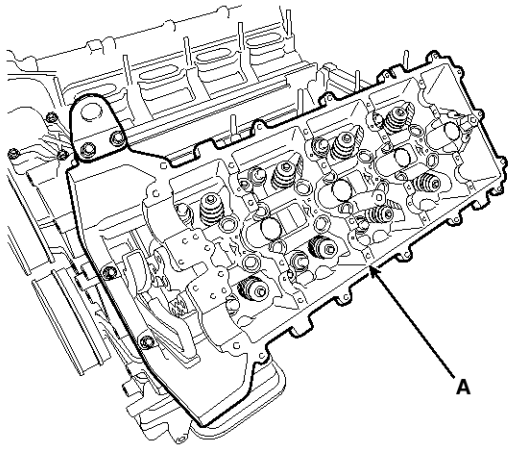
SHMM19161N

35. Remove the roller finger follower and the hydraulic lash adjuster assembly (A).

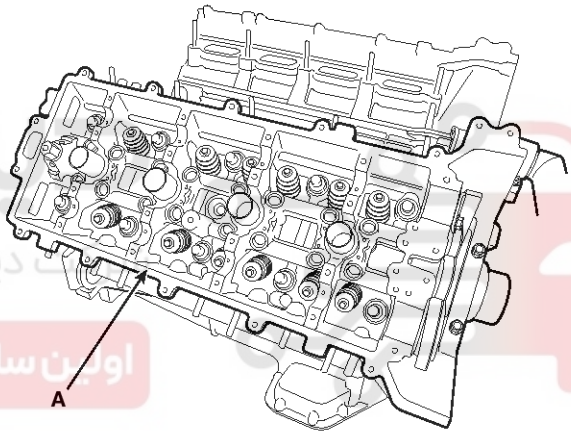


SHMM19040N

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



SHMM19041N

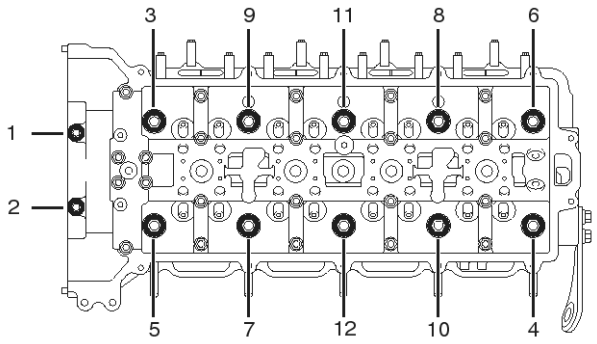


SHMM19042N

NOTICE

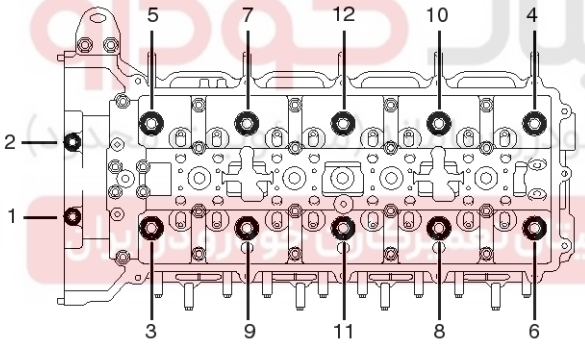
Head warpage or cracking could result from removing bolts in an incorrect order.

[RH]



SHMM19349N

[LH]



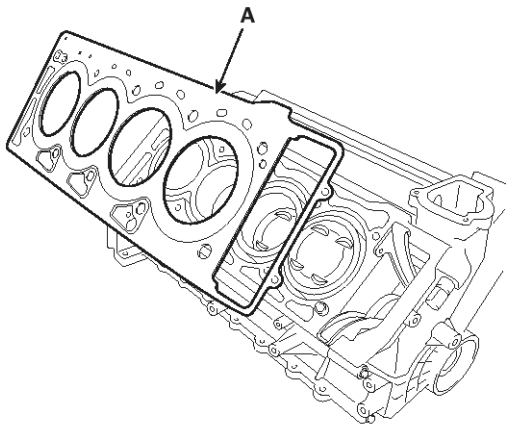
SVIM19121D

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

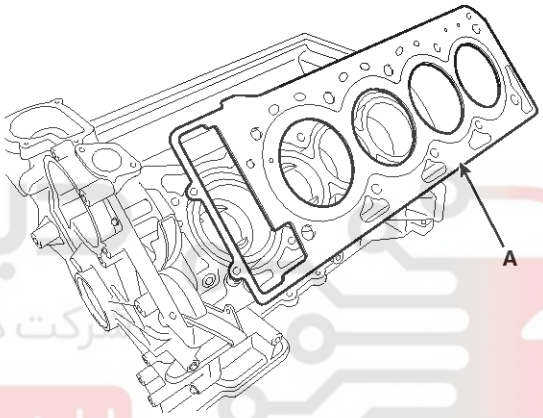
NOTICE

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

37. Remove the cylinder head gasket (A).



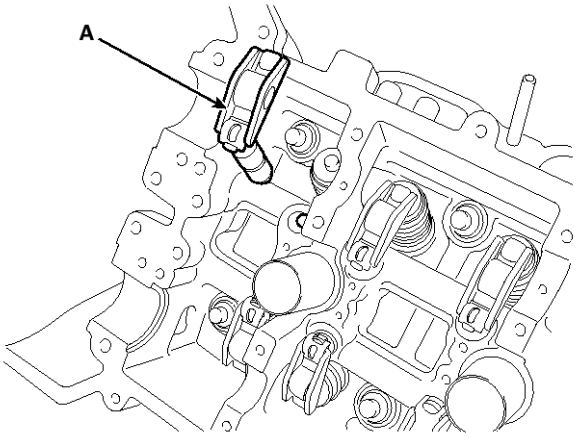
SHMM19359N



SHMM19360N

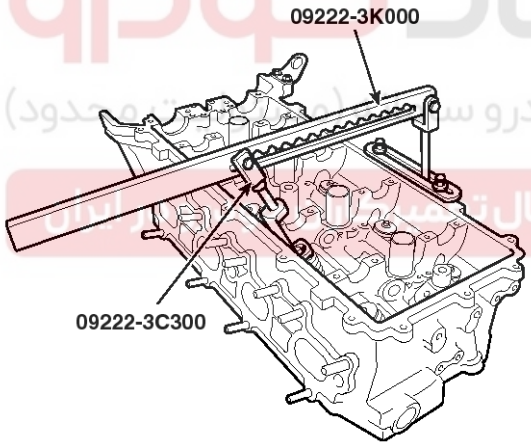
Disassembly

1. Remove the roller finger follower and the hydraulic lash adjuster assembly (A).



SHMM19040N

2. Remove the valves.
   1) Using the SST(09222-3K000, 09222-3C300), compress the valve spring and remove retainer lock.



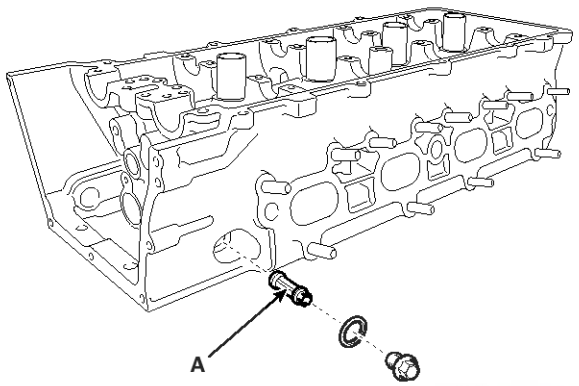
SHMM19119N

   2) Remove the spring retainer.
   3) Remove the valve spring.
   4) Remove the valve.
   5) Remove the valve stem seal.

      NOTICE
      Do not reuse old valve stem seals.

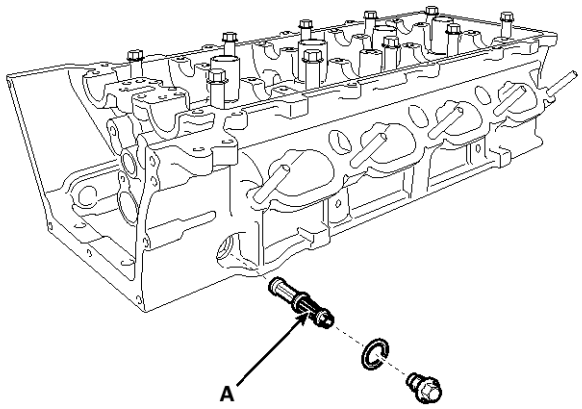
3. Remove the OCV filter(A).

[LH]



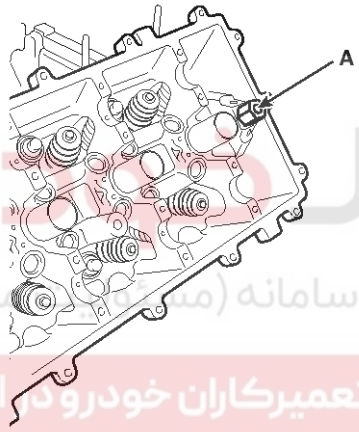
SHMM19121N

[RH]



SHMM19122N

4. Remove the pressure relief valve.



SHMM19312N

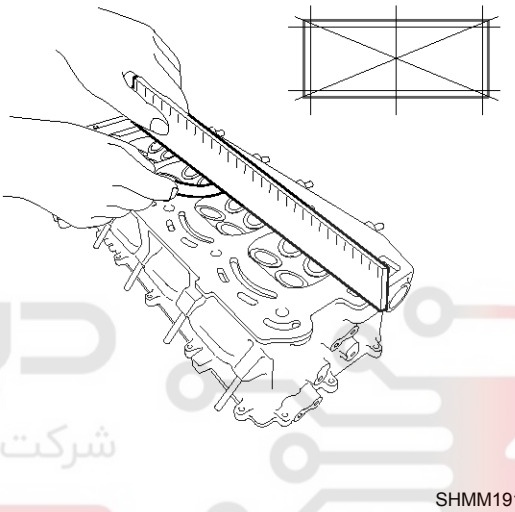
Inspection

Cylinder Head

1. Inspect for flatness.

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

Flatness of cylinder head gasket surface
Standard : Less than 0.05mm(0.002in)
[Less than 0.02mm(0.0008in)/100x100]
Flatness of manifold gasket surface
Standard : Less than 0.1mm(0.004in)
[Less than 0.03mm(0.0012in)/110x110]



SHMM19123N

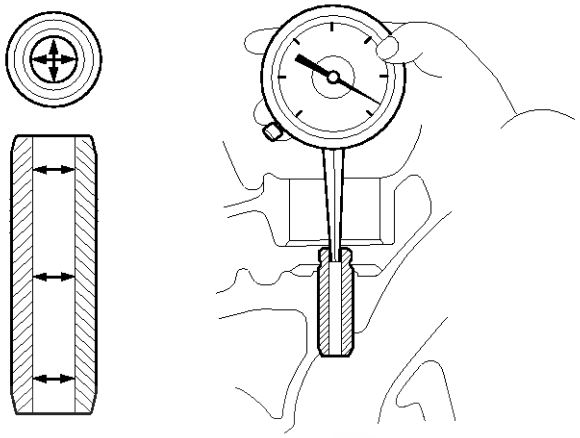
2. Inspect for cracks.

   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.

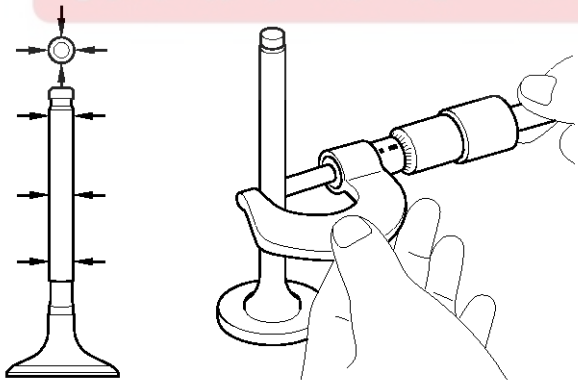
Valve guide I.D.
Intake / Exhaust :
6.000 ~ 6.012mm (0.2362 ~ 0.2367in)



ECBF034A

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

Valve stem O.D.
Intake : 5.965 ~ 5.980mm (0.2348 ~ 0.2354in)
Exhaust : 5.958 ~ 5.970mm (0.2346 ~ 0.2350in)



KCRF227A

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

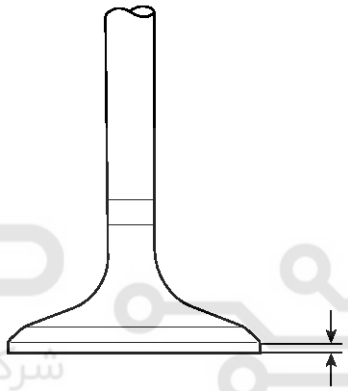
Valve stem-to-guide clearance
Intake : 0.020 ~ 0.047mm (0.0008 ~ 0.0018in)
Exhaust : 0.030 ~ 0.054mm (0.0012 ~ 0.0021in)

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

Valve face angle :
Intake/Exhaust : 45.25˚~ 45.75˚

   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
Intake : 1.2mm (0.0472in)
Exhaust : 1.2mm (0.0472in)



ECKD221A

   4) Check the valve length.

Length
Intake : 107.77mm (4.2429in)
Exhaust : 107.75mm (4.2421in)

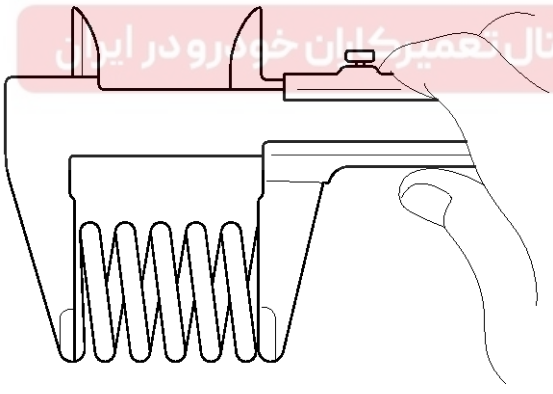
   5) Check the surface of the valve stem tip for wear.If the valve stem tip is worn, replace the valve.

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

Valve seat contact width :
Intake : 1.15 ~ 1.45mm (0.0453 ~ 0.0571in)
Exhaust : 1.35 ~ 1.65mm (0.0531 ~ 0.0650in)
Valve seat angle :
Intake/Exhaust : 44.75˚~ 45.10˚

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

Valve spring
Free height : 47.8mm (1.8819in)
Out-of-square : 1.5˚

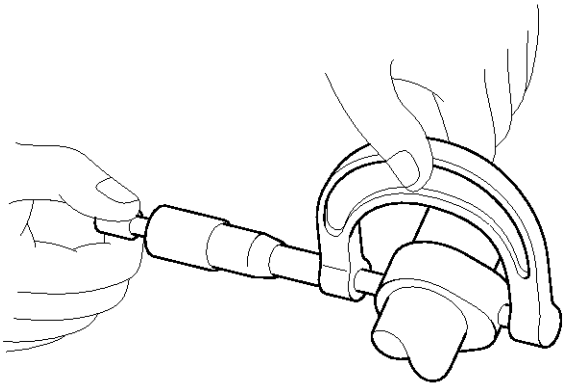


KCRF205A

Camshaft

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

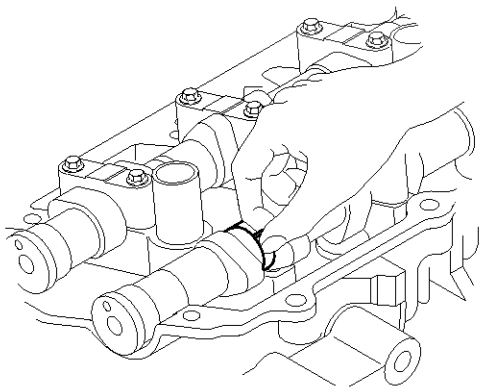
Cam height
Intake : 41.6mm (16.4in)
Exhaust : 41.5mm (16.3in)



KCRF206A

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

2. Inspect the camshaft journal clearance.
   1) Clean the bearing caps and camshaft journals.
   2) Place the camshafts on the cylinder head.
   3) Lay a strip of plastigage across each of the camshaft journals.



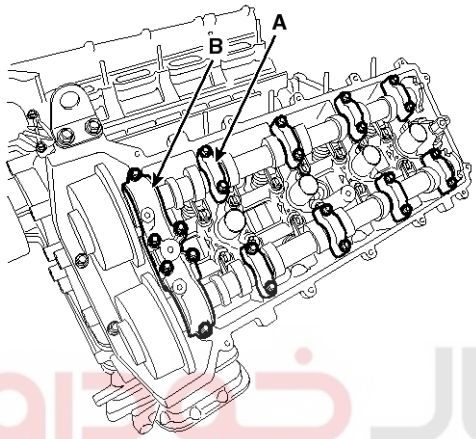
SAMM29101L

4) Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque :
1st step :
6.9 ~ 7.8N.m (0.7 ~ 0.8kgf.m, 5.1 ~ 5.8lb-ft)
2nd step :
13.7 ~ 14.7N.m (1.4 ~ 1.5kgf.m, 10.1 ~ 10.8lb-ft)

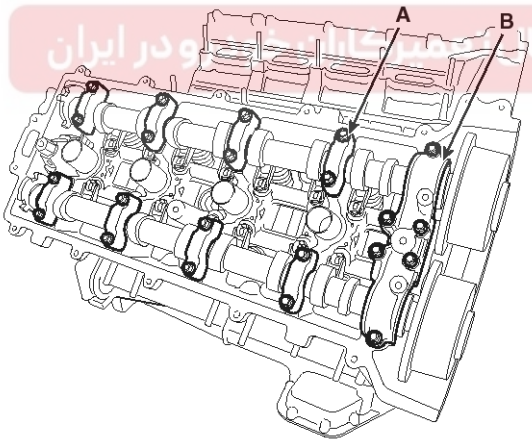
NOTICE
Do not turn the camshaft.

[LH]



SHMM19036N

[RH]



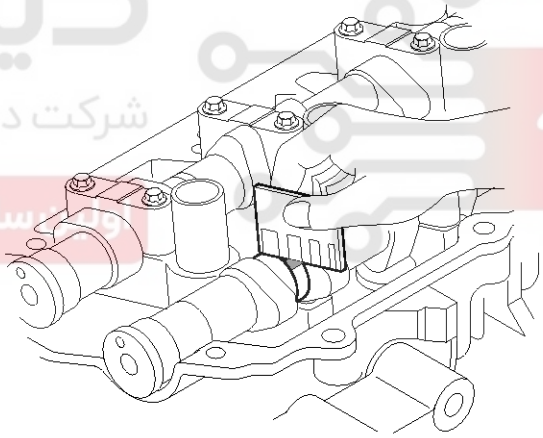
SHMM19037N

5) Remove the bearing caps.
6) Measure the plastigage at its widest point.

Camshaft bearing oil clearance
Intake/Exhaust :
No.1 journal :
0.025 ~ 0.057mm (0.0010 ~ 0.0022in)
No.2, 3, 4, 5 journal :
0.020 ~ 0.057mm (0.0008 ~ 0.0022in)

Camshaft journal outer diameter
Intake/Exhaust :
No.1 journal :
35.964 ~ 35.980mm (1.4159 ~ 1.4165in)
No.2, 3, 4, 5 journal :
25.964 ~ 25.980mm (1.0222 ~ 1.0228in)

Camshaft journal bore inner diameter
Intake/Exhaust :
No.1 journal :
36.005 ~ 36.021mm (1.4175 ~ 1.4181in)
No.2, 3, 4, 5 journal :
26.000 ~ 26.021mm (1.0236 ~ 1.0244in)



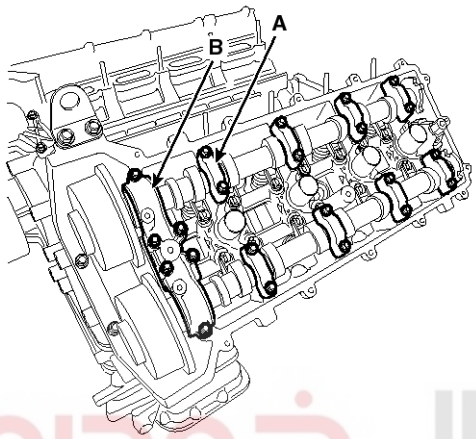
SAMM29102L

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

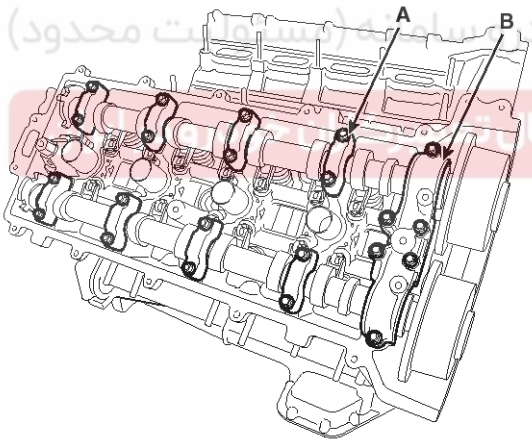
7) Completely remove the plastigage.
8) Remove the camshafts.

3. Inspect the camshaft end play.
   1) Install the camshafts.
   2) Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque :
1st step :
6.9 ~ 7.8N.m (0.7 ~ 0.8kgf.m, 5.1 ~ 5.8lb-ft)
2nd step :
13.7 ~ 14.7N.m (1.4 ~ 1.5kgf.m, 10.1 ~ 10.8lb-ft)



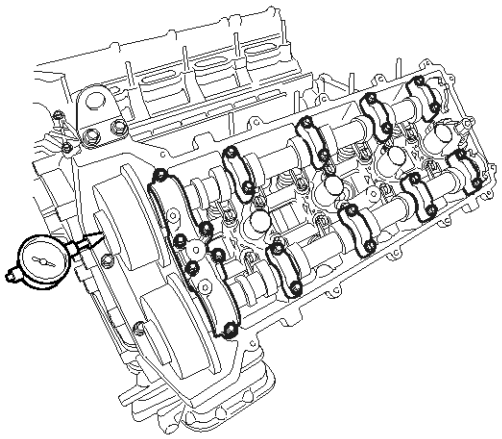
SHMM19036N



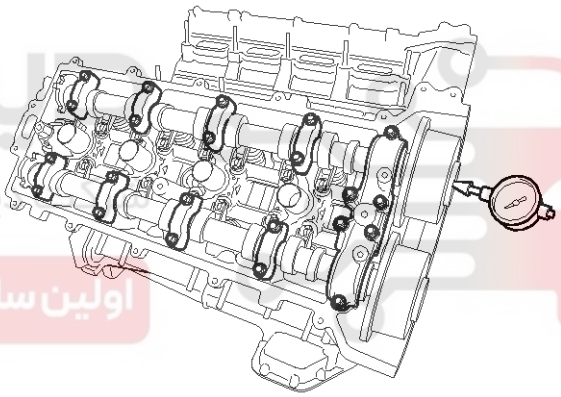
SHMM19037N

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

Camshaft end play :
0.12 ~ 0.22mm (0.0047 ~ 0.0086in)



SHMM19301N



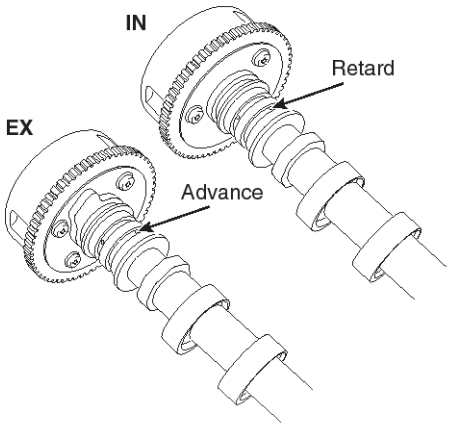
SHMM19302N

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

   4) Remove the camshafts.

CVVT Assembly

1. Inspect the 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.
   3) Apply vinyl tape to the advance holde except the one indicated by the arrow in the illustration.



SHMM19124N

   4) Wrap 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 for the maximum default angle locking.)

In-default : Max retard
Ex-default : Max advance

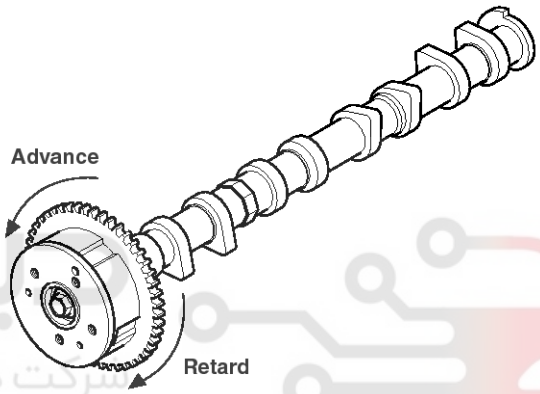
NOTICE
When the oil splashes, wipe it off with a shop rag.

   5) Under the condition of (3), turn the In-CVVT assembly to the advance angle side (the arrow marked direction in the illustration) with your hand.

      Depending on the air pressure, the In-CVVT assembly will turn to the advance side without applying force by hand.

      Under the condition of (3), turn the Ex-CVVT assembly to the retard angle side (the arrow marked direction in the illustration) with your hand.

      Depending on the air pressure, the Ex-CVVT assembly will turn to the retard side without applying force by hand.



SGHEM7010N

   6) Except the position where the lock pin meets at the maximum default angle, let the CVVT assembly turn back and forth and check the movable range and that there is no interference.

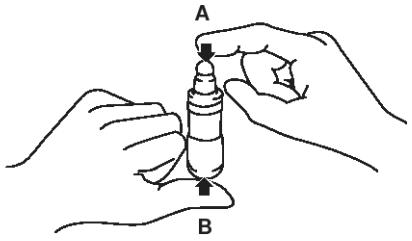
Standard :
Movable smoothly in the range about 22.5°

   7) Turn the In-CVVT assembly with your hand and lock it at the maximum retard angle position (clockwise).

      Turn the Ex-CVVT assembly with your hand and lock it at the maximum advance angle position.

HLA (Hydraulic Lash Adjuster)

With the HLA filled with engine oil, hold A and press B by hand. If B moves, replace the HLA.



EDB9030D

Problem	Possible cause	Action
1. Temporary noise when starting a cold engine	Normal	This noise will disappear after the oil in the engine reaches the normal pressure.
2. Continuous noise when the engine is started after parking more than 48 hours.	Oil leakage of the high pressure chamber on the HLA, allowing air to get in.	Noise will disappear within 15 minutes when engine runs at 2000-3000 rpm.If it doesn't disappear, refer to step 7 below.
3. Continuous noise when the engine is first started after rebuilding cylinder head.	Insufficient oil in cylinder head oil gallery.	
4. Continuous noise when the engine is started after excessively cranking the engine by the starter motor or band.	Oil leakage of the high-pressure chamber in the HLA, allowing air to get in.Insufficient oil in the HLA.	
5. Continuous noise when the engine is running after changing the HLA.		⚠CAUTION **Do not run engine at a speed higher than 3000 rpm, as this may damage the HLA.**
6. Continuous noise during idle after high engine speed.	Engine oil level too high or too low.	Check oil level.Drain or add oil as necessary.
	Excessive amount of air in the oil at high engine speed.	Check oil supply system.
	Deteriorated oil.	Check oil quality.If deteriorated, replace with specified type.
7. Noise continues for more than 15 minutes.	Low oil pressure.	Check oil pressure and oil supply system of each part of engine.
	Faulty HLA.	Remove the cylinder head cover and press HLA down by hand.If it moves, replace the HLA. **WARNING** **Be careful with the hot HLAS.**

Reassembly

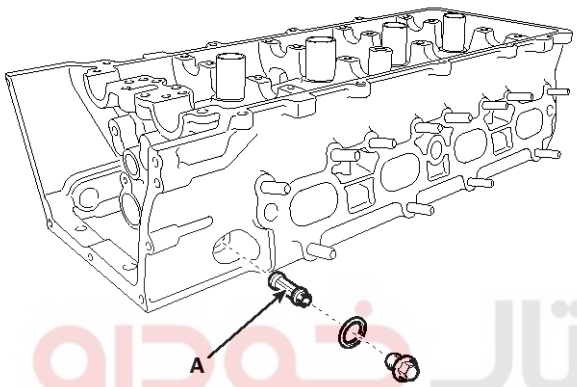
NOTICE

- *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 the OCV filter(A).

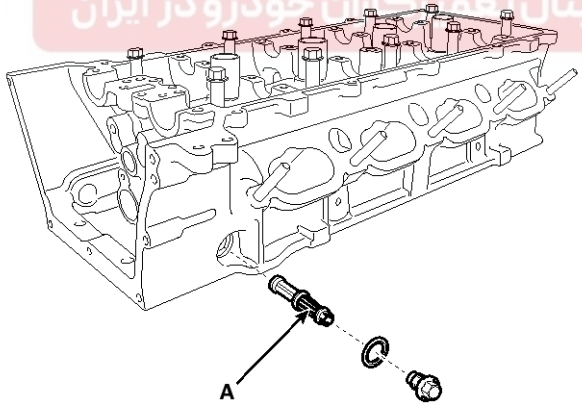
Tightening torque :
53.9 ~ 63.7Nm(5.5 ~ 6.5kgf.m, 39.8 ~ 47.0lb-ft)

[LH]



SHMM19121N

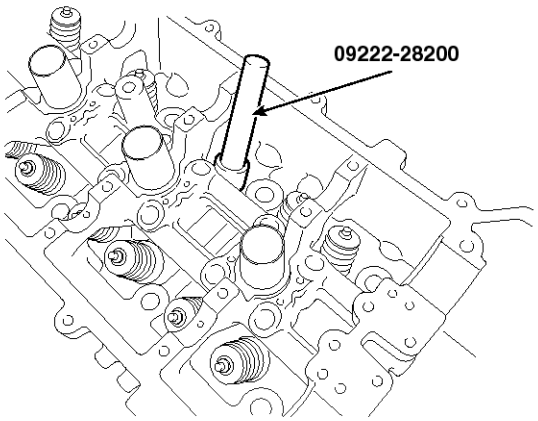
[RH]



SHMM19122N

2. Install the valves.
   1) Using the SST(09222-28200), push in a new oil seal.

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

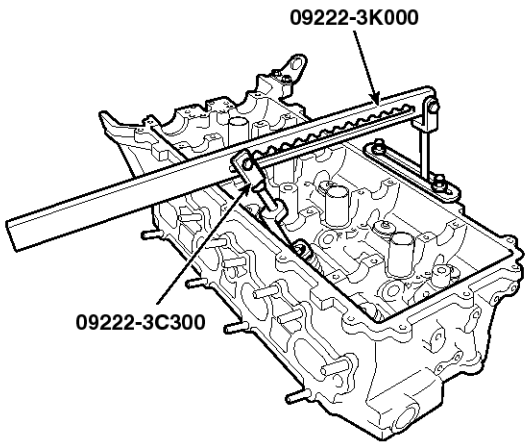


SHMM19125N

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

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

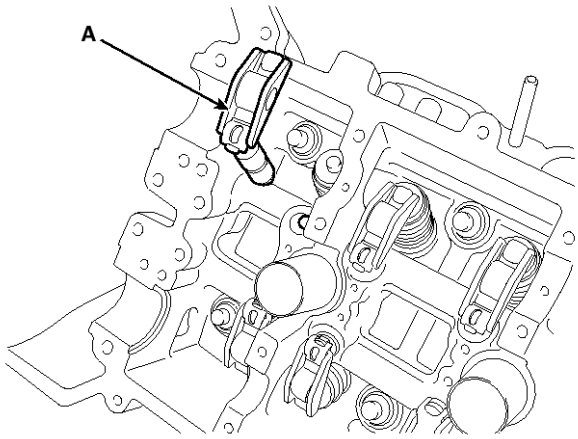
   3) Using the SST(09222 - 3K000, 09222-3C300), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



SHMM19119N

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.

3. Install the roller finger follower and the hydraulic lash adjuster assembly (A).



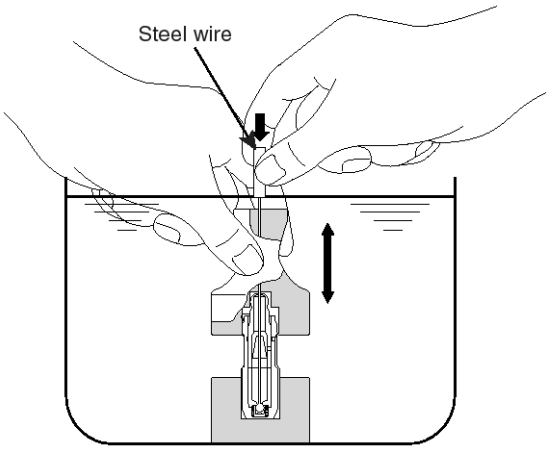
SHMM19040N

1) Until installing HLA shall be held upright so that engine oil in HLA should not spill and assured that dust does not adhere to HLA.
2) HLA shall be inserted tenderly to the cylinder head not to spill engine oil from HLA. In case of spilling, air vent shall be done in accordance with the air bent procedure.

NOTICE

Stroke HLA in engine oil 4~5 times by pushing its cap while pushing the ball down slightly by hard steel wire.

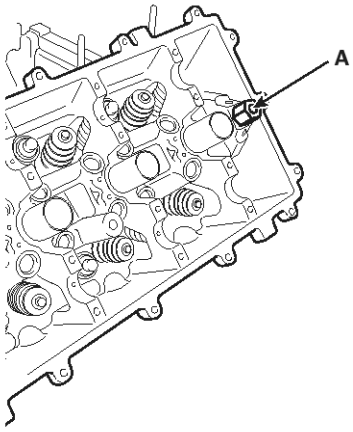
(Take care not to severely push hard steel wire down since ball is several grames.)



LCGF133A

4. Install the pressure relief valve.

Tightening torque :
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)



SHMM19312N

Installation

NOTICE

- *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.*

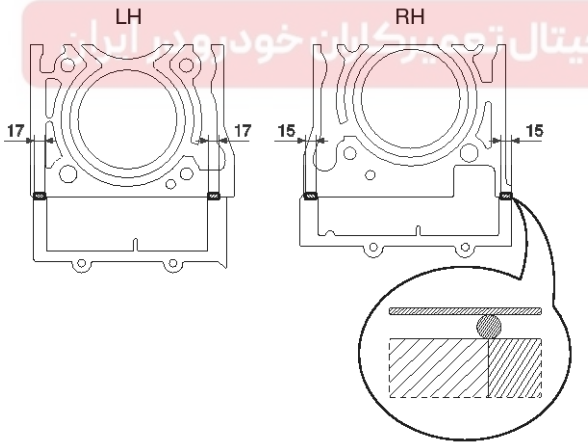
1. Install the cylinder head gasket (A).
   1) The sealant locations on cylinder head gasket, cylinder block and timing chain lower case must be free of engine oil and ETC.
   2) Before assembling the cylinder head gasket, the liquid sealant TB 1217H should be applied on the gap between cylinder block and timing chain lower case.

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

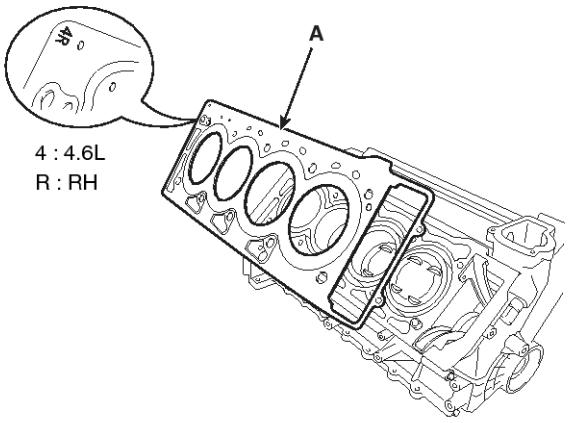
      NOTICE

      Refer to below illustration to apply the sealant.

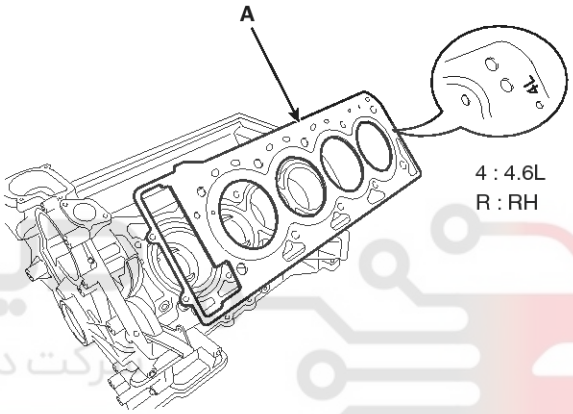
Bead width :
3.5 ~ 4.5 mm (0.1378 ~ 0.1772 in)
Sealant locations :
1.5 ~ 2.5mm (0.0591 ~ 0.0984 in)
from timing chain lower case inner surface
Recommended sealant : Liquid sealant TB1217H



SHMM19150N



SHMM19162N



SHMM19163N

3) Apply sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block.

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

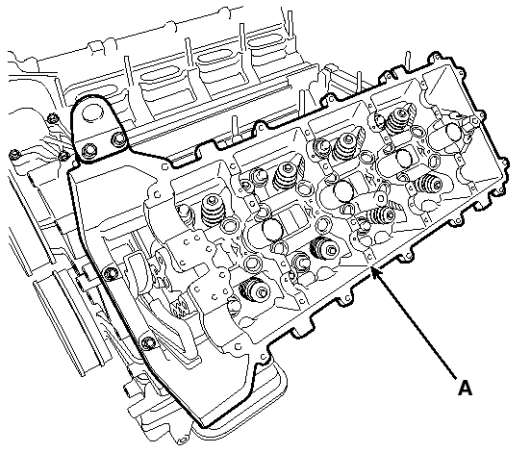
   NOTICE

   Be careful of the installation direction.

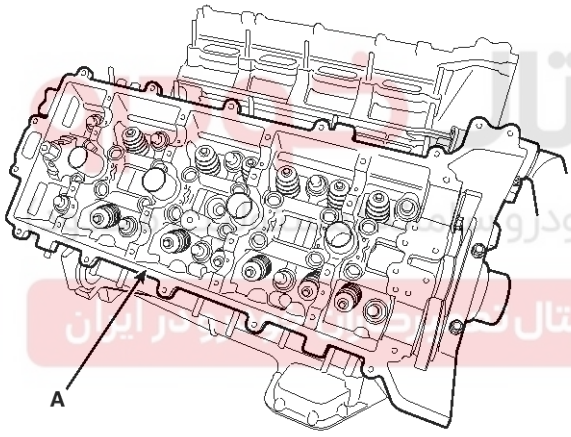
4) Install the cylinder head.

NOTICE

Remove the extruded sealant after assembling cylinder heads.



SHMM19041N



SHMM19042N

2. Install the cylinder head bolts.
   1) Do not apply engine oil on the threads and under the heads of the cylinder head bolts.
   2) Using SST(09221-4A000), install and tighten the cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :

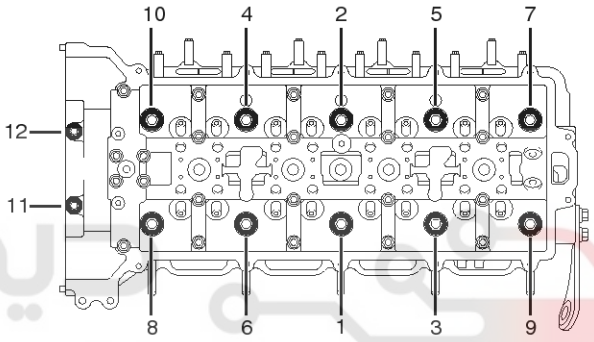
Cylinder head bolts (1~10) :

32.4 ~ 36.3N.m(3.3 ~ 3.7kgf.m, 23.9 ~ 26.8lb-ft) + 88˚~92˚+ 118˚~122˚

Flange bolts (11~12) :

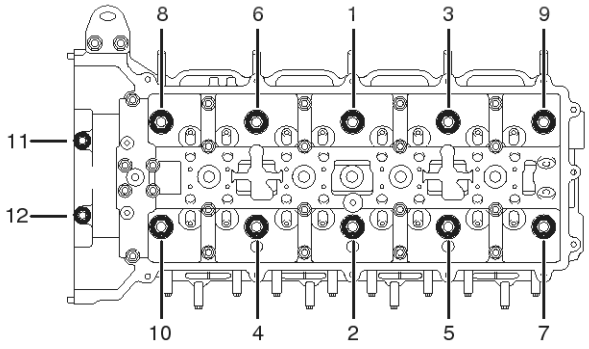
32.4 ~ 36.3N.m(3.3 ~ 3.7kgf.m, 23.9 ~ 26.8lb-ft)

[RH]

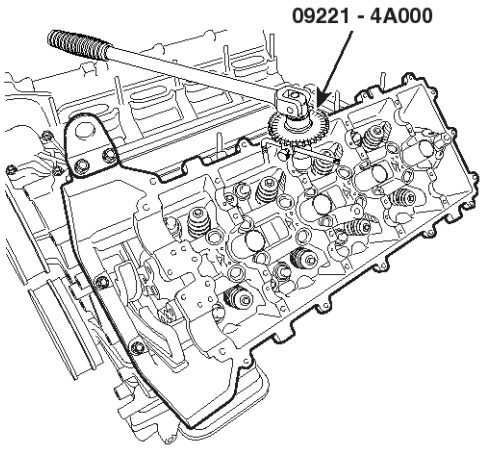


SHMM19148N

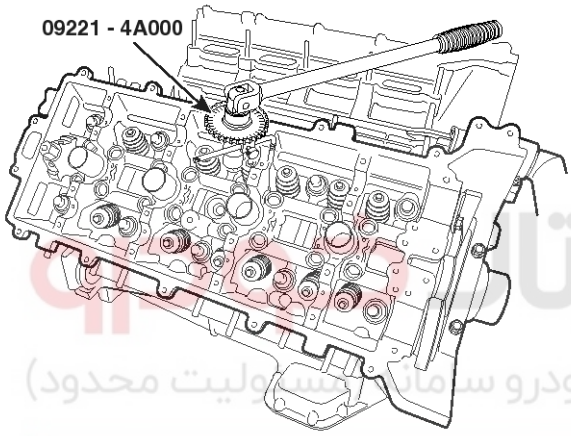
[LH]



SHMM19149N



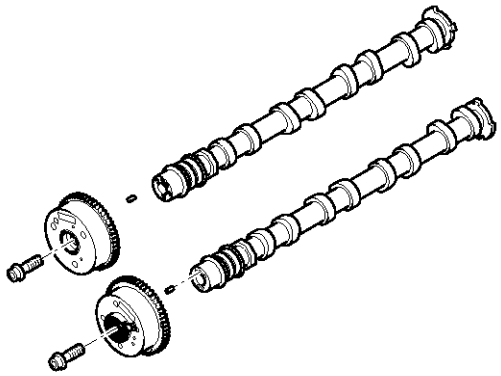
SHMM19313N



SHMM19314N

3. Install the CVVT assembly.

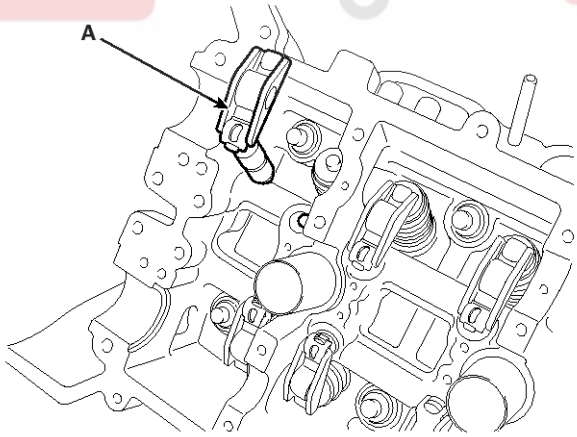
Tightening torque :
73.5 ~ 83.4N.m(7.5 ~ 8.5kgf.m, 54.2 ~ 61.5lb-ft)



SHMM19373N

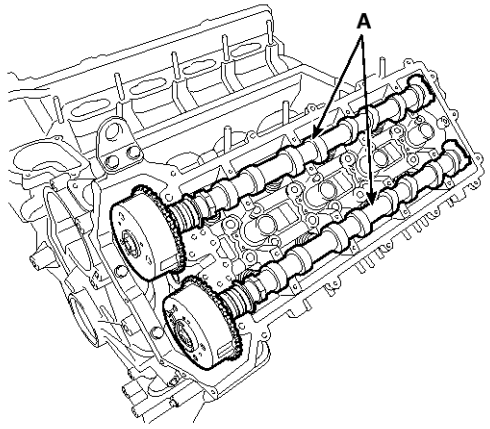
- Install camshaft to dowel pin of CVVT assembly.At this time, attend not to be installed to oil hole of camshaft.
- Hold the hexagonal head wrench portion of the camshaft with a vise, and install the bolt and CVVT assembly.
- Do not rotate CVVT assembly when camshaft is installed to dowel pin of CVVT assembly.

4. Install the roller finger follower and the hydraulic lash adjuster assembly (A).

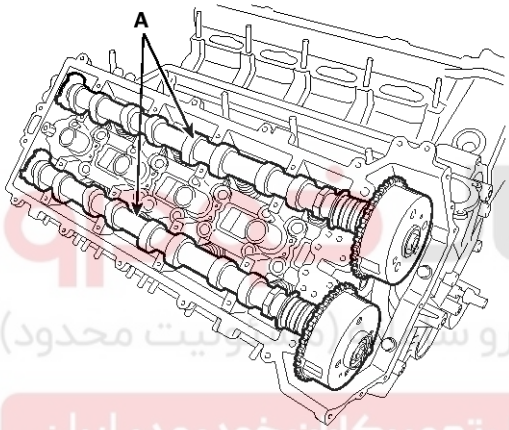


SHMM19040N

5. Install the LH/RH camshaft assembly (A).



SHMM19160N

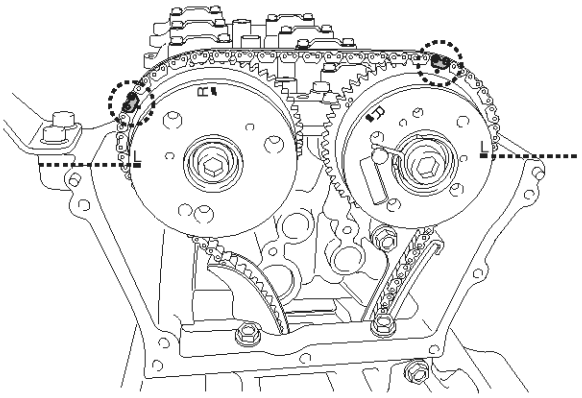


SHMM19161N

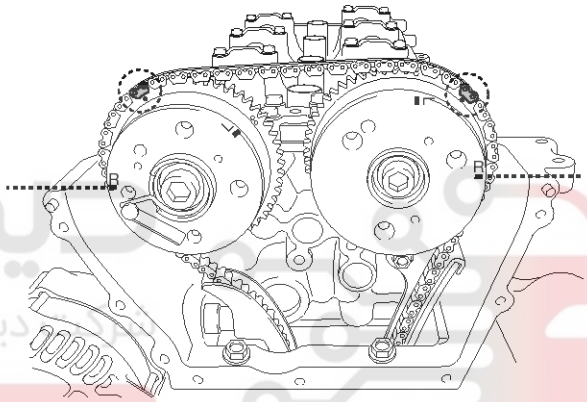
NOTICE

- *Apply a light coat of engine oil on camshaft journals.*
- *Assemble the timing mark of CVVT to the same level of cylinder head top surface.*
- *Be careful the right, left bank, intake, exhaust side before assembling.*
- *Turn the crankshaft to set the No.1 piston at TDC position.*

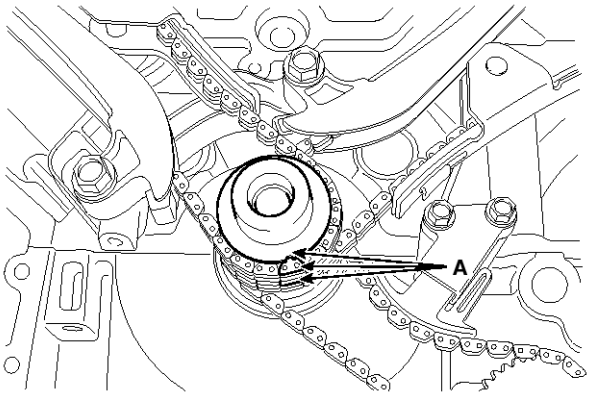
6. Install the timing chain to the camshaft sprocket.



SHMM19028N



SHMM19029N



SHMM19128N

NOTICE

- *Make sure the crankshaft is at TDC position.*
- *Align the chain installation mark (A) of the crankshaft sprocket and the timing mark (A) of the chain link, and then install the chain.*

NOTICE

In case of marking the timing chain links corresponding to the chain installation marks on the sprocket with an identification for on-vehicle repair (for cylinder head assembly, timing chain tensioner, CVVT, camshaft, HLA or etc.), align all of the chain installation mark of the sprocket and the timing marked chain links for reassembly.

