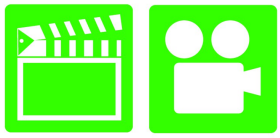
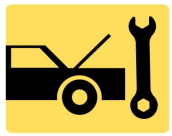
A6 Electricity & Electronics 4th Edition

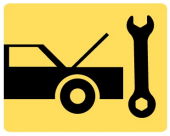
Chapter 19 Cranking System

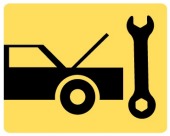
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Electricity and Electronics Systems.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. 1. Describe the parts and operation of a cranking circuit. 2. Discuss how a starter motor converts electrical power into mechanical power. 3. List the different types of starters. 4. Describe the purpose and function of starter drives. **This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronic System Diagnosis).**
Establish the Mood or Climate	Provide a *WELCOME,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

ICONS	Ch19 Cranking System
	**1. SLIDE 1 CH19 Cranking System** **2. SLIDES 2-3 EXPLAIN OBJECTIVES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	4. SLIDE 4 EXPLAIN Cranking Circuit **5. SLIDE 5 EXPLAIN Figure 19-1** typical solenoid-operated starter. **6. SLIDE 6 EXPLAIN Figure 19-2** Some column-mounted ignition switches act directly on the electrical ignition switch itself, whereas others use a link from the lock cylinder to the ignition switch. **7. SLIDE 7 EXPLAIN Figure 19-3** To prevent engine from cranking, an electrical switch is usually installed to open circuit between ignition switch & starter solenoid.
	**Starter Circuit Neutral Safety Switch**
	**DISCUSSION: HAVE THE STUDENTS DISCUSS DIFFERENCE BETWEEN ENGINE CRANKING AND ENGINE STARTING.** **WHAT IS REQUIRED FOR AN ENGINE TO START?**
	**HANDS-ON TASK: HAVE HALF THE STUDENTS LOCATE AND LABEL SYSTEM COMPONENTS WITH NUMBERS. HAVE OTHER HALF IDENTIFY THE COMPONENTS BY NUMBER.**
	**8. SLIDE 8 EXPLAIN**: COMPUTER-CONTROLLED STARTING **9. SLIDE 9 EXPLAIN Figure 19-4** Instead of using an ignition key to start the engine, some vehicles are using a start button which is also used to stop the engine, as shown on this Jaguar. **10. SLIDE 10 EXPLAIN Figure 19-5** top button on this key fob is the remote start button.
	**Starter Circuit**

ICONS	Ch19 Cranking System
	11. **SLIDE 11** EXPLAIN STARTER MOTOR OPERATION 12. **SLIDE 12** EXPLAIN **Figure 19-6** series-wound electric motor shows the basic operation with only two brushes: one hot brush and one ground brush. The current flows through both field coils, then through the hot brush and the loop winding of the armature, before reaching ground through the ground brush. 13. **SLIDE 13** EXPLAIN **Figure 19-7** interaction of the magnetic fields of armature loops and field coils creates a stronger magnetic field on right side of conductor, causing the armature loop to move toward left.
	**DEMONSTRATION: USE TWO BAR MAGNETS TO SHOW THE STUDENTS HOW LIKE MAGNETIC CHARGES REPEL WHILE OPPOSITE CHARGES ATTRACT. FIGURE 19-7**
	**DISCUSSION: HAVE STUDENTS DISCUSS THE PRINCIPLES OF MAGNETISM. WHAT CAUSES A STRONGER MAGNETIC FIELD?**
	14. **SLIDE 14** EXPLAIN **Figure 19-8** armature loops rotate due to the difference in the strength of the magnetic field. The loops move from a strong magnetic field strength toward a weaker magnetic field strength. 15. **SLIDE 15** EXPLAIN **Figure 19-9** Magnetic lines of force in a four-pole motor. 16. **SLIDE 16** EXPLAIN **Figure 19-10** pole shoe/field winding 17. **SLIDE 17** EXPLAIN **Figure 19-11** This wiring diagram illustrates the construction of a series-wound electric motor. Notice that all current flows through the field coils, then through the armature (in series) before reaching ground & EXPLAIN **Figure 19-12** This wiring diagram illustrates the construction of a shunt-type electric motor, and shows the field coils in parallel (or shunt) across the armature.
	**DISCUSSION: DISCUSS PRINCIPLE OF CEMF (COUNTERELECTROMOTIVE FORCE). HOW IS TORQUE OF A SHUNT MOTOR AFFECTED BY CEMF?**
	**DISCUSSION: HAVE STUDENTS DISCUSS CHARACTERISTICS OF A SERIES MOTOR. WHAT IS RELATIONSHIP BETWEEN THE STRENGTH OF MAGNETIC FIELDS AND STARTER TORQUE?**

