General Information

SPECIFICATIONS

Description		Specifications	Limit
General			
Type		In-line, DOHC	
Number of cylinders		4	
Bore		77mm (3.0315in)	
Stroke		85.44mm (3.3638in)	
Total displacement		1,591 cc (97.09 cu.in)	
Compression ratio		10.5 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve	Opens	ATDC 10° / BTDC 40°	
	Closes	ABDC 63° / ABDC 13°	
Exhaust valve	Opens	BBDC 40°	
	Closes	ATDC 3°	
Cylinder head			
Flatness of gasket surface		Less than 0.05mm (0.0020in)	
Valve guide hole diameter (Intake, Exhaust)	STD	10.000 ~ 10.018mm (0.3937 ~ 0.3944in)	
	0.05 OS	10.050 ~ 10.068mm (0.3957 ~ 0.3964in)	
	0.25 OS	10.250 ~ 10.268mm (0.4035 ~ 0.4043in)	
	0.50 OS	10.500 ~ 10.518mm (0.4134 ~ 0.4141in)	
Camshaft			
Cam height	Intake	43.85mm (1.7264in)	
	Exhaust	42.85mm (1.6870in)	
Journal outer diameter (Intake, Exhaust)		22.964 ~ 22.980mm (0.9041 ~ 0.9047in)	
Camshaft cap oil clearance		0.020 ~ 0.057mm (0.0008 ~ 0.0022in)	0.1mm (0.0039in)
End play		0.10 ~ 0.20mm (0.0039 ~ 0.0079in)	
Valve			
Valve length	Intake	93.15mm (3.6673in)	
	Exhaust	92.8mm (3.6457in)	
Stem outer diameter	Intake	5.465 ~ 5.480mm (0.2152 ~ 0.2157in)	
	Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2154in)	
Face angle		45.25° ~ 45.75°	
Thickness of valve head (margin)	Intake	1.1mm (0.0433in)	0.8mm (0.0315in)
	Exhaust	1.26mm (0.0496in)	1.0mm (0.0394in)

Description		Specifications	Limit
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.0008 ~ 0.0019in)	0.10mm (0.0039in)
	Exhaust	0.030 ~ 0.054mm (0.0012 ~ 0.0021in)	0.15mm (0.0059in)
Valve guide			
Length	Intake	40.3 ~ 40.7mm (1.5866 ~ 1.6024in)	
	Exhaust	40.3 ~ 40.7mm (1.5866 ~ 1.6024in)	
Valve spring			
Free length		44.0mm (1.7323in)	
Out of squareness		Less than 1.5°	
Cylinder block			
Cylinder bore		77.00 ~ 77.03mm (3.0315 ~ 3.0327in)	
Flatness of gasket surface		Less than 0.05mm (0.0020in) / Less than 0.02mm (0.0008in) 100mm×100mm	
Piston			
Piston outer diameter		76.97 ~ 77.00mm (3.0303 ~ 3.0315in)	
Piston to cylinder clearance		0.020 ~ 0.040mm (0.0008 ~ 0.0016in)	
Ring groove width	No. 1 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in)	1.26mm (0.0496in)
	No. 2 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in)	1.26mm (0.0496in)
	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in)	2.05mm (0.0807in)
Piston ring			
Side clearance	No.1 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0028in)	0.1 mm (0.0039in)
	No.2 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0028in)	0.1 mm (0.0039in)
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in)	0.2 mm (0.0079in)
End gap	No. 1 ring	0.14 ~ 0.28mm (0.0055 ~ 0.0110in)	0.30mm (0.0118in)
	No. 2 ring	0.30 ~ 0.45mm (0.0118 ~ 0.0177in)	0.50mm (0.0197in)
	Oil ring	0.20 ~ 0.70mm (0.0079 ~ 0.0276in)	0.80mm (0.0315in)
Piston pin			
Piston pin outer diameter		18.001 ~ 18.006mm (0.7087 ~ 0.7089in)	
Piston pin hole inner diameter		18.016 ~ 18.021mm (0.7093 ~ 0.7095in)	
Piston pin hole clearance		0.010 ~ 0.020mm (0.0004 ~ 0.0008in)	
Connecting rod small end hole inner diameter		17.974 ~ 17.985mm (0.7076 ~ 0.7081in)	
Piston pin press-in load		500~1,500 kg (1,102 ~ 3,306 lb)	
Connecting rod			
Connecting rod big end inner diameter		45.000 ~ 45.018mm (1.7717 ~ 1.7724in)	
Connecting rod bearing oil clearance		0.032 ~ 0.052mm (0.0013 ~ 0.0020in)	0.060mm (0.0024in)
Side clearance		0.10 ~ 0.25mm (0.0039 ~ 0.0098in)	0.35m (0.0138in)

Description		Specifications	Limit
Crankshaft			
Main bearing oil clearance	No. 1, 2, 3, 4, 5	0.021 ~ 0.042mm (0.0008 ~ 0.0017in)	0.05mm (0.0020in)
End play		0.05 ~ 0.25mm (0.0020 ~ 0.0098in)	0.3mm (0.0118in)
Engine oil			
Oil quantity (Total)		3.7 L (3.91 US qt, 3.26 Imp qt)	When replacing a short engine or a block assembly
Oil quantity (Excluding oil filer)		3.0 L (3.17 US qt, 2.64 Imp qt)	When replacing an oil pan only
Oil quantity (Drain and refill including oil filter)		3.3 L (3.49 US qt, 2.90 Imp qt)	
Oil quality		5W-20 (Above SL / GF - 3)	
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		5.8 ~ 5.9L (6.13 ~ 6.23US qt., 5.10 ~ 5.19Imp qt.)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82 ± 1.5˚C (179.6 ± 2.7˚F)	
	Pull opening temperature	95˚C (203˚F)	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	MAX. 6.86 kpa(0.07kg/cm², 1.00 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20˚C (68˚F)	2.45±0.14 kΩ	
	80˚C (176˚F)	0.3222 kΩ	

TIGHTENING TORQUE

Item	Quantity	N.m	kgf.m	lb-ft
Cylinder block				
Engine support bracket bolts (engine side)	4	29.4 ~ 41.2	3.0 ~ 4.2	21.7 ~ 30.4
Ladder frame bolts	13	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Connecting rod cap bolt	8	(17.7~21.6) + (88 ~92°)	(1.8~2.2) + (88~92°)	(13.0~15.9) + (88 ~92°)
Crankshaft main bearing cap bolt	10	(17.7~21.6) + (88 ~92°)	(1.8~2.2) + (88~92°)	(13.0~15.9) + (88 ~92°)
Flywheel bolts(M/T)	6	71.6 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Drive plate bolts(A/T)	6	71.6 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Timing chain system				
Timing chain and oil pump assembly cover bolt(M6×20)	10	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain and oil pump assembly cover bolt(M6×38)	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain and oil pump assembly cover bolt(M8×22)	3	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Idler pulley assemlby bolt	1	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39.8
Timing chain tensioner arm bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Crankshaft bolt	1	127.5 ~ 137.3	13.0 ~ 14.0	94.0 ~ 101.3
Timing chain tensioner bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head				
Engine cover bolt	4	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Cylinder head cover bolt	16	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Camshaft bearing cap bolt(M6)	16	11.8 ~ 13.7	1.2 ~ 1.4	8.7 ~ 10.1
Camshaft bearing cap bolt(M8)	4	18.6 ~ 22.6	1.9 ~ 2.3	13.7 ~ 16.6
Cylinder head bolt	10	(17.7~21.6) + (90 ~95°) + (100~105 °)	(1.8~2.2) + (90~95°) + (100~105°)	(13.0~15.9) + (90 ~95°) + (100~105 °)
Cooling system				
Water pump pulley bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt	5	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water temperature control assembly mounting bolts	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water inlet fitting nut	2	18.6 ~ 23.5	1.9~ 2.4	13.7 ~ 17.4
Heater pipe mounting bolts/Nuts(M6)	B-1/N-2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7

Item	Quantity	N.m	kgf.m	lb-ft
Heater pipe mounting bolt(M8)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Engine coolant temperature sensor(ECTS)	1	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9
Gauge unit	1	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9
Lubrication system				
Oil filter	1	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6
Oil pan bolt	11	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pan drain plug	1	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Oil screen bolt	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Oil pressure switch	1	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Oil level gauge assembly mounting bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake and exhaust system				
Intake manifold and cylinder head mounting nut	5	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust manifold and cylinder head mounting nut	9	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
Oxygen sensor mounting	2	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.2
Exhaust manifold heat cover	6	16.7 ~ 21.6	1.7 ~ 2.2	12.3 ~ 15.9
Head cover protector and cylinder head mounting bolts	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Exhaust manifold and cylinder block, ladder frame mounting bolts	4	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.2
Air cleaner lower cover mounting	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Exhaust manifold and front muffler mounting nut	2	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.2
Front muffler and catalytic convertor mounging nut	2	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.2
Center muffler and main muffler mounting nut	2	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.2

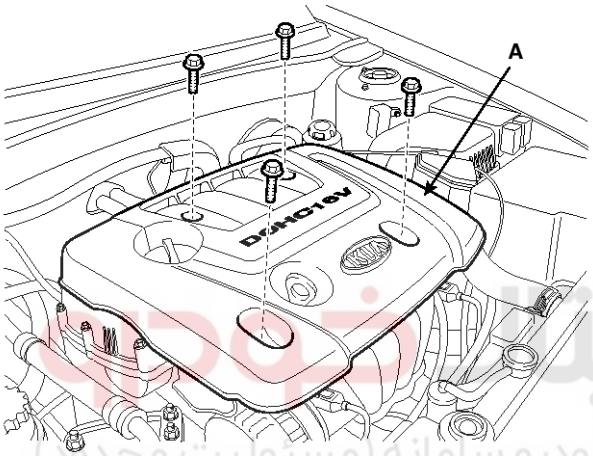
INSPECTION

COMPESSION PRESSURE

NOTICE

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

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



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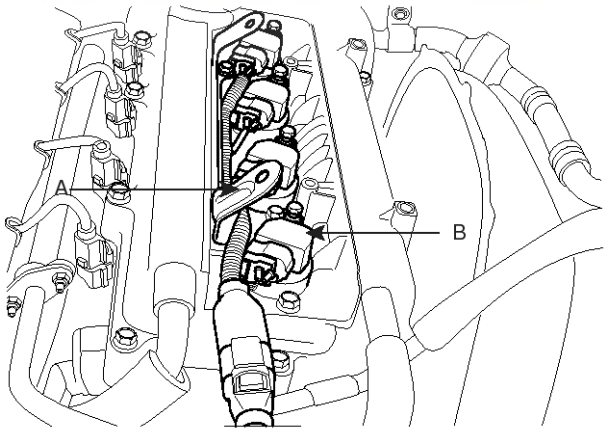
3. Remove the engine cover bracket(A) and the ignition coil(B).



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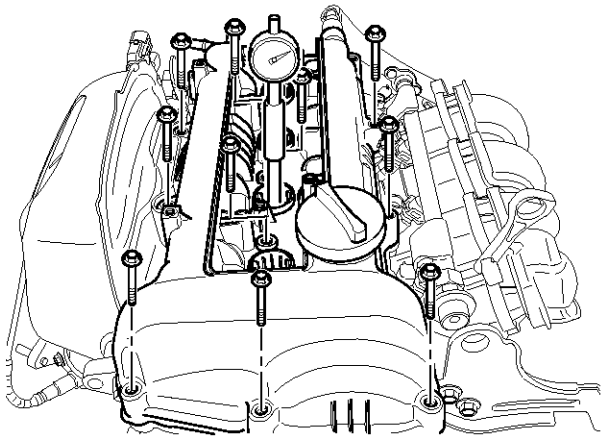
4. Remove the spark plugs.

   Using a 16mm plug wrench, remove the 4 spark plugs.

5. Check the cylinder compression pressure.
   1) Insert a compression gauge into the spark plug hole.



SHDEM6180D

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

      NOTICE

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

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

      NOTICE

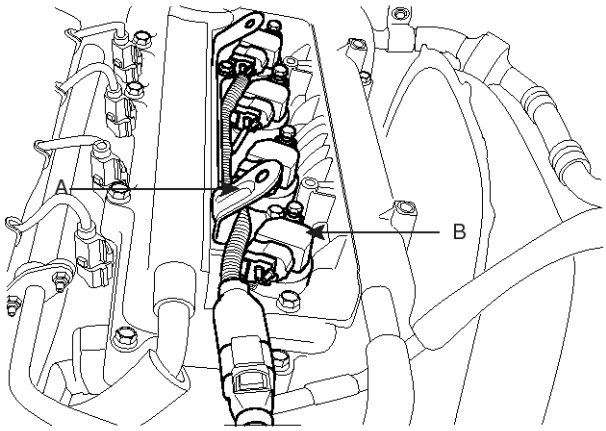
      This measurement must be done in as short time as possible.

Compression pressure

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

   5) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat step 1) through 3) for cylinders with low compression.
      - 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.

6. Reinstall the spark plugs.
7. Install the engine cover bracket(A) and the ignition coil(B).



SHDEE6001D

8. Install the engine cover.

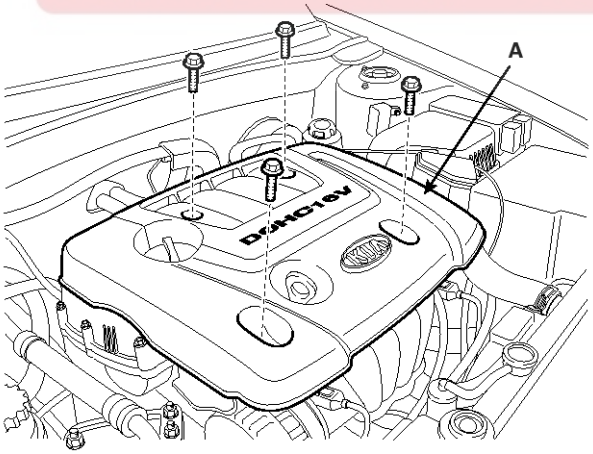
Tightening torque :
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)

VALVE CLEARANCE INSPECTION AND ADJUSTMENT

NOTICE

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

1. Remove the engine cover(A).



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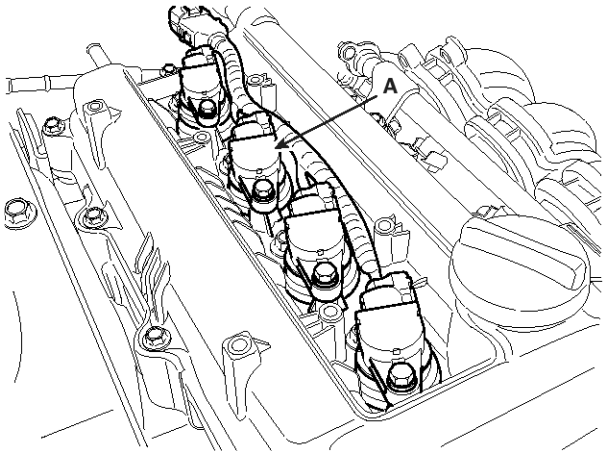
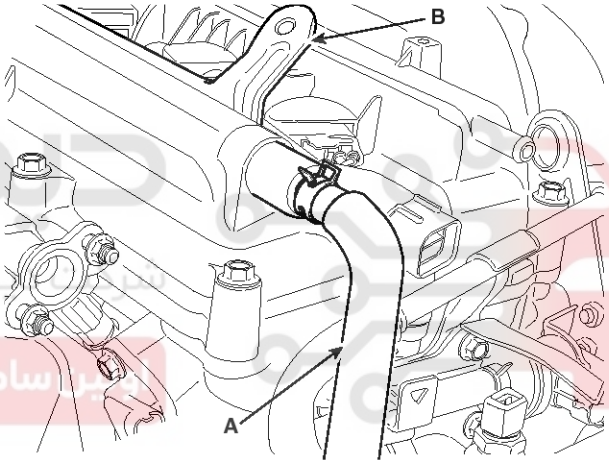
2. Remove the cylinder head cover.
   a. Disconnect the ignition coil(A).



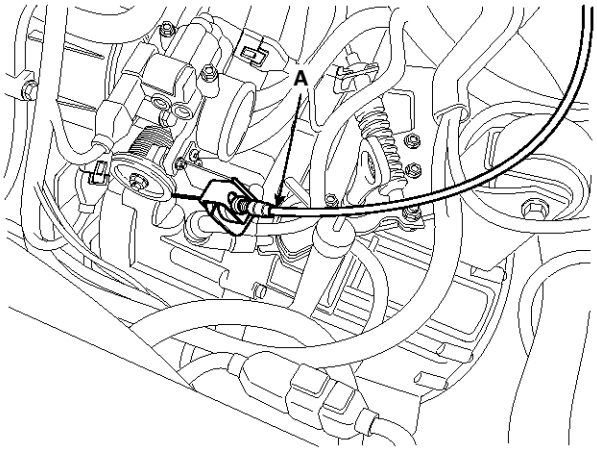
SHDEM6030D

   b. Disconnect the P.C.V hose(A) and the breather hose from the cylinder head cover with the engine bracket(B).



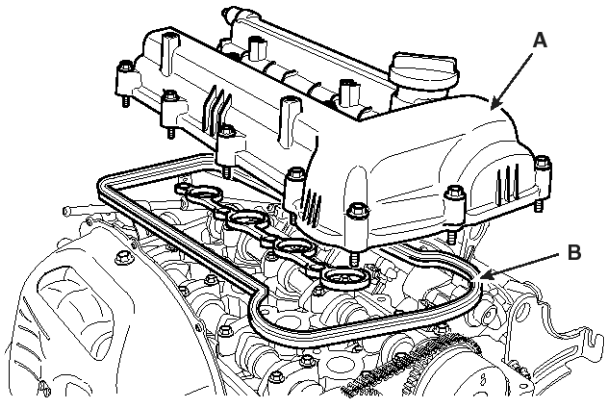
SHDEM6029D

   c. Disconnect the accelerator cable from cylinder head.



SLDEM7002D

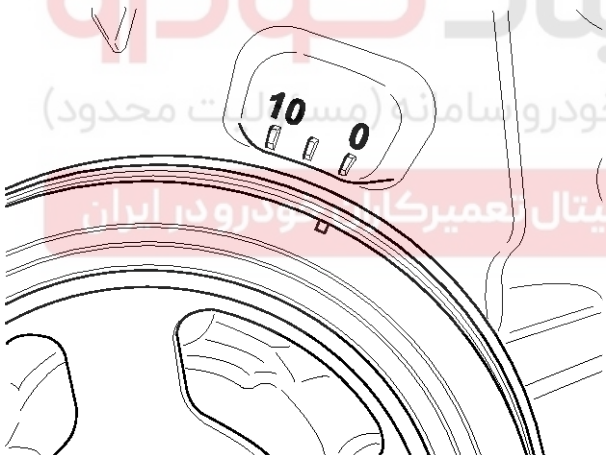
d. Loosen the cylinder head cover bolts and then remove the cover(A).



SHDEM6032D

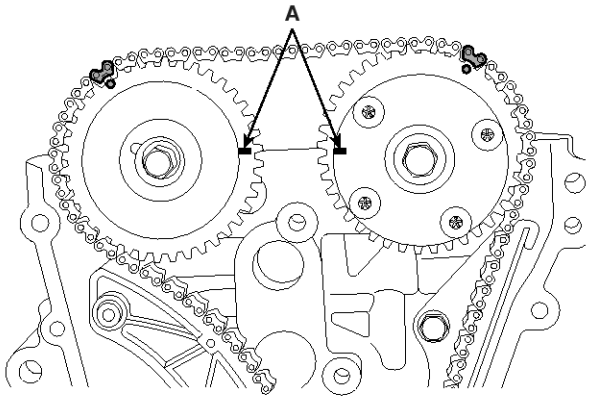
⚠CAUTION
Do not reuse the disassembled gasket.

3. Set No.1 cylinder to TDC/compression.
   a. Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover.



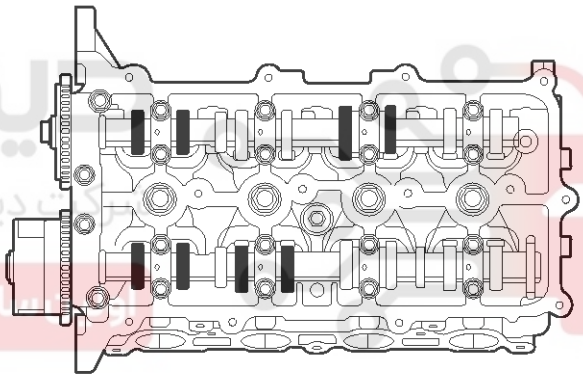
SHDEM6033D

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



SLDEM7120D

4. Inspect the valve clearance.
   a. Check only the intake valves of the 1st and 2nd cylinders and exhaust valves of the 1st and 3rd cylinders for their clearance.



NO.1 Cylinder TDC/Compression

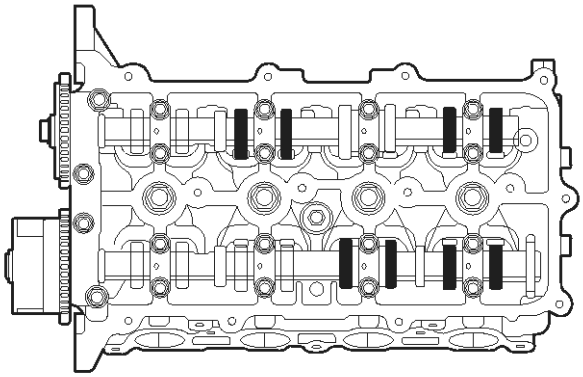
SLDEM7101L

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

Valve clearance specification (Engine coolant temperature : 20˚C [68˚F])
Limit
Intake : 0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust : 0.15 ~ 0.35mm (0.0059 ~ 0.0138in.)

b. Turn the crankshaft pulley one revolution (clockwise 360°) and align its groove with timing mark of the timing chain cover.

c. Check the intake valves of the 3rd and 4th cylinders and exhaust valves of the 2nd and 4th cylinders for their clearance.



NO.4 Cylinder TDC/Compression

SLDEM7102L

5. Adjust the intake and exhaust valve clearance.

a. Set the No.1 cylinder to the TDC/compression position.

b. Mark on the timing chain and camshaft timing sprockets.

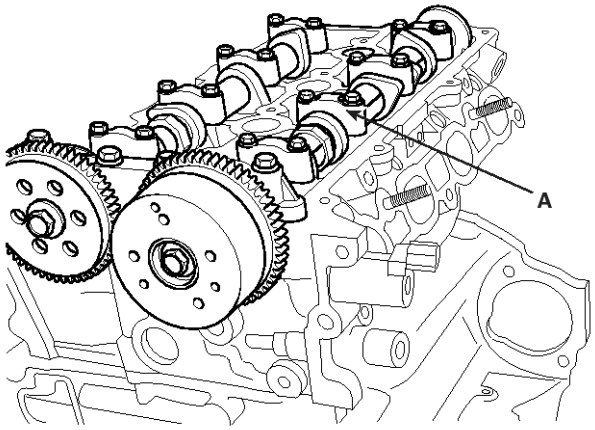
c. Remove the service hole bolt of the timing chain cover.

⚠CAUTION

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

d. Insert a thin rod in the service hole of the timing chain cover and release the ratchet.

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



SHDEM6023L

f. Remove the exhaust camshaft sprocket.

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

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

⚠CAUTION

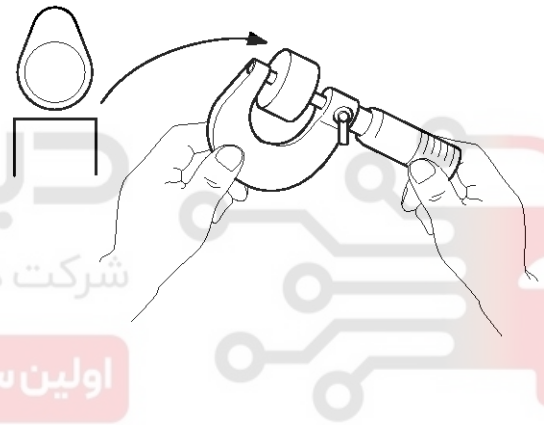
When disconnecting the timing chain from the camshaft timing sprocket, hold the timing chain.

i. Tie a timing chain with a string.

⚠CAUTION

Be careful not to drop anything inside timing chain cover.

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



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

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

l. Select a new tappet with a thickness as close as possible to the caculated value.

NOTICE

Shims are available in 41size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.600mm (0.1417in.)

m. Place a new tappet on the cylinder head.

n. Hold the timing chain, and place the intake camshaft and timing sprocket assembly.

o. Align the matchmarks on the timing chain and camshaft timing sprocket.

p. Install the intake and exhaust camshaft.

q. Install the front bearing cap.

r. Install the sevice hole bolt.

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

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

t. Recheck the valve clearance.

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

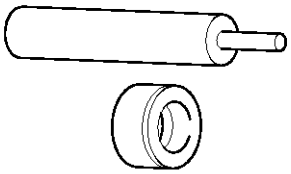
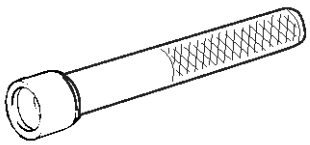
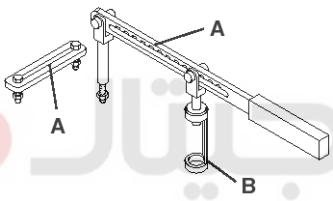
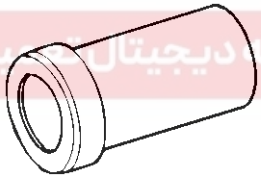
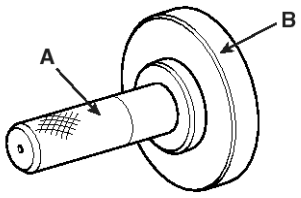
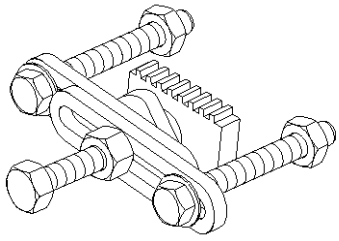
TROUBLESHOOTING

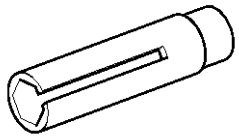
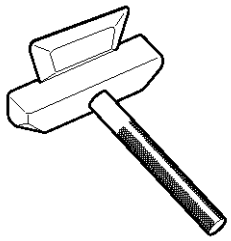
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Loose or improperly installed engine flywheel.	Repair or replace the flywheel as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression . 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 can cause the valve not to close properly.)	Repair or replace as required.
	Excessive worn or mis-aligned timing chain.	Replace the timing chain and sprocket as required.
	Worn camshaft lobes.	Replace the camshaft and MLA.
Engine misfire with coolant consumption.	• Faulty cylinder head gasket and/or cracking or other damage to the cylinder head and engine block cooling system. • 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, valve 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)	Inspection 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 camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair as required.
	Stuck valves. (Carbon on the valve stem or valve seat may cause the valve to stay open.)	Inspect the valves and valve guides, then repair as required.
Lower engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace damaged components as required.
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	Inspect the oil pan. 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 and cylinder bore. Repair as required.
	Excessive piston pin-to-bore 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. • The crankshaft journal.
	Excessive crankshaft bearing clearance.	Inspect the following components and repair as required. • The crankshaft bearings. • The crankshaft journals.
	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 journals. • The cylinder block crankshaft bearing bore.
Engine will not crank. (crankshaft will not rotate)	Hydro 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 gears.	Inspect timing chain and gears. Repair as required.
	Foreign 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 or replace as required.
	Bent or broken connecting rod.	Inspect connecting rods. Repair or replace as required.
	Broken crankshaft.	Inspect crankshaft. Repair or replace as required.

SPECIAL SERVICE TOOLS

Tool (Number and name)	Illustration	Use
Valve guide remover, installer (09221-2B100)		Removal and installation of the valve guide
Valve stem oil seal installer (09222-2B100)		Installation of the valve stem oil seal
Valve spring compressor and holder A : (09222-3K000) B : (09222-3K100)		Removal and installation of the intake or exhaust valve
Camshaft oil seal installer (09221-21000)		Installation of the camshaft oil seal
Crankshaft rear oil seal installer A : (09231-H1100) B : (09231-2B200)		Installation of the crankshaft rear oil seal
Ring gear stoppper (09231-2B100)		Installation of crankshaft pulley bolt

Tool (Number and name)	Illustration	Use
Engine coolant temperature sensor socket wrench (09221-25100)		Removal and installation of engine coolant sensor
Oil pan remover (09215-3C000)		Removal of oil pan
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method

Engine And Transaxle Assembly

REMOVAL

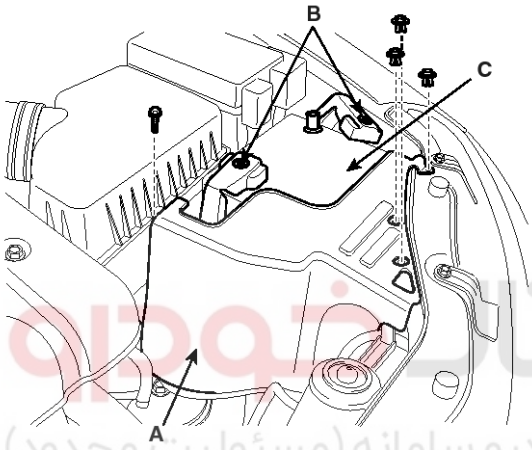
CAUTION

- **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.*

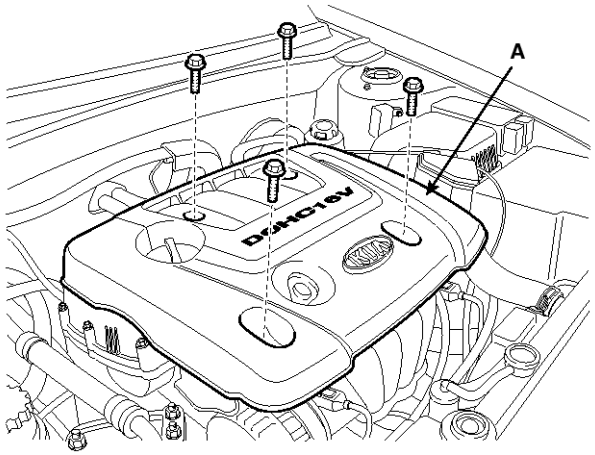
1. Disconnect the battery terminal(B) and remove the heat shield(A), the battery(C).



SLDM16100D

2. Remove the engine cover(A).

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

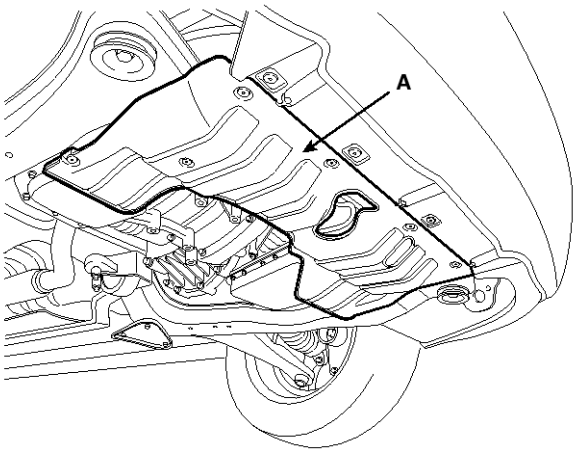


SLDEM7001D

CAUTION
Install the cover surely before driving.

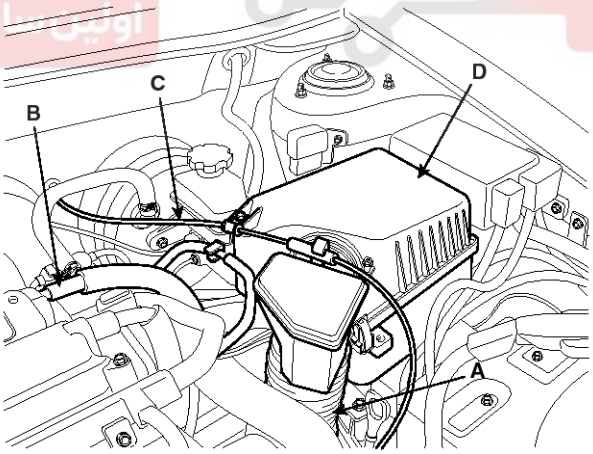
3. Remove the radiator cap to speed draining.
4. Remove the under cover(A).

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



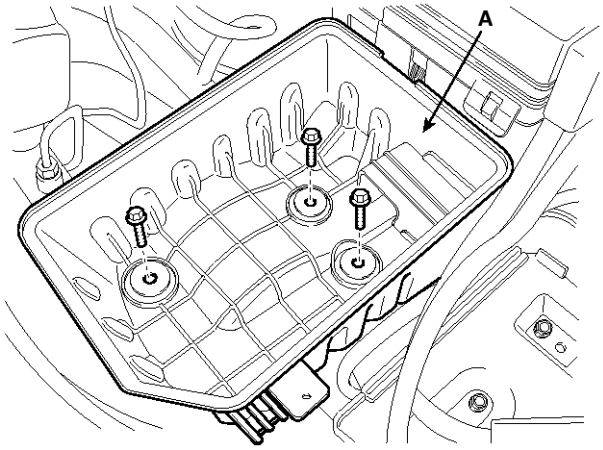
SLDEM7003D

5. Loosen the radiator plug and the drain the engine coolant.
6. Remove the air cleaner.
   1) Disconnect the air cleaner intake hose(A) and bleeder hose(B).
   2) Disconnect the accelerator cable(C) from the air cleaner.
   3) Remove the air cleaner upper cover(D).



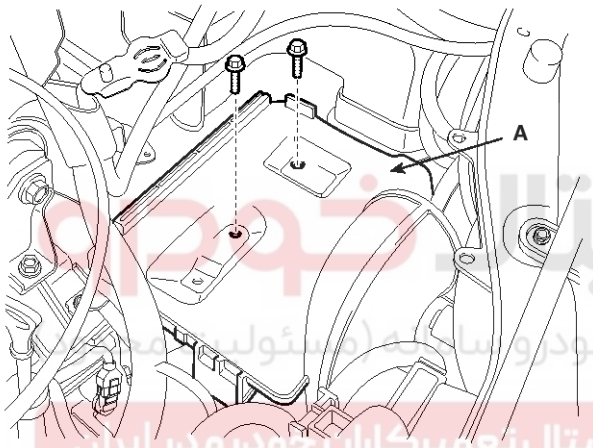
SLDEM7004D

   4) Remove the air cleaner lower cover(A).



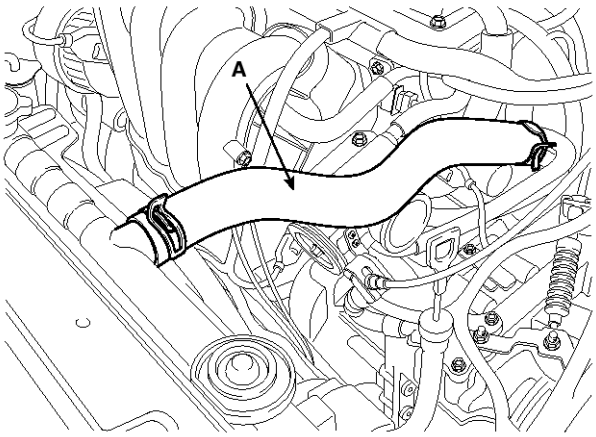
SLDEM7005D

7. Remove the battery tray(A).

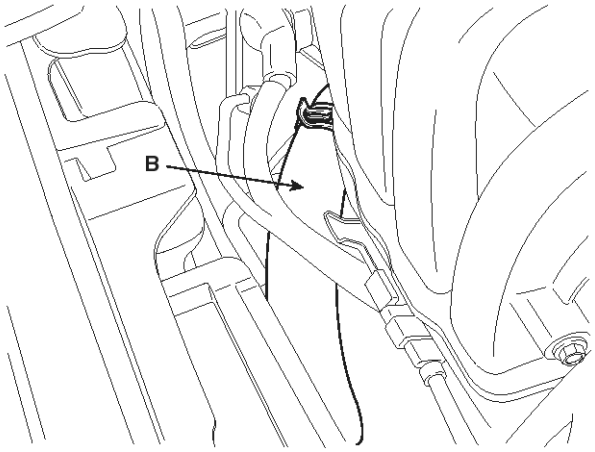


SLDEM7006D

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

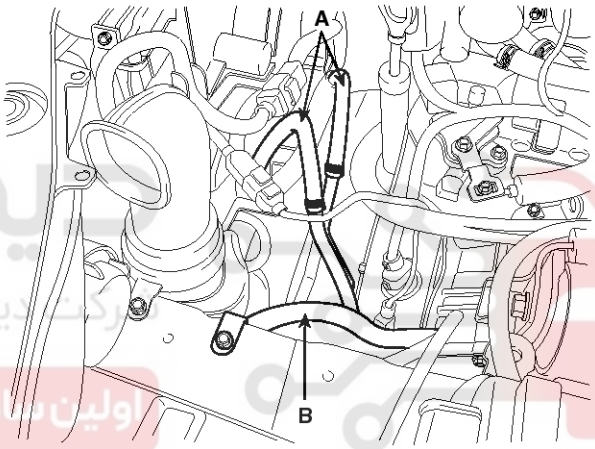


SLDEM7007D



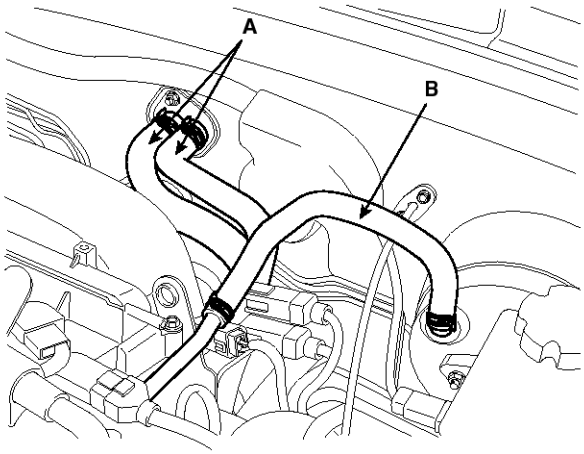
SLDEM7201L

9. Disconnect the automatic transaxle fluid (ATF) oil cooler hoses(A) and the transaxle ground line(B).



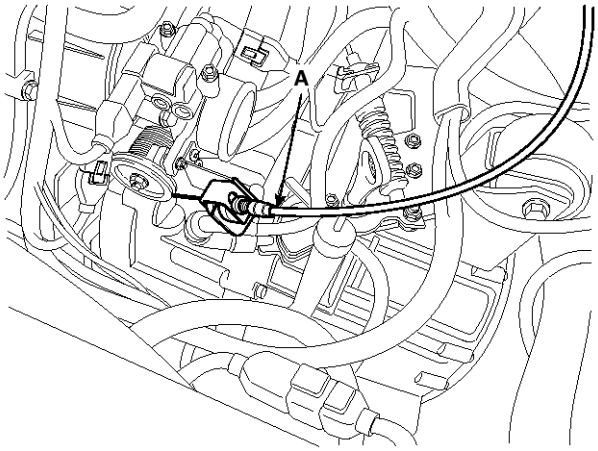
SLDEM7015D

10. Disconnect the front connector.
11. Disconnect the heater hoses(A) and brake booster hose(B).



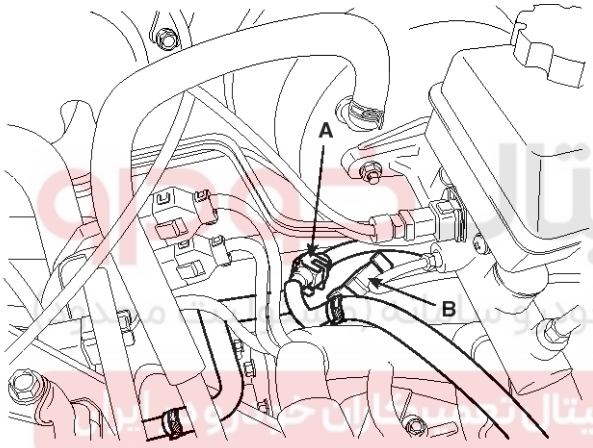
SLDEM7013D

12. Disconnect the accelerator cable(A).



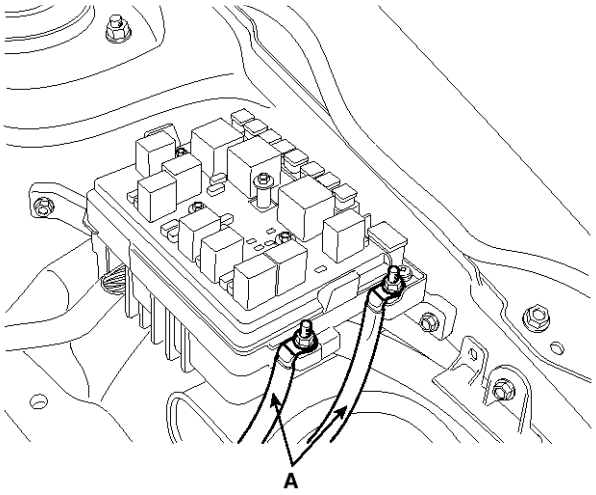
SLDEM7002D

13. Disconnect the fuel hose(A) and the hose(B) of the positive crankcase ventilation (PCV) side.



SLDEM7014D

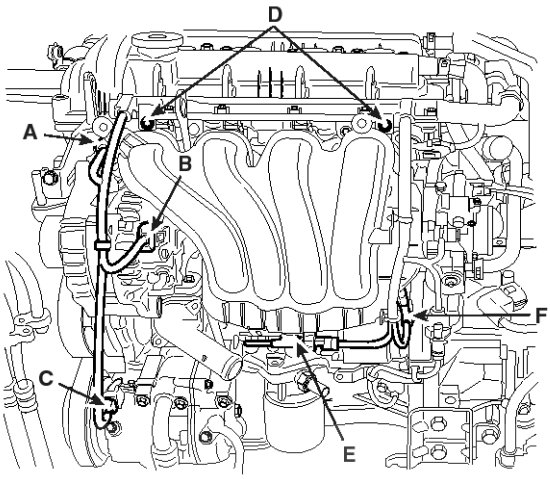
14. Remove the fuse box cover.
15. Disconnect the terminal(A) from the fuse box



SLDEM7016D

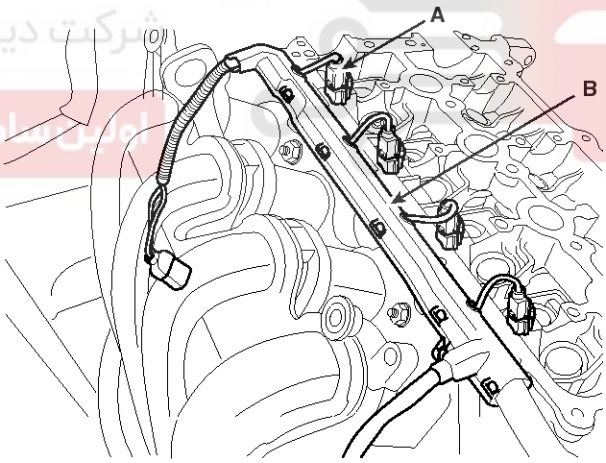
16. Disconnect the engine wiring

1) Disconnect the oil control valve (OCV) connector(A) and the alternator connector(B).
2) Disconnect the A/C compressor connector(C).
3) Remove the harness mounting bolts(D).
4) Disconnect the knock snesor(E).
5) Disconnect map sensor connector(F).