NOTICE

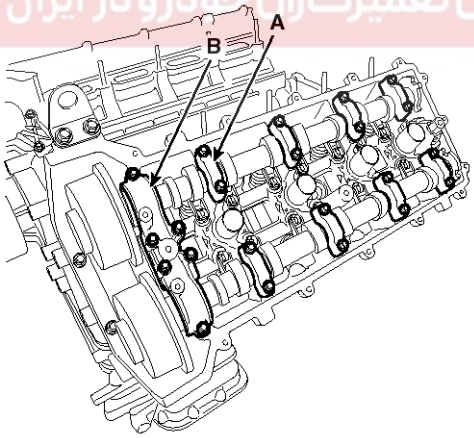
To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.

Crankshaft sprocket → Timing chain guide → Exhaust camshaft sprocket → Intake camshaft sprocket. (LH Bank)

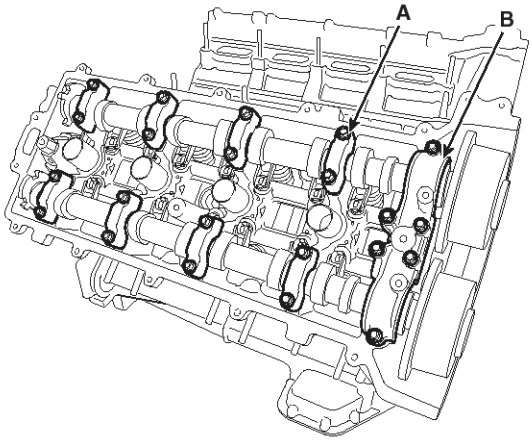
Crankshaft sprocket → Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket. (RH Bank)

When reassembling the timing chain, make sure all of the chain installation mark of the sprocket and the timing marked chain links are aligned.

7. Install the camshaft bearing caps and the camshaft thrust bearing cap.



SHMM19036N



SHMM19037N

Tighten the bolts in order to below sequence.

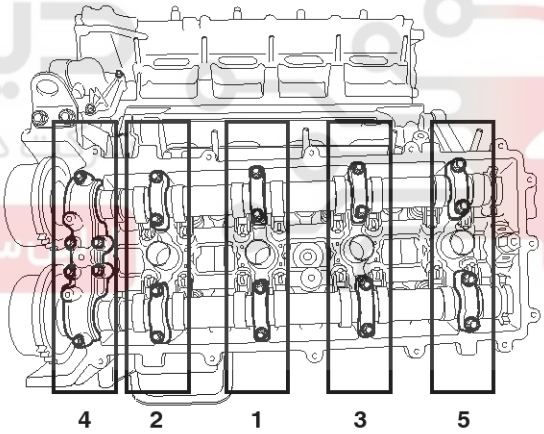
Tightening torque :

1st step :

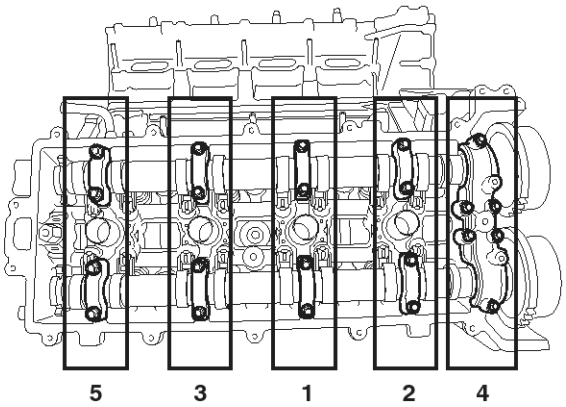
6.9 ~ 7.8N.m (0.7 ~ 0.8kgf.m, 5.1 ~ 5.8lb-ft)

2nd step :

13.7 ~ 14.7N.m (1.4 ~ 1.5kgf.m, 10.1 ~ 10.8lb-ft)



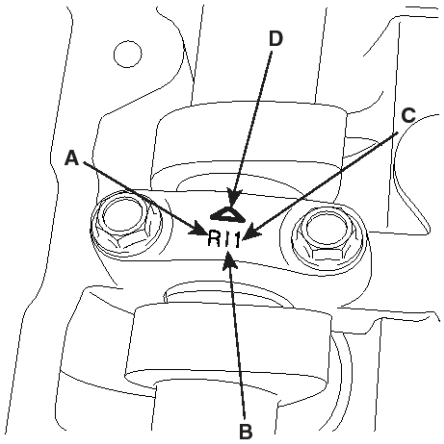
SHMM19038N



SHMM19039N

NOTICE

Be careful the right, left bank, intake, exhaust side before assembling.



ECBF036A

A : L(LH),R(RH)

B : I(Intake), E(Exhaust)

C : Journal number

D : Front mark

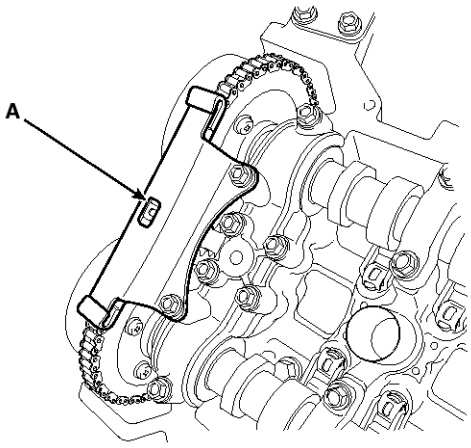
CAUTION

Be sure to install the thrust bearing cap and bearing cap bolts in the correct places.

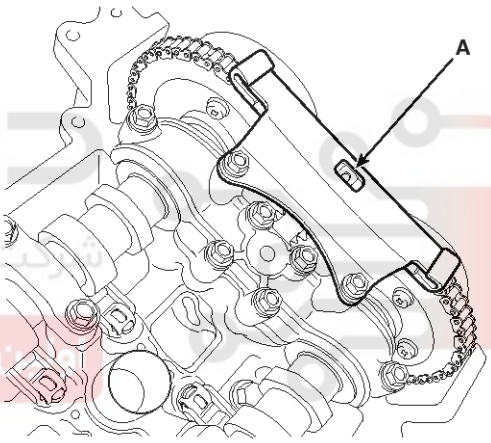
8. Install the cam to cam guide (A).

Tightening torque :

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



SHMM19026N

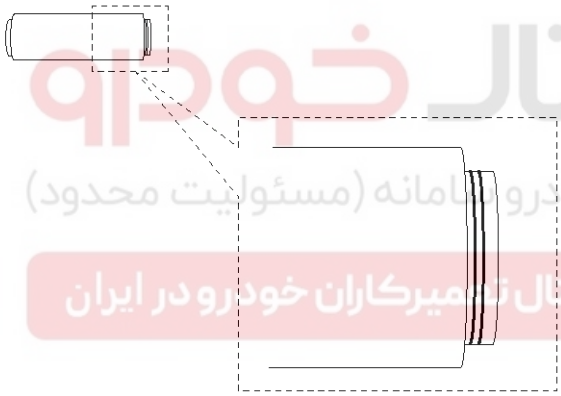


SHMM19027N

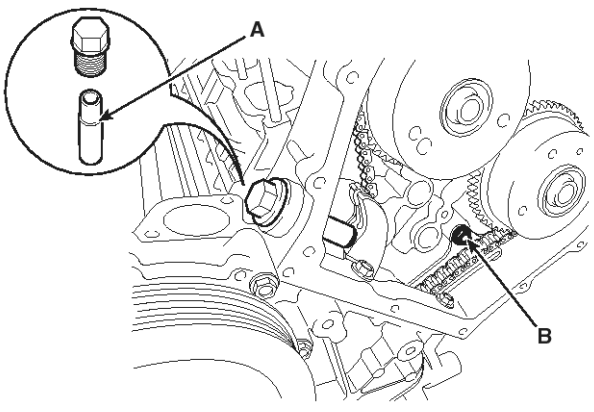
9. Install the LH timing chain guide bolt (B) and then the LH timing chain tensioner (A).
   1) Install the timing chain tensioner & plug bolt in the hole on the cylinder head by hand.
   2) Tighten the plug bolt with the specified torque while pressing the timing chain on the LH intake CVVT.

Tightening torque :
Timing chain guide bolt :
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)
Timing chain tensioner plug bolt :
78.5 ~ 88.3N.m(8.0 ~ 9.0kgf.m, 57.9 ~ 65.1lb-ft)

NOTICE
1. *Do not reuse the timing chain tensioner.*
2. *Make sure the timing chain tensioner is at compressed transport position state.*
3. *Install the timing chain tensioner with the oil hole facing the plug bolt.*



SVIM19190D

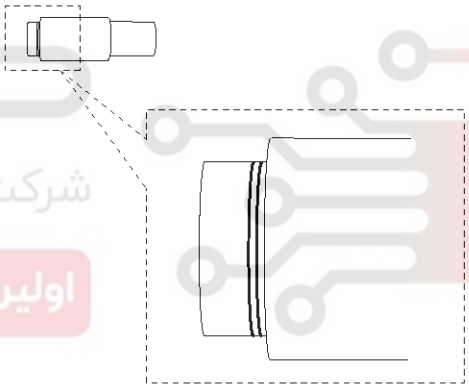


SHMM19034N

10. Install the RH timing chain guide bolt (B) and then the RH timing chain tensioner (A).
    1) Install the timing chain tensioner & plug bolt in the hole on the cylinder head by hand.
    2) Tighten the plug bolt with the specified torque while pressing the timing chain on the RH intake CVVT.

Tightening torque :
Timing chain guide bolt :
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)
Timing chain tensioner plug bolt :
78.5 ~ 88.3N.m(8.0 ~ 9.0kgf.m, 57.9 ~ 65.1lb-ft)

NOTICE
1. *Do not reuse the timing chain tensioner.*
2. *Make sure the timing chain tensioner is at compressed transport position state.*
3. *Install the timing chain tensioner with the oil hole facing the plug bolt.*



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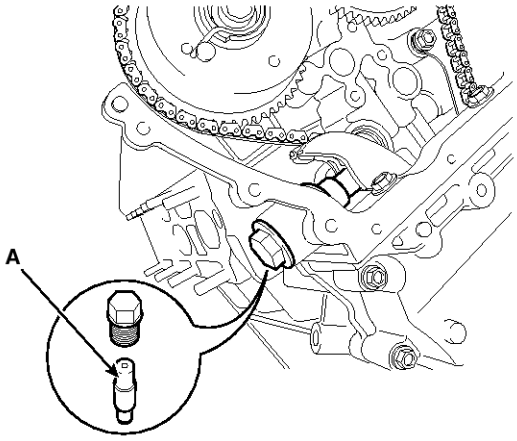
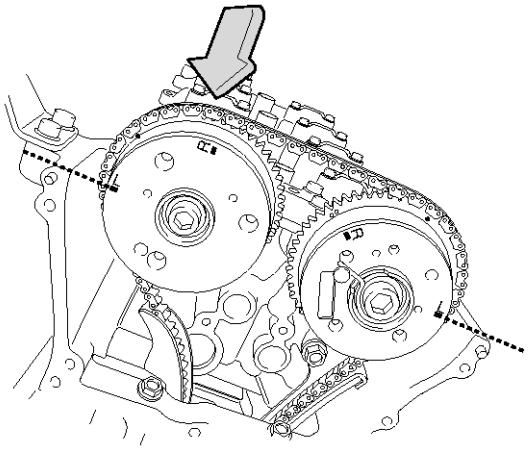


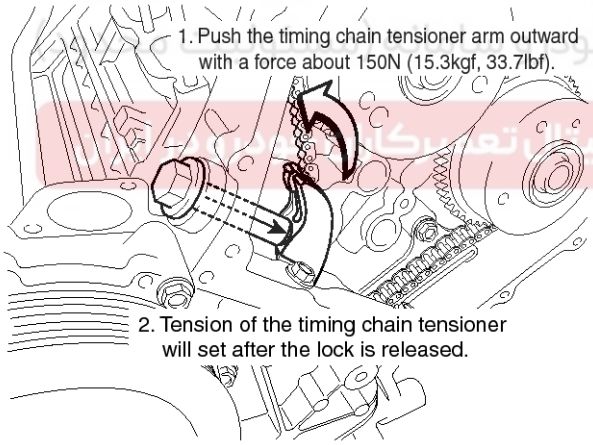
SHMM19035N

11. Set tension of the timing chain tensioner.
    1) LH Bank
        A. Press the timing chain on the LH intake CVVT by hand with the timing mark “L” on the LH intake and exhaust CVVT and the LH cylinder head upper surface aligned.



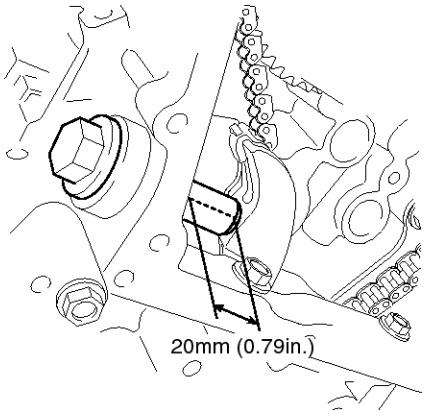
SVIM19173D

        B. To set tension of the timing chain tensioner, push the timing chain tensioner arm outward with a force about 150N (15.3kgf, 33.7lbf).

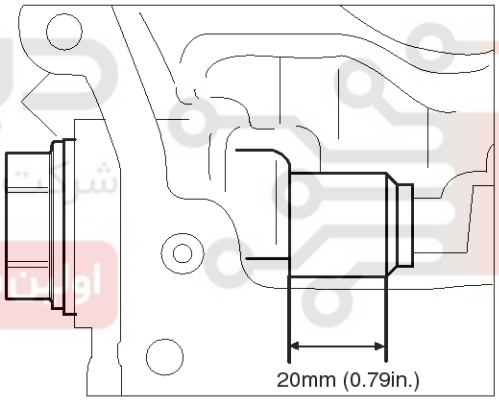


SVIM19174L

        C. To check the tension of the timing chain tensioner, push the timing chain tensioner arm outward strongly. The distance between the cylinder head surface and end of tensioner plunger should be about 20mm (0.79inch).



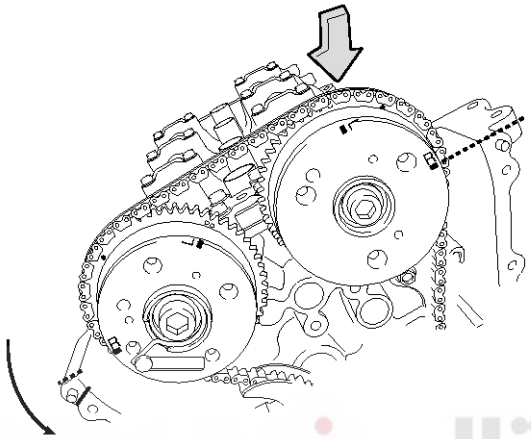
SVIM19175L



SVIM19193L

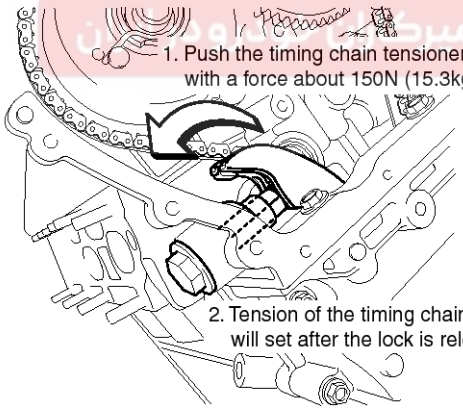
2) RH Bank

A. To align the timing mark “R” on the RH intake and exhaust CVVT and the RH cylinder head upper surface, turn the exhaust CVVT about 20° counterclockwise while pressing the timing chain on the intake CVVT by hand with all of the chain installation mark of the sprocket and the timing marked chain links aligned.



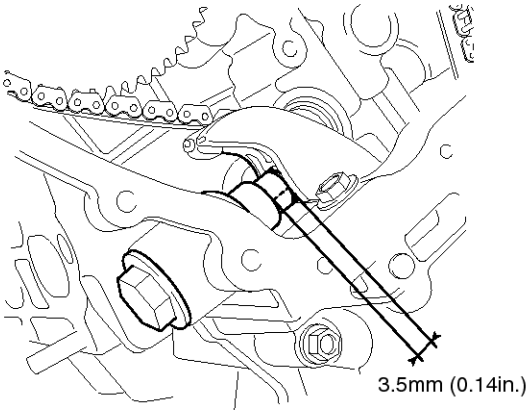
SVIM19194D

B. To set tension of the timing chain tensioner, push the timing chain tensioner arm outward with a force about 150N (15.3kgf, 33.7lbf).

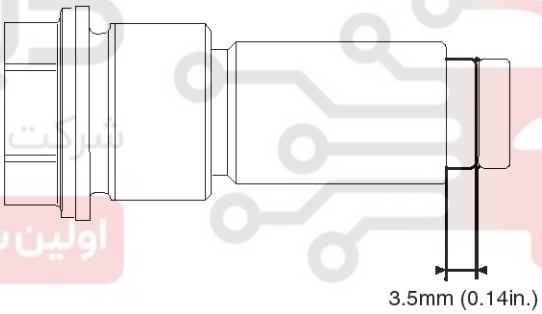


SVIM19177L

C. To check the tension of the timing chain tensioner, push the timing chain tensioner arm outward strongly. The distance between the tensioner body and end of tensioner plunger should be about 3.5mm (0.14inch).



SVIM19178L



SVIM19192L

3) After setting tension of the LH, RH timing chain tensioner, check timing again.

A. Make sure the chain installation mark of the sprocket and the timing marked chain links are aligned.

B. Rotate the crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing marks on the LH, RH intake and exhaust CVVT and the RH cylinder head upper surfaces are aligned.

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

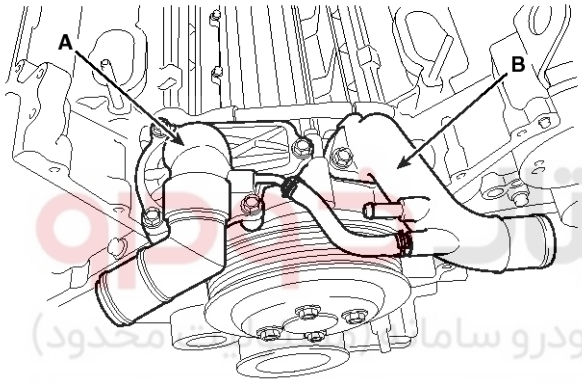
NOTICE

Always turn the crankshaft clockwise.

Turning the crankshaft counter clockwise before building up oil pressure in the hydraulic timing chain tensioner may result in the chain disengaging from the sprocket teeth.

13. Install the water temperature control assembly (A) and the water outlet fitting assembly (B) with new O-ring and new gasket.

Tightening torque :
16.7 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)



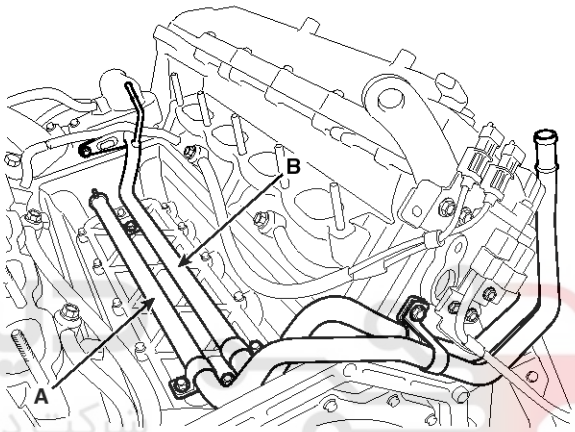
SHMM19033N

14. Install the water outlet pipe (A) and the water inlet pipe (B).

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

NOTICE

- *Use new O-rings when reassembling.*
- *Never apply sort of oil on O-ring and O-ring groove of pipe end.*
- *O-ring must be free from scratching damage.*
- *Make clean the contact face before assembly.*
- *Insert pipe after to be wetting O-ring or inside of attaching hole by water or antifreeze.*

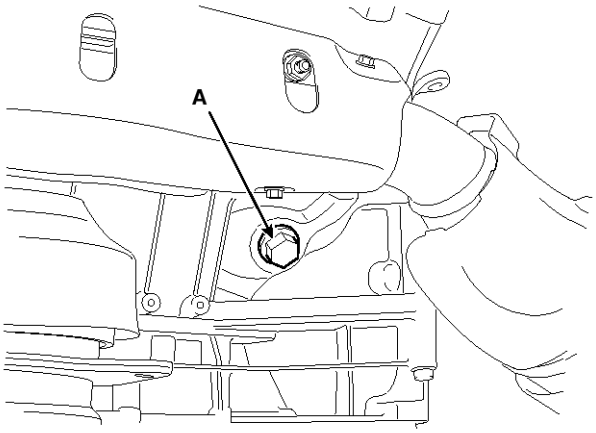


SHMM19084N

NOTICE

Install the drain plug (A).

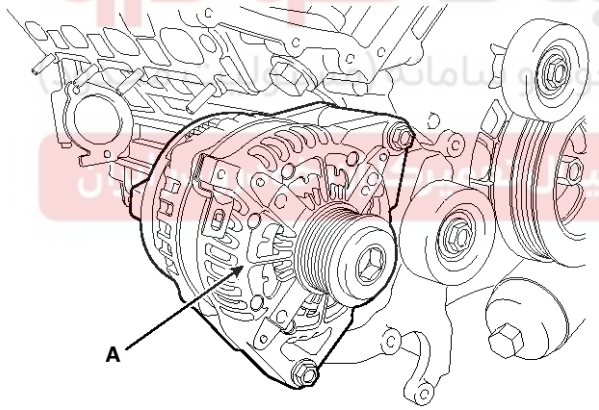
Tightening torque :
96.1~100.0N.m(9.8~10.2kgf.m,70.9~73.8lb-ft)



SHMM19085N

15. Install the alternator (A).

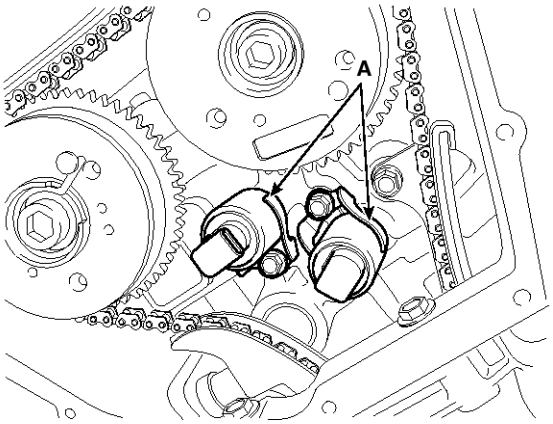
Tightening torque :
29.4 ~ 41.2N.m (3.0 ~ 4.2kgf.m, 21.7 ~ 30.4lb-ft)



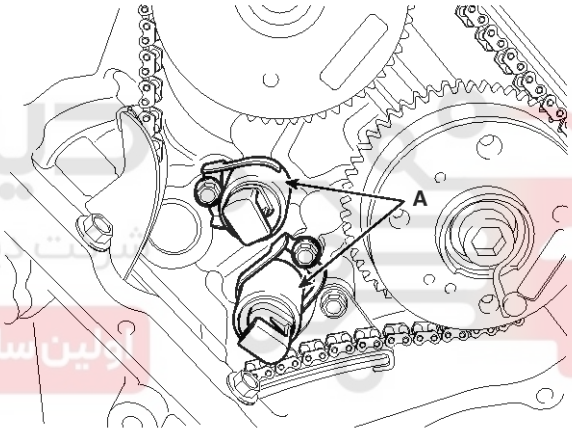
SHMM19030N

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

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



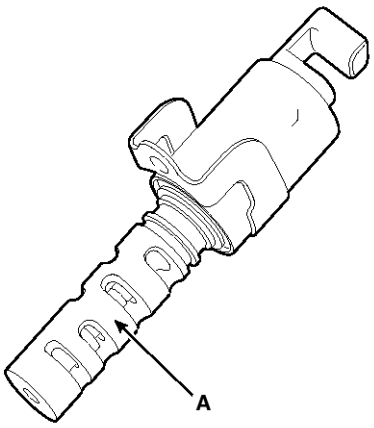
SHMM19024N



SHMM19025N

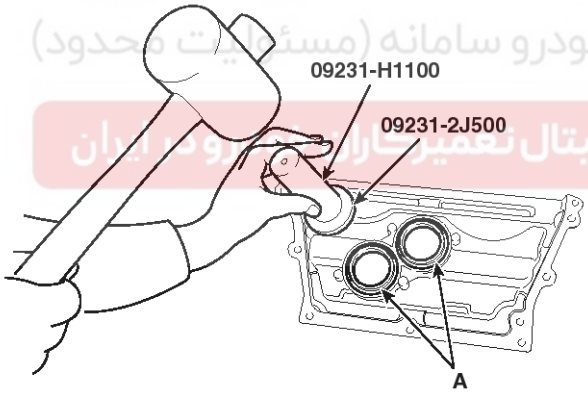
NOTICE

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

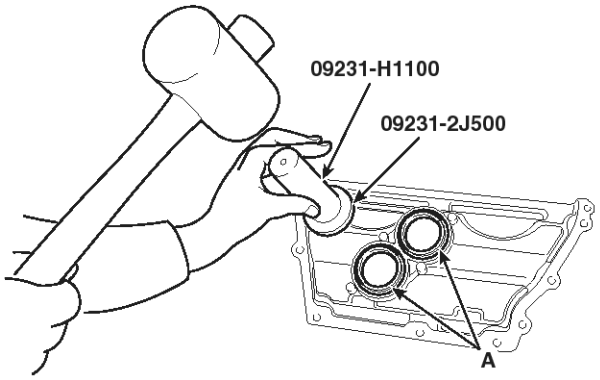


SVIM19146D

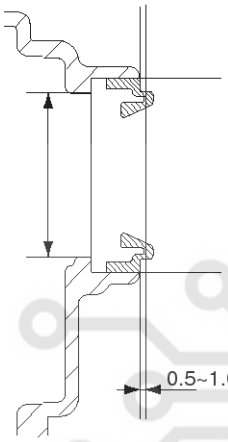
17. Use the SST (09231-2J500, 09231-H1100) install the timing chain upper cover oil seal (A).



SHMM19340N



SHMM19341N

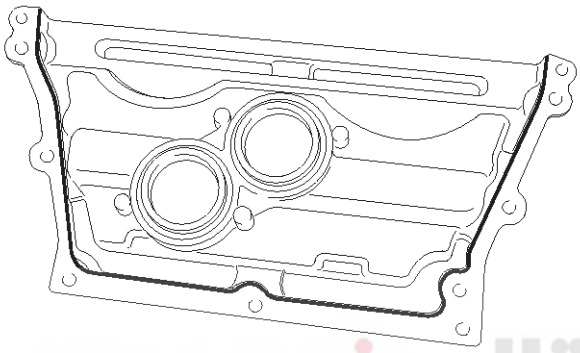


SHMM19141N

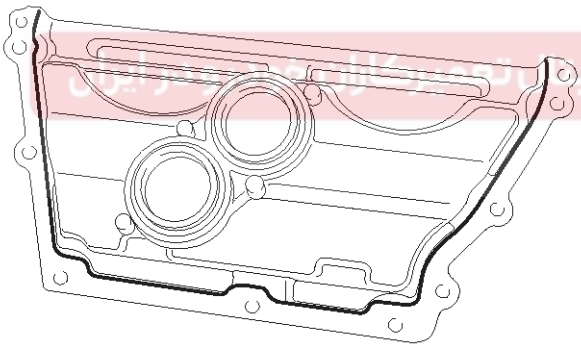
18. Apply sealant to the timing chain upper cover.
    1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
    2) Before assembling the timing chain upper cover, the liquid sealant TB1217H or LT5900H should be applied on upper cover.

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

Bead width : Ø2.5 ± 0.5mm(0.1 ± 0.002in)



SHMM19361N



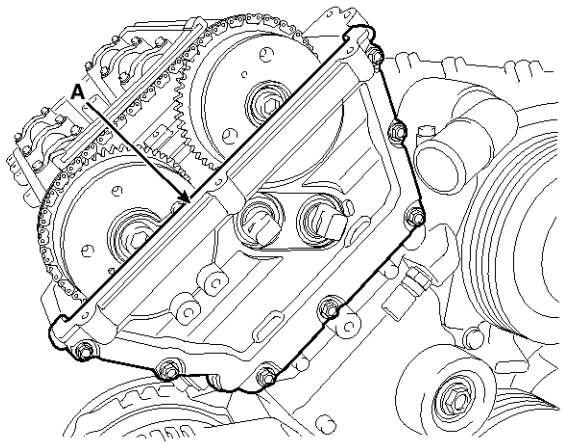
SHMM19362N

NOTICE

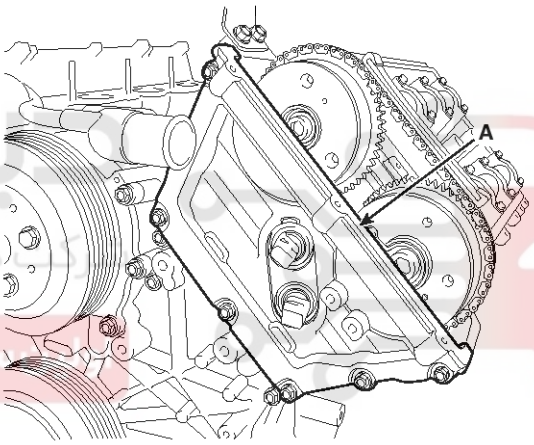
- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *When applying sealant gasket, sealant must not protrude into the inside of upper cover.*
- *To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.*

19. Install the timing chain upper cover (A).

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



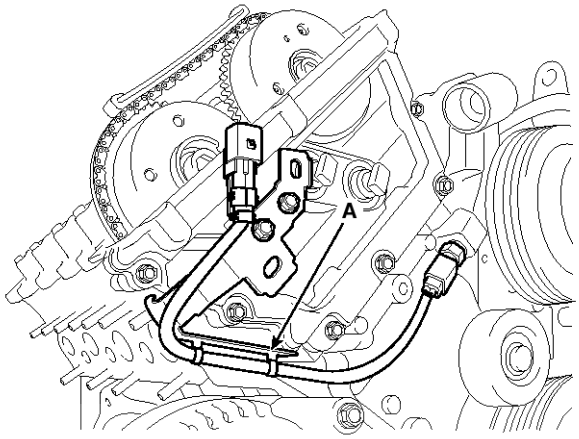
SHMM19020N



SHMM19021N

20. Install the water temperature sensor wiring assembly and bracket (A).

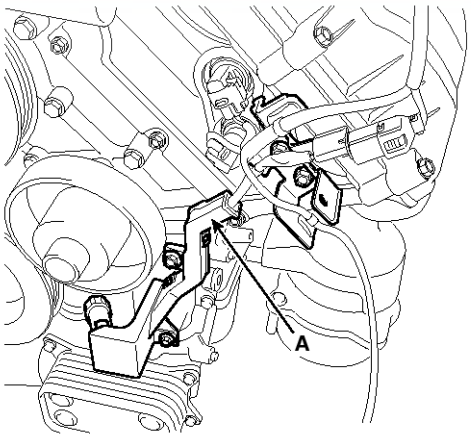
Tightening torque :
Wiring bracket bolts :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
Water temperature sensor :
19.6 ~ 39.2Nm (2.0 ~ 4.0kgf.m, 14.5 ~ 28.9lb-ft)



SHMM19019N

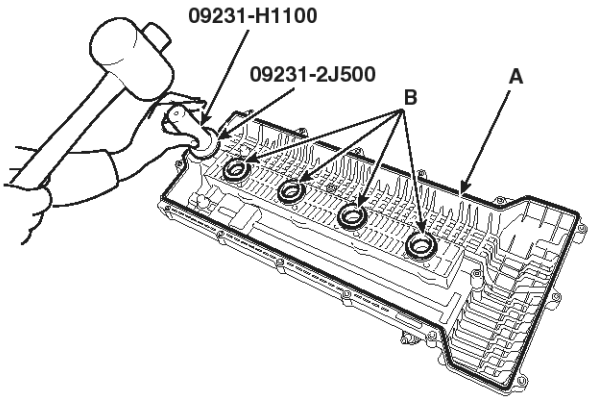
21. Install the oil pressure switch wiring assembly and bracket (A).

Tightening torque :
Wiring bracket bolts :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
Oil pressure switch :
14.7 ~ 21.6Nm (1.5 ~ 2.2kgf.m, 10.8 ~ 15.9lb-ft)

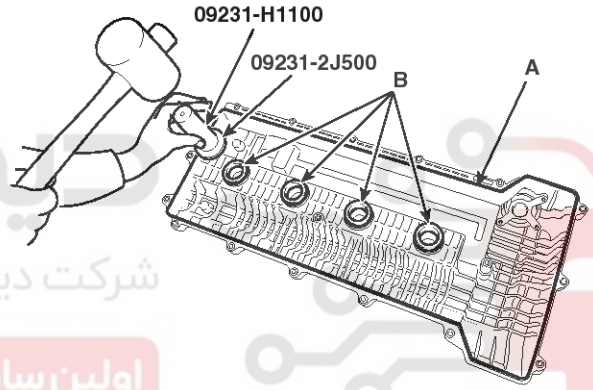


SHMM19083N

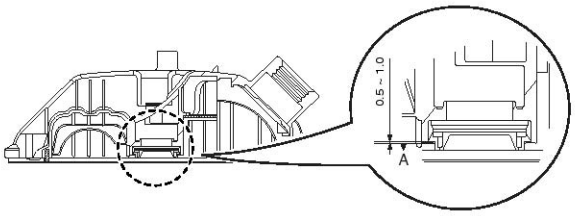
22. Use the SST (09231-2J500, 09231-H1100), install the oil seal (B) and the gasket (A).



SHMM19342N



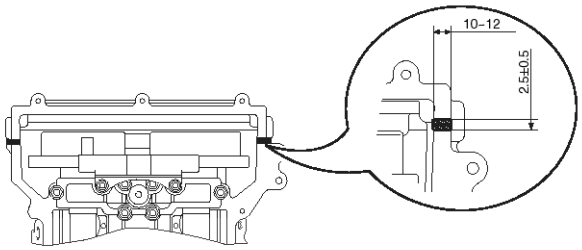
SHMM19343N



SHMM19152N

23. Install the cylinder head cover.
    1) The sealant locations on cylinder head and timing chain upper case must be free of engine oil and ETC.
    2) Before assembling the cylinder head cover, the liquid sealant TB 1217H or LT5900H should be applied on the gap between cylinder head and timing chain upper case.

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

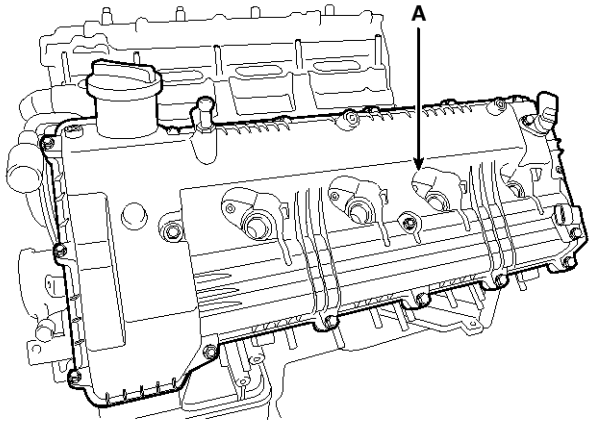


SHMM19151N

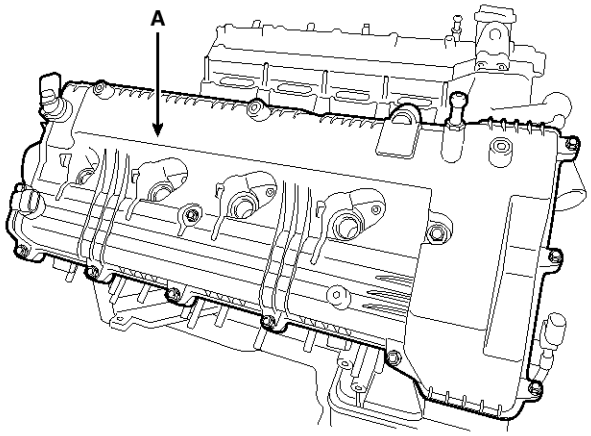
    3) Install the cylinder head cover (A).

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

Tightening torque :
1st step : 4.9 ~ 5.9N.m (0.5 ~ 0.6kgf.m, 3.6 ~ 4.3lb-ft)
2nd step : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



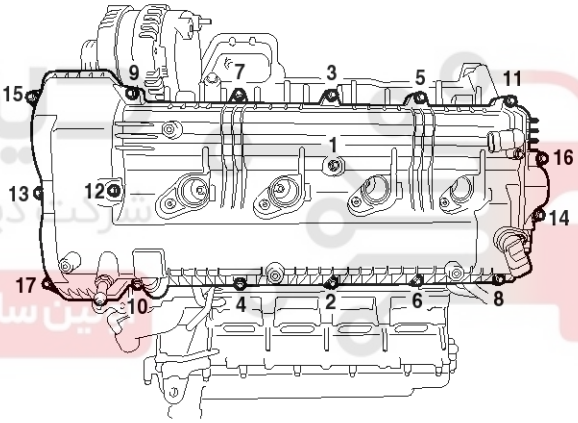
SHMM19012N



SHMM19013N

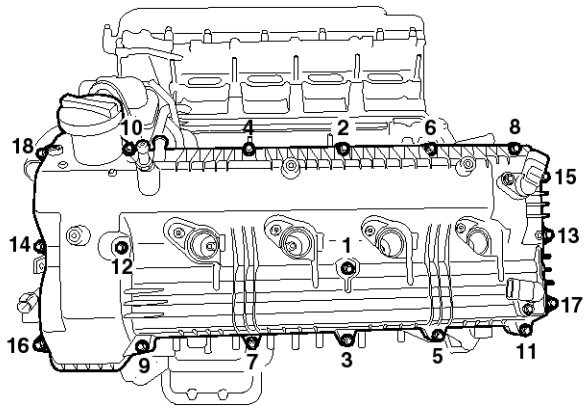
NOTICE
Tighten the cylinder head cover bolts as following method.

[RH]



SVIM19122D

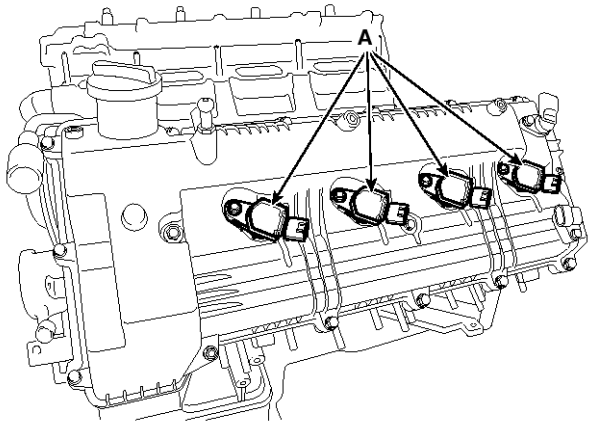
[LH]



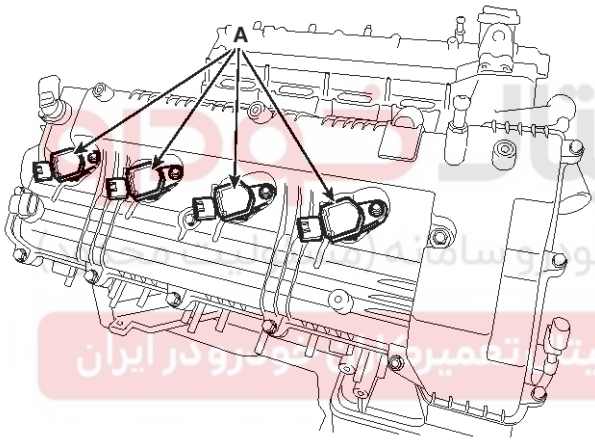
SVIM19123D

24. Install the ignition coils (A).

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



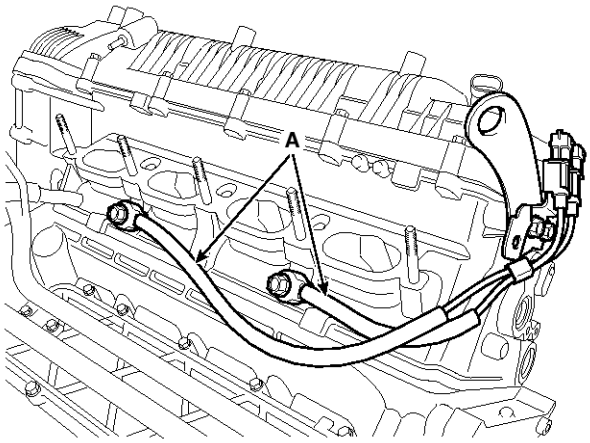
SHMM19010N



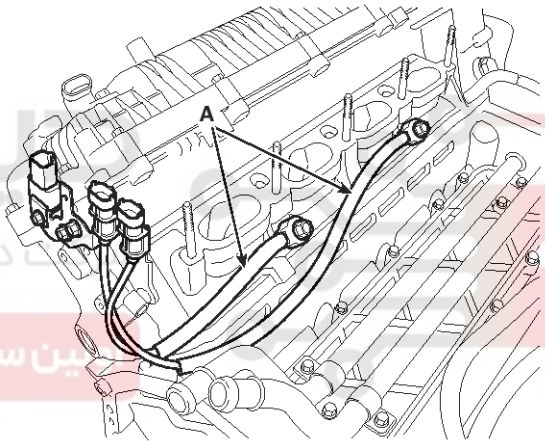
SHMM19011N

25. Install the knock sensors (A).

Tightening torque :
64.7 ~ 76.5N.m (6.6 ~ 7.8kgf.m, 47.7 ~ 56.4lb-ft)



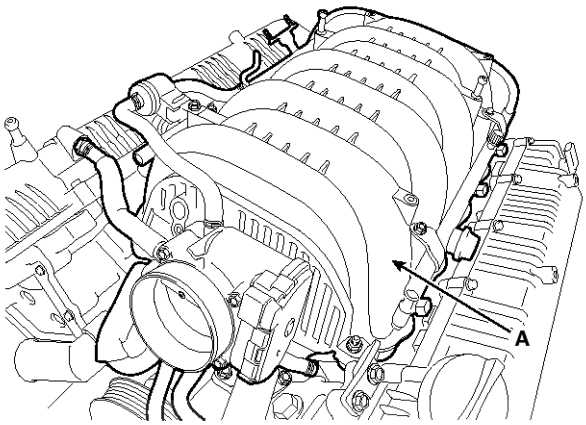
SHMM19008N



SHMM19009N

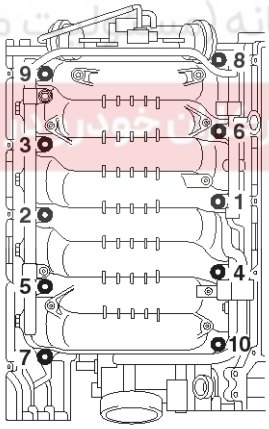
26. Install the intake manifold module (A) tighten the nuts as following method.

Tightening torque :
1st step :
4.9 ~ 7.8N.m (0.5 ~ 0.8kgf.m, 3.6 ~ 5.8lb-ft)
2nd step :
19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)



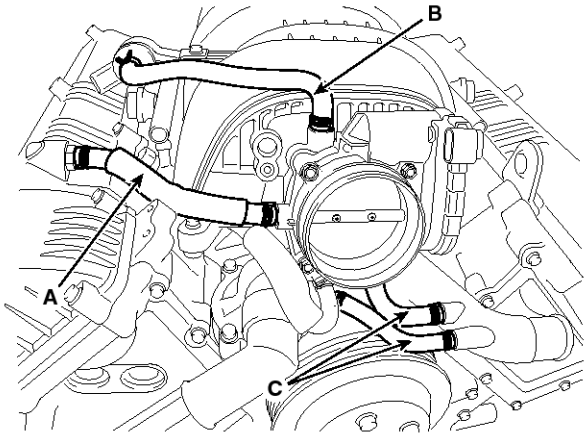
SHMM19082N

NOTICE
Tighten the intake manifold nuts as followig method.



SHMM19153N

27. Reconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) to the intake manifold module and the throttle body.

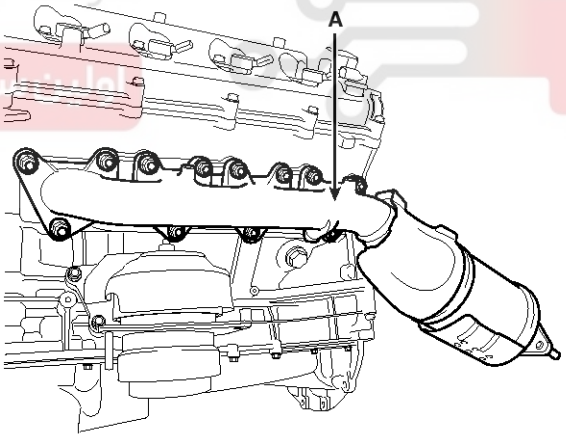


SHMM19081N

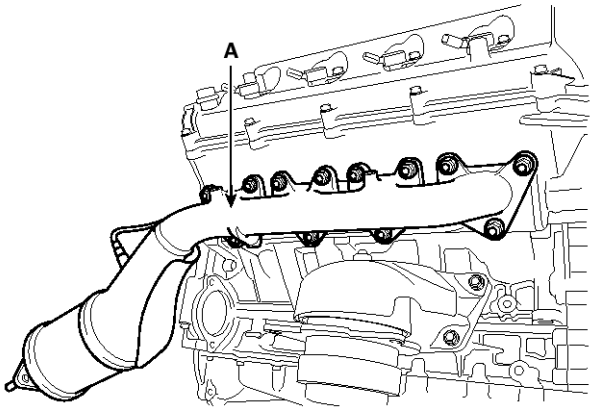
28. Install the exhaust manifold (A) tighten the nuts as following method.

Tightening torque :
49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.2 ~ 39.8lb-ft)

NOTICE
The "TOP"mark of the gasket must be face the exhaust manifold.



SHMM19063N

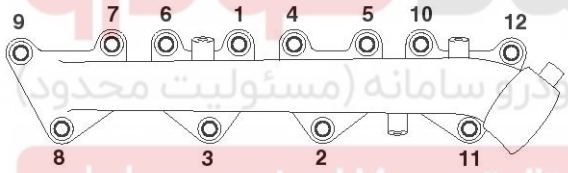


SHMM19064N

NOTICE

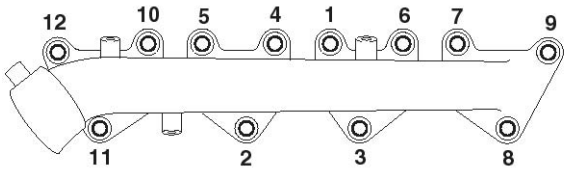
Tighten the exhaust manifold nuts as followig method.