ICONS	Ch19 Cranking System
	**18. SLIDE 18 EXPLAIN Figure 19-13** A compound motor is a combination of series and shunt types, using part of the field coils connected electrically in series with the armature and some in parallel (shunt). **19. SLIDE 19 EXPLAIN**: HOW STARTER MOTOR WORKS **20. SLIDE 20 EXPLAIN Figure 19-14** A typical starter motor showing the drive-end housing. **21. SLIDE 21 EXPLAIN Figure 19-15** Pole shoes and field windings installed in the housing. **22. SLIDE 22 EXPLAIN Figure 19-16** A typical starter motor armature. The armature core is made from thin sheet metal sections assembled on the armature shaft, which is used to increase the magnetic field strength.
	**23. SLIDE 23 EXPLAIN Figure 19-17** armature showing how its copper wire loops are connected to the commutator. **24. SLIDE 24 EXPLAIN Figure 19-18** typical starter motor showing commutator, brushes, & brush spring. **25. SLIDE 25 EXPLAIN FIGURE 19–19** This starter permanent magnet field housing was ruined when someone used a hammer on the field housing in an attempt to "fix" a starter that would not work. A total replacement is the only solution in this case
	**HANDS-ON TASK: HAVE THE STUDENTS DISASSEMBLE A STARTER MOTOR TO INSPECT ITS COMPONENTS**
	**26. SLIDE 26 EXPLAIN: GEAR-REDUCTION STARTERS** **27. SLIDE 27 EXPLAIN FIGURE 19-20 gear-reduction starter.** **28. SLIDE 28 EXPLAIN: STARTER DRIVES** **29. SLIDE 29 EXPLAIN Figure 19-21** cutaway of a typical starter drive showing all of the internal parts.
	**Starter Drive Gear**
	**DISCUSSION: DISCUSS GEAR-REDUCTION STARTERS. WHAT IS THE PURPOSE OF A GEAR REDUCTION STARTER? HAVE THE STUDENTS**

ICONS	Ch19 Cranking System
	DISCUSS HOW GEAR REDUCTION STARTER CONSTRUCTION DIFFERS FROM THAT OF TRADITIONAL STARTER MOTORS.
	30. **SLIDE 30** EXPLAIN **Figure 19-22** ring gear to pinion gear ratio is usually 15:1 to 20:1 & EXPLAIN **Figure 19-23** Operation of the overrunning clutch. (a) Starter motor is driving the starter pinion and cranking the engine. The rollers are wedged against spring force into their slots. (b) The engine has started and is rotating faster than the starter armature. Spring force pushes the rollers so they can rotate freely
	**DEMONSTRATION: SHOW STUDENTS HOW TO BENCH TEST A STARTER MOTOR TO CHECK FOR PROPER OPERATION.**
	31. **SLIDE 31:** EXPLAIN POSITIVE ENGAGEMENT STARTERS 32. **SLIDE 32** EXPLAIN **Figure 19-24** Ford movable pole shoe starter 33. **SLIDE 33** EXPLAIN**: SOLENOID-OPERATED STARTERS** 34. **SLIDE 34** EXPLAIN **FIGURE 19–25** Wiring diagram of a typical starter solenoid. Notice that both the pull-in winding and the hold-in winding are energized when the ignition switch is first turned to the “start” position. As soon as the solenoid contact disk makes electrical contact with both the B and M terminals, the battery current is conducted to the starter motor and electrically neutralizes the pull-in winding. 35. **SLIDE 35** EXPLAIN **Figure 19-26** Palm-size starter armature. 36. **SLIDE 36** EXPLAIN **Summary**
	**NATEF TASK SHEET: RESEARCH APPLICABLE VEHICLE AND SERVICE INFORMATION, SUCH AS ELECTRICAL OR ELECTRONIC SYSTEM OPERATION, VEHICLE SERVICE HISTORY, SERVICE PRECAUTIONS, & TECHNICAL SERVICE BULLETINS**
	**HOMEWORK: SEARCH INTERNET: ASK STUDENTS TO RESEARCH HISTORY OF STARTER MOTOR ON THE INTERNET. ASK THEM TO IDENTIFY THE FIRST CAR COMPANY TO OFFER ELECTRIC START, AND WHEN IT WAS OFFERED. ASK STUDENTS TO**

ICONS	Ch19 Cranking System
	PRESENT THEIR FINDINGS TO THE CLASS.