SHDEM6065D

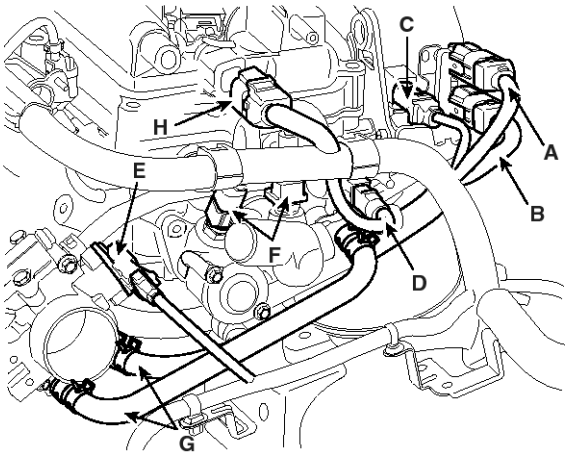
6) Disconnect fuel injector connector(A) and harness bracket(B).



SHDEM6170D

7) Disconnect the front(A) and the rear(B) oxygen sensor connector.
8) Disconnect the ignition coil condenser connector(C) and purge control solenoid valve(PCSV) connector(D).
9) Disconnect the throrrle position sensor connector(E).
10) Disconnect the engine coolant temperature sensor(ECTS) connector(F) and the water hose(G).

11) Disconnect the ignition coil connector(H).

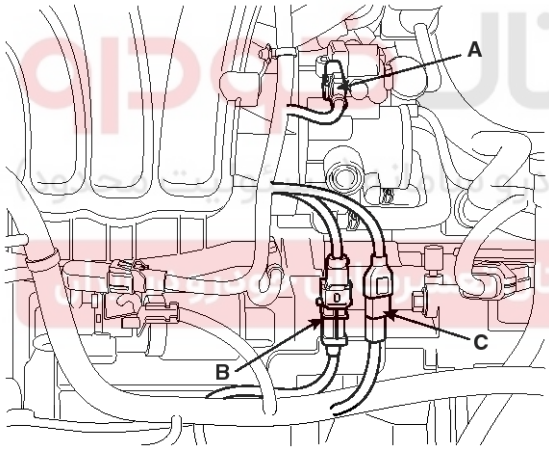


SLDEM7101D

12) Disconnect the idle speed sensor(A).

13) Disconnect the crankshaft position sensor(CKP) sensor(B).

14) Disconnect the battery connector(C).



SLDEM7017D

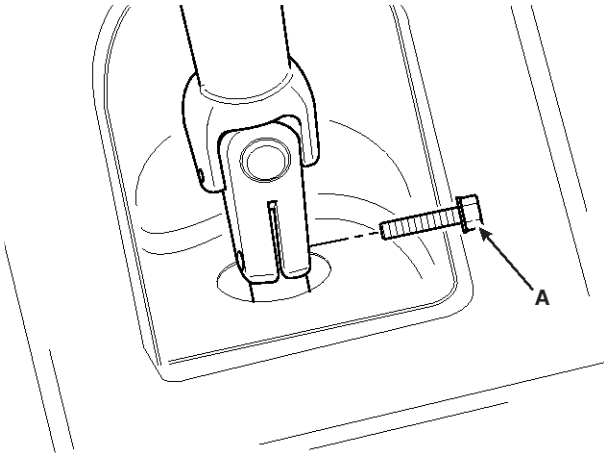
17. Disconnect the transaxle control cable(A). (Refer to Transaxle control system in MT or AT Group).

18. Recover refrigerant and remove the high & low pressure pipe.

(Refer to Air conditioner compressor in HA Group).

19. Remove the power steering hose and connector. (Refer to ST Group).

20. Remove the steering column mounting bolt(A).



SHDEM6017D

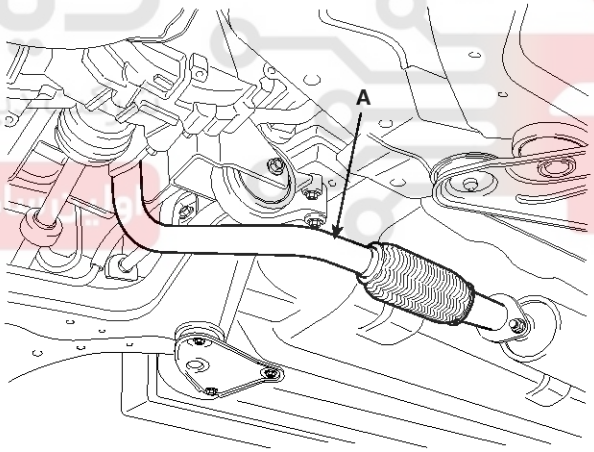
21. Remove the front wheels and tires.

22. Disconnect the stabilizer bar link and remove the mounting bolts from the lower arm and the front axles.(Refer to SS groub)

23. Remove the front muffler(A).

Tightening torque :

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



SLDEM7018D

24. Support the engine and transaxle assembly with a jack.

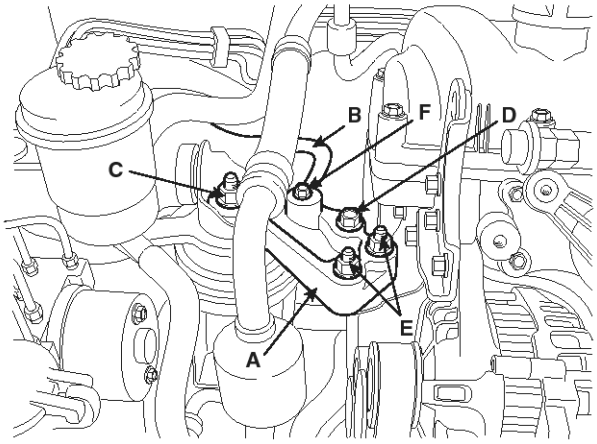
25. Remove the engine mounting support bracket(A) and the ground line(B).

Tightening torque :

Nut (C): 58.8 ~ 83.4N.m (6.0 ~ 8.5kgf.m, 43.4 ~ 61.5lb-ft)

Bolt, nuts(D,E): 49.0 ~ 58.8N.m (5.0 ~ 6.0kgf.m, 36.2 ~ 43.4lb-ft)

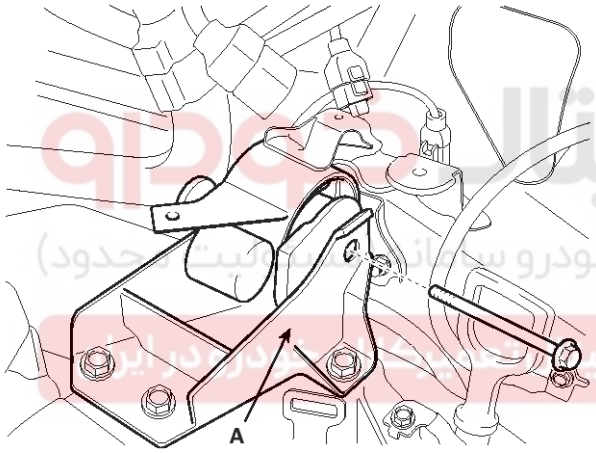
Bolt(F): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SLDEM7103L

26. Remove the transaxle mounting bracet(A).

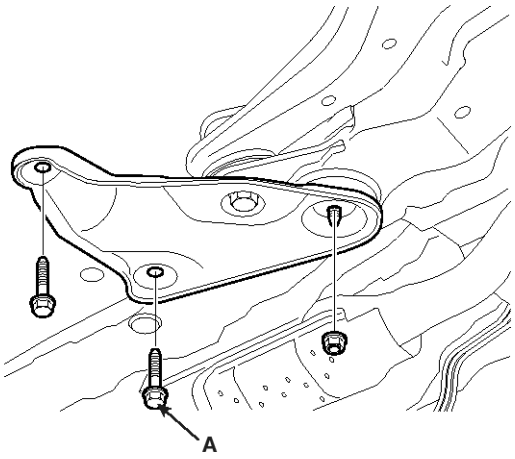
Tightening torque :
58.8 ~ 83.4N.m (6.0 ~ 8.5kgf.m, 43.4 ~ 61.5lb-ft)



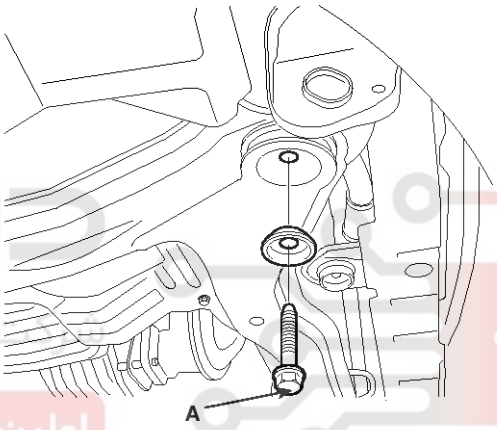
SLDEM7019D

27. Remove the sub frame bolts and nuts.

Tightening torque :
49.0 ~ 63.7N.m (5.0 ~ 6.5kgf.m, 36.2 ~ 47.0lbf.ft)



ECKD617A



ECKD618A

INSTALLATION

Installation is in the reverse order of removal.

Perform the following :

- Adjust the shift cable.
- Adjust the throttle cable.
- Refill the engine with engine oil.
- Refill the transaxle with fluid.
- Refill the radiator and reservoir tank with engine coolant.
- Place the heater control knob on "HOT" position.
- Bleed air from the cooling system
  - Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
  - Turn Off engine. Check the coolant level and add coolant if needed.

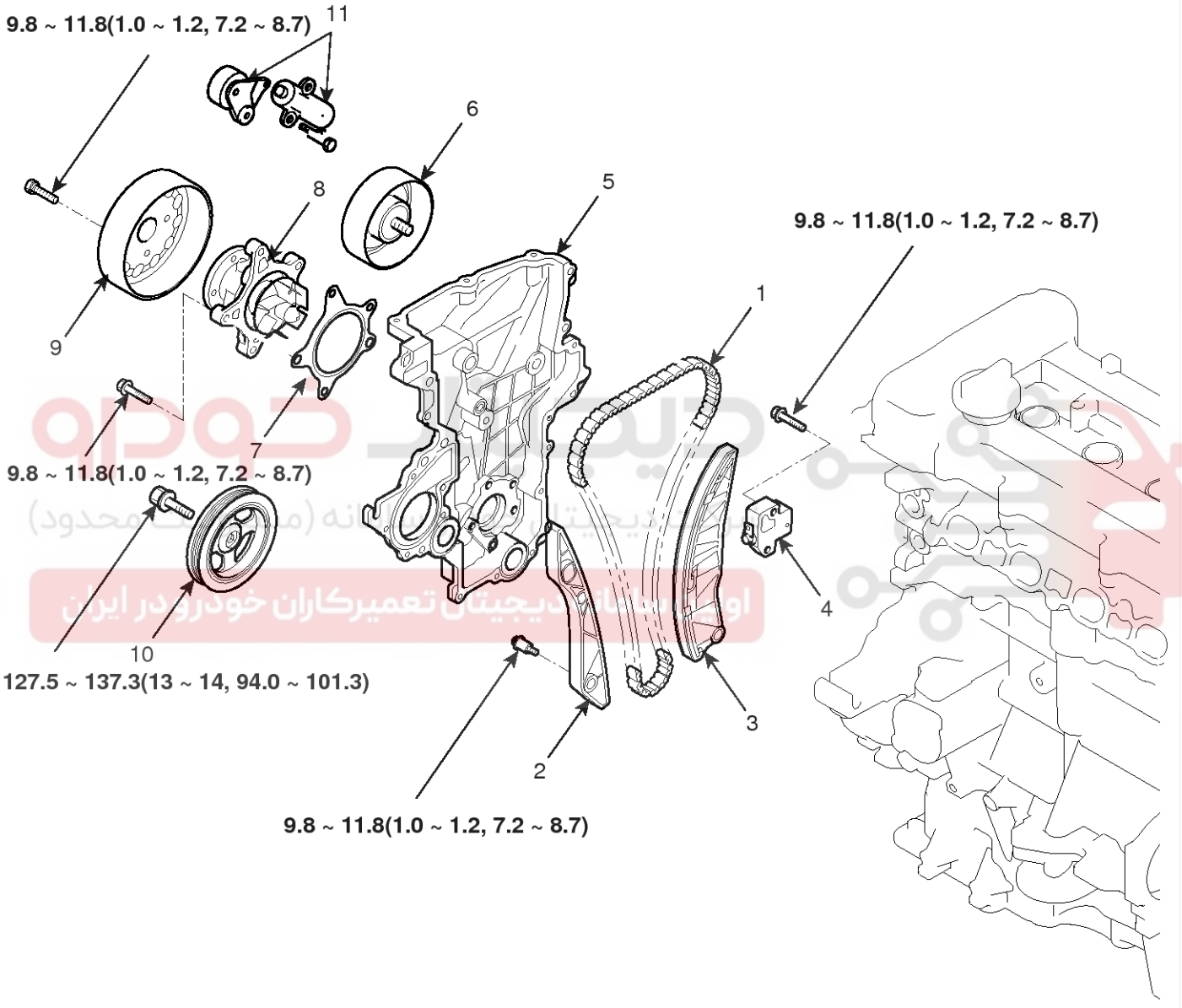
    This will allow trapped air to be removed from the cooling system.
  - Put the radiator cap on tightly, then run engine again and check for leaks.
- Clean the battery posts and cable terminals with sandpaper, assemble them and then apply grease to prevent corrosion.
- Inspect for fuel leakage.
  - After assembling fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump could run for approximately two seconds and fuel line could be pressurized.
  - Repeat this operation two or three times and check for fuel leakage at any point in the fuel line.

Timing System

Timing System

Timing Chain

COMPONENTS



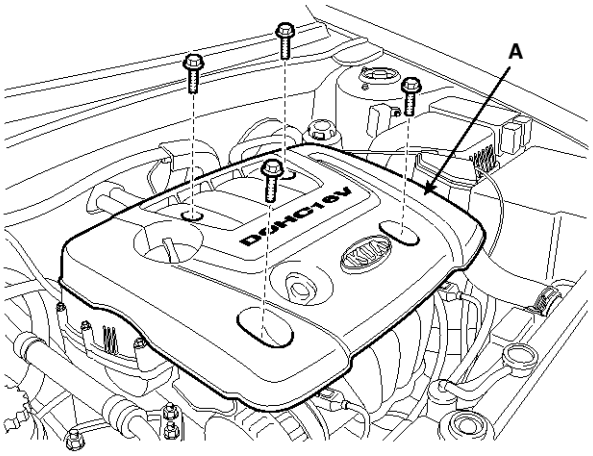
TORQUE : N.m (kgf.m, lb-ft)

1. Timing chain
2. Timing chain guide
3. Timing chain arm
4. Timing chain auto tensionr
5. Timing chain cover
6. Draive belt idler
7. Water pump gasket
8. Water
9. Water pump pulley
10. Crank shaft pulley
11. Dirve belt auto tesnioner

SHDM27001L

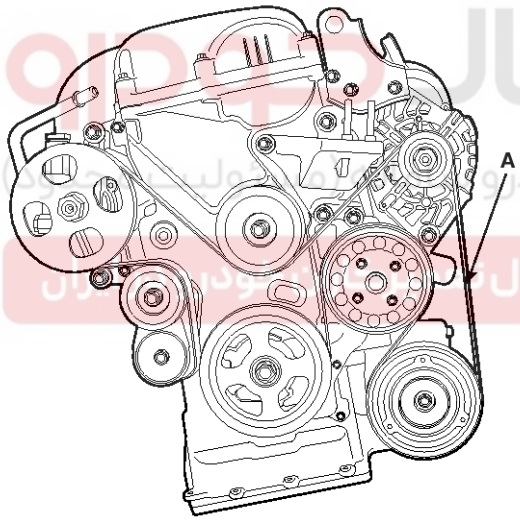
REMOVAL

1. Remove the engine cover(A).



SLDEM7001D

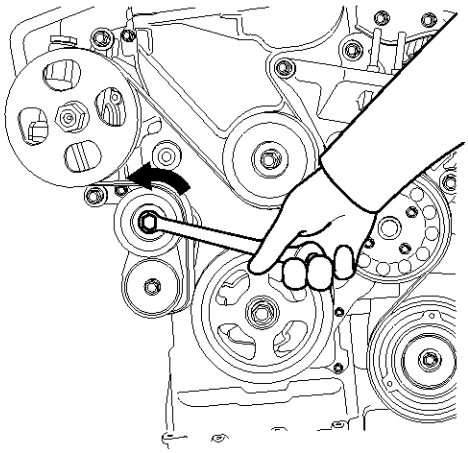
2. Loosen the water pump mounting bolt and the drive idler mounting bolt.
3. Remove the alternator drive belt(A).



SLDEM7009D

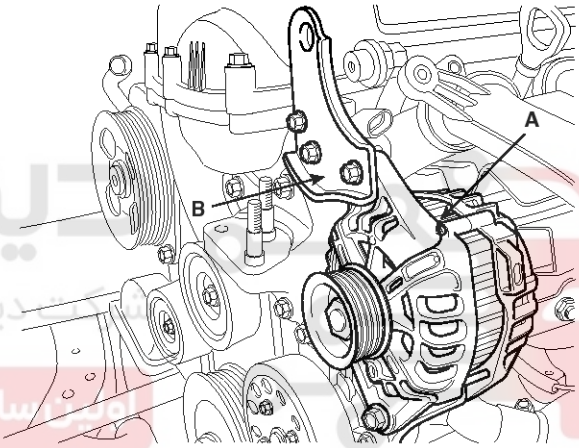
NOTICE

Remove the drive belt by turning the autotensioner counterclockwise.



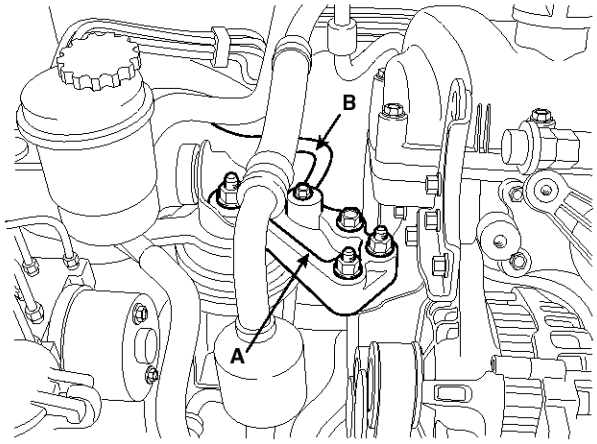
SLDEM7010D

4. Remove the alternator(A) and bracket(B). (Refer to Altemator in EE Group).



SLDEM7011D

5. Remove the RH front wheel.
6. Remove the engine mounting bracket(A) and the ground line(B).

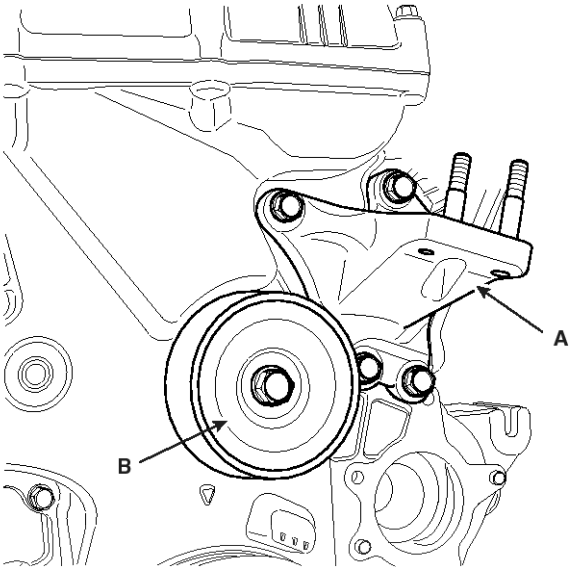


SLDEM7012D

NOTICE

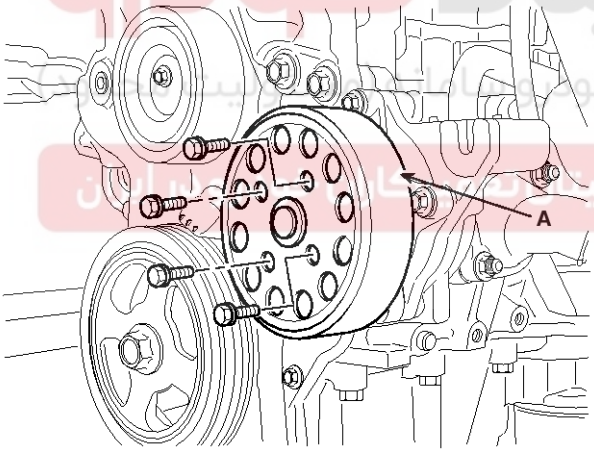
Support the engine with a jack.

7. Remove the engine support bracket(A) and the drive belt idle(B).



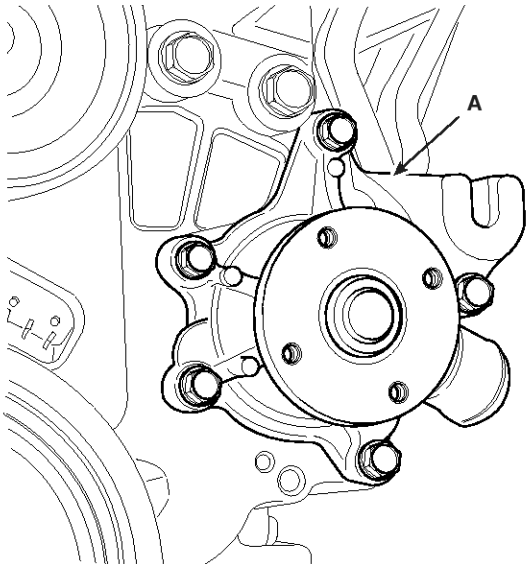
SLDEM7108D

8. Remove the water pump pulley(A).



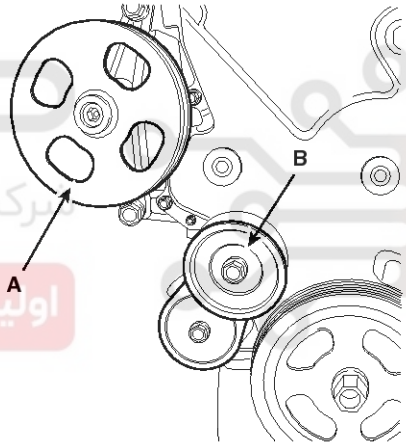
SHDEM6024D

9. Remove the water pump(A).



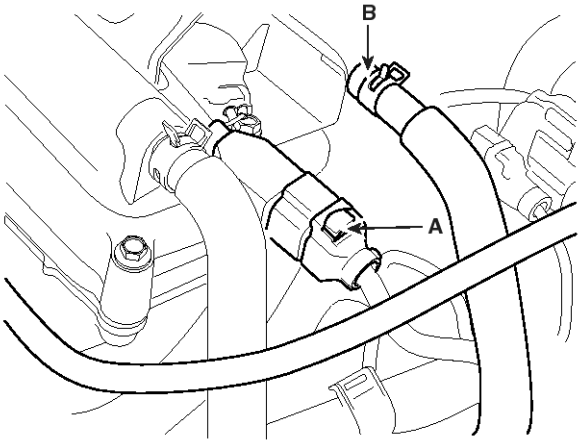
SHDEM6025D

10. Remove the power steering and the drive belt auto-tensioner(B).



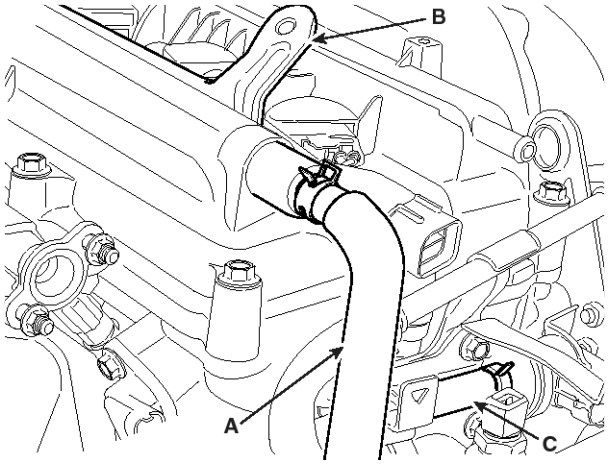
SLDEM7026D

11. Disconnect the ignition coil connector(A) and the breather hose(B).



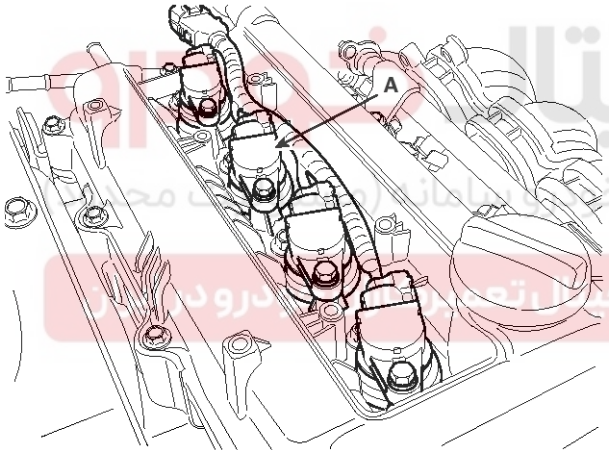
SHDEM6041L

12. Disconnect the positive crankcase ventilation(PCV) hose(A), the engine cover bracket(B) and purge control solenoid valve(PCSV) hose(C).



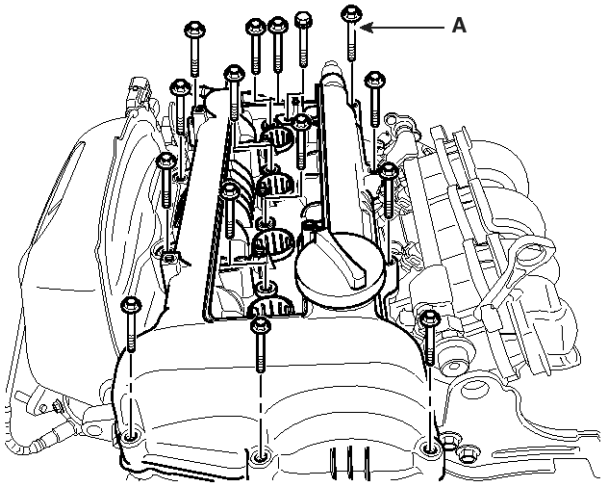
SHDEM6042L

13. Remove the ignition coils(A).



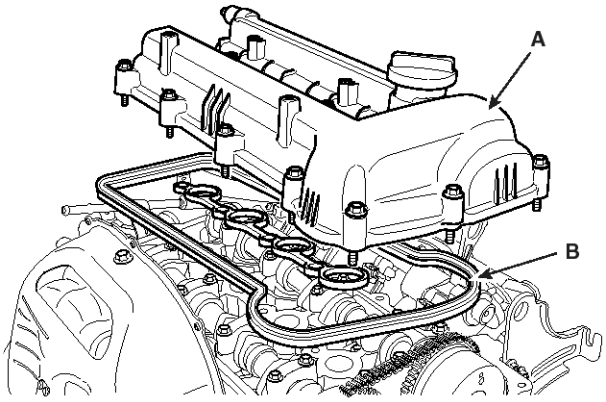
SHDEM6030D

14. Remove the cylinder head cover bolts(A).



SHDEM6160D

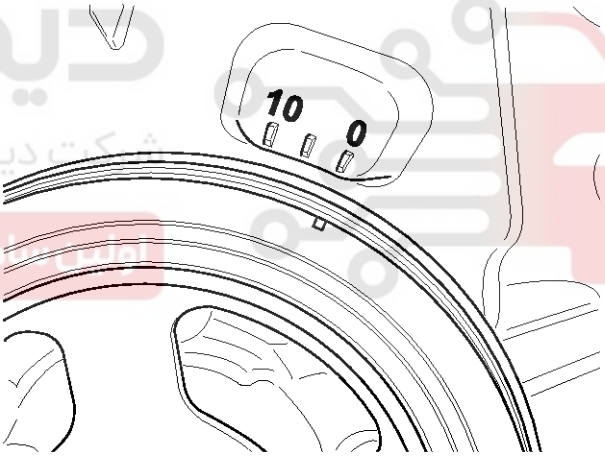
15. Remove the cylinder head cover(A) with its gasket(B).



SHDEM6032D

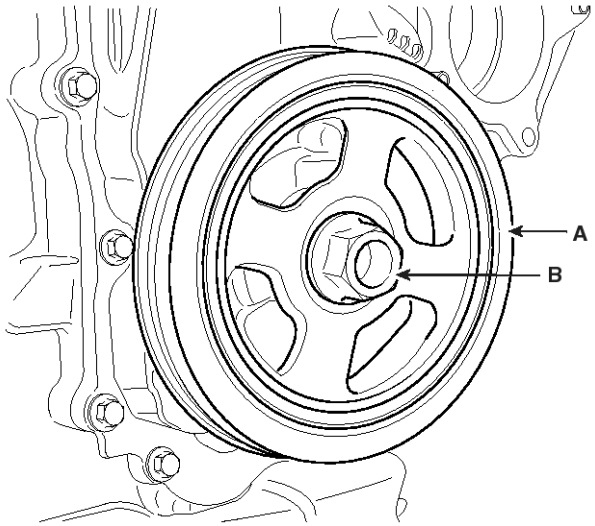
16. Remove the side cover.

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



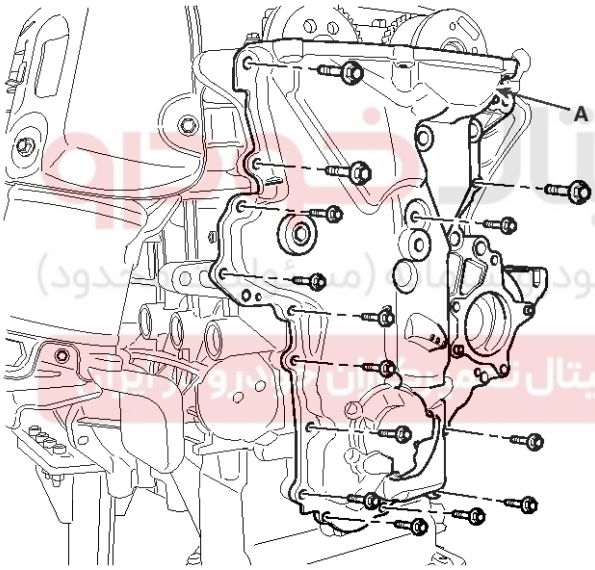
SHDEM6033D

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



SHDEM6028D

19. Remove the timing chain cover(A).

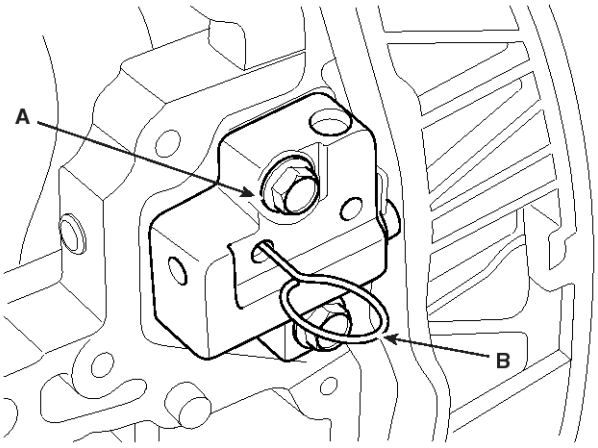


SHDEM6035D

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

    ⚠CAUTION
    Put paint marks on the camshaft and the crankshaft sprockets aligning timing before removing the timing chain.

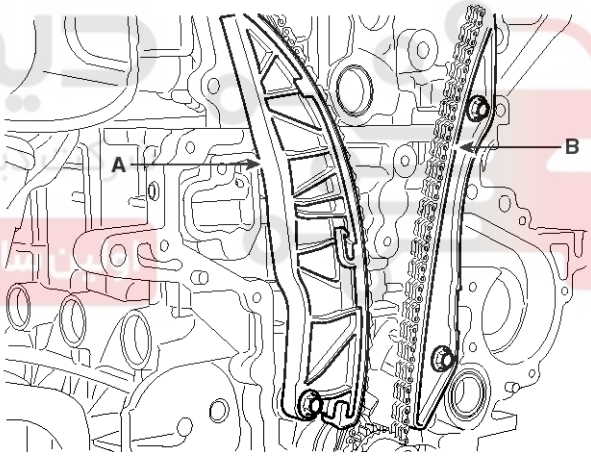
21. Remove the hydraulic tensioner(A).



SHDEM6072D

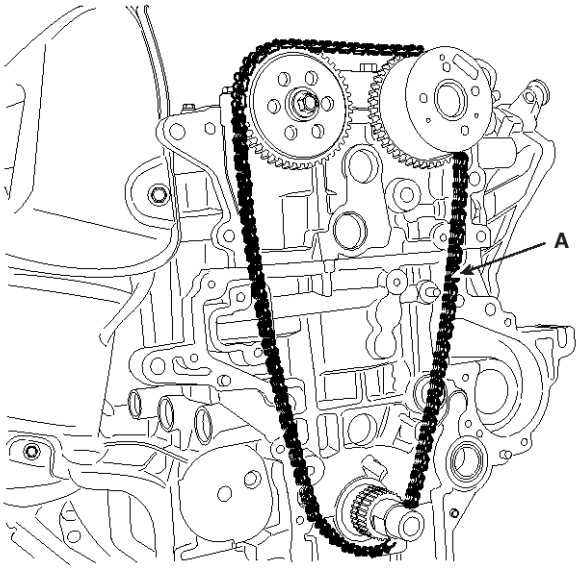
⚠CAUTION
Before removing the tensioner, fix the piston of the tensioner with a pin through the hole(B) at TDC.

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



SHDEM6037D

23. Remove the timing chain(A).



SHDEM6038D

INSPECTION

SPROCKETS, HYDRAULIC TENSIONER, CHAIN GUIDE, TENSIONER ARM

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

BELT, IDLER, PULLEY

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

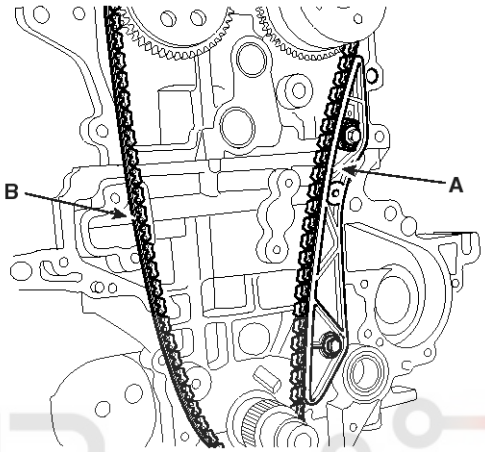
NOTICE

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

INSTALLATION

1. Align the timing marks of the camshaft sprocket with the upper sureface of the cylinder head to make No.1 cylinder be positioned at TDC.
   1) Check the dowel pin of the crankshaft for facing upside of the engine at this monent.
   2) Install the timing chain guide(A).

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



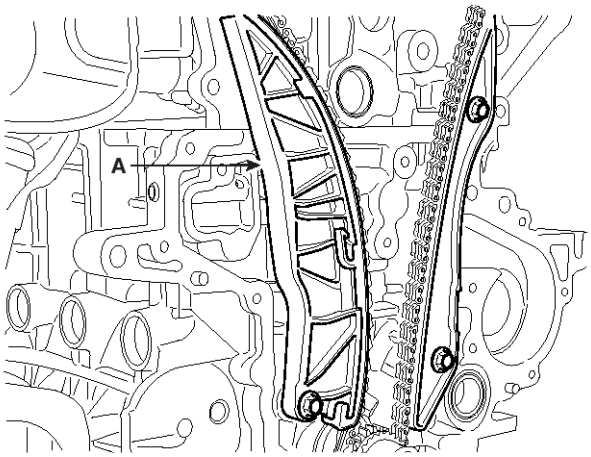
SHDEM6076D

   3) When installing a timing chain, align the timing marks on the sprockets with ones of the chain.

      Order : Crankshaft sprocket → Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket.

2. Install the chain tensioner arm(A).

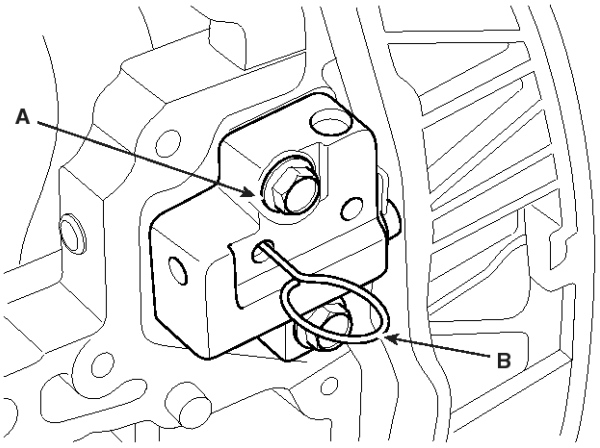
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



SHDEM6162D

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

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

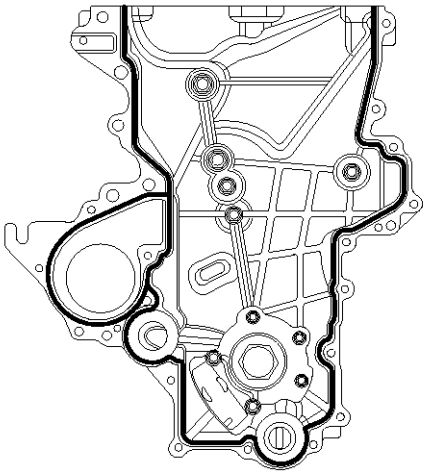


SHDEM6072D

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

4. Install the timing chain cover(A).
   1) Before installing, remove the hardened sealant from the cylinder block and ladder frame surface.
   2) Apply the sealant, THREE BOND 1282B on the timing chain cover and the water pump of the oil pump and the sealant, THREE BOND 1217H on the rest parts.

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



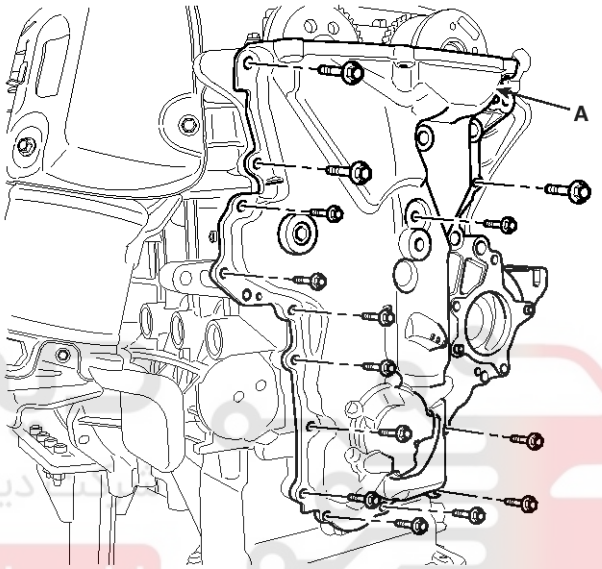
SLDEM7202D

   3) Apply the liquid gasket(1217H) on the surface between the cylinder head and the cylinder block and reassemble the cover(A) within five minites.

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

   4) Align the dowel pin of the cylinder block and the holes of the oil pump.