[LH]



SHMM19154N

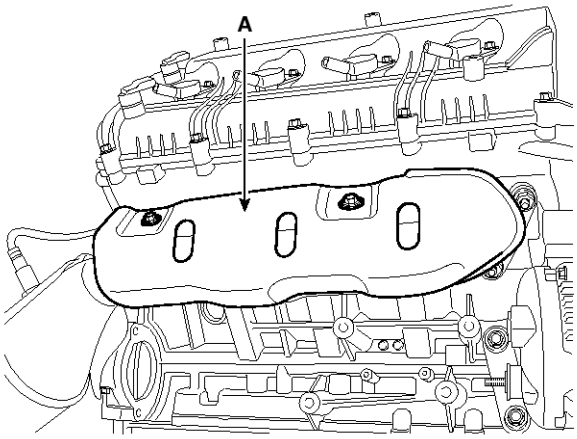
[RH]



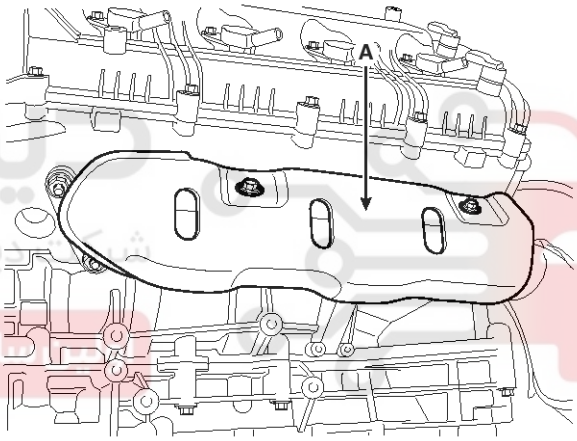
SHMM19363N

29. Install the exhaust manifold heat protector (A).

Tightening torque :
8.8 ~ 10.8 N.m (0.9 ~ 1.1kgf.m, 6.5 ~ 8.0lb-ft)

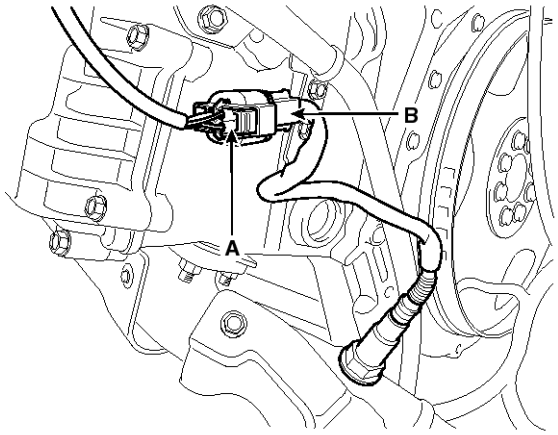


SHMM19002N

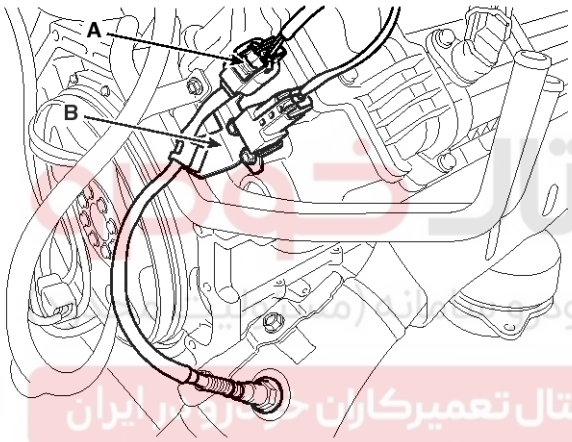


SHMM19003N

30. Reconnect the oxygen sensor connector (A) and Install the oxygen sensor connector bracket (B).



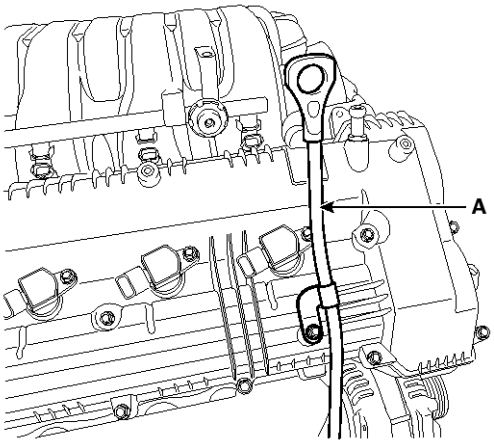
SHMM19079N



SHMM19080N

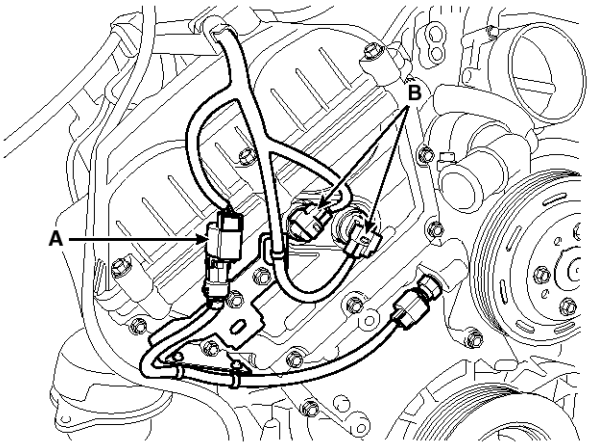
31. Install the oil level gauge (A).

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



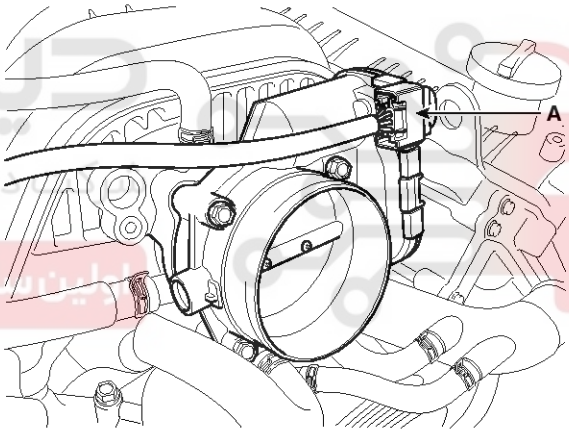
SHMM19001N

32. Install the engine wiring harness to the cylinder head.
    1) Reconnect the water temperature sensor connector (A) and the CVVT oil control valve connectors (B).



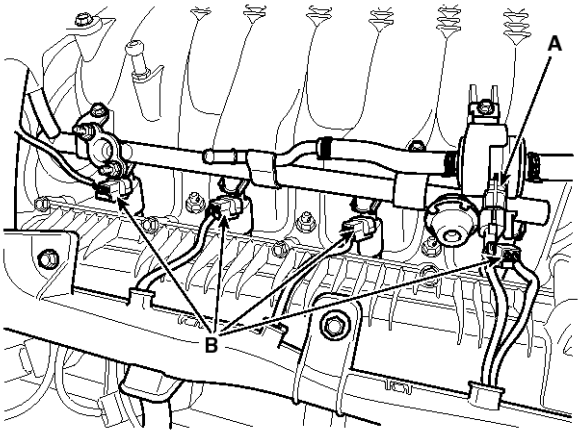
SHMM19069N

    2) Reconnect the ETC module connector (A).



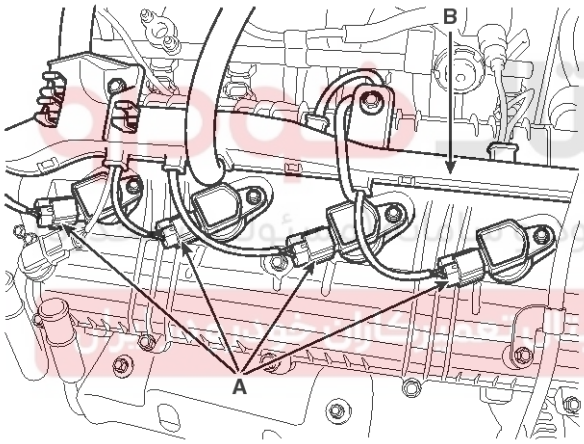
SHMM19070N

3) Reconnect the PCSV connector (A) and the injector connectors (B).



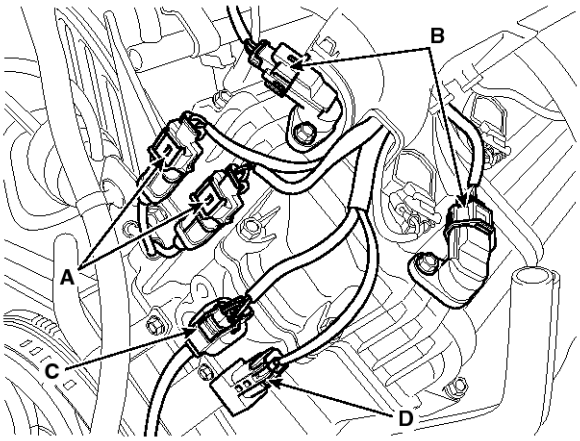
SHMM19071N

4) Reconnect the ignition coil connectors (A) and the wiring harness protector (B).



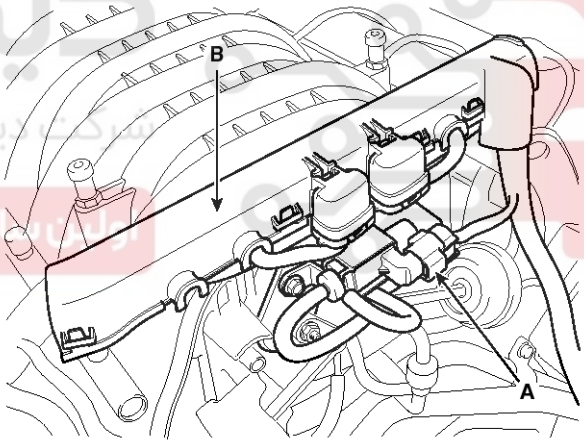
SHMM19072N

5) Reconnect the knock sensor connectors (A), the camshaft position sensor connectors (B), the oxygen sensor connector (C) and the condenser connector (D).



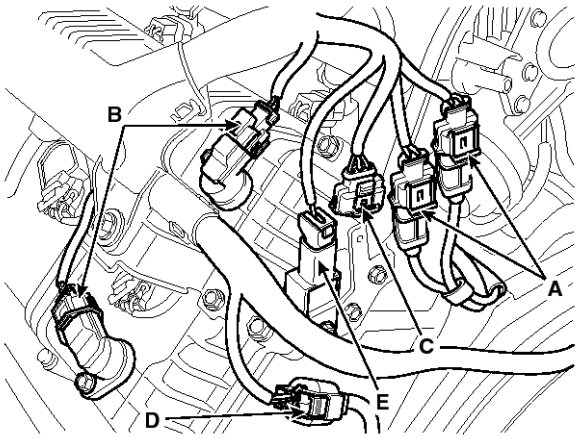
SHMM19073N

6) Reconnect the variable intake system solenoid valve connector (A) and the wiring harness protector (B).



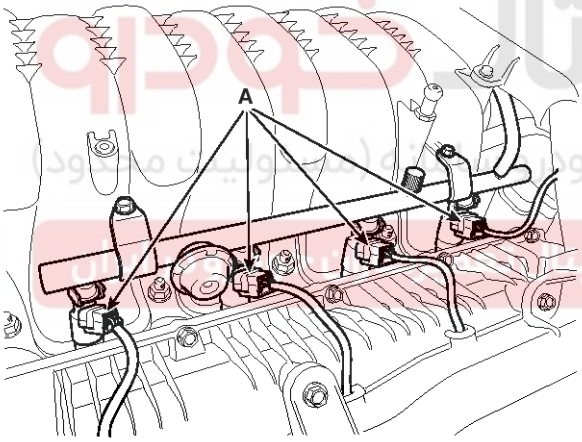
SHMM19074N

7) Reconnect the knock sensor connectors (A), the camshaft position sensor connectors (B), the crankshaft position sensor connector (C), the oxygen sensor connector (D) and the condenser connector (E).



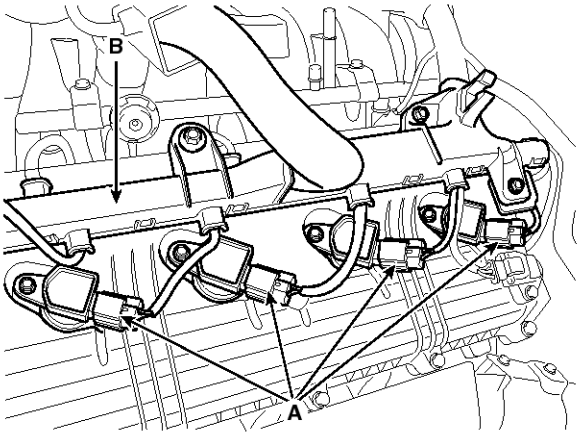
SHMM19075N

8) Reconnect the injector connectors (A).



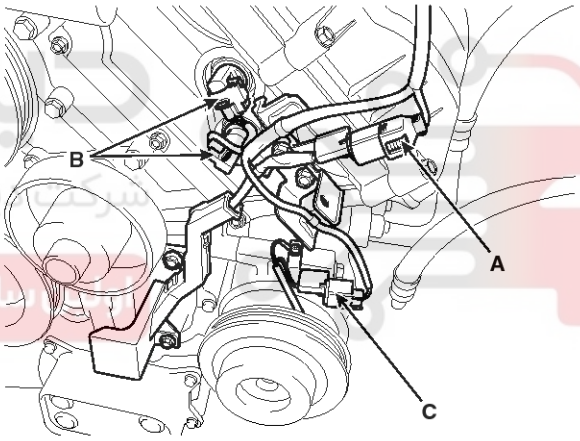
SHMM19076N

9) Reconnect the ignition coil connectors (A) and the wiring harness protector (B).



SHMM19077N

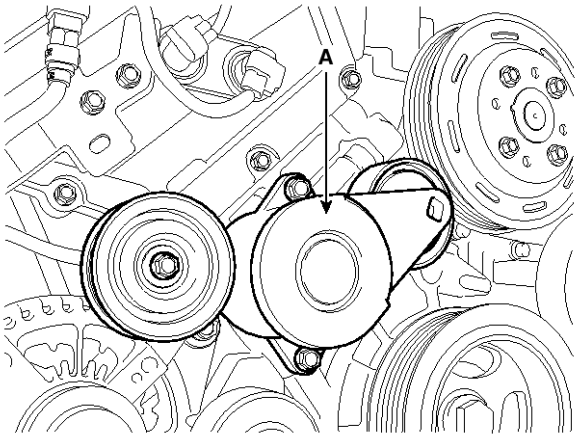
10) Reconnect the oil pressure switch connector (A), the CVVT oil control valve connectors (B) and the air conditioner compressor switch connector (C).



SHMM19078N

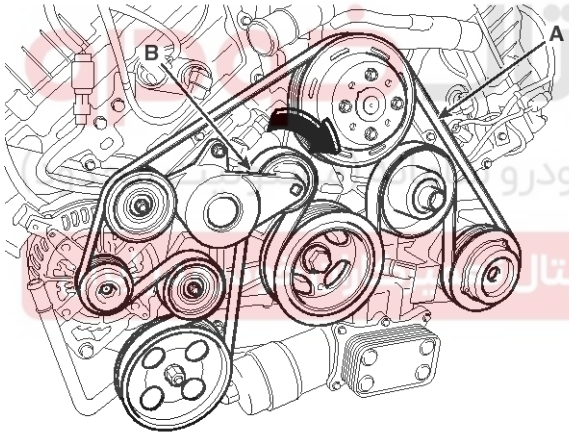
33. Install the drive belt tensioner (A).

Tightening torque :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)



SHMM19068N

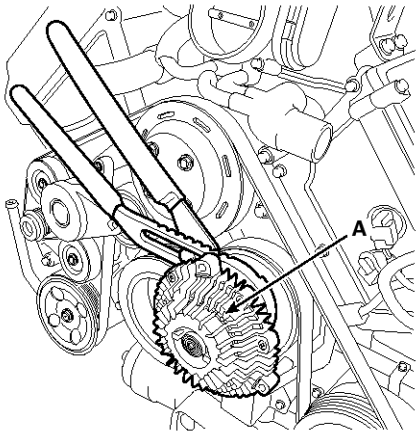
34. Turn the tensioner (B) clockwise and loosen, then install the drive belt (A).



SHMM19067N

35. Install the cooling fan clutch (A).

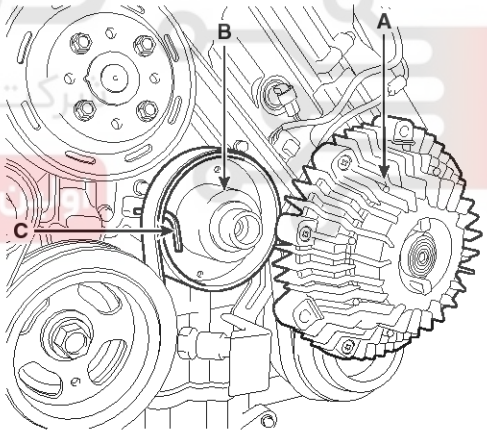
Tightening torque :
58.8N.m (6.0kgf.m, 43.4lb-ft)



SHMM19052N

NOTICE

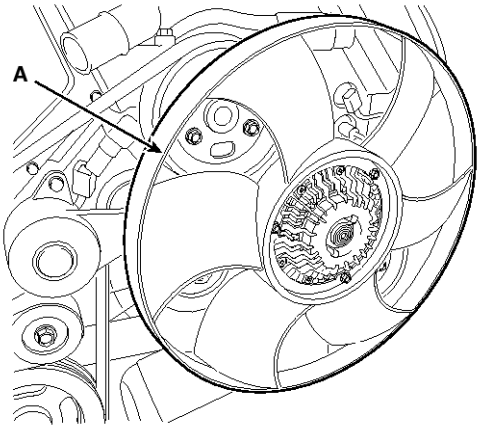
Install the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



SHMM19053N

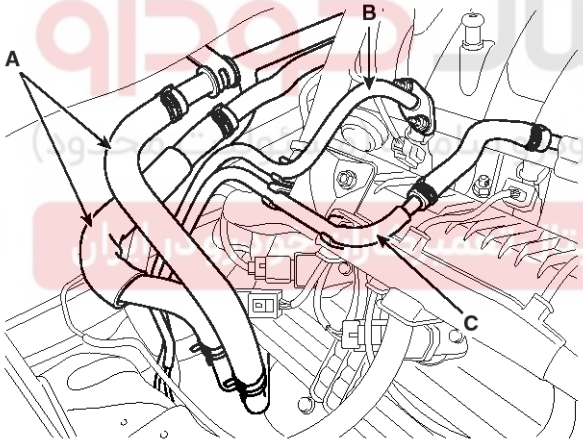
36. Install the cooling fan (A).

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



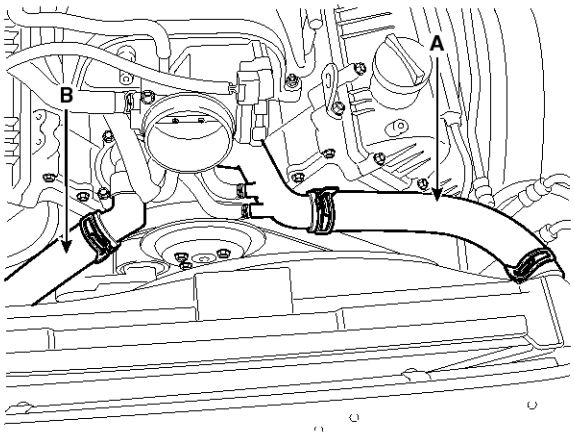
SHMM19051N

37. Reconnect the heater hoses (A), the fuel hose (B) and the purge control solenoid valve (PCSV) hose (C).



SHMM19054N

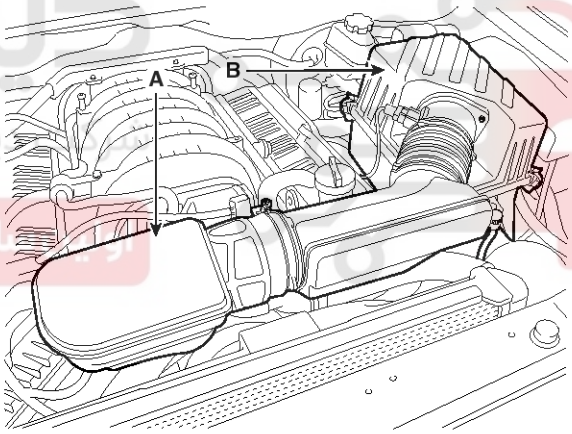
38. Reconnect the radiator upper hose (A) and lower hose (B).



SHMM19049N

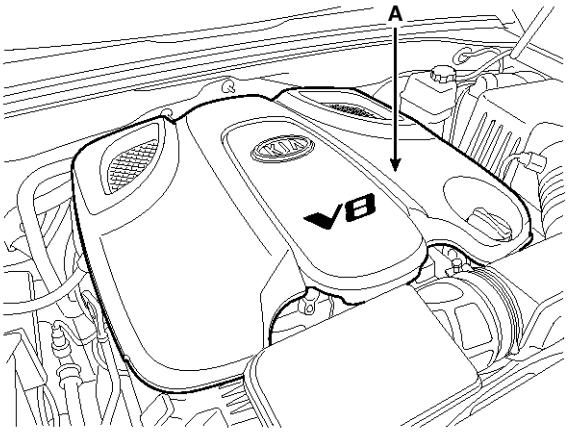
39. Install the air duct (A) and the air cleaner assembly (B).

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



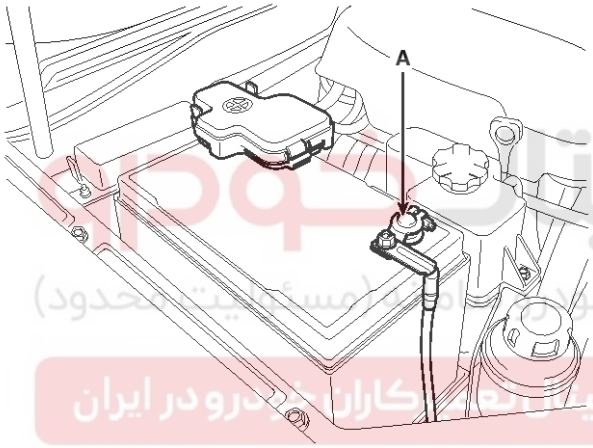
SHMM19048N

40. Install the engine cover (A).



SHMM19044N

41. Reconnect the negative terminal to the battery.



SHMM19043N

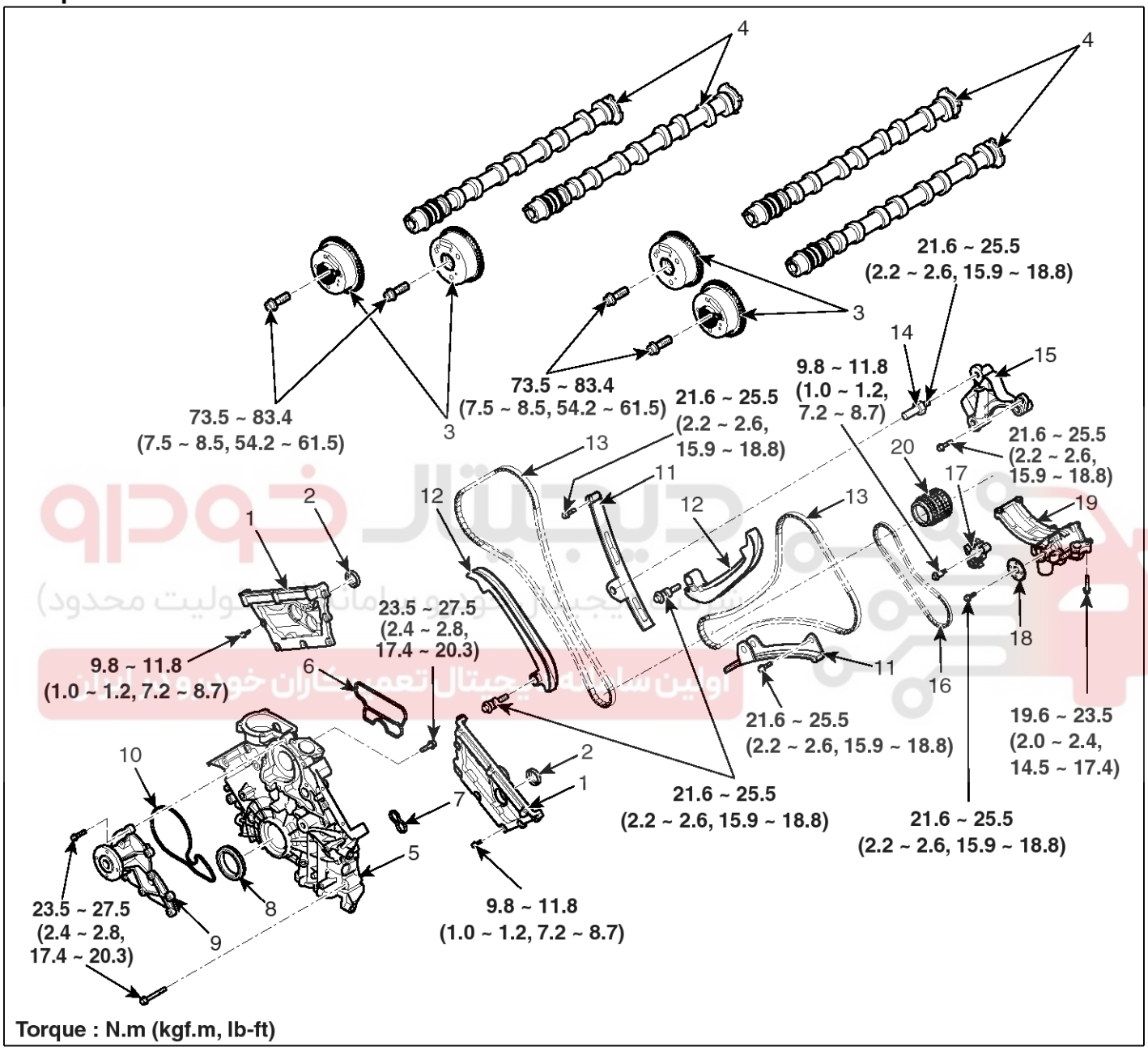
NOTICE

- *Refill engine oil.*
- *Clean the battery posts and cable terminals with sandpaper assemble them, then apply grease to prevent corrosion.*
- *Inspect for fuel leakage.*
  - *After assembling 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 lines.*
- *Refill radiator and reservoir tank with engine coolant.*
- *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.*

Timing System

Timing Chain

Components

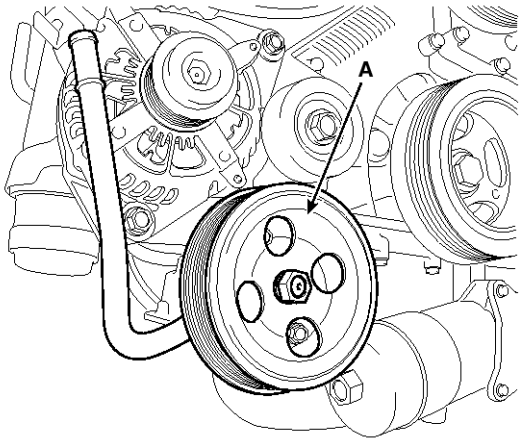


SHMM19325N

1. Timing chain upper cover
2. Timing chain upper cover oil seal
3. CVVT assembly
4. Camshaft
5. Timing chain lower cover
6. Timing chain lower cover gasket
7. Timing chain lower cover gasket
8. Timing chain lower cover oil seal
9. Water pump
10. Water pump gasket
11. Timing chain guide
12. Timing chain tensioner arm
13. Timing chain
14. Timing chain guide bolt
15. Tensioner adapter
16. Oil pump chain
17. Oil pump chain tensioner
18. Oil pump sprocket
19. Oil pump assembly
20. Crankshaft sprocket

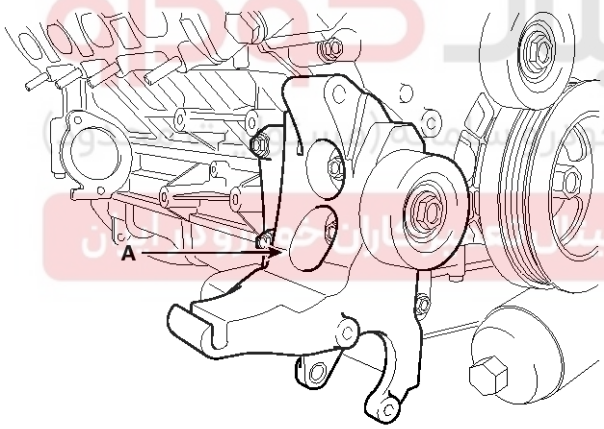
Removal

1. Remove the cylinder head assembly. (Refer to cylinder head assembly in this group)
2. Remove the power steering pump. (Refer to ST group)



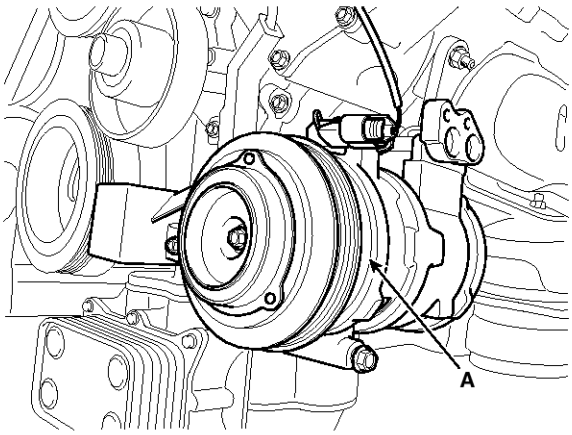
SHMM19086N

3. Remove the alternator bracket (A).



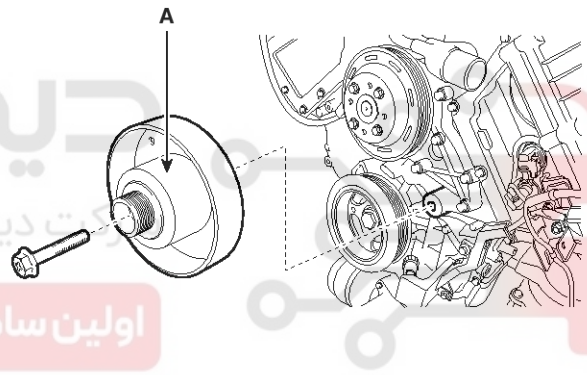
SHMM19031N

4. Remove the air conditioner compressor (A). (Refer to HA group)



SHMM19087N

5. Remove the cooling fan pulley (A).



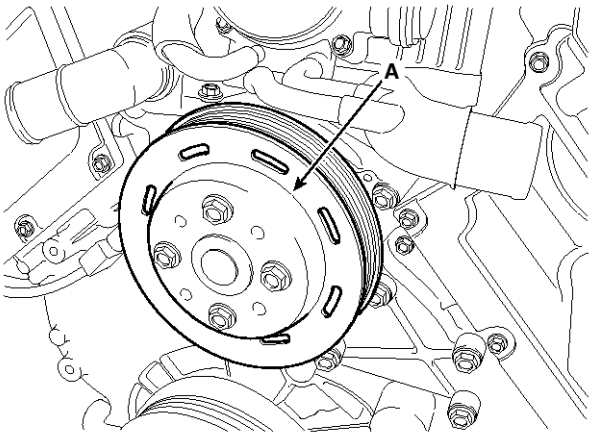
SHMM19088N

⚠CAUTION

The cooling fan pulley bolt is left-hand thread.

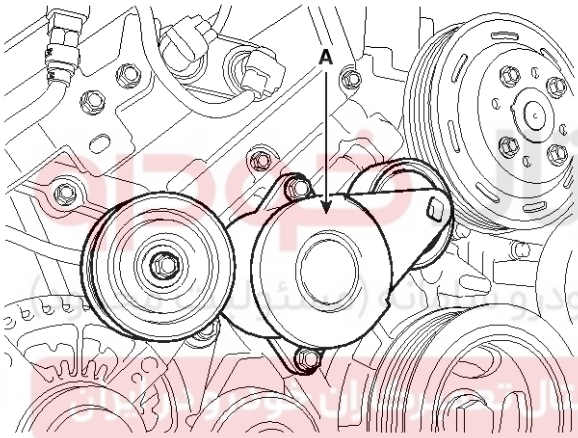
To remove the bolt, screw it clockwise.

6. Remove the water pump pulley (A).



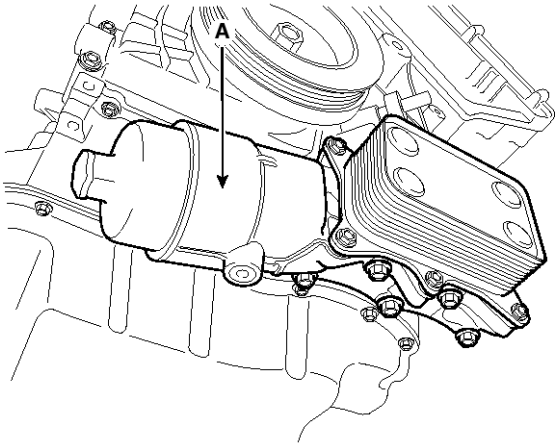
SHMM19089N

7. Remove the drive belt tensioner (A).



SHMM19068N

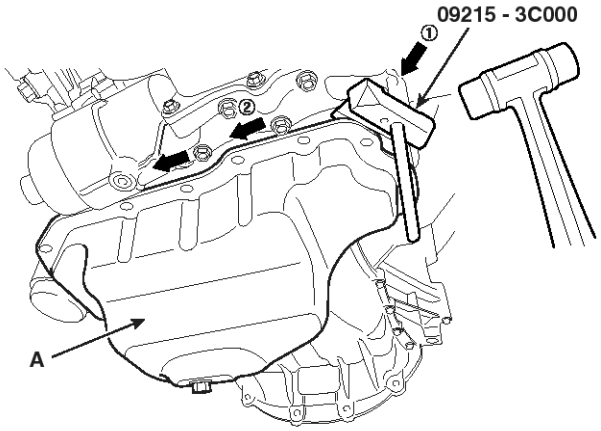
8. Remove the oil filter and oil cooler assembly (A).



SHMM19090N

9. Remove the lower oil pan(A).

   Insert the blade of SST(09215-3C000) between the upper oil pan and the lower oil pan. Cut off applied sealer and remove the lower oil pan.



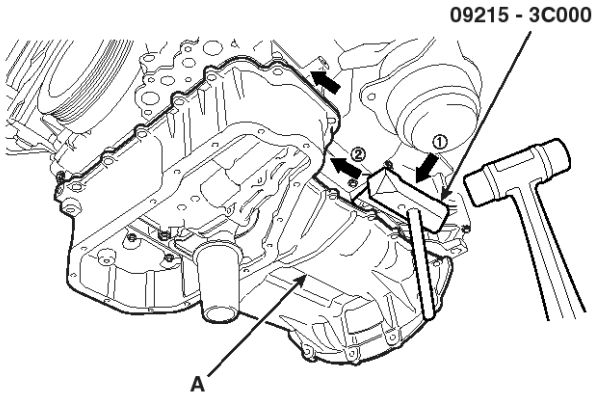
SHMM19315N

NOTICE

- *Insert the SST between the lower oil pan and the upper oil pan by tapping it with a plastic hammer in the direction of (1) arrow.*
- *After tapping the SST with a plastic hammer along the direction of (2) arrow around more than 2/3 edge of the lower oil pan, remove it from the lower oil pan.*
- *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.*

10. Remove the upper oil pan (A).

Insert the blade of SST(09215-3C000) between the upper oil pan and the cylinder block. Cut off applied sealer and remove upper oil pan.

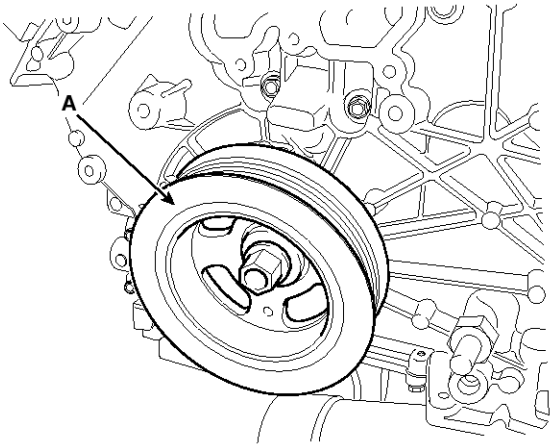


SHMM19316N

NOTICE

- *Insert the SST between the upper oil pan and the cylinder block by tapping it with a plastic hammer in the direction of (1) arrow.*
- *After tapping the SST with a plastic hammer along the direction of (2) arrow around more than 2/3 edge of the upper oil pan, remove it from the upper oil pan.*
- *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 cylinder block.*

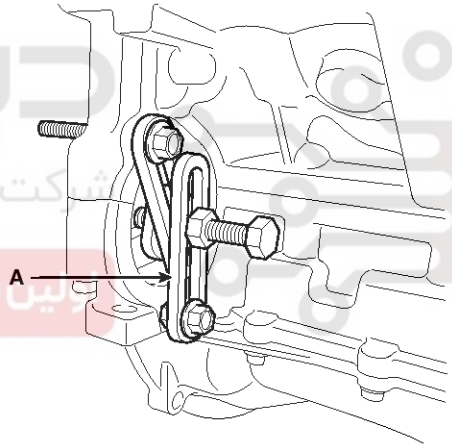
11. Remove the crankshaft pulley (A).



SHMM19098N

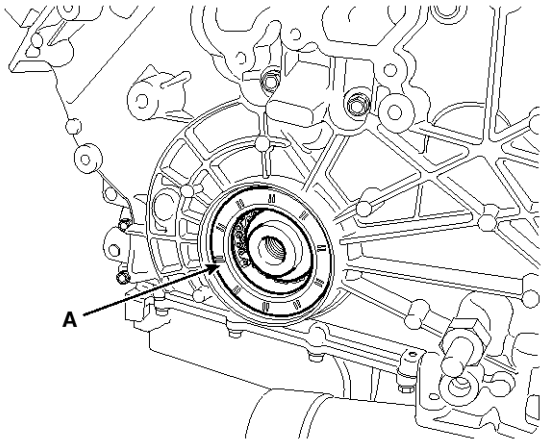
NOTICE

Use the SST(flywheel stopper, 09231-2B100) to remove the crankshaft pulley bolt, after remove the starter.



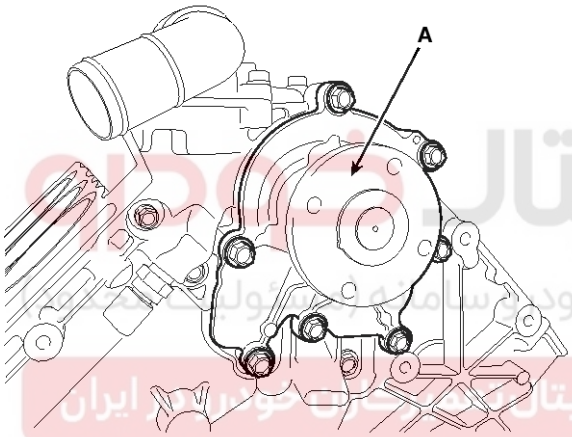
SHMM19099N

12. Remove the front oil seal (A).



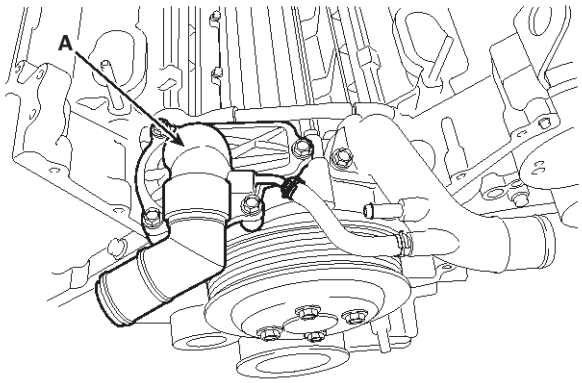
SHMM19100N

13. Remove the water pump (A).



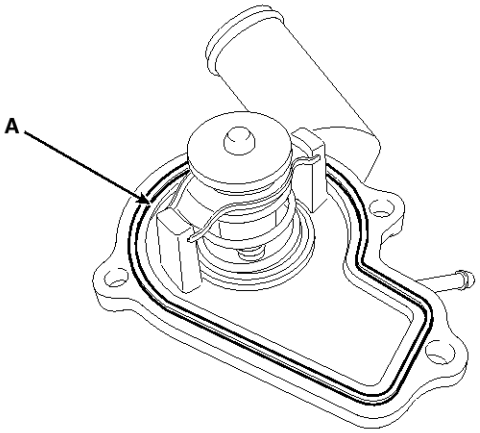
SHMM19101N

14. Remove the water temperature control assembly (A).



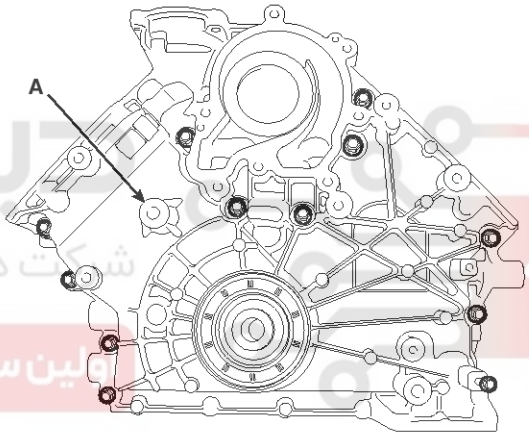
SHMM19102N

15. Remove the O-ring from the water temperature control assembly (A).



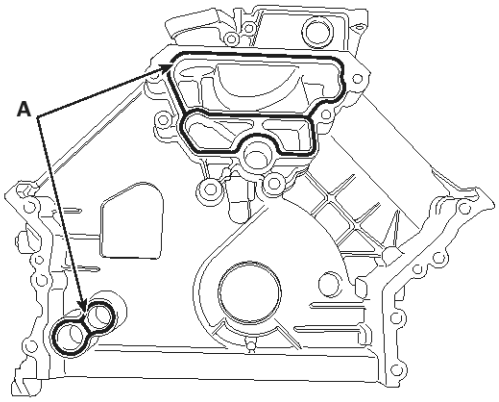
SHMM19103N

16. Remove the timing chain lower cover (A).



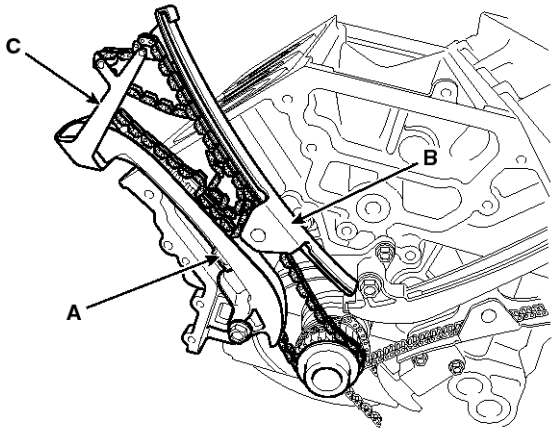
SHMM19105N

17. Remove the O-ring from the timing chain cover (A).

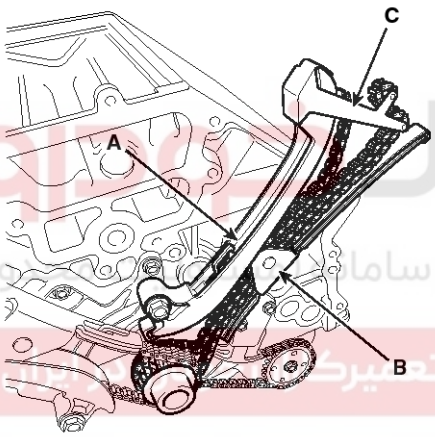


SHMM19344N

18. Remove the timing chain tensioner arm (A) and the timing chain guide (B) and then remove the timing chain.

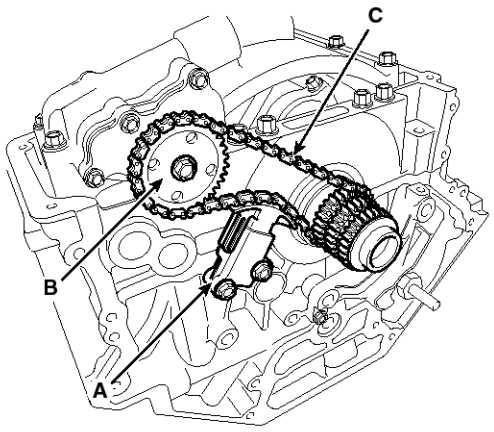


SHMM19126N



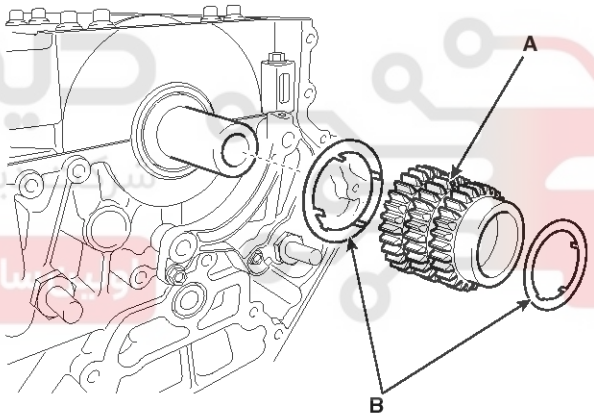
SHMM19127N

19. Insert a set pin after compressing the oil pump chain tensioner (A) and then remove the oil pump sprocket (B) and chain (C).



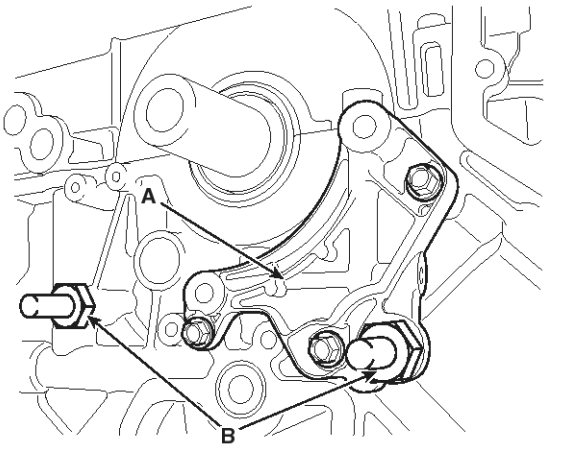
SHMM19169N

20. Remove the crankshaft sprocket (A) and friction plates (B).



SHMM19107N

21. Remove the tensioner adapter (A) and the timing chain guide bolts (B).

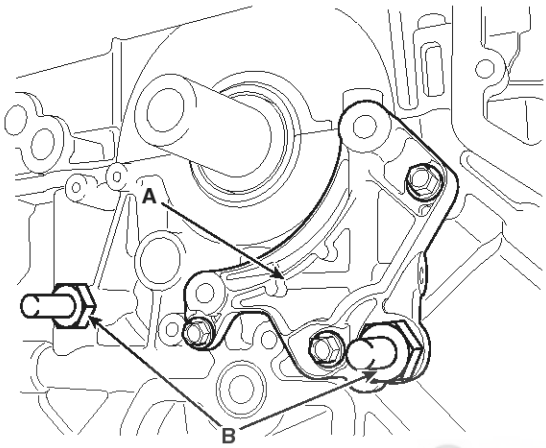


SHMM19108N

Installation

1. Install the tensioner adapter (A) and the timing chain guide bolts (B).

Tightening torque :
Tensioner adapter bolts:
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)
Timing chain guide bolts :
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)



SHMM19108N

2. Install the crankshaft sprocket (A) with the friction plates (B).

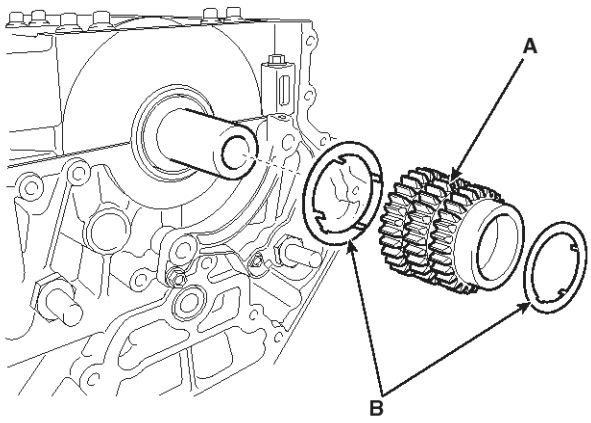
NOTICE

Completely fix the four friction plate clips and the sprocket groove.

Align the key-home of the friction plate with the key-home of the sprocket.

Be careful for the clip not to be folded.

The block is placed at bottom up before install the timing chain system and timing chain cover assembly.

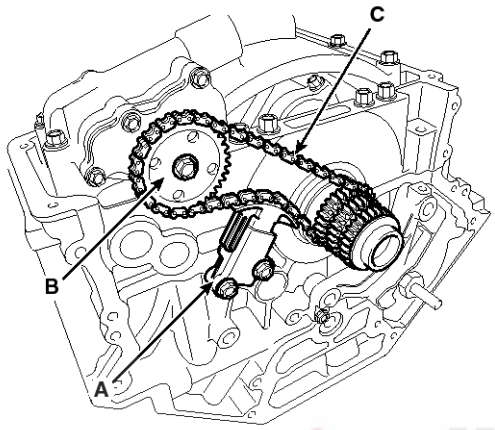


SHMM19107N

CAUTION
The mark of friction plate should be placed top. (Engine is placed bottom up)

3. Install the oil pump chain (C) with the oil pump sprocket (B) and oil pump chain tensioner (A).

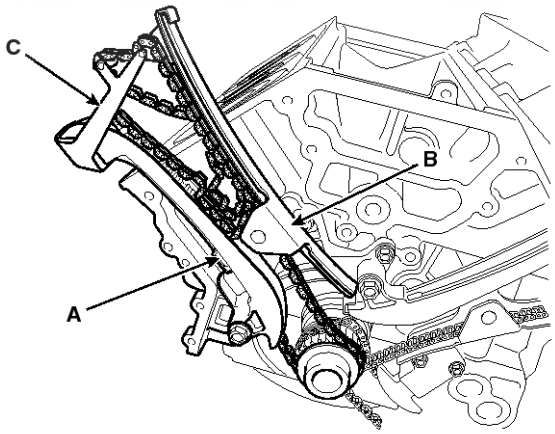
Tightening torque :
A : 9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
B : 21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)



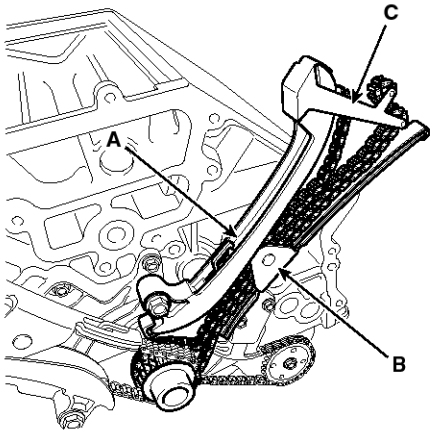
SHMM19169N

4. Install the timing chain with the timing chain tensioner arm (A) , the timing chain guide (B) and the timing chain locking tool (SST : 09231-2J600) (C).

