Automatic Transmissions and Transaxles, 7e

Chapter 8 Drivetrain Electricity and Electronics

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers Automatic Transmissions and Transaxles 7th Edition. It correlates material to task lists specified by **ASE and ASEEducation (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. Explain the characteristics of electricity. 2. Differentiate between conductors, insulators, and semiconductors. 3. Explain the units of electrical measurement. 4. List the parts of a complete circuit. 5. Discuss the types of electrical circuit faults. 6. Explain how to detect and measure electrical voltage, current, and resistance. 7. Discuss the purpose and function of terminals, connectors, relays, and switches. 8. Explain the operation of speed sensors and throttle position (TP) sensors. 9. State the need for networks and discuss network classifications.
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.

NOTE: This lesson plan is based on automatic Transmissions & Transaxle 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

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ICONS	Ch08 Drivetrain Electricity and Electronics
        	**1. SLIDE 1 Drivetrain Electricity and Electronics** **Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Videos** **At the beginning of this class, you can download the crossword puzzle & Word Search from http://www.jameshalderman.com/books_a2.html to familiarize your class with the terms in this chapter & then discuss them** **DOWNLOAD Crossword Puzzle** **DOWNLOAD Word Search Puzzle** **2. SLIDE 2 EXPLAIN FIGURE 8–1** In an atom (left), electrons orbit protons in the nucleus just as planets orbit the sun in our solar system (right). **3. SLIDE 3 EXPLAIN FIGURE 8–2** The nucleus of an atom has a positive (+) charge and the surrounding electrons have a negative (–) charge. **4. SLIDE 4 EXPLAIN FIGURE 8–3** This figure shows a balanced atom. The number of electrons is the same as the number of protons in the nucleus. **5. SLIDE 5 EXPLAIN FIGURE 8–4** Unlike charges attract and like charges repel. Electron Flow (View) (Download) Copper Atom (View) (Download) Copper Atom 2 (View) (Download) Magnetic Induction (View) (Download) **DISCUSSION: DISCUSS FLOW OF ELECTRICAL CURRENT AND HOW THE CONSTANT FLOW, OR JUMPING OF ELECTRONS, CREATES CURRENT** Manual Lever Position Switch (MLPS) (View)(Download) **Transmission Fluid Temperature Sensor (View)(Download)**

ICONS	Ch08 Drivetrain Electricity and Electronics
	**DISCUSSION: DISCUSS DIFFERENT CONDUCTORS. WHY IS COPPER MOST COMMONLY USED CONDUCTOR IN ELECTRICAL SYSTEMS.**
	**DEMONSTRATION: USE MAGNETS TO DEMONSTRATE HOW OPPOSITES FORCES ATTRACT & LIKE FORCES REPEL. SHOW HOW MAGNETS ATTRACT & REPEL EACH OTHER DEPENDING ON ORIENTATION OF THEIR POLES.**
	6. **SLIDE 6 EXPLAIN FIGURE 8–5** A conductor is any element that has one to three electrons in its outer orbit. 7. **SLIDE 7 EXPLAIN FIGURE 8–6** Copper is an excellent conductor of electricity because it has just one electron in its outer orbit, making it easy to be knocked out of its orbit and flow to other nearby atoms. This causes electron flow, which is the definition of electricity. 8. **SLIDE 8 EXPLAIN FIGURE 8–7** Insulators are elements with five to eight electrons in the outer orbit. 9. **SLIDE 9 EXPLAIN FIGURE 8–8** Semiconductor elements contain exactly four electrons in the outer orbit. 10. **SLIDE 10 EXPLAIN FIGURE 8–9** Current electricity is the movement of electrons through a conductor.
	**DISCUSSION: DISCUSS INSULATORS & REASON THEY MAKE POOR CONDUCTORS. WHAT IS RELATIONSHIP BETWEEN NUMBER OF ELECTRONS AN INSULATOR MATERIAL HAS & ITS ABILITY TO ACQUIRE & RELEASE ELECTRONS?**
	11. **SLIDE 11 EXPLAIN FIGURE 8–10** Conventional theory states that current flows through a circuit from positive (+) to negative (–). Automotive electricity uses the conventional theory in all electrical diagrams and schematics. 12. **SLIDE 12 EXPLAIN FIGURE 8–11** One ampere is the movement of 1 coulomb (6.28 billion billion electrons) past a point in 1 second. 13. **SLIDE 13 EXPLAIN FIGURE 8–12** An ammeter is installed in the path of the electrons similar to a water meter used to measure the flow of water in gallons per minute. The ammeter displays current flow in amperes. 14. **SLIDE 14 EXPLAIN FIGURE 8–13** Voltage is the electrical pressure that causes the electrons to flow through a conductor.