Tightening torque :
12mm bolts - 18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)
10mm bolts - 9.8 ~ 11.8 Nm (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

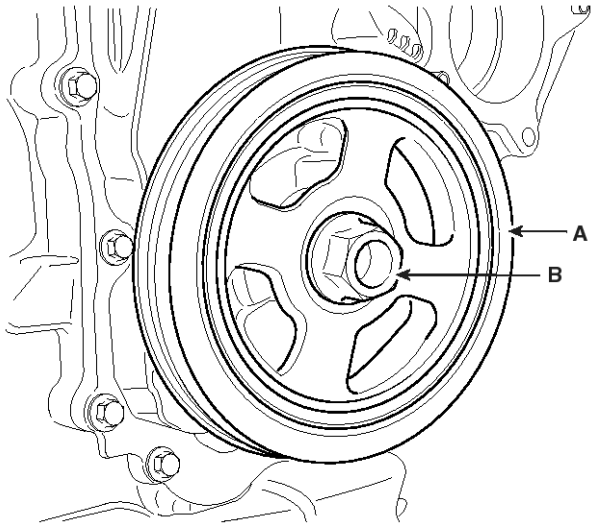


SHDEM6035D

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

5. Install the crankshaft pulley(A).

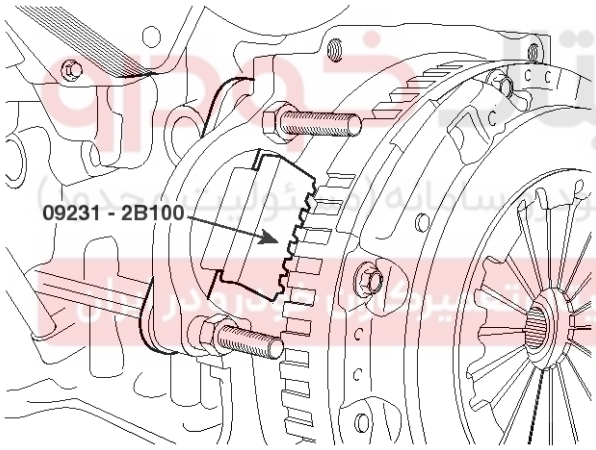
Tightening torque :
127.5 ~ 137.3 N.m (13.0 ~ 14.0 kgf.m, 94.0 ~ 101.3 lb-ft)



SHDEM6028D

NOTICE

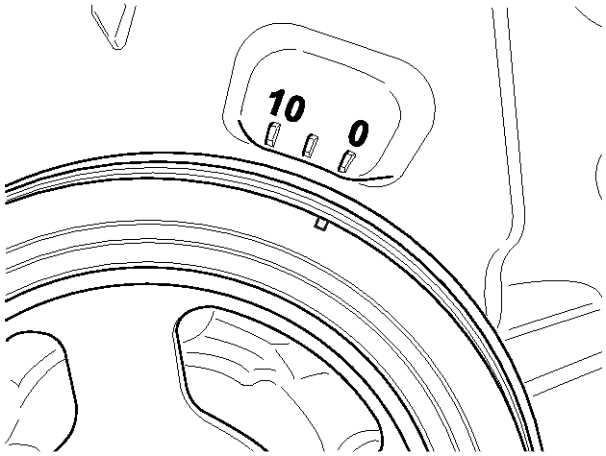
When installing the pulley, remove the starter and fix the SST(09231-2B100).



SHDEM6182D

NOTICE

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



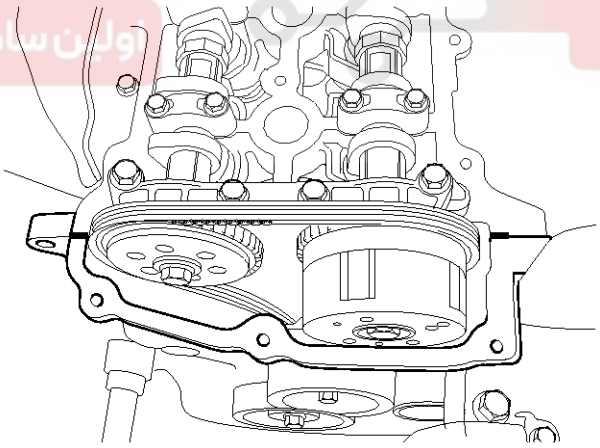
SHDEM6033D

6. Install the side cover.

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

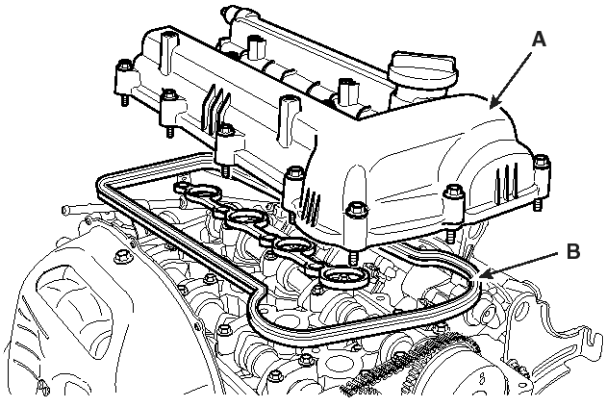
7. Install the front right wheel and tire.
8. Before installing the cylinder head cover, remove oil, dust or hardened sealant from the timing chain cover and the cylinder head upper surface.
9. After applying the liquid gasket, THREE BOND 1217H on the cylinder head cover, reassemble the cover within five minutes.

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



SHDEM6077D

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

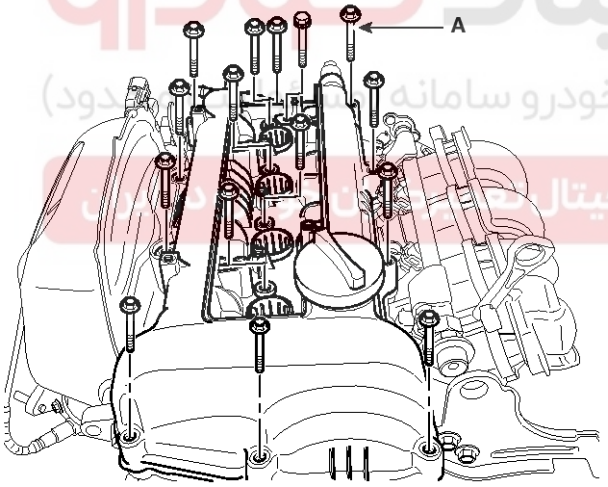


SHDEM6032D

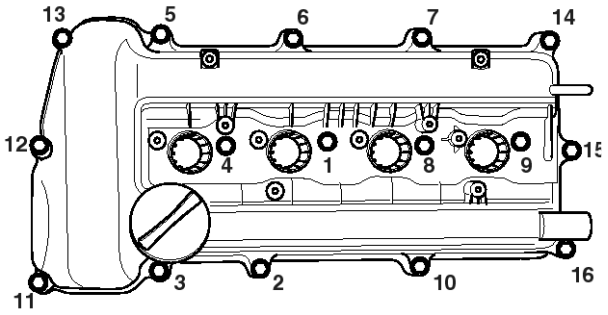
⚠CAUTION
Do not reuse the disassembled gasket.

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

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



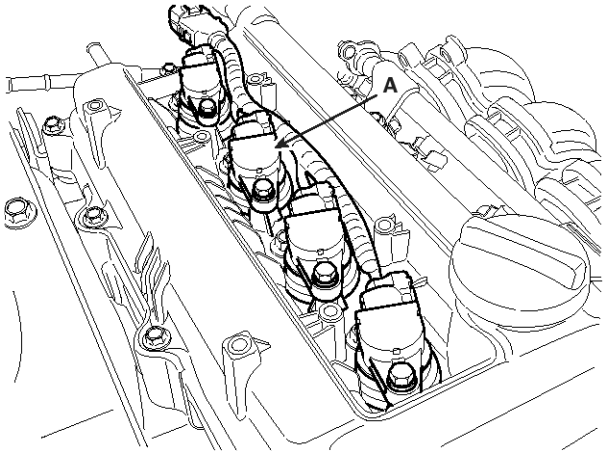
SHDEM6160D



SHDEM6078D

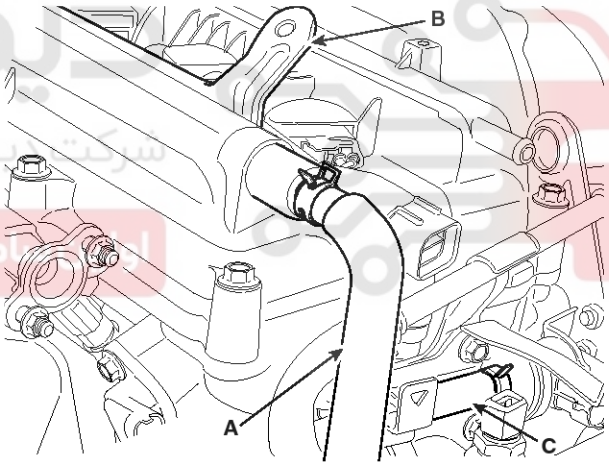
12. Install the ignition coils(A).

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



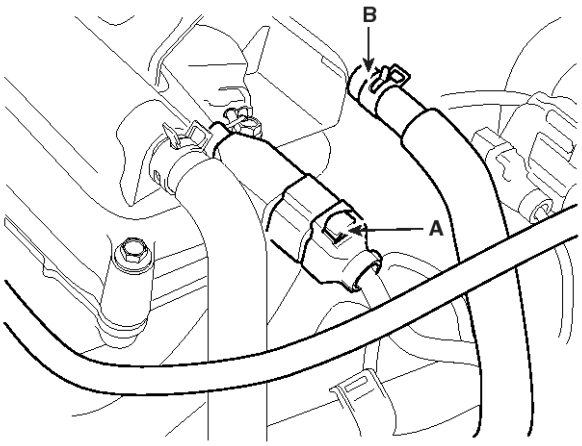
SHDEM6030D

13. Install the engine cover bracket(A), the positive crankcase ventilation(PCV) hose(B) and PCSV hose(C).



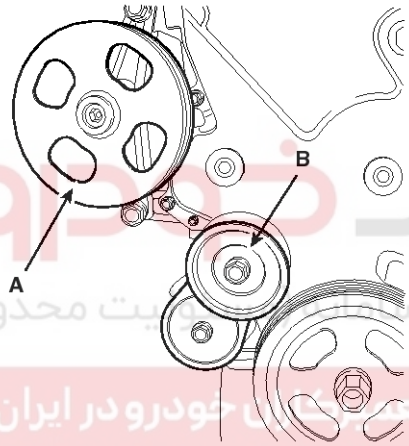
SHDEM6042L

14. Connect the ignition coil connector(A) and the breather hose(B).



SHDEM6041L

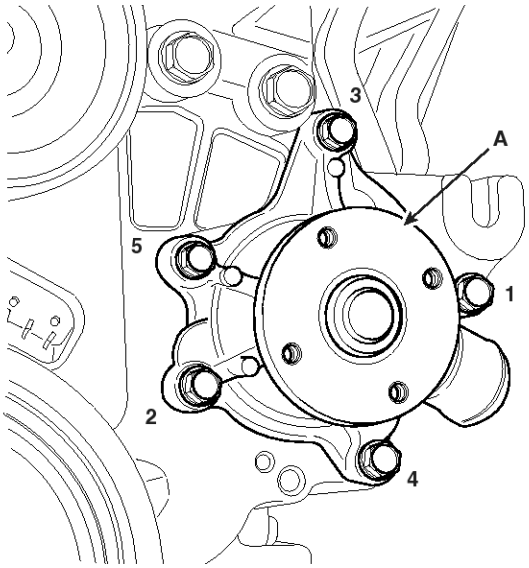
15. Install the power steering(A) and the drive belt auto-tensioner(B).



SLDEM7026D

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

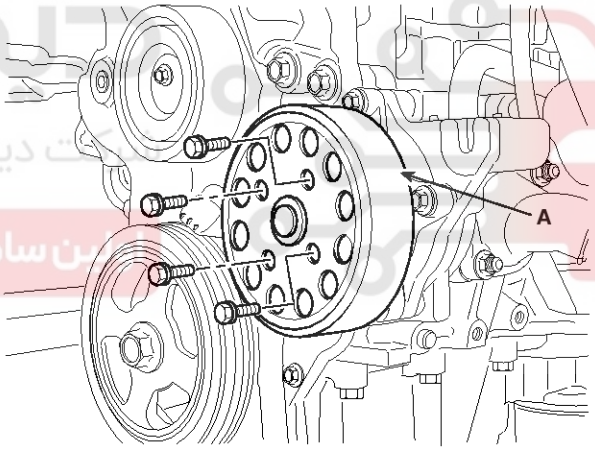
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



SLDEM7122D

17. Install the water pump pulley(A).

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

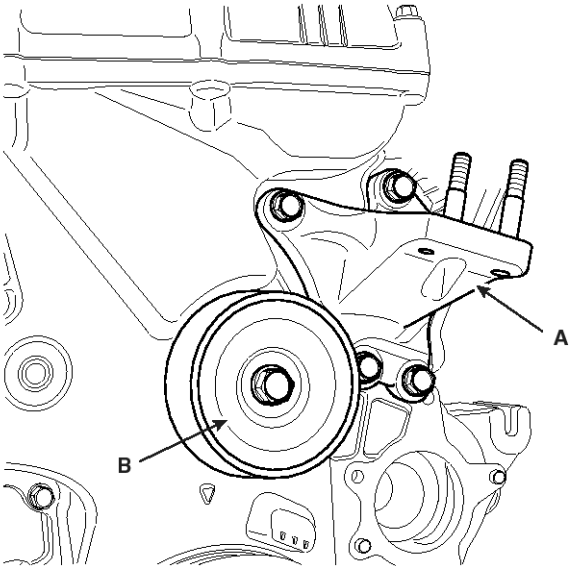


SHDEM6024D

⚠CAUTION
Tighten the bolt diagnoally.

18. Install the engine support bracket(A) and the drive belt idle(B).

Tightening torque :
(A) : 29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)
(B) : 39.2 ~ 53.9 N.m (4.3 ~ 5.5 kgf.m, 28.9 ~ 39.8 lb-ft)



SLDEM7108D

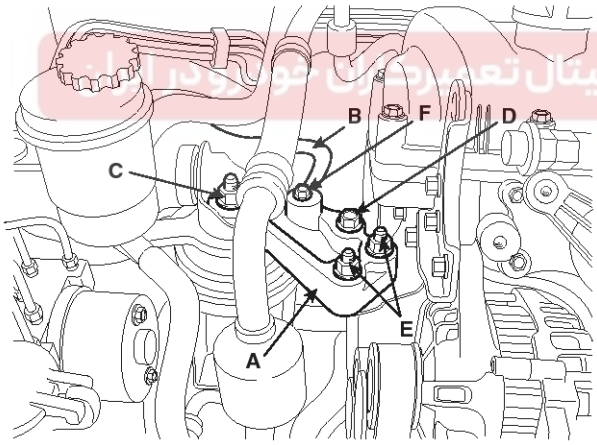
19. Supporting the engine with a jack, install the engine mounting bracket(A) and the ground line(B).

Tightening torque :

Nut(C) - 58.8 ~ 83.4 N.m (6.0 ~ 8.5 kgf.m, 43.4 ~ 61.5 lb-ft)

Bolt, nuts(D,E) - 49.0 ~ 58.8 N.m (5.0 ~ 6.0 kgf.m, 36.2 ~ 43.4 lb-ft)

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



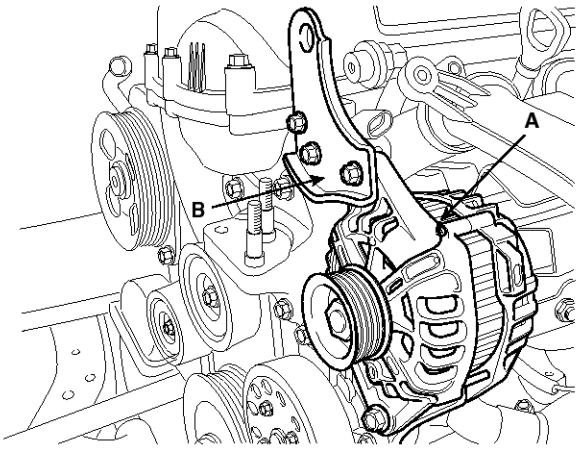
SLDEM7103L

20. Install the alternator(A) and the bracket(B)..

Tightening torque :

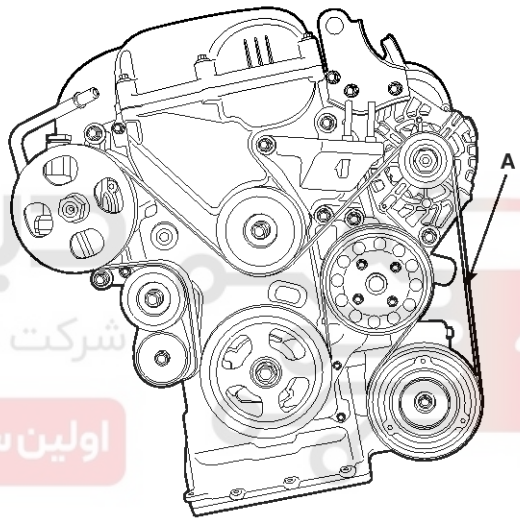
12mm bolts - 19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)

10mm bolts - 29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)



SLDEM7011D

21. Install the drive belt(A).

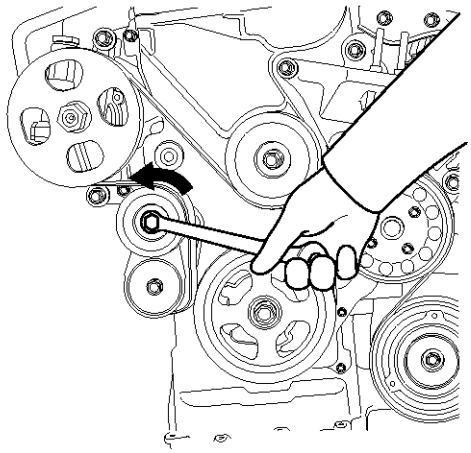


SLDEM7009D

NOTICE

Install drive belt: crankshaft pulley →water pump pulley → alternator pulley → power steering pulley → auto-tensioner idle pulley.

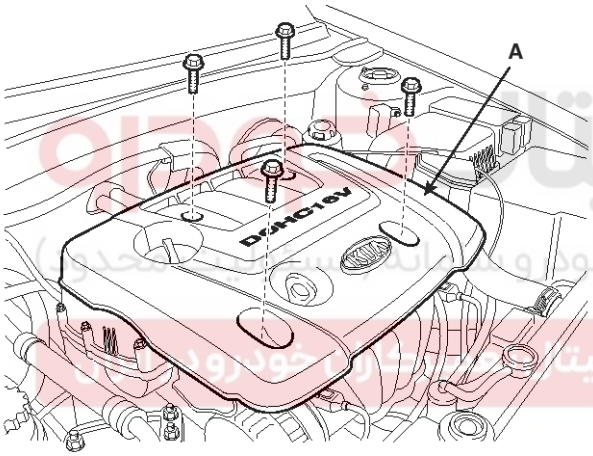
Put the drive bolt to the idle pulley by rotating idle belt of the auto-tensioner in the counter- clockwise, release the auto-tensioner pulley slowly.



SLDEM7010D

22. Install the engine cover(A).

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

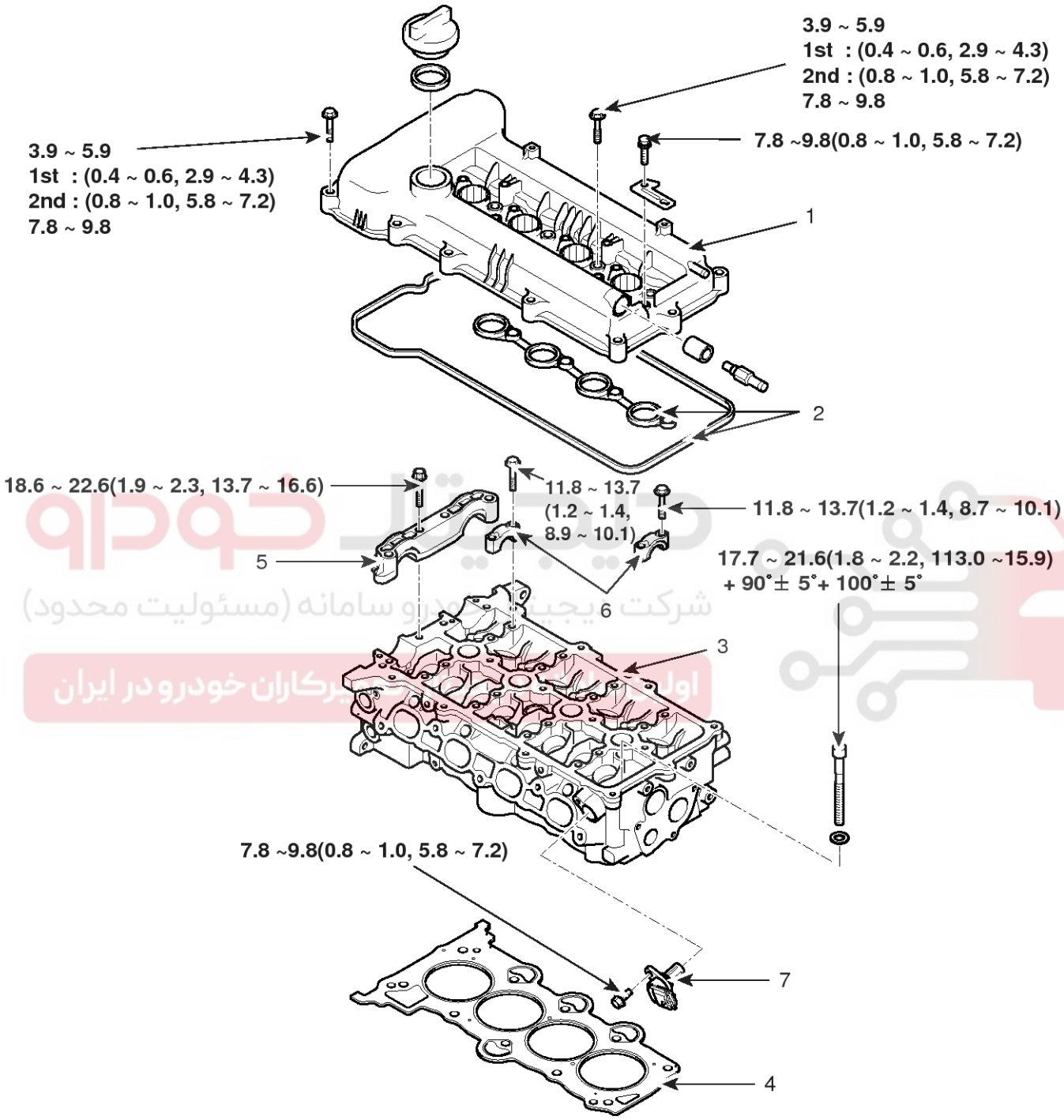


SLDEM7001D

⚠CAUTION
Install the cover surely before driving.

Cylinder Head Assembly

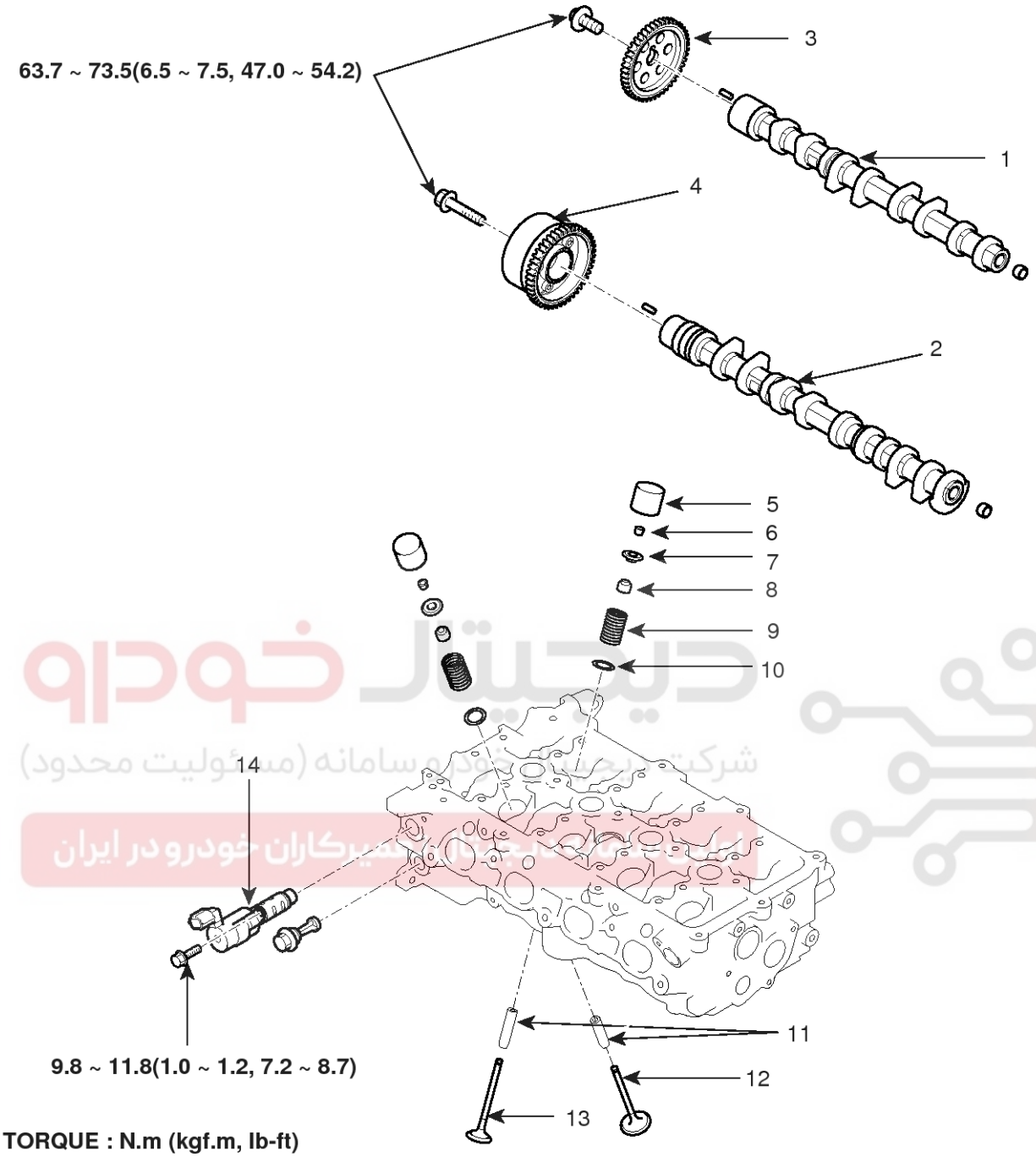
COMPONENTS



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

1. Cylinder head cover
2. Cylinder head cover gasket
3. Cylinder head assembly
4. Cylinder head gasket
5. Camshaft front bearing cap
6. Camshaft bearing cap
7. Camshaft position senser

SHDM27002L



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

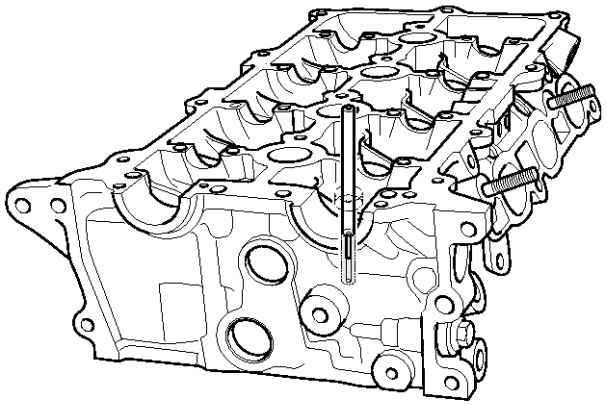
1. Exhaust camshaft
2. Intake camshaft
3. Exhaust camshaft sproket
4. Continuously Variable Valve Timing
5. Mechanincal Lash Adjuster(MLA)
6. Retainer lock
7. Retainer
8. balve stem seal
9. Valve spring
10. Valve spring seat
11. Valve guide
12. Intake valve
13. Exhaust valve
14. Oil Control Valve(OCV)

SHDM27003L

REPLACEMENT

VALVE GUIDE

1. Using the SST(09221 - 2B100), withdraw the old valve guide toward the bottom of cylinder head.

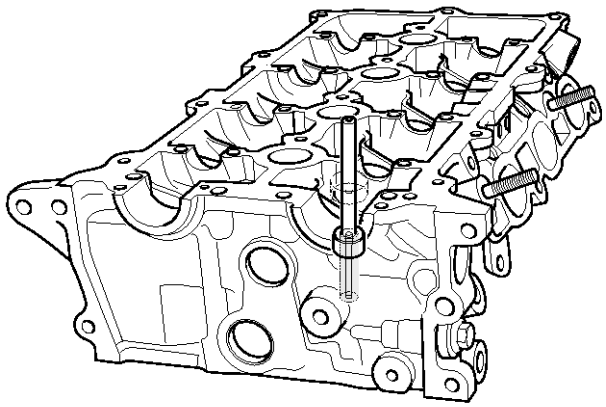


SHDEM6173D

2. Recondition the valve guide hole of cylinder head so that it can match the newly press-fitted oversize valve guide.
3. Using the SST (09221-2B100), press-fit the valve guide. The valve guide must be press-fitted from the upper side of the cylinder head.

Valve guide length

Intake / Exhaust : 40.3 ~ 40.7mm (1.5866 ~ 1.6024in)



SHDEM6171D

4. After the valve guide is press-fitted, insert a new valve and check for proper stem-to-guide clearance.
5. After the valve guide is replaced, check that the valve is seated properly. Recondition the valve seats as necessary.

VALVE GUIDE OVERSIZE

Item	Oversize [mm (in)]	Size mark	Valve guide hole diameter [mm (in)]	Valve guide protrusion height [mm (in)]
Valve guide	STD	-	10.000 ~ 10.018 (0.3937 ~ 0.3944)	12.8 (0.5039)
	0.05 (0.002) OS	5	10.050 ~ 10.068 (0.3957 ~ 0.3964)	
	0.25 (0.010) OS	25	10.250 ~ 10.268 (0.4035 ~ 0.4043)	
	0.50 (0.020) OS	50	10.500 ~ 10.518 (0.4134 ~ 0.4141)	

REMOVAL

Engine removal is not required for this procedure.

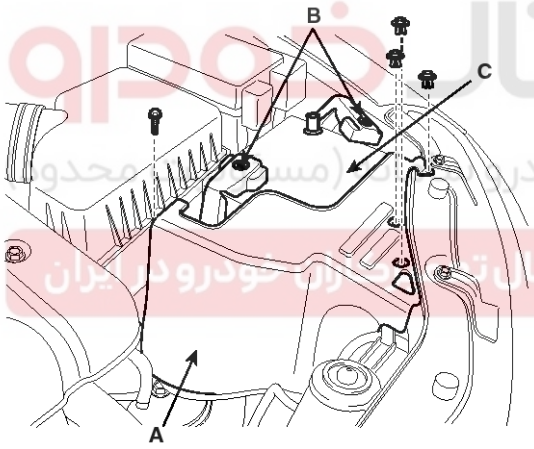
CAUTION

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

NOTICE

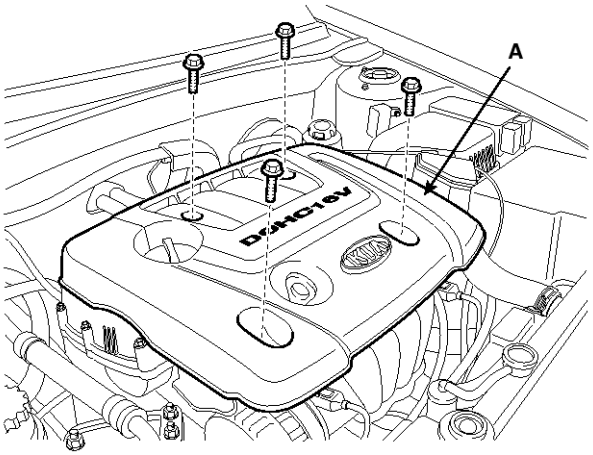
- *Mark all wiring and hoses to avoid misconnection.*
- *Turn the crankshaft pulley so that the No. 1 piston is at top dead center.*

1. Disconnect battery terminal(B) and remove the heat shield, the battery(C).



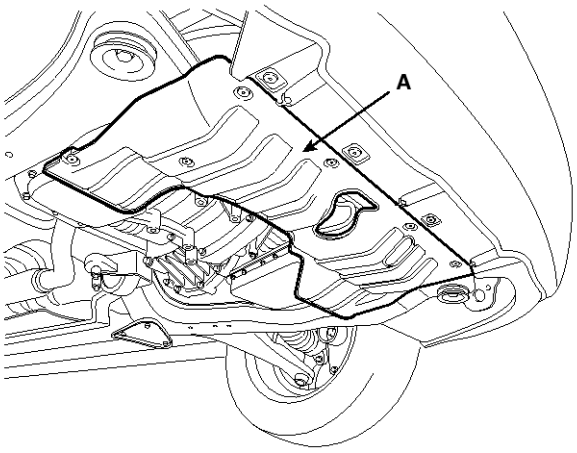
SLDM16100D

2. Remove the engine cover(A).



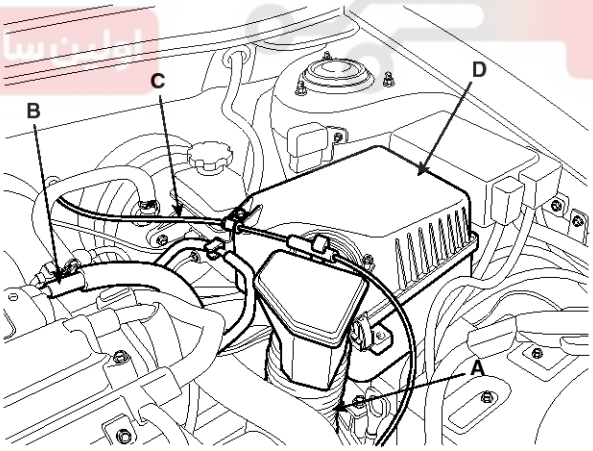
SLDEM7001D

3. Remove the radiator cap to speed draining.
4. Remove the under cover(A).



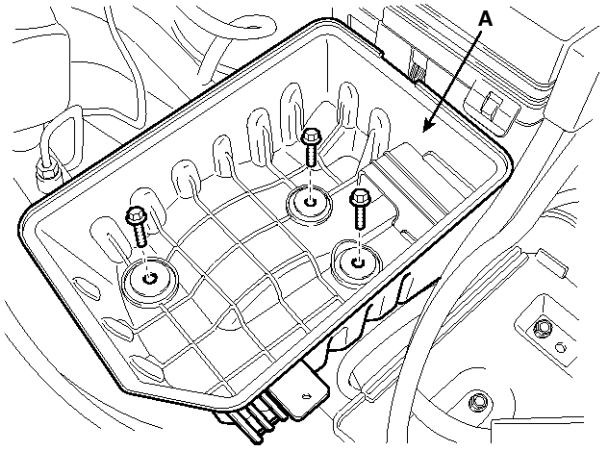
SLDEM7003D

5. Loosen the radiator drain plug and drain engine coolant.
6. Remove the air cleaner assembly.
   1) Disconnect the breather hose(B) from intake air hose(A).
   2) Disconnect the intake air hose(A) and accelerator cable(C).
   3) Remove the air cleaner upper cover(D).



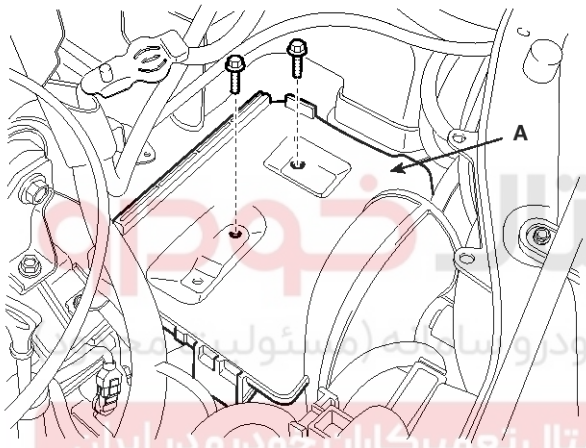
SLDEM7004D

   4) Remove the air cleaner lower cover(A).



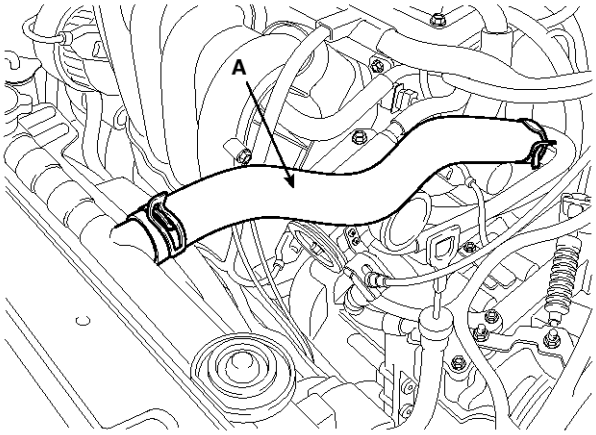
SLDEM7005D

7. Remove the battery tray(A).

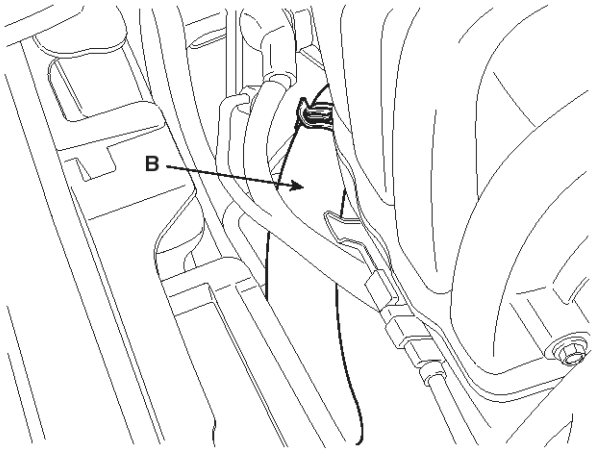


SLDEM7006D

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

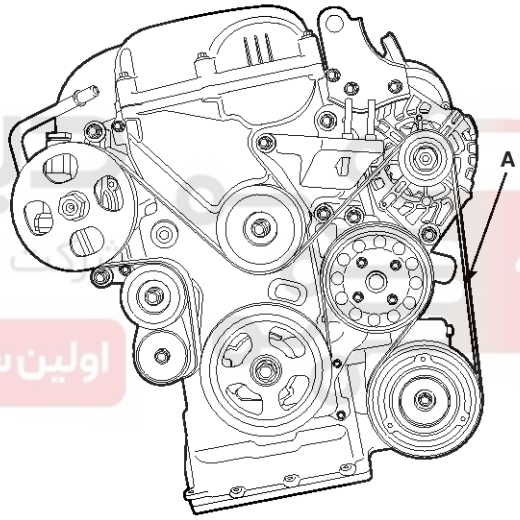


SLDEM7007D



SLDEM7201L

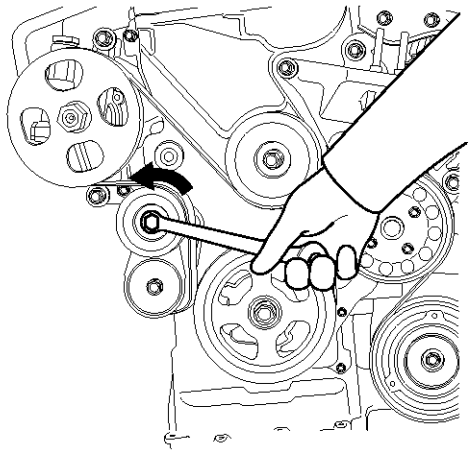
9. Loosen the water pump mounting bolt and the drive idler mounting bolt.
10. Remove the alternator drive belt(A).



SLDEM7009D

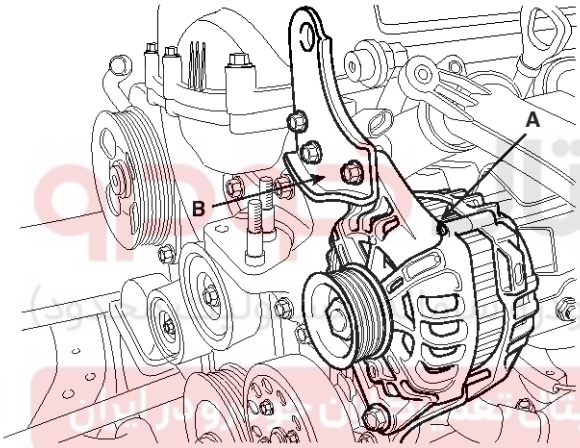
NOTICE

Remove the drive belt by turning the auto-tensioner counterclockwise.



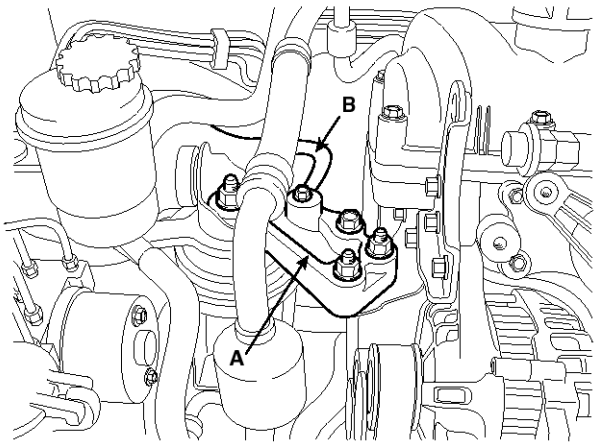
SLDEM7010D

11. Remove the alternator(A) and the bracket(B). (Refer to Alternator in EE Group).



SLDEM7011D

12. Remove the RH front wheel.
13. Remove the engine mounting bracket(A) and the ground line(B).



SLDEM7012D

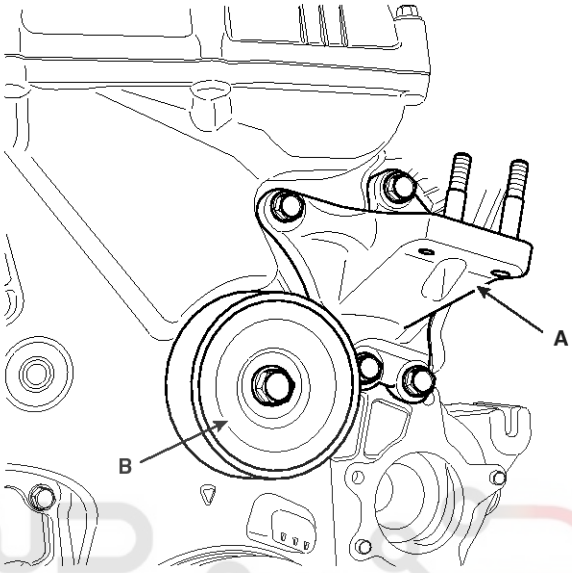
NOTICE

Support the engine with a jack.

