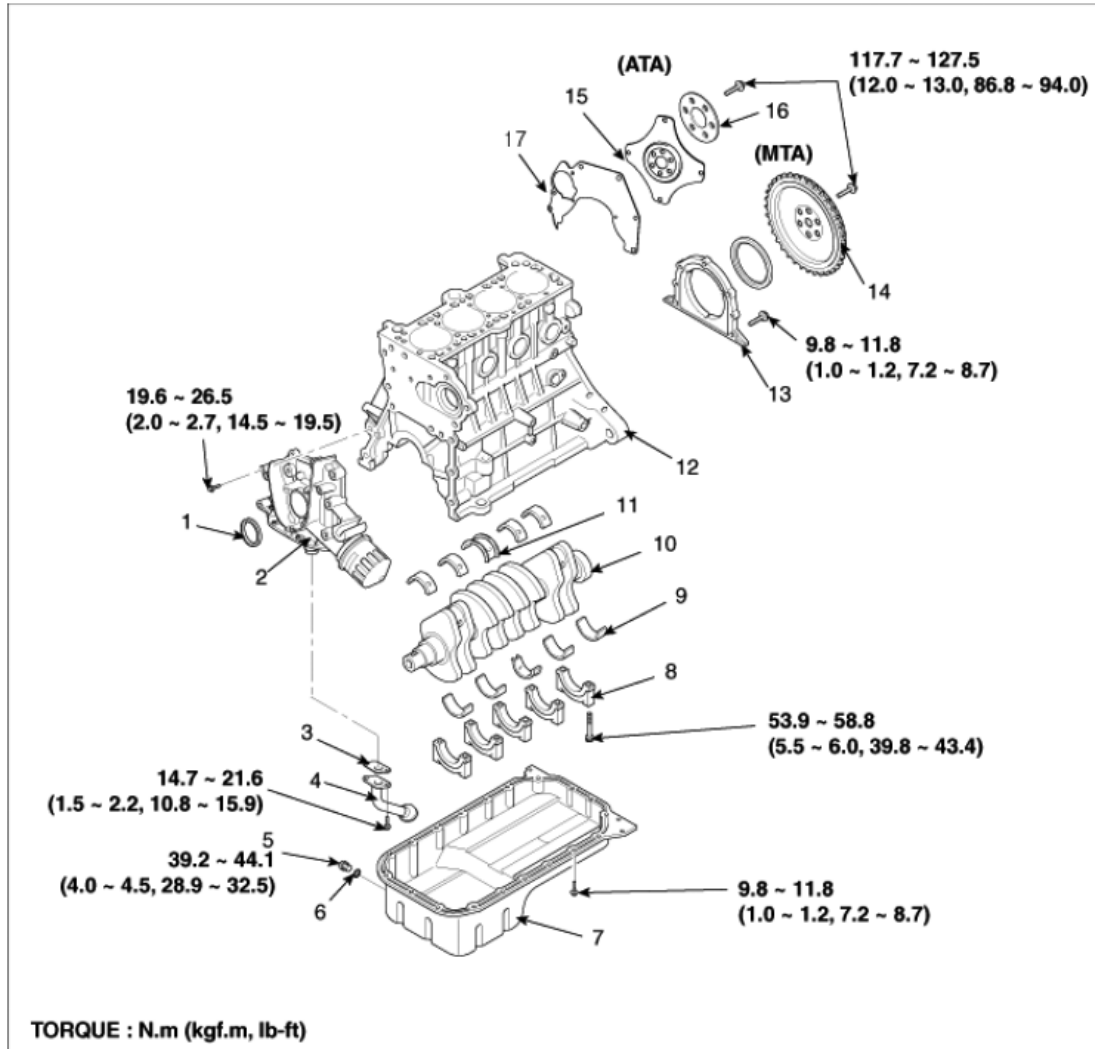


2010 ENGINE

Cylinder Block - Rio

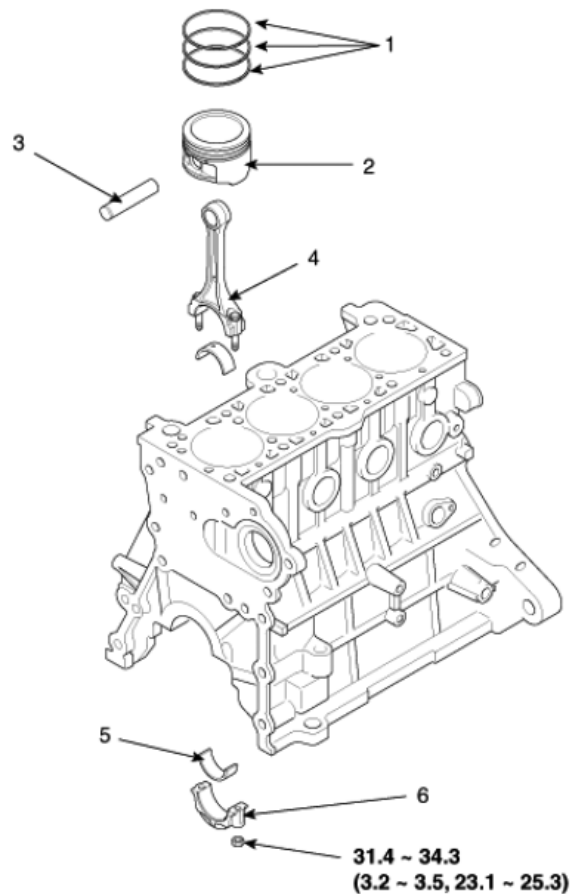
COMPONENTS AND COMPONENTS LOCATION

COMPONENT



- | | |
|---------------------|------------------------|
| 1. Oil seal | 10. Crankshaft |
| 2. Front case | 11. Center bearing |
| 3. Gasket | 12. Cylinder block |
| 4. Oil screen | 13. Rear oil seal case |
| 5. Drain plug | 14. Flywheel |
| 6. Gasket | 15. Drive plate |
| 7. Oil pan | 16. Washer |
| 8. Main bearing cap | 17. Rear plate |
| 9. Main bearing | |

Fig. 1: Identifying Cylinder Block Components With Torque Specification (1 Of 2)
 Courtesy of KIA MOTORS AMERICA, INC.



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

- | | |
|----------------|-------------------------------|
| 1. Piston ring | 4. Connecting rod |
| 2. Piston | 5. Connecting rod bearing |
| 3. Piston pin | 6. Connecting rod bearing cap |

Fig. 2: Identifying Cylinder Block Components With Torque Specification (2 Of 2)
Courtesy of KIA MOTORS AMERICA, INC.

REPAIR PROCEDURES

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 belt. (Refer to **TIMING SYSTEM**)
5. Remove the cylinder head. (Refer to **CYLINDER HEAD ASSEMBLY**)
6. Remove the oil level gauge tube (A).

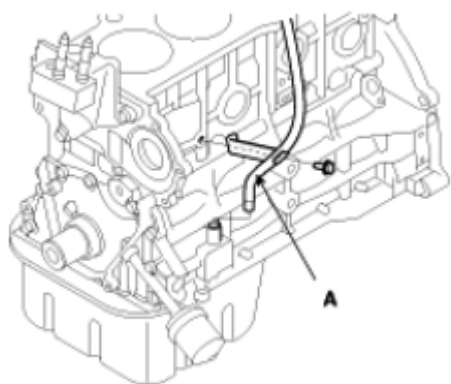


Fig. 3: Identifying Oil Level Gauge Tube
Courtesy of KIA MOTORS AMERICA, INC.

7. Remove the knock sensor (A).

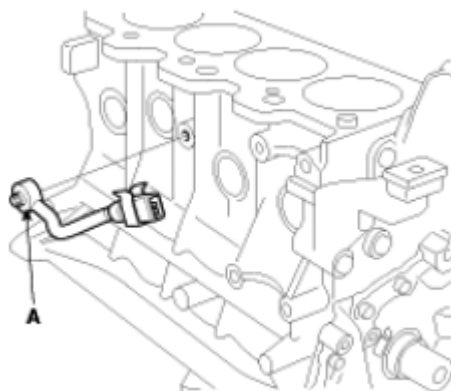


Fig. 4: Identifying Knock Sensor
Courtesy of KIA MOTORS AMERICA, INC.

8. Remove the oil pressure switch (A).

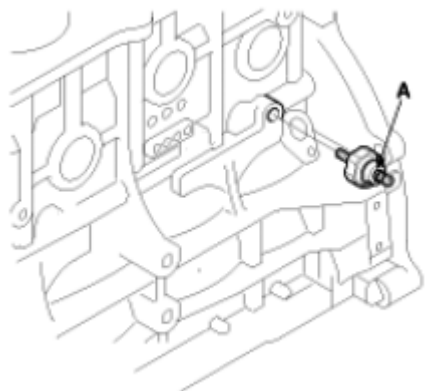


Fig. 5: Identifying Oil Pressure Switch
Courtesy of KIA MOTORS AMERICA, INC.

9. Remove the water pump. (Refer to **WATER PUMP**)
10. Remove the oil pan (A).

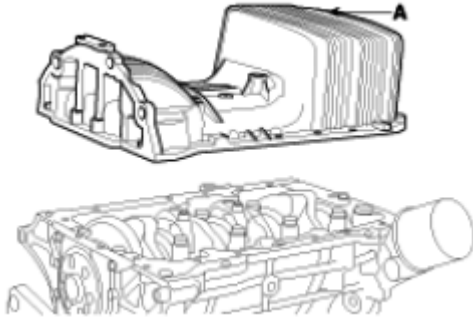


Fig. 6: Identifying Oil Pan
Courtesy of KIA MOTORS AMERICA, INC.

11. Remove the oil screen.

Remove the 2bolts (C), oil screen (A) and gasket (B).

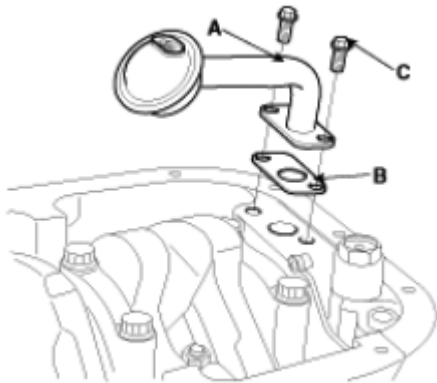


Fig. 7: Identifying Oil Screen, Gasket And Bolts
Courtesy of KIA MOTORS AMERICA, INC.

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

NOTE:

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

15. Remove the front case. (Refer to ENGINE AND TRANSAXLE ASSEMBLY)
16. Remove the rear oil seal case.

Remove the 5bolts (B) and rear oil seal case (A).

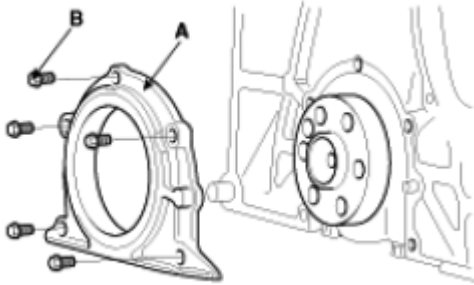


Fig. 8: Identifying Rear Oil Seal Case And Bolts
Courtesy of KIA MOTORS AMERICA, INC.

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

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

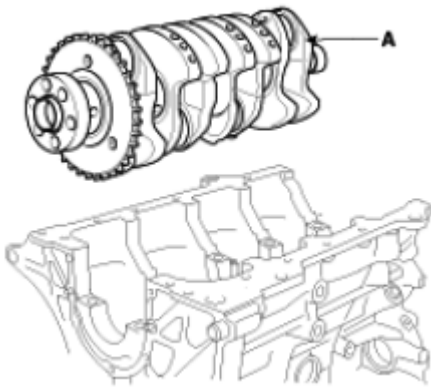


Fig. 9: Identifying Crankshaft
Courtesy of KIA MOTORS AMERICA, INC.

20. Check fit between piston and piston pin.

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

If any movement is felt, replace the piston and pin as a set.

21. Remove the piston rings.
 1. Using a piston ring expander, remove the 2 compression rings.

2. Remove the 2 side rails and oil ring by hand.

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

22. Remove the connecting rod from the piston.

Using a press, remove the piston pin from piston.

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

INSPECTION

CONNECTING ROD AND CRANKSHAFT

1. Check the connecting rod end play.

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

End play

Standard : 0.1 ~ 0.25mm (0.0039 ~ 0.0098in)

Maximum : 0.4mm (0.0157in)

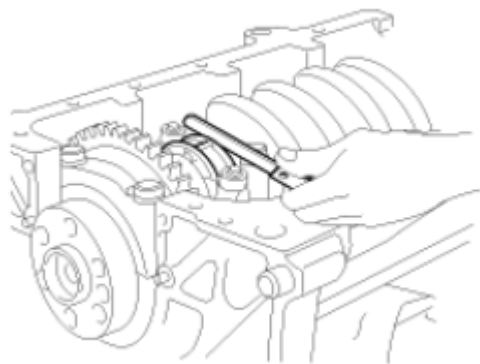


Fig. 10: Measuring Connecting Rod End Play Using Feeler Gauge
Courtesy of KIA MOTORS AMERICA, INC.

- A. If out-of-tolerance, install a new connecting rod.
- B. If still out-of-tolerance, replace the crankshaft.
2. Check the connecting rod bearing oil clearance.
 1. Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.
 2. Remove the 2 connecting rod cap nuts.
 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 nuts.

Tightening torque :

31.4 ~ 34.3N.m (3.2 ~ 3.5kgf.m, 23.1 ~ 25.3lb-ft)

NOTE: **Do not turn the crankshaft.**

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

Standard oil clearance

0.018 ~ 0.036mm (0.0007 ~ 0.0014in)

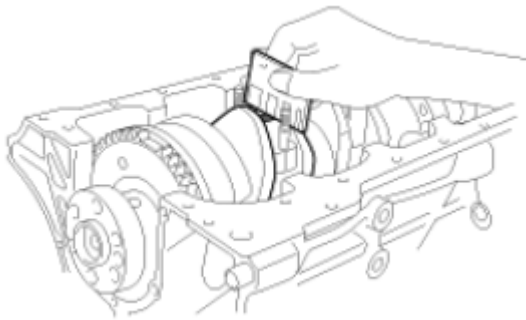


Fig. 11: Measuring Plastigage At Widest Point
Courtesy of KIA MOTORS AMERICA, INC.

9. 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 **CONNECTING ROD BEARING SELECTION CHART**) Recheck the oil clearance.

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

10. If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing. (Refer to **CONNECTING ROD BEARING SELECTION CHART**)

Recheck the oil clearance.

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

CAUTION: If the marks are indecipherable because of an accumulation of

dirt and dust, do not scrub them with a wire brush or scraper.
Clean them only with solvent or detergent.

Connecting rod mark location

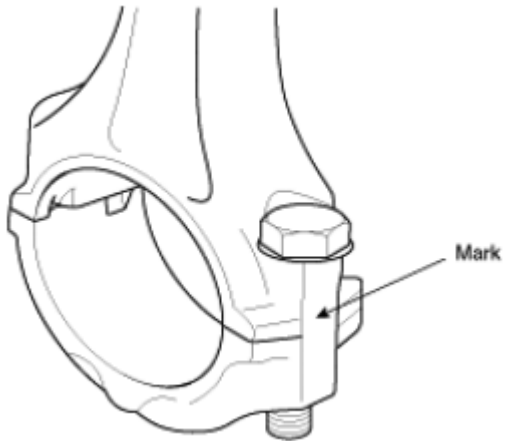


Fig. 12: Identifying Connecting Rod Mark Location
Courtesy of KIA MOTORS AMERICA, INC.

Identification of connecting rod

CONNECTING ROD IDENTIFICATION REFERENCE

Mark	Connecting rod big-end inner diameter
^	48.000 ~ 48.006mm (1.8898 ~ 1.8900in)
b	48.006 ~ 48.012mm (1.8900 ~ 1.8902in)
c	48.012 ~ 48.018mm (1.8902 ~ 1.8905in)

Crankshaft pin journal mark location

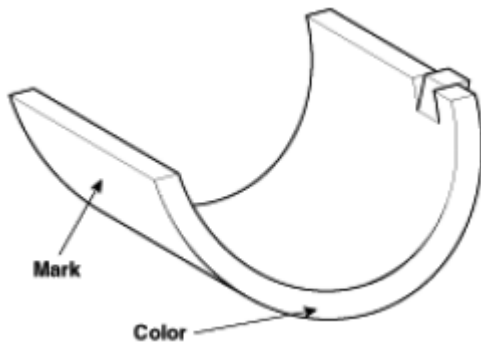


Fig. 13: Identifying Crankshaft Pin Journal Mark Location

Courtesy of KIA MOTORS AMERICA, INC.

Identification of crankshaft pin journal**CRANKSHAFT PIN JOURNAL IDENTIFICATION REFERENCE**

Mark	Crankshaft pin journal outer diameter
^	44.966 ~ 44.972mm (1.7703 ~ 1.7705in)
b	44.960 ~ 44.966mm (1.7701 ~ 1.7703in)
c	44.954 ~ 44.960mm (1.7698 ~ 1.7701in)

Connecting rod bearing mark location**Fig. 14: Identifying Connecting Rod Bearing Mark Location**

Courtesy of KIA MOTORS AMERICA, INC.

Identification of connecting rod bearing**CONNECTING ROD BEARING IDENTIFICATION REFERENCE**

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

(11) Select the bearing by using selection table.

Connecting rod bearing selection table**CONNECTING ROD BEARING SELECTION CHART**

	Connecting rod mark		
	^	b	c
Crank shaft pin journal mark	^ D (Yellow)	C (Green)	B (None)
	b C (Green)	B (None)	A (Black)
	c B (None)	A (Black)	AA (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

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 :

53.9 ~ 58.8N.m (5.5 ~ 6.0kgf.m, 39.8 ~ 43.4lb-ft)

NOTE: Do not turn the crankshaft.

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

Standard oil clearance :

No. 1, 2, 4, 5 : 0.022 ~ 0.040mm (0.0009 ~ 0.0016in)

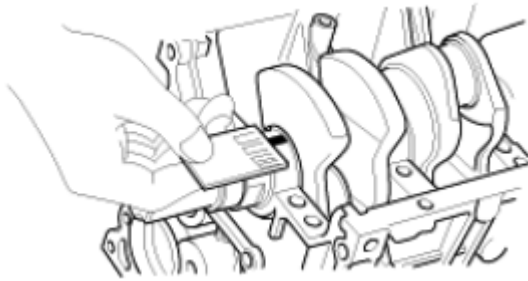


Fig. 15: Measuring Widest Part Of Plastigage
Courtesy of KIA MOTORS AMERICA, INC.

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 CHART**)

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 CHART**)

Recheck the oil clearance.

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

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

Cylinder block crankshaft journal bore mark location

Letters have been stamped on the end 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.

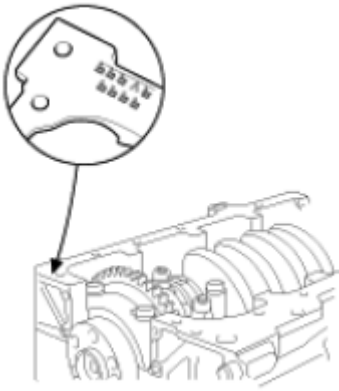


Fig. 16: Identifying Cylinder Block Crankshaft Journal Bore Mark Location
 Courtesy of KIA MOTORS AMERICA, INC.