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	**DEMONSTRATION: SHOW HOW DMM MEASURES VOLTAGE. USE TRAINER TO SHOW STUDENTS MEASURING VOLTAGE**
	**Ohm's Law, Current (View) (Download)** **Ohm's Law, Resistance (View) (Download)** **Ohm's Law, Volt (View) (Download)**
	**15. SLIDE 15 EXPLAIN FIGURE 8–14** This digital multimeter set to read DC volts is being used to test the voltage of a vehicle battery. Most multimeters can also measure resistance (ohms) and current flow (amperes). **16. SLIDE 16 EXPLAIN FIGURE 8–15** Resistance to the flow of electrons through a conductor is measured in ohms. **17. SLIDE 17 EXPLAIN FIGURE 8–16** The return path back to the battery can be any electrical conductor, such as a copper wire or the metal frame or body of the vehicle.
	**DISCUSSION: HAVE STUDENTS TALK ABOUT RESISTANCE TO ELECTRON FLOW, OR OHMS. HOW DOES MATERIAL USED AS A CONDUCTOR AFFECT RESISTANCE?**
	**Electron Travel, Heat (View) (Download)**
	**DISCUSSION: DISCUSS HEAT, LIGHT, PRESSURE, CHEMICAL, & MAGNETIC MEANS OF PRODUCING ELECTRICAL CURRENT. WHICH PRINCIPLE IS BASIS OF AUTOMOTIVE BATTERY? WHICH PRINCIPLE IS BASIS FOR HOW AN ALTERNATOR WORKS?**
	**Electron Travel, Heat (View) (Download)** **Electron Travel, Light (View) (Download)** **Electron Travel, Magnet (View) (Download)** **Electron Travel, Pressure (View) (Download)** **AC, Alternating Current (View) (Download)**
	**DEMONSTRATION: DEMONSTRATE BASIC ELECTRICAL CIRCUIT ON TRAINER. WHAT HAPPENS WHEN CIRCUIT IS SHORTED TO GROUND**