CAUTION

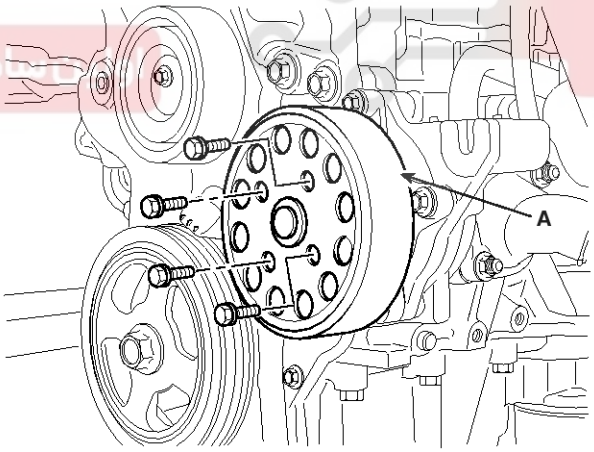
Do not support the engine - transaxle - subframe assembly with the hangers.

14. Remove the engine support bracket(A) and the drive belt idle(B).



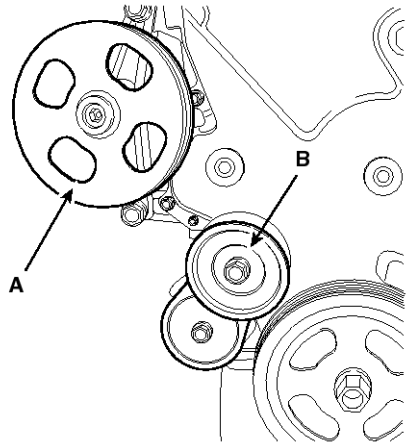
SLDEM7108D

15. Remove the water pump pulley(A).



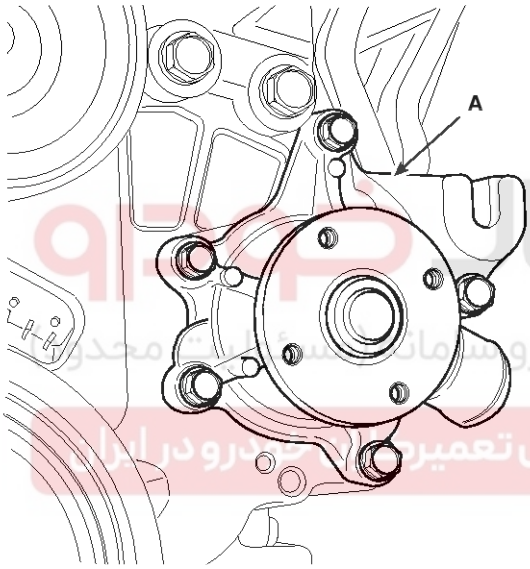
SHDEM6024D

16. Remove the power steering(A) and the drive belt auto-tensioner(B).



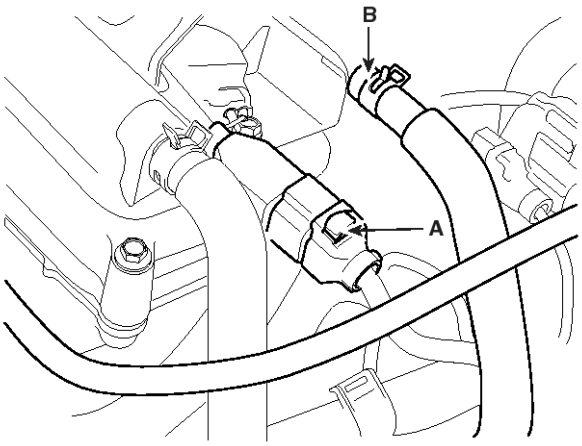
SLDEM7026D

17. Remove the water pump(A).



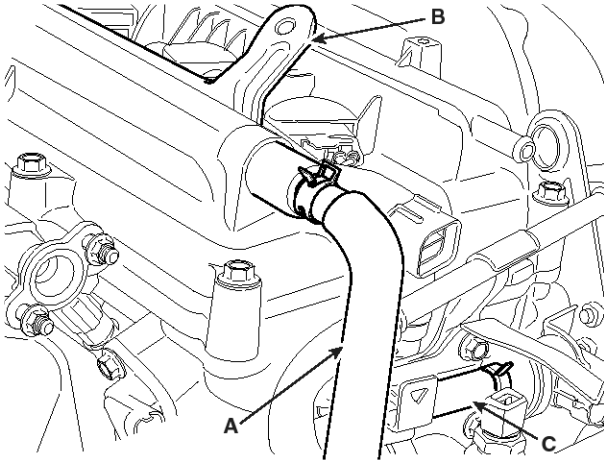
SHDEM6025D

18. Disconnect the ignition coil connector(A) and the breather hose(B).



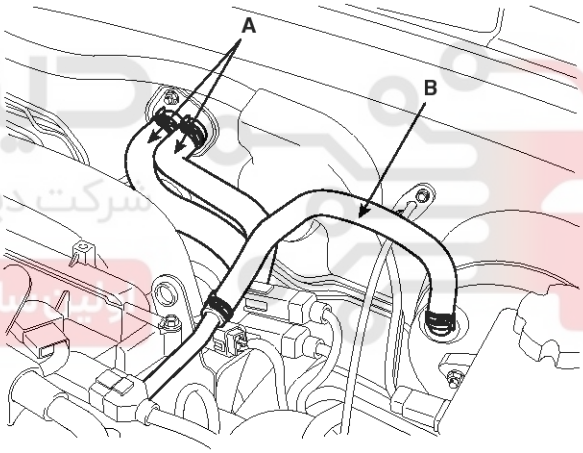
SHDEM6041L

19. Disconnect the positive crankcase ventilation(PCV) hose(A), the engine cover bracket(B) and purge control solenoid valve(PCSV) hose(C).



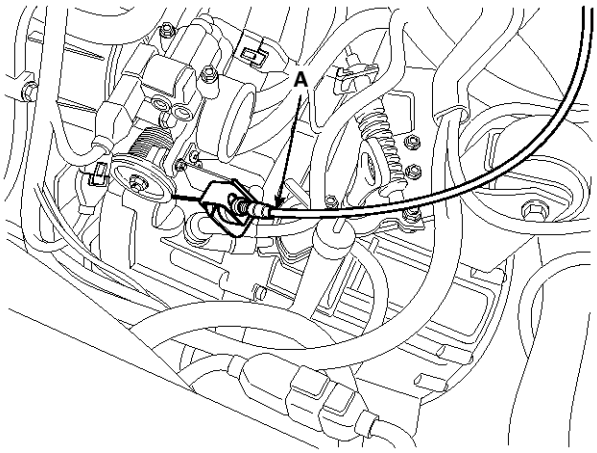
SHDEM6042L

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



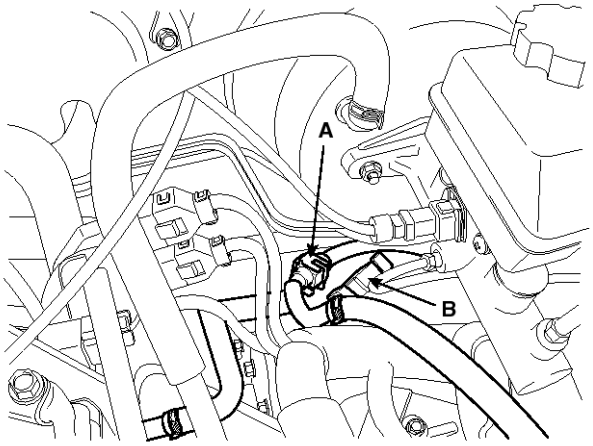
SLDEM7013D

21. Disconnect the accelerator cable(A).



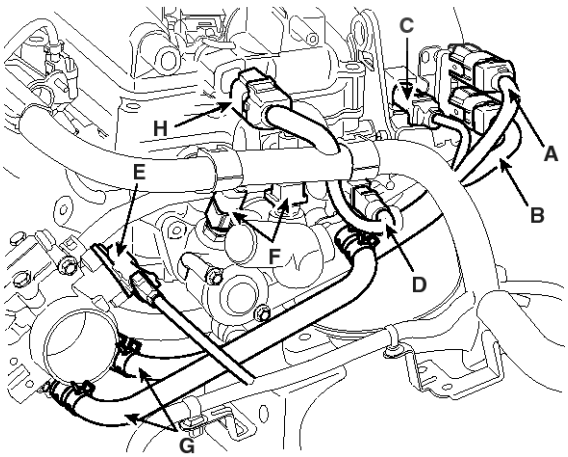
SLDEM7002D

22. Disconnect the fuel hose(A) and the hose(B) of the purge control solenoid valve(PCSV) side.



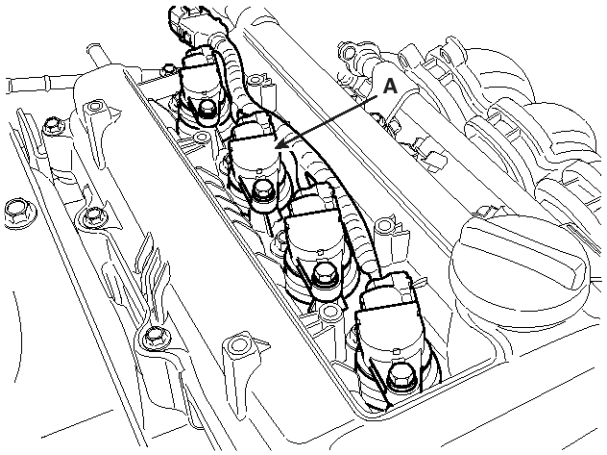
SLDEM7014D

23. Remove the engine wire harness connectors and wire harness clamps from cylinder head and the intake manifold.
    1) Disconnect the front(A) and the rear(B) oxygen sensor connector.
    2) Disconnect the ignition coil condenser connector(C) and the purge control solenoid valve(PCSV) connector(D).
    3) Disconnect the throttle position sensor(TPS) connectoe(E).
    4) Disconnect the engine coolant temperature sensor(ECTS) connector(F) and the water hose(G).



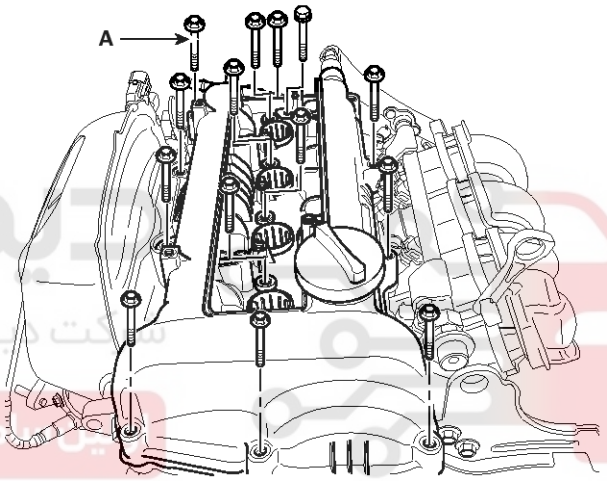
SLDEM7101D

24. Remove the ignition coil(A).



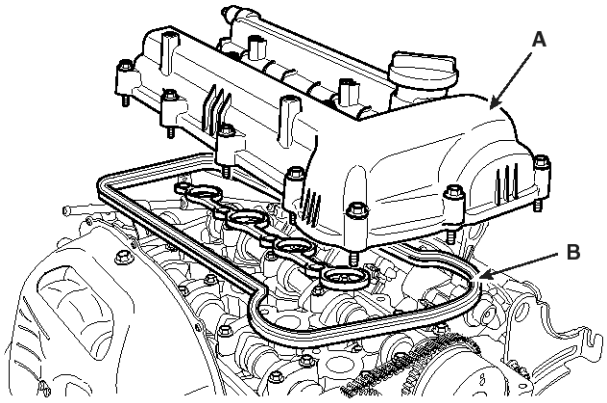
SHDEM6030D

25. Remove the cylinder head cover bolts(A).



SHDEM6031D

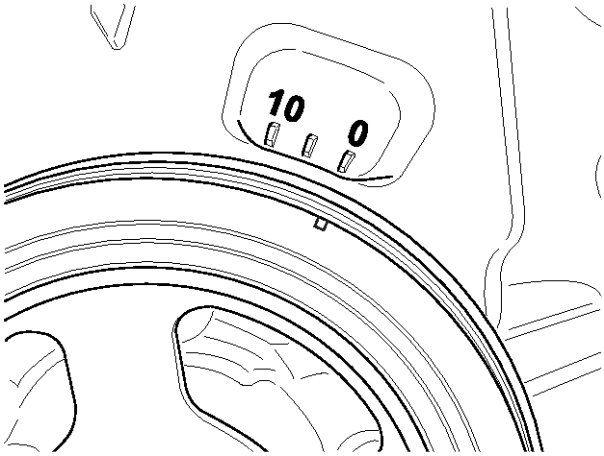
26. Remove the cylinder head cover(A) with its gasket(B).



SHDEM6032D

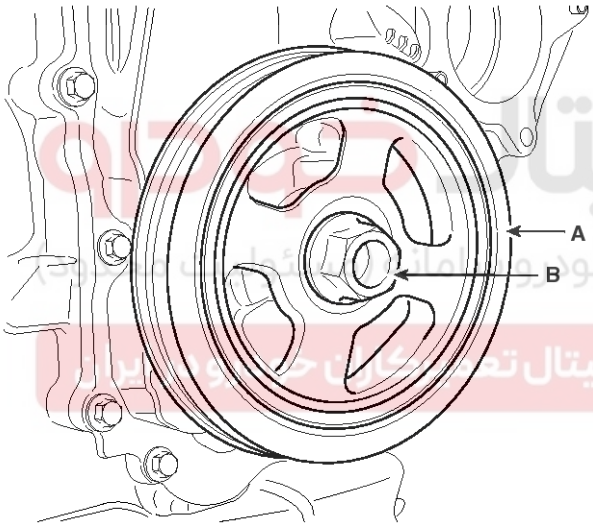
27. Remove the side cover.
28. Turn the crankshaft pulley clockwise, and align its

groove with the timing mark of the timing chain cover.



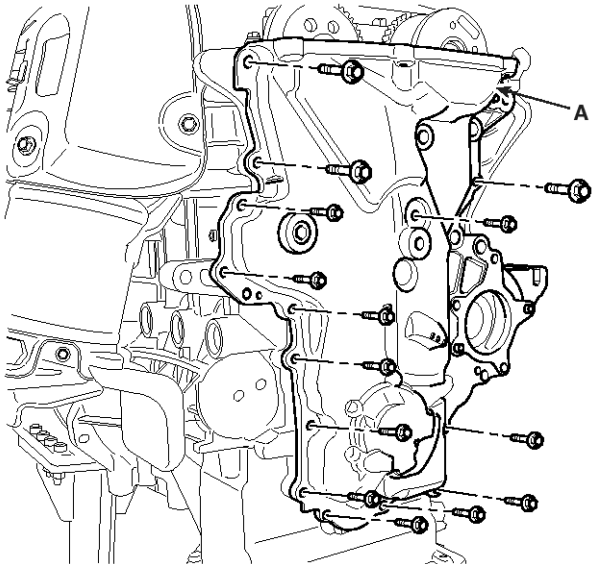
SHDEM6033D

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



SHDEM6028D

30. Remove the timing chain cover(A).

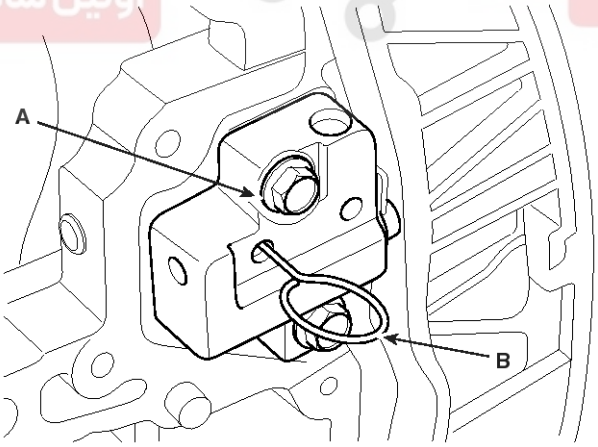


SHDEM6035D

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

⚠CAUTION
Put paint marks on the camshaft and the crankshaft sprockets aligning timing before removing the timing chain.

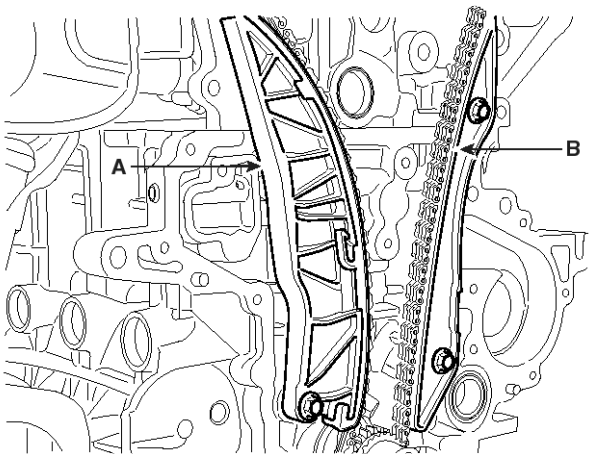
32. Remove the hydraulic tensioner(A).



SHDEM6072D

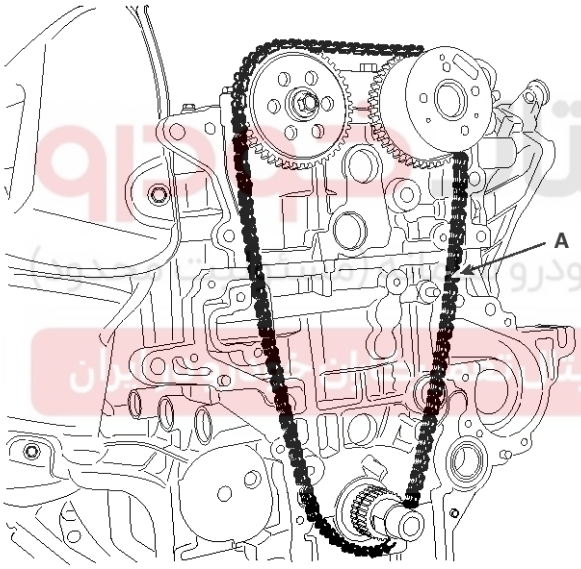
⚠CAUTION
Before removing the tensioner, fix the piston of the tensioner with a pin through the hole(B) at TDC.

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



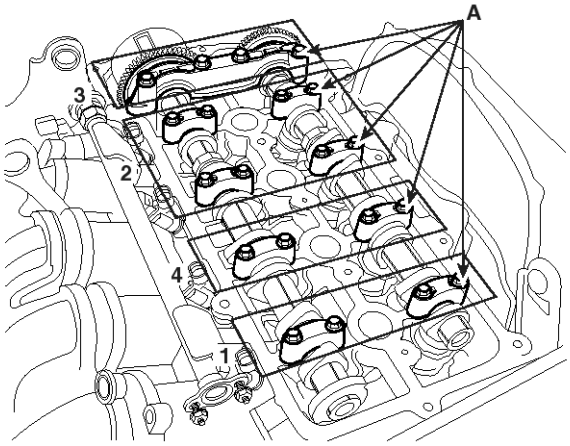
SHDEM6037D

34. Remove the timing chain(A).



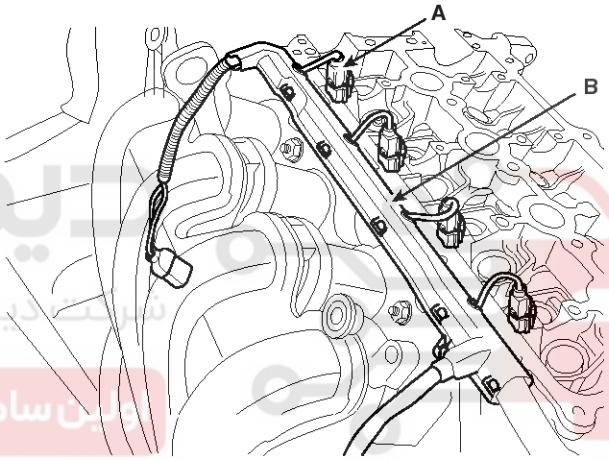
SHDEM6038D

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



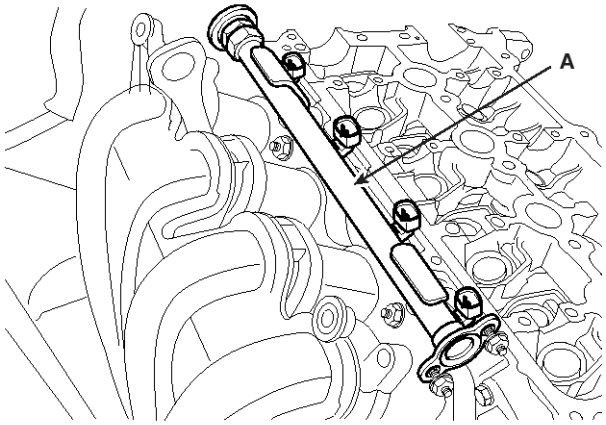
SHDEM6081D

36. Remove the injector connectors(A) and the harness bracket(B).



SHDEM6170D

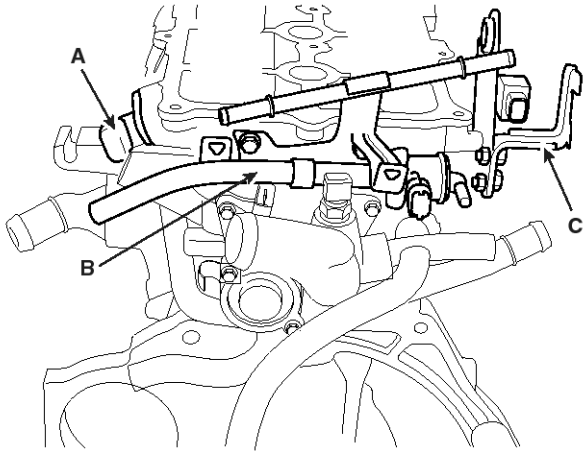
37. Remove the delivery pipe(A).



SHDEM6080D

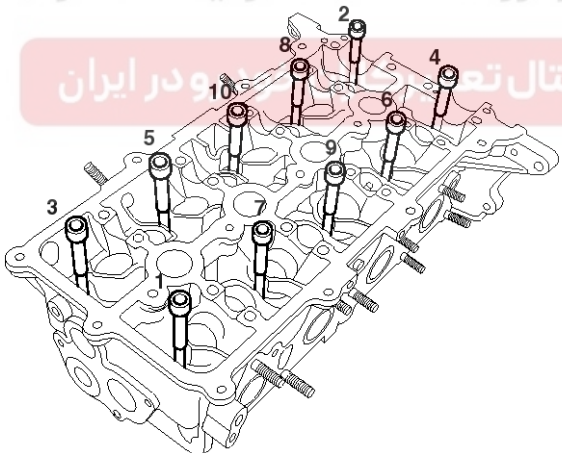
38. Remove the exhaust manifold.
39. Remove the intake manifold.

40. Disconnect the camshaft position sensor(CMP) connector(A) and remove the purge control solenoid valve(PCSV) bracket(B) and the module hanger bracket(C).



SLDEM7102D

41. Remove the water temperature control assembly and the oil control valve(OCV).
42. Remove the cylinder head bolts, then remove the cylinder head.
    1) Uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown.



SHDEM6086D

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

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

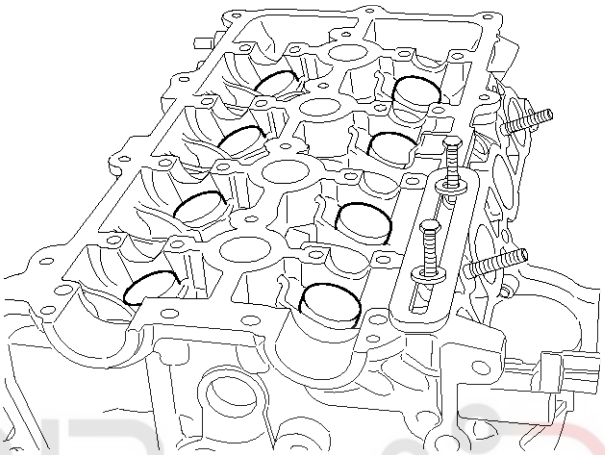
CAUTION
Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

DISASSEMBLY

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

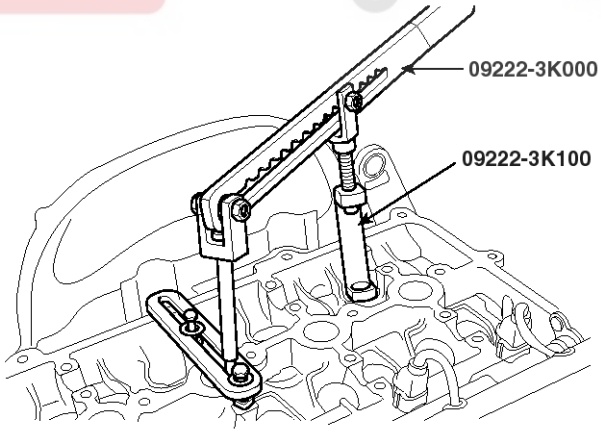
1. Remove the MLAs(A).

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



SHDEM6041D

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



SHDEM6207D

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

    2) Remove the spring retainer.
    3) Remove the valve spring.
    4) Remove the valve.

5) Remove the valve stem seal.

6) Using a magnetic finger, remove the spring seat.

⚠CAUTION
Do not reuse the valve stem seals.

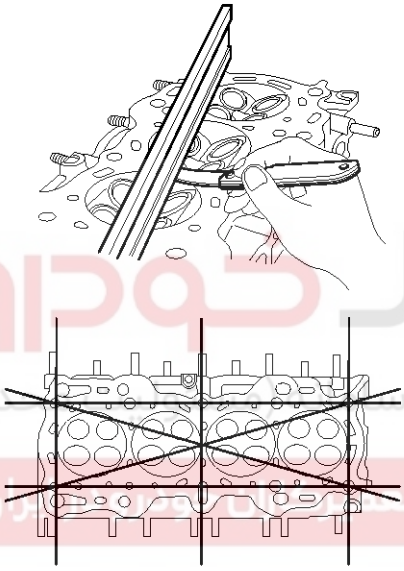
INSPECTION

CYLINDER HEAD

1. Inspect for flatness.

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

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



ECKD001H

2. Inspect for cracks.

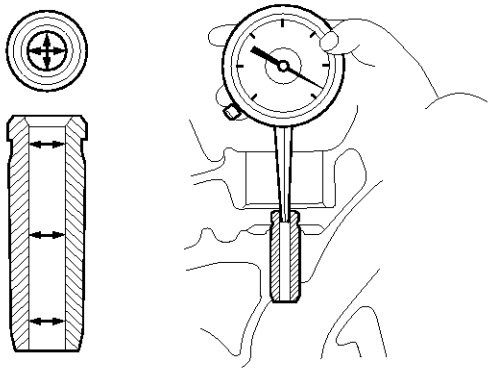
   Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

VALVE AND VALVE SPRING

1. Inspect the valve stems and valve guides.

   1) Using a caliper gauge, measure the inner diameter of valve guide.

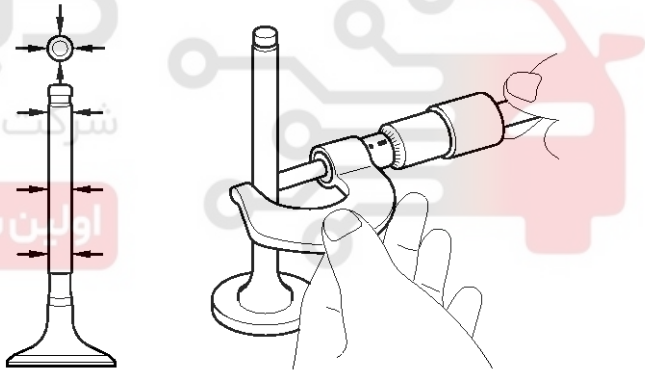
Valve guide inner diameter :
5.500 ~ 5.512mm (0.2165 ~ 0.2170in)



ECKD219A

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

Valve stem outer diameter
Intake : 5.965 ~ 5.980mm (0.2348 ~ 0.2354in)
Exhaust : 5.958 ~ 5.970mm (0.2346 ~ 0.2350in)



ECKD220A

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

2. Inspect the valves.

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

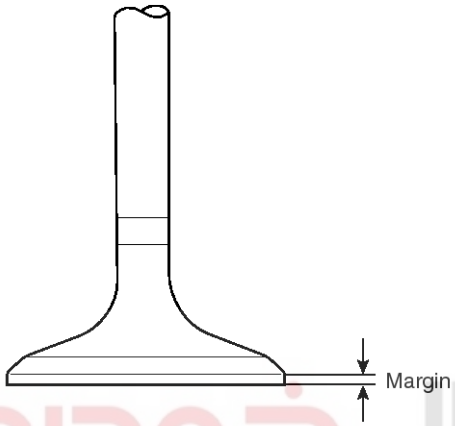
   2) Check that the surface of valve for wear.

      If the valve face is worn, replace the valve.

3) Check the valve head margin thickness.

If the margin thickness is less than minimum, replace the valve.

Margin
Standard
Intake : 1.1mm (0.0433in)
Exhaust : 1.26mm (0.0496in)



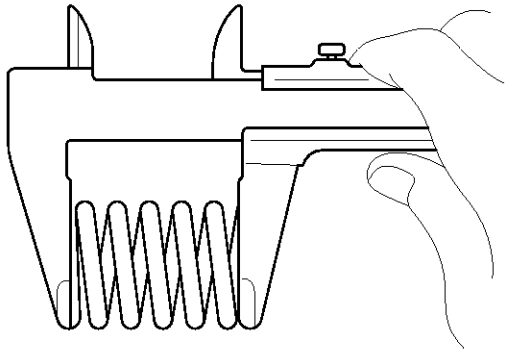
ECKD221A

4) Check the length of valve.

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

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

Valve spring
Standard
Free height : 44mm (1.7323in)
Out of square : Less than 1.5˚



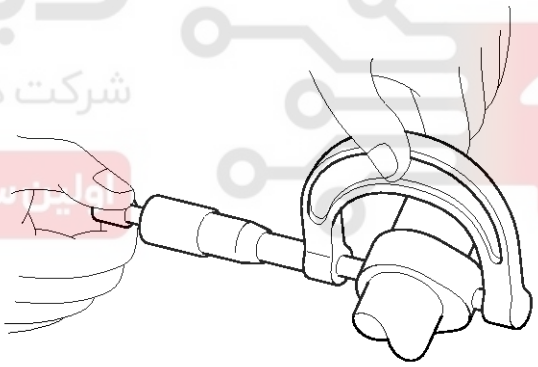
ECKD222A

CAMSHAFT

1. Inspect the cam height.

   Using a micrometer, measure the cam height.

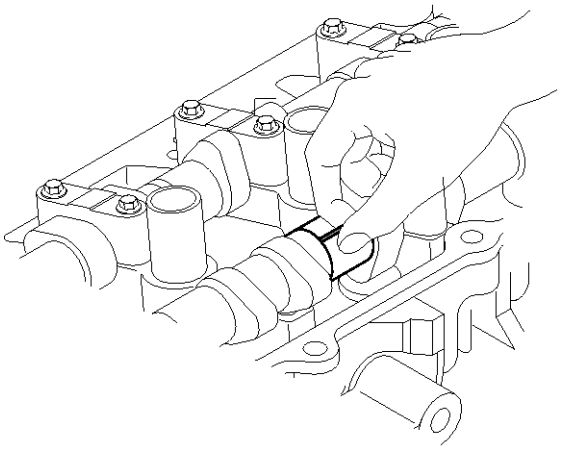
Cam height
Intake : 43.85mm (1.7264in)
Exhaust : 42.85mm (1.6870in)



ECKD223A

If the cam lobe height is less than specified, 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 journal.



SHDEM6043L

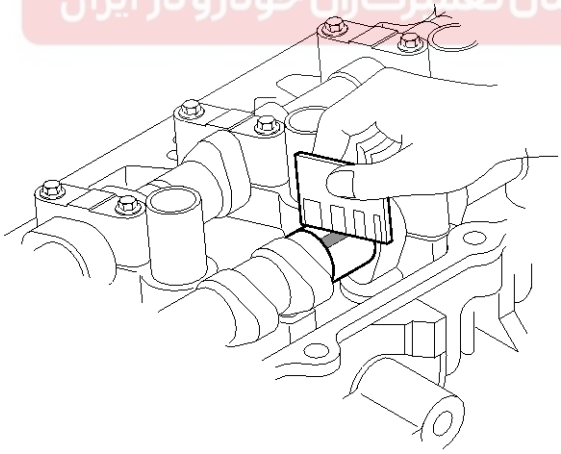
4) Install the bearing caps and tighten the bolts with specified torque.

Tightening torque :
bolts : 11.8 ~ 13.7Nm (1.2 ~ 1.4kgf.m, 8.7 ~ 10.1lb-ft)
bolts : 18.6 ~ 22.6Nm (1.9 ~ 2.3 kgf.m, 13.7 ~ 16.6lb-ft)

⚠CAUTION
Do not turn the camshaft.

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

Bearing oil clearance
Standard : 0.020 ~ 0.057mm (0.0008 ~ 0.0022in)
Limit : 0.1mm (0.0039in)

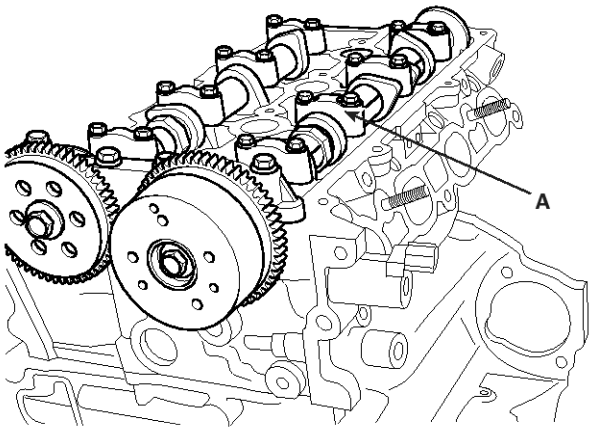


SHDEM6044L

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

3. Inspect the camshaft end play.
   1) Install the camshafts.
   2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

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



SHDEM6089D

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

3) Remove the camshafts.

Continuous Variable Valve Timing(CVVT) ASSEMBLY

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

      NOTICE
      - *Wrap around it with a shop rag and the likes, because the oil splashes.*
      - *After releasing the pin, you can turn the CVVT assembly for advance by hand.*
      - *If there may be much air leakage, the pin can not be released.*

   5) Under the condition of 3), turn the CVVT assembly to the advance angle side with your hand.

- Depending on the air pressure, the CVVT assembly will turn to the advance side.
- Also, under the condition that the pressure can be hardly applied because of the air leakage from the port, there may be the case that the lock pin could be hardly released.

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

: Movable smoothly in the range about 25˚

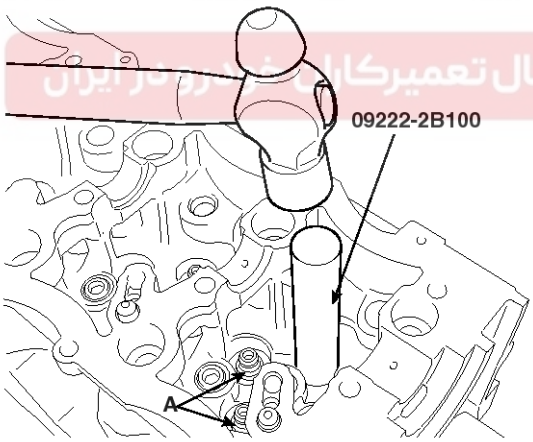
7) Turn the CVVT assembly with your hand counterclockwise and lock it at the maximum delay angle position.

REASSEMBLY

NOTICE

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

1. Install the valves.
   1) Install the spring seats.
   2) Using the SST (09222 - 2B100), push in a new valve stem seal(A).



SHDEM7001D

NOTICE

Do not reuse old valve stem oil seals.

Incorrect installation of the seal could result in oil leakage past the valve guides.

CAUTION

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

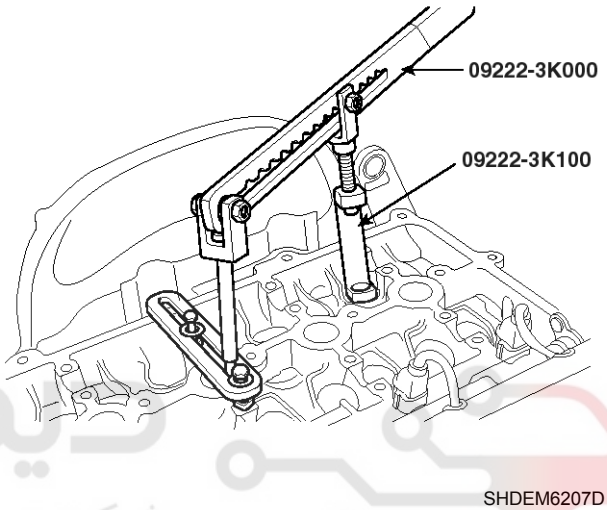
   3) Install the valve, valve spring and spring retainer, after applying engine oil at the end of each valve.

NOTICE

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

2. Using the SST(09222 - 3K000, 09222 - 3K100), compress the spring and install the retainer locks.

   After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.

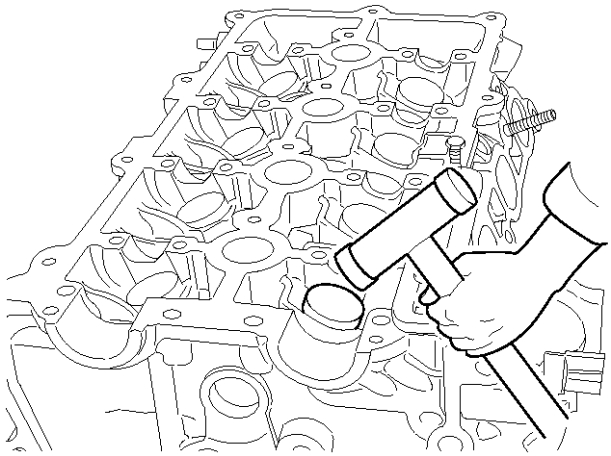


SHDEM6207D

CAUTION

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

3. Lightly tap the end of each valve stem two or three times with the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.



SHDEM6172D

4. Install the MLA(Mechanical lash adjuster)s.
   Check that the MLA rotates smoothly by hand.

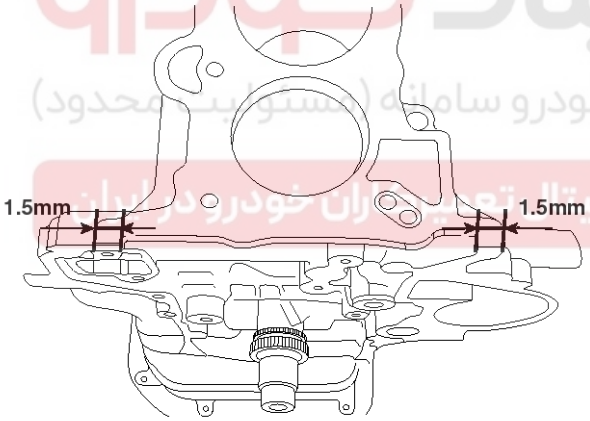
NOTICE
All the MLAs should be installed in its original position.

INSTALLATION

NOTICE

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

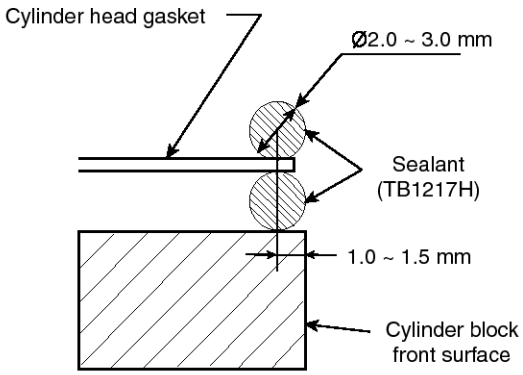
1. Install the cylinder head assembly.
   1) Before installing, remove the hardened sealant from the cylinder block and cylinder head surface.
   2) Before installing the cylinder head gasket, apply sealant on the upper surface of the cylinder block and reassemble the gasket within five minutes.



SHDEM6091D

NOTICE
Refer to the illustration for applying sealant.