Tightening torque :
Timing chain tensioner arm bolts :
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

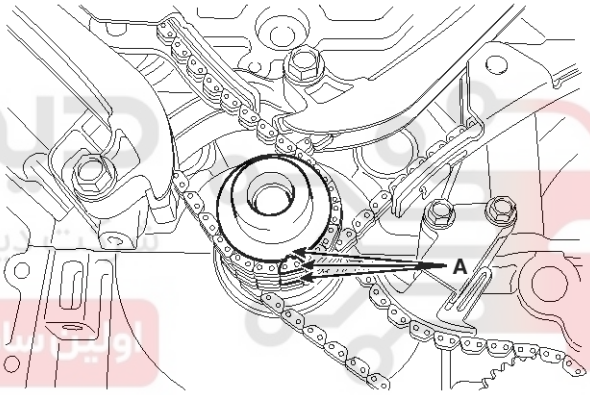


SHMM19126N



SHMM19127N

NOTICE
Align the timing mark of the friction plate and crankshaft sprocket.



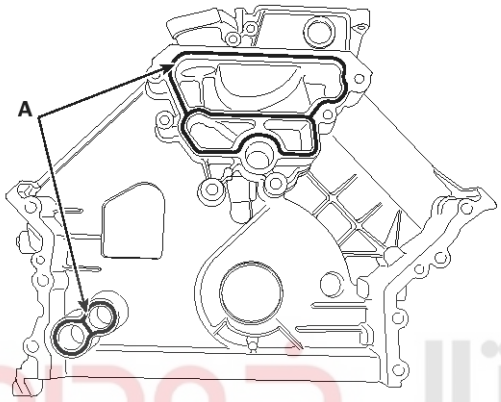
SHMM19128N

5. Install the timing chain lower cover (A).

NOTICE

Assemble the timing chain lower cover with engine bottom up condition.

1) The sealant locations on chain lower cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and etc.
2) Install the new gasket (A) to the timing chain lower cover.

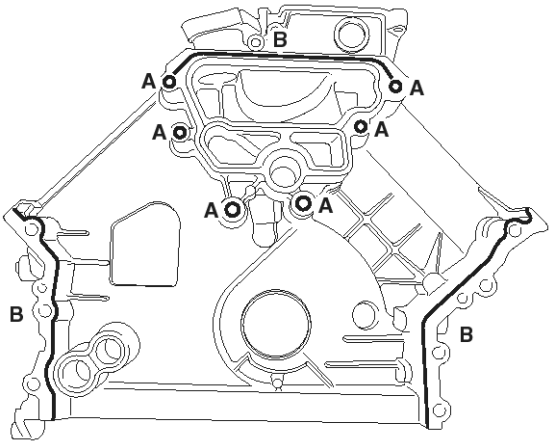


SHMM19344N

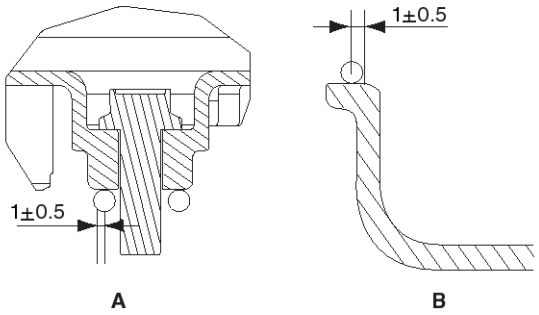
3) Apply liquid sealant TB1217H or LT 5900H on timing chain lower cover. The part must be assembled within 5 minutes after sealant was applied.

   Sealant should be applied in a continuous beed in each of the areas indicated below.

Bead width : Ø2.5 ± 0.5mm



SHMM19106N



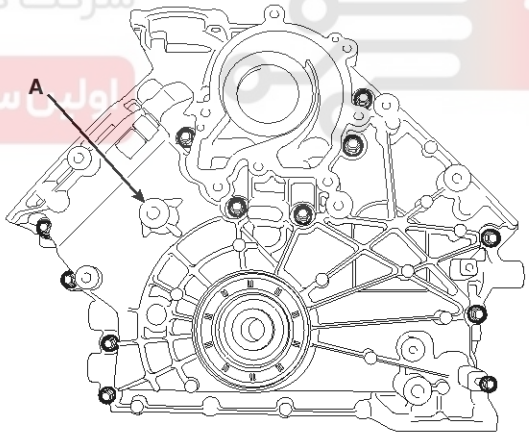
SHMM19323N

NOTICE

During timing chain lower cover installation, care not to take off applied sealant on the timing chain lower cover by contact with other parts.

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

Tightening torque :
23.5 ~ 27.5Nm (2.4 ~ 2.8kgf.m, 17.4 ~ 20.3lb-ft)



SHMM19105N

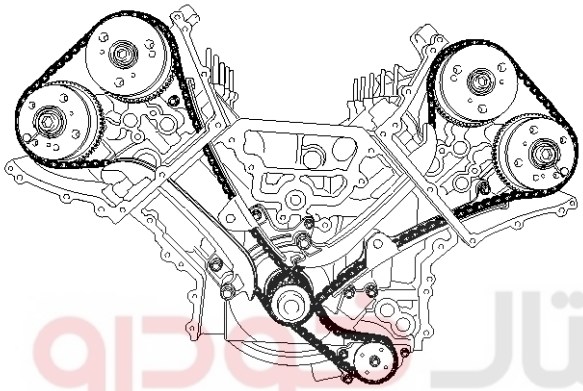
5) The firing and/or blow out test should not be performed within 30 minutes after the timing chain lower cover was assembled.

6. Install the cylinder head assembly. (Refer to cylinder head assembly in this group)

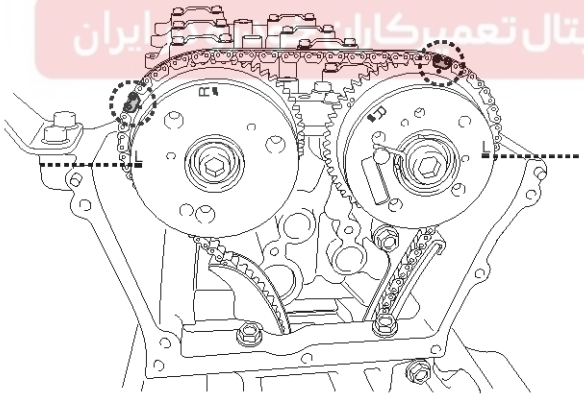
   NOTICE

   Before install the cylinder head assembly, place the engine up right.

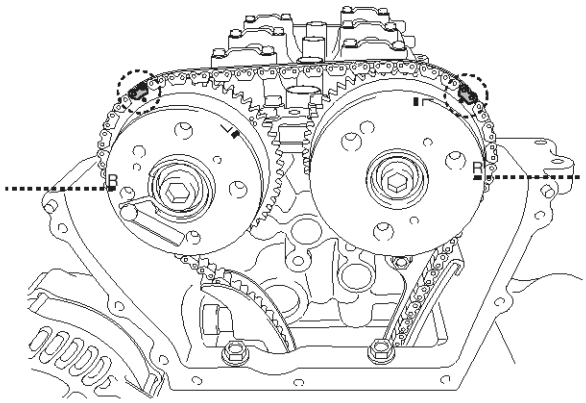
7. Install the camshaft assembly. (Refer to cylinder head assembly in this group)
8. Remove the SST from the timing chain guide and the timing chain tensioner arm.
9. Install the timing chain to the camshaft sprocket. (Refer to cylinder head assembly in this group)



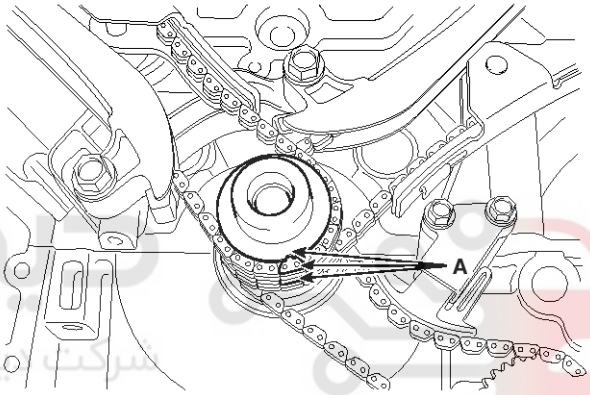
SHMM19129N



SHMM19028N



SHMM19029N



SHMM19128N

NOTICE

To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.

Crankshaft sprocket → Timing chain guide → Exhaust camshaft sprocket → Intake camshaft sprocket. (LH Bank)

Crankshaft sprocket → Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket. (RH Bank)

The timing mark of each sprockets should be matched with timing mark (color link) of timing chain during installation.

10. Install the timing chain tensioner. (Refer to cylinder head assembly in this group)

Tightening torque :
78.5 ~ 88.3N.m (8.0 ~ 9.0kgf.m, 57.9 ~ 65.1lb-ft)

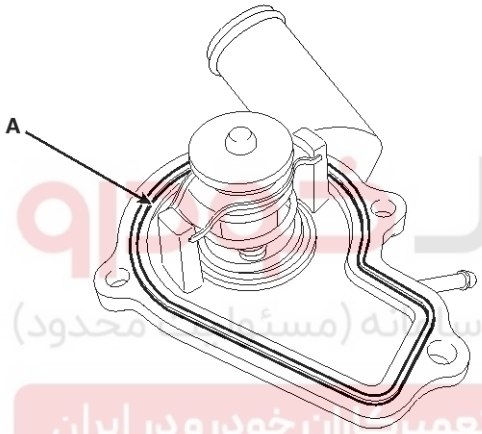
11. After rotating the crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.

NOTICE

Always turn the crankshaft clockwise.

Turning the crankshaft counter clockwise before building up oil pressure in the hydraulic timing chain tensioner may result in the chain disengaging from the sprocket teeth.

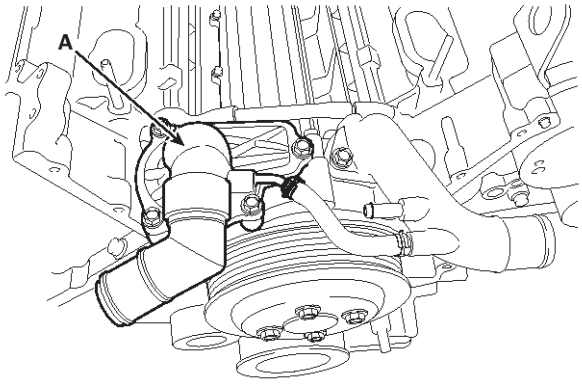
12. Install the O-ring to the water temperature control assembly (A).



SHMM19103N

13. Install the water temperature control assembly (A).

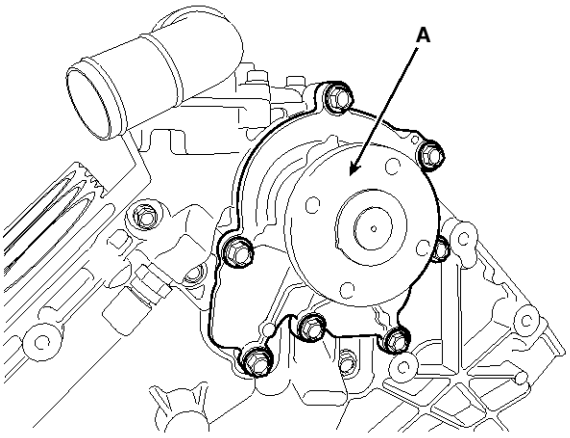
Tightening torque :
16.7 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)



SHMM19102N

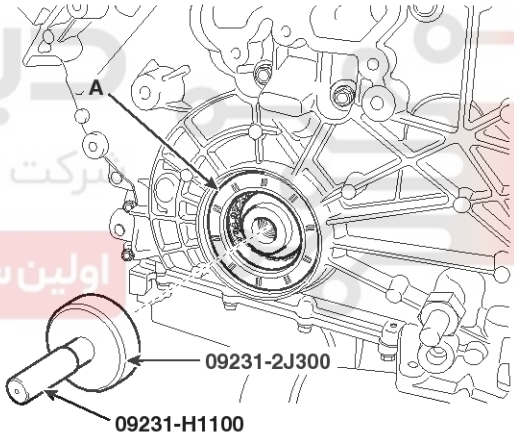
14. Install the water pump (A).

Tightening torque :
19.6 ~ 24.5Nm (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)



SHMM19101N

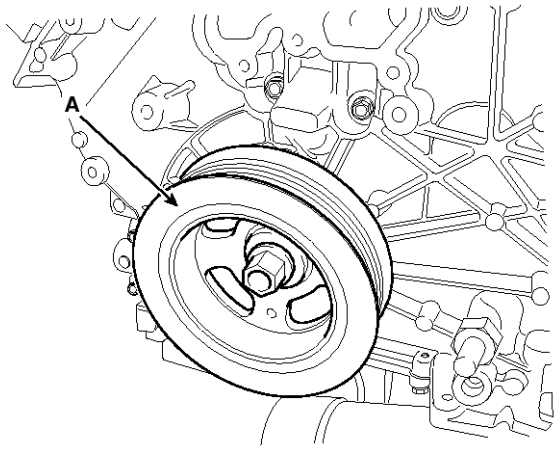
15. Using SST(09231-2J300, 09231-H1100), Install the front oil seal (A).



SHMM19345N

16. Install the crankshaft pulley (A).

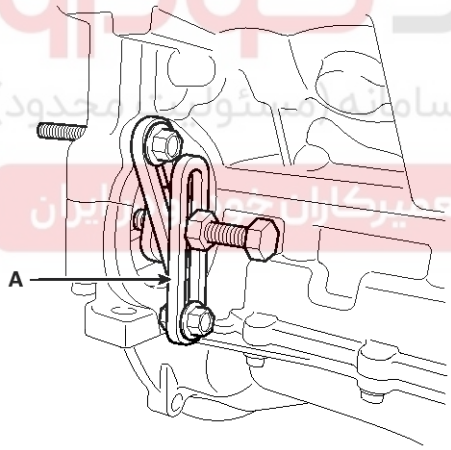
Tightening torque :
392.3~402.1Nm(40.0~41.0kgf.m,289.3~296.6lb-ft)



SHMM19098N

NOTICE

Use the SST(flywheel stopper, 09231-2B100) to Install the crankshaft pulley bolt, after remove the starter.

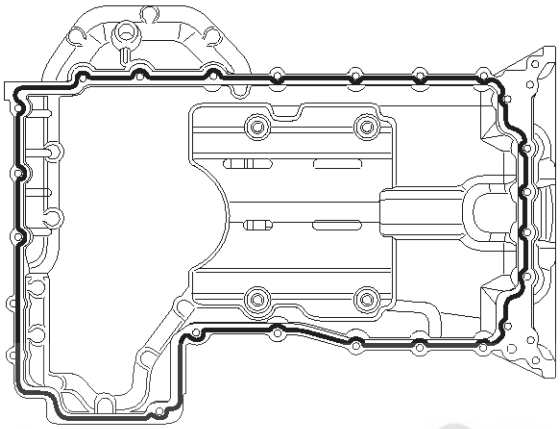


SHMM19099N

17. Install the upper oil pan.
    1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
    2) Before assembling the oil pan, the liquid sealant TB1217H should be applied on upper oil pan.

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

Bead width : 2.5mm(0.1in)

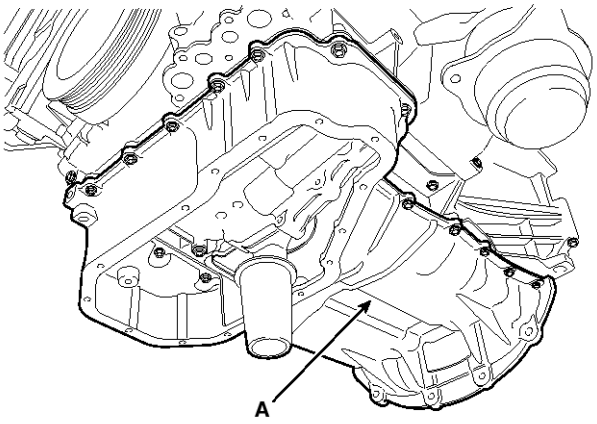


SHMM19143N

NOTICE

- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *When applying sealant gasket, sealant must not protrude into the inside of oil pan.*
- *To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.*

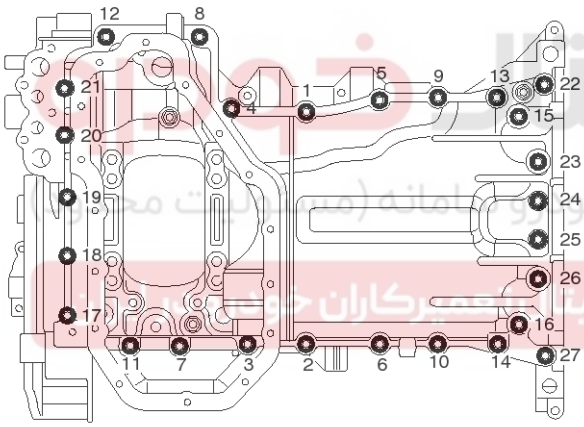
3) Install the upper oil pan.



SHMM19094N

Uniformly tighten the bolts in several passes.

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

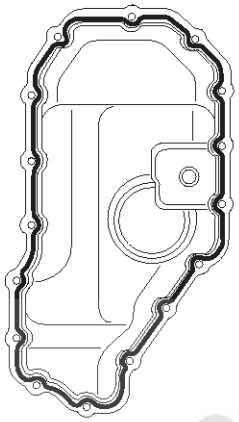


SHMM19145N

18. Install the lower oil pan.
    1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
    2) Before assembling the oil pan, the liquid sealant TB1217H or LT5900H should be applied on lower oil pan.

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

Bead width : 2.5mm(0.1in)

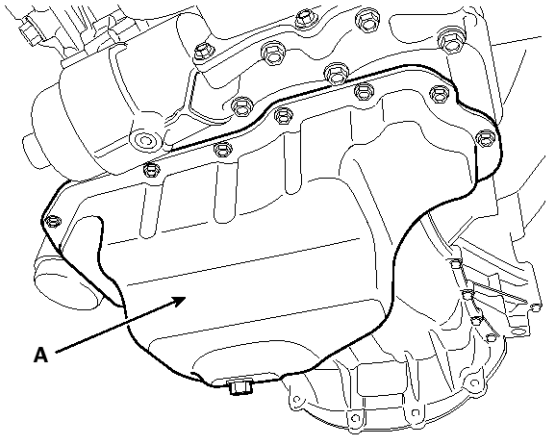


SHMM19146N

NOTICE

- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *When applying sealant gasket, sealant must not protrude into the inside of oil pan.*
- *To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.*

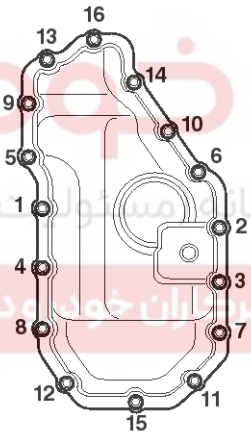
3) Install the lower oil pan.



SHMM19092N

Uniformly tighten the bolts in several passes.

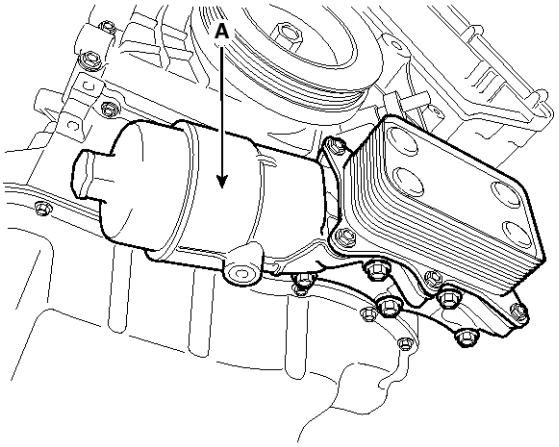
Tightening torque :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHMM19147N

19. Install the oil filter and oil cooler assembly (A).

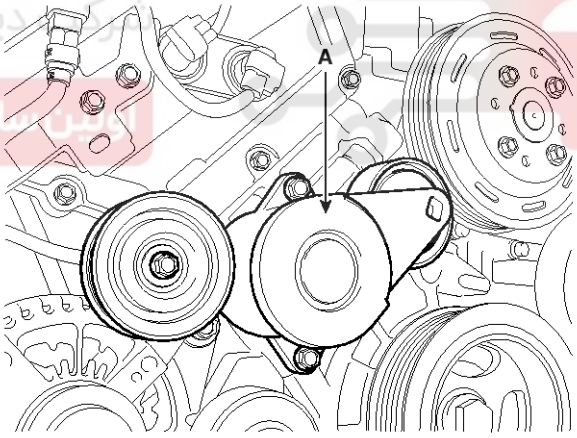
Tightening torque :
Oil filter assembly bolts :
19.6 ~ 23.5Nm (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
Oil cooler bolts :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHMM19090N

20. Install the drive belt tensioner (A).

Tightening torque :
19.6 ~ 23.5Nm (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

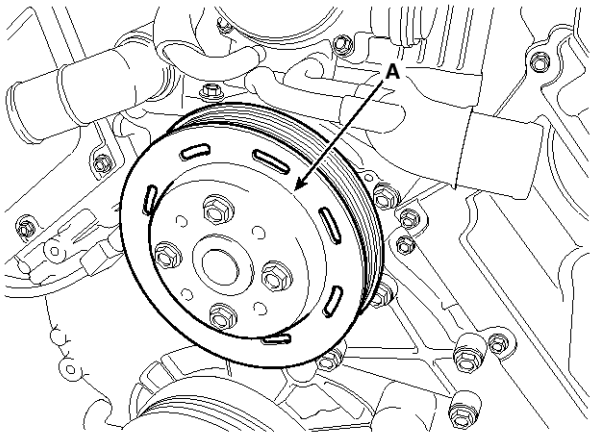


SHMM19068N

21. Install the water pump pulley (A).

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

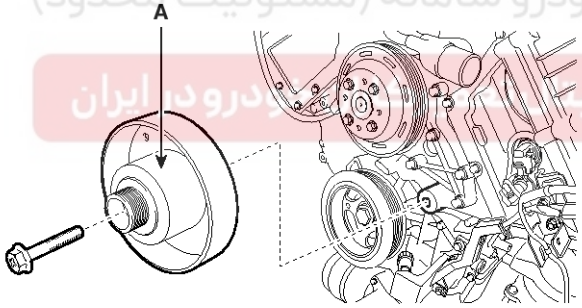
NOTICE
Tighten every bolt diagonally.



SHMM19089N

22. Install the cooling fan pulley (A).

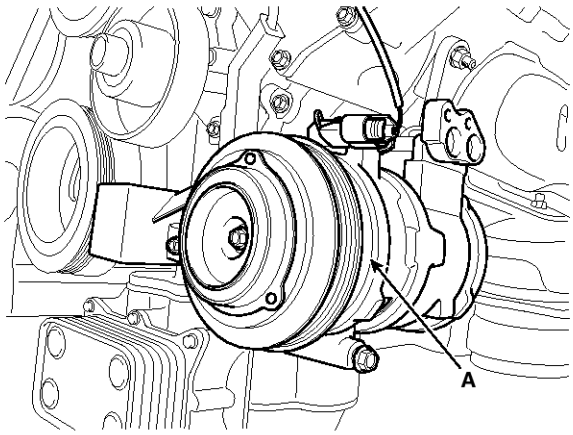
Tightening torque :
76.5 ~ 80.4Nm (7.8 ~8.2kgf.m, 56.4 ~ 59.3lb-ft)



SHMM19088N

CAUTION
The cooling fan pulley bolt is left-hand thread.
To assemble the bolt screw it counterclockwise.

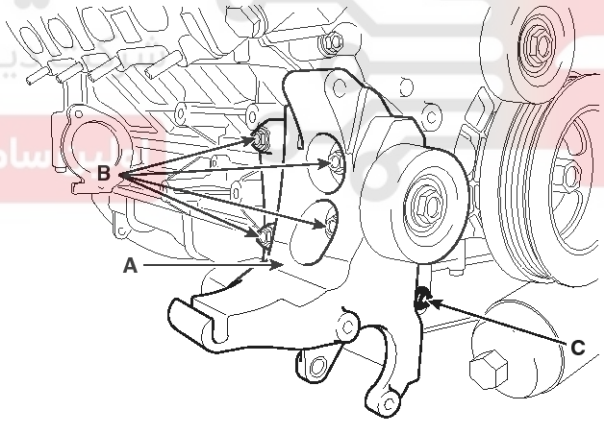
23. Install the air conditioner compressor (A). (Refer to HA group)



SHMM19087N

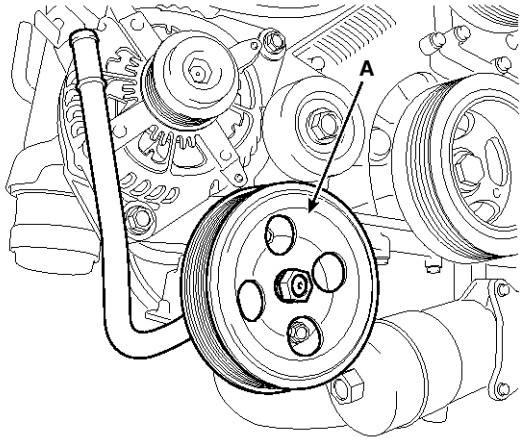
24. Install the alternator bracket (A).

Tightening torque :
Bolts (B) 4EA :
29.4 ~ 41.2N.m (3.0 ~ 4.2kgf.m, 21.7 ~ 30.4lb-ft)
Bolt (C) 1EA :
19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)



SHMM19353N

25. Install the power steering pump. (Refer to ST group)



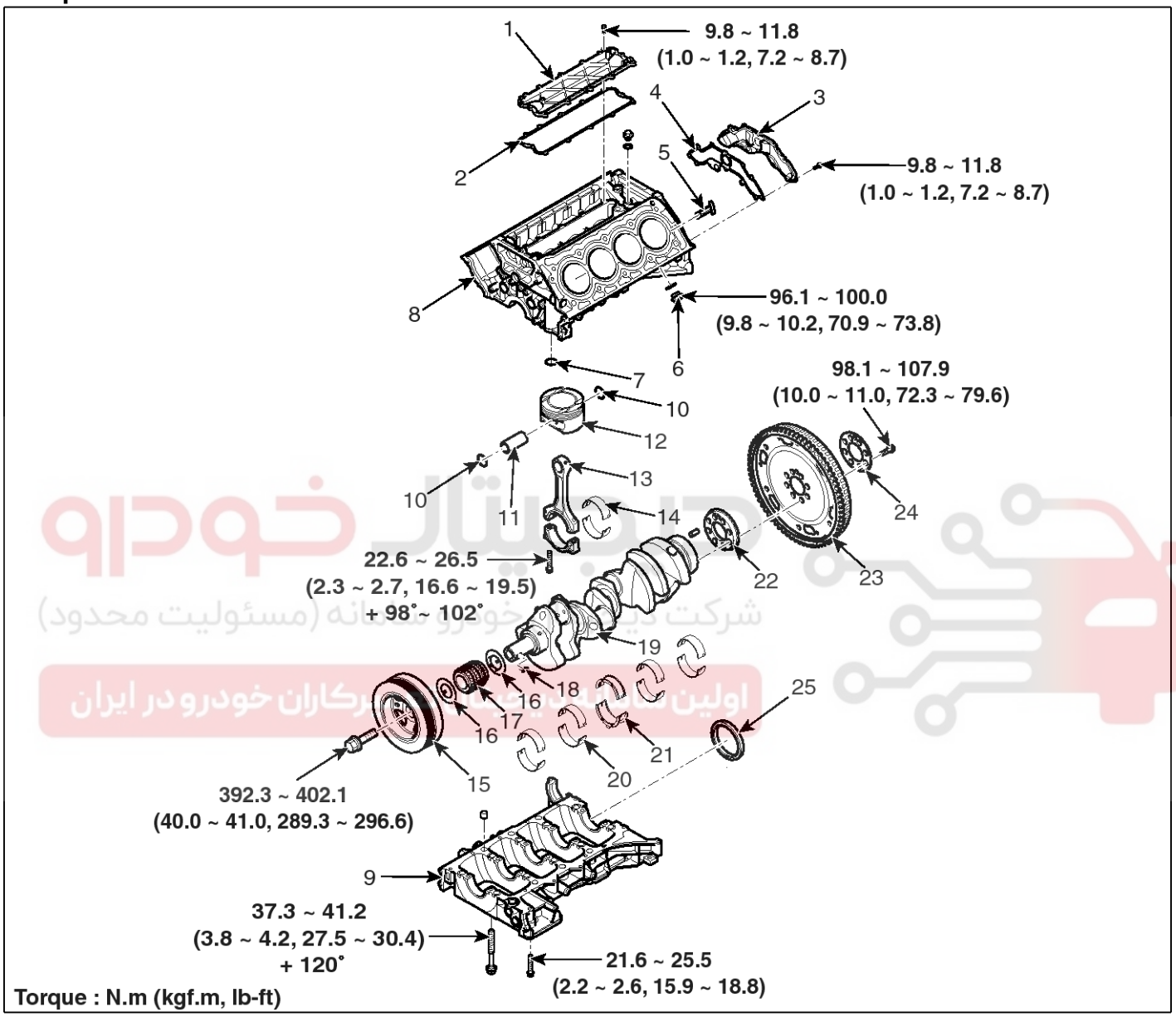
SHMM19086N

26. Install the removed parts. (Refer to cylinder head assembly installation procedure in this group)

Cylinder Block

Cylinder Block

Components



SHMM19328N

1. Cylinder block bank cover
2. Cylinder block bank cover gasket
3. Cylinder block rear cover
4. Cylinder block rear cover gasket
5. Separator
6. Drain plug
7. O-ring
8. Cylinder block
9. Lower crankcase assembly
10. Snap ring
11. Piston pin
12. Piston
13. Connecting rod
14. Connecting rod bearing
15. Crankshaft pulley
16. Friction plate
17. Crankshaft sprocket
18. Key
19. Crankshaft
20. Crankshaft main bearing
21. Crankshaft center main bearing
22. Crankshaft adapter
23. Drive plate
24. Adapter plate
25. Crankshaft rear oil seal

Removal

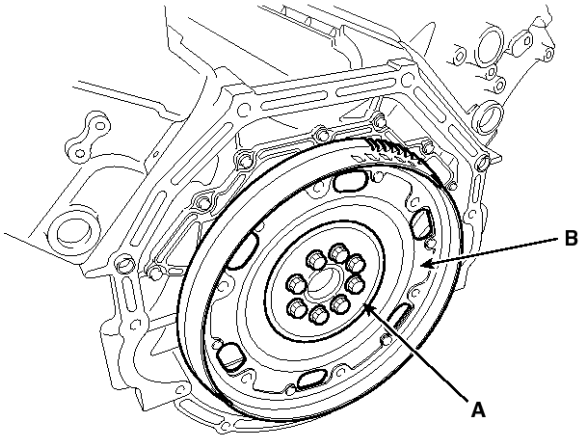
CAUTION

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

NOTICE

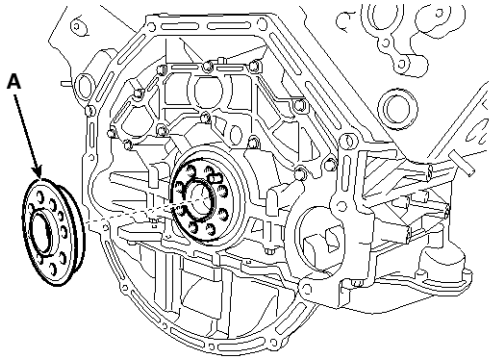
- *Mark all wiring and hoses to avoid misconnection.*
- *Inspect the timing chain before removing the cylinder head.*
- *Turn the crankshaft pulley so that the No.1 piston is at top dead center.*
- *Engine removal is required for this procedure.*

1. Remove the engine assembly from the vehicle. (Refer to Engine and transaxle assembly in this group)
2. Install the engine to engine stand for disassembly.
3. Remove the intake manifold and exhaust manifold. (Refer to Intake and exhaust system in this group)
4. Remove the cylinder head. (Refer to Cylinder head in this group)
5. Remove the timing chain. (Refer to Timing system in this group)
6. Remove the water temperature control assembly. (Refer to Cooling system in this group)
7. Remove the oil pump. (Refer to Lubrication system in this group)
8. Remove the adapter plate (A) and the drive plate (B).



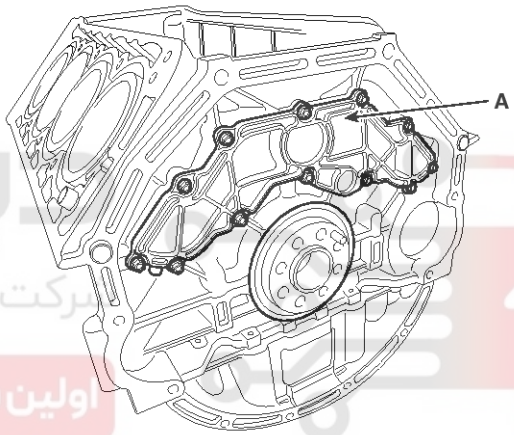
SVIM19164D

9. Remove the crankshaft adapter (A).



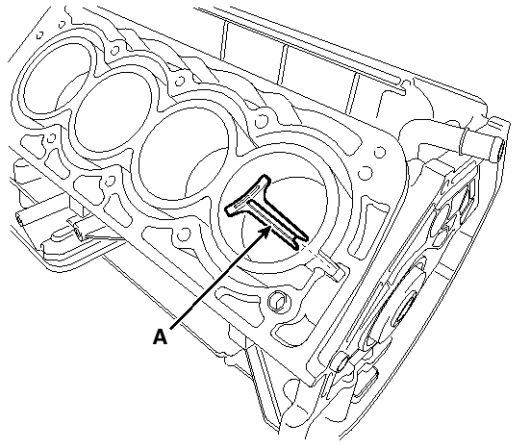
SVIM19165D

10. Remove the cylinder block rear cover (A).

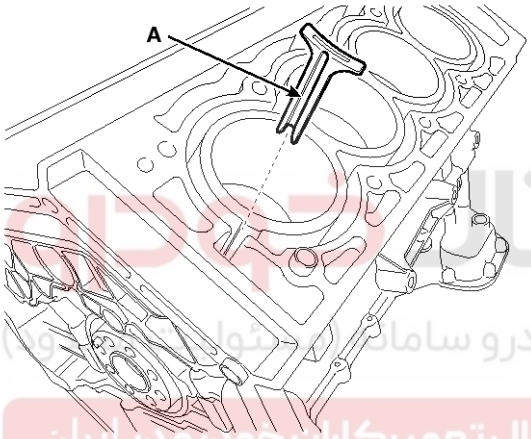


SHMM19113N

11. Remove the separator (A).

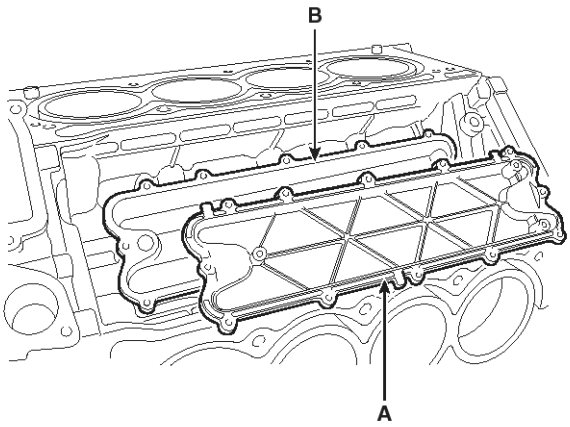


SHMM19110N



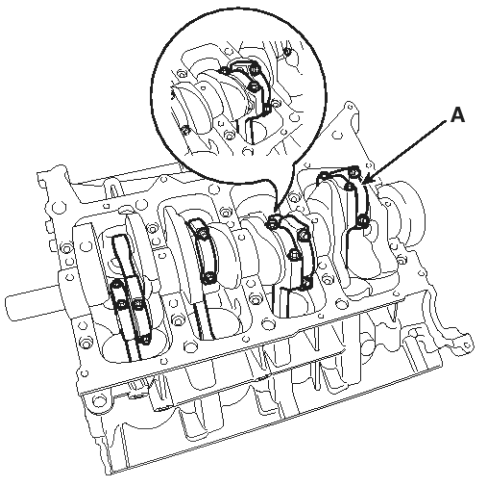
SHMM19111N

12. Remove the cylinder block bank cover (A) and the gasket (B).



SHMM19104N

13. Check the connecting rod end play.
14. Check the connecting rod cap oil clearance.
15. Remove the piston and connecting rod assemblies.
    1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
    2) Remove the connecting rod cap (A).



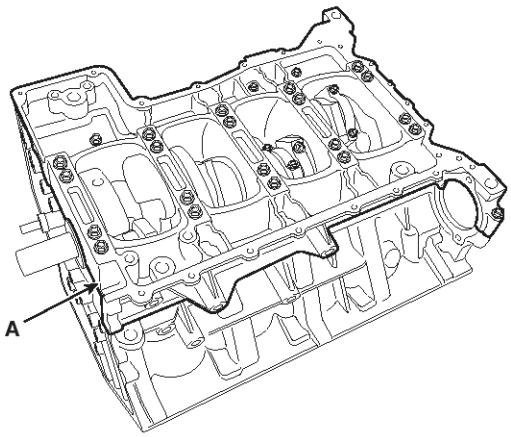
SHMM19116N

    3) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

NOTICE

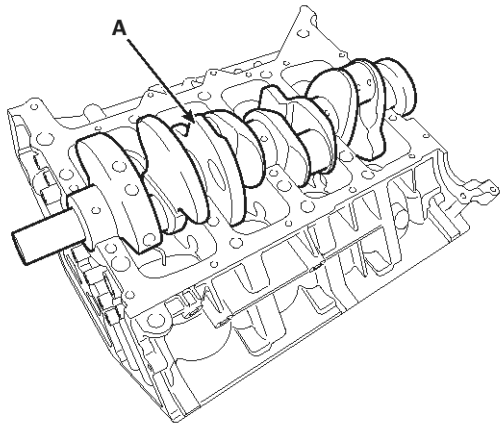
- *Keep the bearings, connecting rod and cap together.*
- *Arrange the piston and connecting rod assemblies in the correct order.*

16. Check the main bearing oil clearance.
17. Check the crankshaft end play.
18. Remove the lower crankcase assembly (A).



SHMM19114N

19. Lift the crankshaft (A) out of engine, being careful not to damage journals.



SHMM19117N

NOTICE

Arrange the main bearings and center bearings in the correct order.

20. Check fit between piston and piston pin.

    Try to move the piston back and forth on the piston pin. If any movement is felt, replace piston and piston pin as a set.

21. Remove the piston rings.
    1) Using a piston ring expander, remove the 2 compression rings.
    2) Remove 2 side rails and the spacer by hand.

    NOTICE

    Arrange the piston rings in the correct order only.

22. Disconnect connecting rod from piston.
    1) Remove the snap rings from piston.
    2) Remove the piston pin.
    3) Remove the connecting rod and the piston.

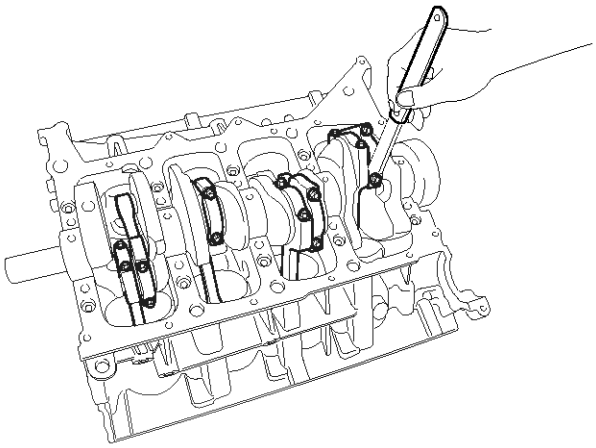
Inspection

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 :
0.10 ~ 0.28mm (0.0039 ~ 0.0110in)



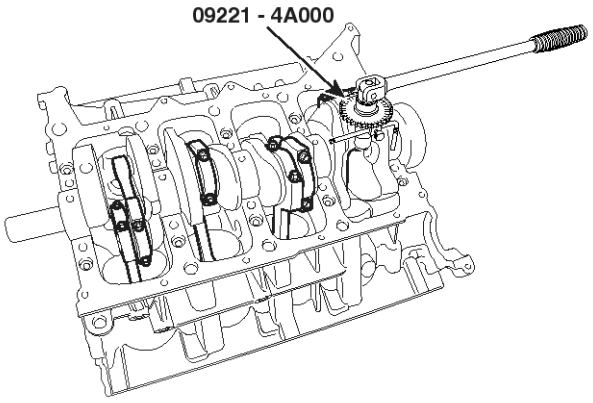
SHMM19317N

   1) If out-of-tolerance, install a new connecting rod.
   2) If still out-of-tolerance, replace the crankshaft.
2. Check the connecting rod bearing oil clearance.
   1) Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.
   2) Remove 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 :
22.6 ~ 26.5Nm (2.3 ~ 2.7kgf.m, 16.6 ~ 19.5lb-ft)
+ 98 ~ 102°

NOTICE
Do not turn the crankshaft.

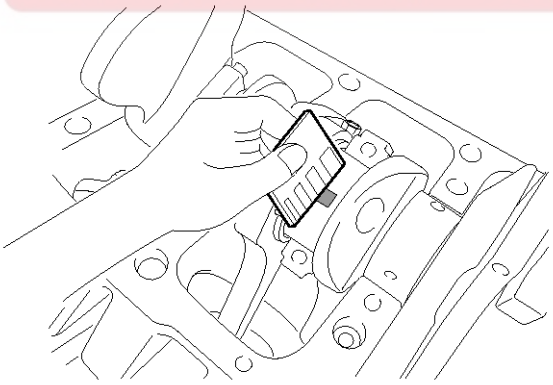


SHMM19318N

7) Remove 2 bolts, connecting rod cap and bearing half.

8) Measure the plastigage at its widest point.

Standard oil clearance :
0.018 ~ 0.036mm (0.0007 ~ 0.0014in)



SHMM19130N

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.

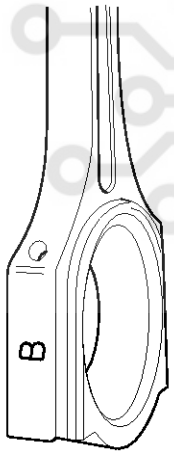
CAUTION
Do not file, shim, or scrape the bearings or the caps to adjust clearance.

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.

NOTICE
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

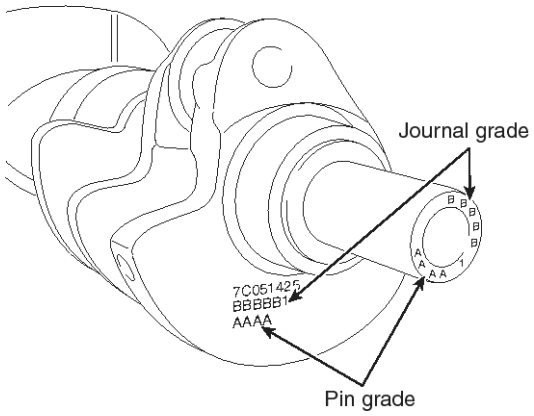


EDQF196A

Discrimination Of Connecting Rod

Class	Mark	Connecting Rod Big-endinner Diameter
a	A	55.000 ~ 55.006mm (2.1654 ~ 2.1656in)
b	B	55.006 ~ 55.012mm (2.1656 ~ 2.1658in)
c	C	55.012 ~ 55.018mm (2.1658 ~ 2.1661in)

Crankshaft Pin Mark Location

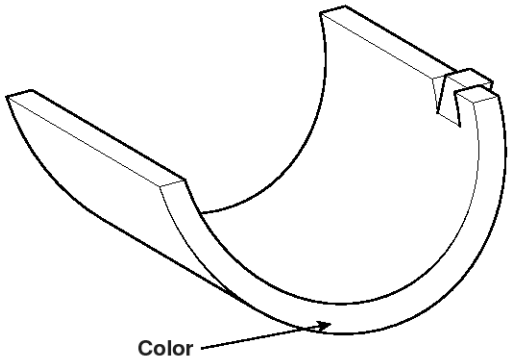


SHMM19131N

Discrimination Of Crankshaft Pin Journal

Class	Mark	Crankshaft Pin Journalouter Diameter
I	A	51.994 ~ 52.000mm (2.0470 ~ 2.0472in)
II	B	51.988 ~ 51.994mm (2.0468 ~ 2.0470in)
III	C	51.982 ~ 51.988mm (2.0465 ~ 2.0468in)

Connecting Rod Bearing Mark Location



ECRF021A

Discrimination Of Connecting Rod Bearing

Class	Color	Connecting Rod Bearing Thic-kness
A	Blue	1.500 ~ 1.503mm (0.0591 ~ 0.0592in)
B	Black	1.497 ~ 1.500mm (0.0589 ~ 0.0591in)
C	None	1.494 ~ 1.497mm (0.0588 ~ 0.0589in)
D	Green	1.491 ~ 1.494mm (0.0587 ~ 0.0588in)
E	Yellow	1.488 ~ 1.491mm (0.0586 ~ 0.0587in)

11) Select the bearing by using selection table.

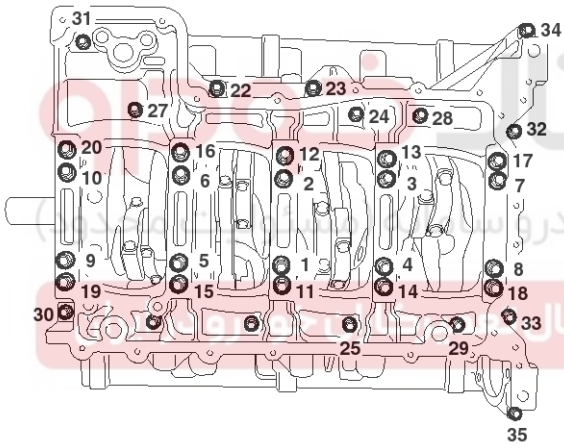
Connecting Rod Bearing Selection Table

Connecting Rod B-earing		Connecting Rod Mark		
		a(A)	b(B)	c(C)
Crank sh-aft pin jo-urnal ma-rk	I(A)	E(Yellow)	D(Green)	C(None)
	II(B)	D(Green)	C(None)	B(Black)
	III(C)	C(None)	B(Black)	A(Blue)

3. Check the crankshaft bearing oil clearance.
   1) To check main bearing-to-journal oil clearance, remove the lower crankcase assembly 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 the lower crankcase assembly, and then torque the bolts.

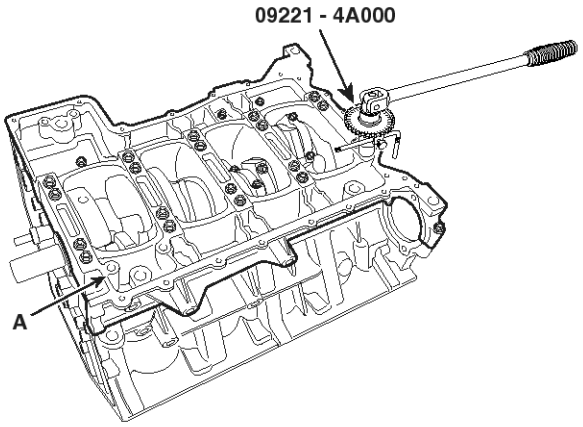
Tightening torque :
Main bearing cap bolts (1~20)
37.3 ~ 41.2 N.m (3.8 ~ 4.2 kgf.m, 27.5 ~ 30.4 lb-ft) + 120°
Flange bolts (21~35)
21.6 ~ 25.5 N.m (2.2 ~ 2.6 kgf.m, 15.9 ~ 18.8 lb-ft)

NOTICE
Do not turn the crankshaft.



SHMM19115N

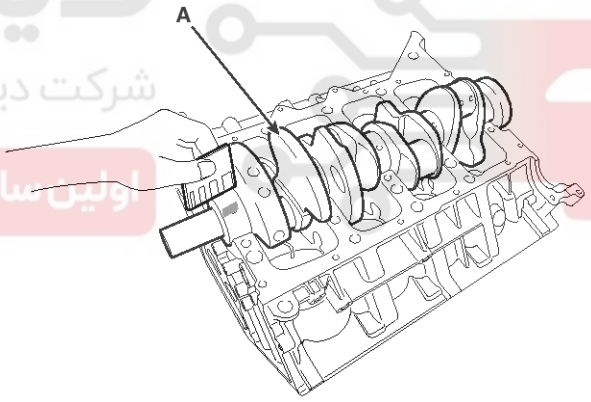
Use the SST(09221-4A000), install main bearing cap bolts.



SHMM19324N

5) Remove the lower crankcase assembly and bearing again, and measure the widest part of the plastigage.

Standard oil clearance :
0.004 ~ 0.022mm (0.0002 ~ 0.0009in)



SHMM19322N

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.

NOTICE

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

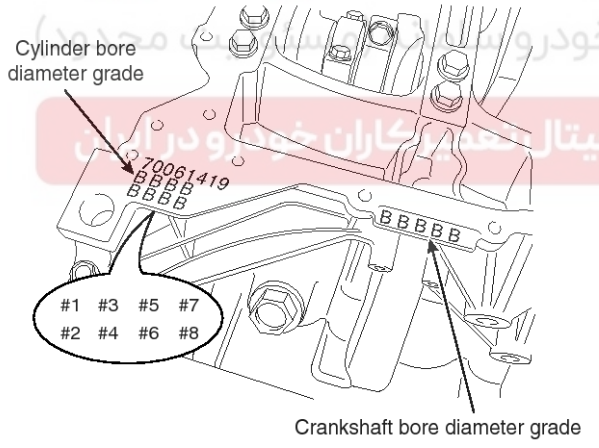
CAUTION

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

Cylinder block crankshaft journal bore mark location

Letters have been stamped on the 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.