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	**TRAINER TASK: ALLOW STUDENTS TO BLOW FUSE BY CREATING A SHORT CIRCUIT, OBSERVING WHAT IT TAKES TO CREATE SHORT CIRCUIT AND WHAT RESULTS ARE FOUND**
	**18. SLIDE 18 EXPLAIN FIGURE 8–17** An electrical switch opens the circuit and no current flows. The switch could also be on the return (ground) path wire.
	19. SLIDE 19 EXPLAIN FIGURE 8–18 The center wire is a solid color wire, meaning that the wire has no other identifying tracer or stripe color. The two end wires could be labeled "BRN/WHT," indicating a brown wire with a white tracer or stripe.
	20. SLIDE 20 EXPLAIN FIGURE 8–19 Typical section of a wiring diagram. Notice that the wire color changes at connection C210. The ".8" represents the metric wire size in square millimeters.
	21. SLIDE 21 EXPLAIN FIGURE 8–20 Typical electrical and electronic symbols used in automotive wiring and circuit diagrams.
	22. SLIDE 22 EXPLAIN FIGURE 8–21 Examples of common causes of open circuits. Some of these causes are often difficult to find.
	23. SLIDE 23 EXPLAIN FIGURE 8–22 A short circuit permits electrical current to bypass some or all of the resistance in the circuit.
	24. SLIDE 24 EXPLAIN FIGURE 8–23 A fuse or circuit breaker opens the circuit to prevent possible overheating damage in the event of a short circuit.
	**DISCUSSION: DISCUSS GROUND PATH. WHY DOESN'T A SEPARATE GROUND WIRE HAVE TO BE RUN FROM THE BATTERY TO EACH ELECTRICAL LOAD? DISCUSS HOW AND WHY A SHORT-TOVOLTAGE OCCURS. WHAT IS THE REASON THAT A SHORT-TO-VOLTAGE MAY/MAY NOT BLOW FUSE?**
	**DISCUSSION:DISCUSS EFFECTS OF HIGHER THAN-NORMAL RESISTANCE ON VARIOUS COMPONENTS IN AUTOMOTIVE ELECTRICAL SYSTEM. WHAT CAN CAUSE HIGH RESISTANCE?**
	**25. SLIDE 25 EXPLAIN FIGURE 8–24** A short-to-ground affects the power side of the circuit. Current flows directly to the ground return, bypassing some or all of the electrical loads in the circuit. There is no current in

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	the circuit past the short. A short-to-ground will also cause the fuse to blow. **26. SLIDE 26 EXPLAIN FIGURE 8–25** A technician-made fused jumper lead, which is equipped with a red 10 ampere fuse. This fused jumper wire uses terminals for testing circuits at a connector instead of alligator clips. **27. SLIDE 27 EXPLAIN FIGURE 8–26** A 12-volt test light is attached to a good ground while probing for power. **28. SLIDE 28 EXPLAIN FIGURE 8–27** A test light can be used to locate an open in a circuit. Note that the test light is grounded at a different location than the circuit itself. **29. SLIDE 29 EXPLAIN FIGURE 8–28** Typical digital multimeter. The black meter lead always is placed in the COM terminal. The red meter test lead should be in the volt-ohm terminal except when measuring current in amperes.
	**DEMONSTRATION: USE AN INDUCTIVE AMMETER OR CHARGING SYSTEM TESTER TO SHOW THAT AMOUNT OF CURRENT LEAVING BATTERY ON POSITIVE IS RETURNED ON NEGATIVE SIDE.**
	**Ohm's Law, Current (View) (Download)** **Ohm's Law, Resistance (View) (Download)** **Ohm's Law, Volt (View) (Download)**
 	**DISCUSSION: ASK STUDENTS TO TALK ABOUT OHM'S LAW. WHAT IS APPLICATION OF OHM'S LAW IN AUTOMOTIVE WIRING CIRCUITS?**
	**EXPLAIN Chart 8–1 Common symbols and abbreviations used on digital meters.** **30. SLIDE 30 EXPLAIN FIGURE 8–29** Typical digital multimeter (DMM) set to read DC volts. **31. SLIDE 31 EXPLAIN FIGURE 8–30a** A typical autoranging digital multimeter automatically selects the proper scale to read the voltage being tested. The scale selected is usually displayed on the meter face. Note that the display indicates "4," meaning that this range can read up to 4 volts. **b** A typical autoranging digital multimeter automatically selects the proper scale to read the voltage being tested. The scale selected is usually