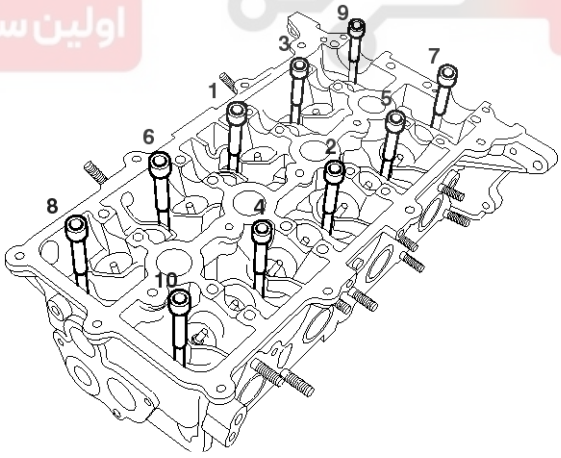
Width: 2.0 ~ 3.0mm(0.0787~0.1181in.)
Position: 1.0 ~ 1.5mm(0.0394~0.0591in.)
Specification: Three bond 1217H



SHDEM6017L

   3) After installing the cylinder head gasket on the cylinder block, apply sealant on the upper surface of the cylinder head gasket and reassemble in five minutes.
2. Place the cylinder head carefully not to damage the gasket.
3. Install the cylinder head bolts with washers.
   1) Tighten the 10 cylinder head bolts, in several passes, in the sequence shown.

Tightening torque :
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 90~95° + 100~105°

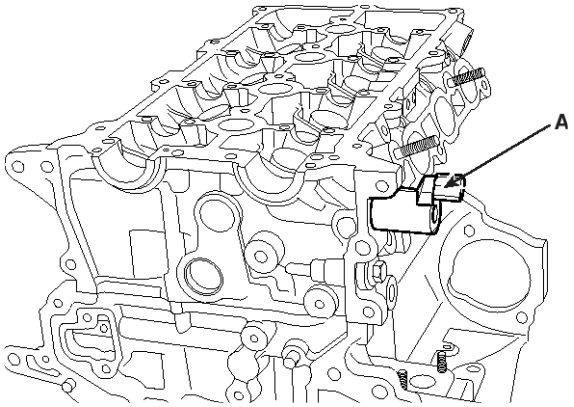


SHDEM6174D

CAUTION
Always use new cylinder head bolts.

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

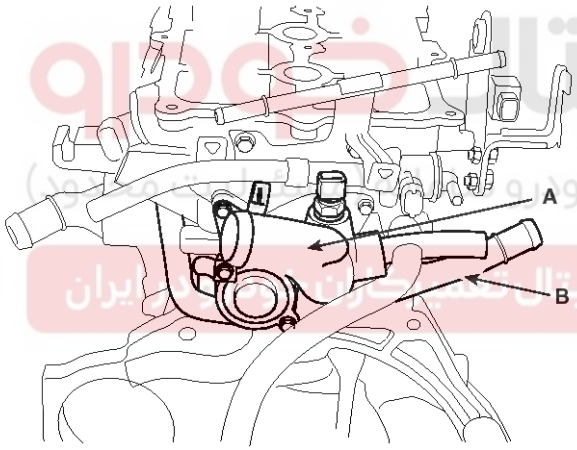
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



SHDEM6085D

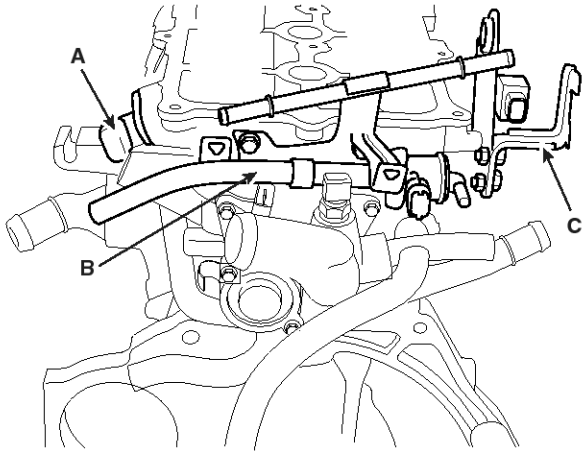
5. Tighten the mounting bolts for the water temperature control assembly(A) after installing the heater pipe(B).

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



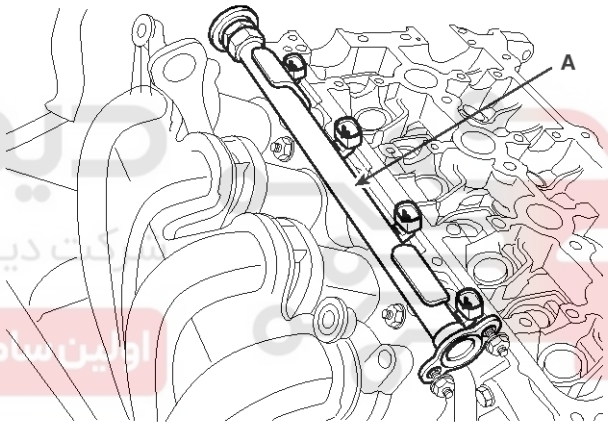
SLDEM7103D

6. Connect the camshaft position sensor(CMP) connector(A) and install the purge control solenoid valve(PCSV) bracket(B) and the module hanger bracket(C).



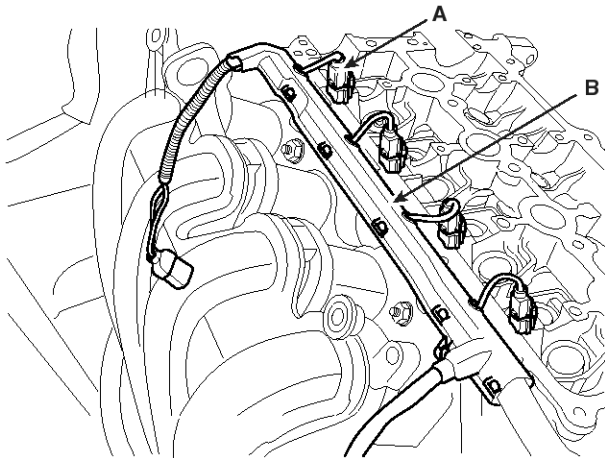
SLDEM7102D

7. Install the intake manifold module assembly.
8. Install the exhaust manifold assembly.
9. Install the delivery pipe assembly(A).



SHDEM6080D

10. Install the injector connector(A) and harness bracket(B).



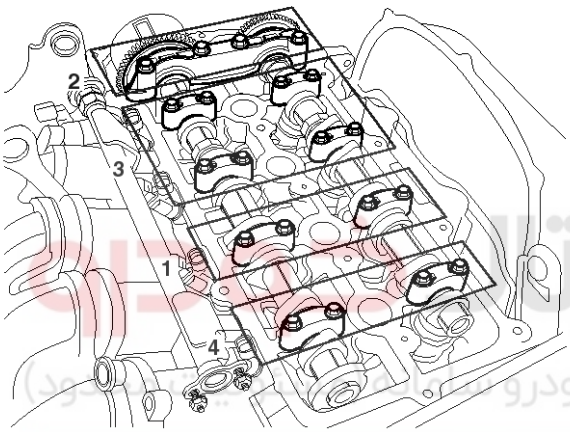
SHDEM6170D

11. Install the camshafts.
    1) Before installing, apply engine oil on journals.

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

    2) After installing, check the valve clearance.
12. Install the camshaft bearing caps with the order below.

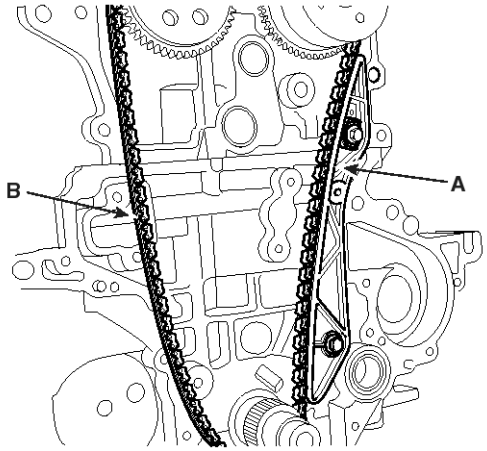
Tightening torque :
M6 bolts - 11.8 ~ 13.7N.m (1.2 ~ 1.4kgf.m, 8.7 ~ 10.1lb-ft)
M8 bolts - 18.6 ~ 22.6N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



SLDEM7203L

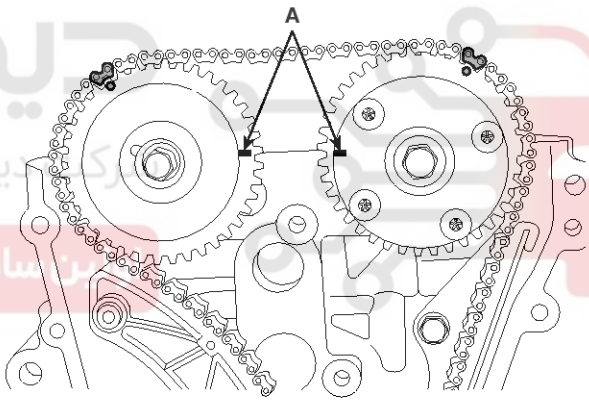
13. Align the timing marks of the camshaft sprocket with the upper sureface of the cylinder head to make No.1 cylinder be positioned at TDC.
    1) Check the dowel pin of the crankshaft for facing upside of the engine at this monent.
14. After installation of the chain guide(A), reassemble the timing chain(B).

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



SHDEM6076D

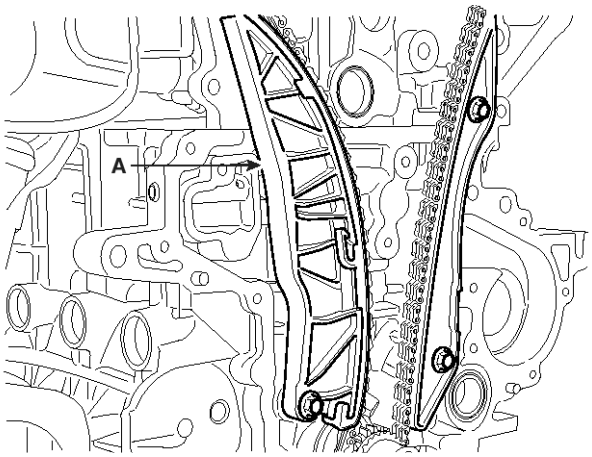
1) When installing a timing chain, align the timing marks(A) on the sprockets with ones of the chain.
   Order : Crankshaft sprocket → Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket.



SLDEM7120D

15. Install the chain tensioner arm(A).

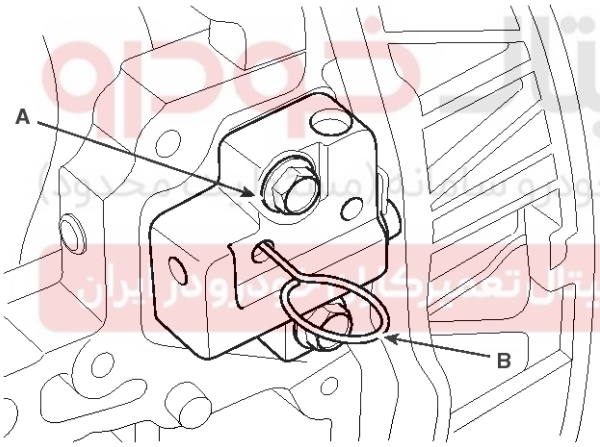
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



SHDEM6162D

16. Fix the hydraulic tensioner(A) with a pin(B) before installing the tensioner(A) and remove the pin(B) after installing the tensioner(A).

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

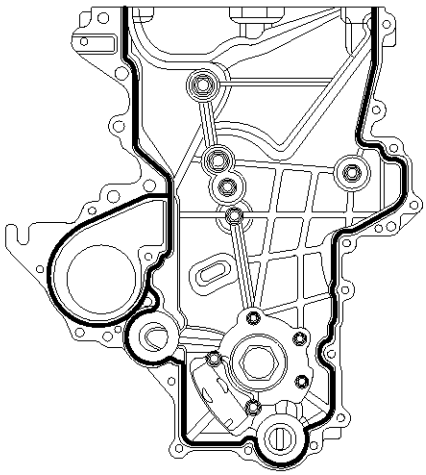


SHDEM6072D

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

17. Install the timing chain cover(A).
    1) Before installing, remove the hardened sealant from the cylinder block and ladder frame surface.
    2) Apply the sealant, THREE BOND 1282B on the timing chain cover and the water pump of the oil pump and the sealant, THREE BOND 1217H on the rest parts.

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



SLDEM7202D

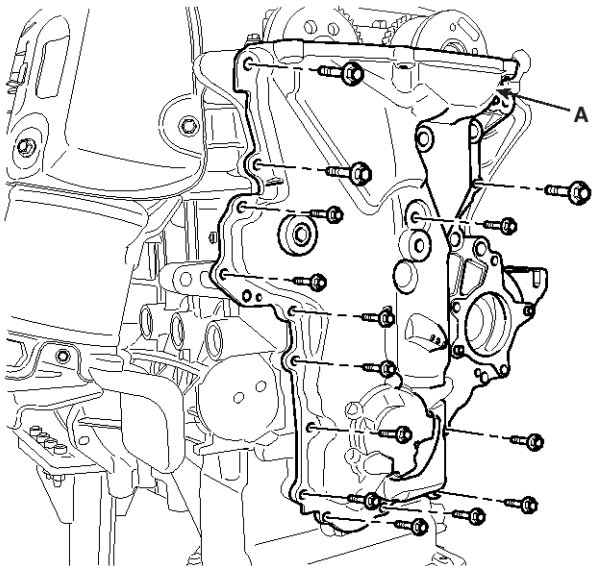
CAUTION
Remove oil or dust on the surface surely.

3) Apply the liquid gasket(1217H) on the surface between the cylinder head and the cylinder block and reassemble the cover(A) within five minutes.

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

4) Align the dowel pin of the cylinder block and the holes of the oil pump.

Tightening torque :
12mm bolts - 18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb-ft)
10mm bolts - 9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

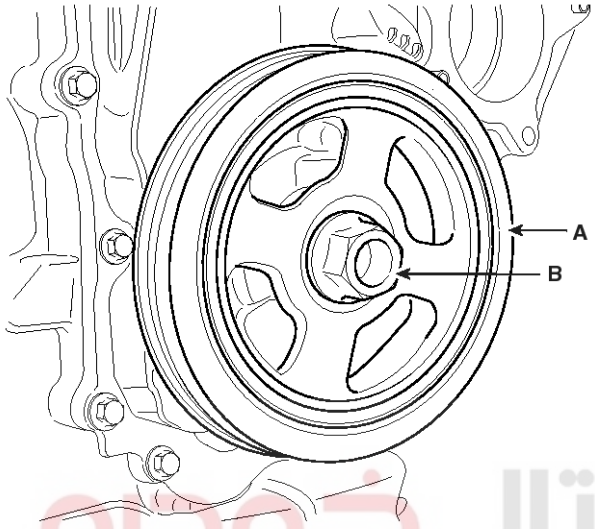


SHDEM6035D

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

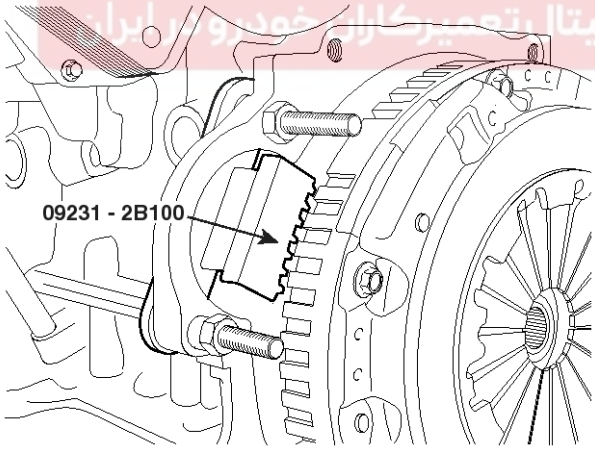
18. Install the crankshaft pulley(A).

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



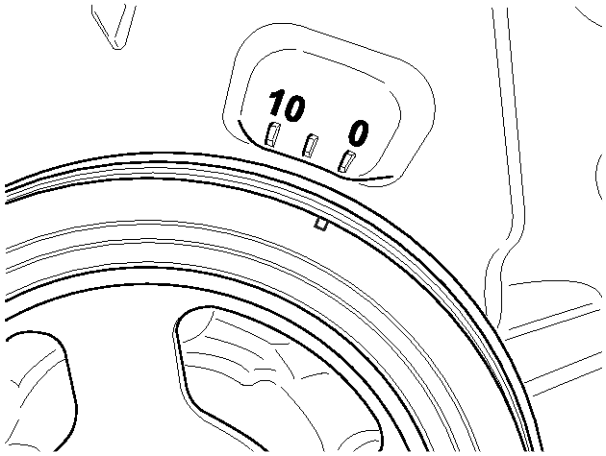
SHDEM6028D

NOTICE
When installing the pulley, remove the starter and fix the SST(09231-2B100).



SHDEM6182D

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



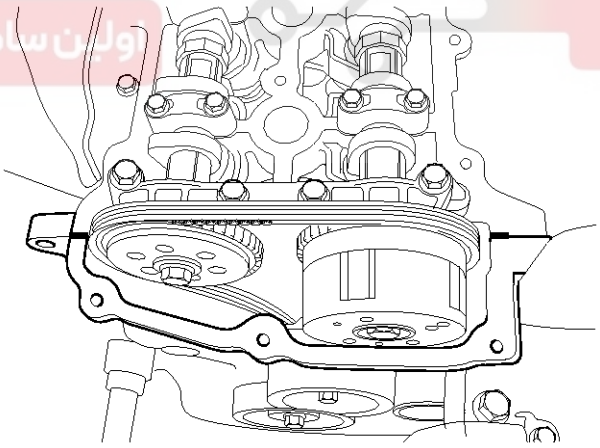
SHDEM6033D

19. Install the side cover.

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

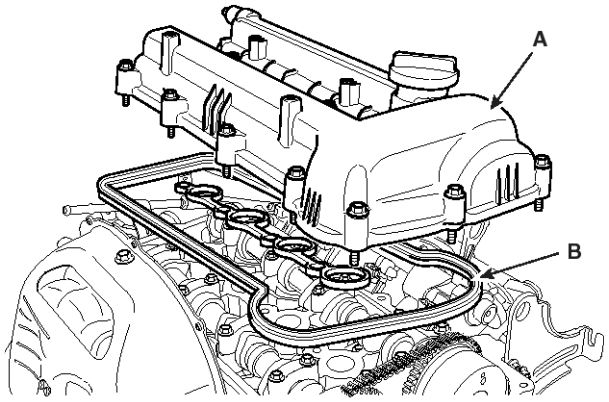
20. Install the front right wheel and tire.
21. Before installing the cylinder head cover, remove oil, dust or hardened sealant from the timing chain cover and the cylinder head upper surface.
22. After applying the liquid gasket, THREE BOND 1217H on the cylinder head cover, reassemble the cover within five minutes.

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



SHDEM6077D

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

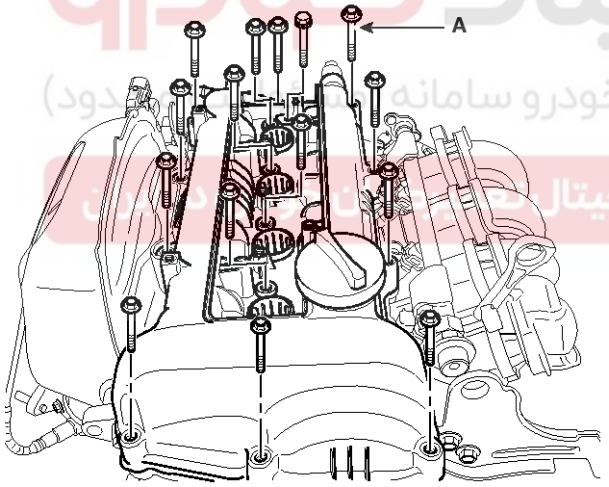


SHDEM6032D

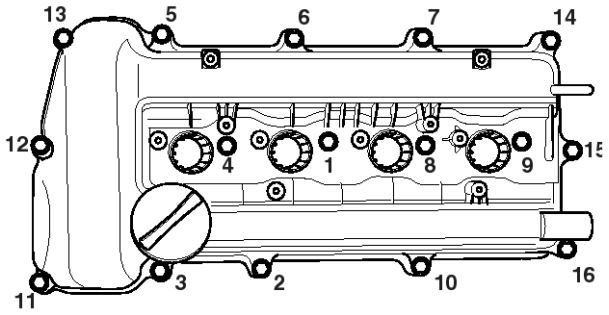
⚠CAUTION
Do not reuse the disassembled gasket.

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

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



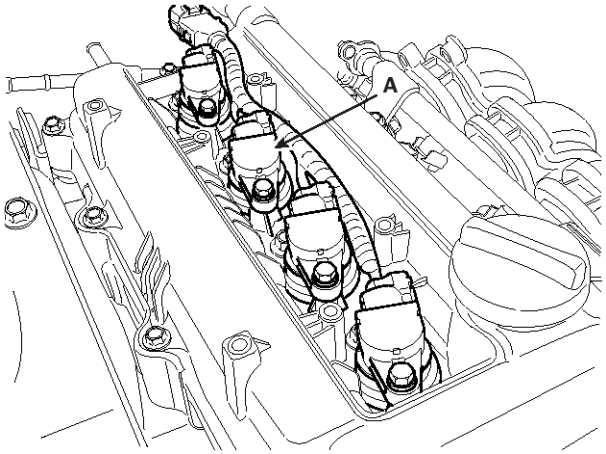
SHDEM6160D



SHDEM6078D

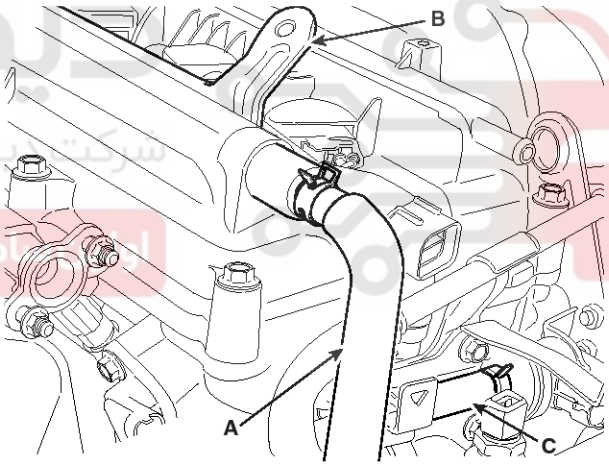
25. Install the ignition coils(A).

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



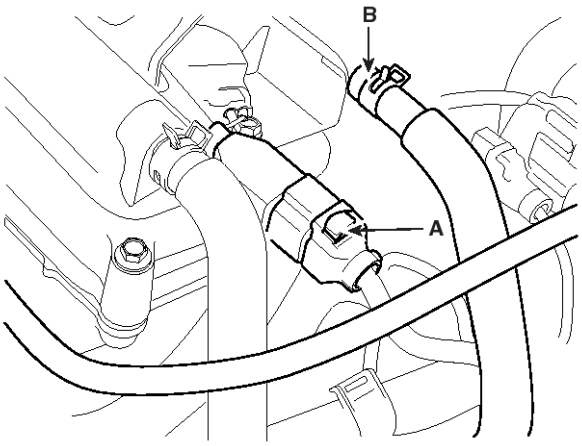
SHDEM6030D

26. Install the engine cover bracket(A), the positive crankcase ventilation(PCV) hose(B) and PCSV hose(C).



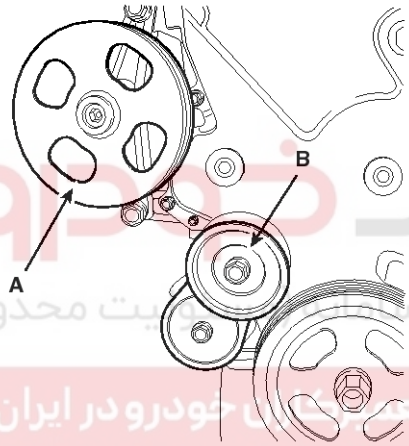
SHDEM6042L

27. Connect the ignition coil connector(A) and the breather hose(B).



SHDEM6041L

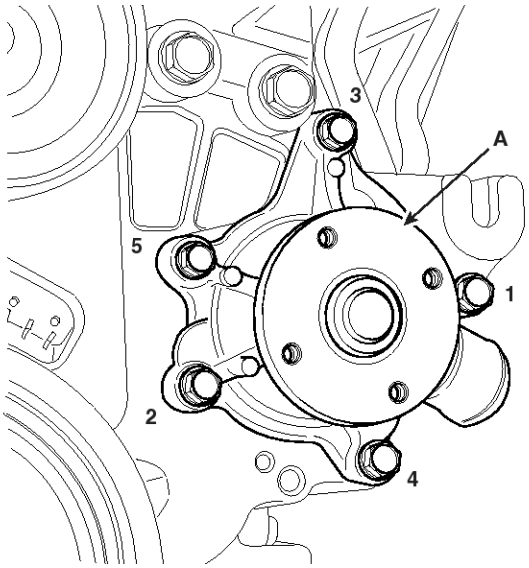
28. Install the power steering(A) and the drive belt auto-tensioner(B).



SLDEM7026D

29. Install the water pump(A) with a new gasket.

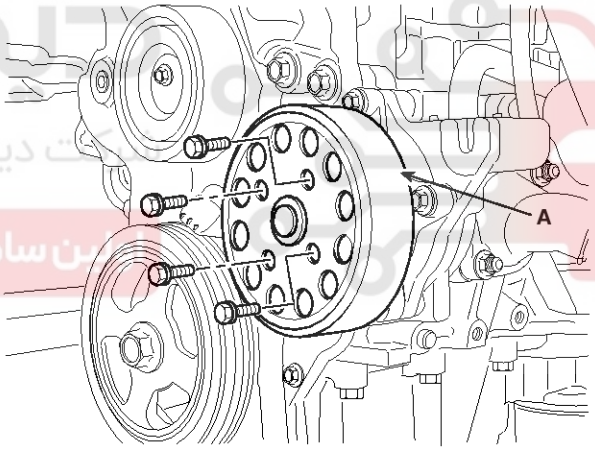
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



SLDEM7122D

30. Install the water pump pulley(A).

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

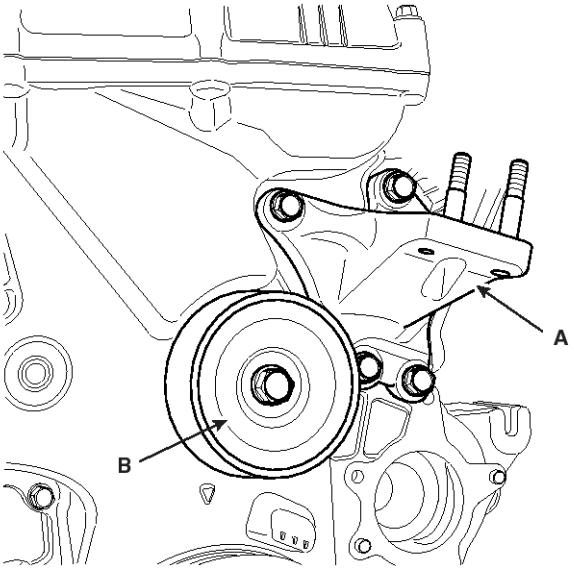


SHDEM6024D

⚠CAUTION
Tighten the bolts diagonally.

31. Install the engine support bracket(A) and the drive idle(B).

Tightening torque :
(A) : 29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)
(B) : 42.2 ~ 53.9 N.m (4.3 ~ 5.5 kgf.m, 31.1 ~ 39.8 lb-ft)



SLDEM7108D

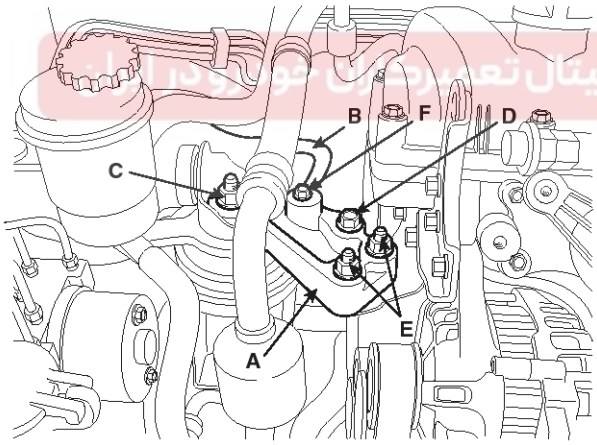
32. Supporting the engine with a jack, install the engine mounting bracket(A) and the ground line(B).

Tightening torque :

Nut(C) - 58.8 ~ 83.4 N.m (6.0 ~ 8.5 kgf.m, 43.4 ~ 61.5 lb-ft)

Bolt, nuts(D,E) - 49.0 ~ 58.8 N.m (5.0 ~ 6.0 kgf.m, 36.2 ~ 43.4 lb-ft)

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



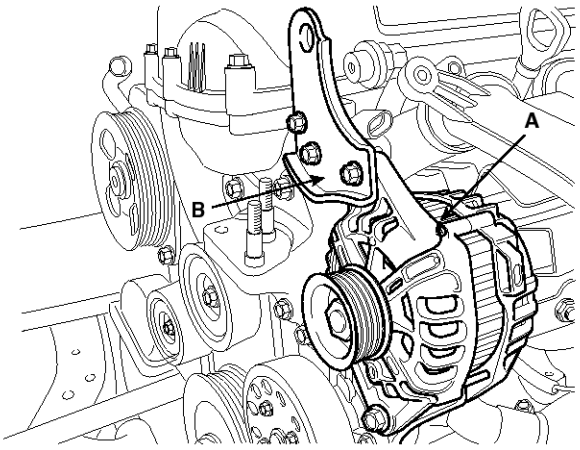
SLDEM7103L

33. Install the alternator(A) and the bracket(B).

Tightening torque :

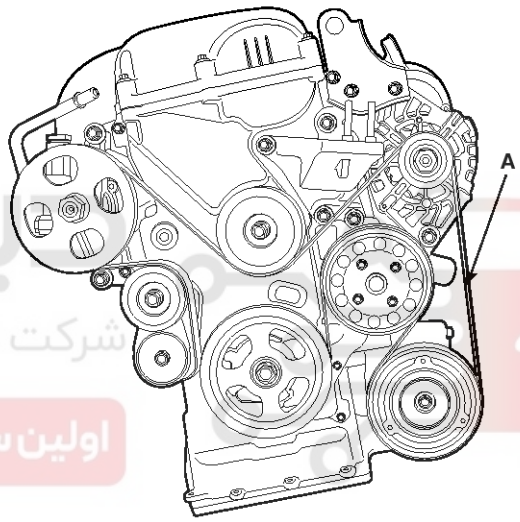
12mm bolts - 19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)

10mm bolts - 29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)



SLDEM7011D

34. Install the drive belt(A).

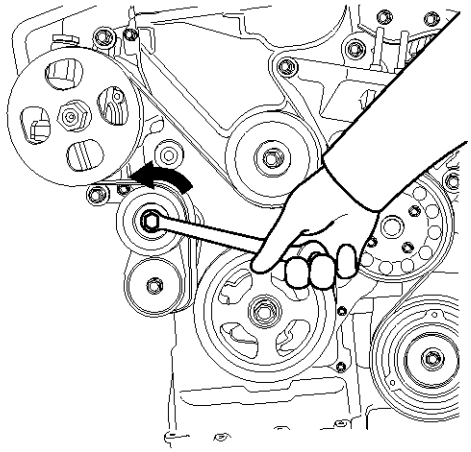


SLDEM7009D

NOTICE

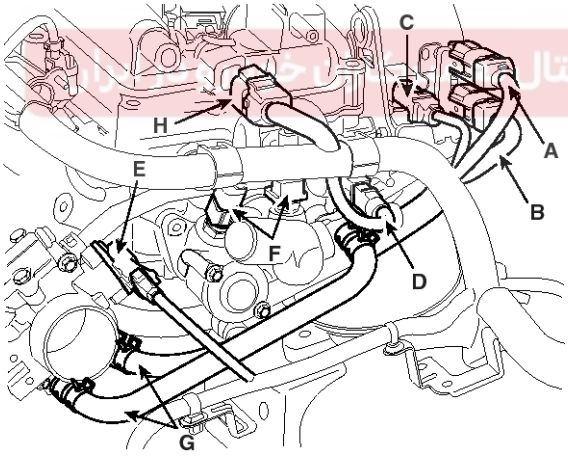
Install drive belt: crankshaft pulley →water pump pulley → alternator pulley → power steering pulley → auto-tensioner idle pulley.

Put the drive bolt to the idle pulley by rotating idle belt of the auto-tensioner in the counter- clockwise, release the auto-tensioner pulley slowly.



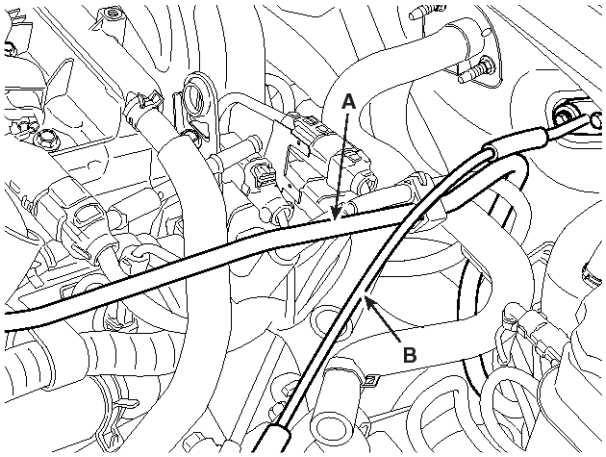
SLDEM7010D

35. Connect the connectors on the cylinder head and install the clamps.
    1) Connect the front(A) and the rear(B) oxygen sensor connector.
    2) Connect the ignition coil condenser connector(C) and the purge control solenoid valve(PCSV) conector(D).
    3) Connect the throttle position sense (TPS) connector(E).
    4) Connect the engine coolant temperature sensor (ECTS) connector(F) and the water hose(G).



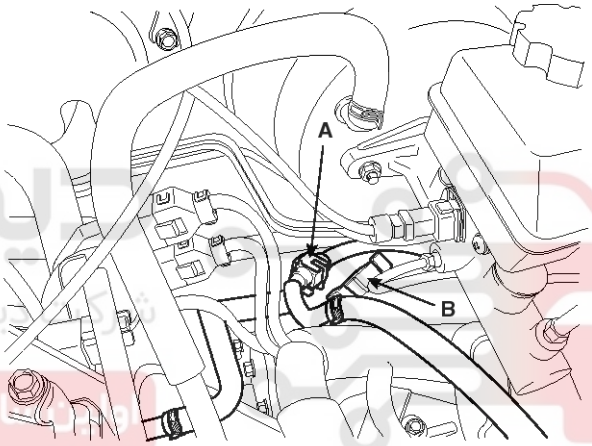
SLDEM7101D

36. Install the fuel hose(A) and the accelerator cable(B).



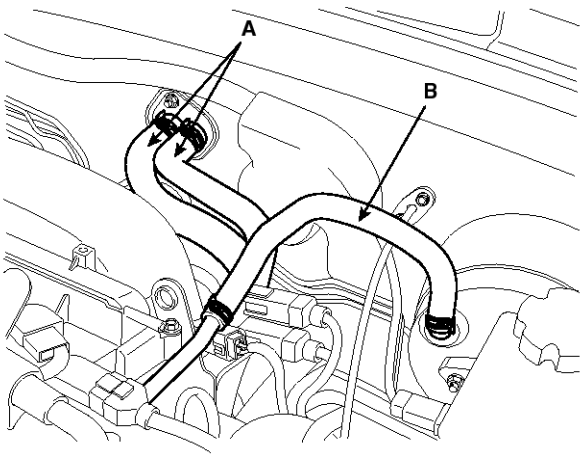
SHDEM6013D

37. Disconnect the fuel hose(A) and the hose(B) of the purge control solenoid valve(PCSV) side.



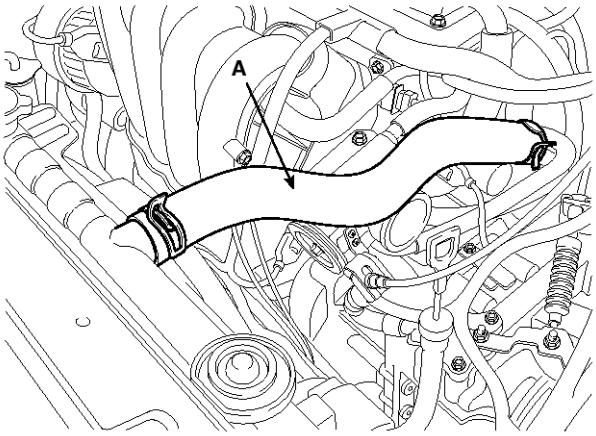
SLDEM7014D

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

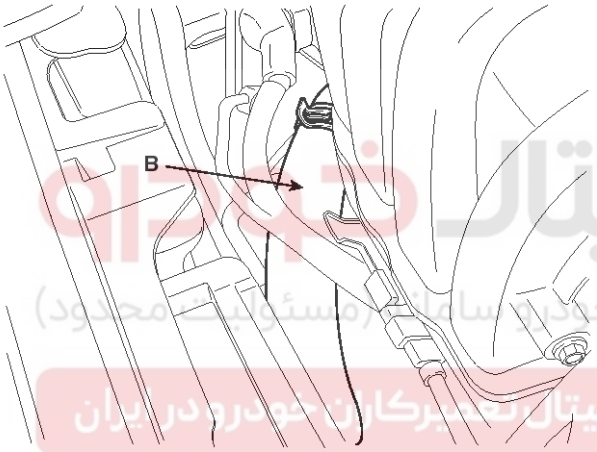


SLDEM7013D

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

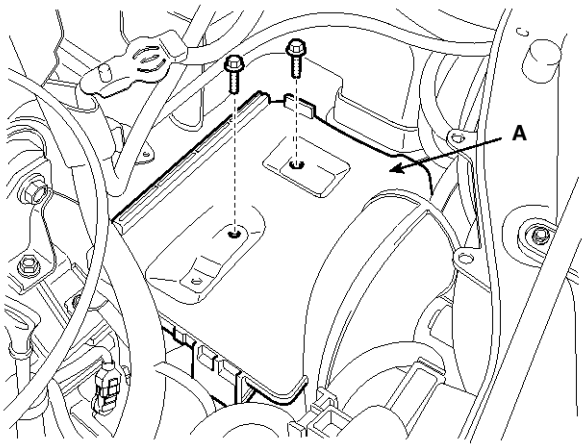


SLDEM7007D



SLDEM7201L

40. Install the battery tray(A).

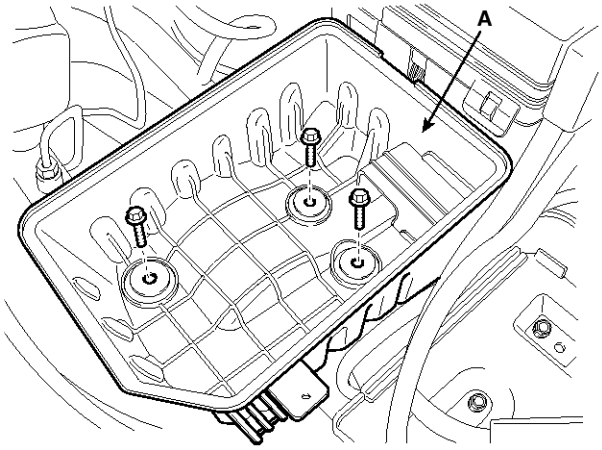


SLDEM7006D

41. Install the air cleaner assembly.

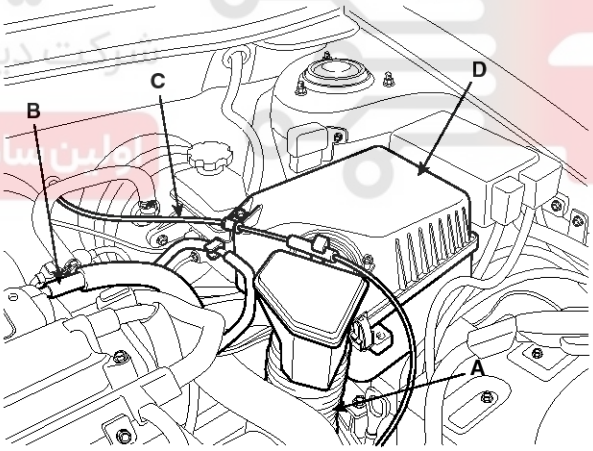
Tightening torque :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)

1) Install the air cleaner lower cover(A).



SLDEM7005D

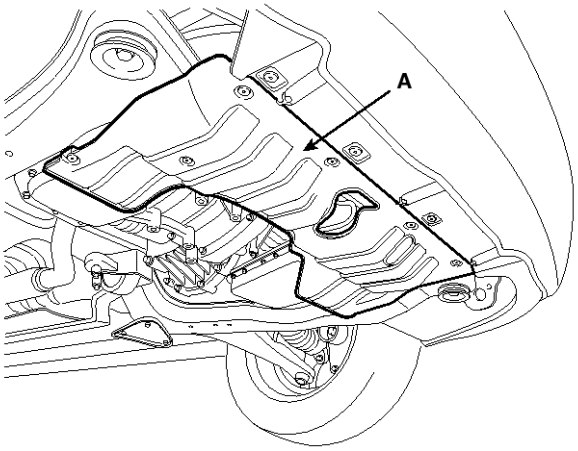
2) Install the air cleaner upper cover(D).
3) Connect the air cleaner intake hose(A) and bleeder(B).
4) Install the accelrator cable(C).