Identification of cylinder block crankshaft journal bore

CYLINDER BLOCK CRANKSHAFT JOURNAL BORE IDENTIFICATION REFERENCE

Mark	Cylinder block crankshaft journal bore inner diameter
^	54.000 ~ 54.006mm (2.1260 ~ 2.1262in)
b	54.006 ~ 54.012mm (2.1262 ~ 2.1265in)
c	54.012 ~ 54.018mm (2.1265 ~ 2.1267in)

Crankshaft main journal mark location

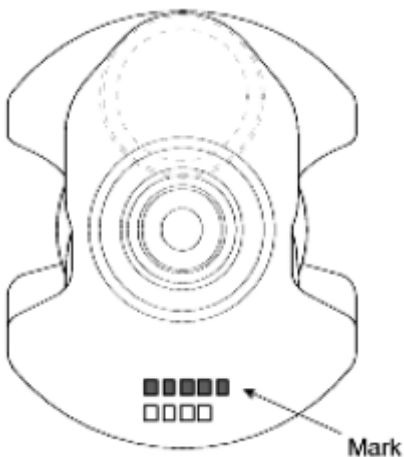
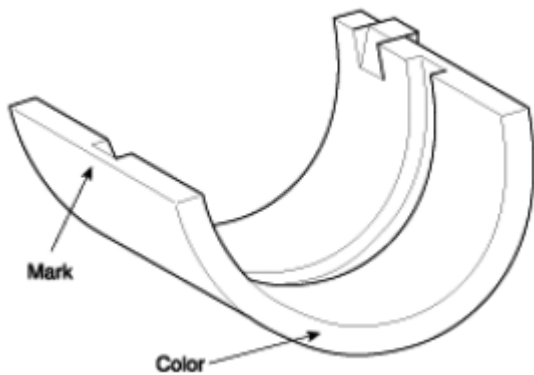


Fig. 17: Identifying Crankshaft Main Journal Mark Location
 Courtesy of KIA MOTORS AMERICA, INC.

Identification of crankshaft main journal

CRANKSHAFT MAIN JOURNAL IDENTIFICATION REFERENCE

Mark	Crankshaft main journal outer diameter
^	49.962 ~ 49.968mm (1.9670 ~ 1.9672in)
b	49.956 ~ 49.962mm (1.9668 ~ 1.9670in)
c	49.950 ~ 49.956mm (1.9665 ~ 1.9668in)

Crankshaft main bearing mark location**Fig. 18: Identifying Crankshaft Main Bearing Mark Location**

Courtesy of KIA MOTORS AMERICA, INC.

Identification of crankshaft main bearing**CRANKSHAFT MAIN BEARING IDENTIFICATION REFERENCE**

Mark	Color	Crankshaft main bearing thickness	
		No. 1, 2, 4, 5	No. 3
AA	Blue	2.014 ~ 2.017 (0.0793 ~ 0.0794)	2.011 ~ 2.014 (0.0792 ~ 0.0793)
A	Black	2.011 ~ 2.014 (0.0792 ~ 0.0793)	2.008 ~ 2.011 (0.0791 ~ 0.0792)
B	None	2.008 ~ 2.011 (0.0791 ~ 0.0792)	2.005 ~ 2.008 (0.0789 ~ 0.0791)
C	Green	2.005 ~ 2.008 (0.0789 ~ 0.0791)	2.002 ~ 2.005 (0.0788 ~ 0.0789)
D	Yellow	2.002 ~ 2.005 (0.0788 ~ 0.0789)	1.999 ~ 2.002 (0.0787 ~ 0.0788)

(8) Select the bearing by using selection table.

Crankshaft main bearing selection table

CRANKSHAFT MAIN BEARING SELECTION CHART

		Cylinder block crankshaft journal bore mark		
		^	b	c
Crank shaft main journal mark	^	D (Yellow)	C (Green)	B (None)
	b	C (Green)	B (None)	A (Black)
	c	B (None)	A (Black)	AA (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 ~ 0.175mm (0.0020 ~ 0.0069in)

Limit : 0.20mm (0.0079in)

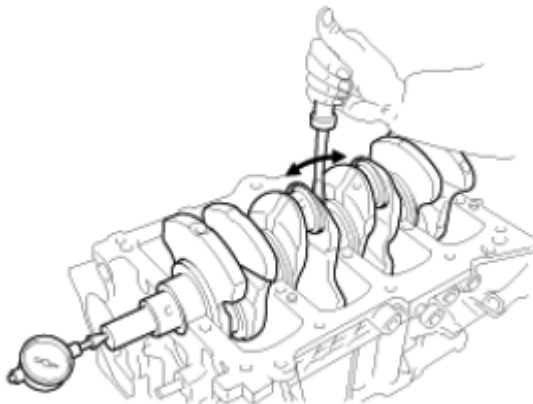


Fig. 19: Measuring Crankshaft End Play Using Dial Indicator
 Courtesy of KIA MOTORS AMERICA, INC.

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

6. Inspect the crankshaft main journals and pin journals.

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

Main journal diameter :

49.950 ~ 49.968mm (1.9665 ~ 1.9672in)

Pin journal diameter :

44.954 ~ 44.972mm (1.7698 ~ 1.7705in)

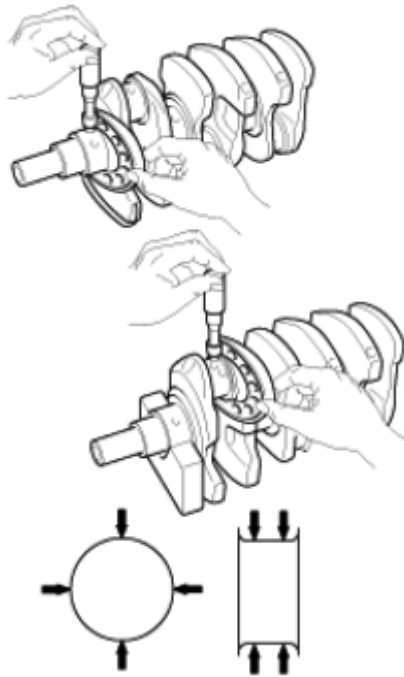


Fig. 20: Measuring Diameter Of Main Journal And Pin Journal Using Micrometer
Courtesy of KIA MOTORS AMERICA, INC.

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)

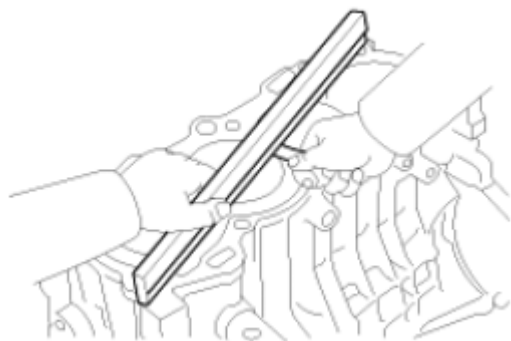


Fig. 21: Inspecting Surface Of Cylinder Block For Flatness
Courtesy of KIA MOTORS AMERICA, INC.

4. Inspect the cylinder bore.

Visually check the cylinder for vertical scratches.

If deep scratches 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 :

1.6 CVVT : 76.50 ~ 76.53mm (3.0118 ~ 3.0130in)

1.4 DOHC : 75.50 ~ 75.53mm (2.9724 ~ 2.9736in)

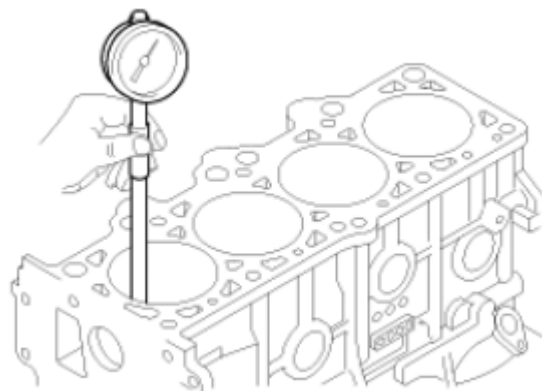


Fig. 22: Inspecting Cylinder Bore Diameter
Courtesy of KIA MOTORS AMERICA, INC.

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

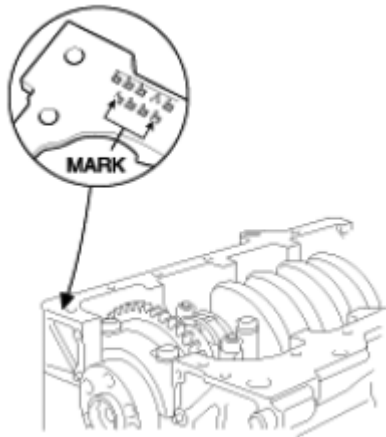


Fig. 23: Identifying Cylinder Bore Size Code On Cylinder Block Bottom Face
 Courtesy of KIA MOTORS AMERICA, INC.

Identification of cylinder bore size

CYLINDER BORE SIZE IDENTIFICATION REFERENCE

Mark	Cylinder bore inner diameter
A	76.50 ~ 76.51mm (3.0118 ~ 3.0122in)
B	76.51 ~ 76.52mm (3.0122 ~ 3.0126in)
C	76.52 ~ 76.53mm (3.0126 ~ 3.0130in)

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

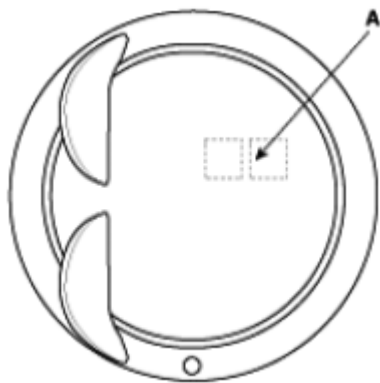


Fig. 24: Identifying Piston Size Mark On Piston Top Face
 Courtesy of KIA MOTORS AMERICA, INC.

Discrimination of piston outer diameter

PISTON OUTER DIAMETER

Mark	Piston outer diameter
A	76.47 ~ 76.48mm (3.0106 ~ 3.0110in)
B	76.48 ~ 76.49mm (3.0110 ~ 3.0114in)
C	76.49 ~ 76.50mm (3.0114 ~ 3.0118in)

- Select the piston related to cylinder bore class.

Piston-to-cylinder clearance :

0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

Boring cylinder

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

NOTE: The size of piston is stamped on top of the piston.

- Measure the outside diameter of the piston to be used.
- 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.)

- 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.

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

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

NOTE: When boring the cylinders, finish all of the cylinders to the same oversize. Do not bore only one cylinder to the oversize.
(1.6 CVVT : Don't use over size)

PISTON AND PISTON RINGS

- Clean the piston.
 - Using a gasket scraper, remove the carbon from the piston top.

2. Using a groove cleaning tool or broken ring, clean the piston ring grooves.
3. Using solvent and a brush, thoroughly clean the piston.

NOTE: Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken, 39.15mm (1.5413in) from top land of the piston.

Standard diameter :

76.47 ~ 76.50mm (3.0106 ~ 3.0118in)

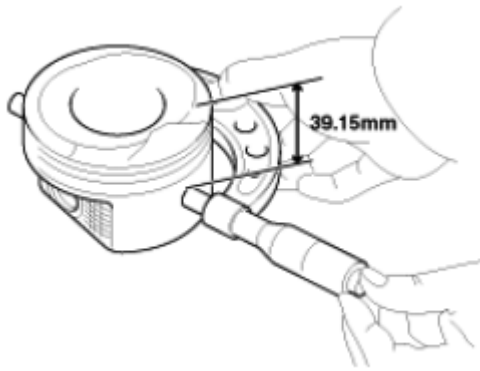


Fig. 25: Measuring Piston Outside Diameter
Courtesy of KIA MOTORS AMERICA, INC.

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

Piston-to-cylinder clearance :

0.02 ~ 0.04mm (0.0008 ~ 0.0016in)

4. Inspect the piston ring side clearance.

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

Piston ring side clearance

No. 1 ring : 0.04 ~ 0.085mm (0.0016 ~ 0.0033in)

No. 2 ring : 0.04 ~ 0.085mm (0.0016 ~ 0.0033in)

Oil ring : 0.08 ~ 0.175mm (0.0031 ~ 0.0069in)

Limit

No. 1 ring : 0.1mm (0.0039in)

No. 2 ring : 0.1mm (0.0039in)



Fig. 26: Measuring Clearance Between Piston Ring And Wall Of Ring Groove Using Feeler Gauge
Courtesy of KIA MOTORS AMERICA, INC.

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. (Refer to **Cylinder block crankshaft journal bore mark location**)

Piston ring end gap

Standard

No. 1 ring : 0.15 ~ 0.30mm (0.0059 ~ 0.0118in)

No. 2 ring : 0.35 ~ 0.50mm (0.0138 ~ 0.0197in)

Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0276in)

Limit

No. 1, 2, oil ring : 1.0mm (0.0394in)

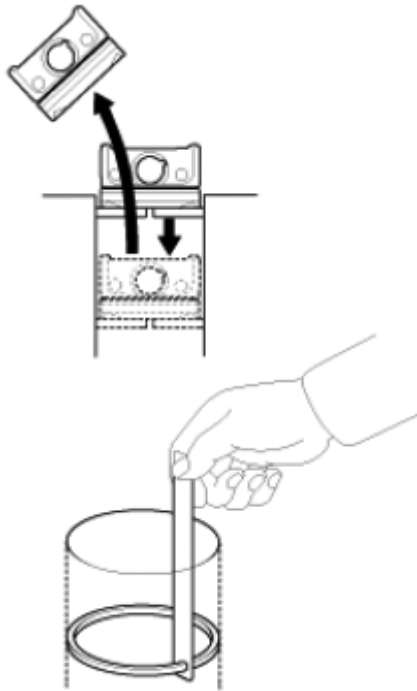


Fig. 27: Inspecting Piston Ring End Gap
Courtesy of KIA MOTORS AMERICA, INC.

PISTON PINS

1. Measure the outer diameter of piston pin

Piston pin diameter :

18.001 ~ 18.007mm (0.7087 ~ 0.7089in)

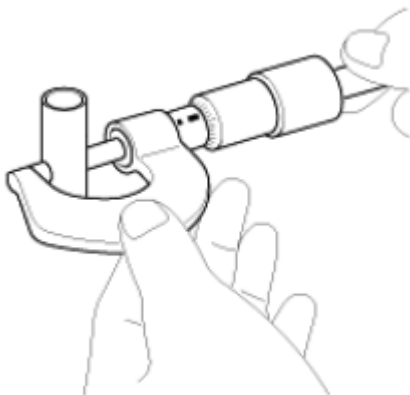


Fig. 28: Measuring Outer Diameter Of Piston Pin
Courtesy of KIA MOTORS AMERICA, INC.

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

Piston pin-to-piston clearance :

0.011 ~ 0.018mm (0.0004 ~ 0.0007in)

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

Piston pin-to-connecting rod interference :

-0.033 ~ -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.

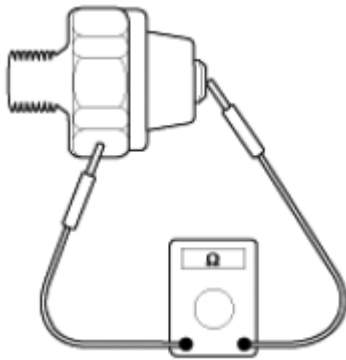


Fig. 29: Checking Continuity Between Terminal And Body With Ohmmeter
Courtesy of KIA MOTORS AMERICA, INC.

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.

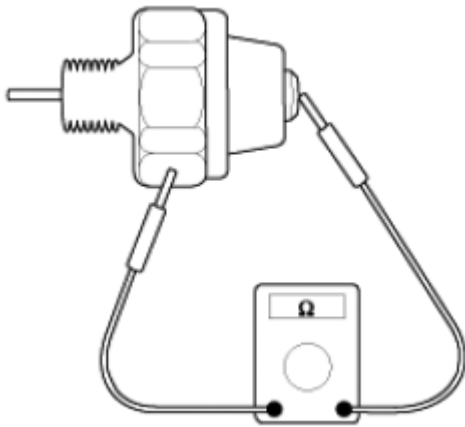


Fig. 30: Checking Continuity Between Terminal And Body
Courtesy of KIA MOTORS AMERICA, INC.

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

NOTE:

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

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

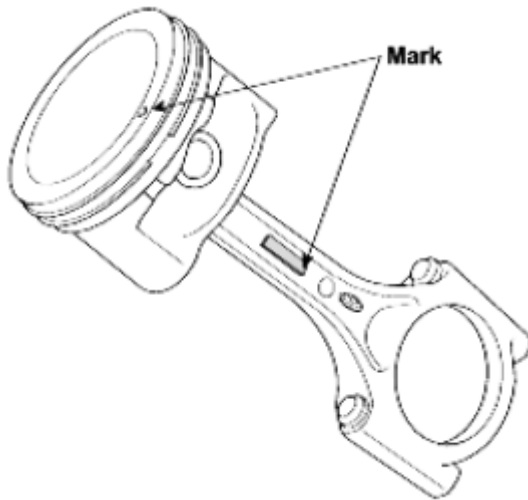


Fig. 31: Identifying Piston Front Mark And Connecting Rod Front Mark
Courtesy of KIA MOTORS AMERICA, INC.

2. Install the piston rings.
 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.

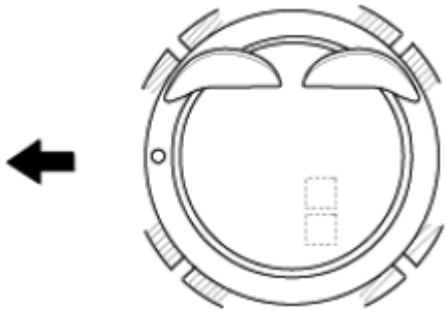


Fig. 32: Identifying Piston Rings Installation Position
Courtesy of KIA MOTORS AMERICA, INC.

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).

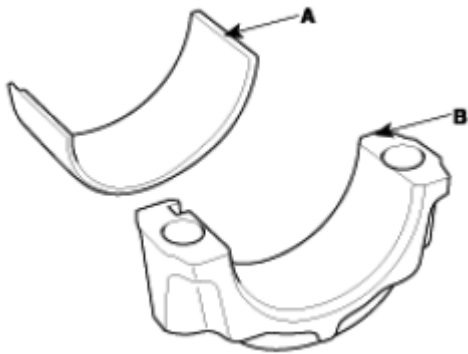


Fig. 33: Identifying Bearings And Connecting Rod Cap
Courtesy of KIA MOTORS AMERICA, INC.

4. Install the crankshaft main bearings.

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

1. Align the bearing claw with the claw groove of the cylinder block, push in the 4 upper bearings (A).

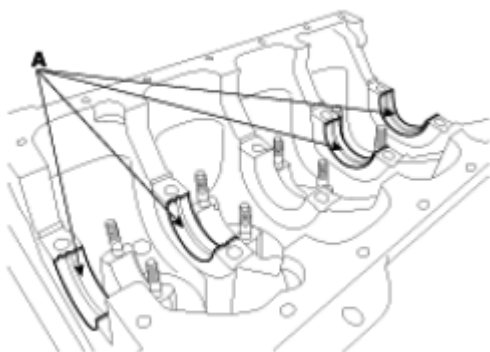


Fig. 34: Identifying Upper Bearings
 Courtesy of KIA MOTORS AMERICA, INC.

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

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



Fig. 35: Identifying Center Bearing
 Courtesy of KIA MOTORS AMERICA, INC.

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

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

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

Tightening torque:

53.9 ~ 58.8N.m (5.5 ~ 6.0kgf.m, 39.8 ~ 43.4lb-ft)

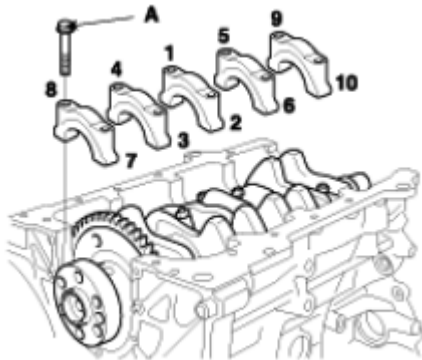


Fig. 36: Identifying Bearing Cap Bolts Tightening Sequence
Courtesy of KIA MOTORS AMERICA, INC.

3. Check that the crankshaft turns smoothly.
9. Check the crankshaft end play. (Refer to **Crankshaft main bearing mark location**)
10. Install the piston and connecting rod assemblies.

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

1. Remove the connecting rod caps, and slip short sections of rubber hose over the threaded ends of the connecting rod bolts
2. Install the ring compressor, check that the rings are securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.
3. Stop after the ring compressor pops free, and check the connecting rod-to-crank journal alignment before pushing the piston into place.
4. Apply engine oil to the bolt threads. install the rod caps with bearings, and tighten the nuts.

Tightening torque :

31.4 ~ 34.3N.m (3.2 ~ 3.5kgf.m, 23.1 ~ 25.3lb-ft)

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

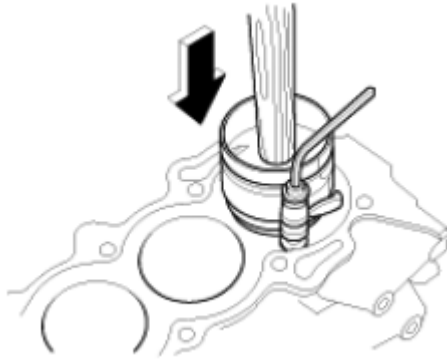


Fig. 37: Installing Piston And Connecting Rod Assemblies
 Courtesy of KIA MOTORS AMERICA, INC.