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	displayed on the meter face. The range is now set to the 40-volt scale, meaning that the meter can read up to 40 volts on the scale. Any reading above this level will cause the meter to reset to a higher scale. If not set on autoranging, the meter display would indicate OL if a reading exceeds the limit of the scale selected. **32. SLIDE 32 EXPLAIN FIGURE 8–31** Using a digital multimeter set to read ohms (Ω) to test this light bulb. The meter reads the resistance of the filament. **33. SLIDE 33 EXPLAIN FIGURE 8–32** Many digital multimeters can have the display indicate zero to compensate for test lead resistance. (1) Connect leads in the V Ω and COM meter terminals. (2) Select the Ω scale. (3) Touch the two meter leads together. (4) Push the "zero" or "relative" button on the meter. (5) The meter display will now indicate zero ohms of resistance. **34. SLIDE 34 EXPLAIN FIGURE 8–33** Measuring the current flow required by a horn requires that the ammeter be connected to the circuit in series and the horn button be depressed by an assistant.
	**Measure AC Ripple (View) (Download)** **Measure Battery Voltage Drop (View) (Download)** **Meter Usage Battery Volt Check (View) (Download)** **Meter Usage Check CAN Circuit (View) (Download)** **Meter Usage Measure Amps (View) (Download)** **Meter Usage Measure Frequency (View)(Download)** **Meter Usage Measure Ohms (View) (Download)** **Meter Usage Measure Volts (View) (Download)** **Meter Usage Testing Diode (View) (Download)**
	**COMPLETE TASK SHEETS ON ELECTRICAL FUNDAMENTALS**
	**DISCUSSION: DISCUSS VARIOUS SCALES AND SETTINGS ON A DMM. WHAT IS REASON THAT TEST RESULTS USING A DMM ARE MORE ACCURATE? DISCUSS THE AUTORANGE FEATURES**
	**EXPLAIN TECH TIP: Fuse Your Meter Leads!**
	**35. SLIDE 35 EXPLAIN FIGURE 8–34** Note the blade-type fuse holder soldered in series with one of the meter leads. A 10 ampere fuse helps protect the internal meter fuse (if equipped) and the meter itself from damage that

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	may result from excessive current flow if accidentally used incorrectly.
	**36. SLIDE 36 EXPLAIN FIGURE 8–35** An inductive ammeter clamp is used with all starting and charging testers to measure the current flow through the battery cables.
	37. SLIDE 37 EXPLAIN FIGURE 8–36 A typical mini clamp-on-type digital multimeter. This meter is capable of measuring alternating current (AC) and direct current (DC) without requiring that the circuit be disconnected to install the meter in series. The jaws are simply placed over the wire and current flow through the circuit is displayed.
 Education Foundation	**ASEEducation TASK SHEET: OHM'S LAW: DIAGNOSE ELECTRICAL/ELECTRONIC INTEGRITY OF SERIES, PARALLEL & SERIES-PARALLEL CIRCUITS USING PRINCIPLES OF ELECTRICITY (OHM'S LAW)**
 Education Foundation	**ASEEducation TASK SHEET: DEMONSTRATE PROPER USE OF DIGITAL MULTIMETER (DMM) DURING DIAGNOSIS OF ELECTRICAL CIRCUIT PROBLEMS, INCLUDING: SOURCE VOLTAGE, VOLTAGE DROP, CURRENT FLOW, & RESISTANCE**
	**38. SLIDE 38 EXPLAIN FIGURE 8–37** Some terminals have seals attached to help seal the electrical connections.
	39. SLIDE 39 EXPLAIN FIGURE 8–38 Separate a connector by opening the lock and pulling the two apart.
	40. SLIDE 40 EXPLAIN FIGURE 8–39 The secondary locks help retain the terminals in the connector.
	41. SLIDE 41 EXPLAIN FIGURE 8–40 Use a small removal tool, sometimes called a pick, to release terminals from the connector.
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE DIFFERENT COLORS FOR AMPERAGE RATINGS. WHY ARE COLORS A GOOD IDEA?**
	**DEMONSTRATION: SHOW SEVERAL DIFFERENT TYPES OF CONNECTORS, INCLUDING THOSE WITH CONNECTOR POSITION ASSURANCE CLIPS. EXPLAIN THAT IT'S NECESSARY TO GUARANTEE THAT CONNECTORS WILL STAY TOGETHER IN SUPPLEMENTAL RESTRAINT SYSTEMS.**