SLDEM7004D

42. Install the under cover(A).

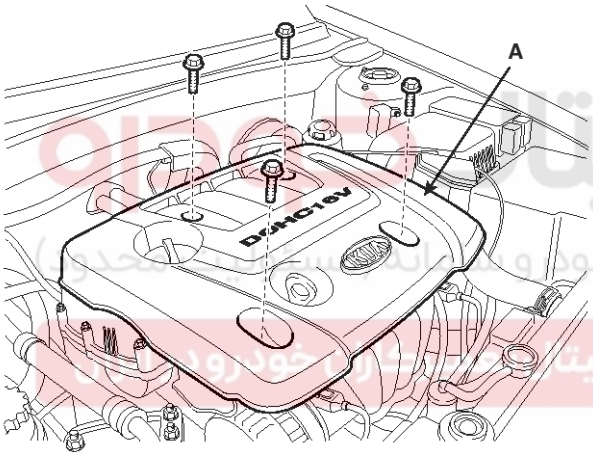
Tightening torque :
8.8 ~ 10.8N.m (0.9 ~ 1.1kgf.m, 6.5 ~ 8.0lb-ft)



SLDEM7003D

43. Install the engine cover(A).

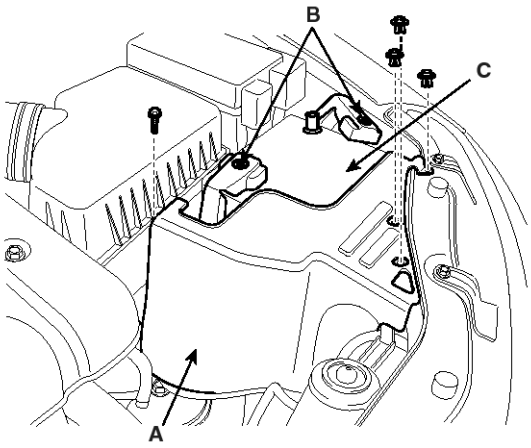
Tightening torque :
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



SLDEM7001D

⚠CAUTION
Install the cover surely before driving.

44. Install the battery(C), the heat shield(A) and connect the battery terminals(B).

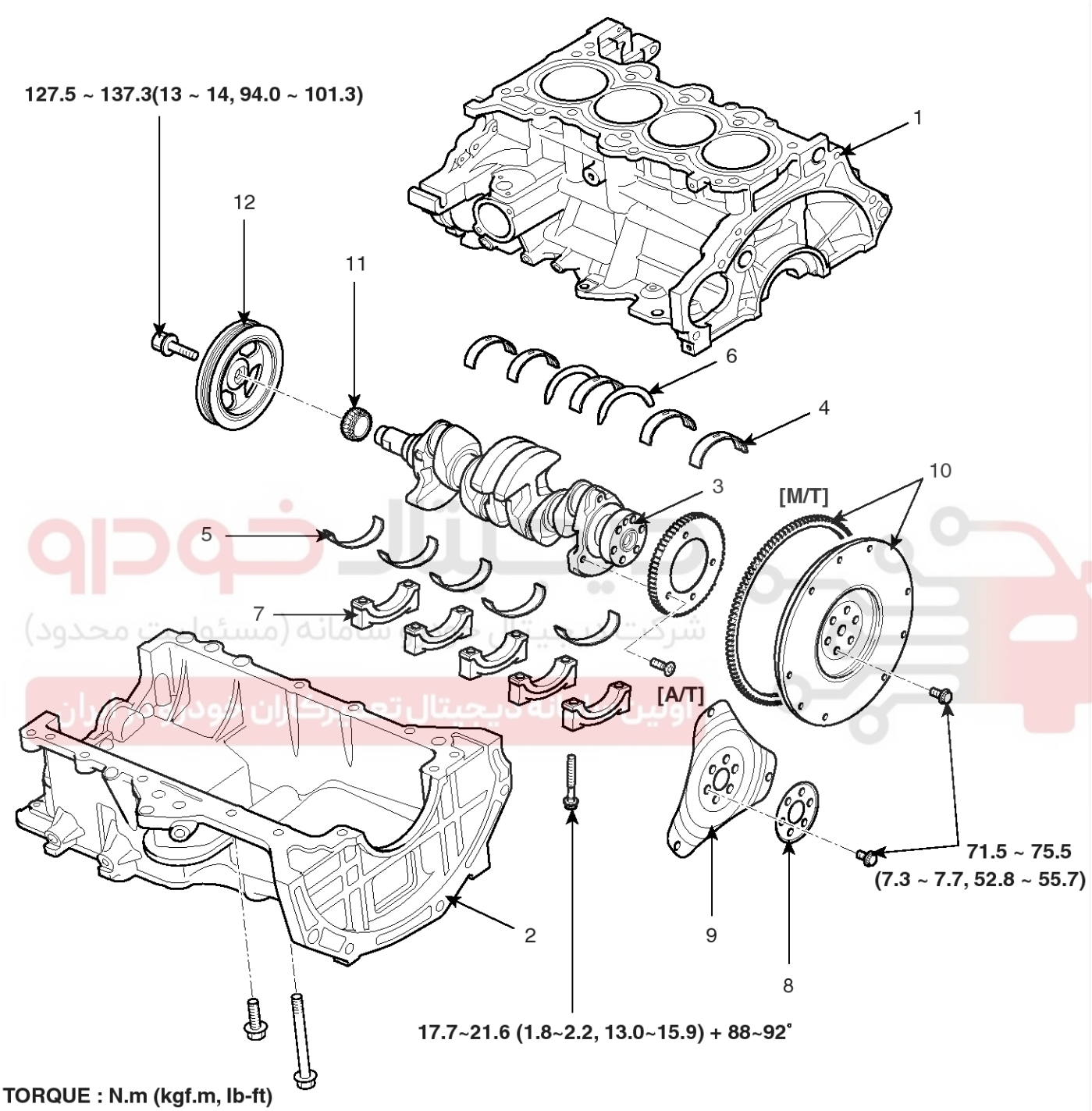


SLDM16100D

45. Refill engine coolant and engine oil.
46. Start engine and check for leakage.
47. Recheck the level of engine oil and coolant.

Cylinder Block

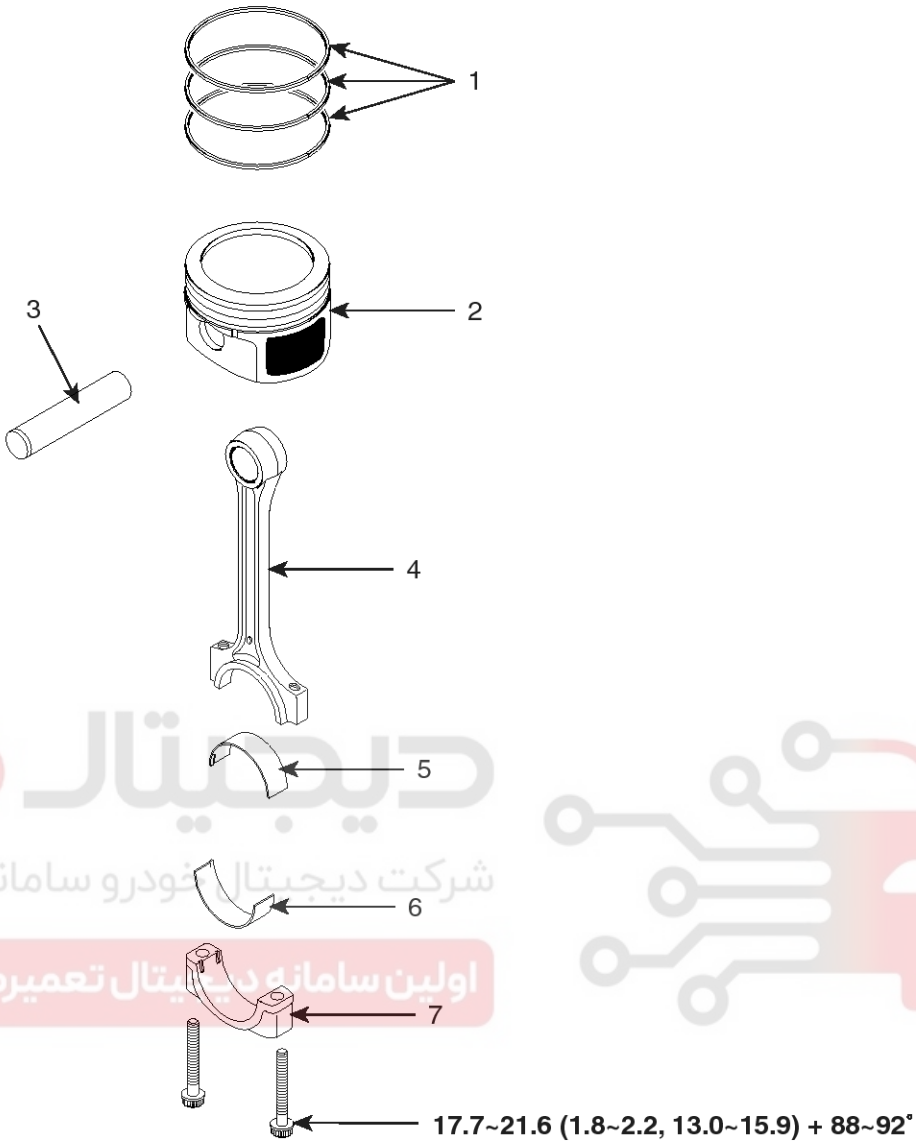
COMPONENTS



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

1. Cylinder block
2. Ladder freme
3. Crankshaft
4. Crankshaft upper bearing
5. Crankshaft lower bearing
6. Thrust bearing
7. Main bearing cap
8. Adapter plate
9. Drive piate
10. Fly wheel
11. Cramkshaft sproket
12. Crankshaft pulley

SLDEM7204L



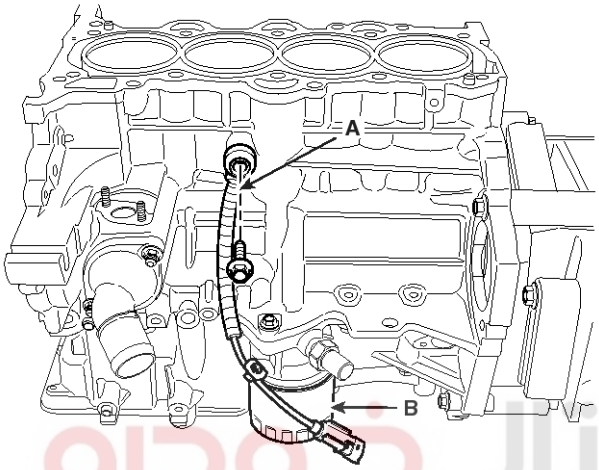
TORQUE : N.m (kgf.m, lb-ft)

1. Piston ring
2. Piston
3. Piston pin
4. Connecting rod
5. Connecting rod upper bearing
6. Connecting rod lower bearing
7. Connecting rod bearing cap

SHDEM6008L

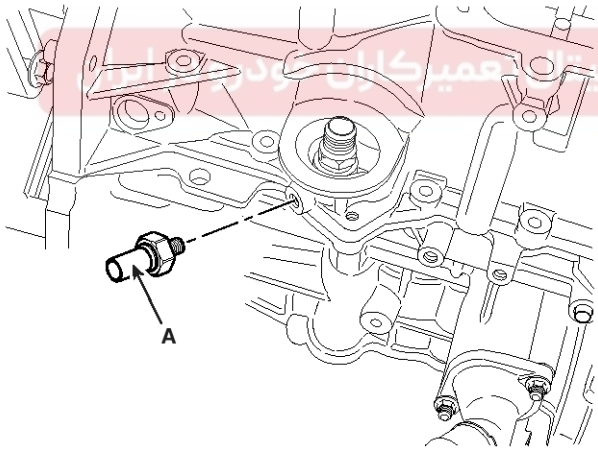
DISASSEMBLY

1. M/T : Remove the fly wheel.
2. A/T : Remove the drive plate.
3. Install the engine to engine stand for disassembly.
4. Remove the timing chain.
5. Remove the cylinder head.
6. Remove the oil level gauge tube.
7. Remove the knock sensor(A) and the oil filter(B).



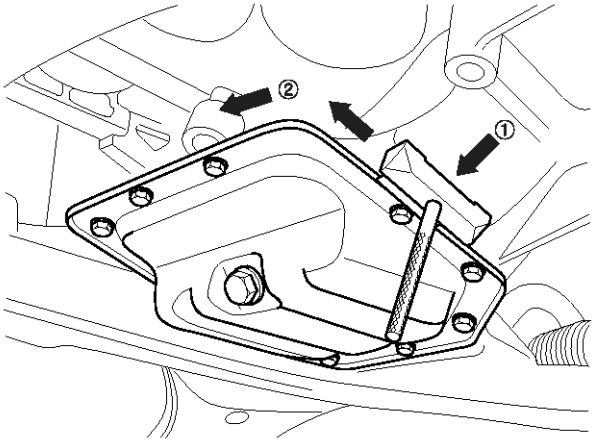
SHDEM6045D

8. Remove the oil pressure switch(A).



SHDEM6048D

9. Using the SST(09215-3C000) and remove the oil pan(A).

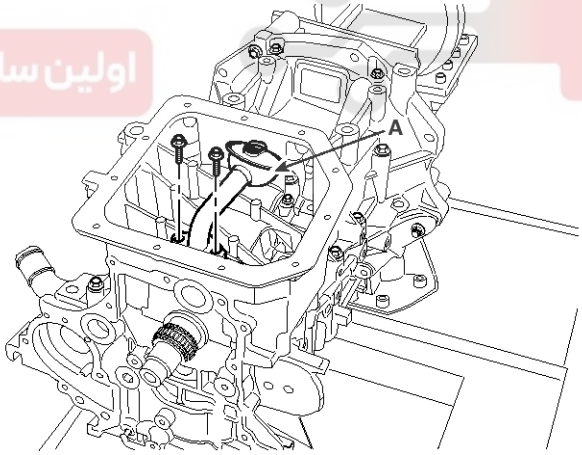


SHDEM6092D

⚠CAUTION

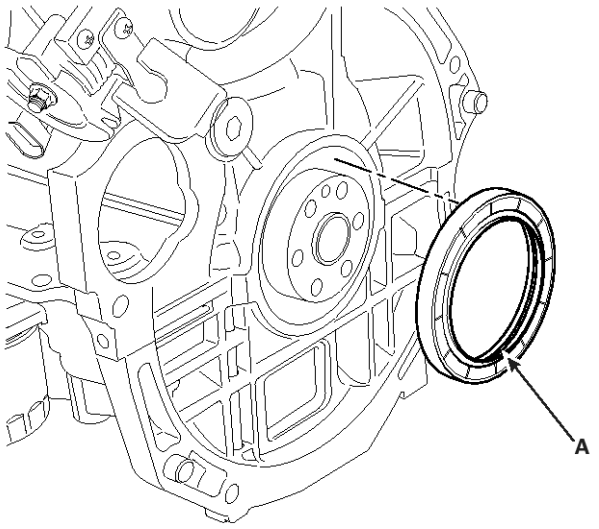
- **Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of ① arrow.**
- **After tapping the SST with a plastic hammer along the direction of ② arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.**
- **Do not turn over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

10. Remove the oil screen(A).



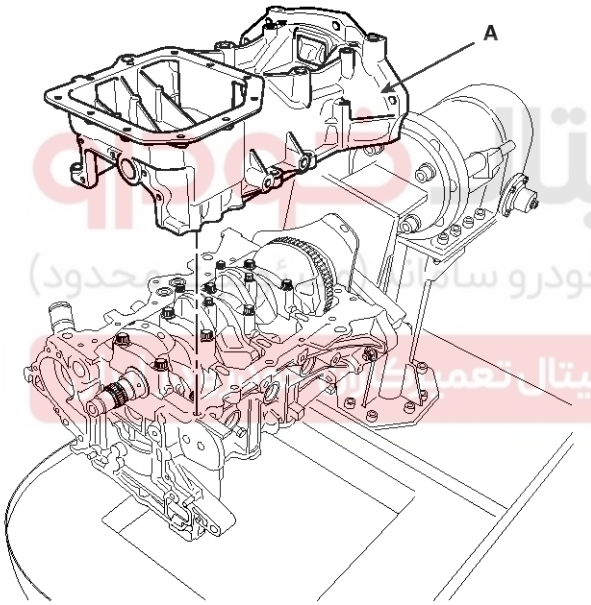
SHDEM6047D

11. Remove the rear oil seal(A).



SHDEM6050D

12. Remove the ladder frame(A).



SHDEM6049D

13. Check the connecting rod end play.
14. Remove the connecting rod caps and check 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) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

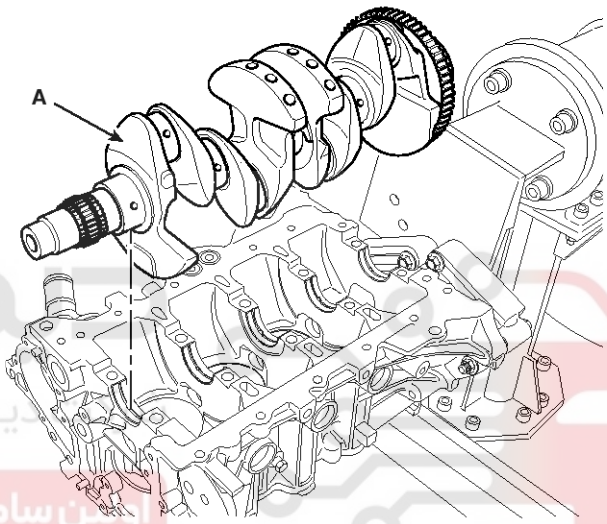
NOTICE

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

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

NOTICE

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



SHDEM6051D

19. Check fit between piston and piston pin.

    Try to move the piston back and forth on the piston pin.

    If any movement is felt, replace the piston and pin as a set.
20. Remove the piston rings.
    1) Using a piston ring expander, remove the 2 compression rings.
    2) Remove the 2 side rails and oil ring by hand.

    NOTICE

    Arrange the piston rings in the correct order only.
21. Remove the connecting rod from the piston.

    Using a press, remove the piston pin from piston.

    (Press-in load : 500 ~ 1,500kg(1,102 ~ 3,306lb))

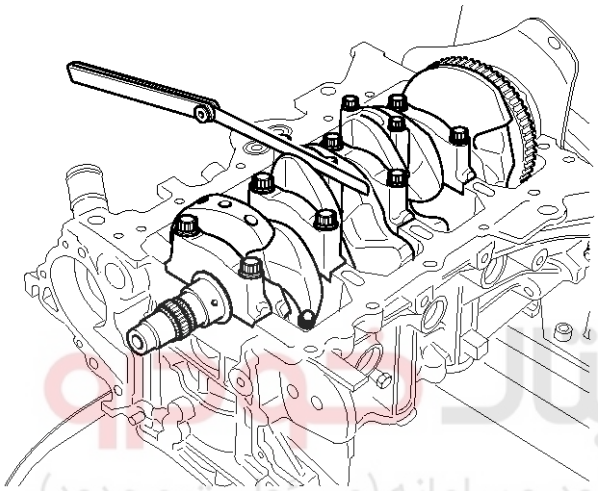
INSPECTION

CONNECTING ROD AND CRANKSHAFT

1. Check the connecting rod end play.

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

End play
Standard : 0.1 ~ 0.25mm (0.0039 ~ 0.0098in)
Maximum : 0.35mm (0.0138in)



SHDEM6052D

- If out-of-tolerance, install a new connecting rod.
- If still out-of-tolerance, replace the crankshaft.

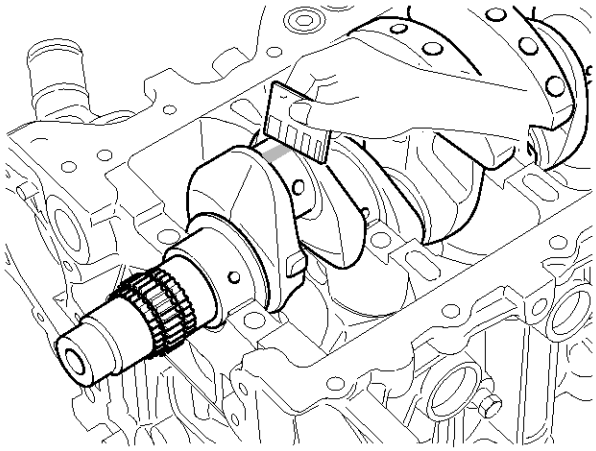
2. Check the connecting rod bearing oil clearance.
   1) Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.
   2) Remove the 2 connecting rod cap bolts.
   3) Remove the connecting rod cap and lower bearing.
   4) Clean the crankshaft pin journal and bearing.
   5) Place a plastigage across the crankshaft pin journal.
   6) Reinstall the lower bearing and cap, and tighten the bolts. Do not reuse the bolts.

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

NOTICE
Do not turn the crankshaft.

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

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



SHDEM6053D

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

      Recheck the oil clearance.

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

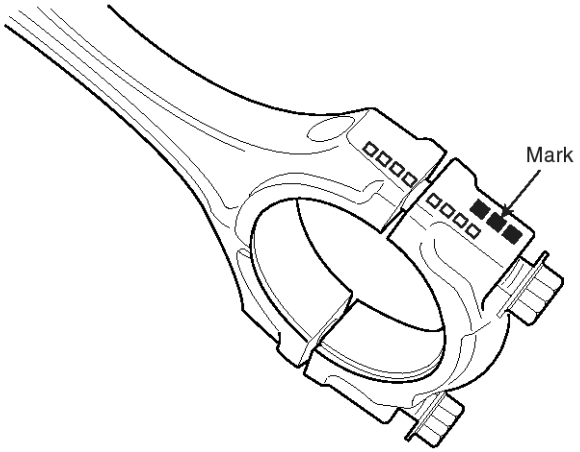
   10) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing.

      Recheck the oil clearance.

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

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

Connecting rod mark location

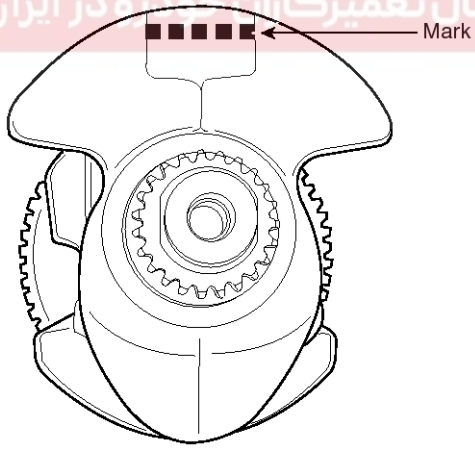


SHDEM6018L

Discrimination of connecting rod

Mark	Connecting rod big-end inner diameter
A, 0	45.000 ~ 45.006mm (1.7717 ~ 1.7719in)
B, 00	45.006 ~ 45.012mm (1.7719 ~ 1.7721in)
C, 000	45.012 ~ 45.018mm (1.7721 ~ 1.7724in)

Crankshaft pin journal mark location

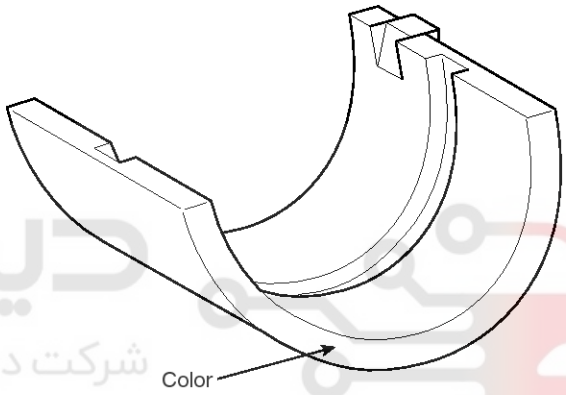


SHDEM6019L

Discrimination of crankshaft pin journal

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

Connecting rod bearing color location



SHDEM6027L

Discrimination of connecting rod bearing

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

11) Select the bearing by using selection table.

Connecting rod bearing selection table

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

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

Allowable bend of connecting rod :
0.05mm / 100mm (0.0020in / 3.94in) or less
Allowable twist of connecting rod :
0.1mm / 100mm (0.0039in / 3.94in) or less

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

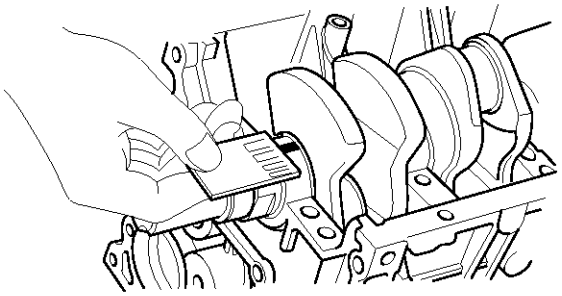
4. Check the crankshaft bearing oil clearance.
   1) To check main bearing-to-journal oil clearance, remove the main bearing caps and lower bearings.
   2) Clean each main journal and lower bearing with a clean shop towel.
   3) Place one strip of plastigage across each main journal.
   4) Reinstall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

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

NOTICE
Do not turn the crankshaft.

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

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



ECKD001I

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

   Recheck the oil clearance.

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

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

   Recheck the oil clearance.

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

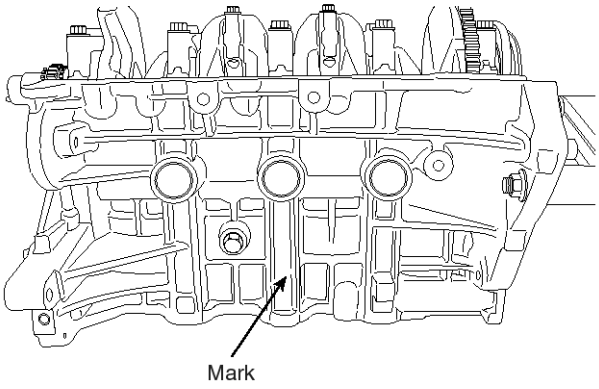
CAUTION
If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

Cylinder block crankshaft journal bore mark location

Letters have been stamped on the side surface of

the block as a mark for the size of each of the 5 main journal bores.

Use them, and the numbers or letters stamped on the crank (marks for main journal size), to choose the correct bearings.

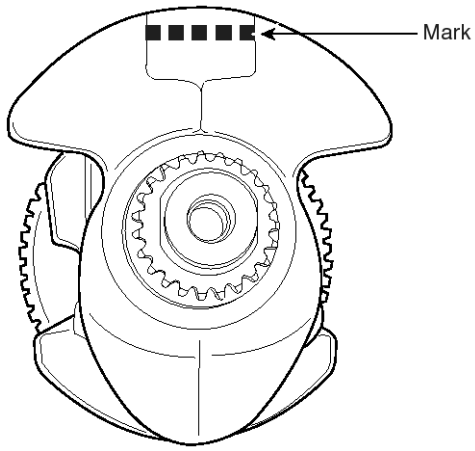


SHDEM6020L

Discrimination of cylinder block crankshaft journal bore

Mark	Cylinder block crankshaft journal bore inner diameter
A	52.000 ~ 52.006mm (2.0472 ~ 2.0475in)
B	52.006 ~ 52.012mm (2.0475 ~ 2.0477in)
C	52.012 ~ 52.018mm (2.0477 ~ 2.0479in)

Crankshaft main journal mark location

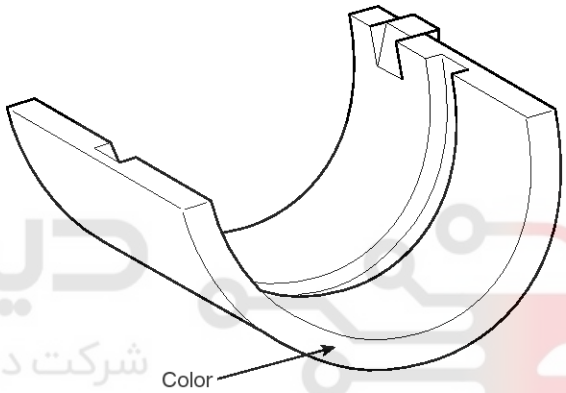


SHDEM6019L

Discrimination of crankshaft main journal

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

Crankshaft main bearing color location



SHDEM6027L

Discrimination of crankshaft main bearing

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

8) Select the bearing by using selection table.

Crankshaft main bearing selection table

		Cylinder block crankshaft journal bore mark		
		A	B	C
Crankshaft main journal mark	1	E (Red)	D (Green)	C (None)
	2	D (Green)	C (None)	B (Black)
	3	C (None)	B (Black)	A (Blue)

5. Check the crankshaft end play.

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

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

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

CYLINDER BLOCK

1. Remove the gasket material.

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

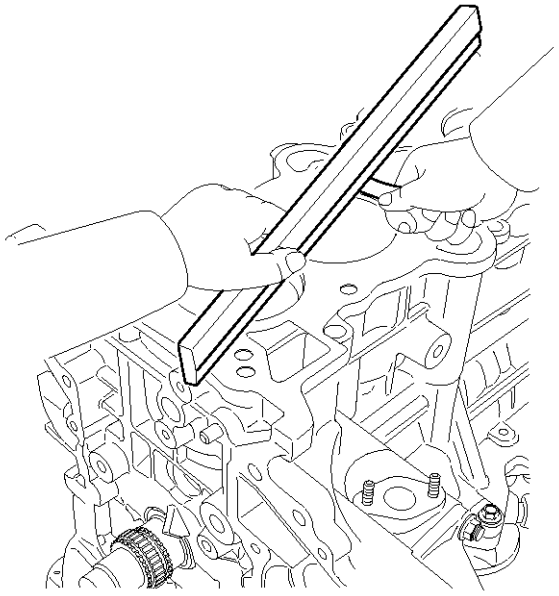
2. Clean the cylinder block

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

3. Inspect the top surface of cylinder block for flatness.

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

Flatness of cylinder block gasket surface
Standard :
Less than 0.05mm (0.0020in)
Less than 0.02mm (0.0008in) - 100mm × 100mm



SHDEM6042D

4. Inspect the cylinder bore.

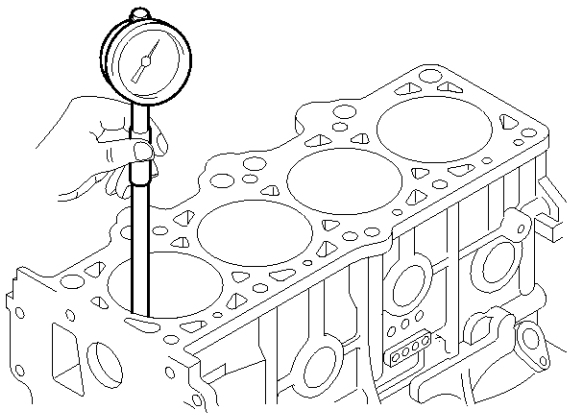
   Visually check the cylinder for vertical scratchs.

   If deep scratchs are present, replace the cylinder block.

5. Inspect the cylinder bore diameter.

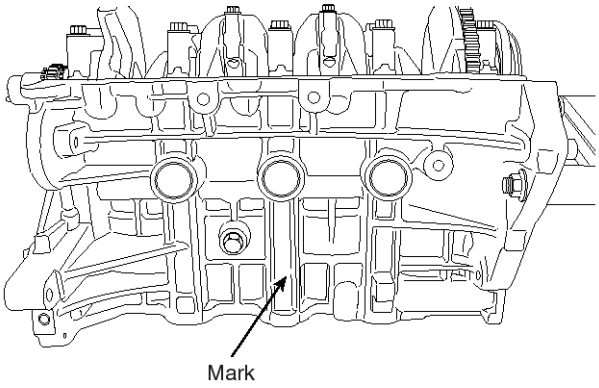
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial direction.

Standard diameter :
77.00 ~ 77.03mm (3.0315 ~ 3.0327in)



ECKD318A

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

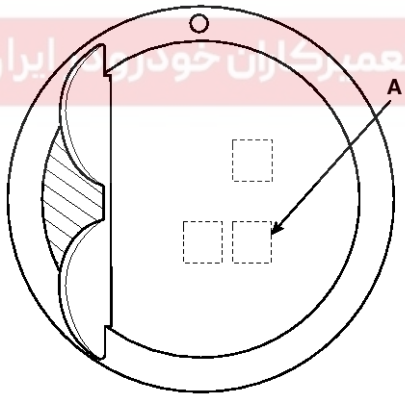


SHDEM6022L

Discrimination of cylinder bore size

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

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



SHDEM9103D

Discrimination of piston outer diameter

Mark	Piston outer diameter
A	76.97 ~ 76.98mm (3.0303 ~ 3.0307in)
B	76.98 ~ 76.99mm (3.0307 ~ 3.0311in)
C	76.99 ~ 77.00mm (3.0311 ~ 3.0315in)

8. Select the piston related to cylinder bore class.

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

Boring cylinder

1. Oversize pistons should be selected according to the largest bore cylinder.

   NOTICE
   The size of piston is stamped on top of the piston.

2. Measure the outside diameter of the piston to be used.
3. According to the measured O.D(Outer Diameter), calculate the new bore size.

New bore size = piston O.D + 0.02 to 0.04mm (0.0008 to 0.0016in) (clearance between piston and cylinder) - 0.01mm (0.0004in) (honing margin.)

4. Bore each of the cylinders to the calculated size.

   CAUTION
   To prevent distortion that may result from temperature rise during honing, bore the cylinder holes in the firing order.

5. Hone the cylinders, finishing them to the proper dimension (piston outside diameter + gap with cylinder).
6. Check the clearance between the piston and cylinder.

Standard : 0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

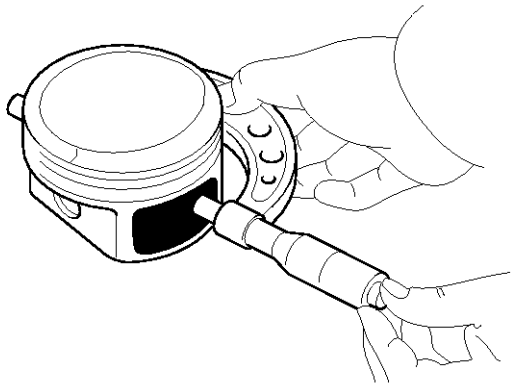
PISTON AND PISTON RINGS

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

      NOTICE
      Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 33.9mm(1.5697in) from top land of the piston.

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



SHDEM6028L

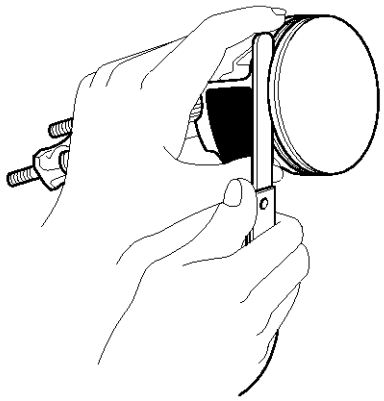
3. Calculate the difference between the cylinder bore inner diameter and the piston outer diameter.

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

4. Inspect the piston ring side clearance.

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

Piston ring side clearance
No.1 ring : 0.03 ~ 0.07mm (0.0012 ~ 0.0028in)
No.2 ring : 0.03 ~ 0.07mm (0.0012 ~ 0.0028in)
Oil ring : 0.06 ~ 0.15mm (0.0024 ~ 0.0059in)
Limit
No.1 ring : 0.1mm (0.0039in)
No.2 ring : 0.1mm (0.0039in)
Oil ring : 0.2mm (0.0079in)



SHDEM6029L

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

5. Inspect the piston ring end gap.

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

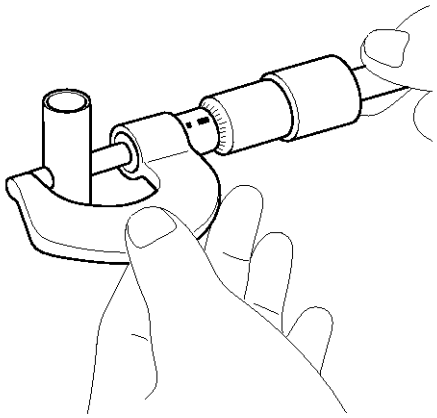
Piston ring end gap
Standard
No.1 ring : 0.14 ~ 0.28mm (0.0079 ~ 0.0138in)
No.2 ring : 0.30 ~ 0.45mm (0.0118 ~ 0.0177in)
Oil ring : 0.20 ~ 0.70mm(0.0079 ~ 0.0276in)
Limit
No.1 ring : 0.3mm(0.0118in)
No.2 ring : 0.5mm(0.0197in)
Oil ring : 0.8mm(0.0315in)

ACJF112A

PISTON PINS

1. Measure the outer diameter of piston pin

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



ECKD001Z

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

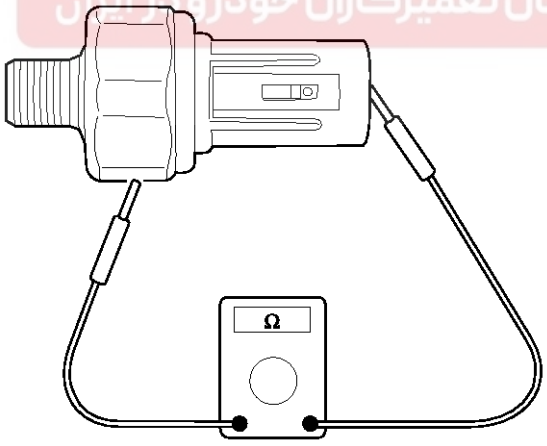
Piston pin-to-piston clearance :
0.010 ~ 0.020mm (0.0004 ~ 0.0008in)

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

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

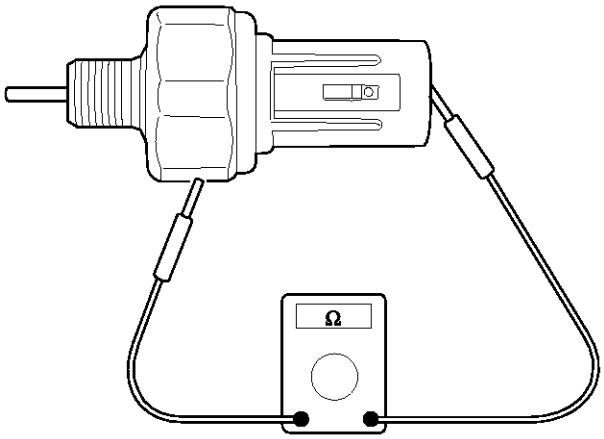
OIL PRESSURE SWITCH

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



SHDEM6059D

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.



SHDEM6157D

3. If there is no continuity when a 49.0kpa (0.5kg/cm², 7.1psi) vacuum is applied through the oil hole, the switch is operating properly.

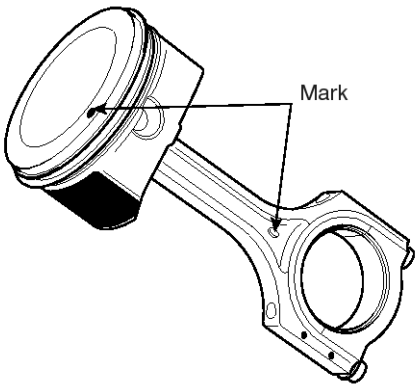
   Check for air leakage. If air leaks, the diaphragm is broken. Replace it.

REASSEMBLY

NOTICE

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

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



SHDEM6009L

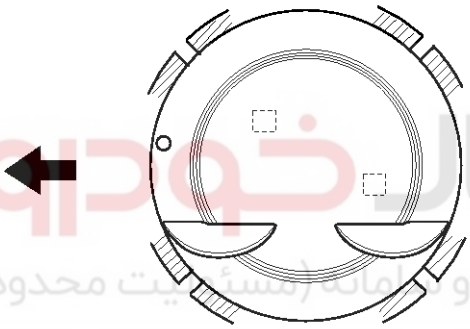
2. Install the piston rings.

NOTICE

The engine's piston ring sets are classified according to the displacement (1.4L, 1.6L), fuel type (Leaded, Unleaded) and application of the ISG(Idle Stop & Go) function.

Identify the engine type before selecting the piston ring set.

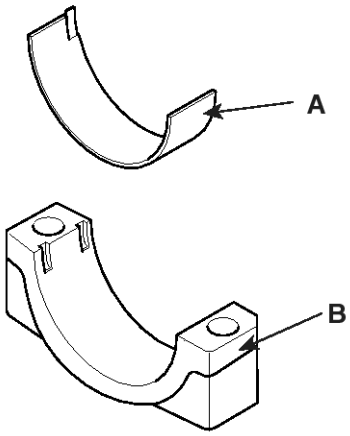
1) Install the oil ring expander and 2 side rails by hand.
2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
3) Position the piston rings so that the ring ends are as shown.



SLDEM7060D

3. Install the connecting rod bearings.

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



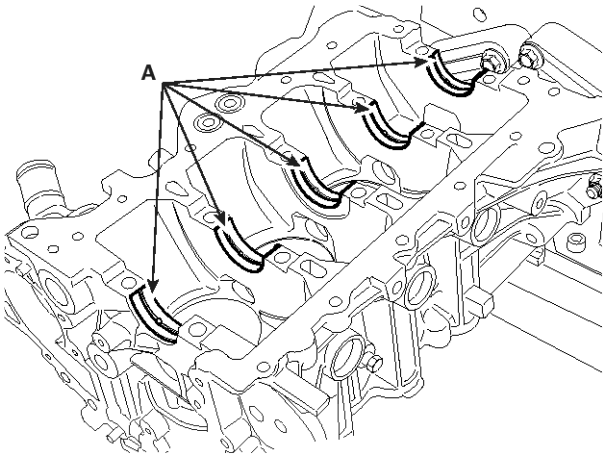
SHDEM6031L

4. Install the crankshaft main bearings.

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 five upper bearings(A).