11. Install the rear oil seal case.

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

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

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

Liquid gasket : MS 721-40A or equivalent

3. Install the rear oil seal case (A) with 5 bolts (B).

Tightening torque :

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

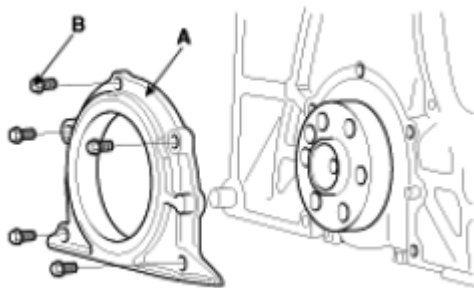


Fig. 38: Identifying Rear Oil Seal Case With Bolts
 Courtesy of KIA MOTORS AMERICA, INC.

12. Install the rear oil seal.

1. Apply engine oil to a new oil seal lip.
2. Using the SST (09231-21000) and a hammer, tap in the oil seal until its surface is flush with the

rear oil seal retainer edge.

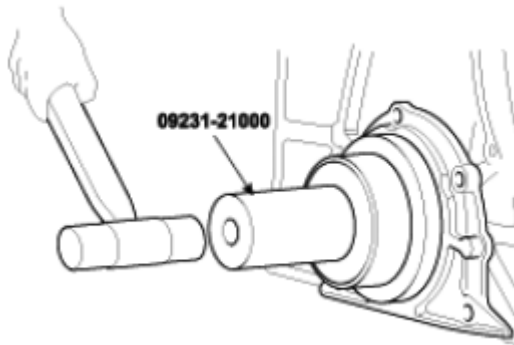


Fig. 39: Tapping Oil Seal Using SST (09231-21000) And Hammer
Courtesy of KIA MOTORS AMERICA, INC.

13. Install the front case. (Refer to **ENGINE AND TRANSAXLE ASSEMBLY**)
14. Install the oil screen.

Install a new gasket (B) and oil screen (A) with 2 bolts (C).

Tightening torque :

14.7 ~ 21.6N.m (1.5 ~ 2.2kgf.m, 10.8 ~ 15.9lb-ft)

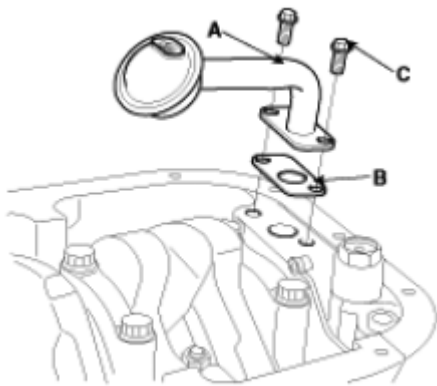


Fig. 40: Identifying Gasket And Oil Screen With Bolts
Courtesy of KIA MOTORS AMERICA, INC.

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

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

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

Liquid gasket : MS 721-40A or equivalent

NOTE:

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

Instead, reapply liquid gasket after removing the residue.

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

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

Uniformly tighten the bolts in several passes.

Tightening torque :

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

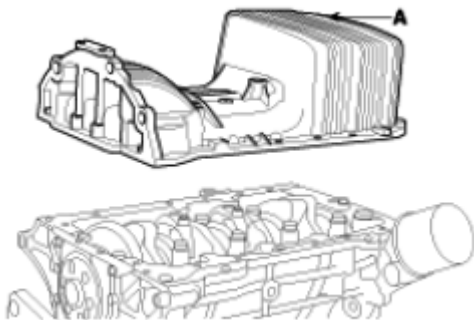


Fig. 41: Identifying Oil Pan
Courtesy of KIA MOTORS AMERICA, INC.

16. Install the water pump. (Refer to **WATER PUMP**)
17. Install the oil pressure switch.
 1. Apply adhesive to 2 or 3 threads.

Adhesive : MS 721-39 (B) or equivalent.

2. Install the oil pressure switch (A).

Tightening torque :

14.7 ~ 21.6N.m (1.5 ~ 2.2kgf.m, 10.8 ~ 15.9lb-ft)

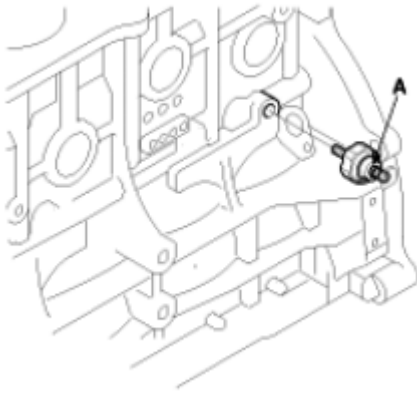


Fig. 42: Identifying Oil Pressure Switch
Courtesy of KIA MOTORS AMERICA, INC.

18. Install the knock sensor (A).

Tightening torque :

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

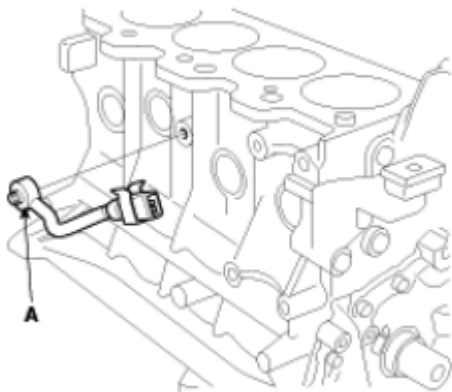


Fig. 43: Identifying Knock Sensor
Courtesy of KIA MOTORS AMERICA, INC.

19. Install the oil level gauge tube (A).
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 (A) with the bolt.

Tightening torque :

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

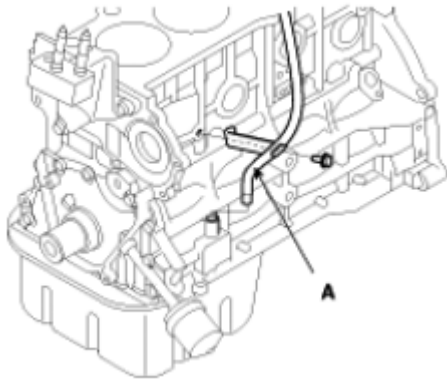


Fig. 44: Identifying Oil Level Gauge Tube With Bolt
 Courtesy of KIA MOTORS AMERICA, INC.

20. Install the cylinder head. (Refer to **CYLINDER HEAD ASSEMBLY**)
21. Install the timing belt. (Refer to **TIMING BELT**)
22. Remove the engine stand.
23. A/T : install the drive plate.

Tightening torque :

117.7 ~ 127.5N.m (12.0 ~ 13.0kgf.m, 86.8 ~ 94.0lb-ft)

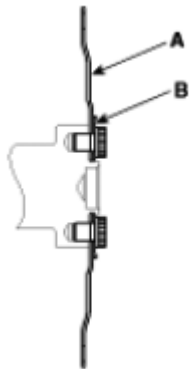


Fig. 45: Identifying Drive Plate With Bolts
 Courtesy of KIA MOTORS AMERICA, INC.

24. M/T : install the fly wheel.

Tightening torque :

117.7 ~ 127.5N.m (12.0 ~ 13.0kgf.m, 86.8 ~ 94.0lb-ft)

2010 ENGINE

Cylinder Head Assembly - Rio

COMPONENTS AND COMPONENTS LOCATION

COMPONENT

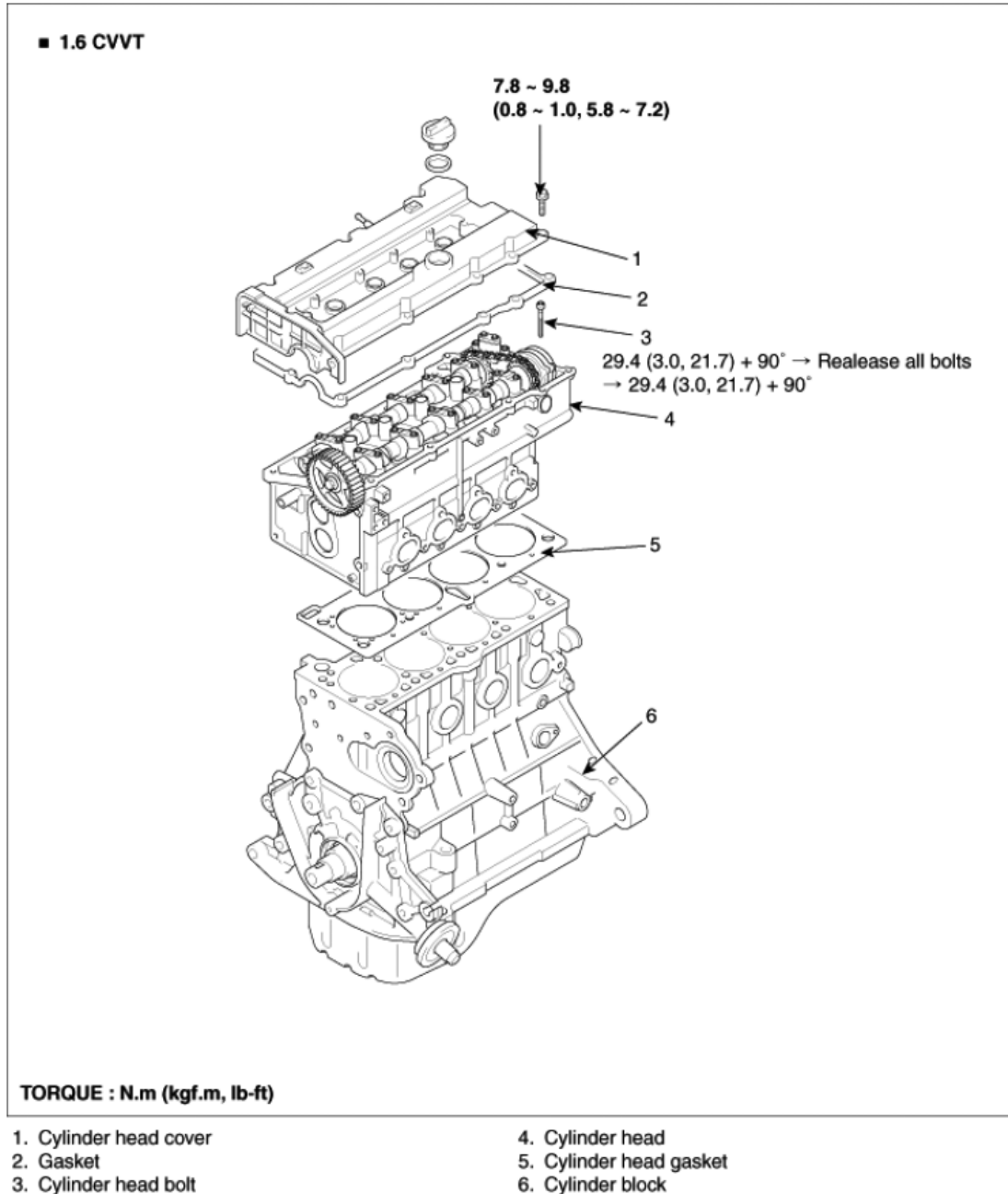
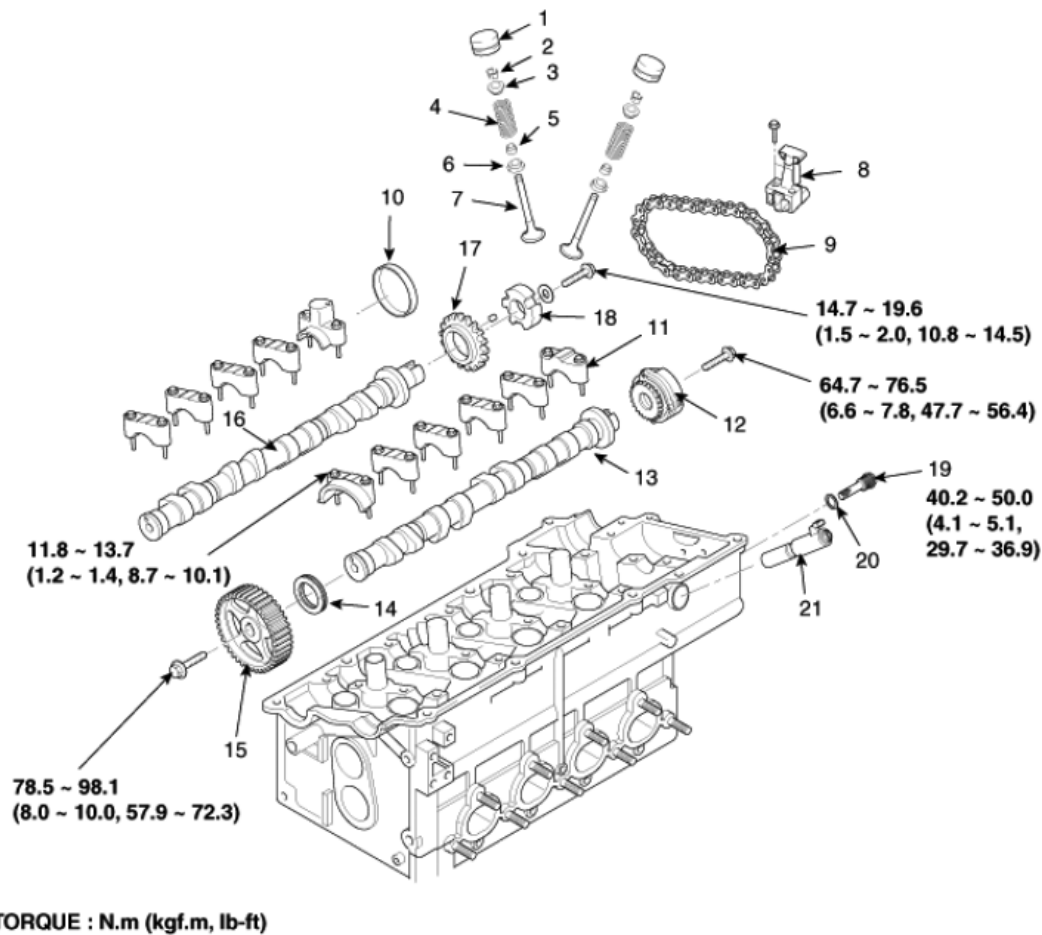


Fig. 1: Identifying Cylinder Head Assembly Components With Torque Specification (1 Of 2)
 Courtesy of KIA MOTORS AMERICA, INC.

■ 1.6 CVVT



- | | |
|-------------------------------------|--|
| 1. HLA
(Hydraulic Lash Adjuster) | 11. Camshaft bearing cap |
| 2. Retainer lock | 12. CVVT (Continuously Variable Valve Timing) assembly |
| 3. Retainer | 13. Exhaust camshaft |
| 4. Valve spring | 14. Oil seal |
| 5. Stem seal | 15. Camshaft sprocket |
| 6. Spring seat | 16. Intake camshaft |
| 7. Valve | 17. Chain sprocket |
| 8. Auto tensioner | 18. Camshaft position sensor target wheel |
| 9. Timing chain | 19. OCV (Oil Control Valve) Filter |
| 10. Oil seal cap | 20. Washer |
| | 21. OCV (Oil Control Valve) |

Fig. 2: Identifying Cylinder Head Assembly Components With Torque Specification (2 Of 2)
 Courtesy of KIA MOTORS AMERICA, INC.

REPAIR PROCEDURES

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.

NOTE:

- Mark all wiring and hoses to avoid misconnection.
- Inspect the timing belt before removing the cylinder head.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center. (Refer to TIMING BELT)

1. Disconnect the terminals (A) from battery and remove the battery.

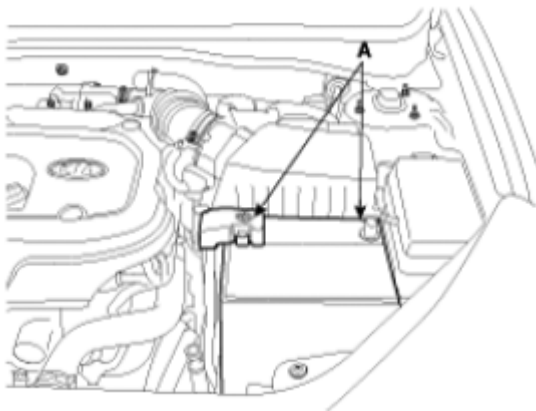


Fig. 3: Identifying Battery Terminals
Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the engine cover (A).

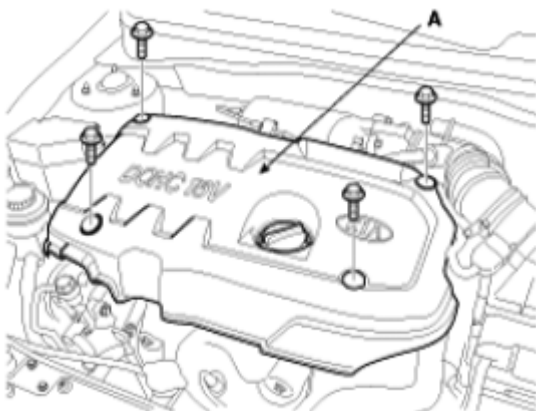
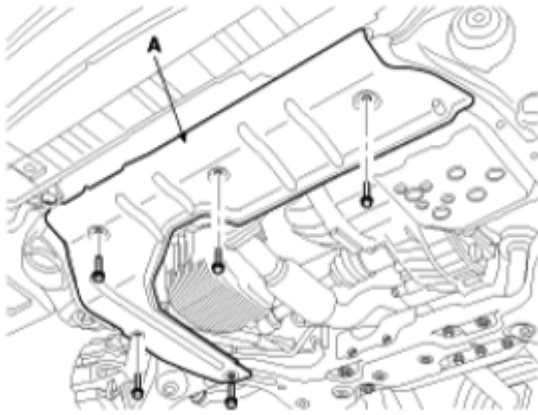


Fig. 4: Identifying Engine Cover

Courtesy of KIA MOTORS AMERICA, INC.

3. Remove the under cover (A).

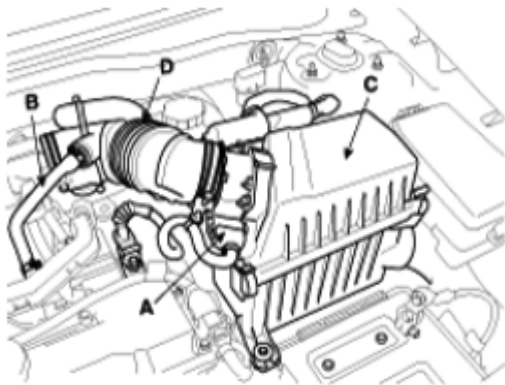
**Fig. 5: Identifying Under Cover**

Courtesy of KIA MOTORS AMERICA, INC.

4. Drain the engine coolant. (Refer to **ENGINE COOLANT REFILLING AND BLEEDING**)

Remove the radiator cap to speed draining.

5. Remove the intake air hose and air cleaner assembly.
 1. Disconnect the AFS (Air Flow Sensor) connector (A).
 2. Disconnect the breather hose (B) from intake air hose (D).
 3. Remove the intake air hose (D) and air cleaner upper cover (C).

**Fig. 6: Identifying AFS (Air Flow Sensor) Connector, Breather Hose, Air Cleaner Upper Cover And Intake Air Hose**

Courtesy of KIA MOTORS AMERICA, INC.

4. Disconnect the ECM connector (A) and ECM connector (B) (A/T only).

5. Remove the air cleaner element and air cleaner lower cover (C).

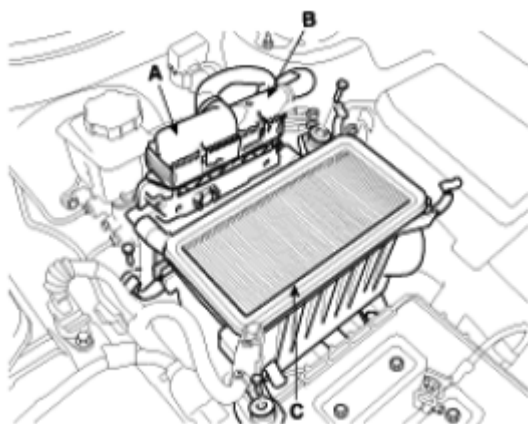


Fig. 7: Identifying ECM Connector And Air Cleaner Lower Cover
Courtesy of KIA MOTORS AMERICA, INC.