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 	**DEMONSTRATE REMOVAL OF TERMINALS FROM SEVERAL DIFFERENT TYPES OF CONNECTORS. MAKE SURE TO HAVE PROPER TERMINAL REMOVAL TOOLS AVAILABLE FOR TEACHING STUDENTS ABOUT DIFFERENT CONNECTORS.** **42. SLIDE 42 EXPLAIN FIGURE 8–41** Always use rosin-core solder for electrical or electronic soldering. Also, use small-diameter solder for small soldering irons. Use large-diameter solder only for large-diameter (large-gauge) wire and higher-wattage soldering irons (guns). **43. SLIDE 43 EXPLAIN FIGURE 8–42** Notice that to create a good crimp, the open part of the terminal is placed in the jaws of the crimping tool toward the anvil or the W-shape part. **44. SLIDE 44 EXPLAIN FIGURE 8–43** All hand-crimped splices or terminals should be soldered to be assured of a good electrical connection.
 	**DISCUSSION: DISCUSS PROCESS OF SOLDERING WIRES AND THE TYPE OF SOLDER USED. WHAT DO THE PERCENTAGES OF EACH ALLOY IN A SOLDER DETERMINE?** **DEMONSTRATION: DEMONSTRATE USE OF A SOLDERING IRON TO CONNECT WIRING. POINT OUT TO THE STUDENTS THAT THEY SHOULD MAKE SURE THAT THE SOLDER JOINT IS SMOOTH; OTHERWISE, A SHARP POINT COULD PUNCTURE SHRINK WRAP AND CAUSE A SHORT CIRCUIT**
	**45. SLIDE 45 EXPLAIN FIGURE 8–44** A butane torch especially designed for use on heat shrink applies heat without an open flame, which could cause damage. **46. SLIDE 46 EXPLAIN FIGURE 8–45** typical crimp-and-seal connector. This type of connector is first lightly crimped to retain ends of wires and then it is heated. Tubing shrinks around wire splice, and thermoplastic glue melts on the inside to provide a resistant seal. **47. SLIDE 47 EXPLAIN FIGURE 8–46** Heating the crimp-and-seal connector melts the glue and forms an effective seal against moisture.

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 Education Foundation	**ASEEducation TASK SHEET REMOVE AND REPLACE TERMINAL END FROM CONNECTOR; REPLACE CONNECTORS AND TERMINAL ENDS**
 Education Foundation We Support NATEF	**ASEEducation TASK SHEET REPAIR WIRING HARNESS (INCLUDING CAN/BUS SYSTEMS)**
 Education Foundation	**ASEEducation TASK SHEET PERFORM SOLDER REPAIR OF ELECTRICAL WIRING**
	**48. SLIDE 48 EXPLAIN FIGURE 8–47** A relay uses a movable arm to complete a circuit whenever there is a power at terminal 86 and a ground at terminal 85. A typical relay only requires about 1/10 ampere through the relay coil. The movable arm then closes the contacts (#30 to #87) and can often handle 30 amperes or more. **49. SLIDE 49 EXPLAIN FIGURE 8–48** A cross-sectional view of a typical four-terminal relay. Current flowing through the coil (terminals 86 and 85) causes the movable arm (called the armature) to be drawn toward the coil magnet. The contact points complete the electrical circuit connected to terminals 30 and 87. **50. SLIDE 50 EXPLAIN FIGURE 8–49** A typical relay showing the schematic of the wiring in the relay. **51. SLIDE 51 EXPLAIN FIGURE 8–50** All schematics are shown in their normal, non-energized position.
	**EXPLAIN TECH TIP: Divide the Circuit in Half**
 QUESTION	**DISCUSSION: PROVIDE THE STUDENTS WITH A WIRING DIAGRAM OF A TP CIRCUIT TO STUDY AND DISCUSS. WHAT IS THE FUNCTION OF EACH WIRE CONNECTED TO SENSOR?**