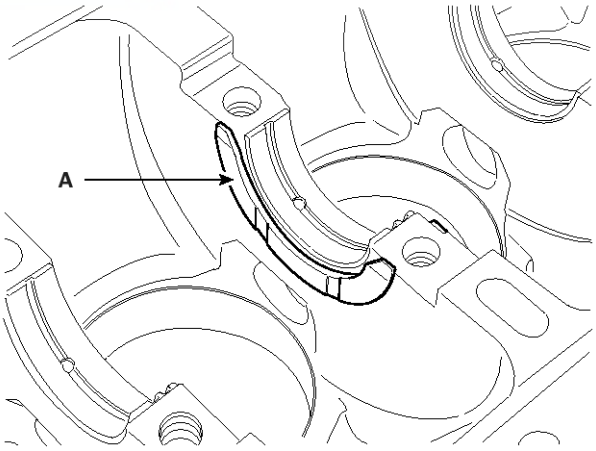


SHDEM6060D

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

5. Install the thrust bearing.

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



SHDEM6061D

6. Place the crankshaft on the cylinder block.
7. Place the main bearing caps on the cylinder block.

8. Install the main bearing cap bolts.

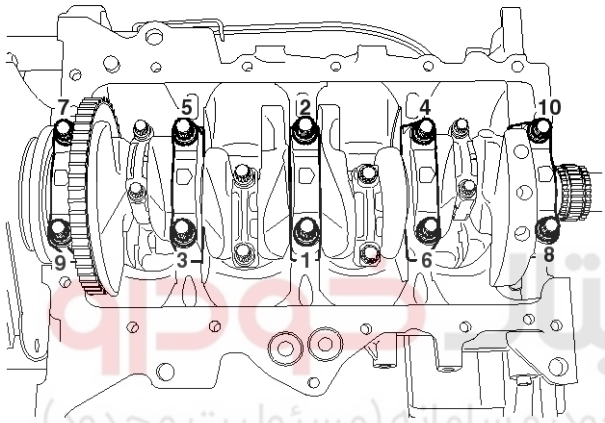
NOTICE

The main bearing cap bolts are tightened in 2 progressive steps.

If any of the bearing cap bolts in broken or deformed, replace it.

1) Apply a light coat of engine oil on the threads and under the bearing cap bolts.
2) Install and uniformly tighten the 10 bearing cap bolts, in several passes, in the sequence shown.

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



SHDEM6062D

CAUTION

Do not reuse the main bearing cap bolts.

3) Check that the crankshaft turns smoothly.

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

NOTICE

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

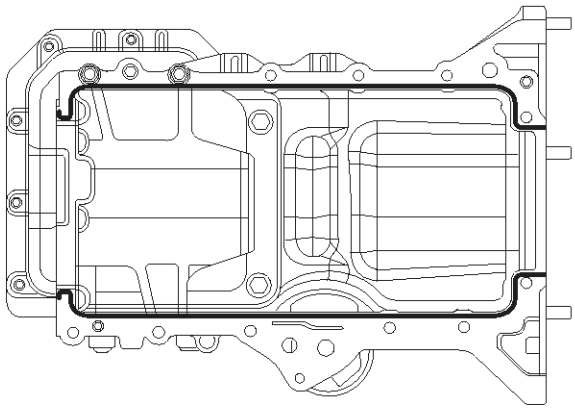
1) Install the ring compressor, check that the rings are securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.
2) Stop after the ring compressor pops free, and check the connecting rod-to-crank journal alignment before pushing the piston into place.
3) Install the rod caps with bearings, and tighten the bolts.

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

CAUTION

Do not reuse the connecting rod cap bolts.

11. Apply the sealant on the ladder frame.



SLDEM7203D

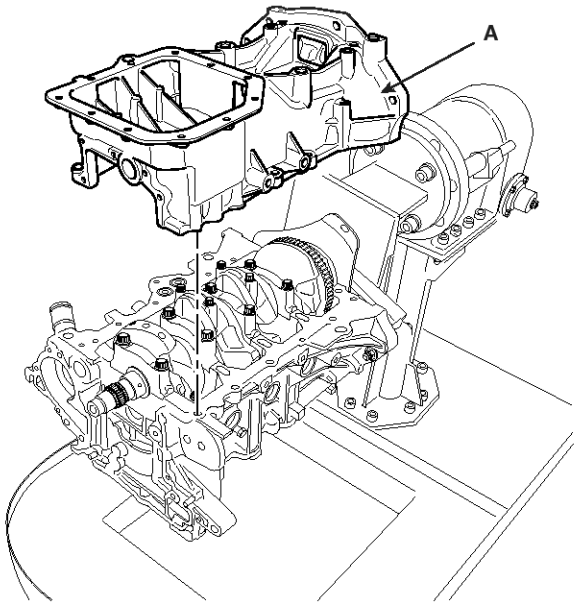
NOTICE

- *Apply the sealant, THREE-BOND 1217H on the ladder frame rail portion and install it with in five minutes.*

  If when sealant is applied to cylinder block bottom position, sealant position to be same with position that is applied to ladder frame rail position
- *Apply sealant along the inner line of the bolt holes.*

12. Install the ladder frame(A).

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



SHDEM6049D

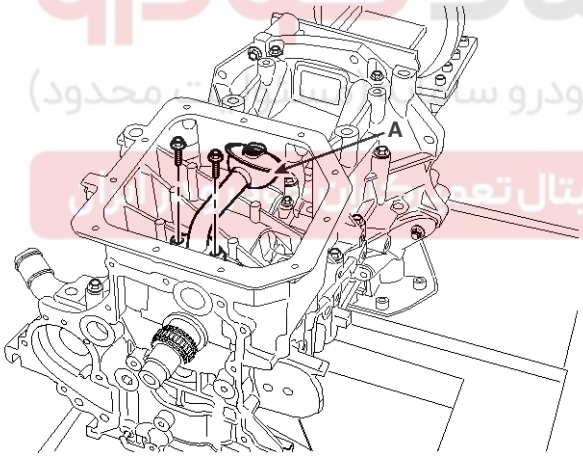
13. Install the rear oil seal.
    1) Apply engine oil to a new oil seal lip.
    2) Using the SST(09231-H1100, 09231-2B200) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

STDEM9036N

14. Install the oil screen.

    Install a new gasket and oil screen with 2 bolts.

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

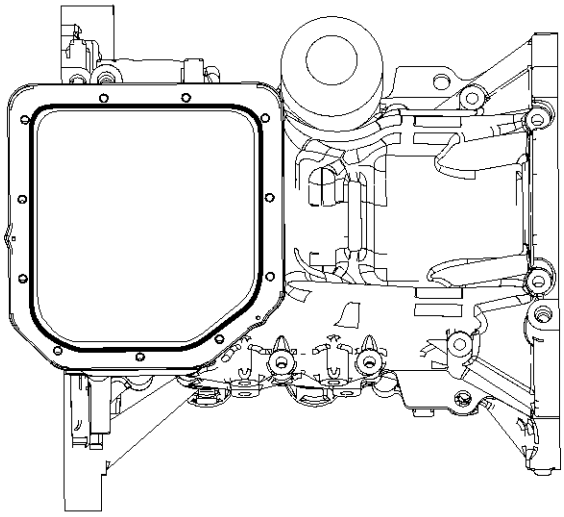


SHDEM6047D

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

       NOTICE
       Check that the mating surfaces are clean and dry before applying liquid gasket.
    2) Apply liquid gasket with the width of Ø3mm, starting 1mm-away position from the inner rounding of the oil pan rail.

Liquid gasket : TB 1217H or equivalent



SHDEM6033L

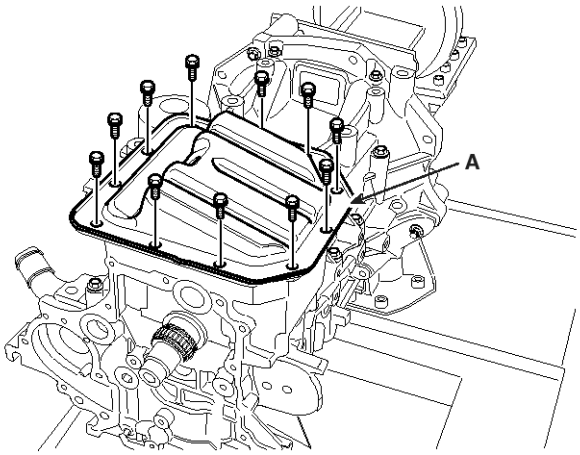
NOTICE
- *To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.*
- *Do not install the parts if five minutes or more have elapsed since applying the liquid gasket.*

  Instead, reapply liquid gasket after removing the residue.
- *After assembly, wait at least 30 minutes before filling the engine with oil.*

    3) Install the oil pan(A) with the bolts.

       Uniformly tighten the bolts in several passes.

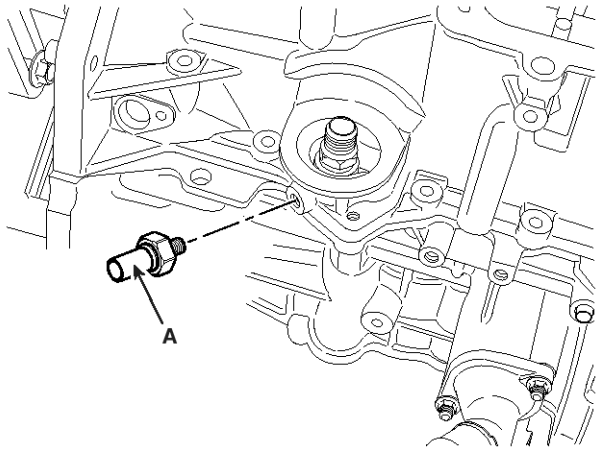
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHDEM6046D

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

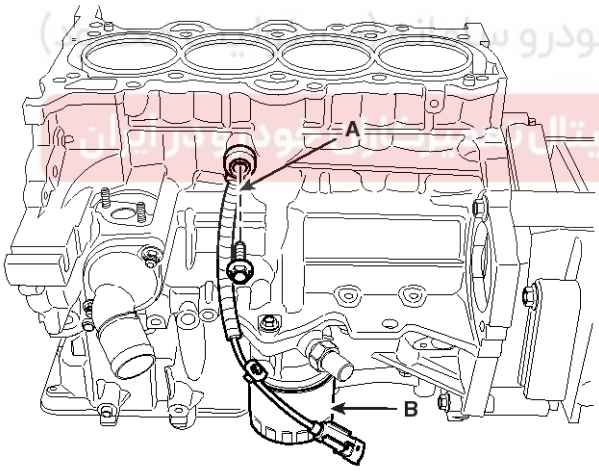
Tightening torque :
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



SHDEM6048D

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

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



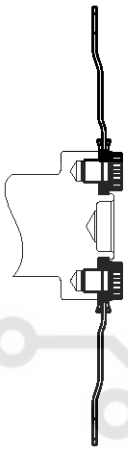
SHDEM6045D

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

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

19. Install the cylinder head.
20. Install the timing chain.
21. Remove the engine stand.
22. A/T :install the drive plate.

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



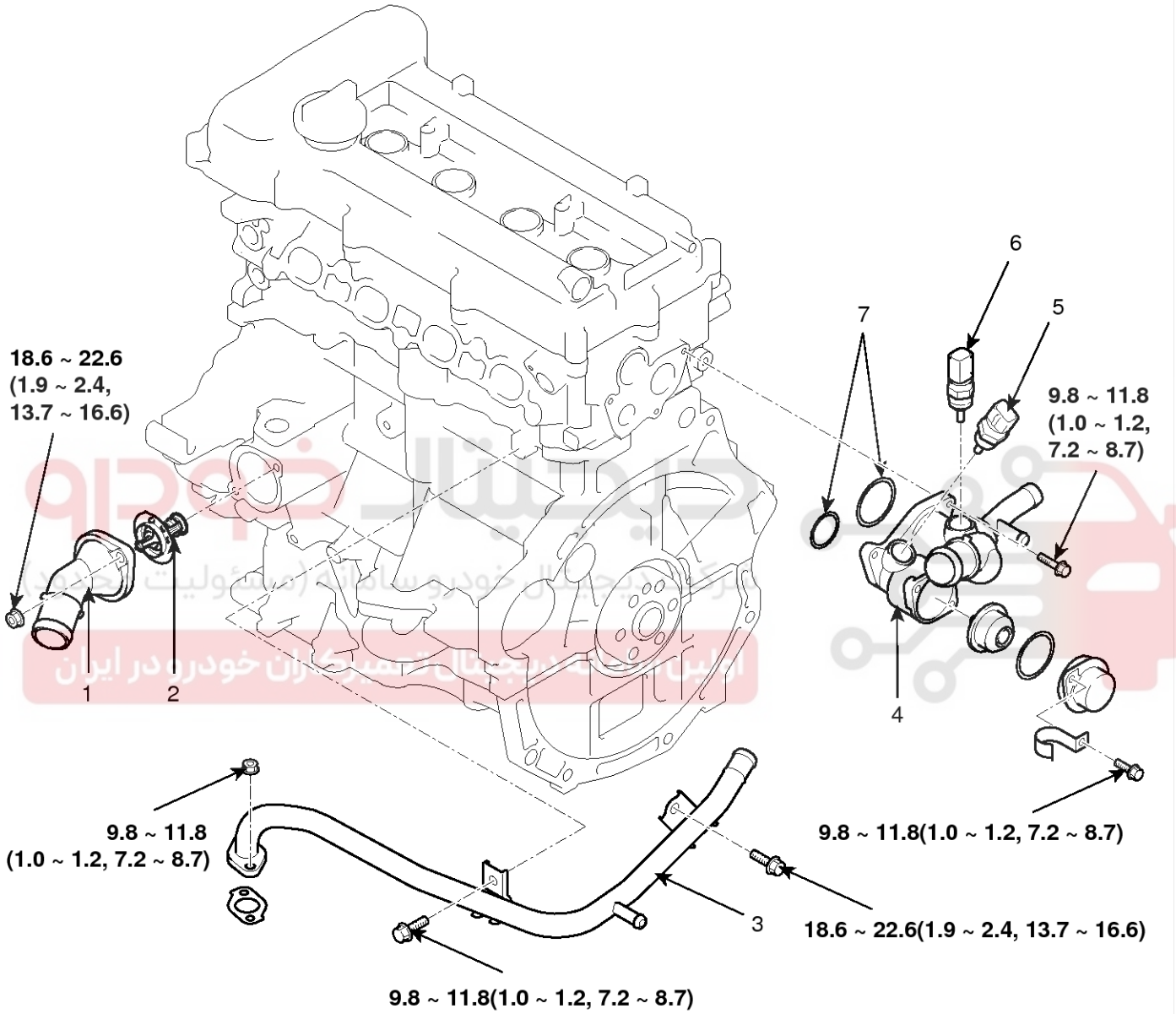
SHDEM6010L

23. M/T :install the fly wheel.

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

Cooling System

COMPONENTS



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

1. Water inlet fitting
2. Thermostat
3. Heater pipe
4. Water pump control assembly
5. Engine coolant temperature sensor
6. Gauge unit
7. Gasket

SHDM27005L

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 of the paint. If any coolant spills, rinse it off immediately.

1. Remove the radiator cap.
2. Loosen the drain plug, and drain coolant.
3. Tighten the radiator drain plug securely.
4. Remove the coolant reservoir tank. Drain the coolant and reinstall the coolant reservoir tank. Fill the coolant reservoir tank to the MAX mark with coolant mixture.(coolant 4 : water 6)
5. Fill coolant mixture into the radiator to the base of filler neck. Gently squeeze the upper/lower hoses of radiator so as to bleed air easily.

   CAUTION

   - **Mix the recommended antifreeze with an equal amount of water in a clean container.**
   - **Use only genuine antifreeze/coolant.**
   - **For best corrosion protection, the coolant concentration must be maintained year-round at 50% minimum. Coolant concentrations less than 50% may not provide sufficient protection against corrosion of freezing.**
   - **Coolant concentration 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.**
6. Start engine and allow coolant mixture to circulate.

   When the cooling fan operates and coolant circulates, refill coolant through the radiator filler neck.
7. Repeat 7 until the cooling fan 3~5 times and bleed air sufficiently out of the cooling system.
8. Install the radiator cap and fill the reservoir tank to the "MAX" line with coolant.
9. Run the vehicle under idle until the cooling fan operates 2~3 times.
10. Stop the engine and allow coolant to cool.
11. Repeat steps 6 to 11 until the coolant level stays constant and all air is bleed out of the cooling system.

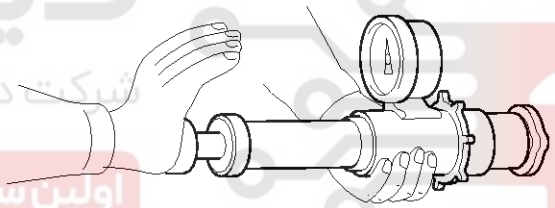
    NOTICE

    Recheck the coolant level in the reservoir tank for 2~3 days after replacing coolant.

Coolant capacity :
5.8 ~ 5.9 liters(6.13 ~ 6.23 US qt, 5.10 ~ 5.19 Imp qt)

RADIATOR CAP TESTING

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

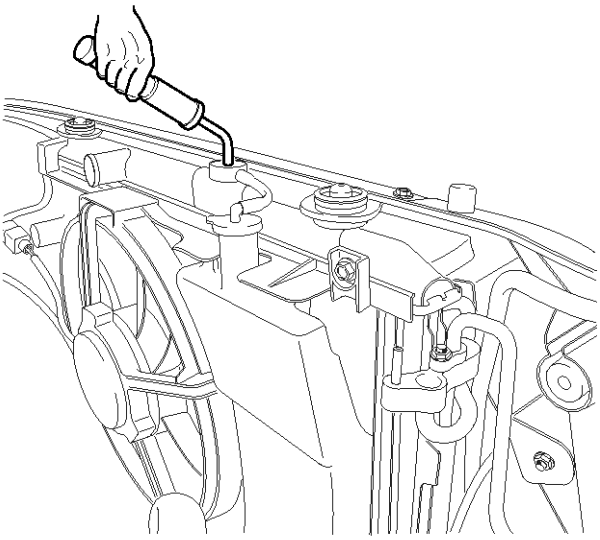


ECKD501X

2. Apply a pressure of 93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi).
3. Check for a drop in pressure.
4. If the pressure drops, replace the cap.

RADIATOR LEAKGE TEST

1. Wait until engine is cool, then carefully remove the radiator cap and fill the radiator with engine coolant, then install it on the pressure tester.
2. Apply a pressure tester to the radiator and apply a pressure of 93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi).



SLDEM7112D

3. Inspect for engine coolant leaks and a drop in pressure.
4. Remove the tester and reinstall the radiator cap.

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

REMOVAL

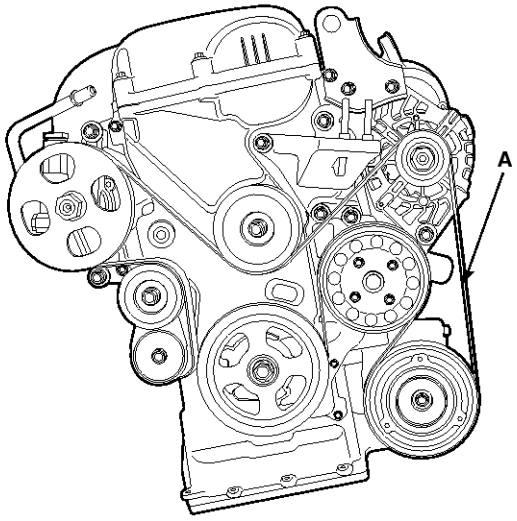
WATER PUMP

1. Drain engine coolant.

WARNING
System is under high pressure when the engine is hot.

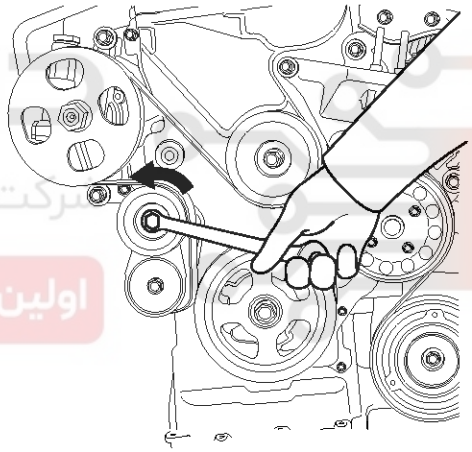
To avoid danger of releasing scalding engine coolant, remove the cap only when the engine is cool.

2. Remove the drive belt(A).



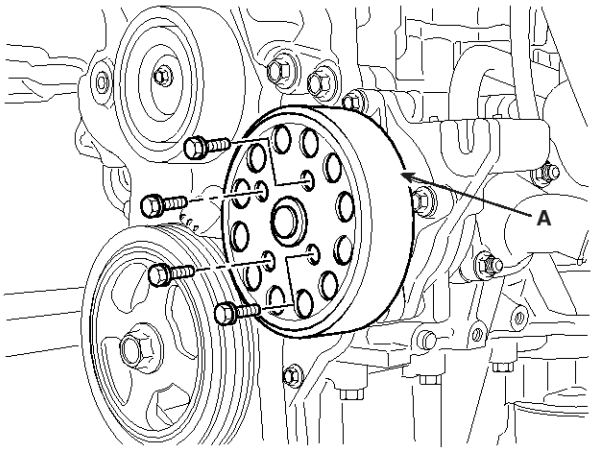
SLDEM7009D

NOTICE
Remove the drive belt by turning the auto-tensioner counterclockwise.



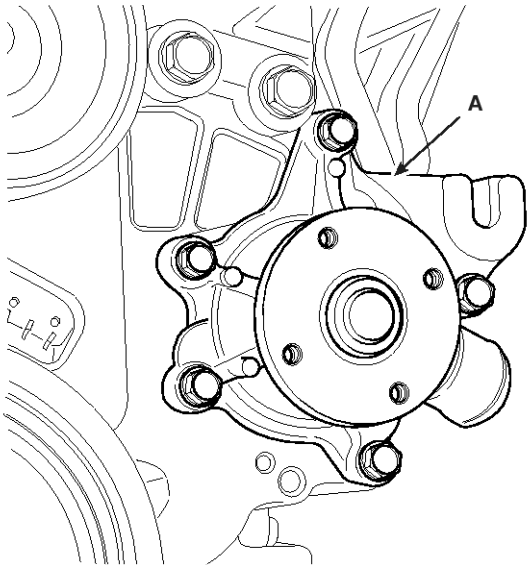
SLDEM7010D

3. Remove the water pump pulley(A).



SHDEM6024D

4. Remove the water pump(A).



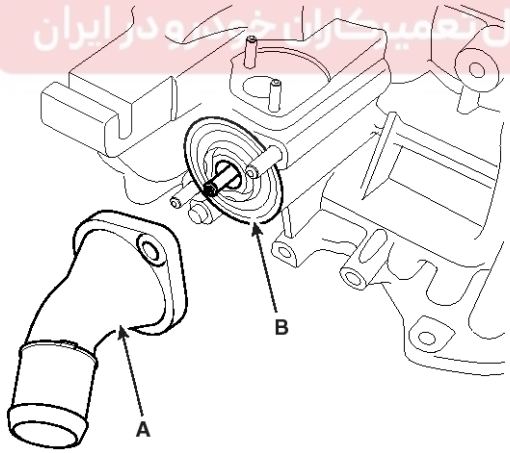
SHDEM6025D

THERMOSTAT

NOTICE

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

1. Drain engine coolant so that its level would be under the thermostat height.
2. Remove the water inlet fitting(A), gasket and thermostat(B).

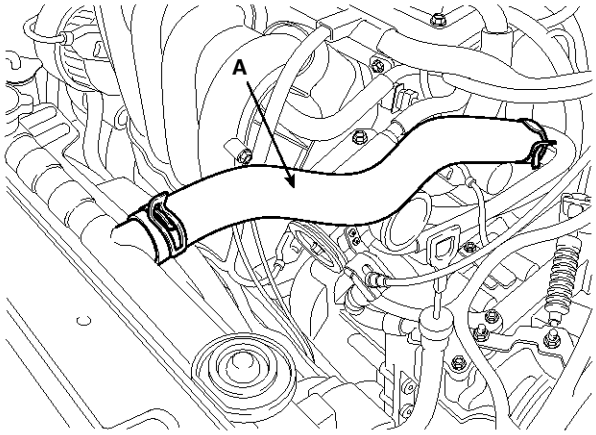


SHDEM6098D

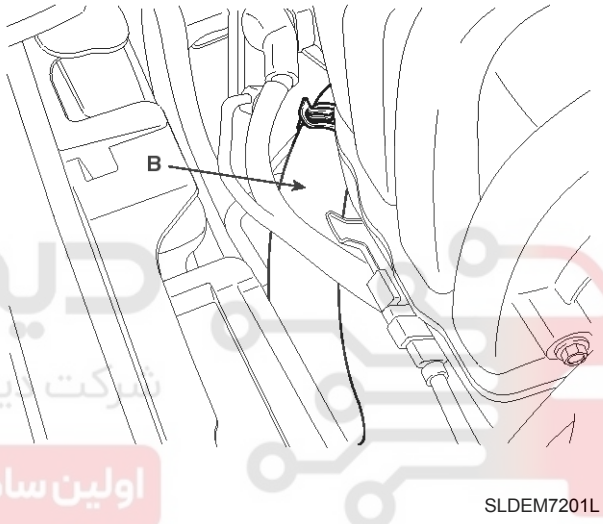
RADIATOR

1. Drain the engine coolant.

   Remove the radiator cap to speed draining.
2. Remove the radiator upper hose(A) and the breather hose(B).

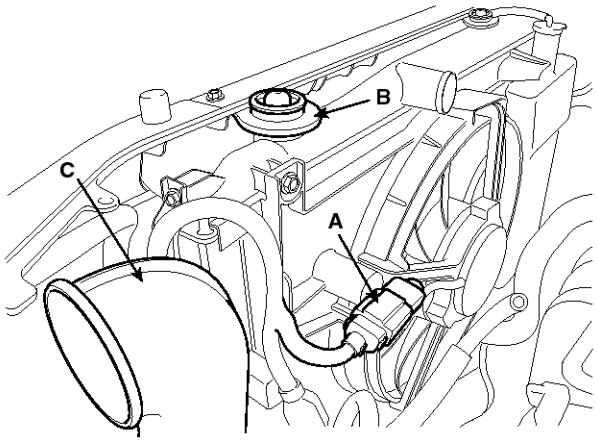


SLDEM7007D



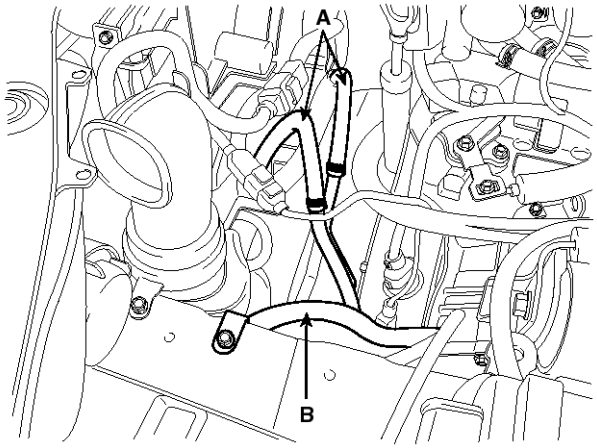
SLDEM7201L

3. Disconnect the fan motor connector(A) and remove the air duct(C).



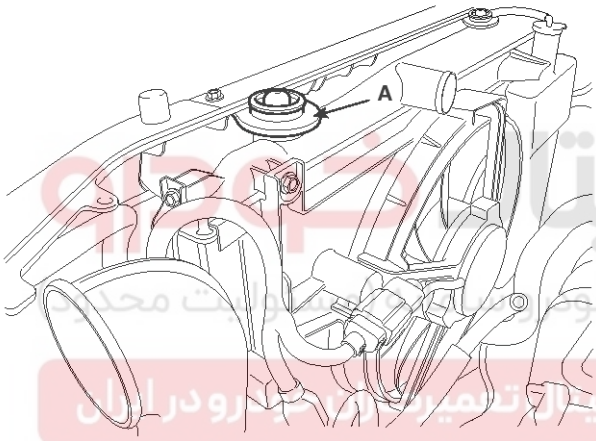
SLDEM7021D

4. Disconnect the automatic transaxle fluid(ATF) oil cooler hoses(A).

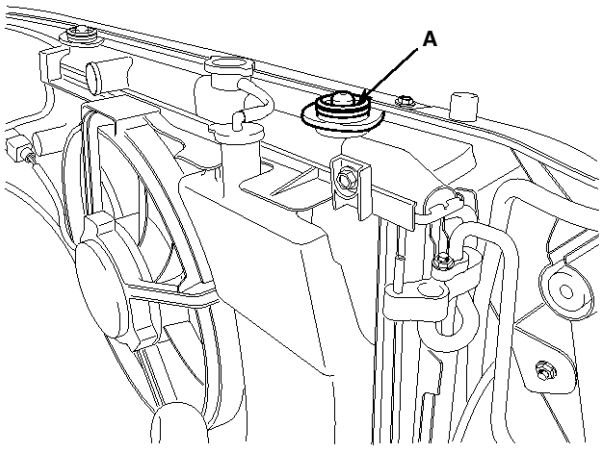


SLDEM7015D

5. Remove the radiator upper bracket(A), then pull up the radiator.

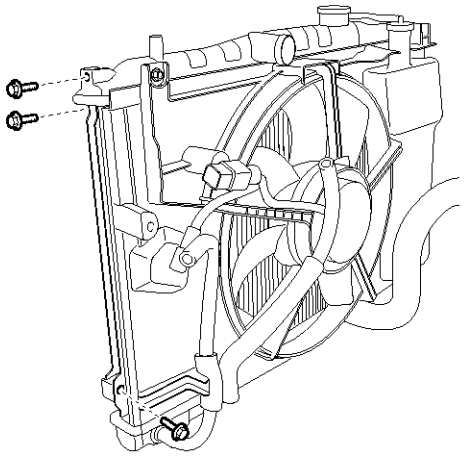


SLDEM7202L

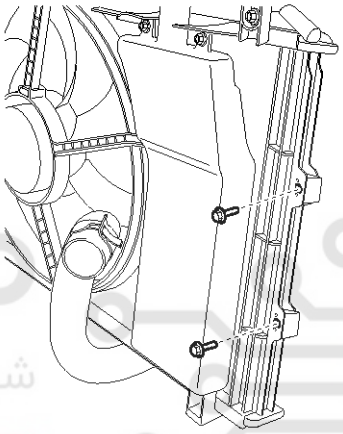


SLDEM7020D

6. Remove the condenser mounting bolt and bracket.



SLDEM7023D

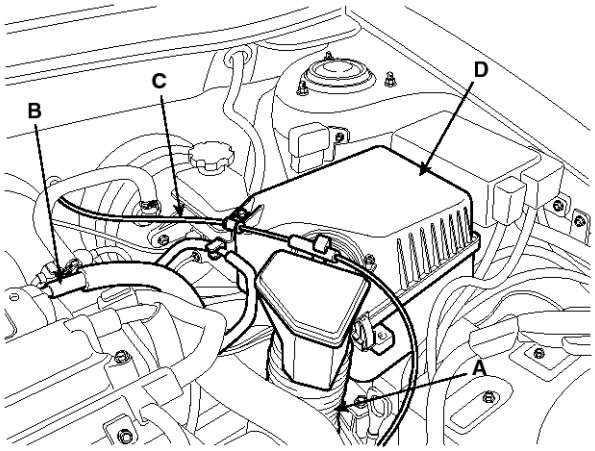


SLDEM7024D

7. Remove the radiator from engine room.

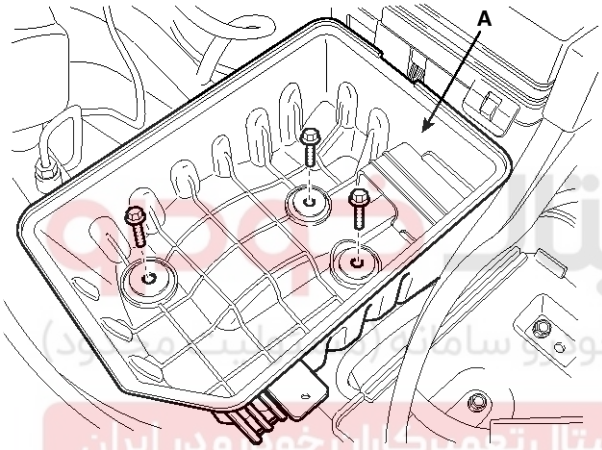
WATER TEMPERATURE CONTROL ASSEMBLY

1. Drain engine coolant.
2. Remove the air cleaner assemlby.
   1) Disconnect the air cleaner hose(A) and breather hose(B).
   2) Remove the accelerator cable(C) from air cleaner.
   3) Remove the air cleaner upper cover(D).



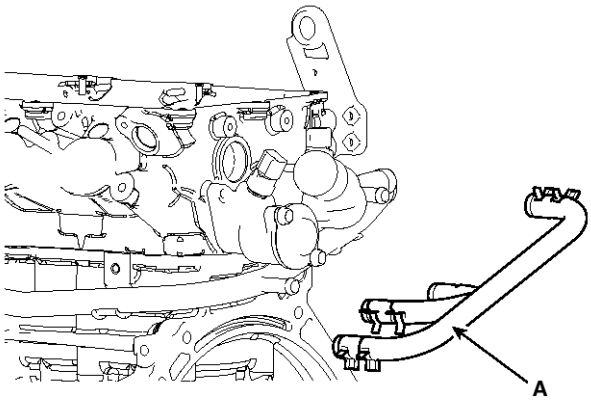
SLDEM7004D

4) Remove the air cleaner lower cover(A).



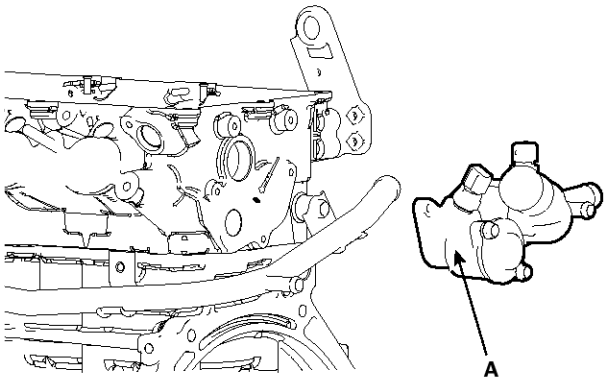
SLDEM7005D

3. Remove the engine coolant hose(A).



SHDEM6115D

4. Remove the water temperature control assemlby(A).



SHDEM6116D

5. To install, reverse the removal orders.

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

INSPECTION

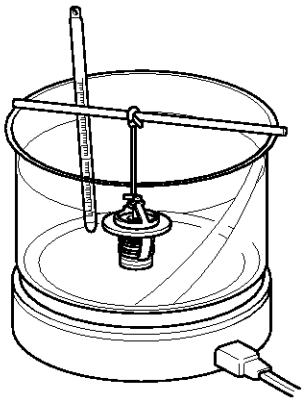
WATER PUMP

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

NOTICE
A small amount of "weeping" from the bleed hole is normal.

THERMOSTAT

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



ECKD503B

2. Check the valve opening temperature.

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

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

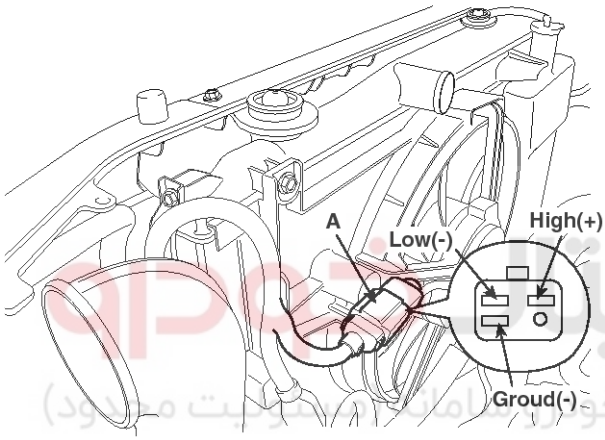
3. Check the valve lift.

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

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

COOLING FAN

1. Disconnect the cooling fan motor connector.



SLDEM7109D

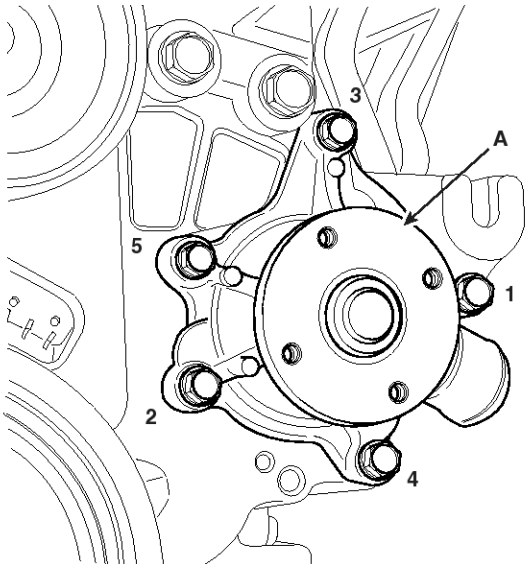
2. Check that the radiator fan rotates when battery voltage is applied between the terminals.

Cooing fan inspection		Cooling fan motor connector			Action
		1	2	3	
Battery	+	O			High speed
	-			O	
Battery	+		O		Low speed
	-			O	

INSTALLATION

WATER PUMP

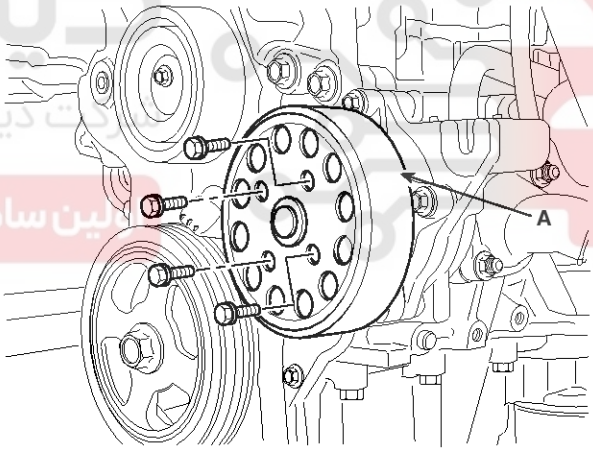
1. Install the water pump.
   1) Install the water pump(A) and a new gasket with the bolts.



SLDEM7122D

   2) Install the water pump pulley(A) with the four bolts.

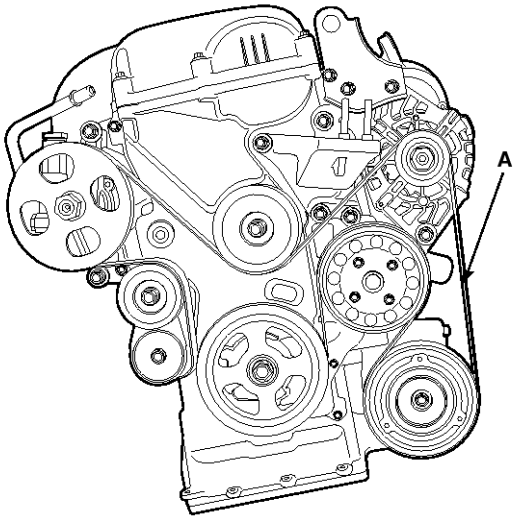
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHDEM6024D

NOTICE
Tighten the bolts diagonally.

2. Install the drive belts(A).

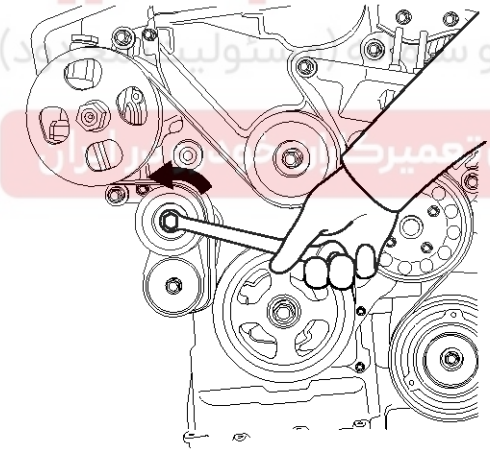


SLDEM7009D

NOTICE

Install drive belt: crankshaft pulley →water pump pulley → alternator pulley → power steering pulley → auto-tensioner idle pulley.

Put the drive bolt to the idle pulley by rotating idle belt of the auto-tensioner in the counter- clockwise, release the auto-tensioner pulley slowly.