6. Remove the battery tray (A).

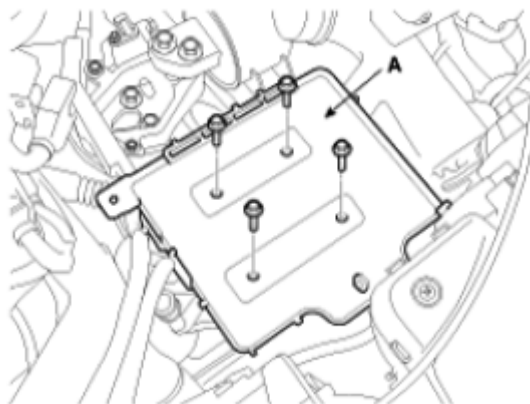


Fig. 8: Identifying Battery Tray
Courtesy of KIA MOTORS AMERICA, INC.

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

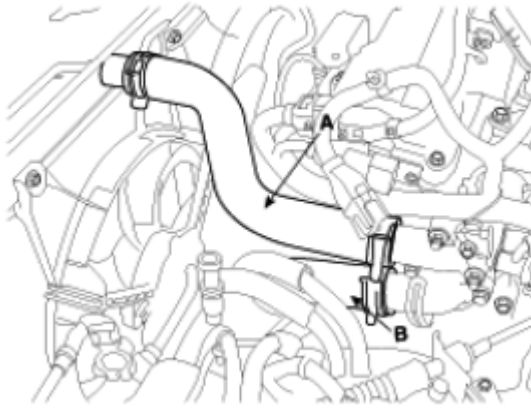


Fig. 9: Identifying Upper Radiator Hose And Lower Radiator Hose
 Courtesy of KIA MOTORS AMERICA, INC.

8. Remove the heater hoses (A).
9. Remove the fuel hose (B).

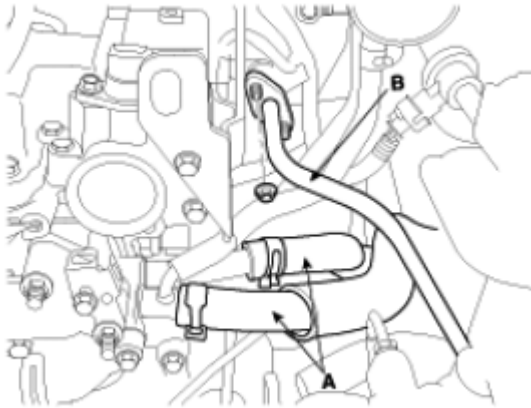


Fig. 10: Identifying Heater Hoses And Fuel Hose
 Courtesy of KIA MOTORS AMERICA, INC.

10. Remove the accelerator cable (A) by loosening the lock-nut, then slip the cable end out of the throttle linkage.
11. Disconnect the TPS (Throttle Position Sensor) connector (B).

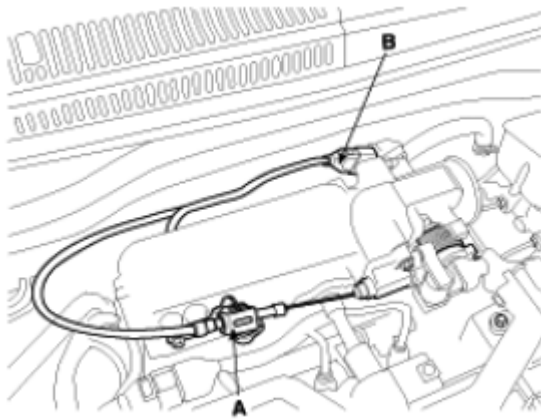


Fig. 11: Identifying Accelerator Cable And TPS (Throttle Position Sensor) Connector
Courtesy of KIA MOTORS AMERICA, INC.

12. Remove the engine wire harness connectors and wire harness clamps from cylinder head and the intake manifold.
 1. Disconnect the rear oxygen sensor connector (A).
 2. Disconnect the air conditioner compressor switch connector (B).
 3. Disconnect the knock sensor connector (C).
 4. Disconnect the injector connectors (No. 3,4) (D).
 5. Disconnect the injector connectors (No. 1,2) (E)

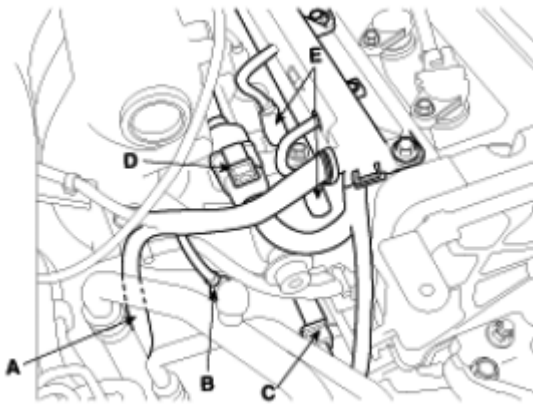


Fig. 12: Identifying Rear Oxygen Sensor Connector, Air Conditioner Compressor Switch Connector, Knock Sensor Connector And Injector Connectors
Courtesy of KIA MOTORS AMERICA, INC.

6. Remove the wire harness bracket (A).
 7. Disconnect the ISA (Idle Speed Actuator) connector (B).

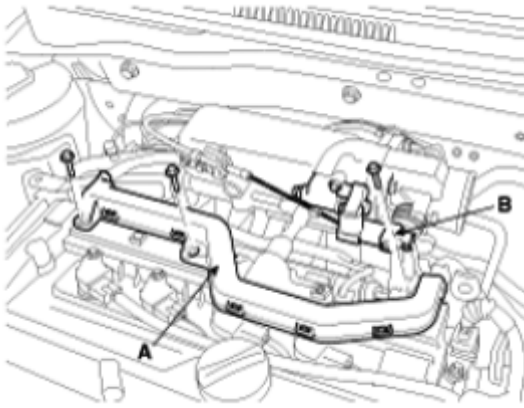


Fig. 13: Identifying Wire Harness Bracket And ISA (Idle Speed Actuator) Connector
Courtesy of KIA MOTORS AMERICA, INC.

8. Disconnect the front oxygen sensor connector (A).
9. Disconnect the CKP (Crankshaft Position Sensor) connector (B).
10. Disconnect the OCV (Oil Control Valve) connector (C).

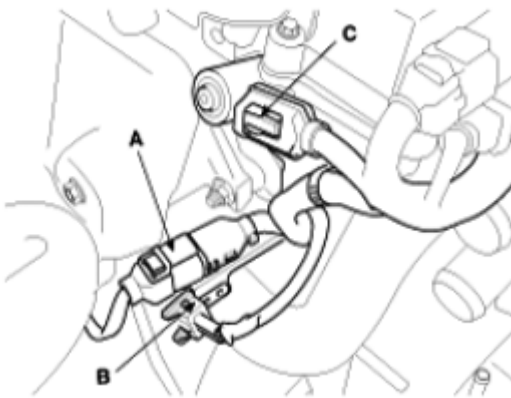


Fig. 14: Identifying Front Oxygen Sensor Connector, CKP (Crankshaft Position Sensor) Connector And OCV (Oil Control Valve) Connector
Courtesy of KIA MOTORS AMERICA, INC.

11. Disconnect the ignition coil connector (A).
12. Disconnect the ignition coil condenser connector (B).
13. Disconnect the CMP (Camshaft Position Sensor) connector (C).
14. Disconnect the ground cable (D).
15. Remove the wire harness bracket (E).

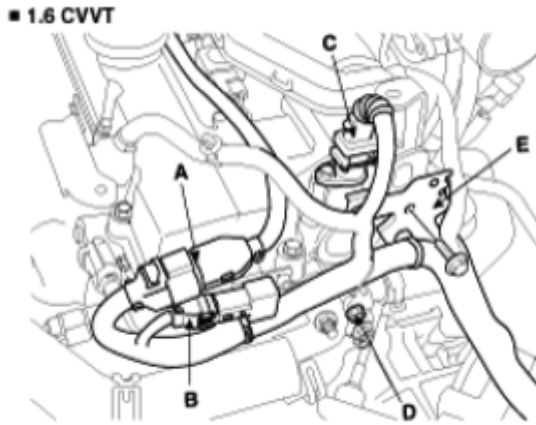


Fig. 15: Identifying Ignition Coil Connector, Ignition Coil Condenser Connector, CMP Connector, Ground Cable And Wire Harness Bracket
 Courtesy of KIA MOTORS AMERICA, INC.

13. Disconnect the hose (A) of the PCSV (Purge Control Solenoid Valve) side.
14. Remove the brake booster vacuum hose (B).

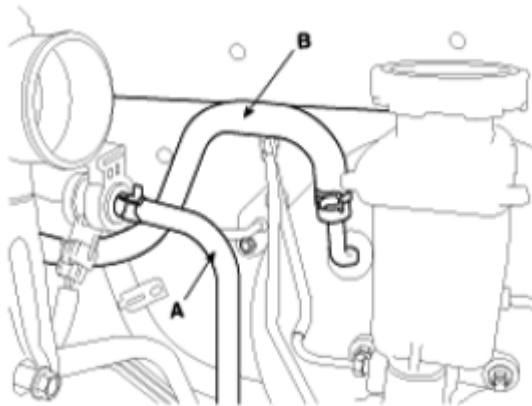


Fig. 16: Identifying PCSV (Purge Control Solenoid Valve) Hose And Brake Booster Vacuum Hose
 Courtesy of KIA MOTORS AMERICA, INC.

15. Remove the power steering pump and fix the pump to vehicle with a wire. (Refer to **HYDRAULIC POWER STEERING SYSTEM**)
16. Remove the ignition coil. (Refer to **IGNITION SYSTEM**)
17. Remove the exhaust manifold. (Refer to **EXHAUST MANIFOLD**)
18. Remove the intake manifold. (Refer to **INTAKE MANIFOLD**)
19. Remove the timing belt. (Refer to **TIMING BELT**)
20. Remove the cylinder head cover. (Refer to **Components and Components Location**)
21. Remove the camshaft sprocket. (Refer to **Components and Components Location**)
22. Remove the timing chain auto tensioner (A).

■ 1.6 CVVT



Fig. 17: Identifying Timing Chain Auto Tensioner
Courtesy of KIA MOTORS AMERICA, INC.

23. Remove the camshaft bearing caps (A) and camshafts (B).

■ 1.6 CVVT

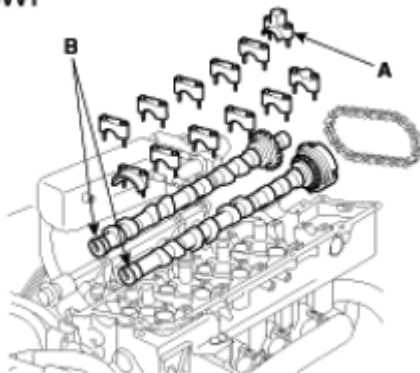


Fig. 18: Identifying Camshaft Bearing Caps And Camshafts
Courtesy of KIA MOTORS AMERICA, INC.

24. Remove the OCV (Oil Control Valve) (A).

■ 1.6 CVVT

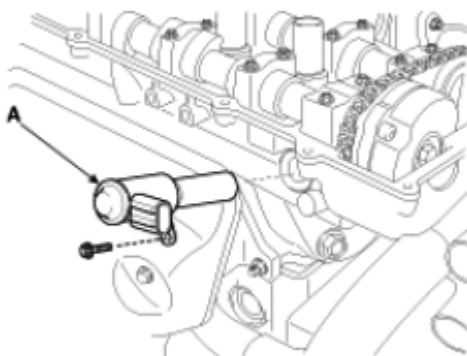


Fig. 19: Identifying OCV (Oil Control Valve)
Courtesy of KIA MOTORS AMERICA, INC.

25. Remove the OCV (Oil Control Valve) filter (A).

■ 1.6 CVVT

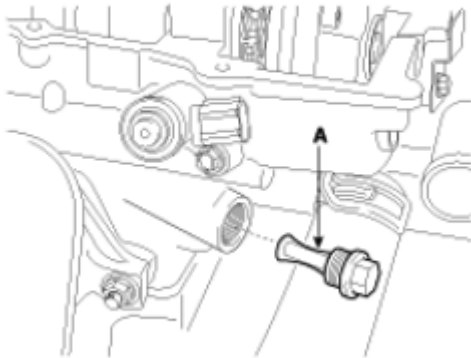


Fig. 20: Identifying OCV (Oil Control Valve) Filter
Courtesy of KIA MOTORS AMERICA, INC.

26. Remove the engine mounting support bracket fixing bolts (A).

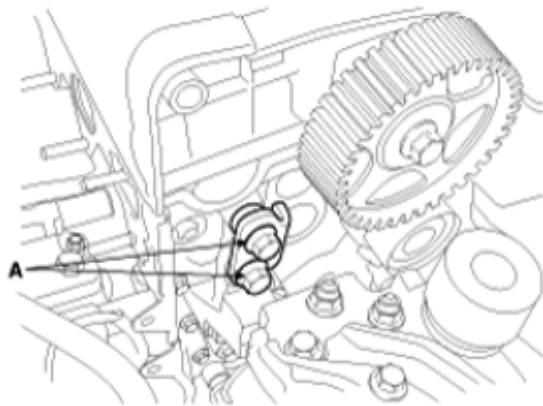


Fig. 21: Identifying Engine Mounting Support Bracket Fixing Bolts
Courtesy of KIA MOTORS AMERICA, INC.

27. Remove the cylinder head bolts, then remove the cylinder head.
1. Using 8mm hexagon wrench, uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown.

■ 1.6 CVVT

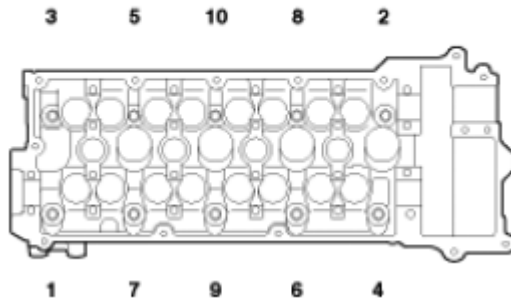


Fig. 22: Identifying Cylinder Head Bolts Loosening Sequence
 Courtesy of KIA MOTORS AMERICA, INC.

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

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

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

REPLACEMENT

VALVE GUIDE

1. Using the SST (09221 - 3F100A), withdraw the old valve guide toward the bottom of cylinder head.

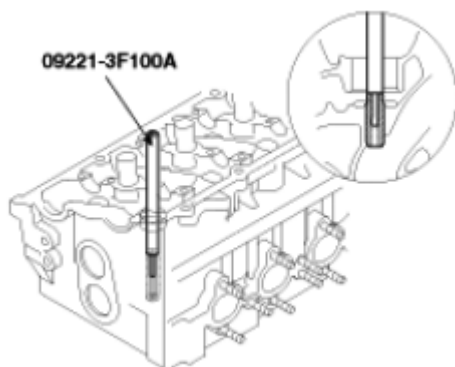


Fig. 23: Removing Old Valve Guide Using SST (09221 - 3F100A)
 Courtesy of KIA MOTORS AMERICA, INC.

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 (09221-3F100A, 09221-26000), press-fit the valve guide. The valve guide must be press-

fitted from the upper side of the cylinder head. Keep in mind that the intake and exhaust valve guides are different in length.

Valve guide length

Intake : 36.3 ~ 36.7mm (1.4291 ~ 1.4449in)

Exhaust : 40.8 ~ 41.2mm (1.6063 ~ 1.6220in)

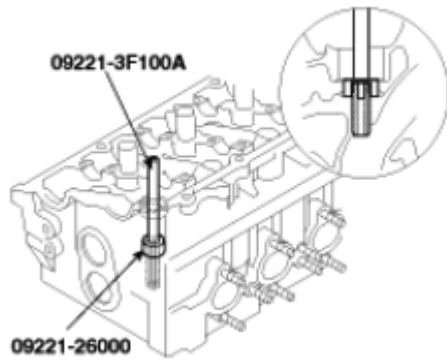


Fig. 24: Pressing Valve Guide Using SST (09221-3F100A, 09221-26000)

Courtesy of KIA MOTORS AMERICA, INC.

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

VALVE GUIDE OVERSIZE

VALVE GUIDE OVERSIZE SPECIFICATION

Item	Oversize [mm (in)]	Size mark	Valve guide hole inner diameter [mm (in)]	Valve guide outer diameter [mm (in)]	Valve guide protrusion height [mm (in)]
Valve guide	STD	-	11.000 ~ 11.018 (0.4331 ~ 0.4338)	11.050 ~ 11.060 (0.4350 ~ 0.4354)	12.8 (0.5039)
	0.05 (0.002) OS	5	11.050 ~ 11.068 (0.4350 ~ 0.4357)	11.100 ~ 11.110 (0.4370 ~ 0.4374)	
	0.25 (0.010) OS	25	11.250 ~ 11.268 (0.4429 ~ 0.4436)	11.300 ~ 11.310 (0.4449 ~ 0.4453)	
	0.50 (0.020) OS	50	11.500 ~ 11.518 (0.4528 ~ 0.4535)	11.550 ~ 11.560 (0.4547 ~ 0.4551)	

VALVE SEAT RING

- Cut away the inner face of the valve seat to reduce the wall thickness.

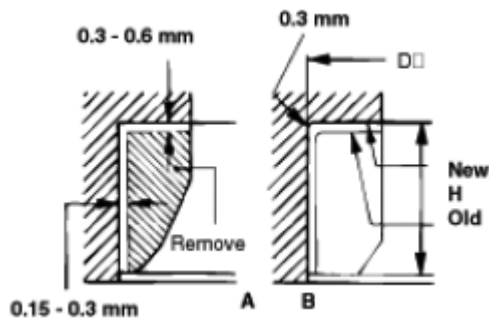


Fig. 25: Identifying Valve Seat Thickness
 Courtesy of KIA MOTORS AMERICA, INC.

2. Enlarge the seat ring hole of cylinder head so that matches the specified cylinder head hole inner diameter of new valve seat ring.
3. Heat the cylinder head to about 250°C (480°F) and press-fit an oversize seat ring for the cylinder head hole size.
4. Using lapping compound, lap the valve to the new seat.

VALVE SEAT RING OVERSIZE

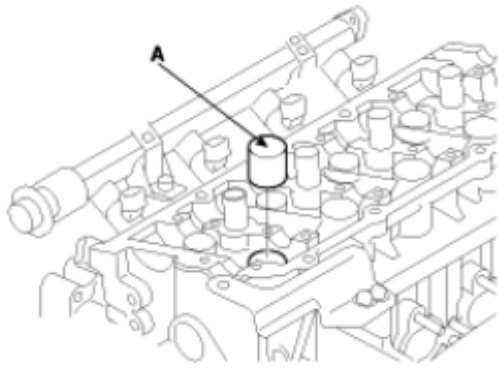
VALVE SEAT RING OVERSIZE SPECIFICATION

Item	Over size [mm (in.)]	Size mark	Seat ring hole inner diameter [mm (in)]	Seat ring outer diameter [mm (in)]	Seat ring height [mm (in)]
Intake valve seat ring	STD	-	30.400 ~ 30.421 (1.1968 ~ 1.1977)	30.490 ~ 30.505 (1.2004 ~ 1.2010)	4.800 ~ 5.000 (0.1890 ~ 0.1969)
	0.3 (0.012) OS	30	30.700 ~ 30.721 (1.2087 ~ 1.2095)	30.790 ~ 30.805 (1.2122 ~ 1.2128)	5.100 ~ 5.300 (0.2008 ~ 0.2087)
	0.6 (0.024) OS	60	31.000 ~ 31.021 (1.2205 ~ 1.2213)	31.090 ~ 31.105 (1.2240 ~ 1.2246)	5.400 ~ 5.600 (0.2126 ~ 0.2205)
Exhaust valve seat ring	STD	-	27.000 ~ 27.021 (1.0630 ~ 1.0638)	27.095 ~ 27.115 (1.0667 ~ 1.0675)	5.900 ~ 6.100 (0.2323 ~ 0.2402)
	0.3 (0.012)	30	27.300 ~ 27.321 (1.0748 ~ 1.0756)	27.395 ~ 27.415 (1.0785 ~ 1.0793)	6.200 ~ 6.400 (0.2441 ~ 0.2520)
	0.6 (0.024)	60	27.600 ~ 27.621 (1.0866 ~ 1.0874)	27.695 ~ 27.715 (1.0904 ~ 1.0911)	6.500 ~ 6.700 (0.2559 ~ 0.2638)

DISASSEMBLY

NOTE: Identify HLA (Hydraulic Lash Adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

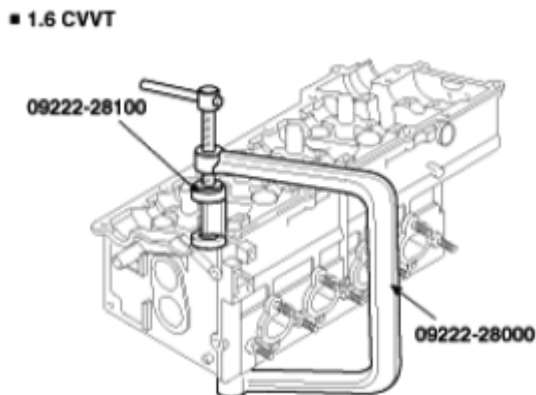
1. Remove the HLAs (A).