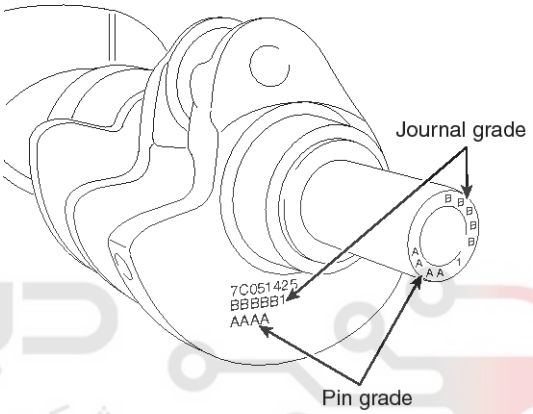


SHMM19132N

Discrimination Of Cylinder Block Crankshaft Journal Bore

Class	Mark	Cylinder Block Crankshaftjou-rnal Bore Inner Diameter
a	A	70.000 ~ 70.006mm (2.7559 ~2.7561in)
b	B	70.006 ~ 70.012mm (2.7561 ~ 2.7564in)
c	C	70.012 ~ 70.018mm (2.7564 ~ 2.7566in)

Crankshaft Main Journal Mark Location

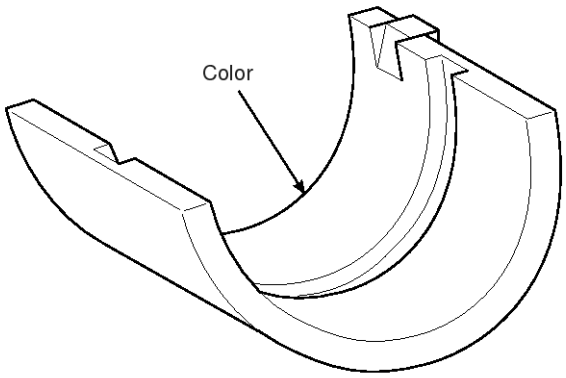


SHMM19131N

Discrimination Of Crankshaft Main Journal

Class	Mark	Crankshaft Main Journalouter Diameter
I	A	64.994 ~ 65.000mm (2.5588 ~2.5591in)
II	B	64.988 ~ 64.994mm (2.5586 ~ 2.5588in)
III	C	64.982 ~ 64.988mm (2.5583 ~2.5586in)

Crankshaft Main Bearing Mark Location



ECRF022A

Discrimination Of Crankshaft Main Bearing

Class	Color	Crankshaft Main Bearing Thickness
A	Blue	2.507 ~ 2.510mm (0.0987 ~ 0.0988in)
B	Black	2.504 ~ 2.507mm (0.0986 ~ 0.0987in)
C	None	2.501 ~ 2.504mm (0.0985 ~ 0.0986in)
D	Green	2.498 ~ 2.501mm (0.0983 ~ 0.0985in)
E	Yellow	2.495 ~ 2.498mm (0.0982 ~ 0.0983in)

8) Select the bearing by using selection table.

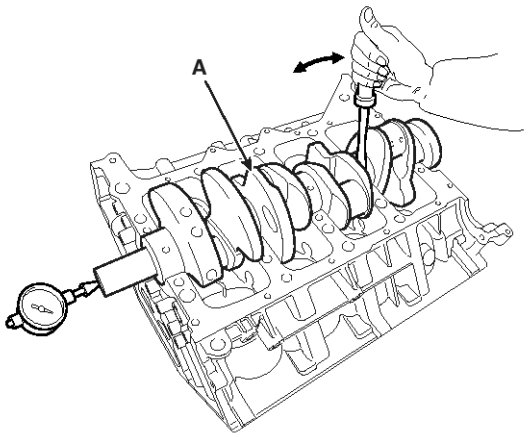
Crankshaft Main Bearing Selection Table

Crankshaft Main Bearing		Cylinder Block Crankshaft Journal Bore Mark		
		A (a)	B (b)	C (c)
Crank shaft main journal mark	A (I)	E(Yellow)	D(Green)	C(None)
	B (II)	D(Green)	C(None)	B(Black)
	C (III)	C(None)	B(Black)	A(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 :
0.10 ~ 0.28mm (0.0039 ~ 0.0110in)



SHMM19364N

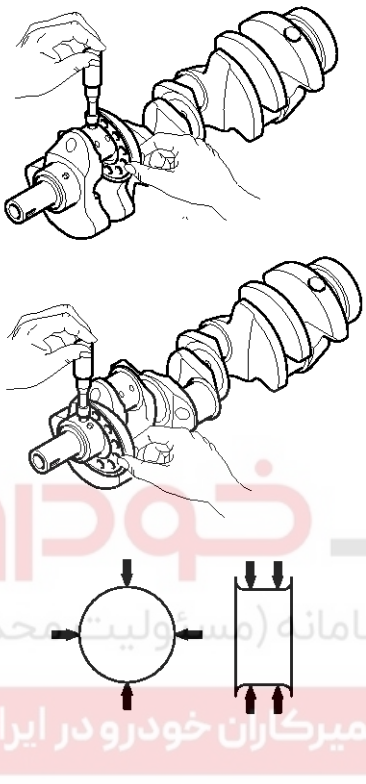
If the end play is greater than maximum, replace the center bearings as a set.

Thrust bearing thickness (center bearing)
2.36 ~ 2.40mm (0.0929 ~ 0.0945in)

5. Inspect main journals and crank pins.

   Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter :
64.982 ~ 65.000mm (2.5583 ~ 2.5591in)
Crank pin diameter :
51.982 ~ 52.000mm (2.0465 ~ 2.0472in)



SHMM19354N

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

Cylinder Block

1. Remove the gasket material.

   Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

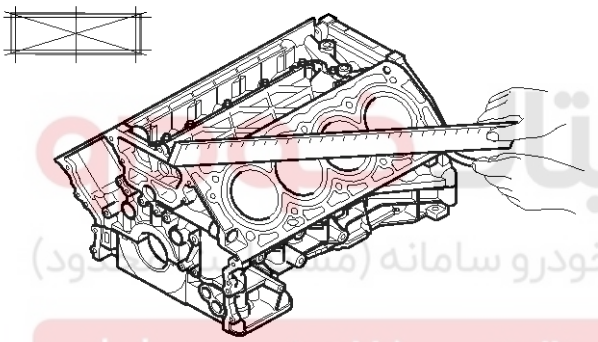
2. Clean the cylinder block.

   Using a soft brush and solvent, thoroughly clean the cylinder block.

3. Inspect the top surface of the 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),
Less than 0.02mm(0.0008in) / 150 x 150



SHMM19355N

4. Inspect cylinder bore diameter.

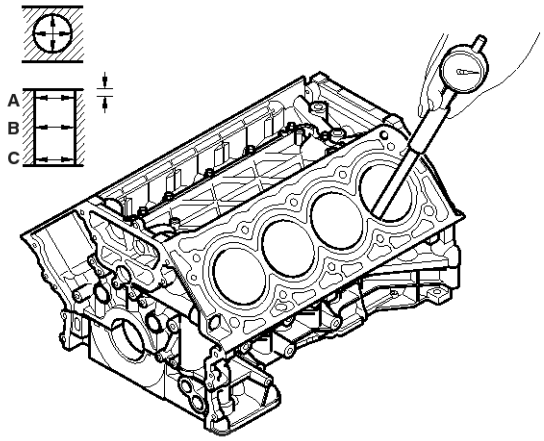
   Visually check the cylinder for vertical scratches.

   If deep scratches are present, replace the cylinder block

5. Inspect cylinder bore diameter.

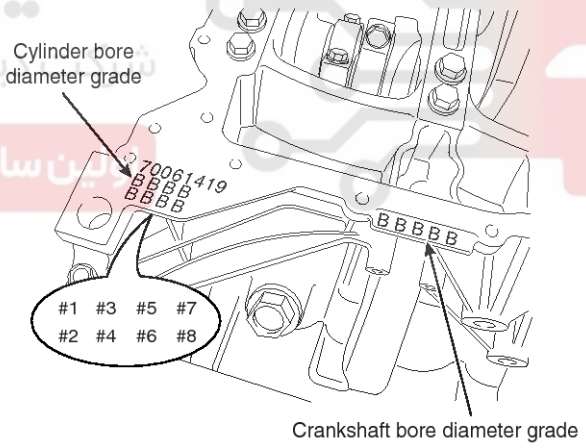
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

Standard diameter
92.000 ~ 92.030mm (3.6220 ~ 3.6232in)



SHMM19356N

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

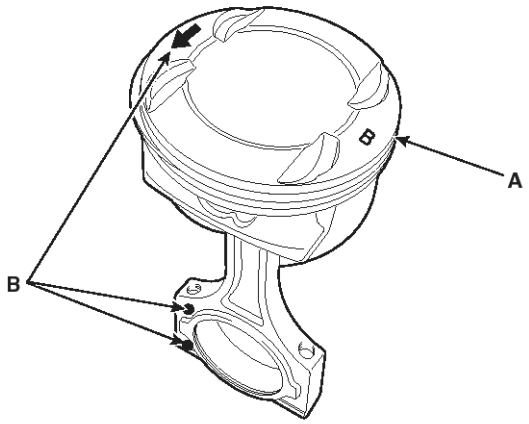


SHMM19132N

Discrimination Of Cylinder Bore Size

Class	Size code	Cylinder Boreinner Diameter
A	A	92.000 ~ 92.010mm (3.6220 ~ 3.6224in)
B	B	92.010 ~ 92.020mm (3.6224 ~ 3.6228in)
C	C	92.020 ~ 92.030mm (3.6228 ~ 3.6232in)

7. Check the piston size code(A) and the front mark(B) on the piston top face.



SHMM19133N

Discrimination Of Piston Outer Diameter

Class	Size code	Piston Outer Diameter
A	A	91.945 ~ 91.955mm (3.6199 ~ 3.6203in)
B	B	91.955 ~ 91.965mm (3.6203 ~ 3.6207in)
C	C	91.965 ~ 91.975mm (3.6207 ~ 3.6211in)

8. Select the piston related to cylinder bore class.

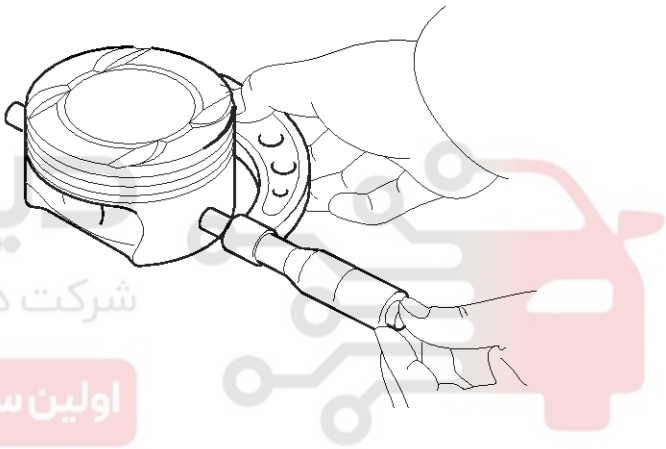
Clearance : 0.045 ~ 0.065mm (0.0018 ~ 0.0026in)

Piston And Rings

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

   NOTICE
   Do not use a wire brush.
2. The standard measurement of the piston outside diameter is taken 15 mm (0.5906 in) from the bottom of the piston.

Standard diameter
91.945 ~ 91.975mm (3.6199 ~ 3.6211in)



SHMM19357N

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

Piston-to-cylinder clearance :
0.045 ~ 0.065mm (0.0018 ~ 0.0026in)

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 groove width
No.1 : 1.23 ~ 1.25mm (0.0484 ~ 0.0492in)
No.2 : 1.23 ~ 1.25mm (0.0484 ~ 0.0492in)
Oil ring : 2.01 ~ 2.03mm (0.0791 ~ 0.0799in)
Piston ring width
No.1 : 1.17 ~ 1.19mm (0.0461 ~ 0.0469in)
No.2 : 1.17 ~ 1.19mm (0.0461 ~ 0.0469in)
Oil ring : 1.88 ~ 1.95mm (0.0740 ~ 0.0768in)
Piston ring side clearance
No.1 : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)
No.2 : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)
Oil ring : 0.06 ~ 0.15mm (0.0024 ~ 0.0059in)

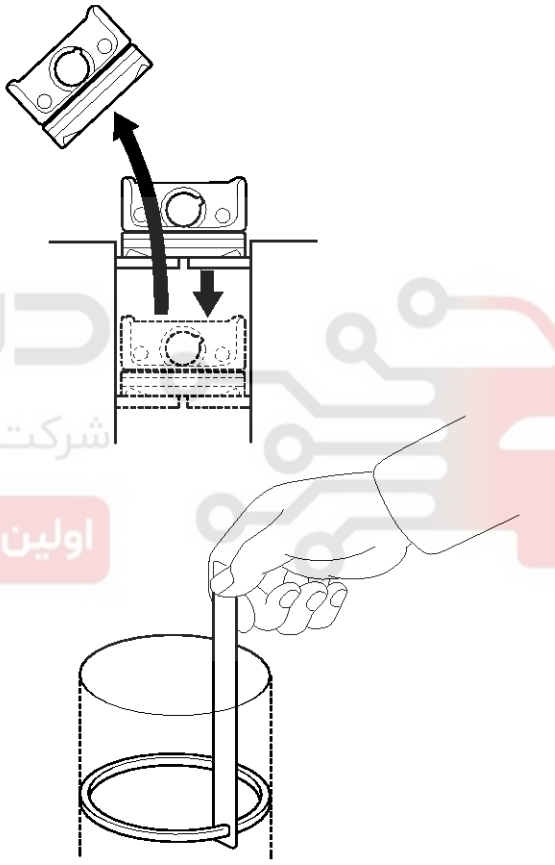
ECKD001G

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 replaced.

Piston ring end gap
No.1 : 0.17 ~ 0.32mm (0.0067 ~ 0.0126in)
No.2 : 0.37 ~ 0.52m (0.0146 ~ 0.0205in)
Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0276in)

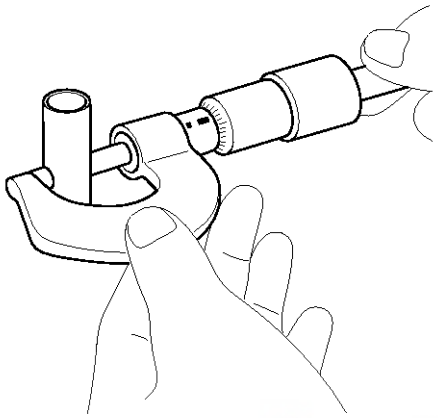


ECKD001K

Piston Pins

1. Measure the diameter of the piston pin.

Piston pin outer diameter :
21.995 ~ 22.000mm (0.8659 ~ 0.8661in)
Piston pin hole inner diameter :
22.004 ~ 22.010mm (0.8663 ~ 0.8665in)
Connecting rod small end inner diameter :
22.007 ~ 22.018mm (0.8664 ~ 0.8668in)



ECKD001Z

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

Piston pin-to-piston clearance :
0.004 ~ 0.015mm (0.0002 ~ 0.0006in)

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

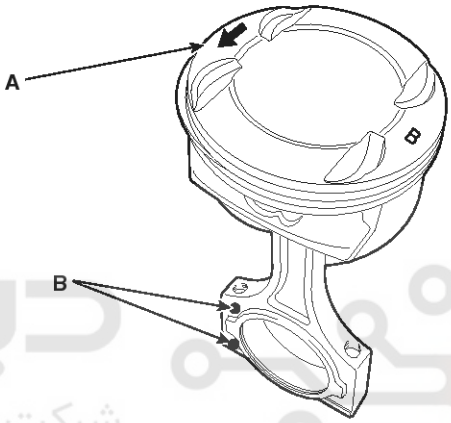
Piston pin-to-connecting rod interference :
0.007 ~ 0.023mm (0.0003 ~ 0.0009in)

Reassembly

NOTICE

- *Thoroughly clean all parts to be 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 the connecting rod.
   1) Install the snap ring in one side of the piston pin hole.
   2) Align the piston front mark and the connecting rod front mark.



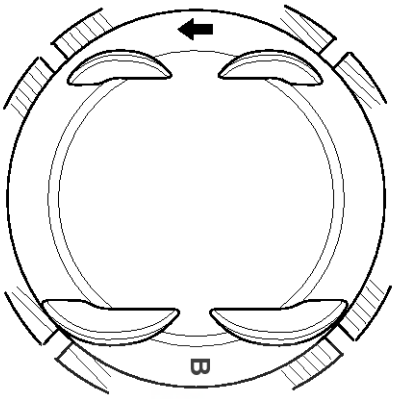
SHMM19347N

   3) Insert the piston pin into the piston pin hole and the small end bore of connecting rod.
   4) Install the snap ring in the other side after inserting the piston pin.

NOTICE

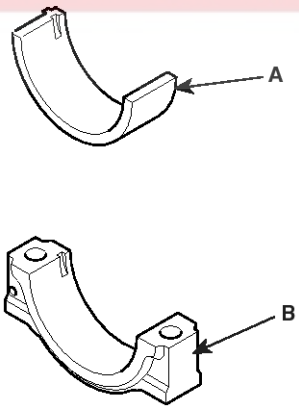
Apply a sufficient amount of engine oil to outer surface of the piston, inner surface of piston pin hole and small end bore of the connecting rod before inserting the piston pin.

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.



SHMM19346N

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).



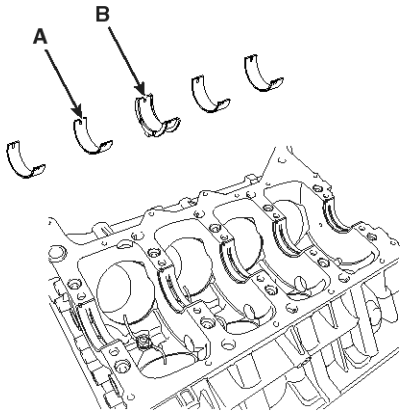
SHMM19358N

4. Install the main bearings (A) (No.1,2,4,5 journal) and the center bearings (B) (No.3 journal).

NOTICE

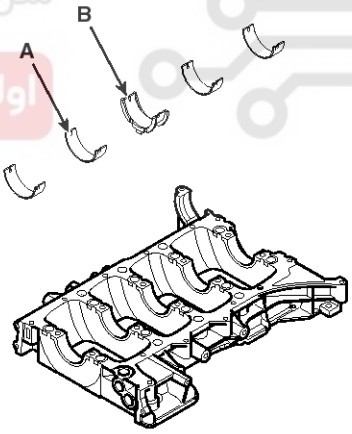
Upper bearings have an oil groove of oil holes; Lower bearings do not.

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



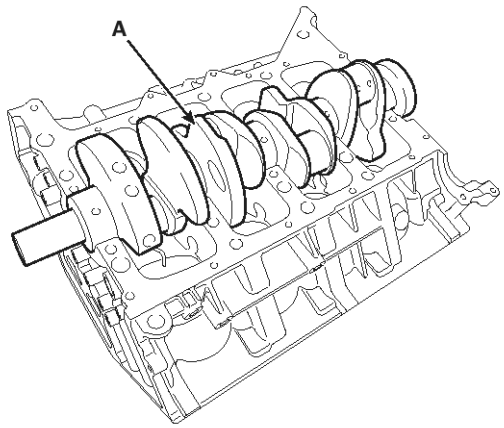
SHMM19134N

   2) Align the bearing claw with the claw groove of the lower crankcase and push in the 5 lower bearings.



SHMM19365N

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

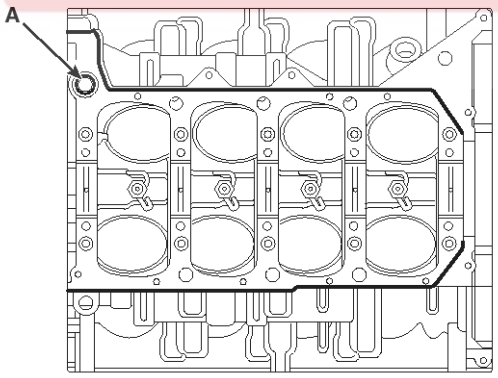


SHMM19117N

6. Place the lower crankcase assembly on cylinder block.
   1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
   2) Install the O-ring (A) to cylinder block.
   3) Before assembling the lower crankcase assembly, the liquid sealant TB1217H should be applied on cylinder block bottom.

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

Bead width : 2.5mm(0.1in)



SHMM19366N

NOTICE

- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *When applying sealant gasket, sealant must not protrude into the inside of cylinder block.*
- *To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.*

   4) Install the lower crankcase assembly.

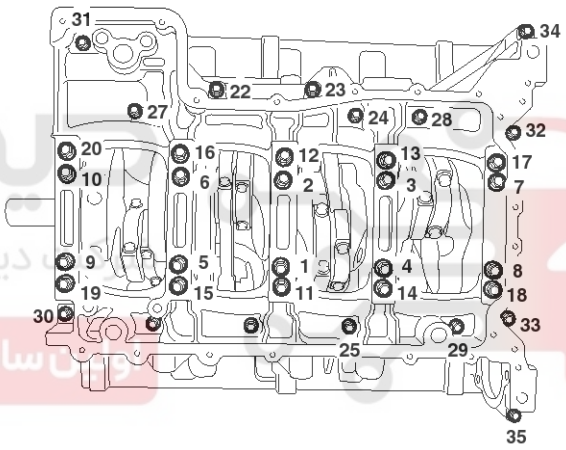
7. Install the lower crankcase assembly bolts.
   1) Install and uniformly tighten the lower crankcase assembly bolts, in several passes, in the sequence shown.

Tightening torque

Main bearing cap bolts (1~20)
37.3 ~ 41.2 N.m
(3.8 ~ 4.2 kgf.m, 27.5 ~ 30.4 lb-ft) + 120°
Flange bolts (21~35)
21.6 ~ 25.5 N.m (2.2 ~ 2.6 kgf.m, 15.9 ~ 18.8 lb-ft)

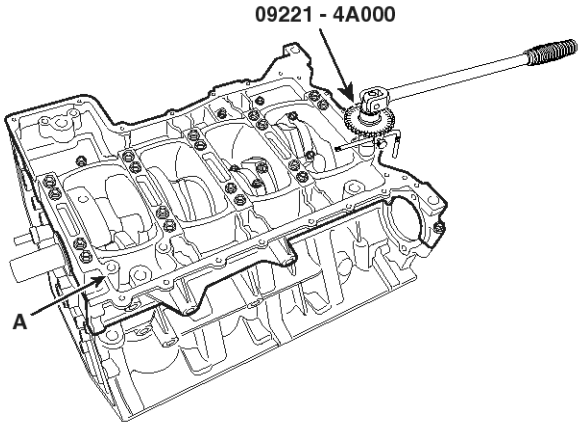
NOTICE

- *Always use new main bearing cap bolts.*
- *If any of the bearing cap bolts are broken or deformed, replace it.*



SHMM19115N

Use the SST(09221-4A000), install main bearing cap bolts.



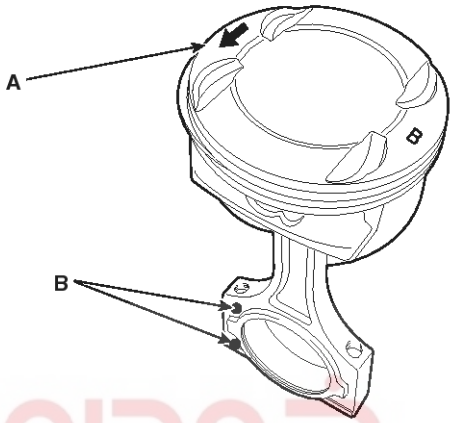
SHMM19324N

2) Check that the crankshaft turns smoothly.

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

NOTICE

- *Before installing the pistons, apply a coat of engine oil to the ring grooves and cylinder bores.*
- *The piston front mark (A) and the connecting rod front mark (B) must face the timing chain side of the engine.*

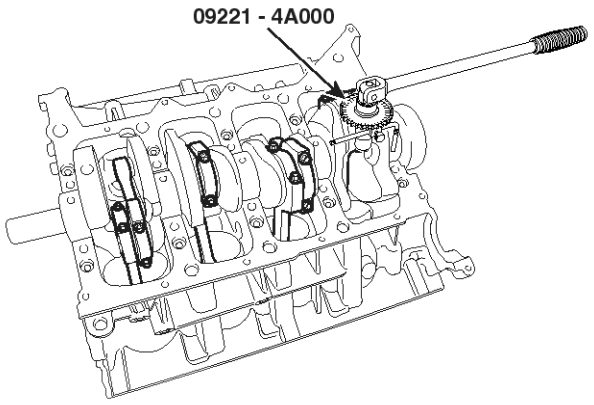


SHMM19347N

1) 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.
2) Stop after the ring compressor pops free, and check the connecting rod-to-check journal alignment before pushing the piston into place.
3) Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

Tightening torque :
22.6 ~ 26.5Nm
(2.3 ~ 2.7kgf.m, 16.6 ~ 19.5lb-ft) + 98 ~ 102°

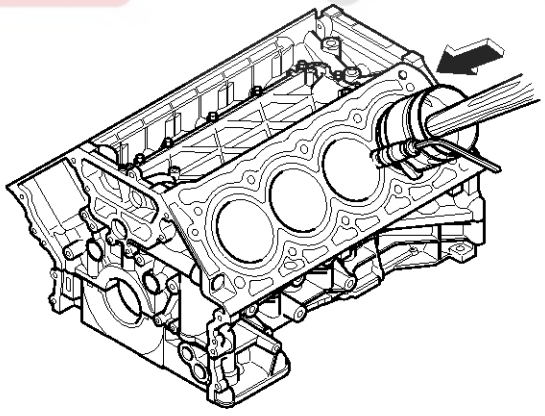
Use SST(09221-4A000), install connecting rod bearing cap bolts.



SHMM19318N

NOTICE

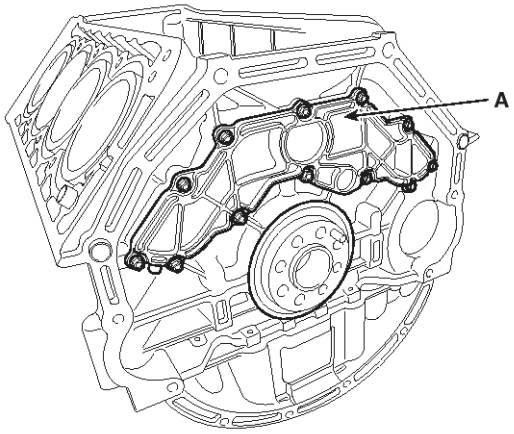
- *Always use new connecting rod bearing cap bolts.*
- *Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.*



SHMM19374N

10. Check the connecting rod end play.
11. Install the cylinder block rear cover (A) and a new gasket.

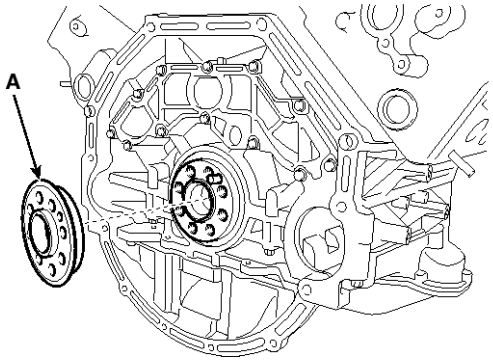
Tightening torque :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHMM19113N

NOTICE
- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *Before assembling oil drain cover, the liquid sealant TB1217H should be applied to the oil drain cover.*
- *The part must be assembled within 5 minutes after sealant was applied.*
- *Apply sealant to the inner threads of the bolt holes.*

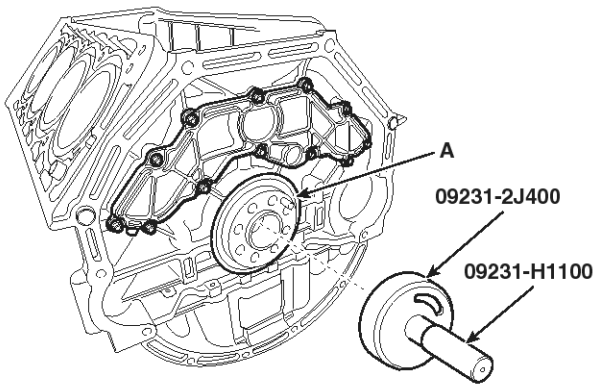
12. Install the crankshaft adapter plate (A).



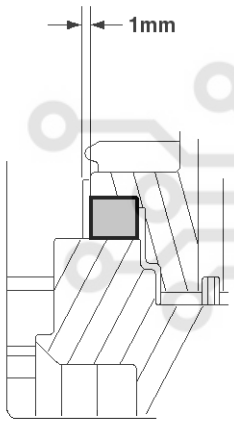
SVIM19165D

13. Using the SST(09231-2J400, 09231-H1100) and a plastic hammer, tap in a new oil seal(A) until SST surface is flush with the cylinder block.

    At this time, the depth of the oil seal(A) from the cylinder block surface is 1mm(0.039in).



SHMM19319N



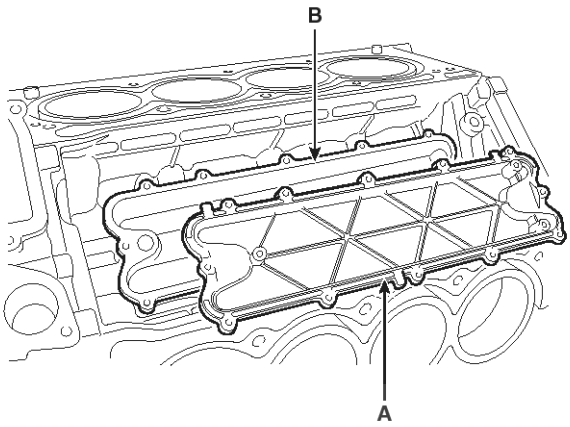
SHMM19140N

NOTICE
- *Before assembling oil seal, the hardened sealant or injurious material located on the boundary area between cylinder block and lower crankcase must be removed.*
- *Apply engine oil to a new oil seal lip.*
- *When pressing oil seal, confirm to direction and take care not to damage oil seal.*

14. Install the cylinder block bank cover (A) and a new gasket (B).

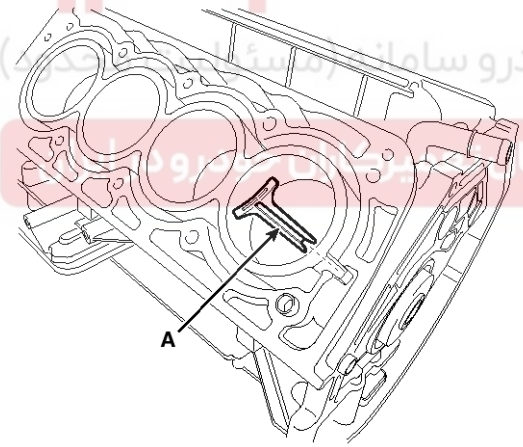
Tightening torque :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

NOTICE
The "F"mark of the gasket must be face the front of the engine.

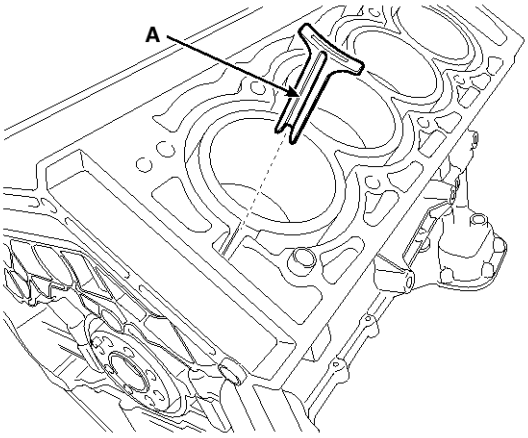


SHMM19104N

15. Install the separator (A).



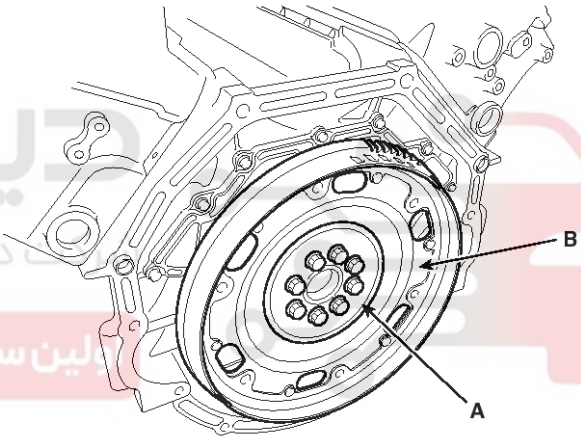
SHMM19110N



SHMM19111N

16. Install the drive plate (B) and the adapter plate (A).

Tightening torque :
98.1~107.9N.m(10.0~11.0kgf.m,72.3~79.6lb-ft)



SVIM19164D

17. Install the oil pump. (Refer to Lubrication system in this group)
18. Install the water temperature control assembly. (Refer to Cooling system in this group)
19. Install the timing chain. (Refer to Timing system in this group)
20. Install the cylinder head. (Refer to Cylinder head in this group)
21. Install the intake manifold and exhaust manifold. (Refer to Intake and exhaust system in this group)
22. Remove the engine from engine stand.
23. Install the engine assembly to the vehicle. (Refer to Engine and transaxle assembly in this group)

Cooling System

Coolant

Engine Coolant Refilling And Bleeding

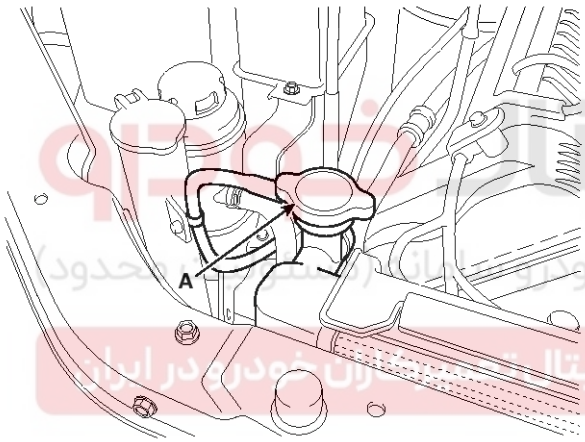
WARNING

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

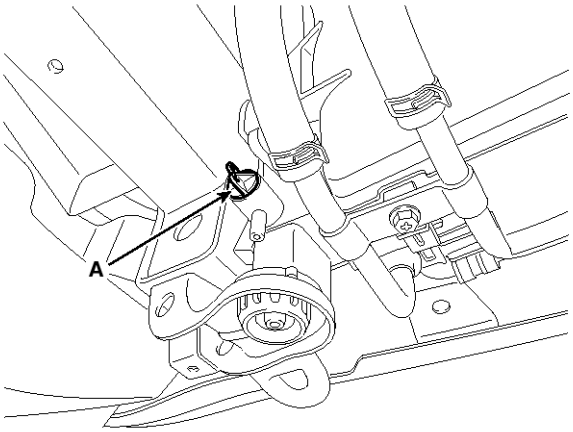
When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

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



SHMM19047N

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



SHMM19046N

4. Tighten the radiator drain plug(A) 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.

   NOTICE

   To most effectively bleed the air, pour the water slowly and press on the upper/lower radiator hoses.
7. Start the engine and allow to come to normal operating temperature. Wait for the cooling fans to turn on several times. Accelerate the engine to aid in purging trapped air. Shut engine off.
8. Wait until the engine is cool.
9. Repeat steps 1 to 8 until the drained water runs clear.
10. Fill fluid mixture with coolant and water(5 : 5) (Tropical region – 4:6) slowly through the radiator cap. Push the upper/lower hoses of the radiator so as bleed air easily.

    NOTICE

    - *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 gets cool.
16. Repeat 10 to 15 until the coolant level doesn't fall any more, bleed air out of the cooling system.

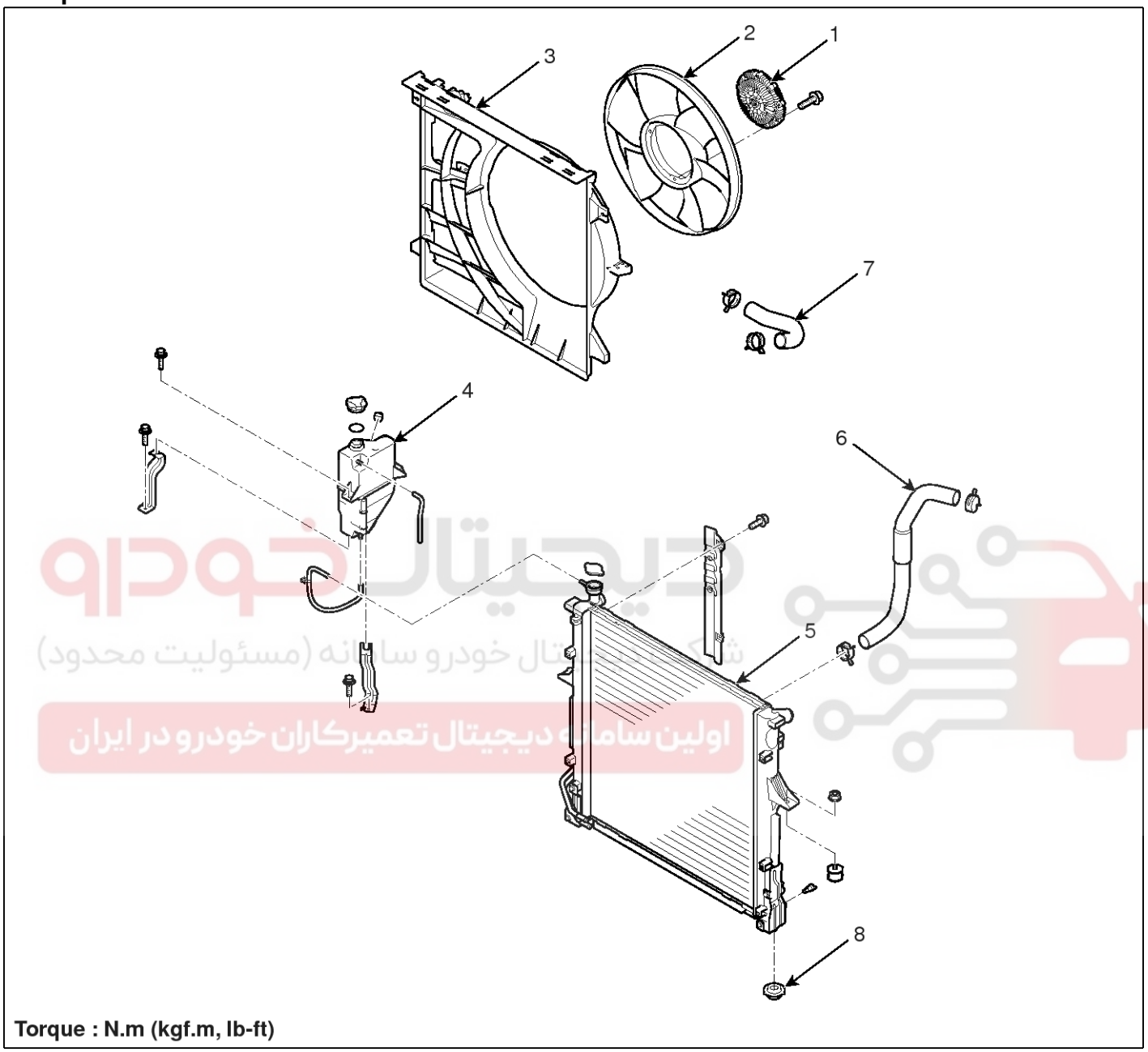
NOTICE

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 : 14L (14.79US qt, 12.31 Imp qt)

Radiator

Components



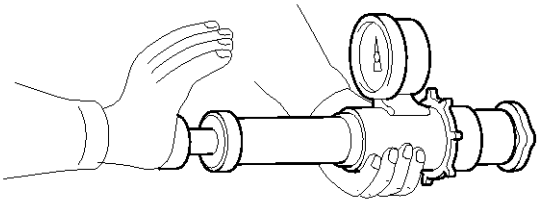
SHMM19329N

1. Fan clutch
2. Cooling fan
3. Shroud
4. Coolant reservoir tank
5. Radiator
6. Radiator lower hose
7. Radiator upper hose
8. Mounting insulator

Inspection

Radiator Cap Testing

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

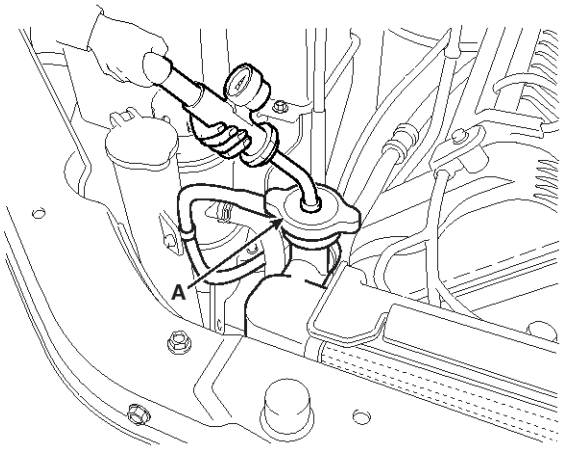


ECKD501X

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

Radiator Leakage Test

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



SHMM19303N

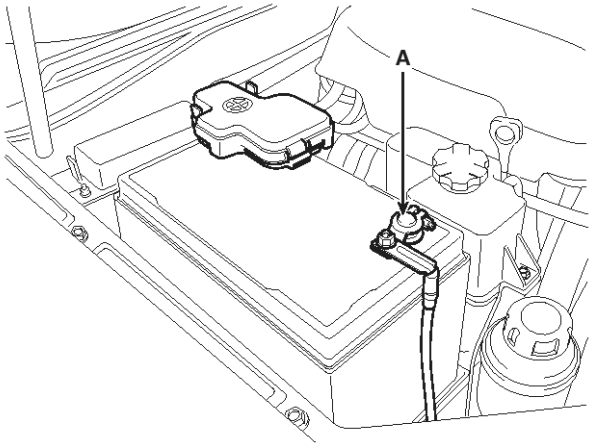
2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm², 14 ~ 19psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. If the pressure drops, check hoses, the radiator and the water pump for leakage. If there is no leakage, inspect the heater core, the cylinder block and the cylinder head.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

NOTICE

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

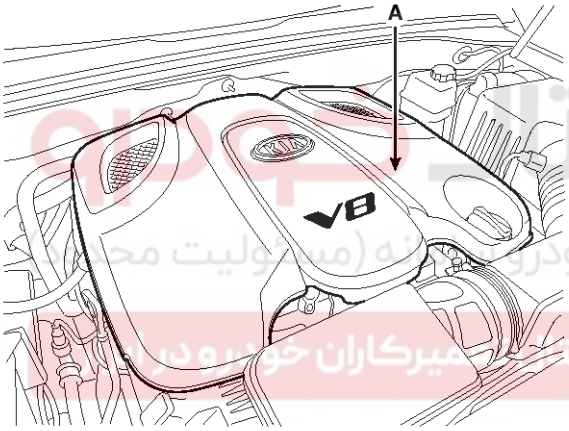
Removal

1. Disconnect the negative terminal from the battery.



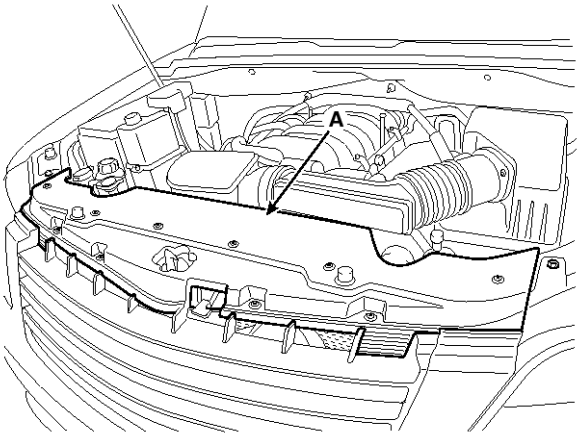
SHMM19043N

2. Remove the engine cover (A).



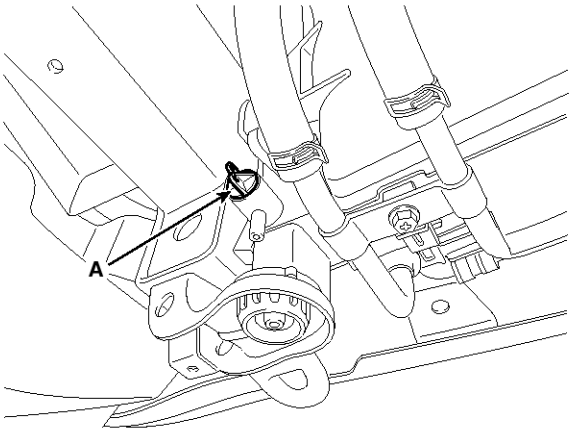
SHMM19044N

3. Remove the radiator grill upper guard (A).



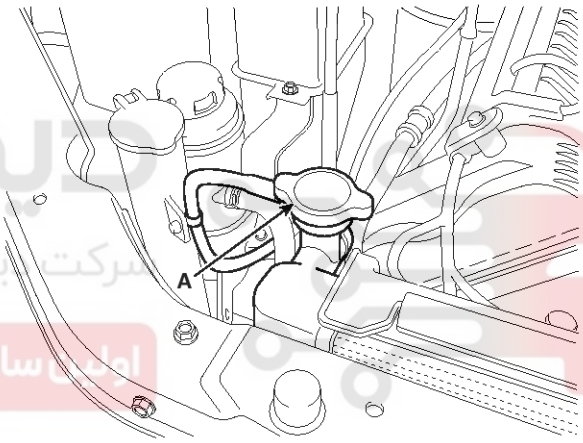
SHMM19045N

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



SHMM19046N

Remove the radiator cap (A) to speed draining.

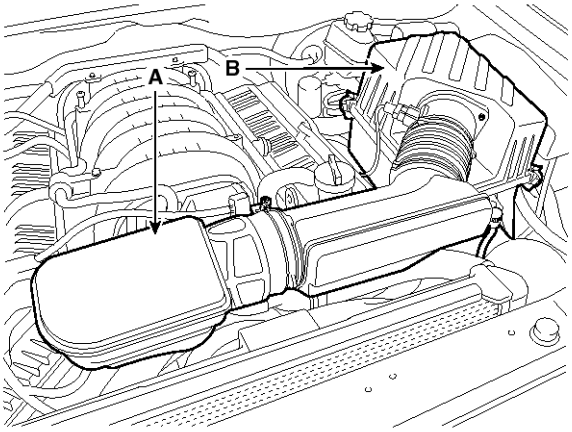


SHMM19047N

WARNING

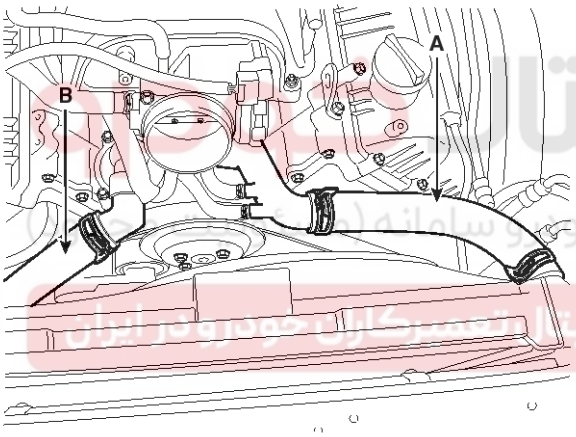
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

5. Remove the air duct (A) and the air cleaner assembly (B).



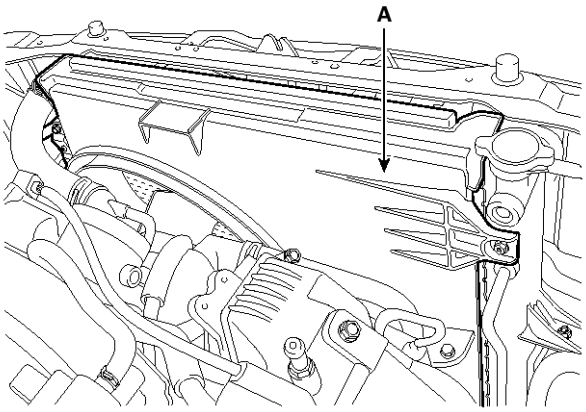
SHMM19048N

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



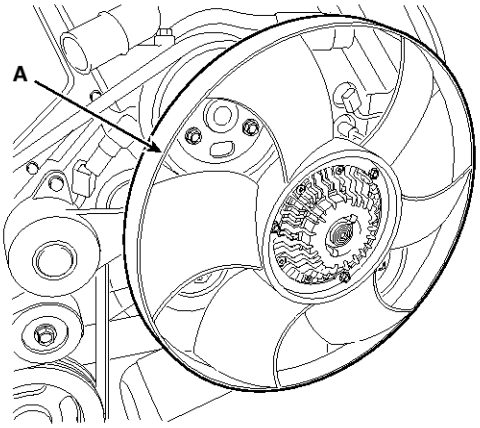
SHMM19049N

7. Remove the radiator upper shroud (A).



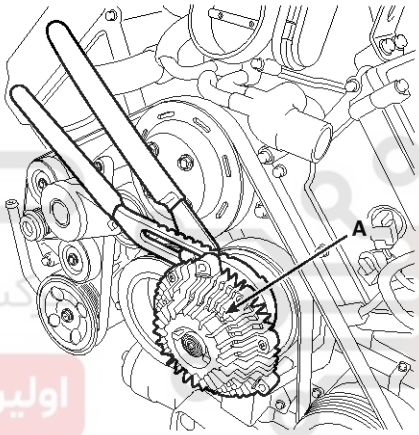
SHMM19050N

8. Remove the cooling fan (A).



SHMM19051N

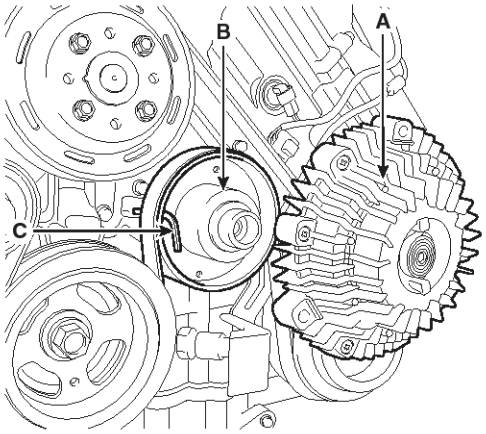
9. Remove the cooling fan clutch (A).