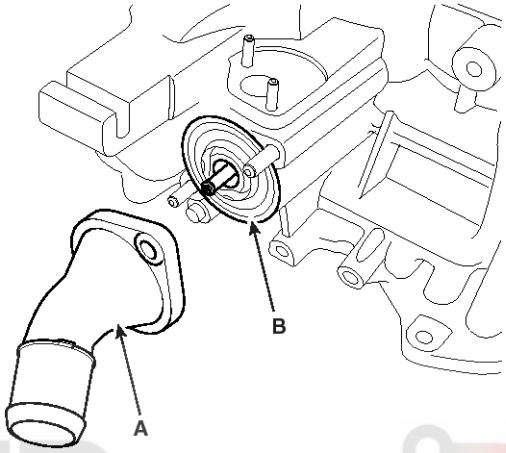
SLDEM7010D

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

THERMOSTAT

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

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



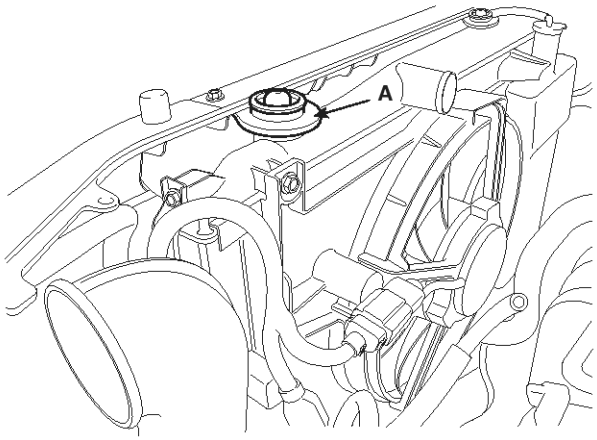
SHDEM6098D

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

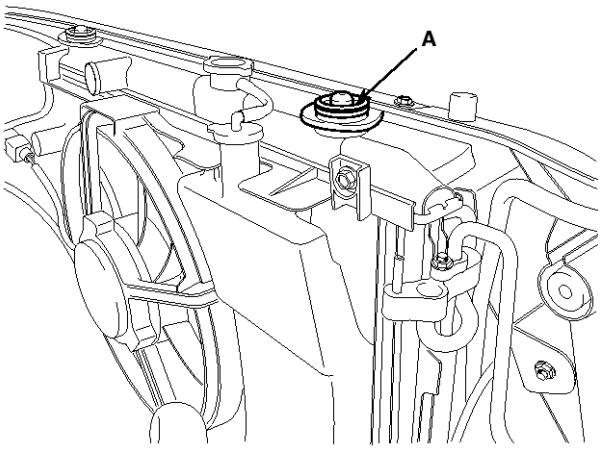
RADIATOR

1. Install the radiator.
2. Install the condenser mounting bolts.
3. Install the radiator upper bracket(A).

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

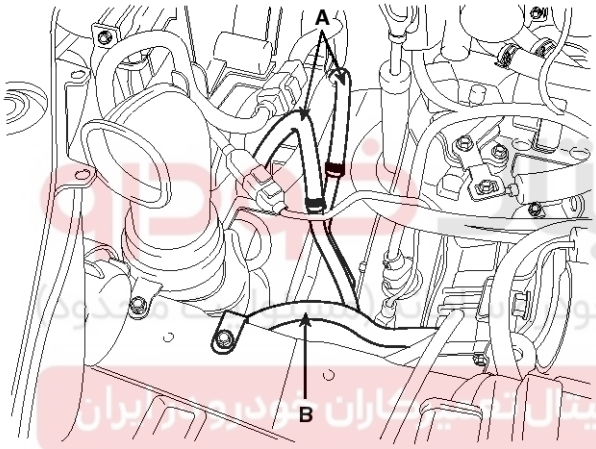


SLDEM7202L



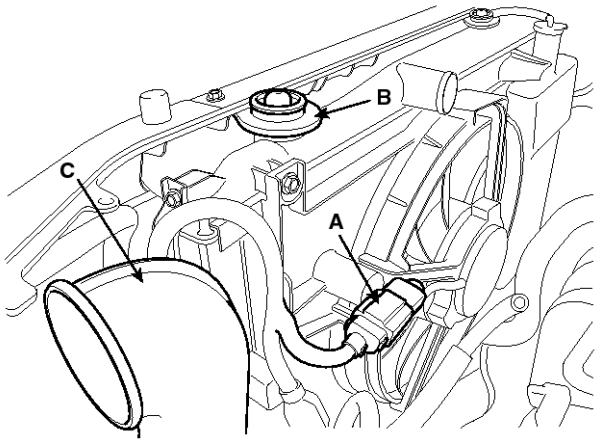
SLDEM7020D

4. Install the automatic transaxle fluid(ATF) oil cooler hoses(A).



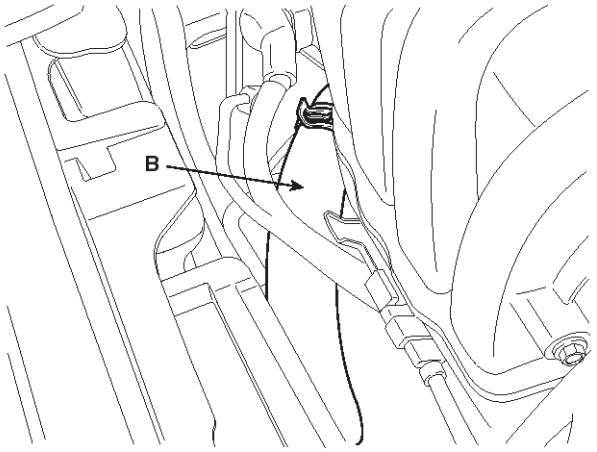
SLDEM7015D

5. Connect the fan motor connector(A) and install the air duct(C).



SLDEM7021D

6. Connect the radiator upper hose(A) and the breather hose(B).

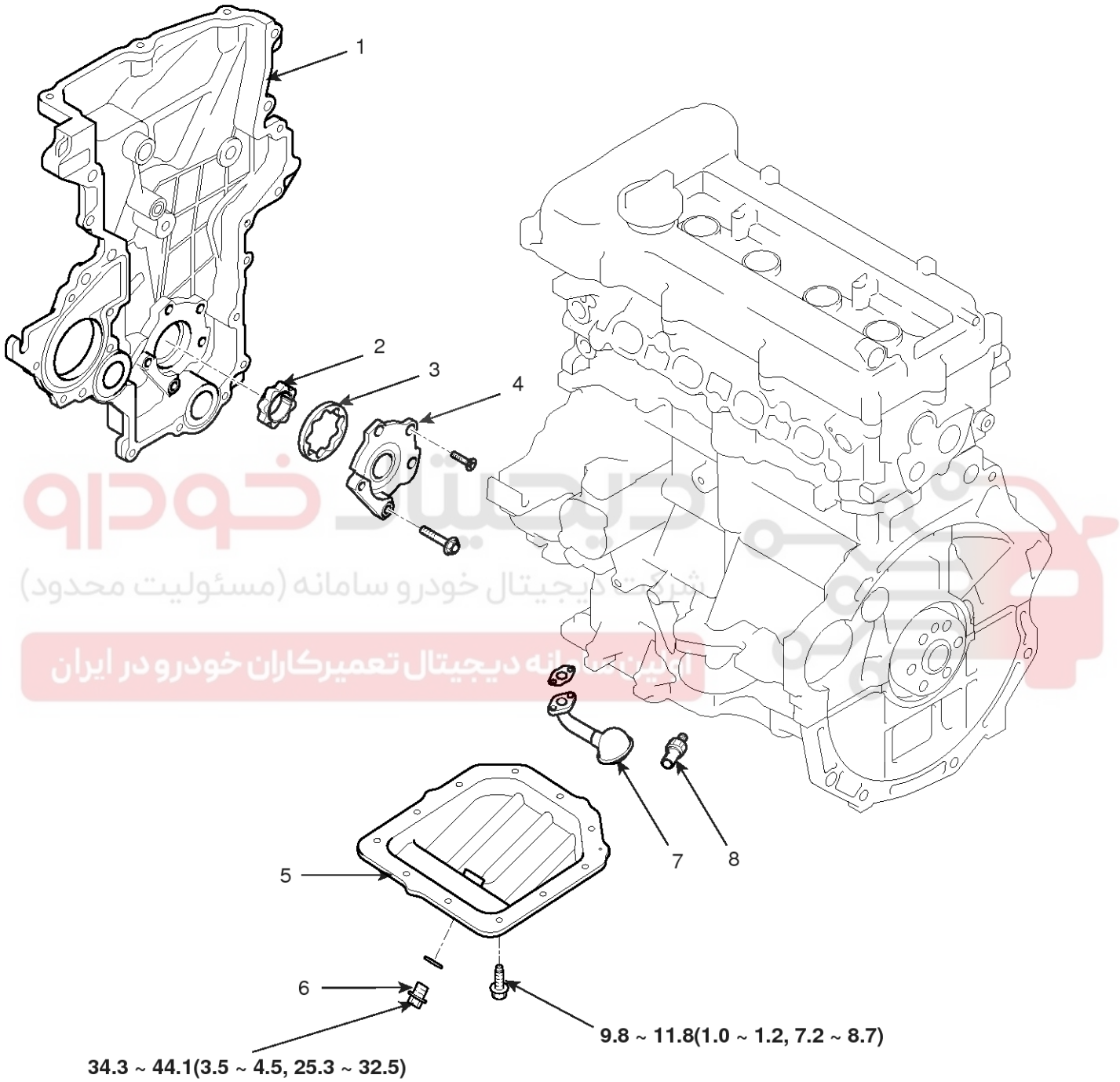


SLDEM7201L

7. Fill with engine coolant.
8. Start engine and check for leaks.

Lubrication System

COMPONENTS



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

1. Timing chain cover
2. Inner roter
3. Outer roter
4. Pump cover
5. Oil pan
6. Oil drain plug
7. Oil screen
8. Oil pressure gauge

SHDM27006L

REPLACEMENT

OIL AND FILTER

⚠CAUTION

- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Exercise caution in order to minimize the length and frequency of contact of your skin to used oil. Wear protective clothing and gloves. Wash your skin thoroughly with soap and water, or use water-less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.**
- **In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.**

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

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

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

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

   2) Fill with fresh engine oil.

Capacity
When replacing a short engine or a block assembly
- 3.7L (3.91 US qt, 3.26 Imp qt)
When replacing oil pan only
- 3.0 L (3.17 US qt, 2.64 Imp qt)

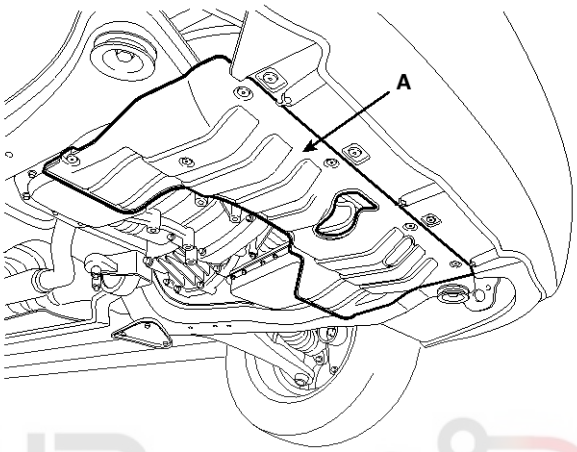
Drain and refil including oil filter :
3.3 L (3.49 US qt, 2.90 Imp qt)

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

REMOVAL

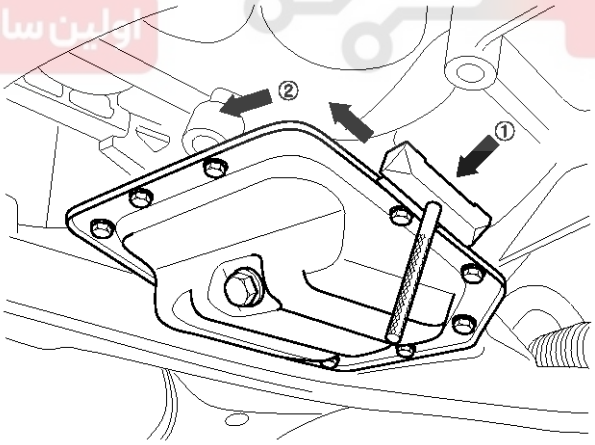
OIL PAN

1. Remove the under cover(A).



SLDEM7003D

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



SHDEM6092D

⚠CAUTION

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

- **Do not turn over the SST abruptly without tapping. It be result in damage of the SST.**

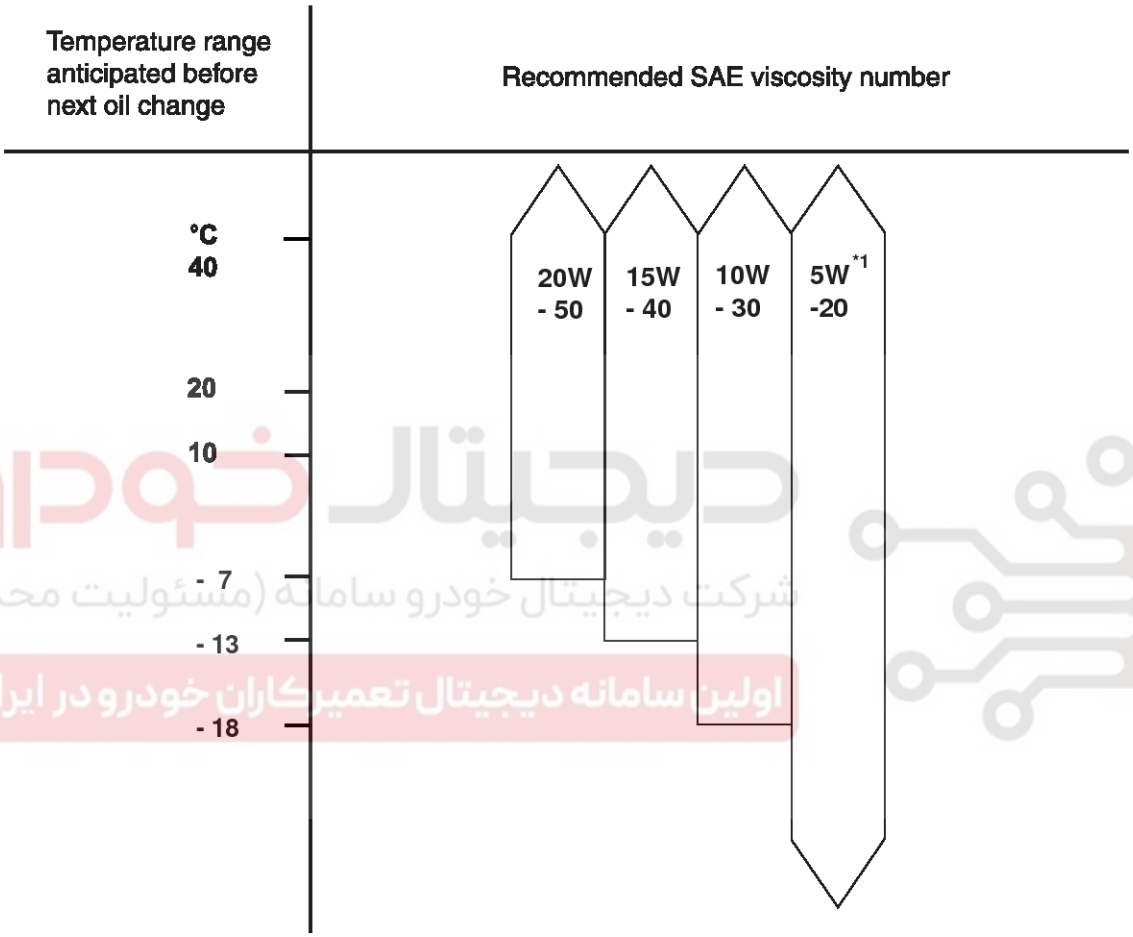
INSPECTION

SELECTION OF ENGINE OIL

Recommended ILSAC classification : GF3 OR ABOVE

Recommended API classification : SJ / SL OR ABOVE

Recommended SAE viscosity grades :



*1 : Recommended regardless of environment.
If not available, refer to the recommended SAE viscosity numbers.

LC8F002A

NOTICE

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

1. *Satisfy the requirement of the API 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 service classification on the container should not be used.*

ENGINE OIL

1. Check the engine oil quality.

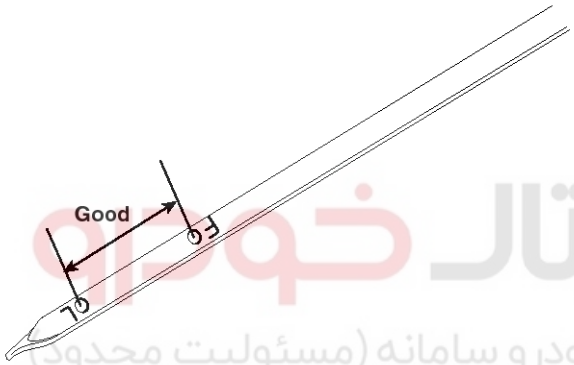
   Check the oil deterioration, entry of water, discoloring of thinning.

   If the quality is visibly poor, replace the oil.

2. Check the engine oil level.

   After warning up the engine and then 5 minutes after the engine stop, oil level should be between the "L" and "F" marks in the dipstick.

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



SBLEM6027L

NOTICE

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

INSTALLATION

OIL PAN

1. Install the oil pan.

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

      NOTICE

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

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

Liquid gasket : TB 1217H or equivalent

NOTICE

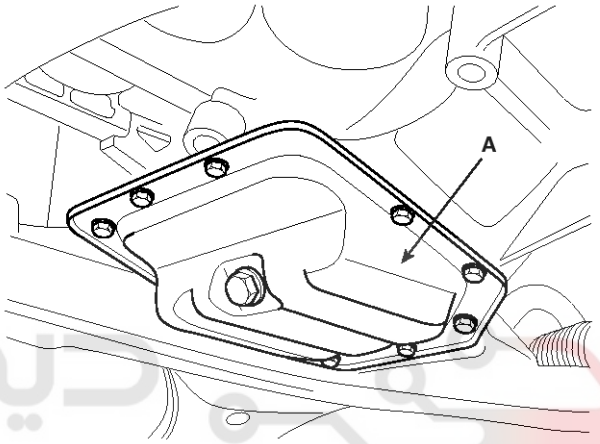
- *To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.*
- *Do not install the parts if five minutes or more have elapsed since applying the liquid gasket.*

  Instead, reapply liquid gasket after removing the residue.
- *After assembly, wait at least 30 minutes before filling the engine with oil.*

   3) Install the oil pan(A) with the bolts.

      Uniformly tighten the bolts in several passes.

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



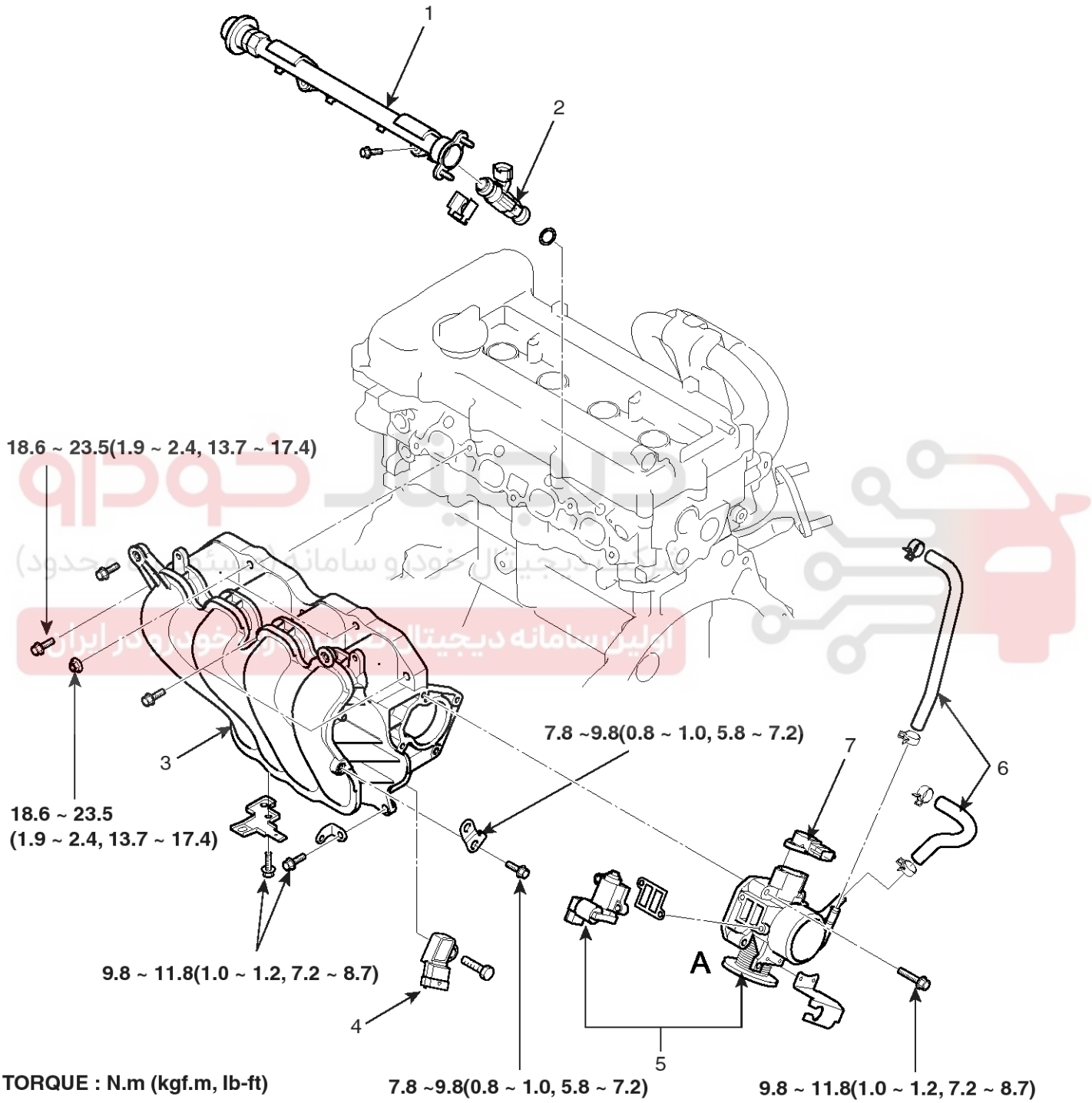
SHDEM6178D

2. Refill engine oil.

Intake And Exhaust System

Intake Manifold

COMPONENTS



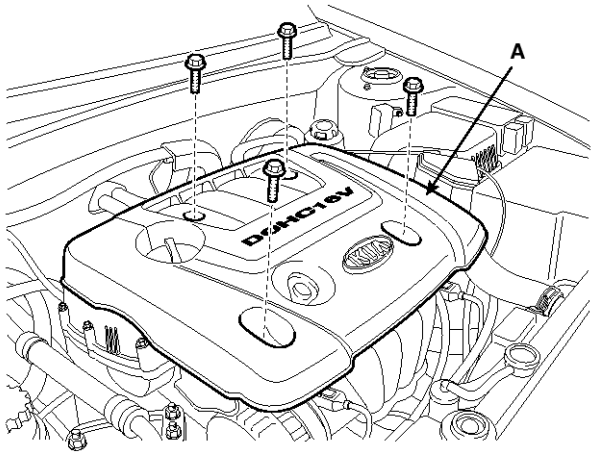
1. Delivery pipe
2. Injector
3. Intake manifold
4. MAP semsor
5. Throttle body
6. Water hose
7. Throttle position sensor(TPS)

SHDM27007L

REMOVAL

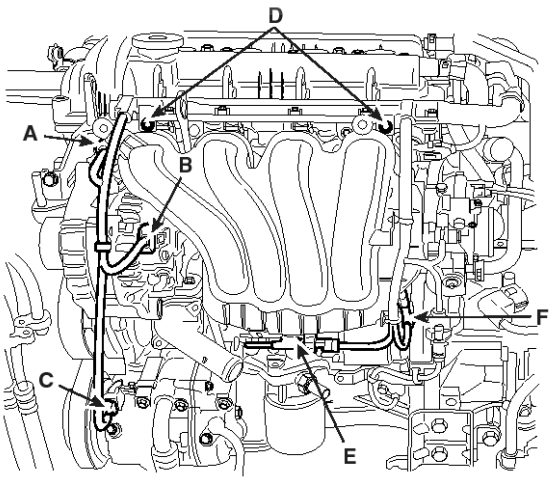
1. Remove the engine cover(A).

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



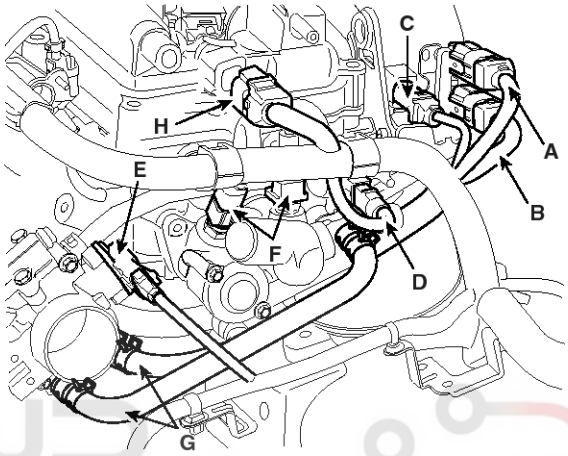
SLDEM7001D

2. Disconnect the harness connectors over the cylinder head.
   1) Disconnect the oil control valve(OCV) connector(A) and alternator connector(B).
   2) Disconnect the air conditioning compressor connector(C).
   3) Remove the ignition coil harness mounting bolts(D).
   4) Disconnect the manifold absolute pressure(MAP) sensor connector(F) and the bracket(E) for the knock sensor connector.



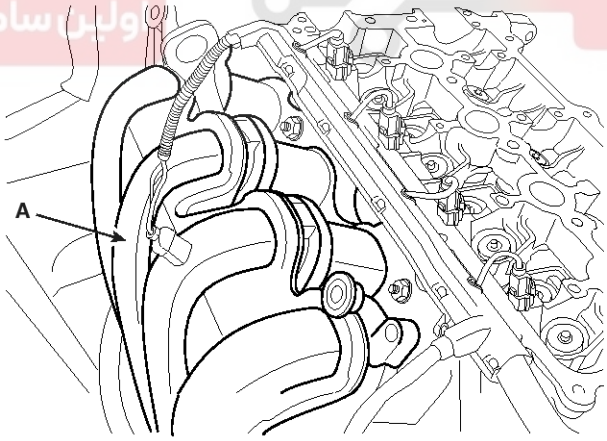
SHDEM6065D

3. Remove the engine wire harness connectors and wire harness clamps from cylinder head and the intake manifold.
   1) Disconnect the front(A) and the rear(B) oxygen sensor connector.
   2) Disconnect the ignition coil condenser connector(C) and the purge control solenoid valve(PCSV) connector(D).
   3) Disconnect the throttle position sensor(TPS) connectoe(E).
   4) Disconnect the engine coolant temperature sensor(ECTS) connector(F) and the water hose(G).



SLDEM7101D

4. Remove the oil level gange bracket.
5. Remove the intake manifold assembly(A).



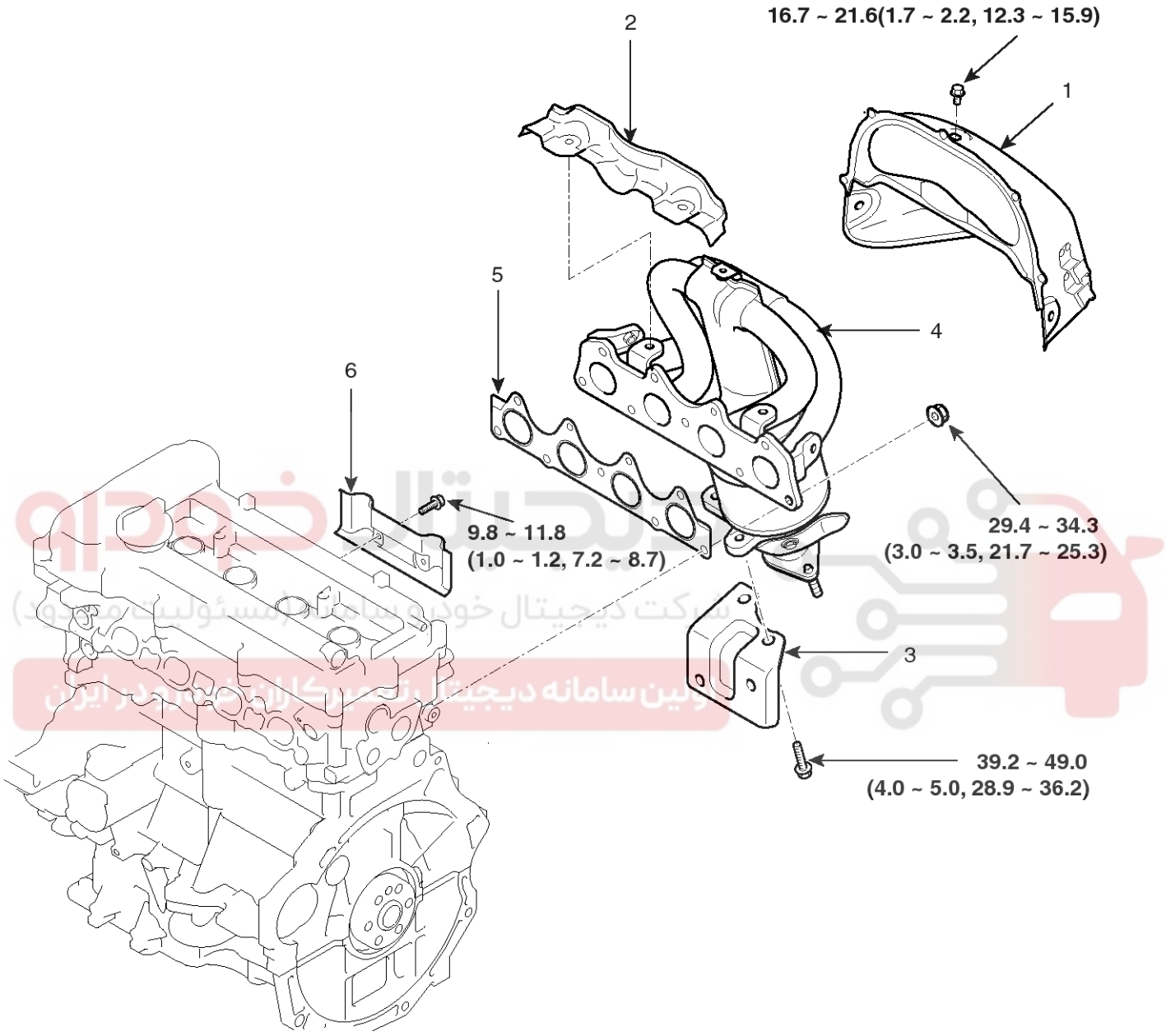
SHDEM6079D

6. To install, reverse the removal or dec with a new gasket.

⚠CAUTION
Install the cover surely before driving.

Exhaust Manifold

COMPONENTS



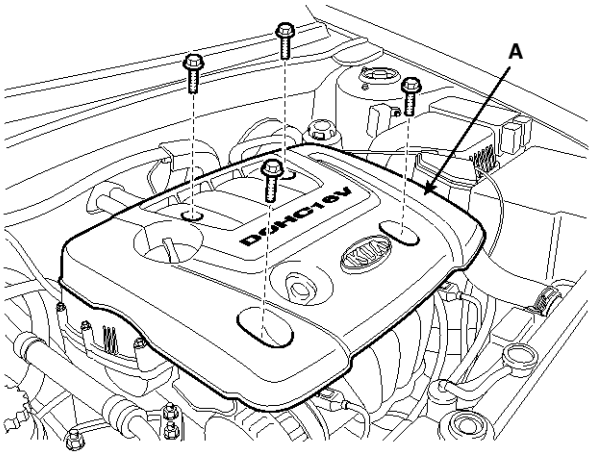
TORQUE : N.m (kgf.m, lb-ft)

1. Heat protector
2. Sub heat protector
3. Exhaust manifold assembly stay
4. Exhaust manifold
5. Gahket
6. Head cover protector

SLDEM7100L

REMOVAL

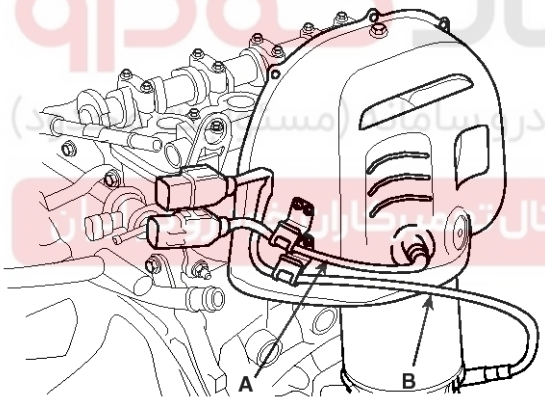
1. Remove the engine cover(A).



SLDEM7001D

2. Disconnect the front oxygen sensor connector(A) and the rear one(B).

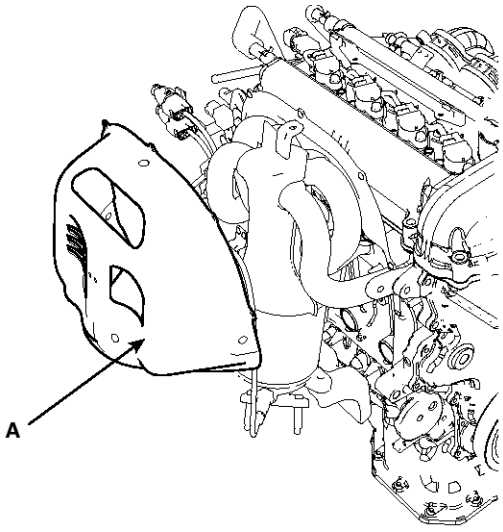
Tightening torque :
39.2 ~ 49.0N.m (4.0 ~ 5.0kgf.m, 28.9 ~ 36.2lb-ft)



SLDEM7300D

3. Remove the heat protector(A).

Tightening torque :
16.7 ~ 21.6N.m (1.7 ~ 2.2kgf.m, 12.3 ~ 15.9lb-ft)



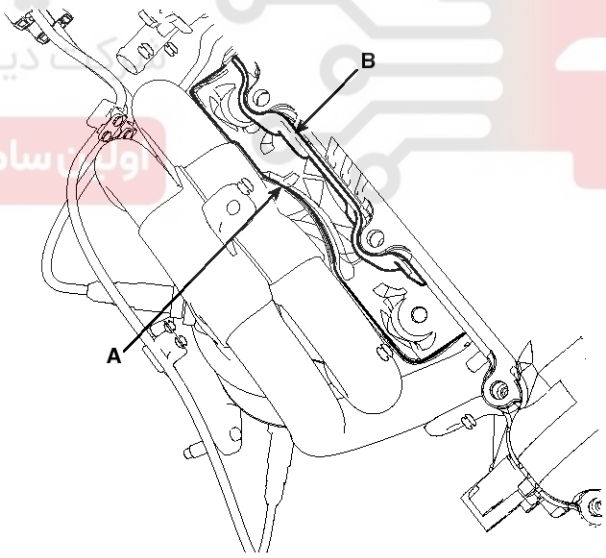
SLDEM7058D

4. Remove the sub heat protector(A).

Tightening torque :
16.7 ~ 21.6N.m (1.7 ~ 2.2kgf.m, 12.3 ~ 15.9lb-ft)

5. Remove the head cover protector(B).

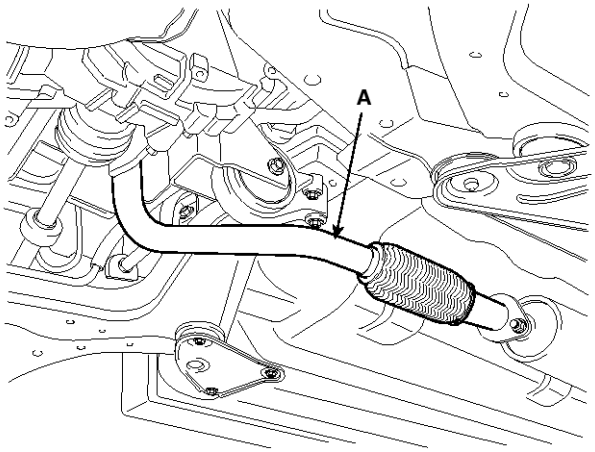
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SHDEM6037L

6. Remove the front muffler(A).

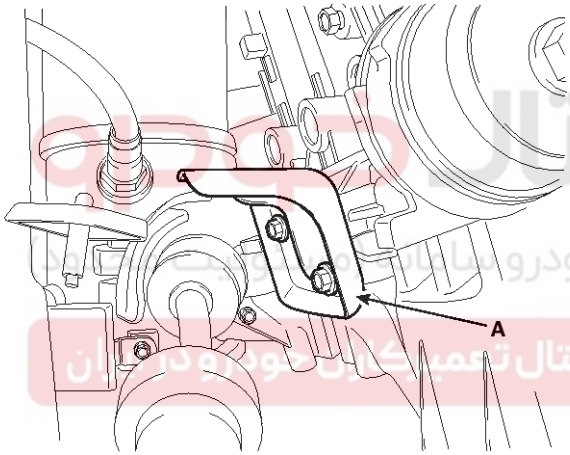
Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SLDEM7018D

7. Remove the exhaust manifold assembly stay(A).

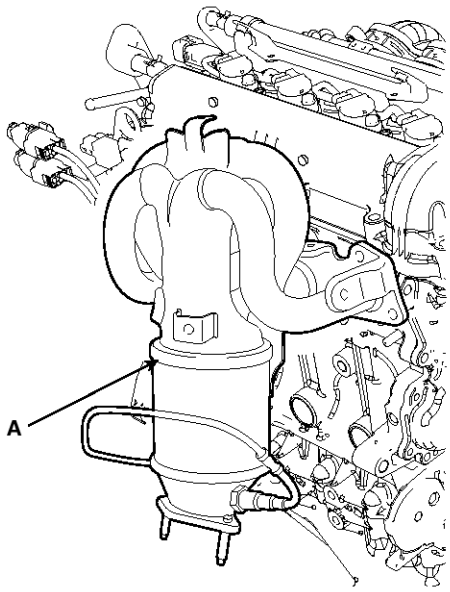
Tightening torque :
Bolts : 39.2 ~ 49.0N.m (4.0 ~ 5.0kgf.m, 28.9 ~ 36.2lb-ft)



SLDEM7025D

8. Remove the exhaust manifold(A) with its gasket.

Tightening torque :
29.4~ 34.3N.m (3.0 ~ 3.5kgf.m, 21.7 ~ 25.3lb-ft)



SLDEM7059D

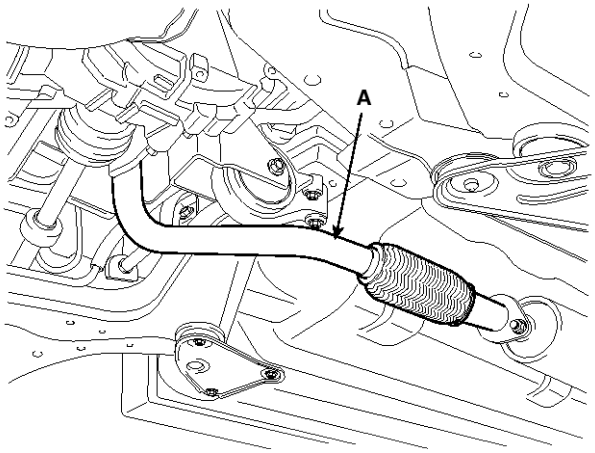
9. To install, reverse the removal order with a new gasket.

Front Exhaust Pipe

REMOVAL

1. Remove the front muffler(A).

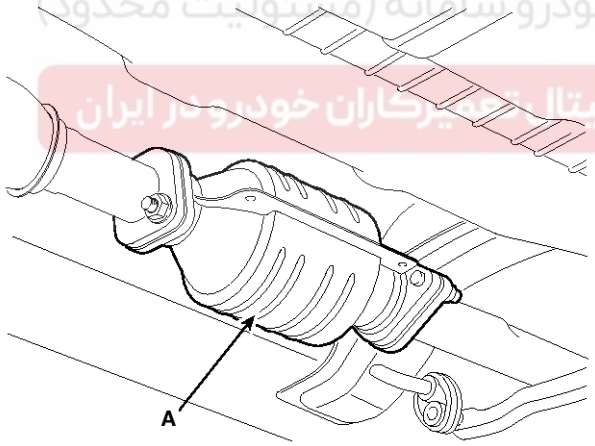
Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SLDEM7018D

2. Remove the center muffler(A).

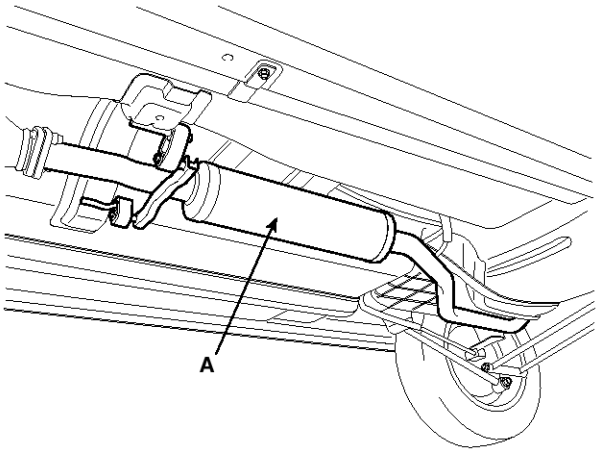
Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SLDEM7027D

3. Remove the center muffler(A).

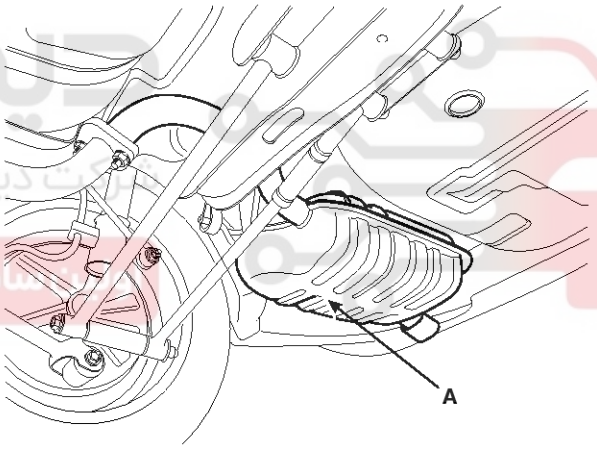
Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SLDEM7028D

4. Remove the main muffler(A).

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



SLDEM7029D

5. To install, reverse the removal order with a new gasket.