**Fig. 26: Identifying HLAs**

Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the valves.

1. Using the SST (09222 - 28000, 09222 - 28100), compress the valve spring and remove the retainer lock.

**Fig. 27: Compressing Valve Spring Using SST (09222 - 28000, 09222 - 28100)**
Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the spring retainer.
3. Remove the valve spring.
4. Remove the valve.
5. Using a needle-nose pliers, remove the oil seal.
6. Using a magnetic finger, remove the spring seat.

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 0.03mm (0.0012in)

Limit : 0.05mm (0.0020in)

Flatness of manifold mating surface

Standard : Less than 0.15mm (0.0059in)

Limit : 0.20mm (0.0079in)

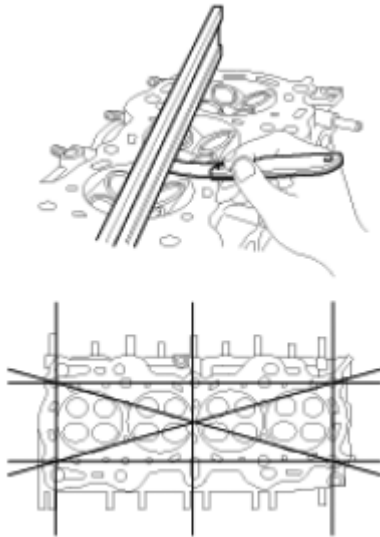


Fig. 28: Measuring Cylinder Block For Flatness
Courtesy of KIA MOTORS AMERICA, INC.

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 :

6.000 ~ 6.015mm (0.2362 ~ 0.2368in)

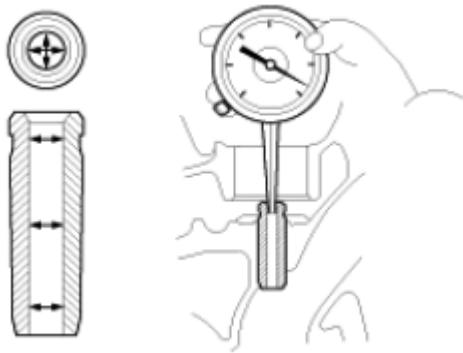


Fig. 29: Measuring Inner Diameter Of Valve Guide Using Caliper Gauge
 Courtesy of KIA MOTORS AMERICA, INC.

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 : 5.950 ~ 5.965mm (0.2343 ~ 0.2348in)

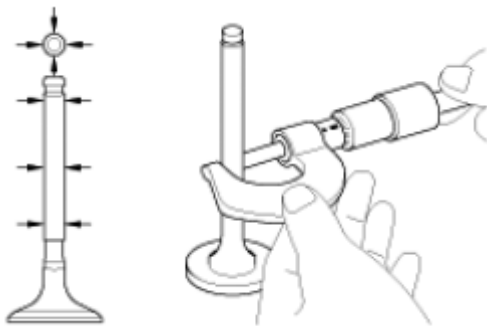


Fig. 30: Measuring Outer Diameter Of Valve Stem Using Micrometer
 Courtesy of KIA MOTORS AMERICA, INC.

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

Valve stem- to-guide clearance

Standard

Intake : 0.02 ~ 0.05mm (0.0008 ~ 0.0020in)

Exhaust : 0.035 ~ 0.065mm (0.0014 ~ 0.0026in)

Limit

Intake : 0.10mm (0.0039in)

Exhaust : 0.15mm (0.0059in)

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

2. Inspect the valves.

1. Check the valve is ground to the correct valve face angle.
2. Check 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 : 1.3mm (0.0512in)

Limit

Intake : 0.8mm (0.0315in)

Exhaust : 1.0mm (0.0394in)

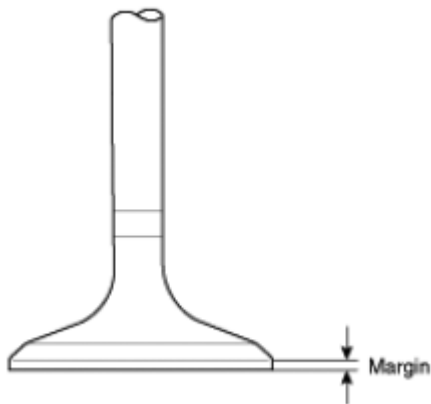


Fig. 31: Identifying Valve Head Margin Thickness
Courtesy of KIA MOTORS AMERICA, INC.

4. Check the surface of valve stem tip for wear.

If the valve stem tip is worn, replace the valve.

3. Inspect the valve seats.

1. Check the valve seat for evidence of overheating and improper contact with the valve face.

Replace the seat if necessary.

2. Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace it, then recondition the seat.
3. Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.

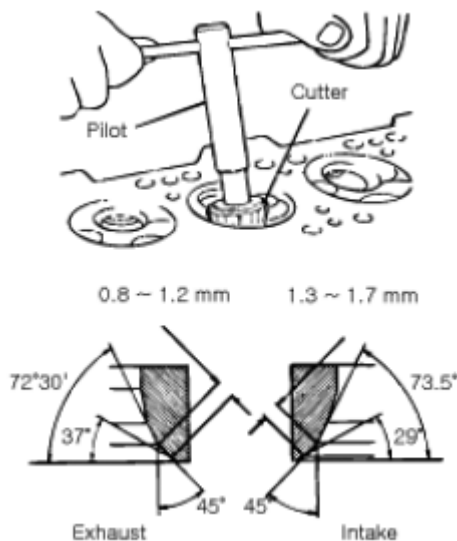


Fig. 32: Inspecting Valve Seats
Courtesy of KIA MOTORS AMERICA, INC.

4. Inspect the valve springs.

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

Valve spring

Standard

Free height : 44mm (1.7323in)

Load : 21.6±1.1kg/35.0mm (47.6±2.4lb/1.3780in)

45.1±2.2kg/27.2mm (99.4±4.9lb/1.0709in)

Out of square : Less than 1.5°

Limit

Out of square : 3°

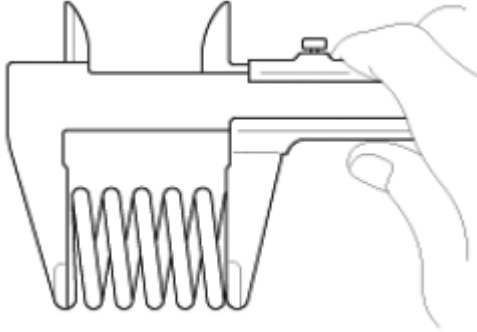


Fig. 33: Measuring Free Length Of Valve Spring Using Vernier Calipers
Courtesy of KIA MOTORS AMERICA, INC.

If the loads is not as specified, replace the valve spring.

CAMSHAFT

1. Inspect the cam lobes.

Using a micrometer, measure the cam lobe height.

Cam height

Intake : 43.7492 ~ 43.9492mm (1.72241 ~ 1.73028in)

Exhaust : 44.1494 ~ 44.3494mm (1.73816 ~ 1.74604in)

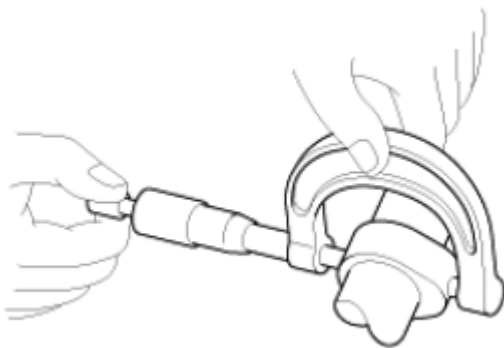


Fig. 34: Measuring Cam Lobe Height Using Micrometer
Courtesy of KIA MOTORS AMERICA, INC.

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.

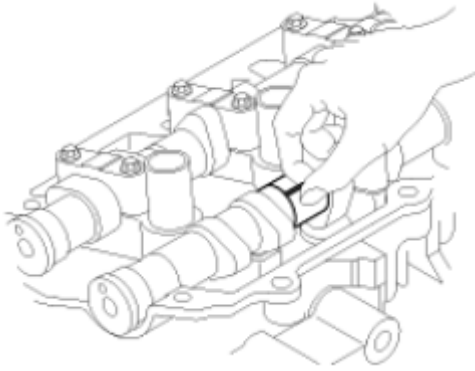


Fig. 35: Laying Strip Of Plastigage Across Of Camshaft Journal
Courtesy of KIA MOTORS AMERICA, INC.

4. Install the bearing caps and tighten the bolts with specified torque. (Refer to **CAMSHAFT**)

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 ~ 0.061mm (0.0008 ~ 0.0024in)

Limit : 0.1mm (0.0039in)

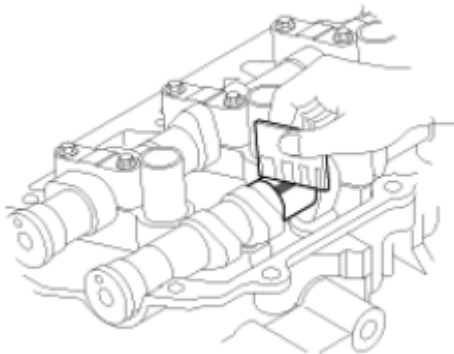


Fig. 36: Measuring Plastigage

Courtesy of KIA MOTORS AMERICA, INC.

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

7. Completely remove the plastigage.
8. Remove the camshafts.
3. Inspect the camshaft end play.
 1. Install the camshafts. (Refer to **CAMSHAFT**)
 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)

■ 1.6 CVVT

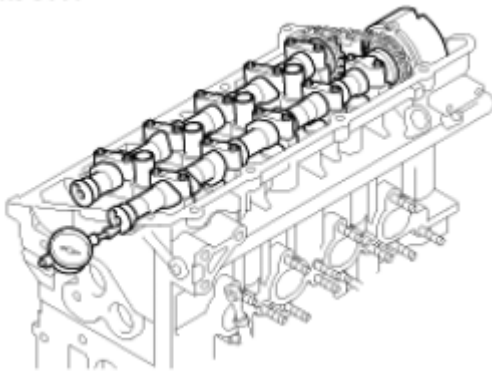


Fig. 37: Measuring Camshaft End Play Using Dial Indicator
Courtesy of KIA MOTORS AMERICA, INC.

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.

CVVT (Continuous Variable Valve Timing) ASSEMBLY

1. Inspect the CVVT (Continuous Variable Valve Timing) assembly.
 1. Check that the CVVT (Continuous Variable Valve Timing) assembly will not turn.
 2. Apply vinyl tape to all the parts except the one indicated by the arrow in the illustration.

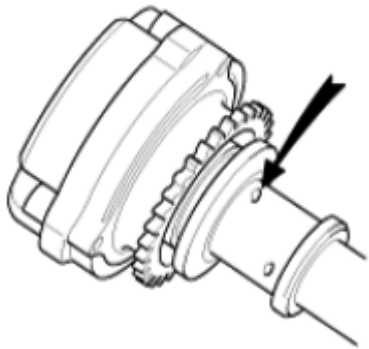


Fig. 38: Identifying Vinyl Tape Applying Area
 Courtesy of KIA MOTORS AMERICA, INC.

3. Wrap tape around the tip of the air gun and apply air of approx. 98kpa (1kg/cm², 14psi) to the port of the camshaft. Perform this order to release the lock pin for the maximum delay angle locking.)

NOTE: **Wrap around it with a shop rag and the likes, because the oil splashes.**

4. Under the condition of 3), turn the CVVT assembly to the advance angle side with your hand.
 - A. Depending on the air pressure, the CVVT assembly will turn to the advance side.
 - B. If air is leaking from the port and air pressure cannot be maintained, the locking pin will not release.

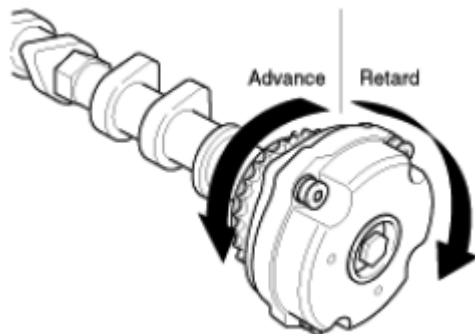


Fig. 39: Turning CVVT Assembly To Advance Angle Side
 Courtesy of KIA MOTORS AMERICA, INC.

5. 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 20°

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

HLA (HYDRAULIC LASH ADJUSTER)

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

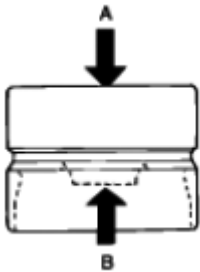


Fig. 40: Pressing HLA (Hydraulic Lash Adjuster)
Courtesy of KIA MOTORS AMERICA, INC.

POSSIBLE CAUSE REFERENCE

No.	Problem	Possible cause	Action
1	Temporary noise when starting a cold engine	Normal	This noise will disappear after the oil in the engine reaches the normal pressure.
2	Continuous noise when the engine is started after parking more than 48 hours.	Oil leakage of the high pressure chamber on the HLA, allowing air to get in.	Noise will disappear within 15 minutes when engine runs at 2,000~3,000 rpm. If it doesn't disappear, refer to step 7 below. CAUTION: Do not run engine at a speed higher than 3,000 rpm, as this may damage the HLA.
3	Continuous noise when the engine is first started after rebuilding cylinder head.	Insufficient oil in cylinder head oil gallery.	
4	Continuous noise when the engine is started after excessively cranking the engine by the starter motor.	Oil leakage of the high-pressure chamber in the HLA, allowing air to get in.	
5	Continuous noise when the engine is running after changing the HLA.	Insufficient oil in the HLA.	
6	Continuous noise during idle after high engine speed.	Engine oil level too high or too low.	Check oil level. Drain or add oil as necessary.
		Excessive amount of air in the oil at high engine speed.	Check oil supply system
		Deteriorated oil.	Check oil quality. If deteriorated, replace with specified type.
7	Noise continues for more than 15 minutes.	Low oil pressure	Check oil pressure and oil supply system of each part of engine.
		Faulty HLA.	Remove the cylinder head cover and press HLA down by hand. If it moves, replace the HLA.

REASSEMBLY**NOTE:**

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

1. Install the valves.

1. Install the spring seats.
2. Using the SST (09222 - 22001), push in a new oil seal.

NOTE:

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

■ 1.6 CVT

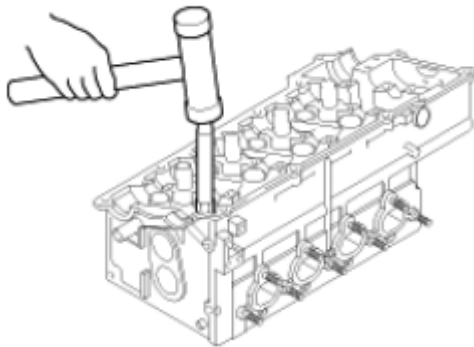


Fig. 41: Pushing Oil Seal Using SST (09222 - 22001)
Courtesy of KIA MOTORS AMERICA, INC.

3. Install the valve, valve spring and spring retainer.

NOTE:

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

4. Using the SST (09222 - 28000, 09222 - 28100), 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.

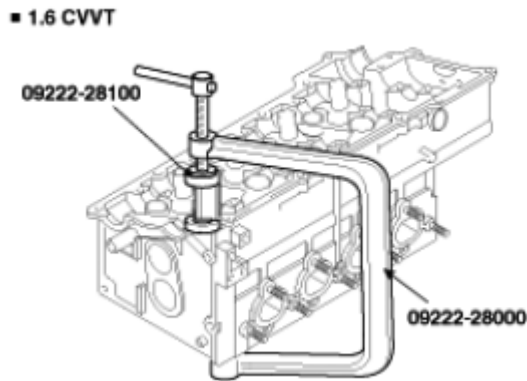


Fig. 42: Compressing Spring Using SST (09222 - 28000, 09222 - 28100)
Courtesy of KIA MOTORS AMERICA, INC.

5. 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.

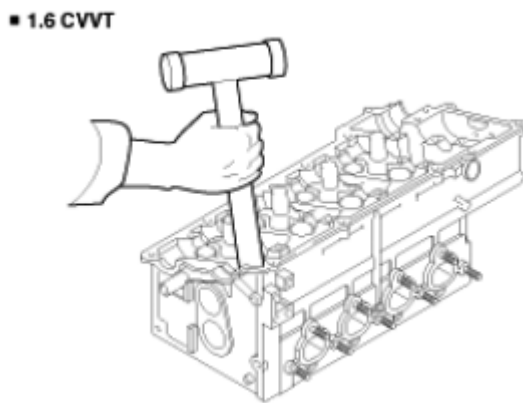


Fig. 43: Tapping End Of Valve Stem With Wooden Handle Of Hammer
Courtesy of KIA MOTORS AMERICA, INC.

2. Install the HLA (Hydraulic Lash Adjuster) s.

Check that the HLA rotates smoothly by hand.

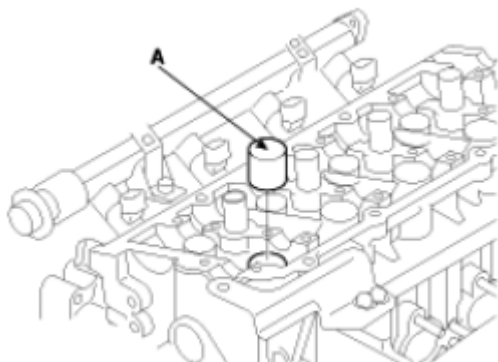


Fig. 44: Identifying HLA (Hydraulic Lash Adjuster)
Courtesy of KIA MOTORS AMERICA, INC.

INSTALLATION

NOTE:

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

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

NOTE: Be careful of the installation direction.

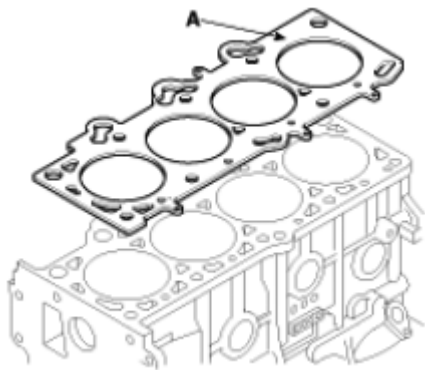


Fig. 45: Identifying Cylinder Head Gasket
Courtesy of KIA MOTORS AMERICA, INC.

2. Place the cylinder head quietly in order not to damage the gasket with the bottom part of the end.
3. Install the cylinder head bolts.
 1. Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.
 2. Using 8mm and 10mm hexagon wrench, install and tighten the 10 cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :

29.4N.m (3.0kgf.m, 21.7lb-ft) + 90° --> Release all bolts --> 29.4N.m (3.0kgf.m, 21.7lb-ft) + 90°

■ 1.6 CVVT

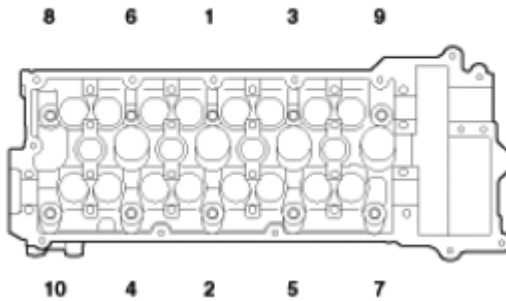


Fig. 46: Identifying Cylinder Head Bolts Tightening Sequence
 Courtesy of KIA MOTORS AMERICA, INC.