SHMM19052N

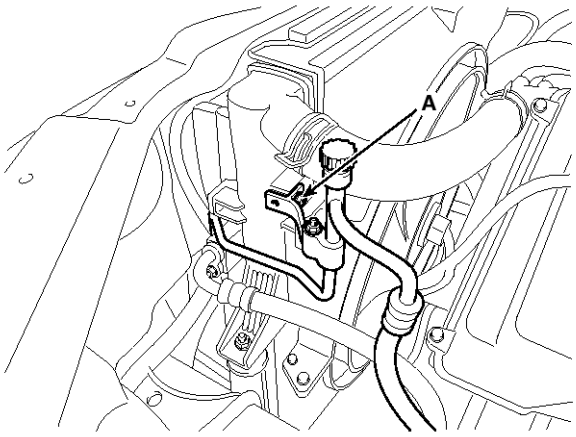
NOTICE

Remove the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



SHMM19053N

10. Remove the air conditioner high pressure pipe bracket bolt.



SHMM19135N

11. Remove the ATF cooler hose, the ATF cooler bracket bolts and the power steering oil cooler bracket bolts.
12. Remove the radiator & condenser mounting bolt.
13. Remove the radiator assembly from the vehicle.

Installation

1. Install the radiator assembly to the vehicle.
2. Install the radiator & condenser mounting bolt.

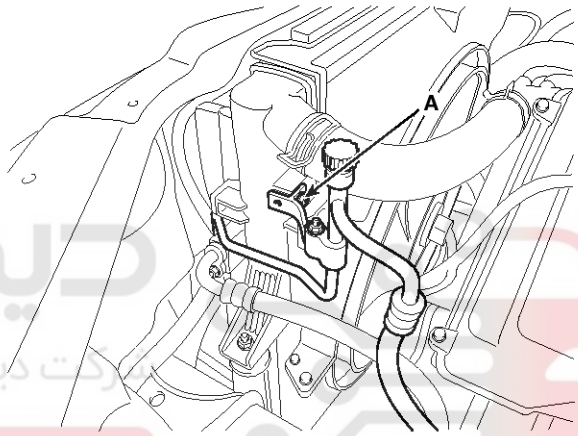
Tightening torque :
7.8 ~ 11.8Nm (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)

3. Install the ATF cooler hose, the ATF cooler bracket bolts and the power steering oil cooler bracket bolts.

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

4. Install the air conditioner high pressure pipe bracket bolt.

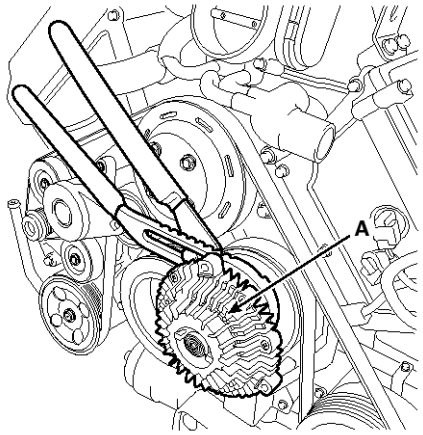
Tightening torque :
7.8 ~ 11.8Nm (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



SHMM19135N

5. Install the cooling fan clutch (A).

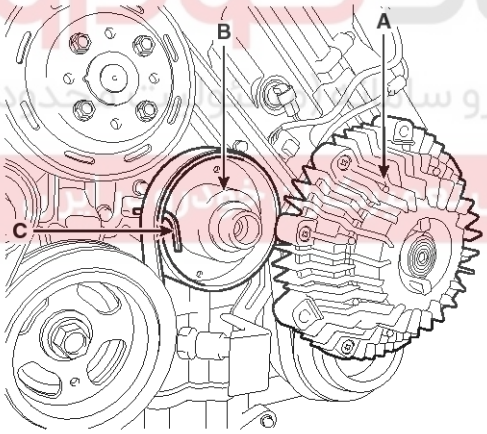
Tightening torque :
58.8N.m (6.0kgf.m, 43.4lb-ft)



SHMM19052N

NOTICE

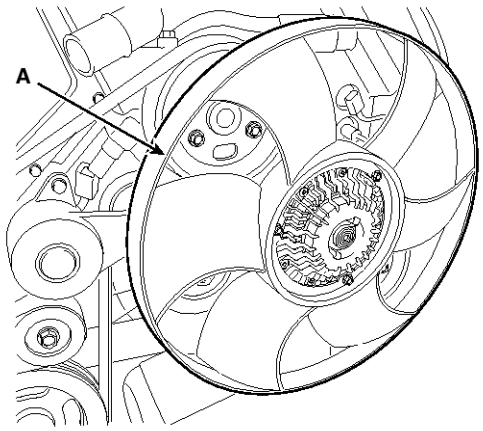
Install the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



SHMM19053N

6. Install the cooling fan (A).

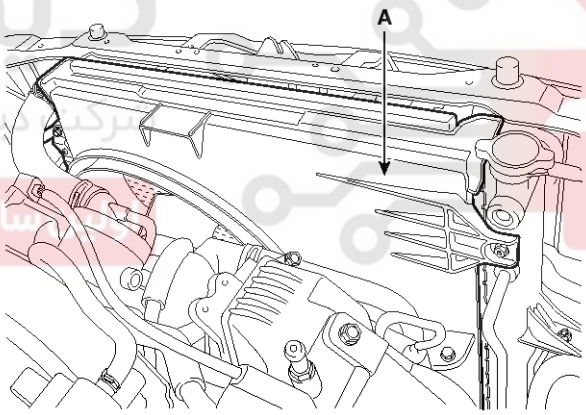
Tightening torque :
8.8 ~ 13.7Nm (0.9 ~ 1.4kgf.m, 6.5 ~ 10.1lb-ft)



SHMM19051N

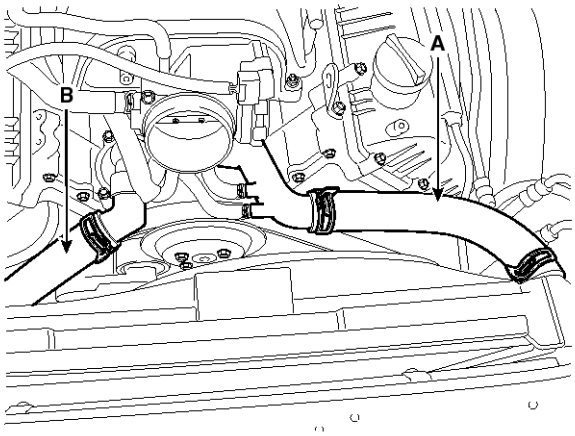
7. Install the radiator upper shroud (A).

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



SHMM19050N

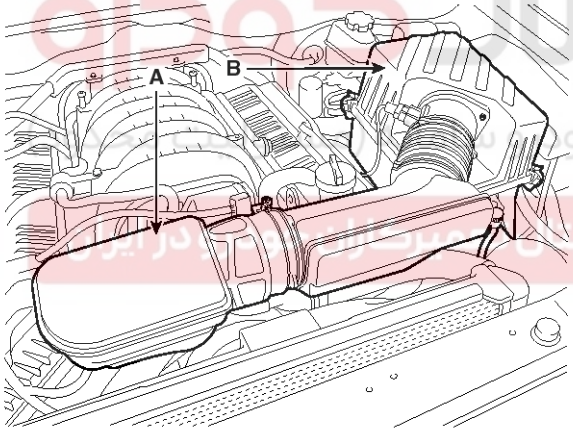
8. Reconnect the radiator upper hose (A) and lower hose (B).



SHMM19049N

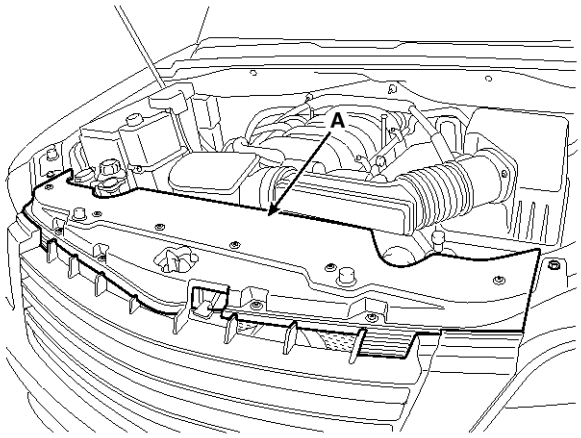
9. Install the air duct (A) and the air cleaner assembly (B).

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



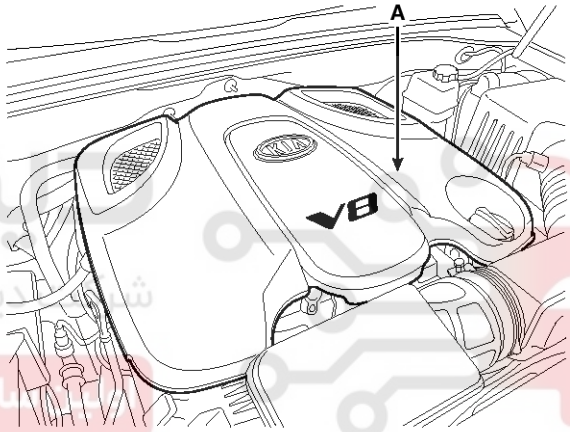
SHMM19048N

10. Install the radiator grill upper guard (A).



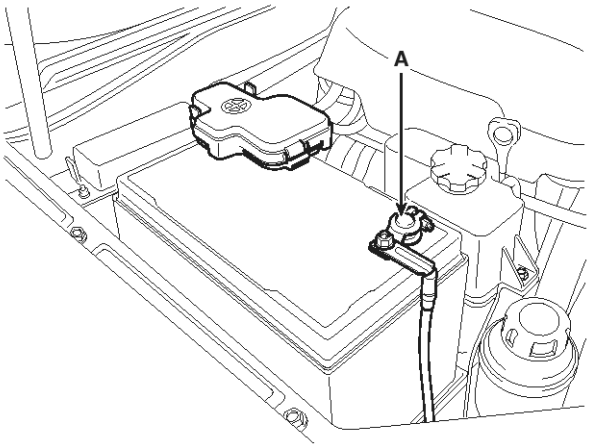
SHMM19045N

11. Install the engine cover (A).



SHMM19044N

12. Reconnect the negative terminal from the battery.

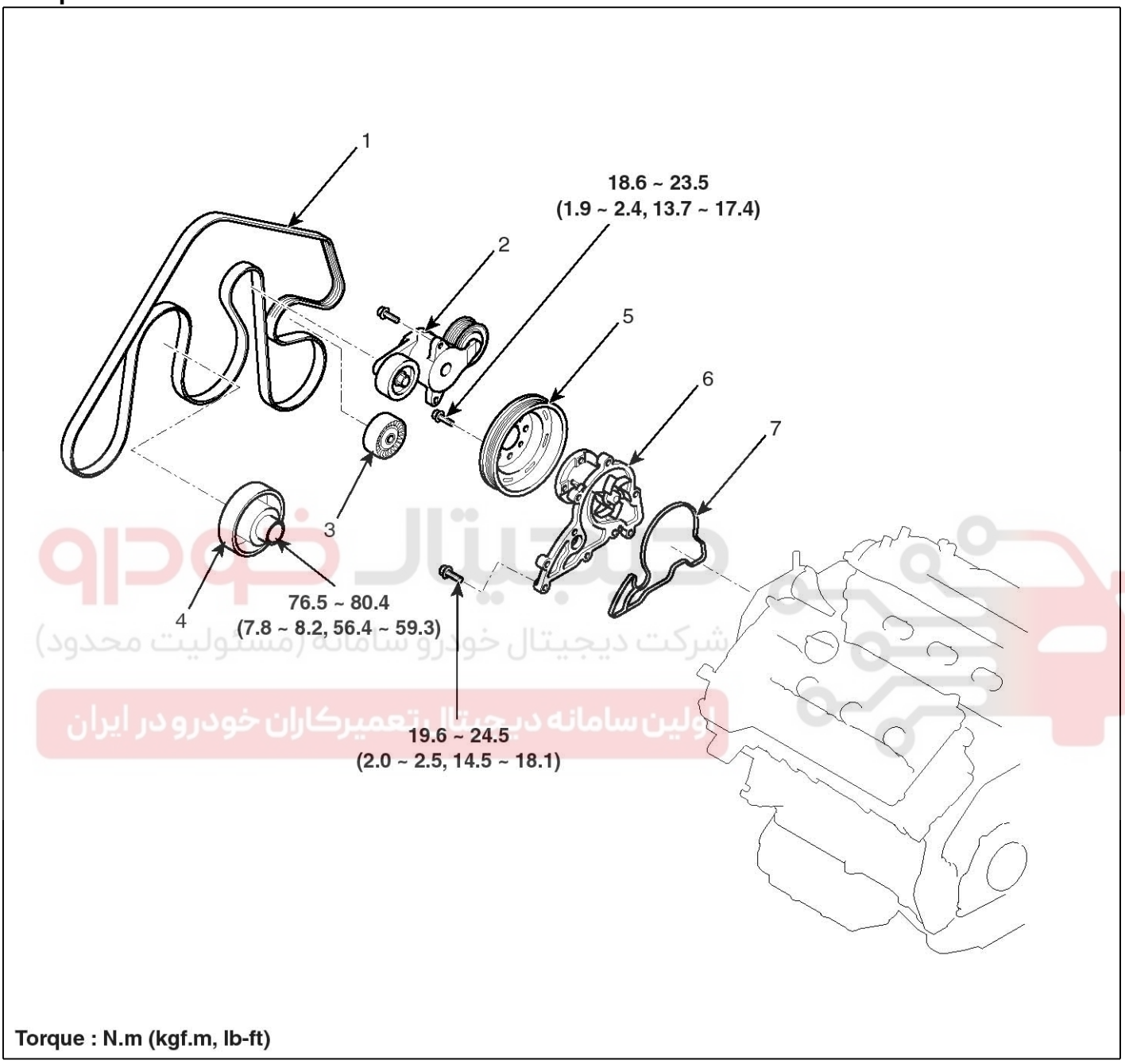


SHMM19043N

13. Fill the radiator with coolant and check for leaks.

Water pump

Components

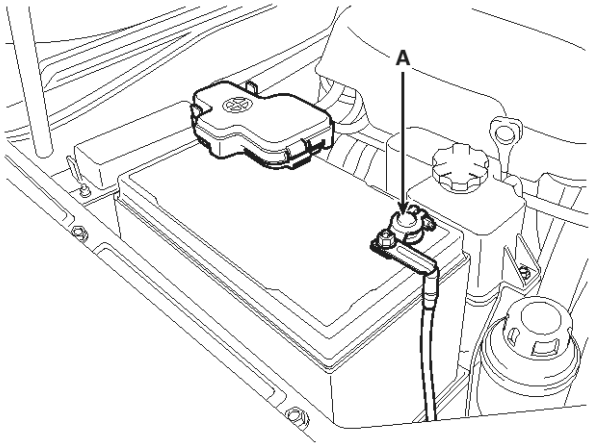


SHMM19330N

1. Drive belt
2. Drive belt tensioner
3. Drive belt idler
4. Cooling fan pulley
5. Water pump pulley
6. Water pump
7. Water pump gasket

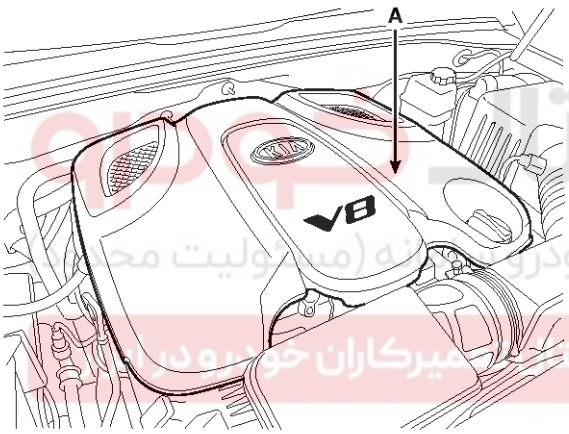
Removal

1. Disconnect the negative terminal from the battery.



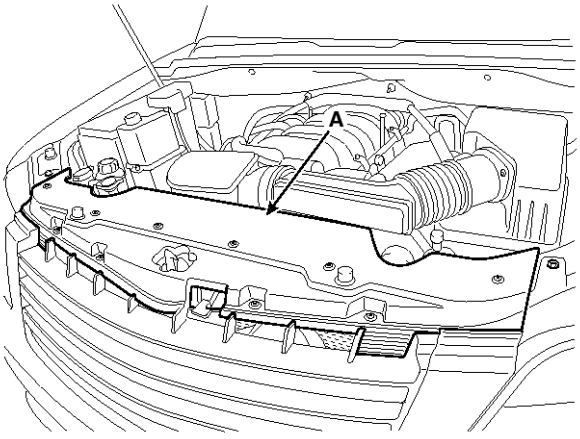
SHMM19043N

2. Remove the engine cover (A).



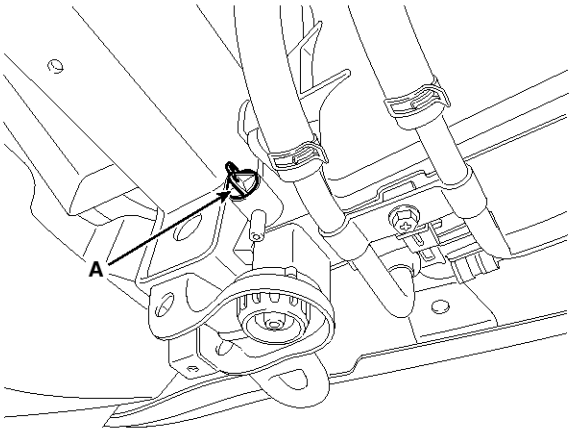
SHMM19044N

3. Remove the radiator grill upper guard (A).



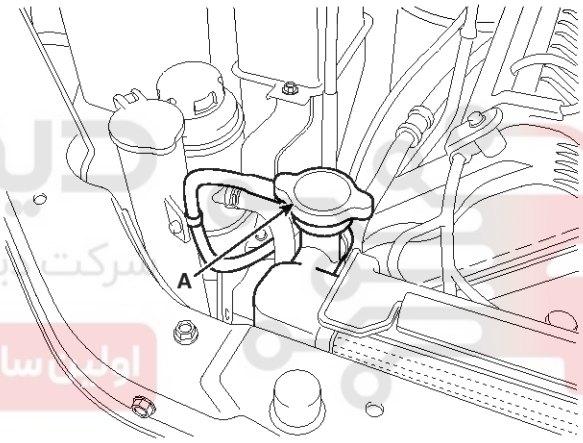
SHMM19045N

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



SHMM19046N

Remove the radiator cap (A) to speed draining.

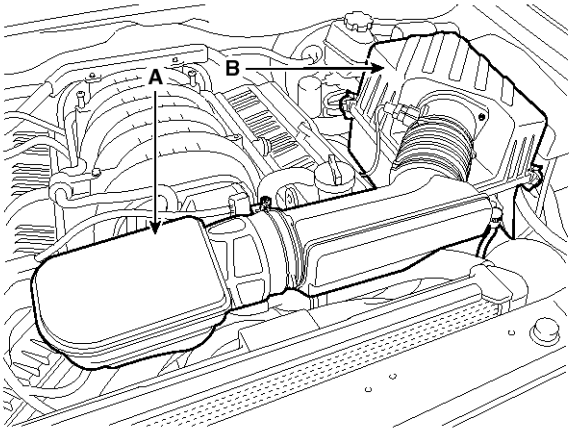


SHMM19047N

WARNING

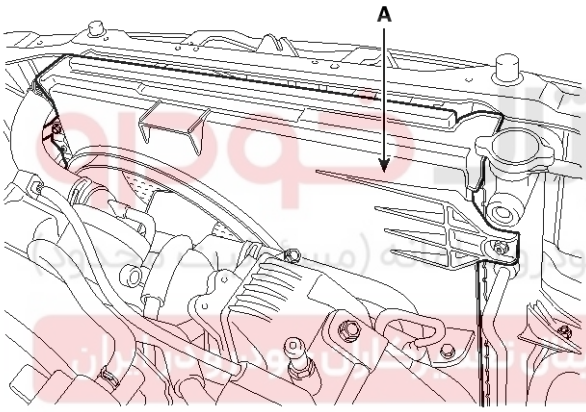
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

5. Remove the air duct (A) and the air cleaner assembly (B).



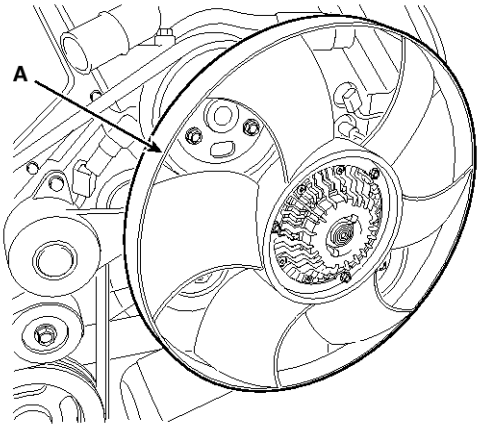
SHMM19048N

6. Remove the radiator upper shroud (A).



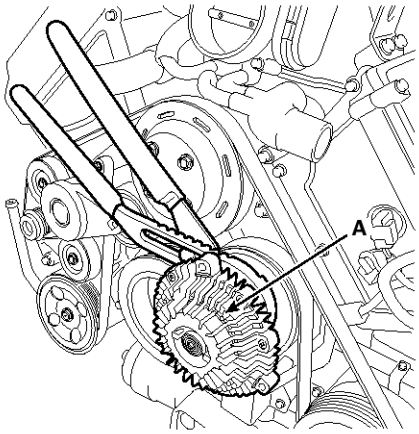
SHMM19050N

7. Remove the cooling fan (A).



SHMM19051N

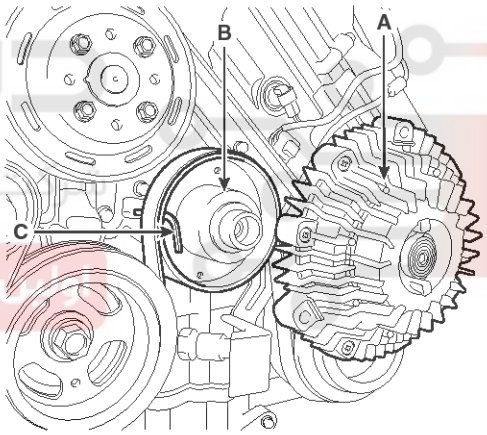
8. Remove the cooling fan clutch (A).



SHMM19052N

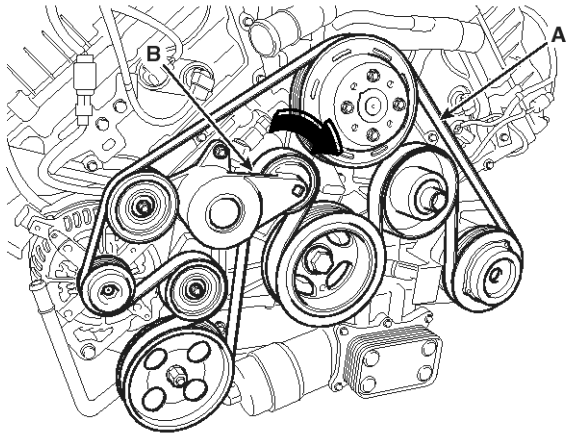
NOTICE

Remove the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



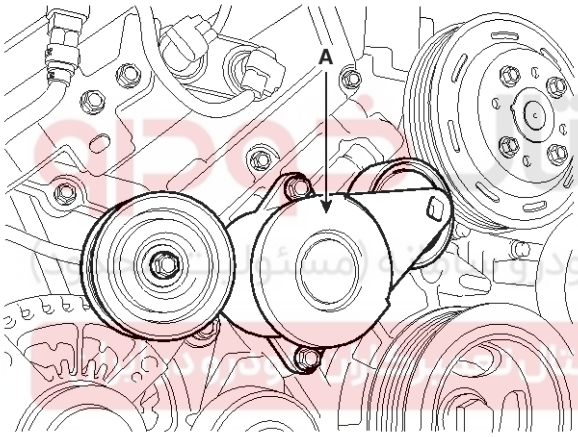
SHMM19053N

9. Turn the tensioner (B) clockwise and loosen, then remove the drive belt (A).



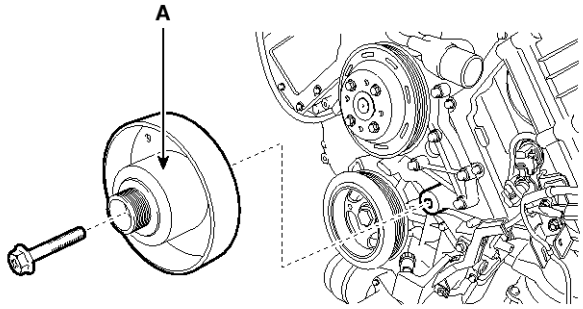
SHMM19067N

10. Remove the drive belt tensioner (A).



SHMM19068N

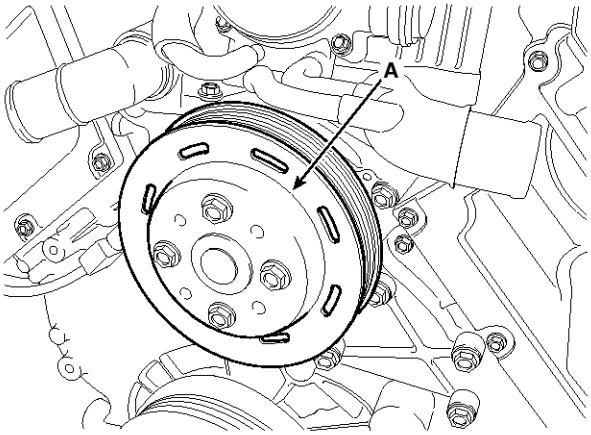
11. Remove the cooling fan pulley (A).



SHMM19088N

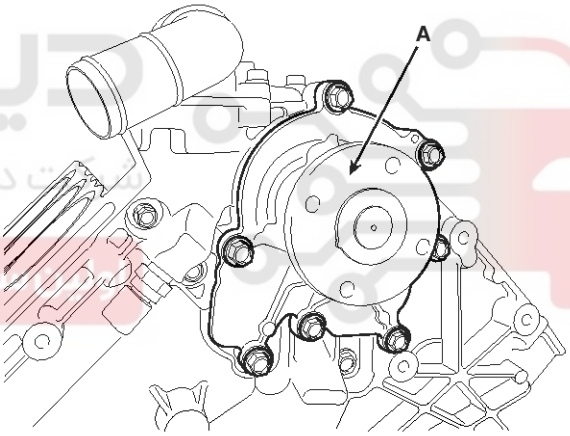
⚠CAUTION
The cooling fan pulley bolt is left-hand thread.
To remove the bolt, screw it clockwise.

12. Remove the water pump pulley (A).



SHMM19089N

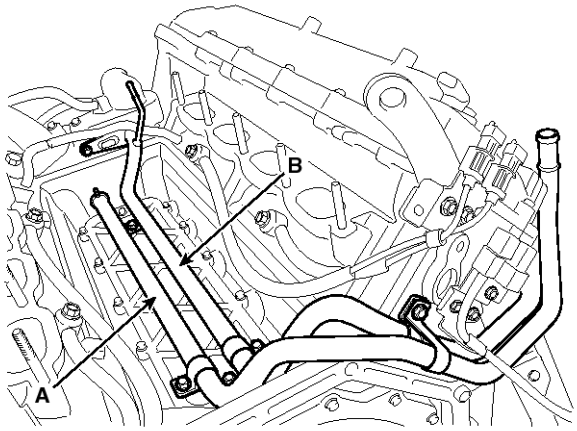
13. Remove the water pump (A).



SHMM19101N

Water pipe

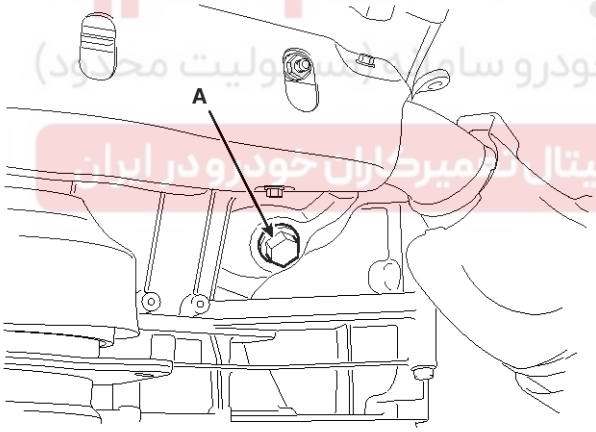
1. Remove the intake manifold module. (Refer to intake and exhaust system in this group)
2. Remove the water outlet pipe (A) and the water inlet pipe (B).



SHMM19084N

NOTICE

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

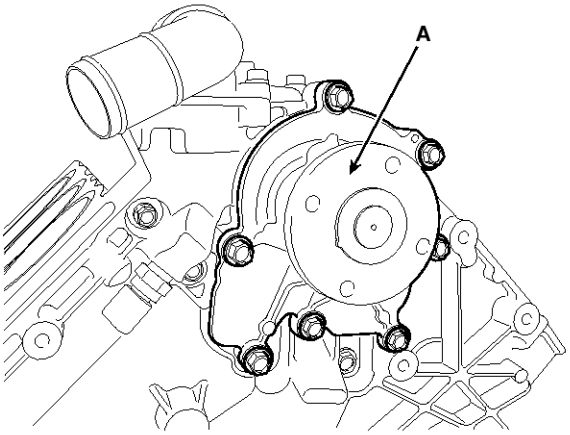


SHMM19085N

Installation

1. Install the water pump (A).

Tightening torque :
19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)



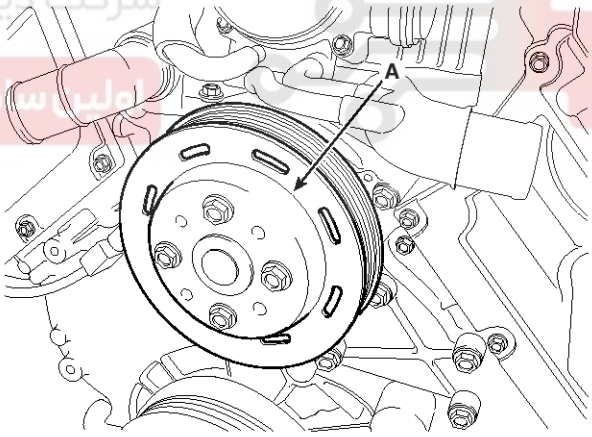
SHMM19101N

2. Install the water pump pulley (A).

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

NOTICE

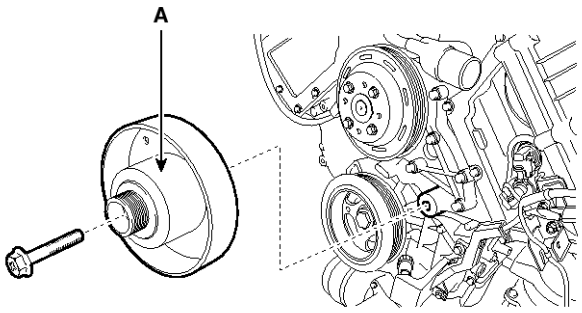
Tighten every bolt diagonally.



SHMM19089N

3. Install the cooling fan pulley (A).

Tightening torque :
76.5 ~ 80.4Nm (7.8 ~ 8.2kgf.m, 56.4 ~ 59.3lb-ft)

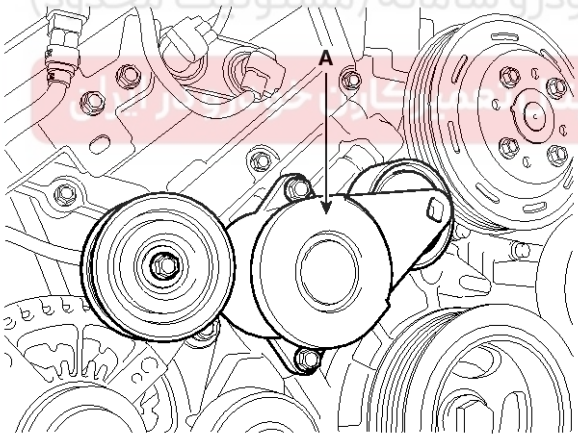


SHMM19088N

⚠CAUTION
The cooling fan pulley bolt is left-hand thread.
To assemble the bolt, screw it counterclockwise.

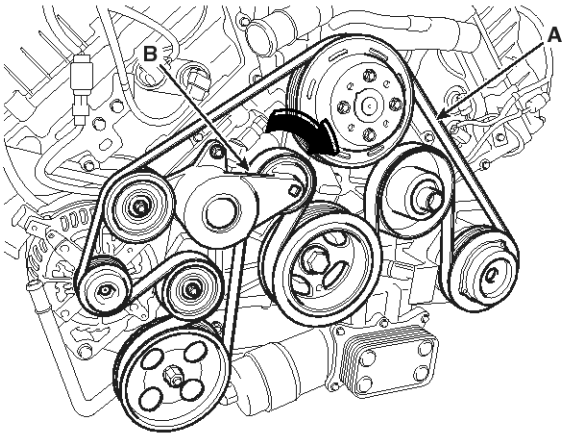
4. Install the drive belt tensioner (A).

Tightening torque :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)



SHMM19068N

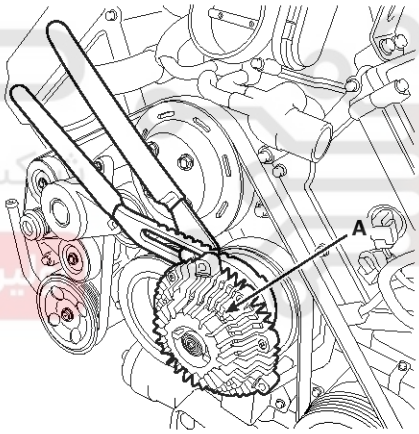
5. Turn the tensioner (B) clockwise and loosen, then install the drive belt (A).



SHMM19067N

6. Install the cooling fan clutch (A).

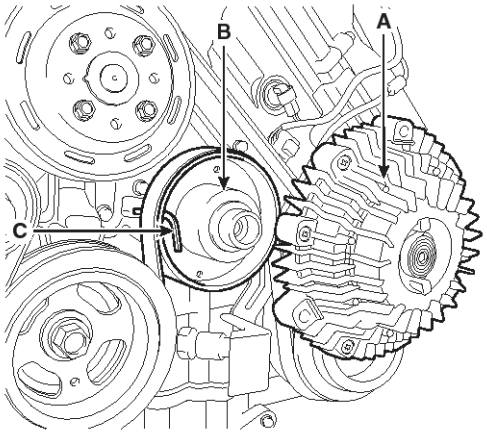
Tightening torque :
58.8N.m (6.0kgf.m, 43.4lb-ft)



SHMM19052N

NOTICE

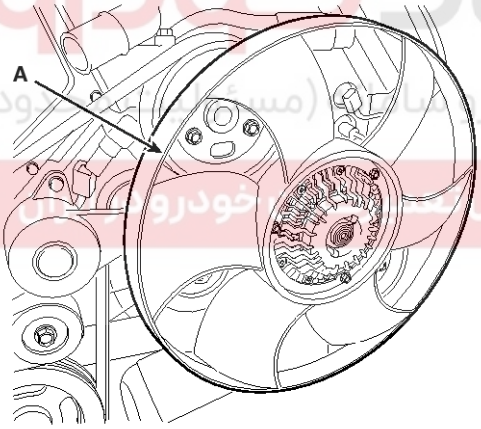
Install the cooling fan clutch (A) after fixing the cooling fan pulley (B) by inserting a pin (C) into the hole of it.



SHMM19053N

7. Install the cooling fan (A).

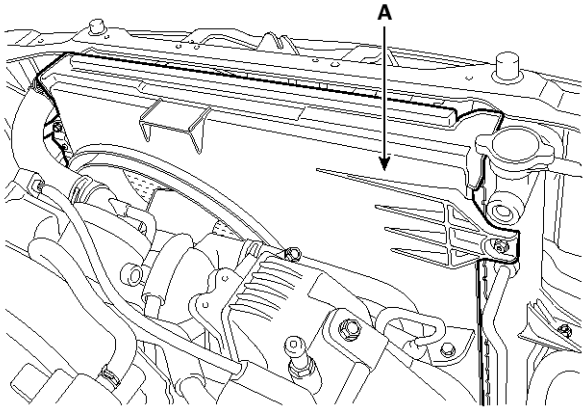
Tightening torque :
8.8 ~ 13.7Nm (0.9 ~ 1.4kgf.m, 6.5 ~10.1lb-ft)



SHMM19051N

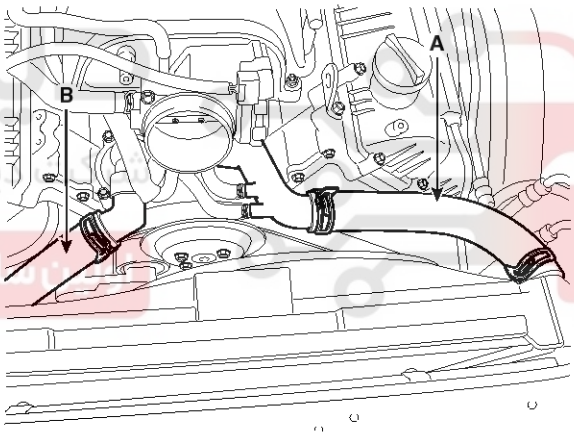
8. Install the radiator upper shroud (A).

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



SHMM19050N

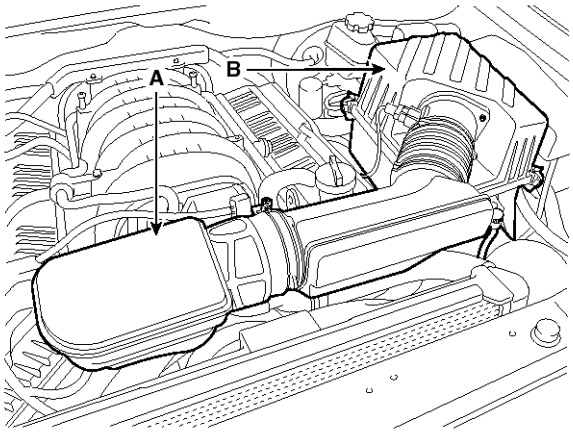
9. Reconnect the radiator upper hose (A) and lower hose (B).



SHMM19049N

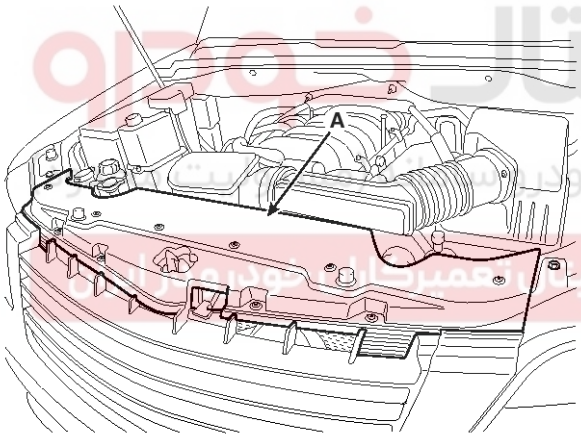
10. Install the air duct (A) and the air cleaner assembly (B).

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



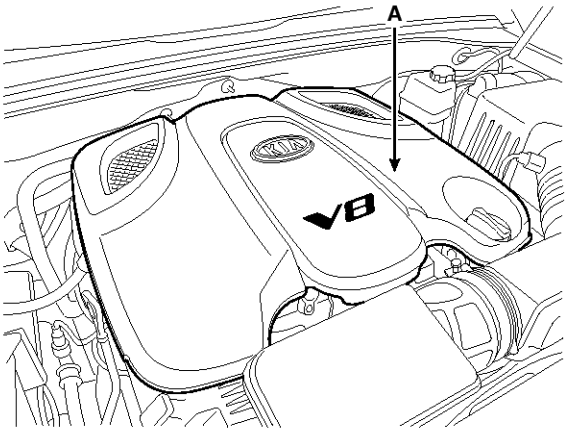
SHMM19048N

11. Install the radiator grill upper guard (A).



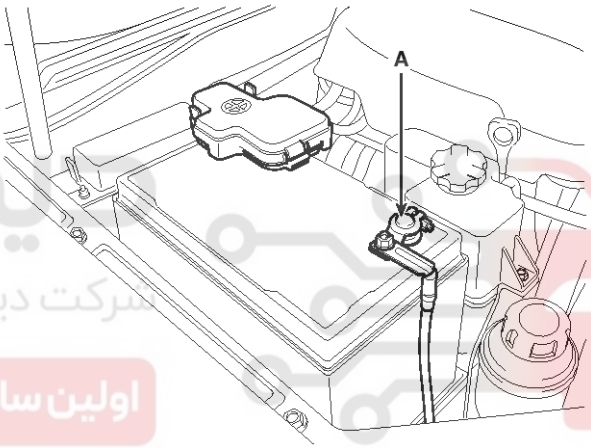
SHMM19045N

12. Install the engine cover (A).



SHMM19044N

13. Reconnect the negative terminal from the battery.



SHMM19043N

14. Fill the radiator with coolant and check for leaks.

Water pipe

1. Install the O-ring to the water pipes.

NOTICE

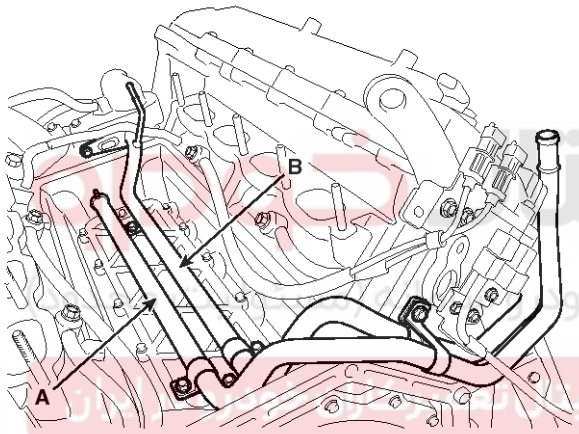
- *Use new O-rings when reassembling.*
- *Never apply sort of oil on O-ring and O-ring groove of pipe end.*
- *O-ring must be free from scratching damage.*

2. Install the water outlet pipe (A) and the water inlet pipe (B).

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

NOTICE

- *Make clean the contact face before assembly.*
- *Insert pipe after to be wetting O-ring or inside of attaching hole by water or antifreeze.*

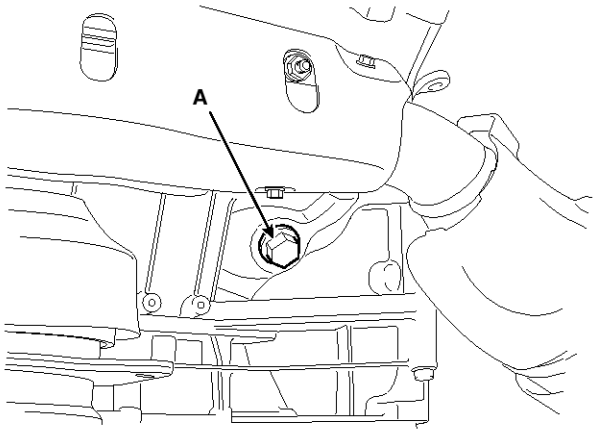


SHMM19084N

NOTICE

Install the drain plug (A).

Tightening torque :
96.1~100.0N.m(9.8~10.2kgf.m,70.9~73.8lb-ft)



SHMM19085N

3. Install the intake manifold module. (Refer to intake and exhaust system in this group)

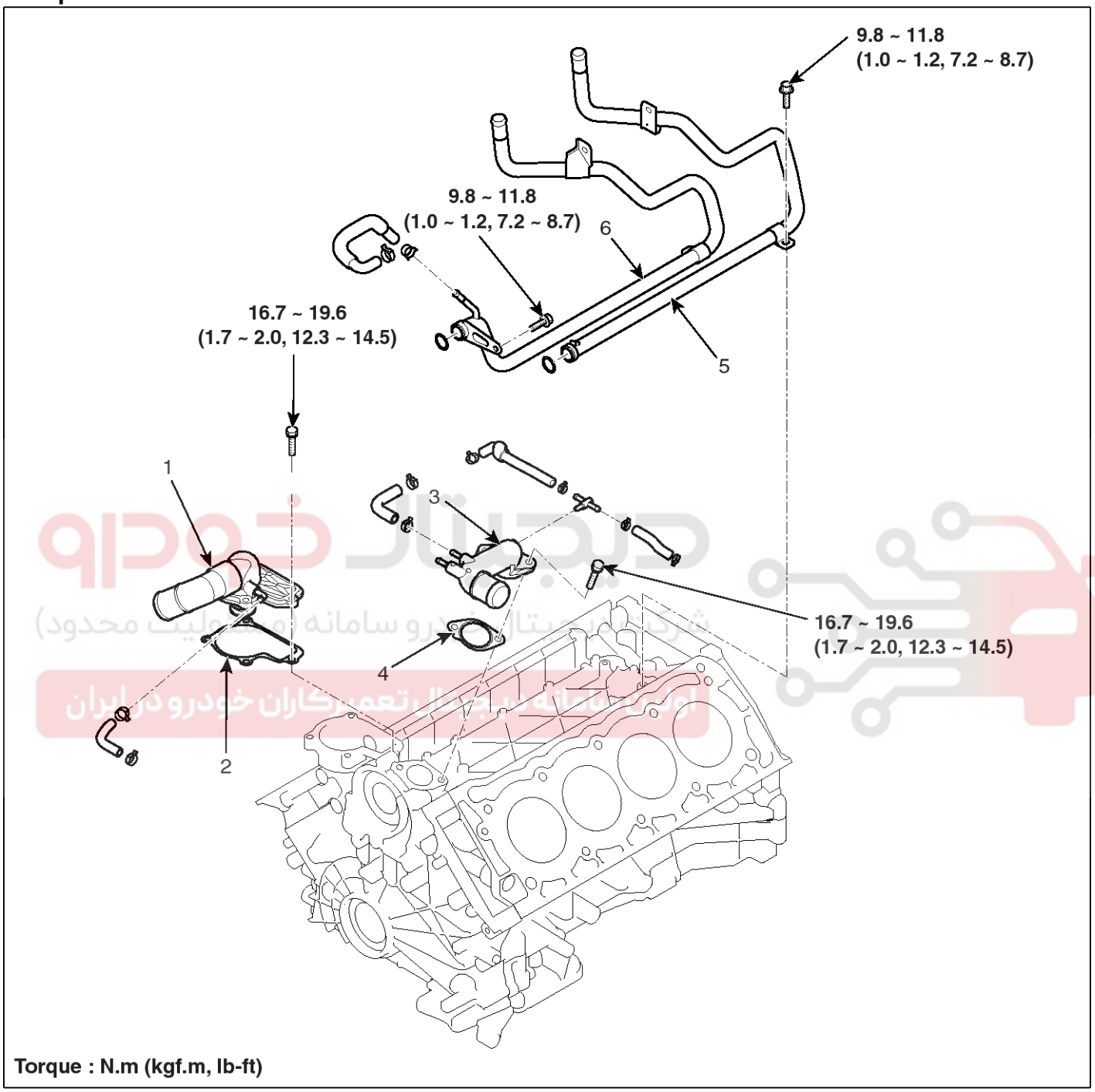
Troubleshooting

Water Pump

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

Thermostat

Components

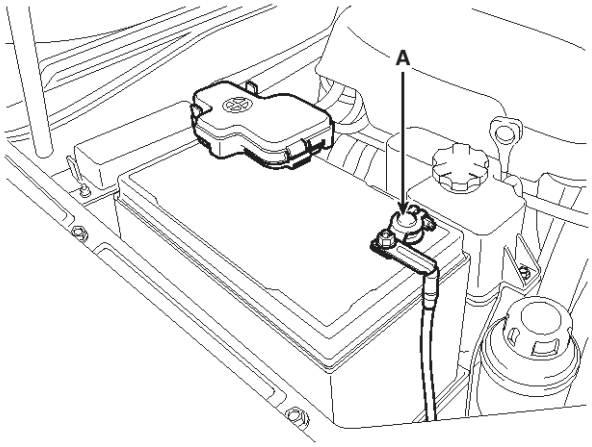


SHMM19331N

1. Water temperature control assembly
2. Water temperature control assembly gasket
3. Water outlet fitting assembly
4. Water outlet fitting assembly gasket
5. Water inlet pipe
6. Water outlet pipe

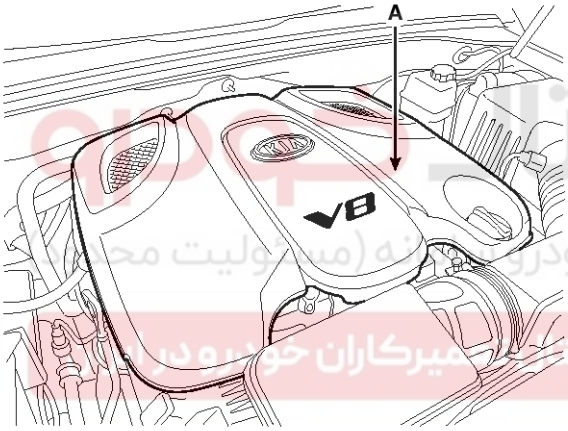
Removal

1. Disconnect the negative terminal from the battery.



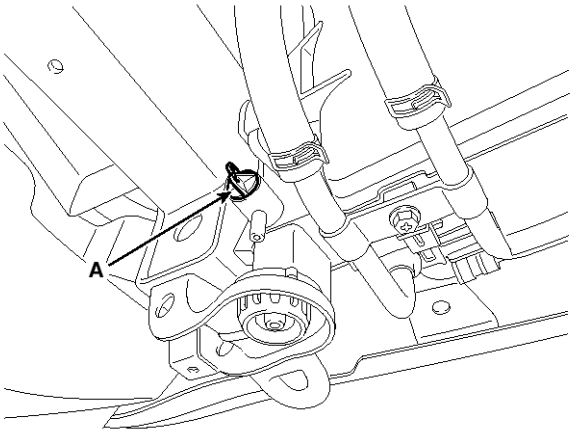
SHMM19043N

2. Remove the engine cover (A).



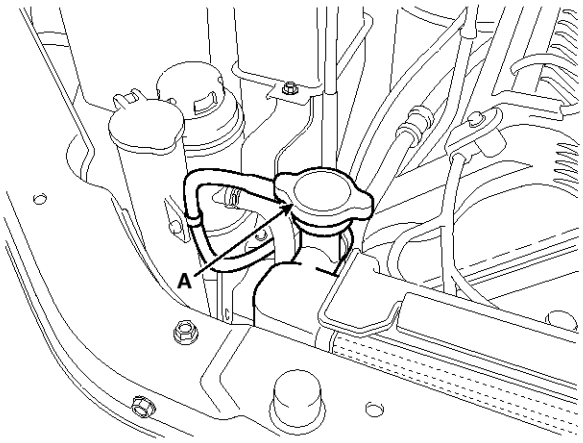
SHMM19044N

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



SHMM19046N

Remove the radiator cap (A) to speed draining.