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	**HANDS-ON TASK: HAVE STUDENTS LOCATE AND VISUALLY INSPECT A TP SENSOR FOR PROPER CONNECTION, ATTACHMENT, AND CONDITION.**
	**SOME TP SENSORS HAVE 4 WIRES. THE FOURTH WIRE IS COMMONLY A SWITCH CIRCUIT USED TO PROVIDE A SIGNAL THAT VEHICLE IS AT IDLE.**
	**SOME TP SENSORS GO BAD IN ONLY ONE SPOT—VEHICLES THAT ARE DRIVEN AT CONSTANT SPEEDS TEND TO WEAR THE TP IN ONE SPOT.**
	**Throttle Position Sensor (View) (Download)** **Throttle Position Volt Check Ref Signal (View) (Download)** **Throttle Postion Ground Check (View) (Download)**
	**DISCUSSION: HAVE STUDENTS DISCUSS HOW TP SENSORS AFFECT AUTOMATIC TRANSMISSION FUNCTION. HOW COULD VARIOUS TP MALFUNCTIONS CAUSE ABNORMAL AUTOMATIC TRANSMISSION OPERATION?**
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE DIFFERENT TYPES OF COMMUNICATION BETWEEN MODULES OR NODES. WHY DO THERE NEED TO BE DIFFERENT TYPES OF COMMUNICATION?**
	**DEMONSTRATION: DEMONSTRATE OR EXPLAIN TO THE STUDENTS HOW A POWER WINDOW SYSTEM WORKED 10 YEARS AGO AND HOW A MODERN POWER WINDOW SYSTEM WORKS. USE PROJECT BOARD TO DEMO CAN & NETWORK COMMUNICATION**
	**HANDS-ON TASK: PRINT OUT STEPS FOR DIAGNOSING AND TESTING NETWORK DIAGNOSTIC CODE. ASK STUDENTS TO FOLLOW DIAGNOSTIC STEPS TO SEE REPAIR PATH.**
	**52. SLIDE 52 EXPLAIN FIGURE 8–51** typical horn circuit. Note relay contacts supply the heavy current to operate horn when horn switch simply completes a low-current circuit to ground, causing relay contacts to close. **53. SLIDE 53 EXPLAIN FIGURE 8–52** typical transmission range switch is also similar to the circuit

used for electronic transfer case switches. In this example, power, 12 volts, is applied at pin 30 & pin 46 is an input to PCM. The change in voltage at pin 46 indicates how much resistance the circuit has, which is used to detect the gear selected.

54. **SLIDE 54 EXPLAIN FIGURE 8–53** A magnetic sensor uses a permanent magnet surrounded by a coil of wire. The notches on the rotating shaft create a variable magnetic field strength around the coil. When a metallic section is close to the sensor, the magnetic field is stronger because metal is a better conductor of magnetic lines of force than air.
55. **SLIDE 55 EXPLAIN FIGURE 8–54** A Hall-Effect sensor produces an on-off voltage signal whether it is used with a blade or a notched wheel.
56. **SLIDE 56 EXPLAIN FIGURE 8–55** The signal voltage from a throttle position increases as the throttle is opened because the wiper arm is closer to the 5-volt reference. At idle, the resistance of the sensor winding effectively reduces the signal voltage output to the powertrain control module (PCM).
57. **SLIDE 57 EXPLAIN FIGURE 8–56** Module communications makes controlling multiple electrical devices and accessories easier by using simple low-current switches to signal another electronic control module (ECM), which does the actual switching of the current to the device.
58. **SLIDE 58 EXPLAIN FIGURE 8–57** A network allows all modules to communicate with other modules.
59. **SLIDE 59 EXPLAIN FIGURE 8–58** A typical BUS system showing module CAN communications and twisted pairs of wire.
60. **SLIDE 60 EXPLAIN FIGURE 8–59** A schematic of a Chevrolet Equinox shows that the vehicle uses a GMLAN BUS (DLC pins 6 and 14), plus a Class 2 (pin 2). A scan tool can therefore communicate to the transmission control module (TCM) through the high-speed network. Pin 1 connects to the low-speed GMLAN network.

EXPLAIN FREQUENTLY ASKED QUESTION: What Are U Codes?