4. Install the engine mounting support bracket fixing bolts (A).

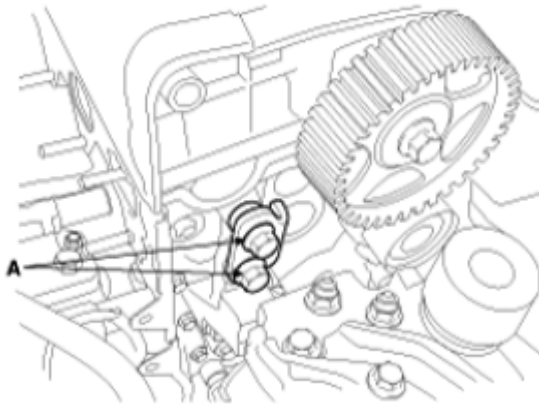


Fig. 47: Identifying Engine Mounting Support Bracket Fixing Bolts
 Courtesy of KIA MOTORS AMERICA, INC.

5. Install the OCV (Oil Control Valve) filter (A).

Tightening torque :

40.2 ~ 50.0N.m (4.1 ~ 5.1kgf.m, 29.7 ~ 36.9lb-ft)

■ 1.6 CVVT

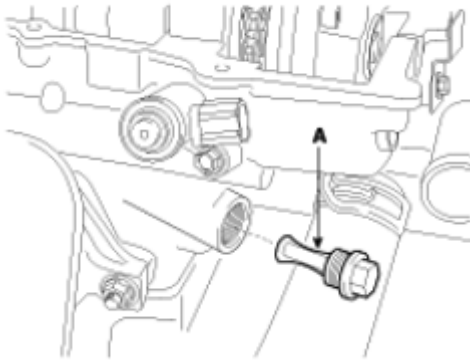


Fig. 48: Identifying OCV (Oil Control Valve) Filter
 Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Always use a new OCV (Oil Control Valve) filter gasket.
- Keep clean the OCV (Oil Control Valve) filter.

6. Install the OCV (Oil Control Valve) (A).

Tightening torque :

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

■ 1.6 CVVT

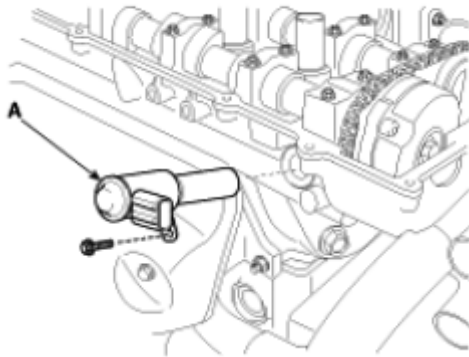


Fig. 49: Identifying OCV (Oil Control Valve)
 Courtesy of KIA MOTORS AMERICA, INC.

CAUTION:

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

7. Install the camshafts.

1. Align the camshaft timing chain with the intake timing chain sprocket and exhaust timing chain sprocket as shown.

■ 1.6 CVVT

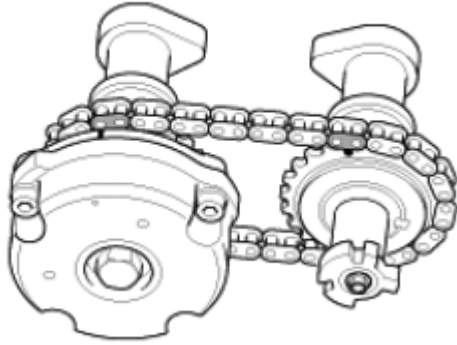


Fig. 50: Identifying Intake Timing Chain Sprocket And Exhaust Timing Chain Sprocket
Courtesy of KIA MOTORS AMERICA, INC.

2. Install the camshaft (A) and bearing caps (B).

Tightening torque :

11.8 ~ 13.7N.m (1.2 ~ 1.4kgf.m, 8.7 ~ 10.1lb-ft)

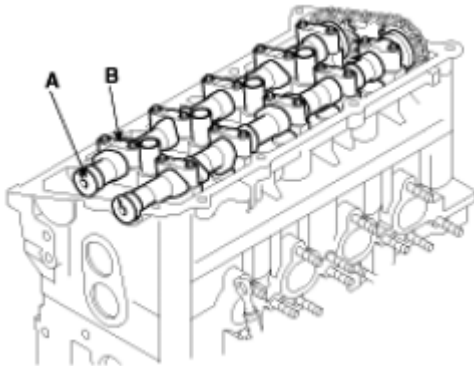


Fig. 51: Identifying Camshaft And Bearing Caps
Courtesy of KIA MOTORS AMERICA, INC.

3. Install the timing chain auto tensioner (A).

Tightening torque :

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

■ 1.6 CVVT



Fig. 52: Identifying Timing Chain Auto Tensioner
 Courtesy of KIA MOTORS AMERICA, INC.

8. Using the SST (09221 - 21000), install the camshaft bearing oil seal.

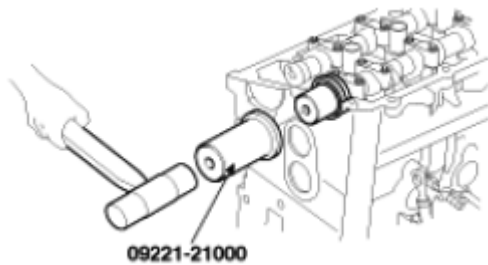


Fig. 53: Installing Camshaft Bearing Oil Seal Using SST (09221 - 21000)
 Courtesy of KIA MOTORS AMERICA, INC.

9. Install the camshaft sprocket. (Refer to **CAMSHAFT**)
10. Install the cylinder head cover.
 1. Install the cylinder head cover gasket (A) in the groove of the cylinder head cover (B).

■ 1.6 CVVT

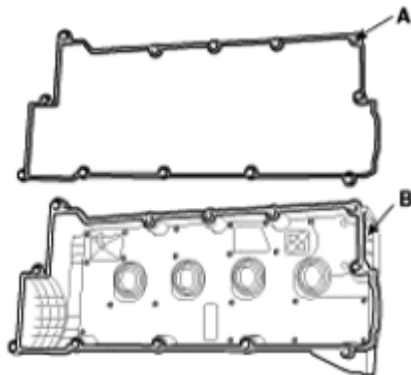


Fig. 54: Identifying Cylinder Head Cover Gasket And Cylinder Head Cover
 Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Before installing the cylinder head cover gasket, thoroughly clean the cylinder head cover and the groove.
- When installing, make sure the cylinder head cover gasket is seated securely in the corners of the recesses with no gap.

2. Apply liquid gasket to the head cover gasket at the corners of the recess.

■ 1.6 CVVT

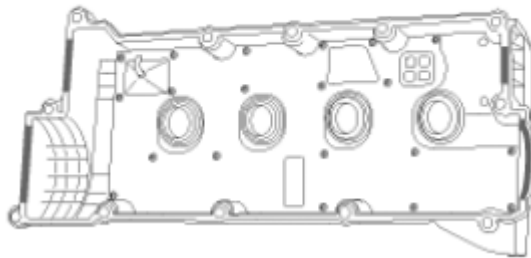


Fig. 55: Identifying Liquid Gasket Applying Area On Head Cover Gasket
Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Use liquid gasket, Loctite No. 5999.
- Check that the mating surfaces are clean and dry before applying liquid gasket.
- After assembly, wait at least 30 minutes before filling the engine with oil.

3. Install the cylinder head cover (A) with bolts (B).

Uniformly tighten the bolts in several passes.

Pre-tighten all bolts by 3.9~4.9N.m (0.4~0.5kgf.m, 2.9~3.6lb-ft) and then tighten by the specified torque.

Tightening torque :

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

■ 1.6 CVVT

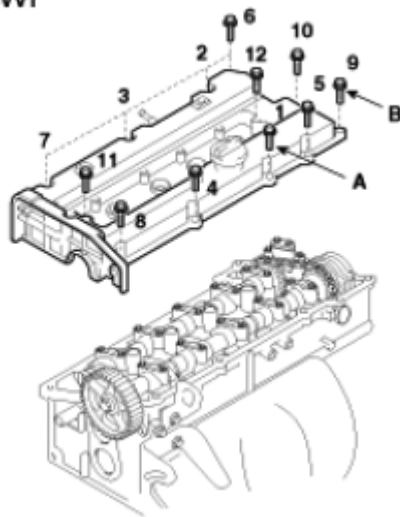


Fig. 56: Identifying Cylinder Head Cover Bolts Tightening Sequence
Courtesy of KIA MOTORS AMERICA, INC.

11. Install the timing belt. (Refer to **TIMING BELT**)
12. Install the intake manifold. (Refer to **INTAKE MANIFOLD**)
13. Install the exhaust manifold. (Refer to **EXHAUST MANIFOLD**)
14. Install the ignition coil. (Refer to **IGNITION SYSTEM**).
15. Install the power steering pump. (Refer to **HYDRAULIC POWER STEERING SYSTEM**)
16. Install the brake booster hose (B).
17. Connect the hose (A) of the PCSV (Purge Control Solenoid Valve) side.

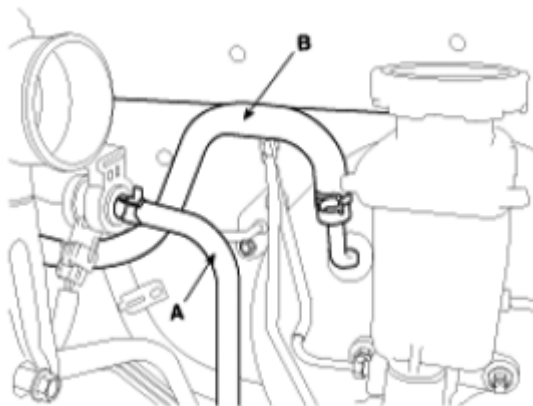


Fig. 57: Identifying PCSV (Purge Control Solenoid Valve) Hose And Brake Booster Hose
Courtesy of KIA MOTORS AMERICA, INC.

18. Install the engine wire harness connectors and wire harness clamps to the cylinder head and the intake manifold.
 1. Install the wire harness bracket (E).

2. Connect the ground cable (D).
3. Connect the CMP (Camshaft position sensor) connector (C).
4. Connect the ignition coil condenser connector (B).
5. Connect the ignition coil connector (A).

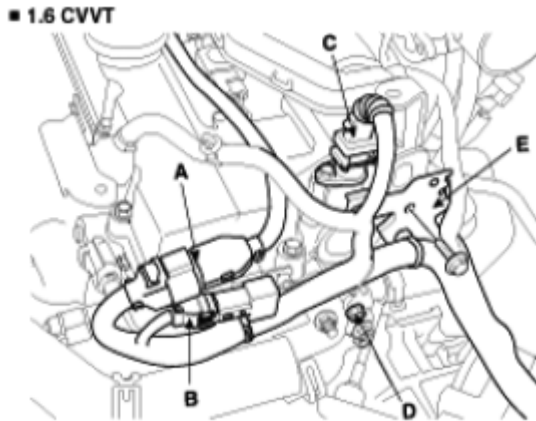


Fig. 58: Identifying Ignition Coil Connector, Ignition Coil Condenser Connector And CMP (Camshaft Position Sensor) Connector
 Courtesy of KIA MOTORS AMERICA, INC.

6. Connect the OCV (Oil Control Valve) connector (C).
7. Connect the CKP (Crankshaft Position Sensor) connector (B).
8. Connect the front oxygen sensor connector (A).

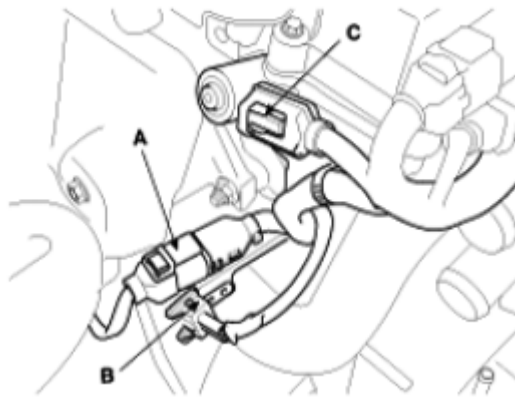


Fig. 59: Identifying Front Oxygen Sensor Connector And CKP (Crankshaft Position Sensor) Connector
 Courtesy of KIA MOTORS AMERICA, INC.

9. Connect the ISA (Idle Speed Actuator) connector (B).
10. Install the wire harness bracket (A).

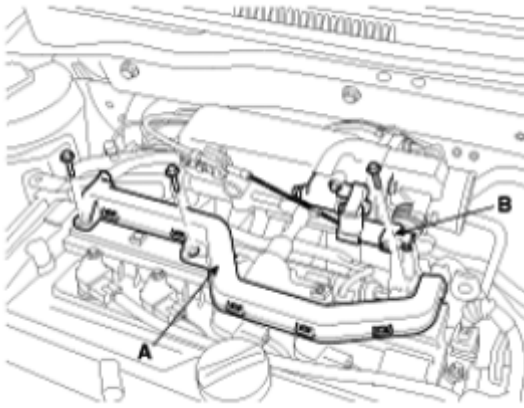


Fig. 60: Identifying Wire Harness Bracket And ISA (Idle Speed Actuator) Connector
Courtesy of KIA MOTORS AMERICA, INC.

11. Connect the injector connectors (No. 1,2) (E).
12. Connect the injector connectors (No. 3,4) (D).
13. Connect the knock sensor connector (C).
14. Connect the air conditioner compressor switch connector (B).
15. Connect the rear oxygen sensor connector (A).

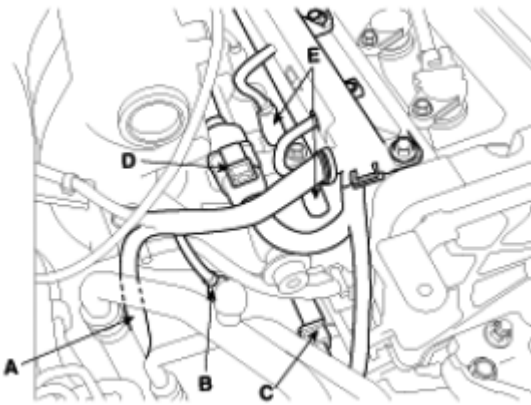


Fig. 61: Identifying Rear Oxygen Sensor Connector, Air Conditioner Compressor Switch Connector And Knock Sensor Connector
Courtesy of KIA MOTORS AMERICA, INC.

19. Connect the TPS (Throttle Position Sensor) connector (B).
20. Install the accelerator cable (A).

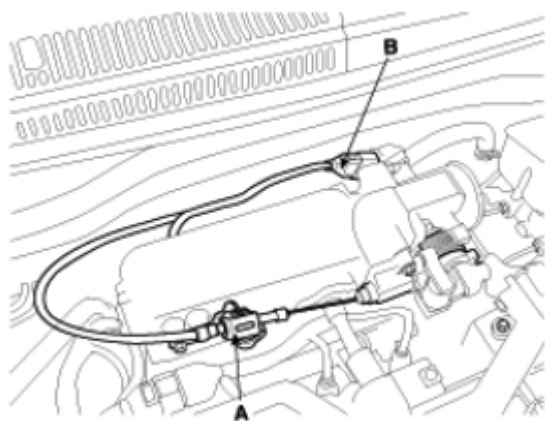


Fig. 62: Identifying Accelerator Cable And TPS (Throttle Position Sensor) Connector
Courtesy of KIA MOTORS AMERICA, INC.

21. Install the fuel hose (B).
22. Install the heater hoses (A).

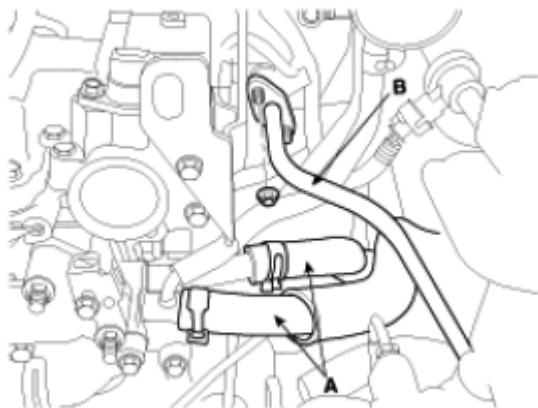


Fig. 63: Identifying Heater Hoses And Fuel Hose
Courtesy of KIA MOTORS AMERICA, INC.

23. Install the upper radiator hose (A) and lower radiator hose (B).

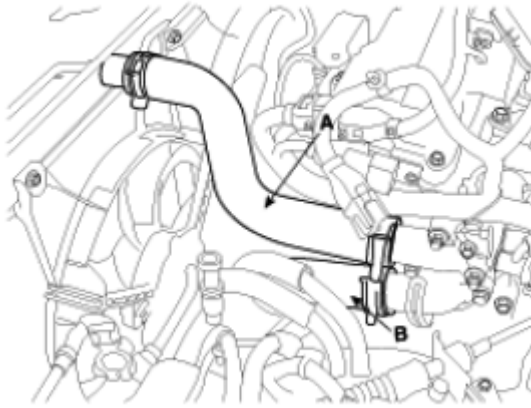


Fig. 64: Identifying Upper Radiator Hose And Lower Radiator Hose
Courtesy of KIA MOTORS AMERICA, INC.

24. Install the battery tray (A).

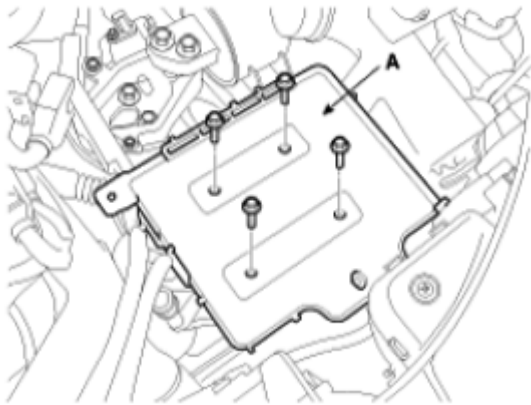


Fig. 65: Identifying Battery Tray
Courtesy of KIA MOTORS AMERICA, INC.

25. Install the intake air hose and air cleaner assembly.
1. Install the air cleaner element and air cleaner lower cover (C).
- Tightening torque :**
- 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
2. Connect the ECM connector (A) and ECM connector (B) (A/T only).

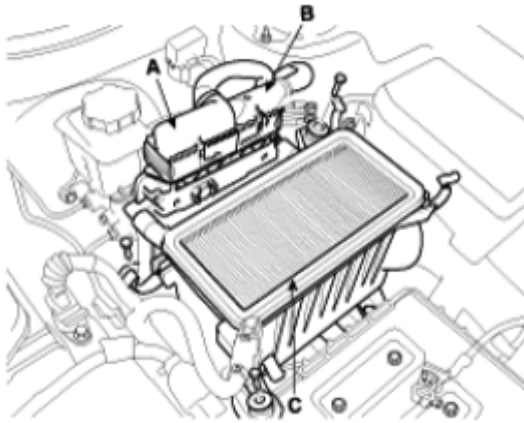


Fig. 66: Identifying ECM Connector And ECM Connector
Courtesy of KIA MOTORS AMERICA, INC.

3. Install the intake air hose (D) and air cleaner upper cover (C).
4. Connect the breather hose (B) to intake air hose (D).
5. Connect the AFS (Air Flow Sensor) connector (A).

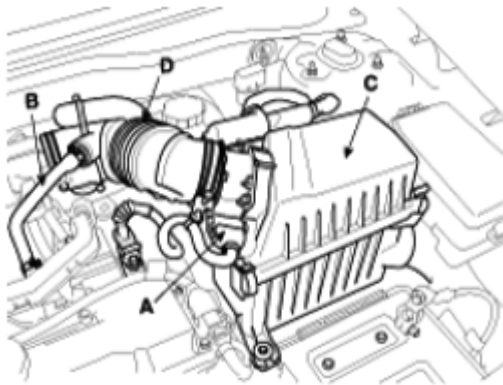


Fig. 67: Identifying AFS (Air Flow Sensor) Connector, Breather Hose And Intake Air Hose
Courtesy of KIA MOTORS AMERICA, INC.