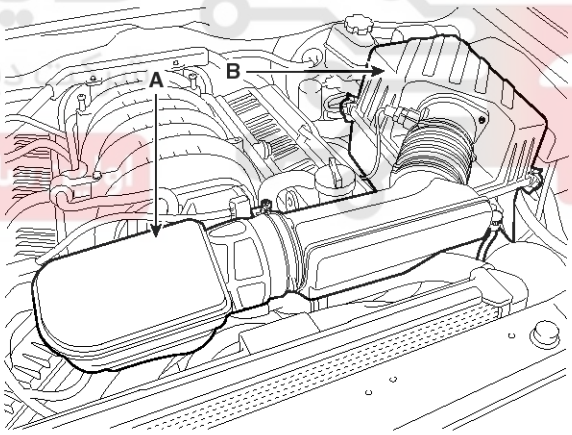


SHMM19047N

WARNING

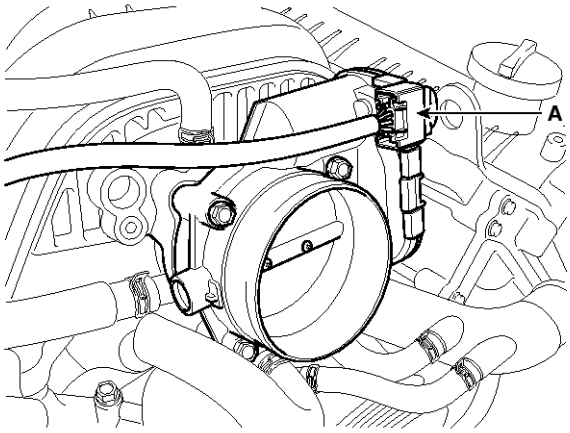
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

4. Remove the air duct (A) and the air cleaner assembly (B).



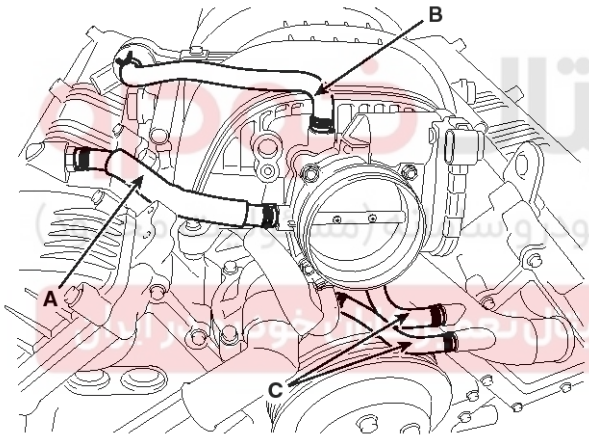
SHMM19048N

5. Disconnect the ETC module connector (A).



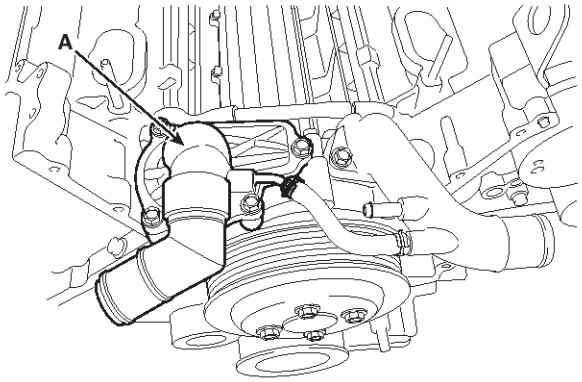
SHMM19070N

6. Disconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) from the intake manifold module and the throttle body.



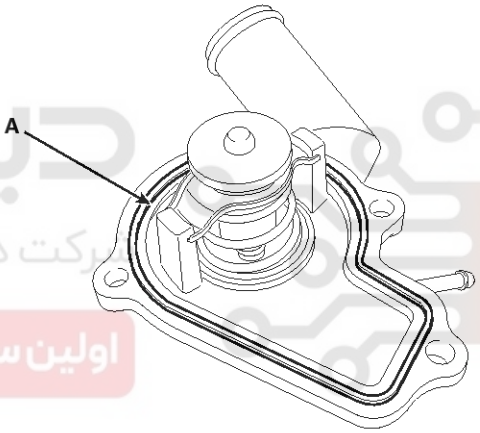
SHMM19081N

7. Remove the throttle body.
8. Remove the water temperature control assembly (A).



SHMM19102N

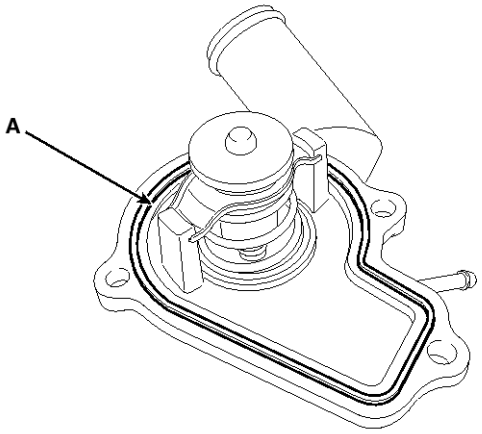
9. Remove the O-ring (A).



SHMM19103N

Installation

1. Install the O-ring (A).

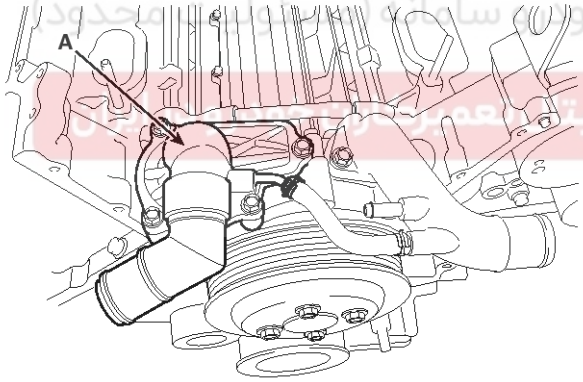


SHMM19103N

2. Install the water temperature control assembly (A).

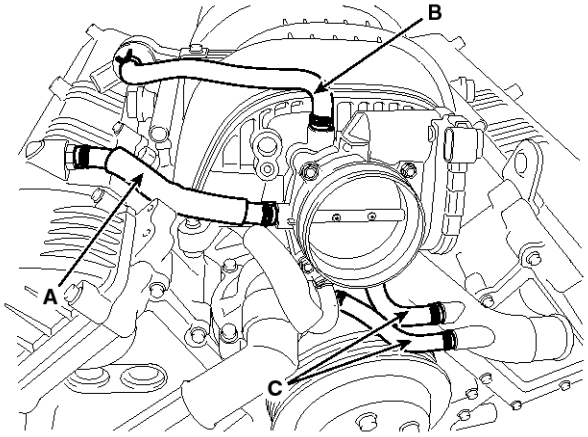
Tightening torque :
16.7 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)

NOTICE
The protrusion of the gasket must be face the front of the engine.



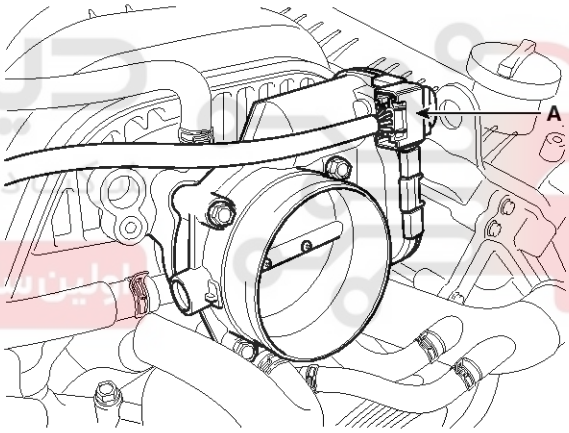
SHMM19102N

3. Install the throttle body. (Refer to FL group)
4. Reconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) to the intake manifold module and the throttle body.



SHMM19081N

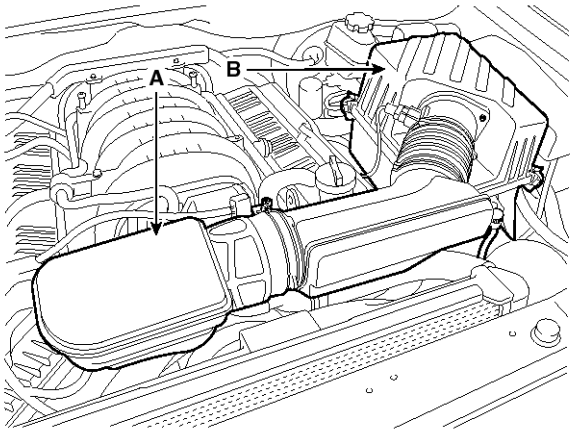
5. Reconnect the ETC module connector (A).



SHMM19070N

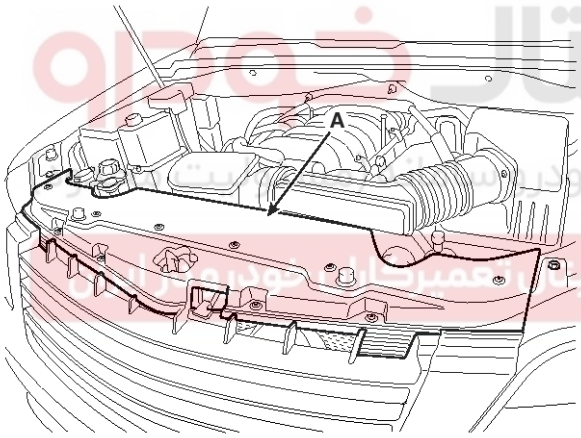
6. Install the air duct (A) and the air cleaner assembly (B).

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



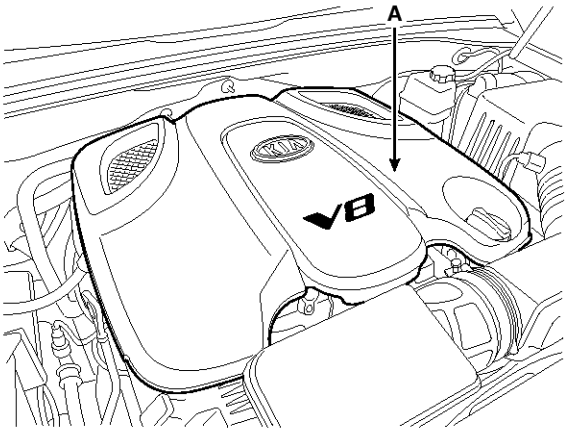
SHMM19048N

7. Install the radiator grill upper guard (A).



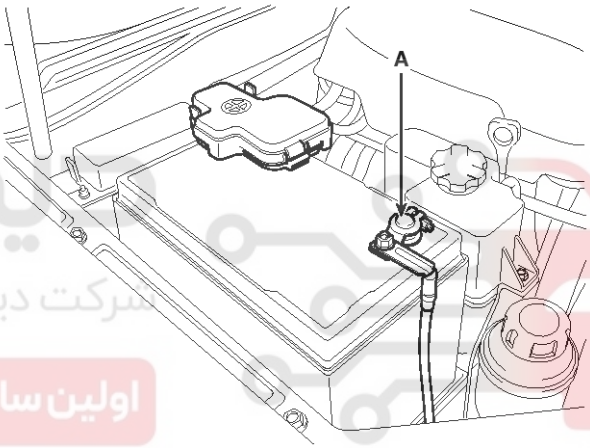
SHMM19045N

8. Install the engine cover (A).



SHMM19044N

9. Reconnect the negative terminal from the battery.



SHMM19043N

10. Fill the radiator with coolant and check for leaks.

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 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'	Visually check 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 .

Lubrication System

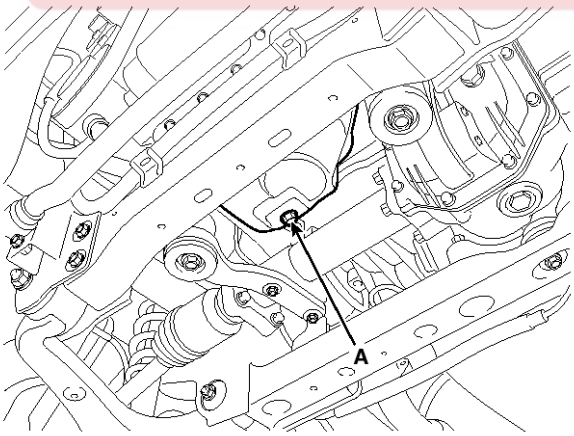
Engine Oil

Engine Oil And Filter Replacement

⚠CAUTION

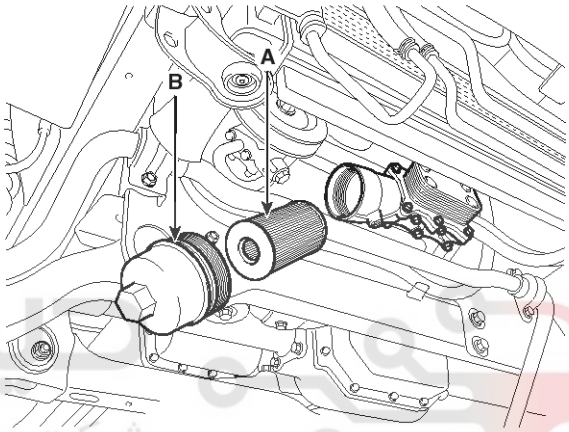
- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Exercise caution in order to minimize 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. Park the car on level ground.
   Start the engine and let it warm up.
2. Drain engine oil.
   1) Remove the oil filler cap.
   2) After lifting the car, remove the oil drain plug (A) and drain oil into a container.



SHMM19156N

3. Replace the oil filter.
   1) Remove the oil filter cap from the oil filter body.
   2) Remove the oil filter element.
   3) Check and clean the oil filter installation surface.
   4) Check the part number of a new oil filter is same as old one.
   5) Install a new oil filter element (A) and two new O-rings (B).



SHMM19158N

   6) Apply clean engine oil to the new O-rings.
      Lightly screw the oil filter cap into place, and tighten it until the O-ring contacts the seat.
   7) Finally tighten it again by specified tightening torque.

Tightening torque :
25N.m (2.54kgf.m, 18.4lb-ft)

4. Fill new engine oil.
   1) 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 new engine oil, after removing the engine oil level gauge.

Capacity
Total : 7.5L (7.92US qt, 6.59Imp qt)
Oil pan : 6.2 L (6.55 US qt, 5.46 Imp qt)
Drain and refill including oil filter : 6.7L (7.07US qt, 5.89Imp qt)

   - Fill a half oil of the total amount first and do the rest again after about one minute later.
   - Do not fill oil over the 'F' line, checking the level with the oil level gauge.

   3) Install the oil filler cap and oil level gauge.
5. Start the engine and check to be sure no oil is leaking from the drain plug or oil filter.
6. 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 warming up the engine and then 5 minutes after the engine stop, oil level should be between the “L” and “F” marks in the dipstick.

   If low, check for leakage and add oil up to the “F” mark.

NOTICE
Do not fill with engine oil above the “F” mark.

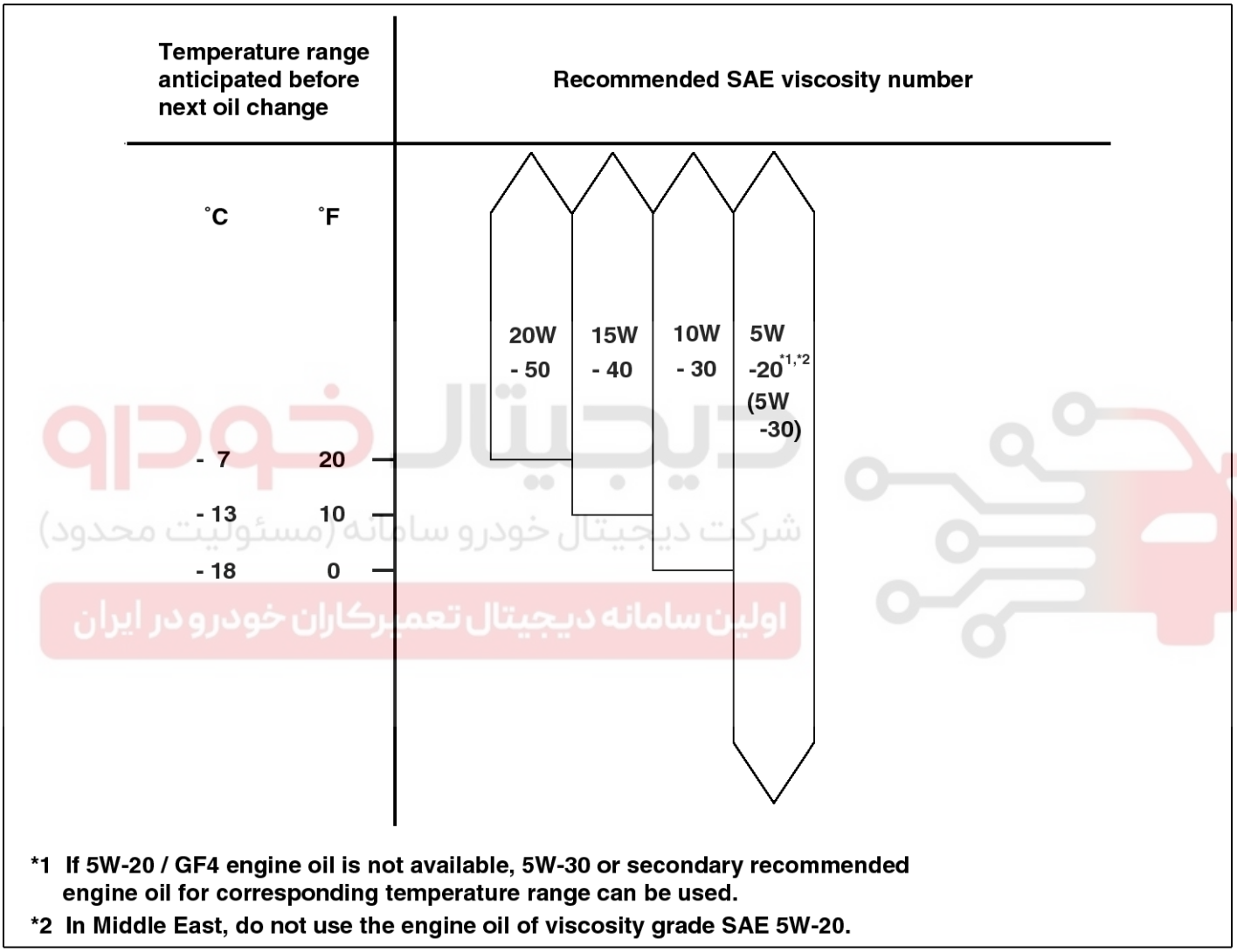
Selection Of Engine Oil

Recommendation (except Middle East) : 5W-20/GF4&SM (If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.)

API classification : SL, SM or above

ILSAC classification : GF3, GF4 or above

SAE viscosity grade : Refer to the recommended SAE viscosity number.



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

***2 In Middle East, do not use the engine oil of viscosity grade SAE 5W-20.**

SAMM29103L

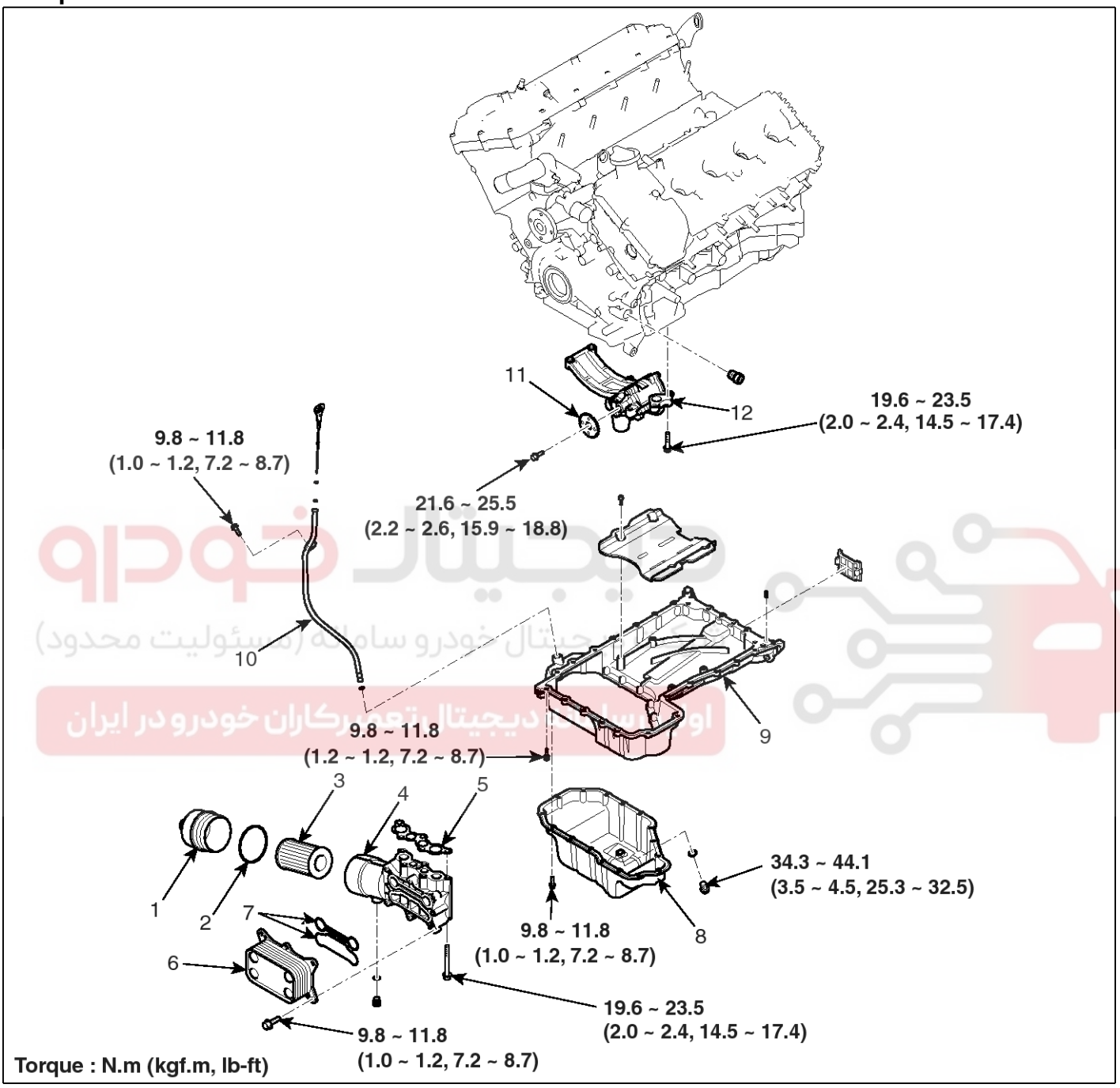
NOTICE

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

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

Oil Pump

Components

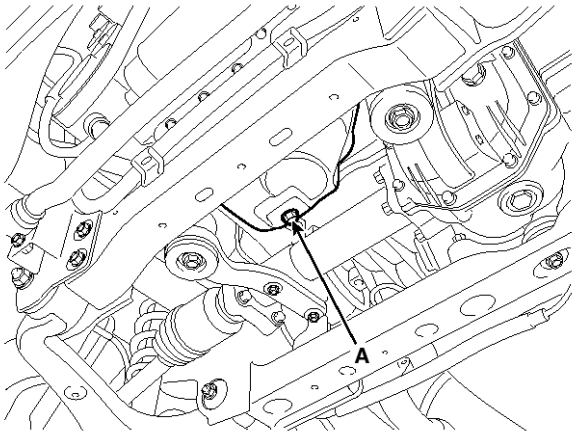


SHMM19332N

1. Oil filter cap
2. Oil filter cap O-ring
3. Oil filter
4. Oil filter assembly
5. Oil filter assembly gasket
6. Oil cooler assembly
7. Oil cooler gasket
8. Lower oil pan
9. Upper oil pan
10. Oil level gauge
11. Oil pump sprocket
12. Oil pump assembly

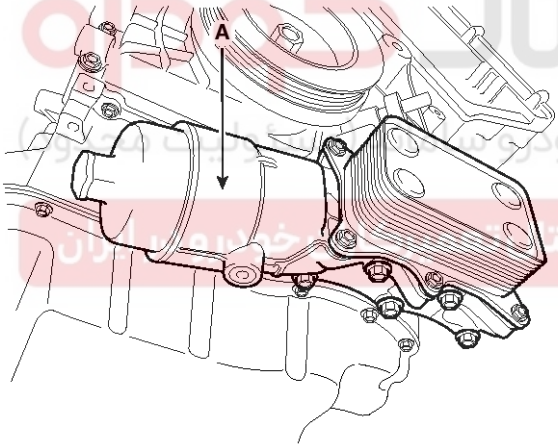
Removal

1. Drain engine oil.
   1) Remove the oil filler cap.
   2) After lifting the car, remove the oil drain plug (A) and drain oil into a container.



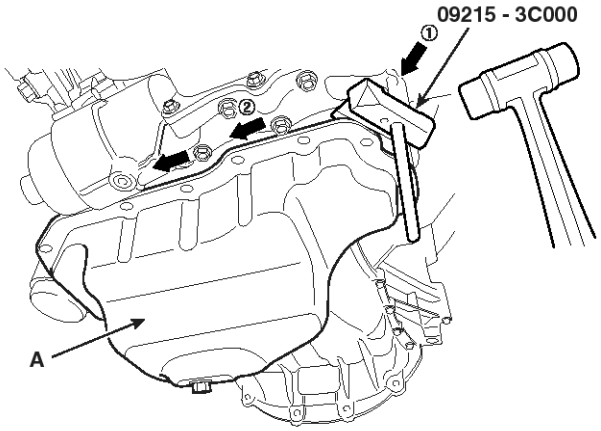
SHMM19156N

2. Remove the oil filter and oil cooler assembly (A).



SHMM19090N

3. Remove the lower oil pan(A).
   Insert the blade of SST(09215-3C000) between the upper oil pan and the lower oil pan. Cut off applied sealer and remove the lower oil pan.



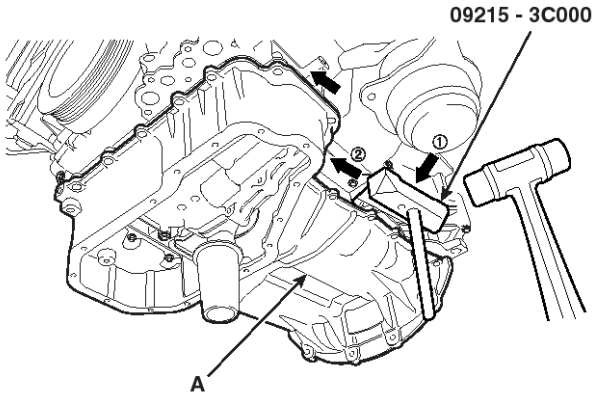
SHMM19315N

NOTICE

- *Insert the SST between the lower oil pan and the upper oil pan by tapping it with a plastic hammer in the direction of (1) arrow.*
- *After tapping the SST with a plastic hammer along the direction of (2) arrow around more than 2/3 edge of the lower oil pan, remove it from the lower oil pan.*
- *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.*

4. Remove the upper oil pan (A).

   Insert the blade of SST(09215-3C000) between the upper oil pan and the cylinder block. Cut off applied sealer and remove upper oil pan.

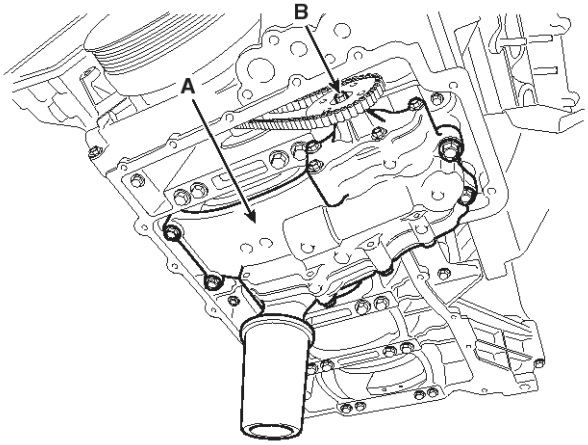


SHMM19316N

NOTICE

- *Insert the SST between the upper oil pan and the cylinder block by tapping it with a plastic hammer in the direction of (1) arrow.*
- *After tapping the SST with a plastic hammer along the direction of (2) arrow around more than 2/3 edge of the upper oil pan, remove it from the upper oil pan.*
- *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 cylinder block.*

5. Remove the oil pump assembly (A) after remove the oil pump sprocket (B).

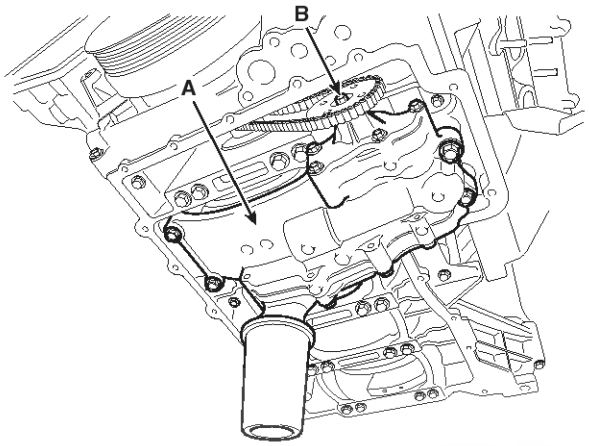


SHMM19348N

Installation

1. Install the oil pump assembly (A) and then oil pump sprocket (B).

Tightening torque :
Oil pump assembly bolts :
19.6 ~ 23.5Nm (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
Oil pump sprocket bolts :
21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

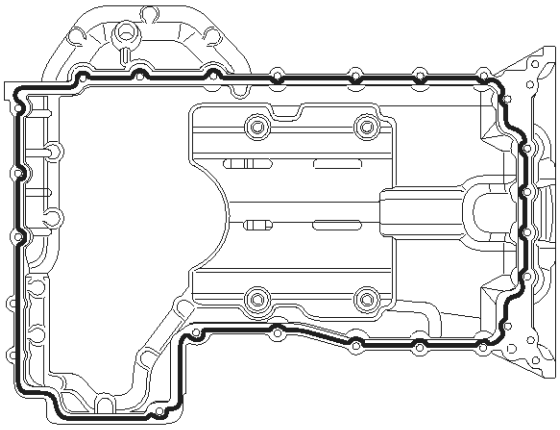


SHMM19348N

2. Install the upper oil pan.
   1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
   2) Before assembling the oil pan, the liquid sealant TB1217H or LT5900H should be applied on upper oil pan.

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

Bead width : 2.5mm(0.1in)

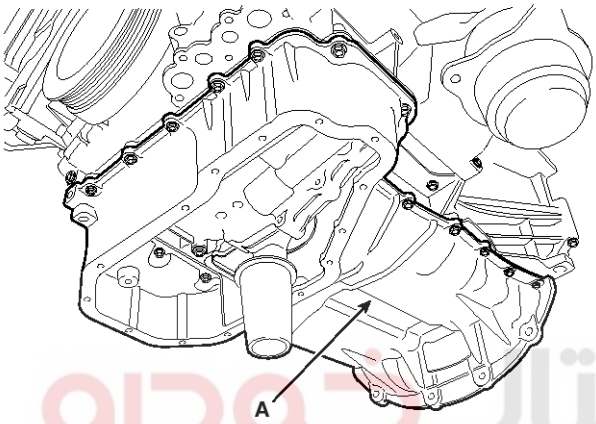


SHMM19143N

NOTICE

- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *When applying sealant gasket, sealant must not protrude into the inside of oil pan.*
- *To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.*

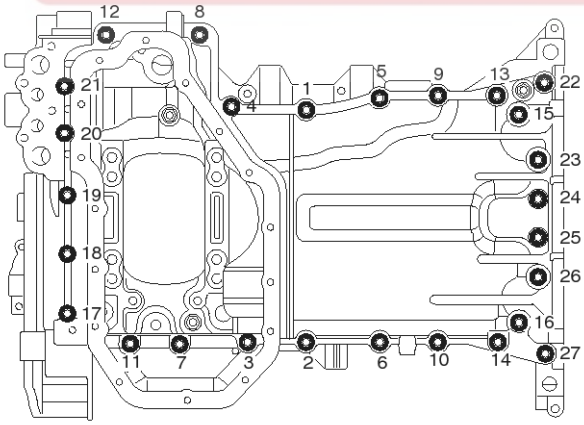
3) Install the upper oil pan.



SHMM19094N

Uniformly tighten the bolts in several passes.

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

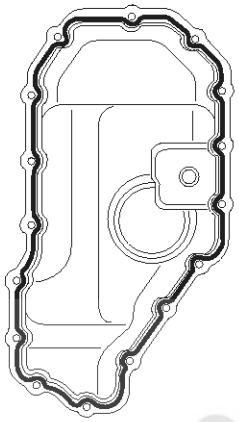


SHMM19145N

3. Install the lower oil pan.
   1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
   2) Before assembling the oil pan, the liquid sealant TB1217H or LT5900H should be applied on lower oil pan.

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

Bead width : 2.5mm(0.1in)

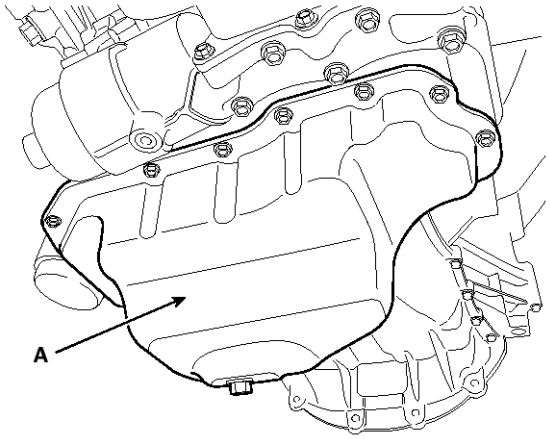


SHMM19146N

NOTICE

- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant.*
- *When applying sealant gasket, sealant must not protrude into the inside of oil pan.*
- *To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.*

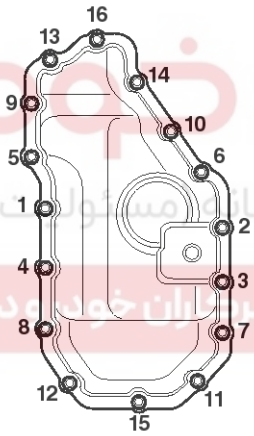
3) Install the lower oil pan.



SHMM19092N

Uniformly tighten the bolts in several passes.

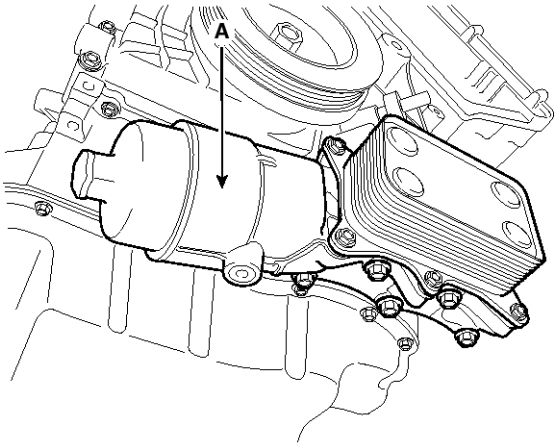
Tightening torque :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHMM19147N

4. Install the oil filter and oil cooler assembly (A).

Tightening torque :
Oil filter assembly bolts :
19.6 ~ 23.5Nm (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
Oil cooler bolts :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHMM19090N

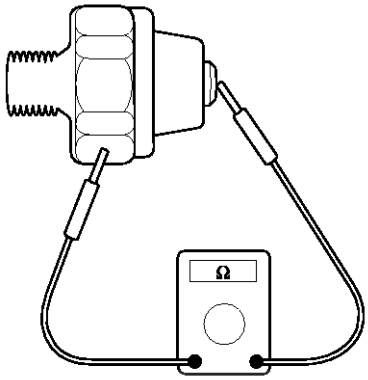
5. Refill the engine oil.

Oil Pressure Switch

Inspection

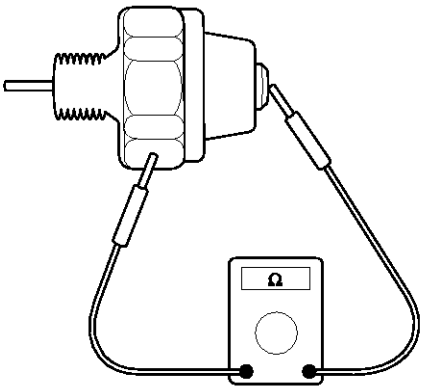
1. Check the continuity between the terminal and the body with an ohmmeter.

   If there is no continuity, replace the oil pressure switch.



ECKD001W

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.

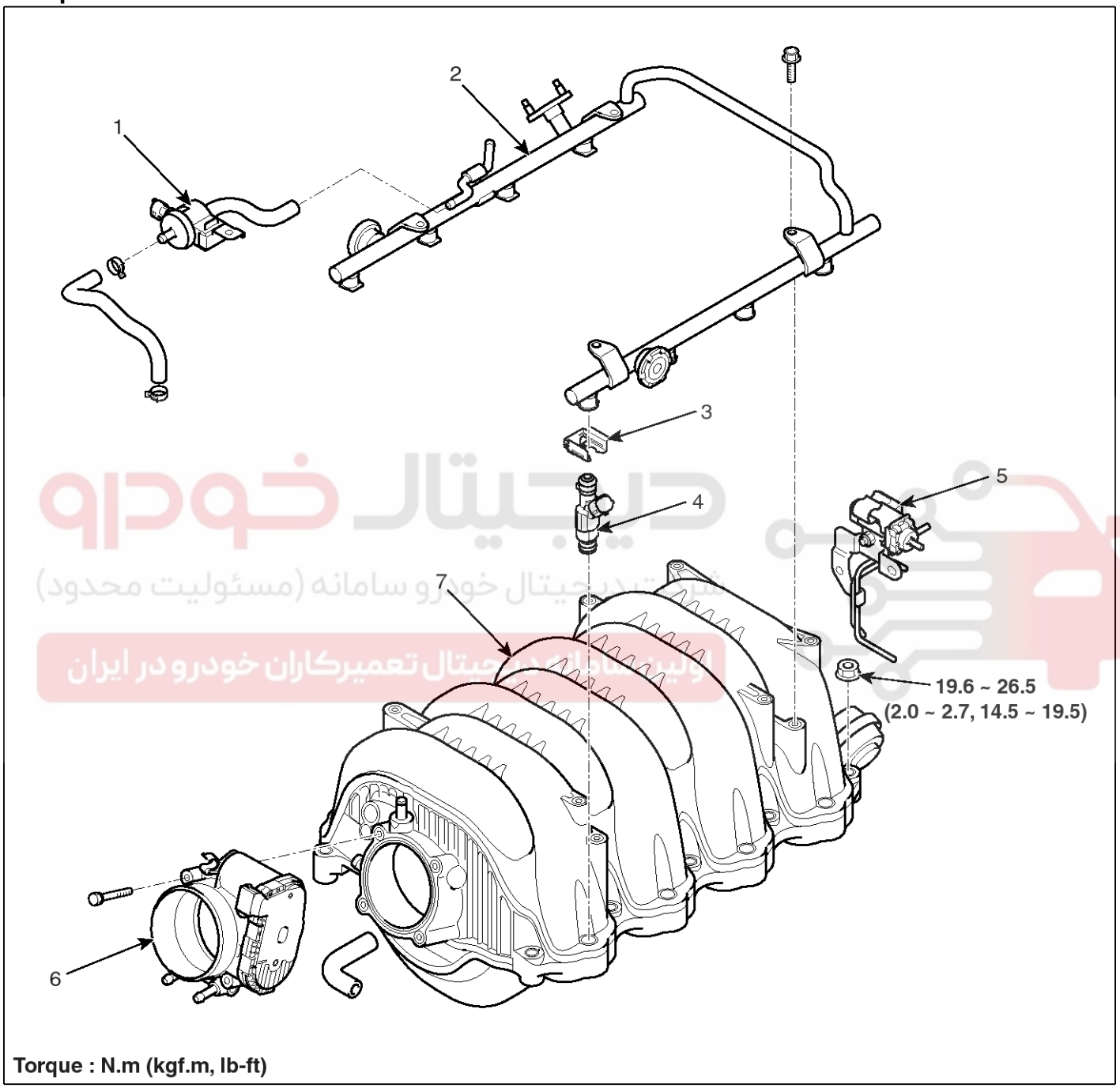


ECKD001Y

Intake And Exhaust System

Intake Manifold

Components

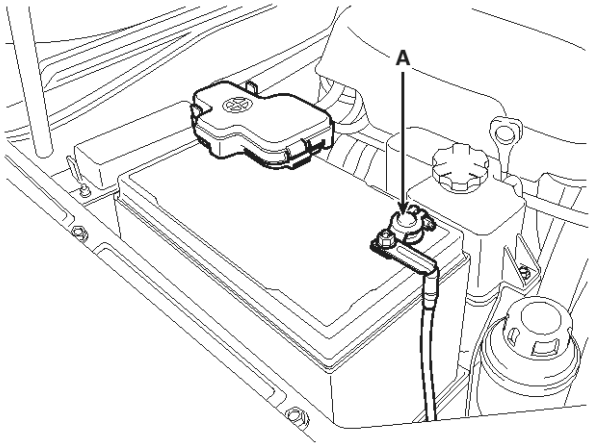


SHMM19333N

1. PCSV (Purge control solenoid valve)
2. Delivery pipe assembly
3. Injector clip
4. Injector
5. VIS solenoid valve
6. ETC module
7. Intake manifold module