26. Install the under cover (A).

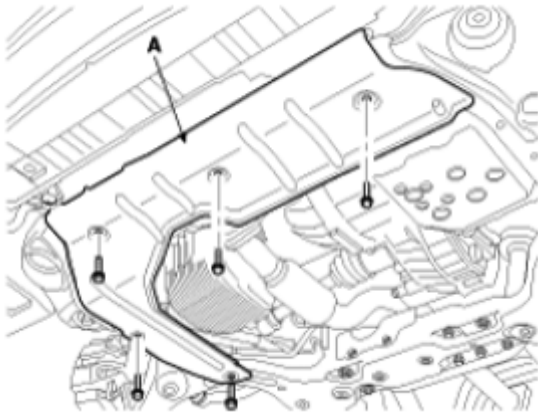


Fig. 68: Identifying Under Cover
 Courtesy of KIA MOTORS AMERICA, INC.

27. Install the engine cover (A).

Tightening torque :

3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)

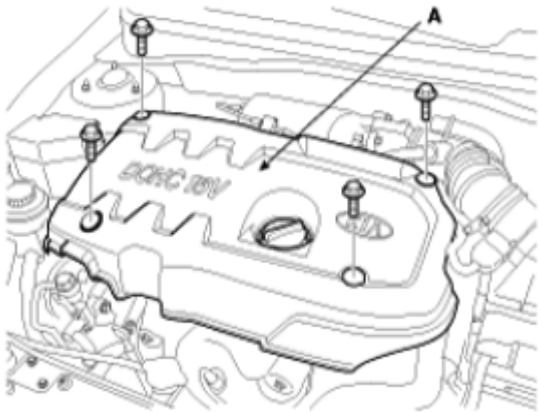


Fig. 69: Identifying Engine Cover
 Courtesy of KIA MOTORS AMERICA, INC.

28. Install the battery and connect the battery terminals (A).

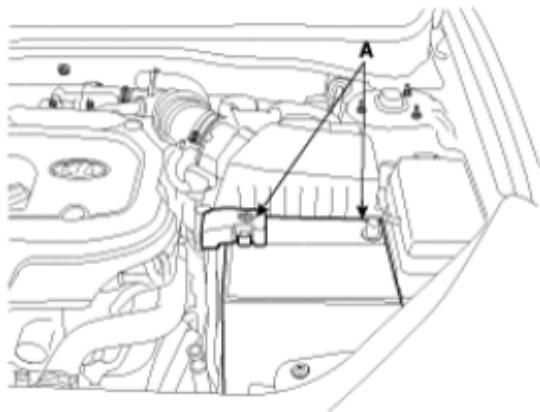


Fig. 70: Identifying Battery Terminals

Courtesy of KIA MOTORS AMERICA, INC.

29. Fill with engine coolant. (Refer to **ENGINE COOLANT REFILLING AND BLEEDING**)
30. Start the engine and check for leaks.
31. Recheck engine coolant level and oil level.

2010 ENGINE

General Information - Engine Mechanical System - Rio

SPECIFICATIONS

GENERAL

SPECIFICATIONS

GENERAL SPECIFICATIONS

Description		Specifications	Limit
		1.6 CVVT	
General			
Type		In-line, DOHC	
Number of cylinders		4	
Bore		76.5mm (3.0118in)	
Stroke		87mm (3.4252in)	
Total displacement		1,599 cc (97.57 cu.in)	
Compression ratio		10.0 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve	Opens (BTDC)	-8°	
	Closes (ABDC)	60°	
Exhaust valve	Opens (BBDC)	46°	
	Closes (ATDC)	10°	
Cylinder head			
Flatness of gasket surface		Less than 0.03mm (0.0012in)	0.1mm (0.0039in)
Flatness of manifold mounting surface	Intake	Less than 0.15mm (0.0059in)	0.2mm (0.0079in)
	Exhaust	Less than 0.15mm (0.0059in)	0.2mm (0.0079in)
Valve guide hole diameter (Intake, Exhaust)	STD	11.000 ~ 11.018mm (0.4331 ~ 0.4338in)	
	0.05 OS	11.050 ~ 11.068mm (0.4350 ~ 0.4357in)	
	0.25 OS	11.250 ~ 11.268mm (0.4429 ~ 0.4436in)	
	0.50 OS	11.500 ~ 11.518mm (0.4528 ~ 0.4535in)	
	STD	30.400 ~ 30.421mm (1.1968 ~ 1.1977in)	

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

Intake valve seat ring hole diameter	0.3 OS	30.700 ~ 30.721mm (1.2087 ~ 1.2095in)	
	0.6 OS	31.000 ~ 31.021mm (1.2205 ~ 1.2213in)	
Exhaust valve seat ring hole diameter	STD	27.000 ~ 27.021mm (1.0630 ~ 1.0638in)	
	0.3 OS	27.300 ~ 27.321mm (1.0748 ~ 1.0756in)	
	0.6 OS	27.600 ~ 27.621mm (1.0866 ~ 1.0874in)	
Camshaft			
Cam height	Intake	43.7492 ~ 43.9492mm (1.72241 ~ 1.73028in)	
	Exhaust	44.1494 ~ 44.3494mm (1.73816 ~ 1.74604in)	
Journal outer diameter (Intake, Exhaust)		26.964 ~ 26.980mm (1.0616 ~ 1.0622in)	
Camshaft cap oil clearance		0.02 ~ 0.061mm (0.0008 ~ 0.0024in)	0.1mm (0.0039in)
End play		0.10 ~ 0.20mm (0.0039 ~ 0.0079in)	
Valve			
Valve length	Intake	91.8mm (3.6142in)	
	Exhaust	92.4mm (3.6378in)	
Stem outer diameter	Intake	5.965 ~ 5.980mm (0.2348 ~ 0.2354in)	
	Exhaust	5.950 ~ 5.965mm (0.2343 ~ 0.2348in)	
Face angle		45° ~ 45° 30'	
Thickness of valve head (margin)	Intake	1.1mm (0.0433in)	0.8mm (0.0315in)
	Exhaust	1.3mm (0.0512in)	1.0mm (0.0394in)
Valve stem to valve guide clearance	Intake	0.02 ~ 0.05mm (0.0008 ~ 0.0020in)	0.10mm (0.0039in)
	Exhaust	0.035 ~ 0.065mm (0.0014 ~ 0.0026in)	0.15mm (0.0059in)
Valve guide			
Length	Intake	36.3 ~ 36.7mm (1.4291 ~ 1.4449in)	
	Exhaust	39.3 ~ 39.7mm (1.5472 ~ 1.5630in)	
Valve seat			
Width of seat	Intake	0.8 ~ 1.2mm (0.0315 ~ 0.0472in)	

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

contact	Exhaust	1.3 ~ 1.7mm (0.0512 ~ 0.0669in)	
Seat angle	Intake	45° ~ 45° 30'	
	Exhaust	45° ~ 45° 30'	
Valve spring			
Free length		44.0mm (1.7323in)	
Load		21.6±1.1kg/35mm (47.6±2.4 lb/1.3780in)	
		45.1±2.2kg/27.2mm (99.4±4.9 lb/1.0709in)	
Out of squareness		Less than 1.5°	3°
Cylinder block			
Cylinder bore		76.50 ~ 76.53mm (3.0118 ~ 3.0130in)	
Flatness of gasket surface		Less than 0.05mm (0.0020in)	
Piston			
Piston outer diameter		76.47 ~ 76.50mm (3.0106 ~ 3.0118in)	
Piston to cylinder clearance		0.020 ~ 0.040mm (0.0008 ~ 0.0016in)	
Ring groove width	No. 1 ring groove	1.230 ~ 1.255mm (0.0484 ~ 0.0494in)	
	No. 2 ring groove	1.230 ~ 1.255mm (0.0484 ~ 0.0494in)	
	Oil ring groove	2.030 ~ 2.055mm (0.0799 ~ 0.0809in)	
Piston ring			
Side clearance	No. 1 ring	0.04 ~ 0.085mm (0.0016 ~ 0.0033in)	0.1 mm (0.0039in)
	No. 2 ring	0.04 ~ 0.085mm (0.0016 ~ 0.0033in)	0.1 mm (0.0039in)
	Oil ring	0.08 ~ 0.175mm (0.0031 ~ 0.0069in)	
End gap	No. 1 ring	0.15 ~ 0.30mm (0.0059 ~ 0.0118in)	1.0mm (0.0394in)
	No. 2 ring	0.35 ~ 0.50mm (0.0138 ~ 0.0197in)	1.0mm (0.0394in)
	Oil ring	0.20 ~ 0.70mm (0.0079 ~ 0.0276in)	1.0mm (0.0394in)
Piston pin			
Piston pin outer diameter		18.001 ~ 18.007mm (0.7087 ~ 0.7089in)	
		18.016 ~ 18.021mm (0.7093	

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

Piston pin hole inner diameter		~ 0.7095in)	
Piston pin hole clearance		0.011 ~ 0.018mm (0.0004 ~ 0.0007in)	
Connecting rod small end hole inner diameter		17.974 ~ 17.985mm (0.7076 ~ 0.7081in)	
Connecting rod small end hole clearance		-0.033 ~ -0.016mm (-0.0013 ~ -0.0006in)	
Piston pin press-in load		500~1,500 kg (1,102 ~ 3,306 lb)	
Connecting rod			
Connecting rod big end inner diameter		48.000 ~ 48.018mm (1.8898 ~ 1.8905in)	
Connecting rod bearing oil clearance		0.018 ~ 0.036mm (0.0007 ~ 0.0014in)	
Side clearance		0.10 ~ 0.25mm (0.0039 ~ 0.0098in)	0.4mm (0.0157in)
Crankshaft			
Main journal outer diameter		49.950 ~ 49.968mm (1.9665 ~ 1.9672in)	
Pin journal outer diameter		44.954 ~ 44.972mm (1.7698 ~ 1.7705in)	
Main bearing oil clearance	No. 1, 2, 4, 5	0.022 ~ 0.040mm (0.0009 ~ 0.0016in)	0.1mm (0.0039in)
	No. 3	0.028 ~ 0.046mm (0.0011 ~ 0.0018in)	0.1mm (0.0039in)
End play		0.05 ~ 0.175mm (0.0020 ~ 0.0069in)	0.2mm (0.0079in)
Flywheel			
Runout		0.1mm (0.0039in)	0.13mm (0.0051in)
Oil pump			
Side clearance	Inner rotor	0.040 ~ 0.085mm (0.0016 ~ 0.0033in)	
	Outer rotor	0.040 ~ 0.090mm (0.0016 ~ 0.0035in)	
Body clearance		0.060 ~ 0.090mm (0.0024 ~ 0.0035in)	
Relief valve opening pressure		500±49.0kpa (5.1±0.5kg/cm ² , 72.5±7.1psi)	
Relief spring	Free length	46.6mm (1.8346in)	
	Load	6.1±0.4kg/40.1mm (13.4±0.9 lb/1.5787in)	
Engine oil			
		3.8L (4.02US qt, 3.34Imp	When replacing a short engine or a

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

Oil quantity	Total	qt)	block assembly
	Oil pan	3.0L (3.17US qt, 2.64Imp qt)	
	Drain and refill	3.3L (3.49US qt, 2.90Imp qt)	Including oil filter
Oil grade	Recommendation	5W-20/GF4 & SM	If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.
	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the " LUBRICATION SYSTEM "
Oil pressure (at 800rpm)		100kPa (1.0kg/cm ² , 14.5psi) or above	Oil temperature in oil pan : 90 ~ 100°C (194 ~ 212°F)
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		5.5 ~ 5.8 L (5.81 ~ 6.13 US qt, 4.84 ~ 5.10 Imp 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/cm ² , 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05kg/cm ² , 0.14 ~ 0.71 psi)	
Water temperature sensor			
Type		Thermistor type	
Resistance	20°C (68°F)	2.45±0.14 kohms	
	80°C (176°F)	0.3222 kohms	

TIGHTENING TORQUE

TIGHTENING TORQUES

Item	Quantity	Tightening torque		
		N.m	kgf.m	lb-ft
Cylinder block				
Engine support bracket bolt	2	44.1 ~ 53.9	4.5 ~ 5.5	32.5 ~ 39.8

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

Engine support bracket nut	1	44.1 ~ 53.9	4.5 ~ 5.5	32.5 ~ 39.8
Engine support bracket stay bolt	2	44.1 ~ 53.9	4.5 ~ 5.5	32.5 ~ 39.8
Rear plate bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Engine mounting				
Engine mounting bracket and body fixing bolt	3	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Engine mounting insulator and engine mounting support bracket fixing nut	1	68.6 ~ 93.2	7.0 ~ 9.5	50.6 ~ 68.7
Engine mounting support bracket and engine support bracket fixing bolt	2	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Engine mounting support bracket and engine support bracket fixing nut	1	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transaxle mounting bracket and body fixing bolt	3	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transaxle mounting insulator and transaxle support bracket fixing bolt	2	68.6 ~ 93.2	7.0 ~ 9.5	50.6 ~ 68.7
Front roll stopper bracket and sub frame fixing bolt	3	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Front roll stopper insulator and front roll stopper support bracket fixing bolt, nut	1	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Rear roll stopper bracket and sub frame fixing bolt	3	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Rear roll stopper insulator and rear roll stopper support bracket fixing bolt, nut	1	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Main moving system				
Connecting rod cap nut	8	31.4 ~ 34.3	3.2 ~ 3.5	23.1 ~ 25.3
Crankshaft main bearing cap bolt	10	53.9 ~ 58.8	5.5 ~ 6.0	39.8 ~ 43.4
Flywheel bolt (M/T)	5	117.7 ~ 127.5	12.0 ~ 13.0	86.8 ~ 94.0
Drive plate bolt (A/T)	5	117.7 ~ 127.5	12.0 ~ 13.0	86.8 ~ 94.0
Timing belt				
Timing belt front upper cover bolt	4	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Timing belt front lower cover bolt	5	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Timing belt rear lower LH cover bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing belt rear upper LH cover bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing belt rear upper RH cover bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

Crankshaft pulley bolt	1	137.3 ~ 147.1	14.0 ~ 15.0	101.3 ~ 108.5
Camshaft sprocket bolt	1	78.5 ~ 98.1	8.0 ~ 10.0	57.9 ~ 72.3
Timing belt tensioner bolt	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing belt idler bolt	1	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39.8
Cylinder head				
Engine cover bolt	4	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Cylinder head cover bolt	12	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Camshaft bearing cap bolt	24	11.8 ~ 13.7	1.2 ~ 1.4	8.7 ~ 10.1
Intake camshaft and CMP sensor target wheel fixing bolt	1	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Exhaust camshaft and CVVT assembly fixing bolt	1	64.7 ~ 76.5	6.6 ~ 7.8	47.7 ~ 56.4
Timing chain auto tensioner bolt	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
OCV (oil control valve) bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
OCV (oil control valve) filter	1	40.2 ~ 50.0	4.1 ~ 5.1	29.7 ~ 36.9
Cylinder head bolt	10	29.4+90° --> Release all bolts --> 29.4+90°	3.0+90° --> Release all bolts --> > 3.0+90°	21.7+90° --> Release all bolts --> 21.7+90°
Cooling system				
Water pump pulley bolt	4	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Water pump bolt (8 X 28)	3	11.8 ~ 14.7	1.2 ~ 1.5	8.7 ~ 10.8
Water pump and alternator brace fixing bolt (8 X 45)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Water pump and alternator brace fixing bolt (8 X 65)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Thermostat housing nut	2	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Water outlet fitting nut	2	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Water inlet fitting bolt	3	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water temperature sensor	1	19.6 ~ 39.2	2.0 ~ 4.0	14.5 ~ 28.9
Water pipe fixing bolt	1	9.8 ~ 14.7	1.0 ~ 1.5	7.2 ~ 10.8
Lubrication system				
Oil filter	1	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6
Front case bolt (8 X 22)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Front case bolt (8 X 30)	3	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Front case bolt (8 X 45)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Front case bolt (8 X 60)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil pan bolt	18	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pan drain plug	1	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Oil screen bolt	2	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Oil pressure switch	1	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Rear oil seal case	5	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake and exhaust system				

Intake manifold and cylinder head fixing nut	6	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Intake manifold and cylinder head fixing bolt (8X45)	2	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Intake manifold and cylinder head fixing bolt (8X22)	1	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Intake manifold stay bolt	4	17.7 ~ 24.5	1.8 ~ 2.5	13.0 ~ 18.1
Exhaust manifold and cylinder head fixing nut	9	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
O2 sensor to exhaust manifold	1	49.0 ~ 58.8	5.0 ~ 6.0	36.2 ~ 43.4
Exhaust manifold heat cover and exhaust manifold fixing bolt	3	16.7 ~ 21.6	1.7 ~ 2.2	12.3 ~ 15.9
Air cleaner lower cover fixing bolt	3	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Throttle body and surge tank fixing bolt and nut	4	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Exhaust manifold and front muffler fixing nut	2	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9
Front muffler and center muffler fixing nut	2	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9
Center muffler and main muffler fixing nut	2	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9

GENERAL INFORMATION

COMPRESSION PRESSURE INSPECTION

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

1. Warm up and stop engine.

Allow the engine to warm up to normal operating temperature.

2. Disconnect the ignition coil connectors and the spark plug cables. (Refer to **IGNITION SYSTEM**)

■ 1.6 CVVT

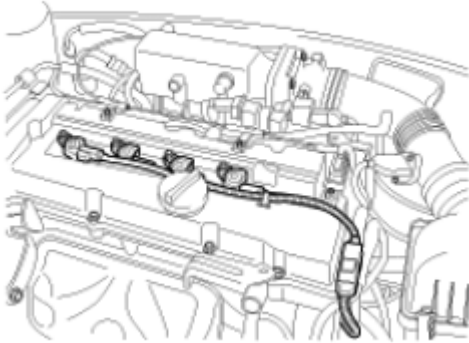


Fig. 1: Identifying Ignition Coil Connectors And Spark Plug Cables
Courtesy of KIA MOTORS AMERICA, INC.

3. Remove the spark plugs.

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

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

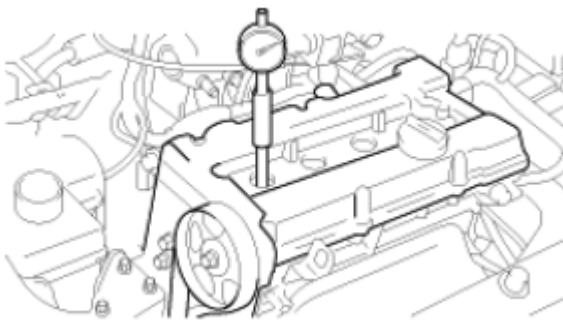


Fig. 2: Checking Cylinder Compression Pressure
Courtesy of KIA MOTORS AMERICA, INC.

2. Fully open the throttle.
3. While cranking the engine, measure the compression pressure.

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

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

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

Compression pressure (1.6 CVVT)

Standard : 1,422kPa (14.5kg/cm² , 206psi) (250~400 rpm)

Minimum : 1,275kPa (13.0kg/cm² , 185psi)

Difference between each cylinder :

98kPa (1.0kg/cm² , 14psi) or less

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

TIMING BELT TENSION ADJUSTMENT

1. Remove the engine cover (A).

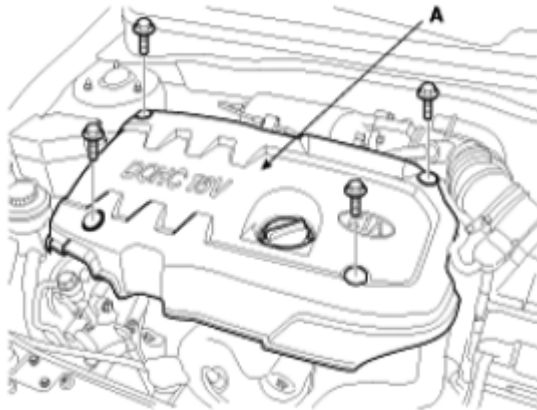


Fig. 3: Locating Engine Cover
 Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the RH front wheel.
3. Remove the bolts (B) and RH side cover (A).

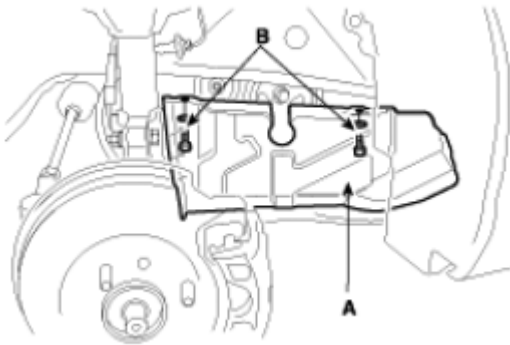


Fig. 4: Locating Bolts And RH Side Cover
Courtesy of KIA MOTORS AMERICA, INC.

4. Loosen the water pump pulley bolts.

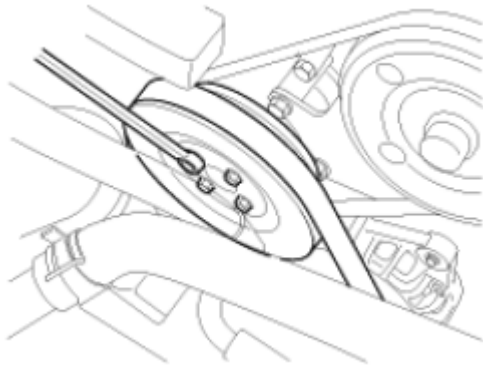


Fig. 5: Loosening Water Pump Pulley Bolts
Courtesy of KIA MOTORS AMERICA, INC.

5. Remove the alternator drive belt (A). (Refer to **ALTERNATOR**)

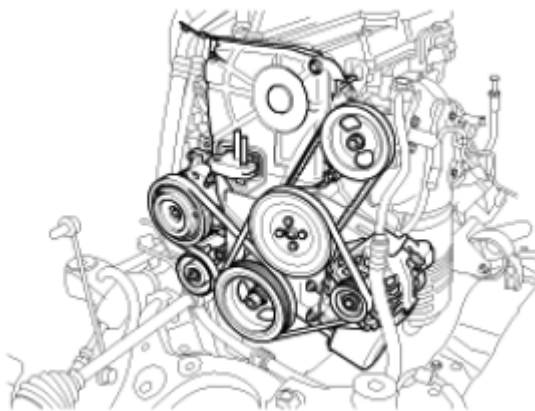


Fig. 6: Identifying Alternator Drive Belt
Courtesy of KIA MOTORS AMERICA, INC.

6. Remove the air conditioner compressor drive belt (B).

(Refer to **COMPRESSOR**)

7. Remove the power steering pump drive belt (C).

(Refer to **HYDRAULIC POWER STEERING SYSTEM**)

8. Remove the water pump pulley.
9. Remove the 4 bolts (B) and timing belt upper cover (A).

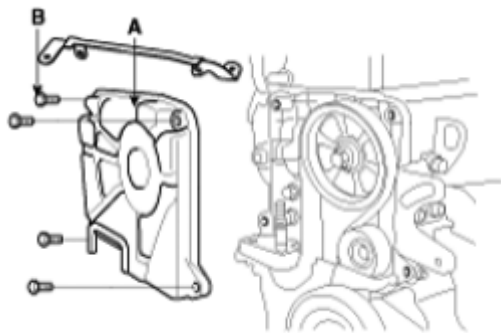


Fig. 7: Identifying Bolts And Timing Belt Upper Cover
Courtesy of KIA MOTORS AMERICA, INC.

10. Turn the crankshaft pulley, and align its groove with timing mark "T" of the timing belt cover. Check that the timing mark of camshaft sprocket (A) is aligned with the timing mark of cylinder head cover. (No. 1 cylinder compression TDC position)



Fig. 8: Aligning Crankshaft Pulley Groove With Timing Mark "T" Of Timing Belt Cover
Courtesy of KIA MOTORS AMERICA, INC.

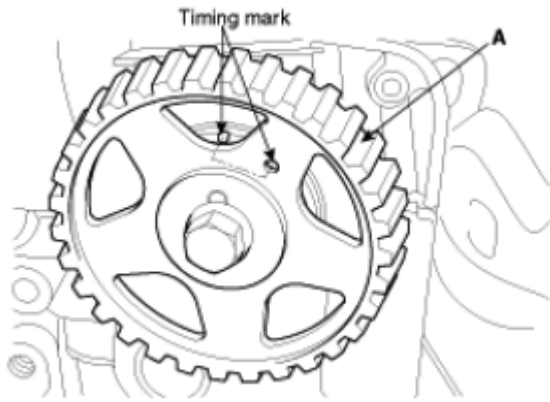


Fig. 9: Checking That Timing Mark Of Camshaft Sprocket Is Aligned With Timing Mark Of Cylinder Head Cover

Courtesy of KIA MOTORS AMERICA, INC.

11. Remove the crankshaft pulley (A).

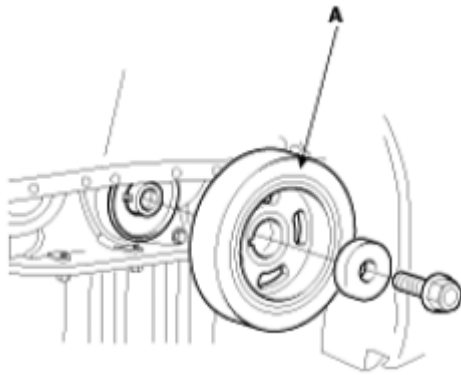


Fig. 10: Locating Crankshaft Pulley

Courtesy of KIA MOTORS AMERICA, INC.

12. Remove the 4 bolts (B) and timing belt lower cover (A).

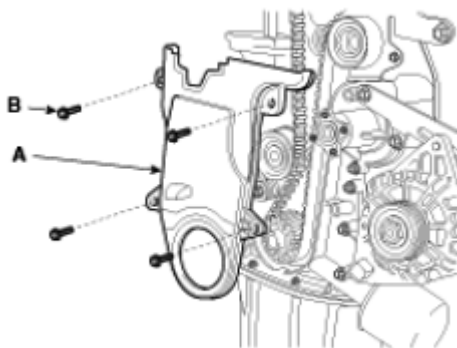


Fig. 11: Identifying Bolts And Timing Belt Lower Cover

Courtesy of KIA MOTORS AMERICA, INC.

13. Move the tensioner pulley (C) in the direction of the arrow shown after loosen the mounting bolt (A, B). And temporarily tighten mounting bolt (A, B).

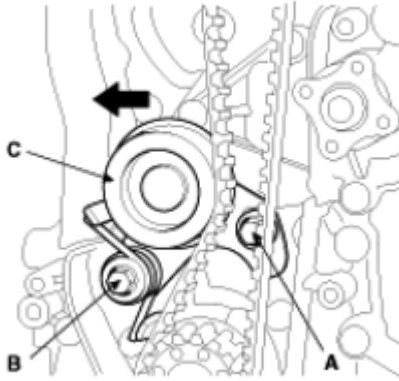


Fig. 12: Locating Tensioner Pulley And Mounting Bolt
Courtesy of KIA MOTORS AMERICA, INC.

14. Adjust the timing belt tension.
 1. After inspecting the timing belt, replace it if necessary.
 2. Loosen the tensioner pulley mounting bolt and apply tension to the timing belt.

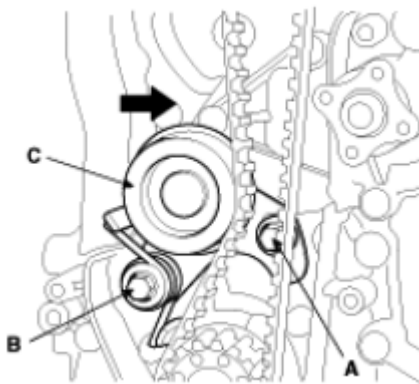


Fig. 13: Locating Tensioner Pulley And Mounting Bolt
Courtesy of KIA MOTORS AMERICA, INC.

3. After checking the alignment between each sprocket and each timing belt tooth, tighten the mounting bolt (A) and (B) one by one.

Tightening torque :

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

4. Then recheck the belt tension.

Verify that when the tensioner and the tension side of the timing belt are pushed in horizontally

with a moderate force [approx. 49N (11lb)], the timing belt cog end is approx. 1/2 of the tensioner mounting bolt head radius (across flats) away from the bolt head center.



Fig. 14: Checking Belt Tension
Courtesy of KIA MOTORS AMERICA, INC.

5. Timing belt tension measuring procedure (by a sonic tension gauge)

Rotate crankshaft in clockwise direction to set 1st piston on top dead center (TDC) and rotate crankshaft in counterclockwise to 90° then measure the belt tension in the middle of tension side span (in arrow direction of above illustration) by free vibration method.

**CAUTION: Avoid rotating the crankshaft in a counter clock wise direction.
Engine damage could occur.**

Conversion equation of frequency into tension :

$$T = (4/9.8) \times S^2 \times M \times W \times f^2 / 100000000$$

S: Measured belt span (mm)

M: Unit weight of belt (gf/cm²)

W: Belt width (mm)

f: Transverse natural frequency of belt (Hz)

Timing Belt Specifications

TIMING BELT SPECIFICATIONS

Item	Specifications
S (mm)	249.6
M (gf/cm ²)	0.4543
W (mm)	22

f (Hz)	70.4 ~ 87.9
T (kgf)	16 ± 3.5

15. Turn the crankshaft two turns in the operating direction (clockwise) and realign the crankshaft sprocket and camshaft sprocket timing mark.
16. Install the timing belt lower cover (A) with bolts (B).

Tightening torque :

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

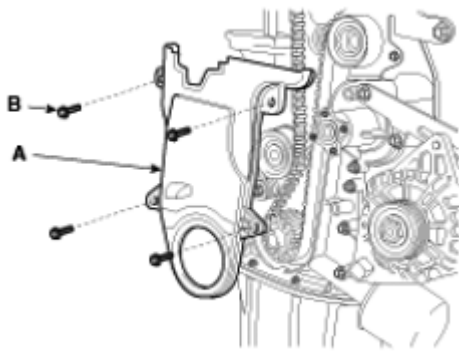


Fig. 15: Locating Timing Belt Lower Cover And Bolts
Courtesy of KIA MOTORS AMERICA, INC.

17. Install the crankshaft pulley (A).

Tightening torque :

137.3 ~ 147.1N.m (14.0 ~ 15.0kgf.m, 101.3 ~ 108.5lb-ft)

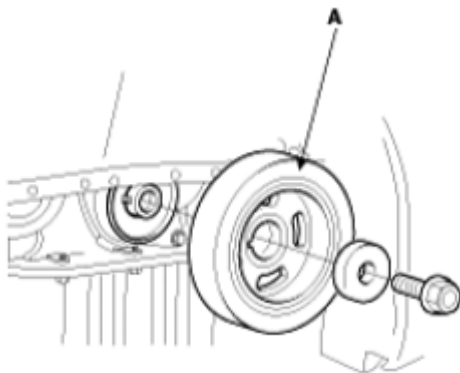


Fig. 16: Locating Crankshaft Pulley
Courtesy of KIA MOTORS AMERICA, INC.

18. Install the timing belt upper cover (A) with bolts (B).

Tightening torque :

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

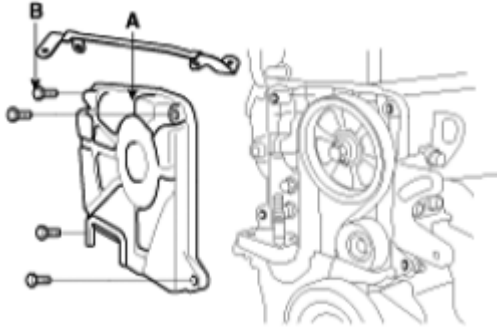


Fig. 17: Identifying Timing Belt Upper Cover And Bolts
Courtesy of KIA MOTORS AMERICA, INC.

19. Install the water pump pulley.
20. Install the power steering pump drive belt (C). (Refer to **HYDRAULIC POWER STEERING SYSTEM**)

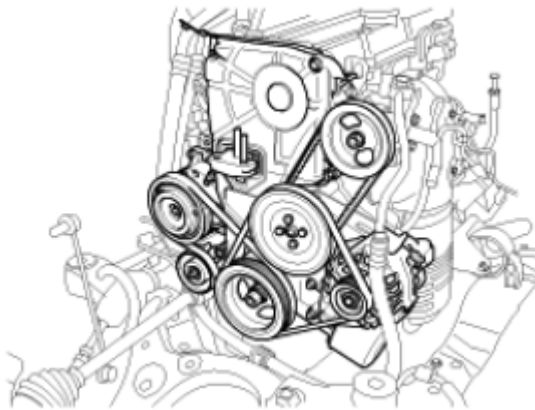


Fig. 18: Identifying Power Steering Pump Drive Belt
Courtesy of KIA MOTORS AMERICA, INC.

21. Install the air conditioner compressor drive belt (B).
(Refer to **COMPRESSOR**)
22. Install the alternator drive belt (A). (Refer to **ALTERNATOR**)
23. Install the RH side cover (A) with bolts (B)

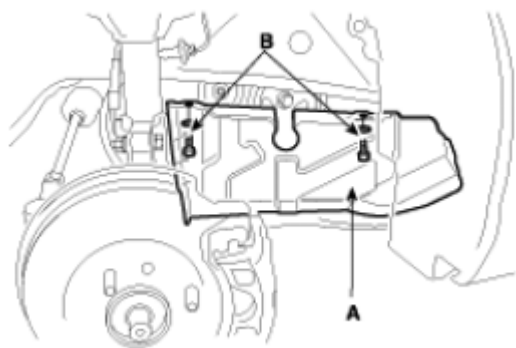


Fig. 19: Locating RH Side Cover And Bolts
Courtesy of KIA MOTORS AMERICA, INC.

24. Install the RH front wheel.

Tightening torque :

88.3 ~ 107.9N.m (9 ~ 11kgf.m, 65.1 ~ 79.6lb-ft)

25. Install the engine cover (A) with bolts.

Tightening torque :

3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)

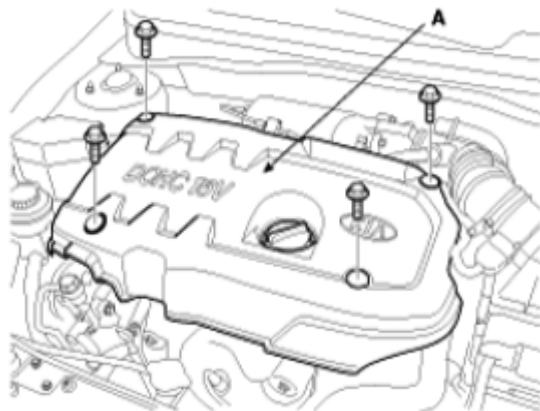


Fig. 20: Locating Engine Cover And Bolts
Courtesy of KIA MOTORS AMERICA, INC.

TROUBLESHOOTING

TROUBLESHOOTING

TROUBLESHOOTING CHART

Symptom	Suspect area	Remedy
---------	--------------	--------

2010 Kia Rio

2010 ENGINE General Information - Engine Mechanical System - Rio

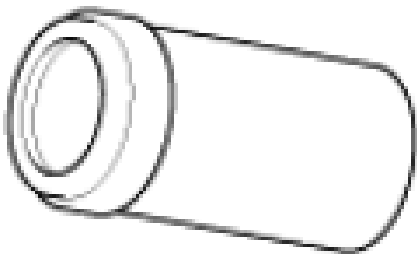
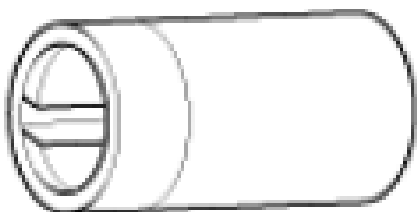
Engine misfire with abnormal internal lower engine noises.	Loose or improperly installed engine flywheel.	Repair or replace the flywheel as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression. Repair or replace as 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 valve lifters.
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)	Inspect the cylinder for a loss of compression. Repair or replace as required.
Engine noise on startup, but only lasting a few seconds.	Incorrect oil viscosity.	Drain the oil. Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	Inspect the thrust bearing and crankshaft. Repair or replace as required.
Upper engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	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	Inspect the valves and valve guides, then repair as required.

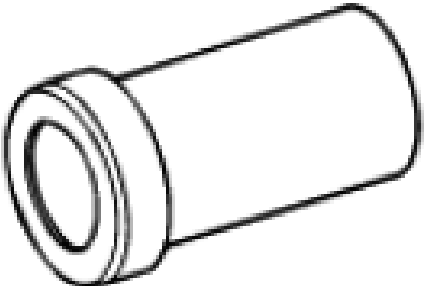
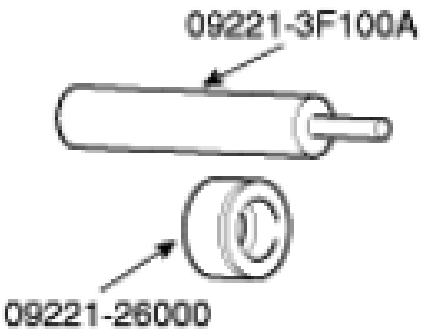
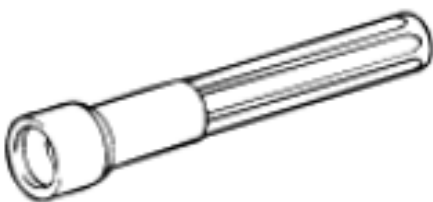
	open.)	
Lower engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace damaged components as required.
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	Inspect the oil pan. Inspect the oil pump screen. Repair or replace 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.
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)	Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	Remove spark plugs and check for fluid. Inspect for broken head gasket. Inspect for cracked engine block or cylinder head. Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain 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.

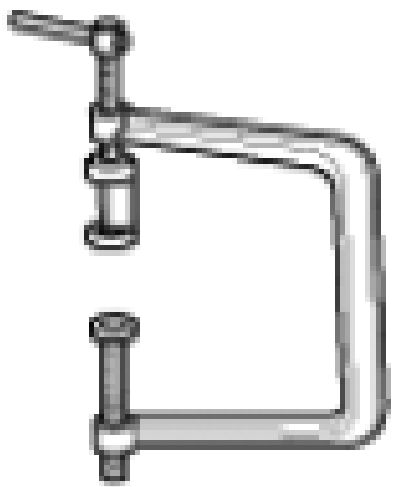
SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS

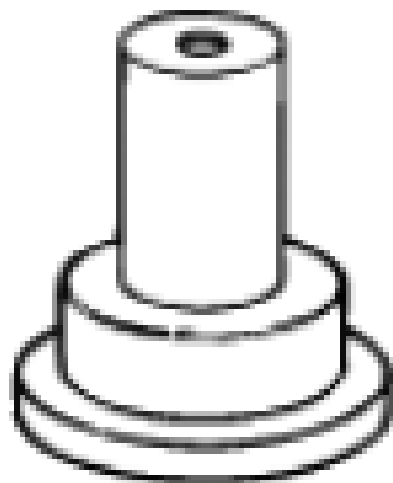
Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-32000)		Installation of the front oil seal
Crankshaft front oil seal guide (09214-32100)		Installation of the front oil seal

Camshaft oil seal installer (09221-21000)		Installation of the camshaft oil seal
Valve guide remover (09209221-3F100 (A)) Valve guide installer (09221-26000)		Removal and installation of the valve guide
Valve stem oil seal installer (09222-22001)		Installation of the valve stem oil seal

SPECIAL SERVICE TOOLS

Tool (Number and name)	Illustration	Use
Valve spring compressor (09222-28000) Valve spring compressor adaptor (09222-28100)		Removal and installation of the intake or exhaust valve

Crankshaft rear oil seal
installer
(09231-21000)



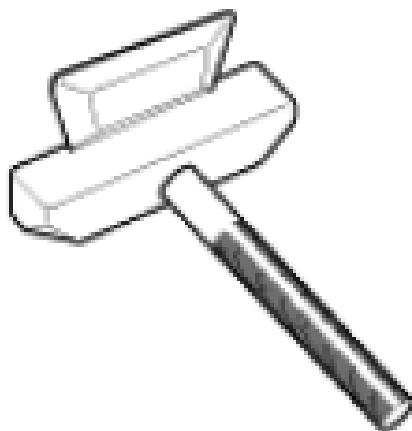
Installation of the crankshaft rear oil
seal

Water temperature sensor
socket wrench
(09221-25100)



Removal and installation of water
temperature sensor

Oil pan remover
(09215-3C000)



Removal of oil pan

Torque angle adapter
(09221-4A000)

Installation of bolts & nuts needing
an angular method