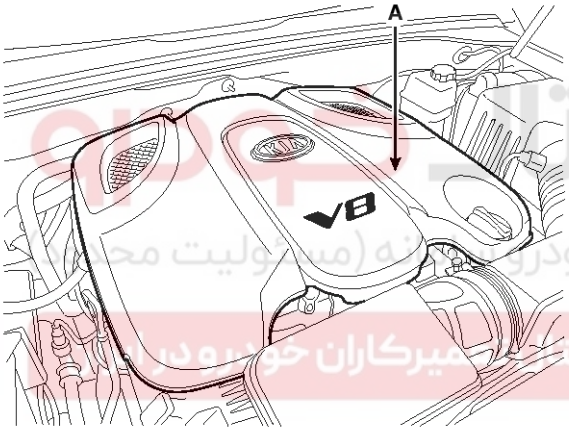
Removal

1. Disconnect the negative terminal from the battery.



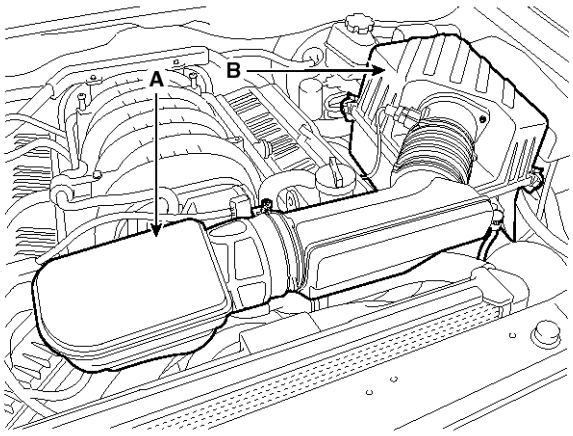
SHMM19043N

2. Remove the engine cover (A).



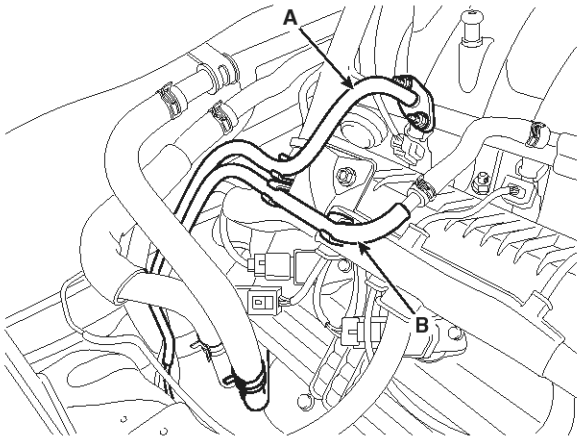
SHMM19044N

3. Remove the air duct (A) and the air cleaner assembly (B).



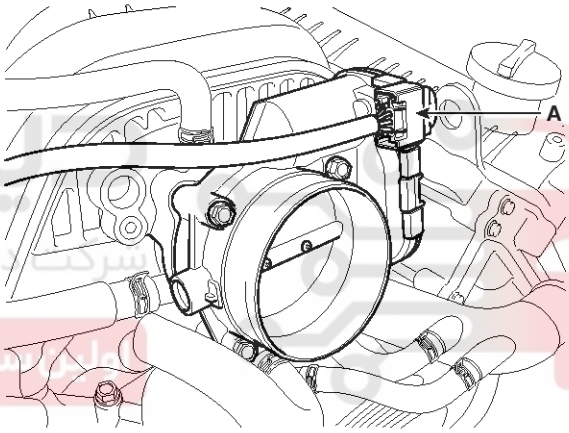
SHMM19048N

4. Disconnect the fuel hose (A) and the purge control solenoid valve (PCSV) hose (B).



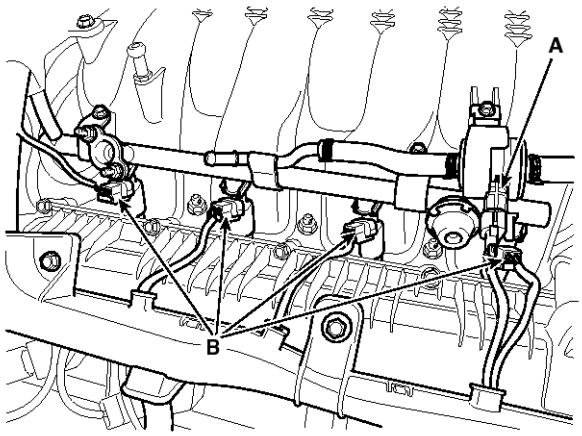
SHMM19375N

5. Disconnect the ETC module connector (A).



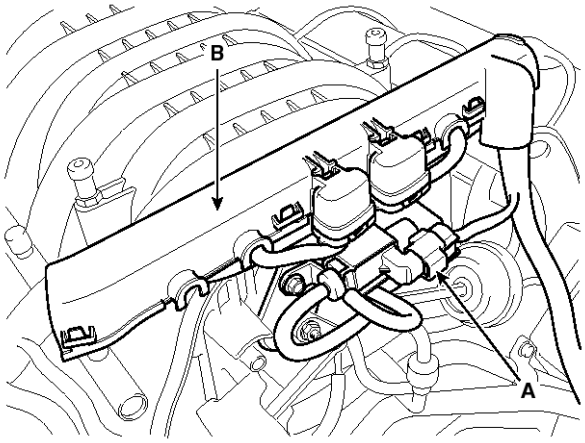
SHMM19070N

6. Disconnect the PCSV connector (A) and the injector connectors (B).



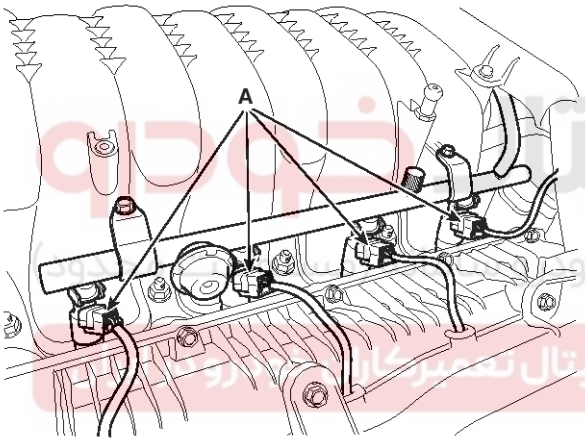
SHMM19071N

7. Disconnect the variable intake system solenoid valve connector (A) and the wiring harness protector (B).



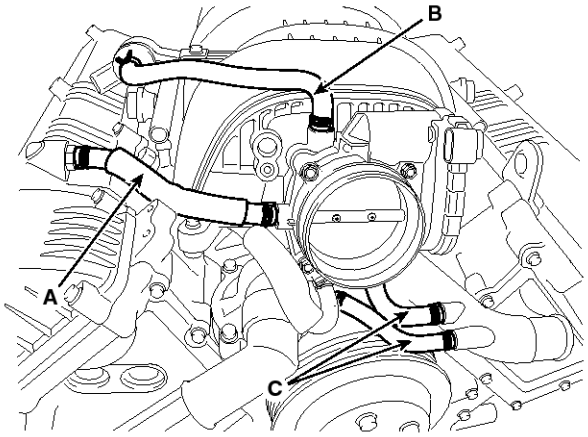
SHMM19074N

8. Disconnect the injector connectors (A).



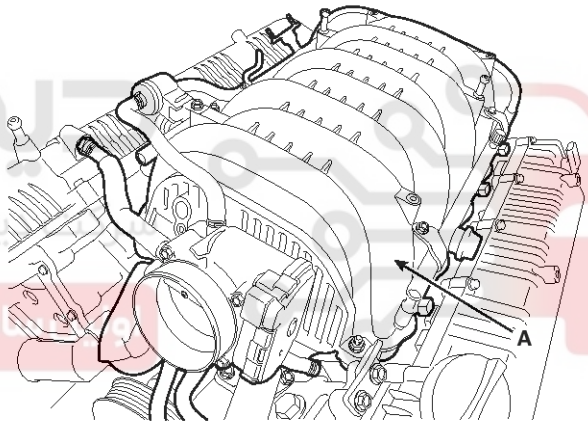
SHMM19076N

9. Disconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) from the intake manifold module and the throttle body.



SHMM19081N

10. Remove the intake manifold module (A).

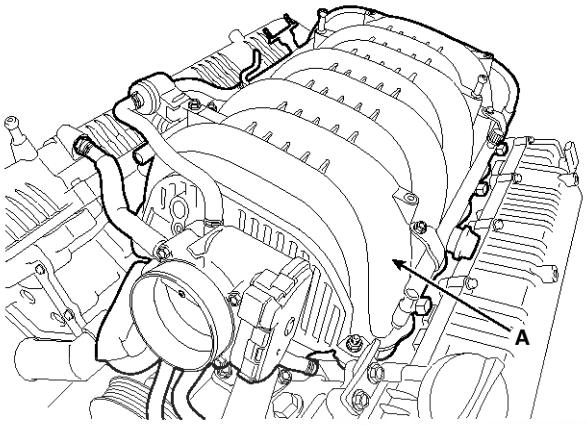


SHMM19082N

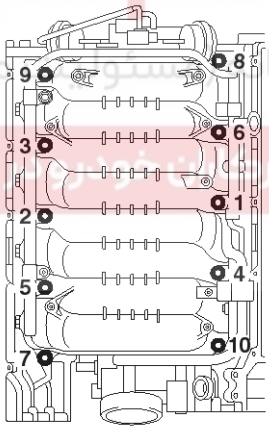
Installation

1. Installation the intake manifold module (A), tighten the nuts as following method.

Tightening torque :
1st step :
4.9 ~ 7.8N.m (0.5 ~ 0.8kgf.m, 3.6 ~ 5.8lb-ft)
2nd step :
19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)

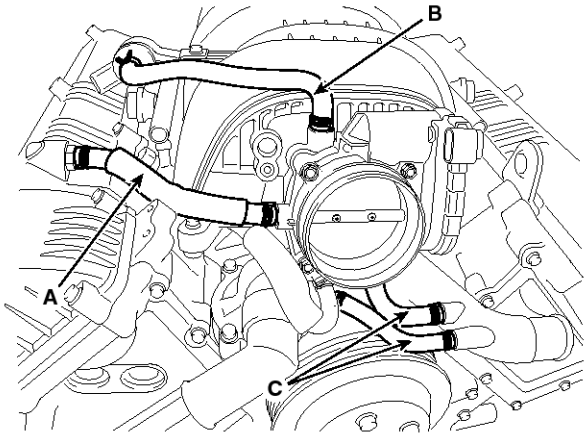


SHMM19082N



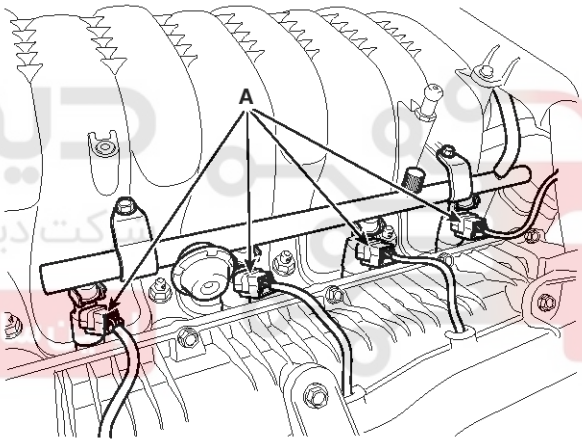
SHMM19153N

2. Reconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) to the intake manifold module and the throttle body.



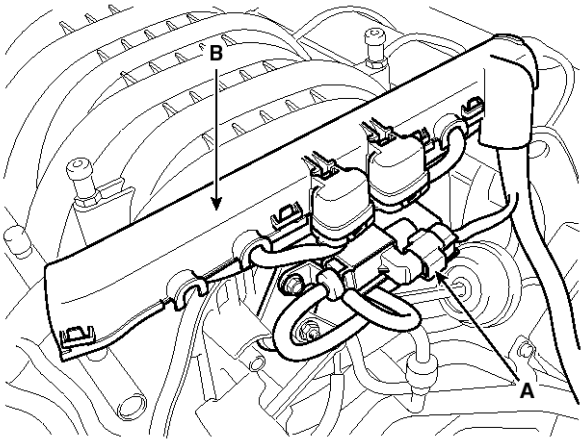
SHMM19081N

3. Reconnect the injector connectors (A).



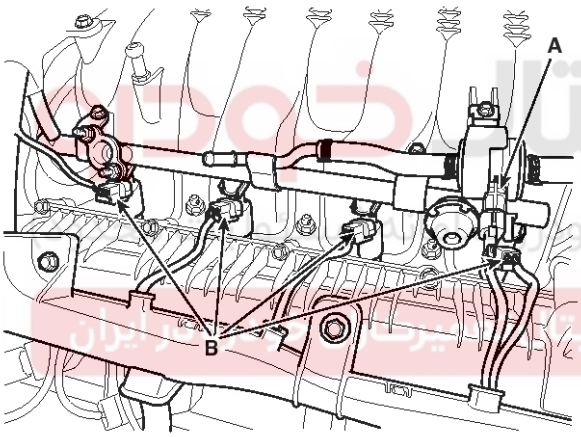
SHMM19076N

4. Reconnect the variable intake system solenoid valve connector (A) and the wiring harness protector (B).



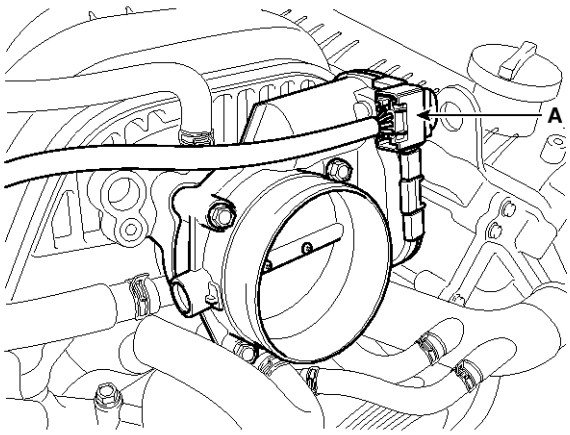
SHMM19074N

5. Reconnect the PCSV connector (A) and the injector connectors (B).



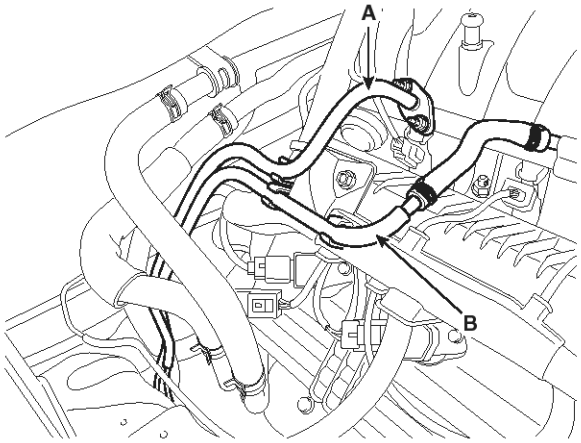
SHMM19071N

6. Reconnect the ETC module connector (A).



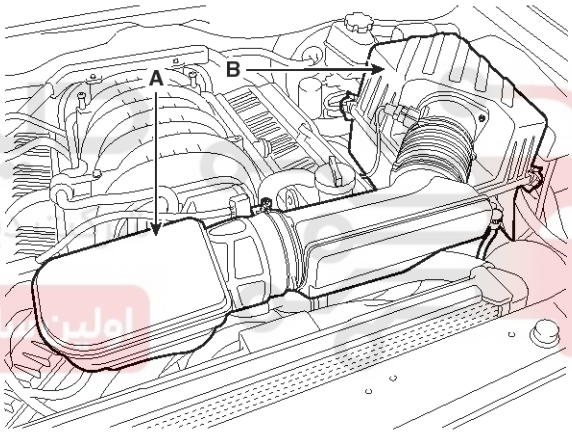
SHMM19070N

7. Reconnect the fuel hose (A) and the purge control solenoid valve (PCSV) hose (B).



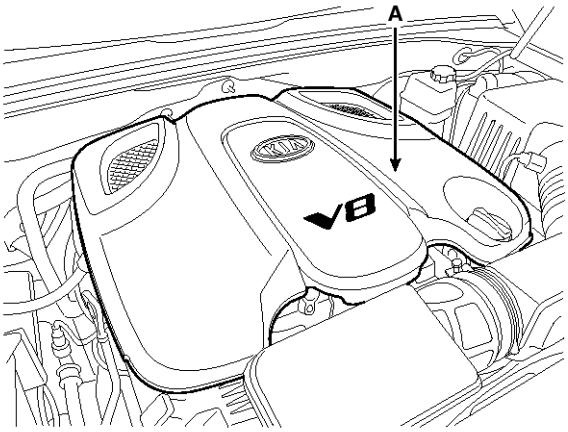
SHMM19304N

8. Install the air duct (A) and the air cleaner assembly (B).



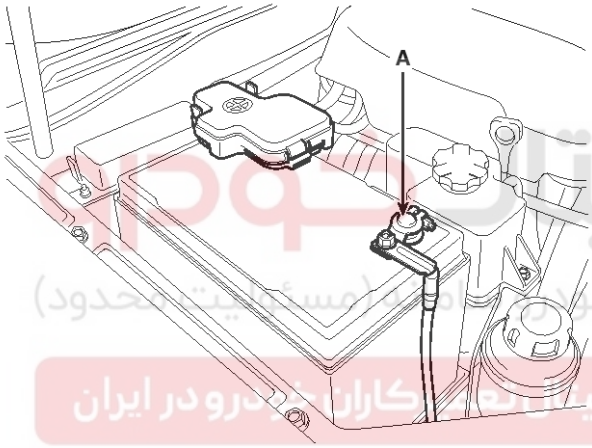
SHMM19048N

9. Install the engine cover (A).



SHMM19044N

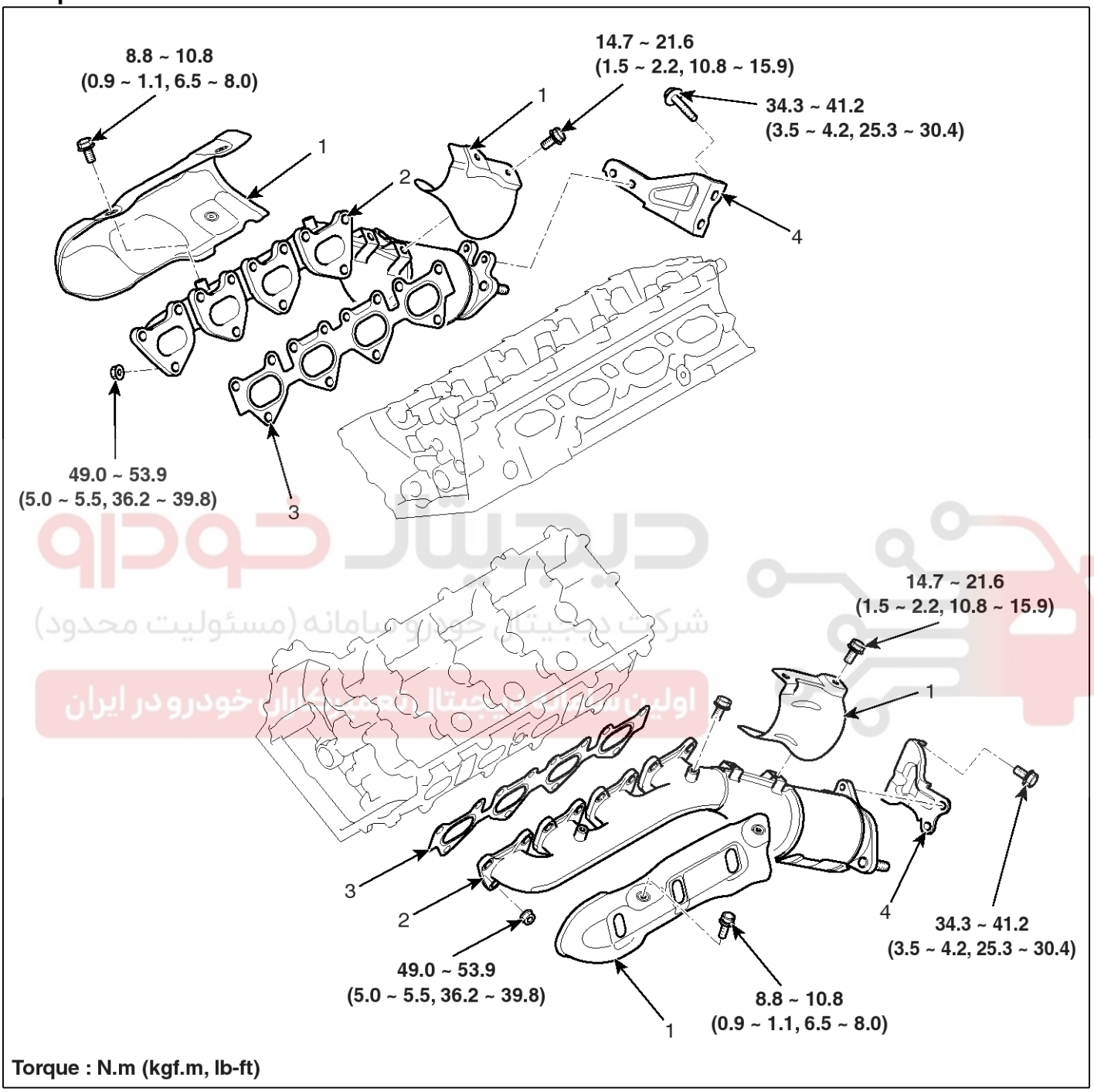
10. Reconnect the negative terminal to the battery.



SHMM19043N

Exhaust Manifold

Components

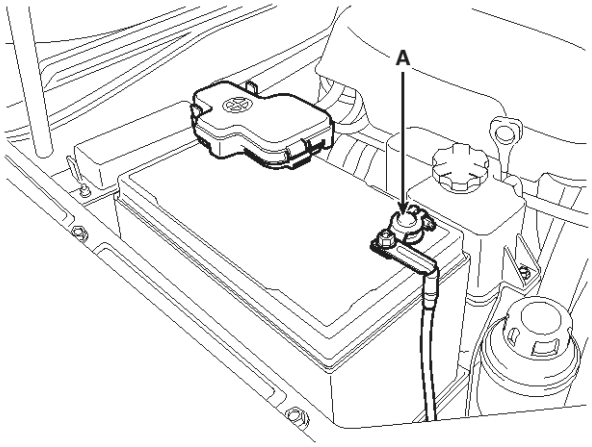


SHMM19334N

1. Exhaust manifold heat protector
2. Exhaust manifold
3. Exhaust manifold gasket
4. Exhaust manifold stay

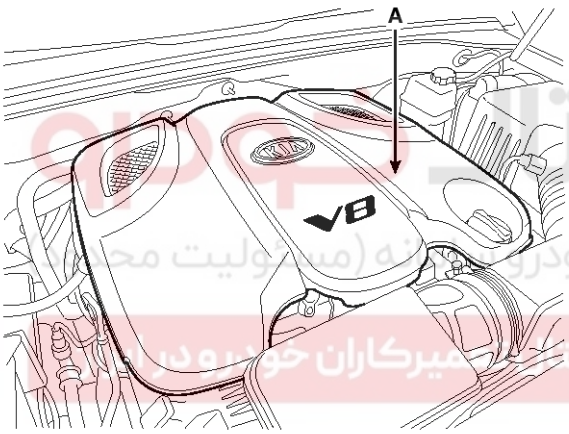
Removal

1. Disconnect the negative terminal from the battery.



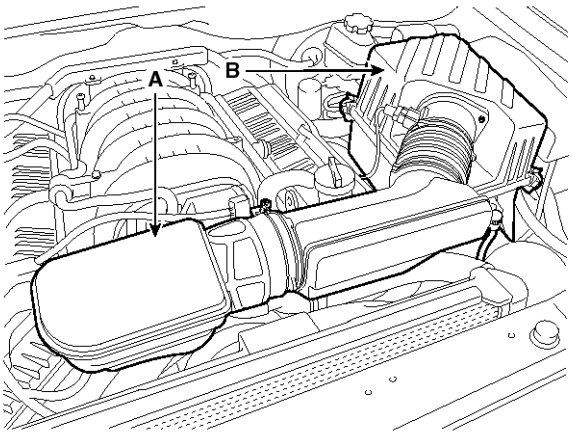
SHMM19043N

2. Remove the engine cover (A).



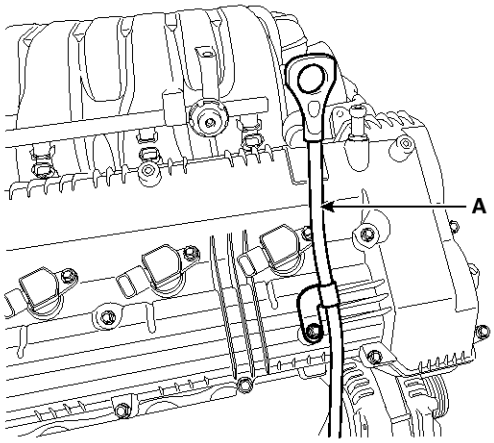
SHMM19044N

3. Remove the air duct (A) and the air cleaner assembly (B).



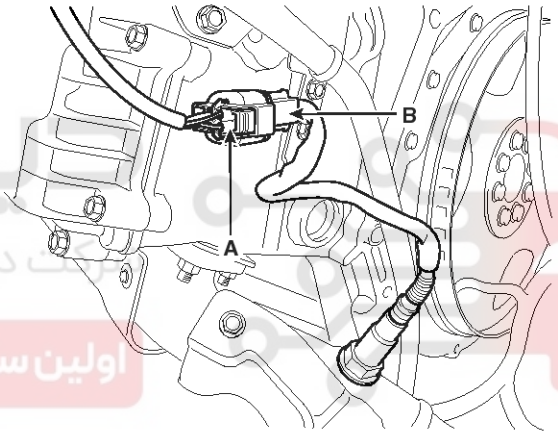
SHMM19048N

4. Remove the oil level gauge (A).

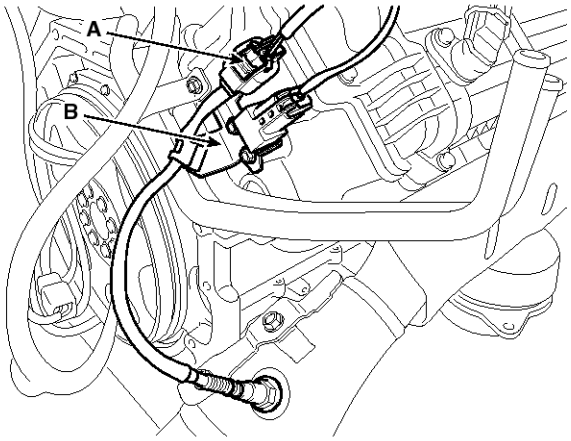


SHMM19001N

5. Disconnect the oxygen sensor connector (A) and remove the oxygen sensor connector bracket (B).

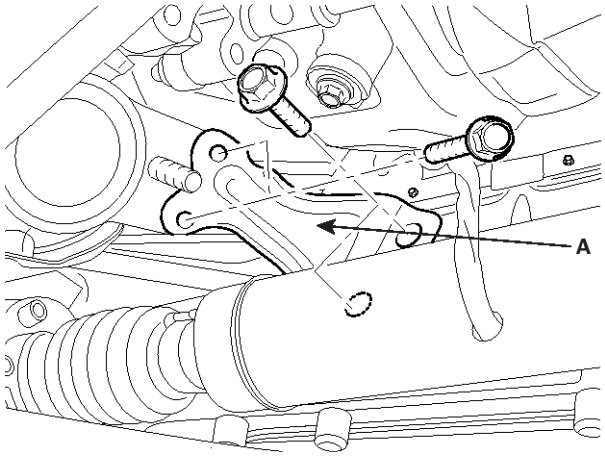


SHMM19079N

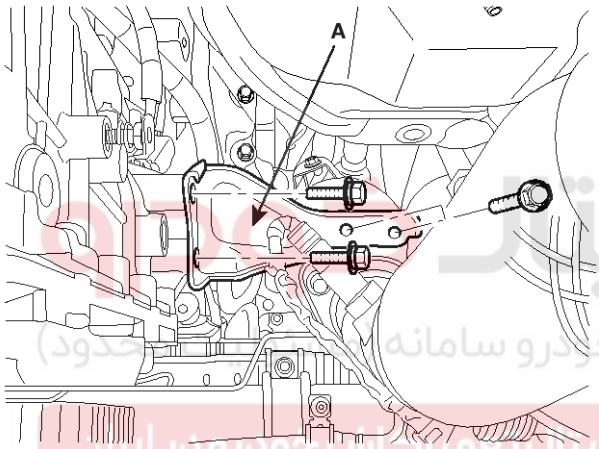


SHMM19080N

6. Remove the LH/RH exhaust manifold stay (A).

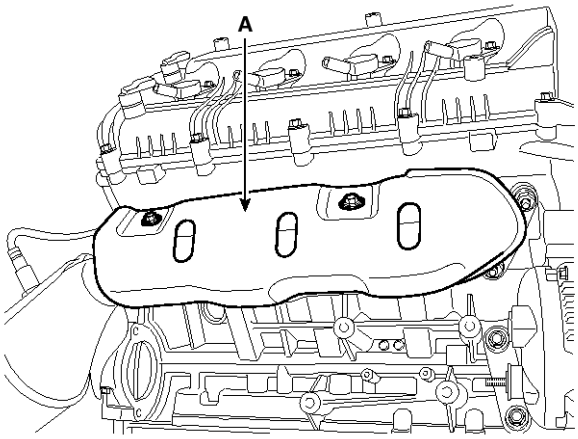


SHMM19351N

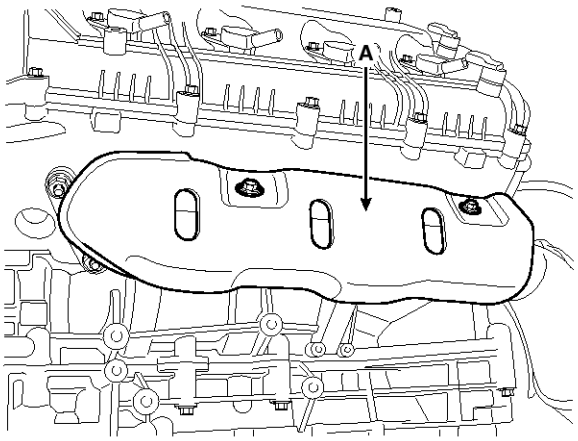


SHMM19352N

7. Remove the exhaust manifold heat protector (A).

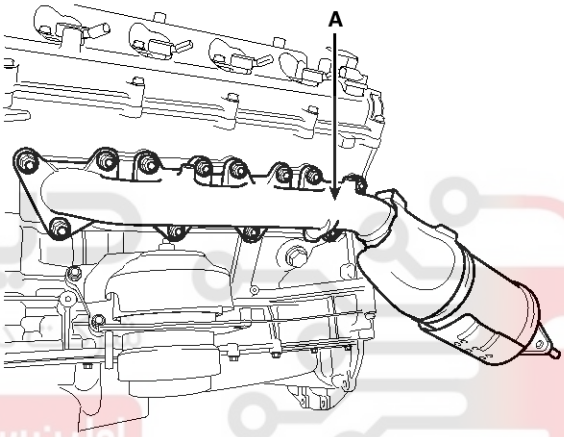


SHMM19002N

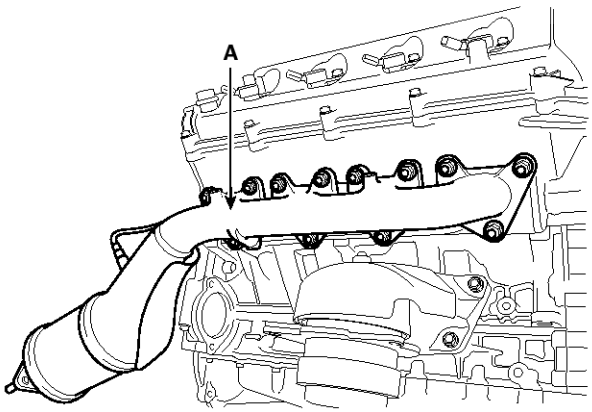


SHMM19003N

8. Remove the exhaust manifold (A).



SHMM19063N



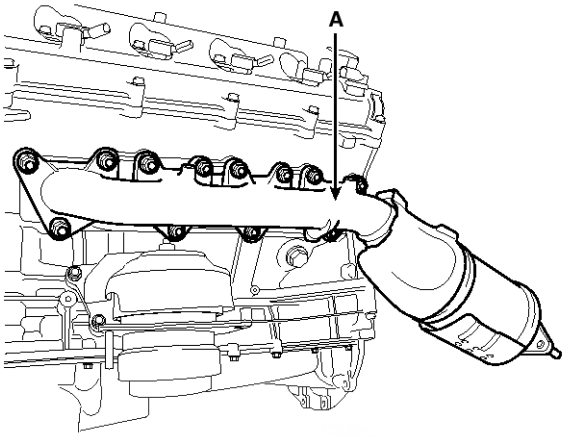
SHMM19064N

Installation

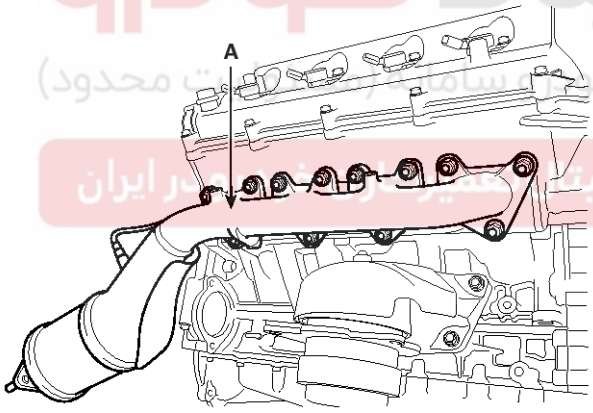
1. Install the exhaust manifold (A).

Tightening torque :
49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.2 ~ 39.8lb-ft)

NOTICE
The "TOP"mark of the gasket must be face the exhaust manifold.



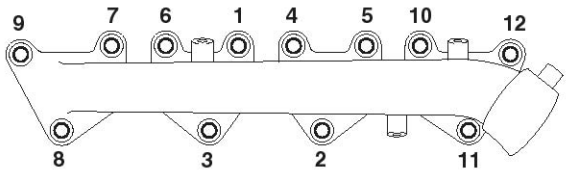
SHMM19063N



SHMM19064N

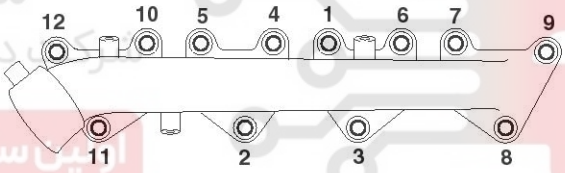
NOTICE
Tighten the exhaust manifold mounting nuts as following method.

[LH]



SHMM19154N

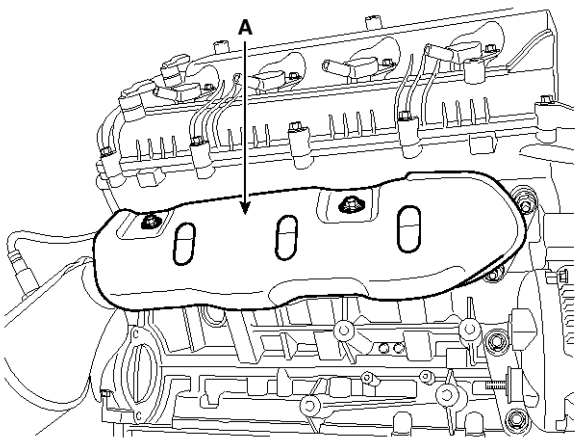
[RH]



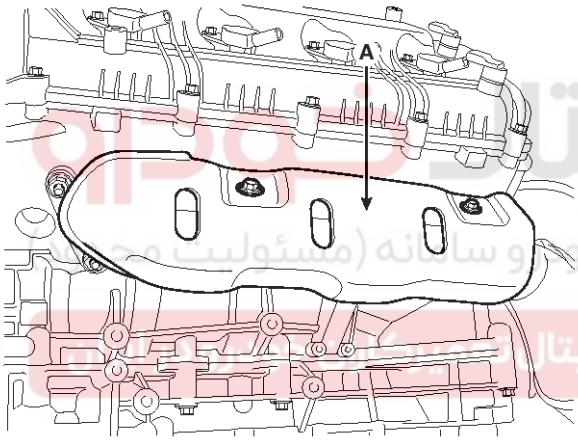
SHMM19363N

2. Install the exhaust manifold heat protector (A).

Tightening torque :
8.8 ~ 10.8 N.m (0.9 ~ 1.1kgf.m, 6.5 ~ 8.0lb-ft)



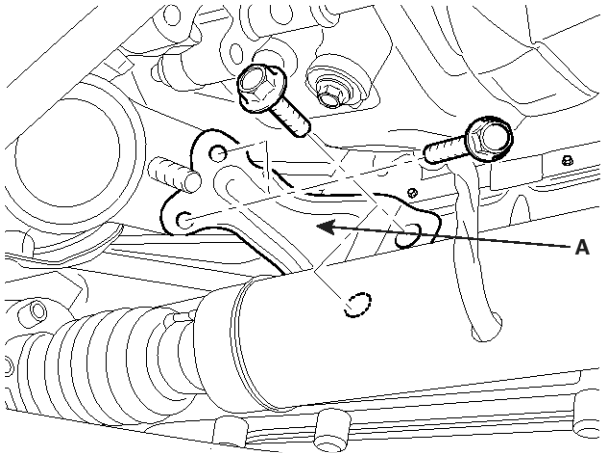
SHMM19002N



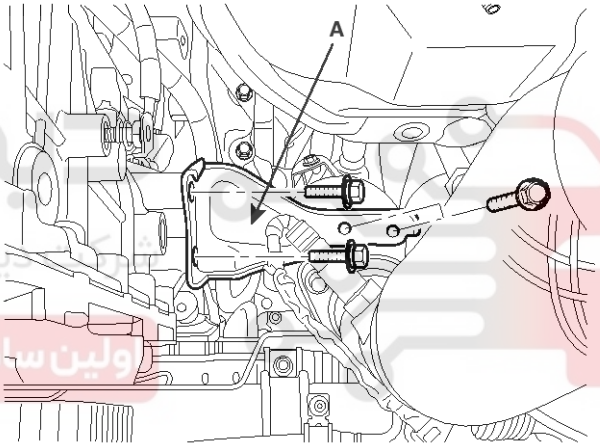
SHMM19003N

3. Install the LH/RH exhaust manifold stay (A).

Tightening torque :
34.3 ~ 41.2N.m (3.5 ~ 4.2kgf.m, 25.3 ~ 30.4lb-ft)

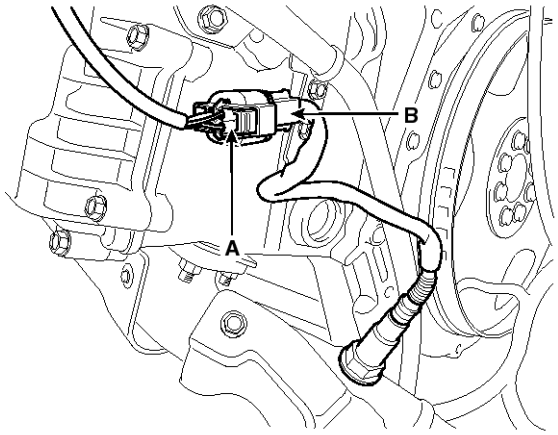


SHMM19351N

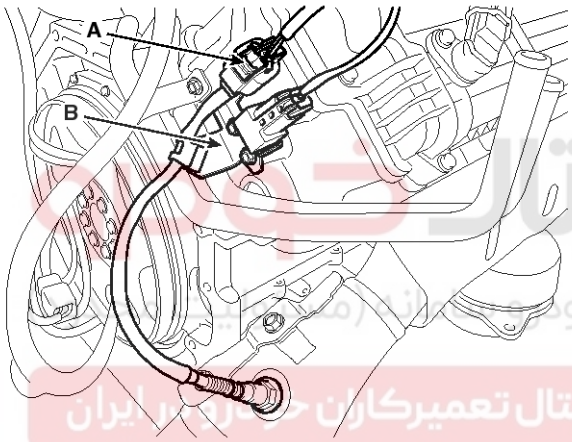


SHMM19352N

4. Reconnect the oxygen sensor connector (A) and Install the oxygen sensor connector bracket (B).



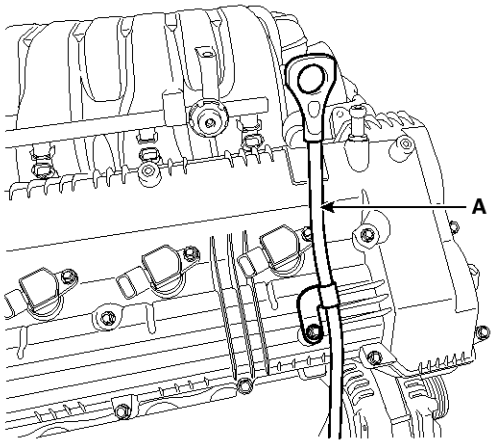
SHMM19079N



SHMM19080N

5. Install the oil level gauge (A).

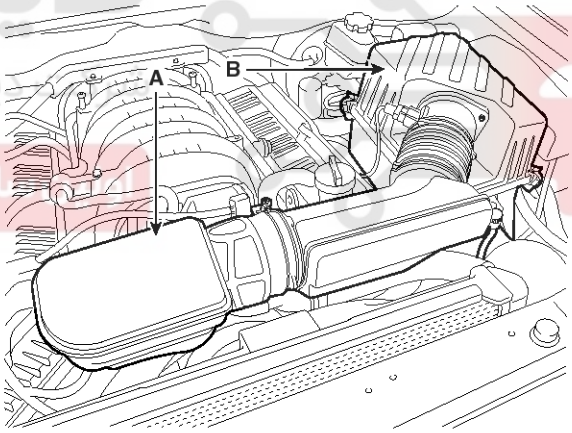
Tightening torque :
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHMM19001N

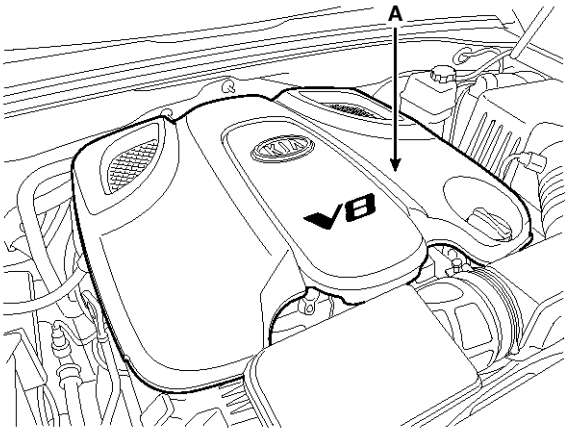
6. Install the air duct (A) and the air cleaner assembly (B).

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



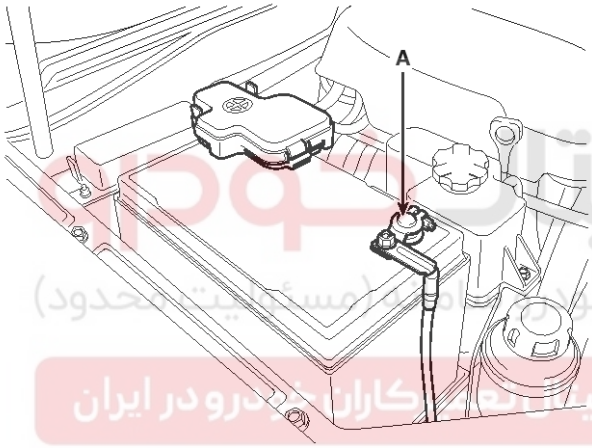
SHMM19048N

7. Install the engine cover (A).



SHMM19044N

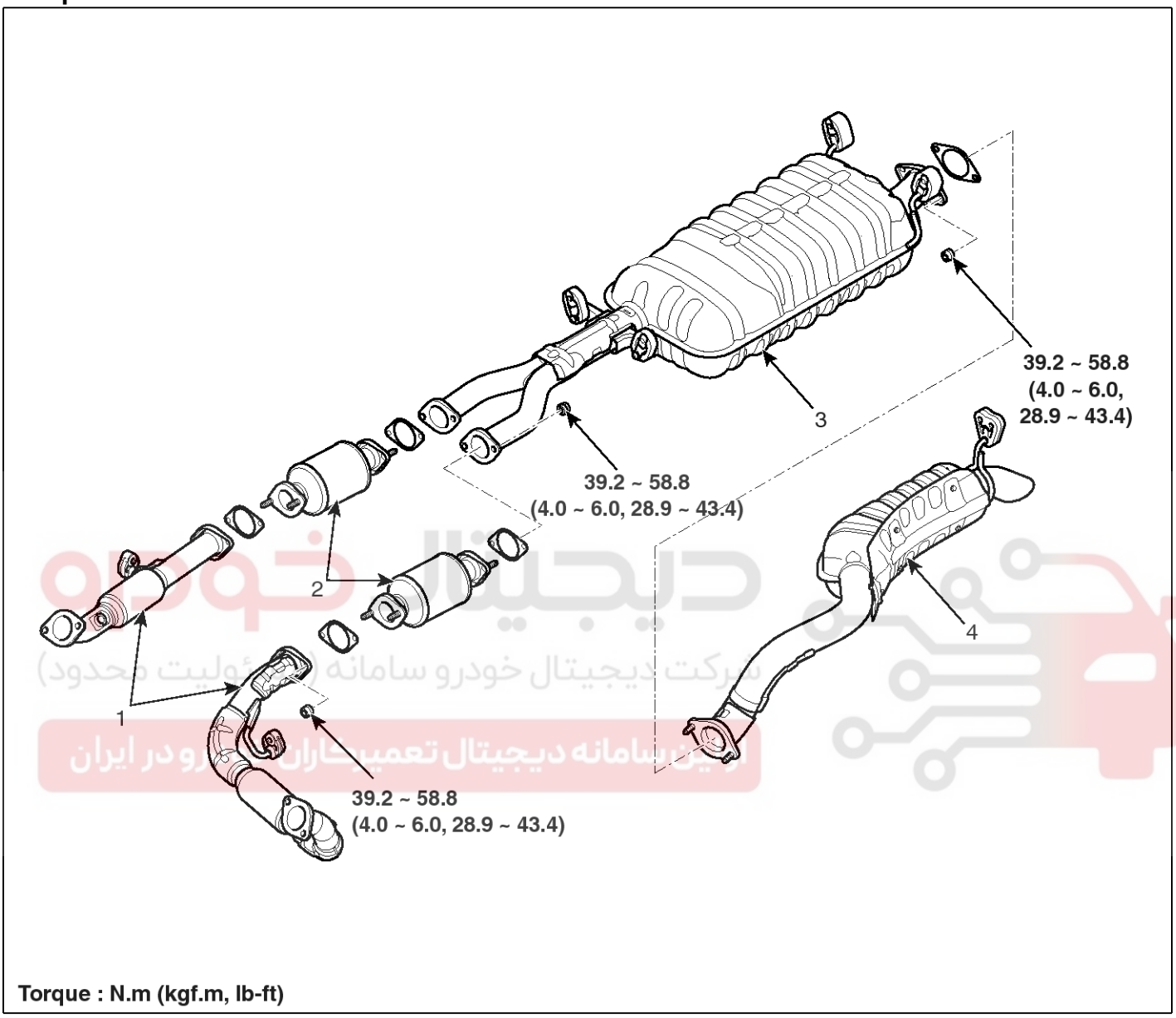
8. Reconnect the negative terminal to the battery.



SHMM19043N

Muffler

Components

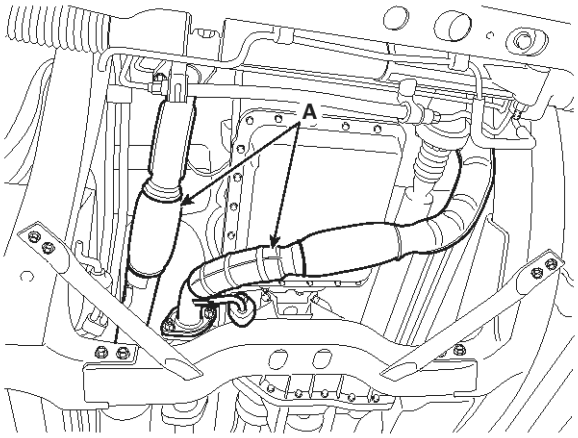


SHMM19335N

1. Front muffler
2. Catalytic converter
3. Main muffler
4. Tail pipe

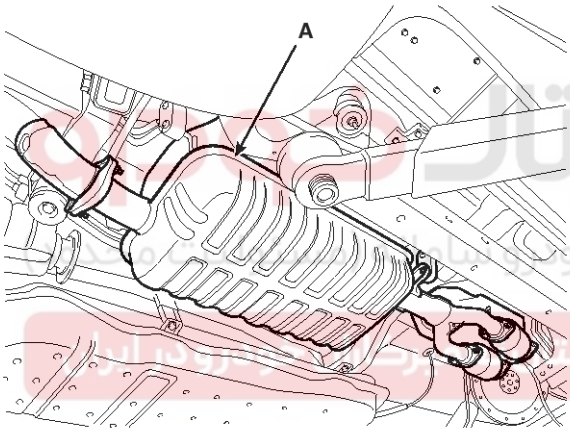
Removal

1. Remove the front muffler (A).



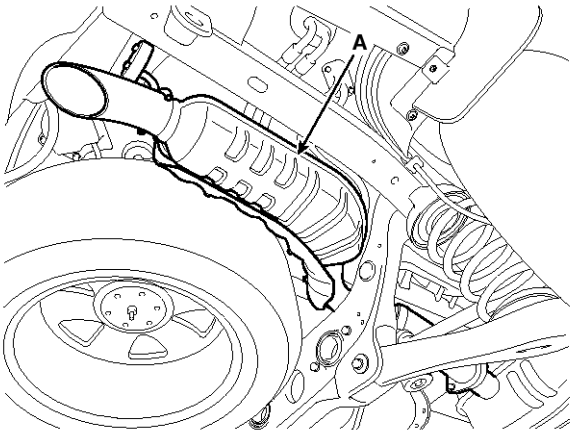
SHMM19157N

2. Remove the main muffler (A).



SHMM19138N

3. Remove the tail pipe (A).

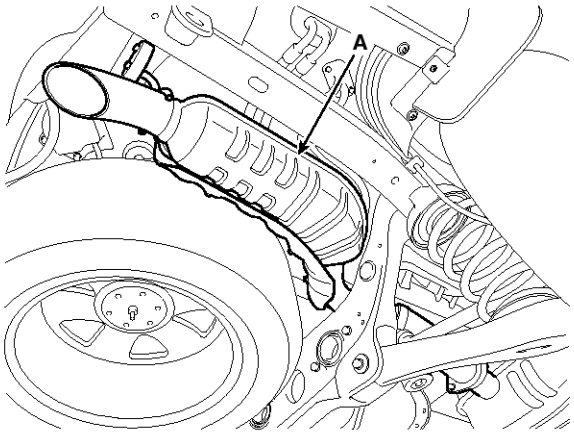


SHMM19139N

Installation

1. Install the tail pipe (A).

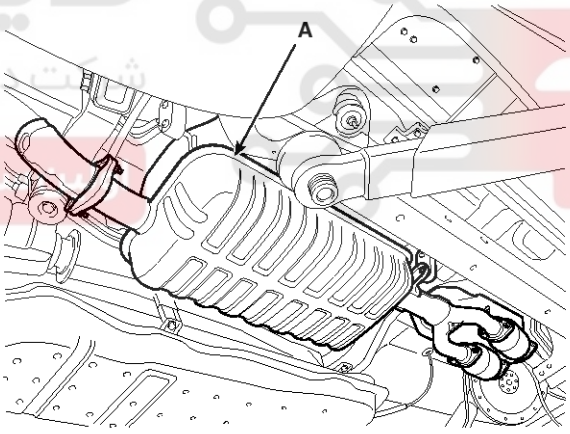
Tightening torque :
39.2 ~ 58.8Nm (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SHMM19139N

2. Install the main muffler (A).

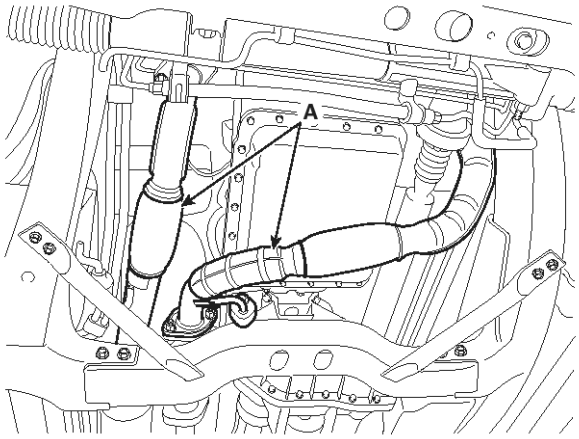
Tightening torque :
39.2 ~ 58.8Nm (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SHMM19138N

3. Install the front muffler (A).

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



SHMM19157N