

**Reference Materials:** Note: This exam may contain some "accepted practice" type questions not found in the reference material listed below.

**NFPA 1917**, *Standard for Automotive Ambulances*, including annexes National Fire Protection Association (800) 344-3555 or [www.nfpa.org](http://www.nfpa.org)

**Ford Ambulance QVM** Guide, <https://www.fleet.ford.com/truckbbas/non-html/gpg/2004/ambulanceguidelines04.pdf>

**Any** good automotive or electrical repair manual . The following are suggested reference materials

**Auto Electricity & Electronics** by James Duffy, Goodheart-Wilcox publisher 708-687-5000 or online retailers

**OR Heavy Duty ProClinic Manual** by Interstate Battery-Call Jeff Barron at 469-221-4655 for your local interstate dealer ordering information

### LEARNING OBJECTIVES FOR THE E-2 EXAM

#### 1. Basic Principles of Electricity - Define or identify:

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| <ul style="list-style-type: none"> <li>a. Electron Flow               <ul style="list-style-type: none"> <li>(1) Resistance in circuits</li> <li>(2) Causes of voltage drops</li> <li>(3) Principles of Electron Flow</li> <li>(4) Cause &amp; effect of bad connections in circuits</li> </ul> </li> <li>b. Ohms Law as applied to electrical circuits               <ul style="list-style-type: none"> <li>(1) Using the formula</li> <li>(2) Proper terminology</li> </ul> </li> <li>c. Principles of Electromagnetism</li> </ul> | <ul style="list-style-type: none"> <li>d. Electrical symbols and schematics</li> <li>e. Circuit theory               <ul style="list-style-type: none"> <li>(1) Proper terminology</li> </ul> </li> <li>f. Laws for resistance in series and parallel circuits</li> <li>g. Understanding of SAE electrical symbols</li> <li>h. Definition of a microprocessor</li> </ul> |
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#### 2. Principles of Operation-Describe or identify:

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| <ul style="list-style-type: none"> <li>a. Function and application of electrical components and accessories               <ul style="list-style-type: none"> <li>(1) Invertors &amp; on board chargers</li> <li>(2) Five terminal automotive relays</li> <li>(3) Relays, switches, solenoids, potentiometer, thermistor, sensors etc.</li> <li>(4) spike suppression diodes</li> </ul> </li> <li>b. Function and application of electronic components               <ul style="list-style-type: none"> <li>(1) Strobe lights</li> <li>(2) Wig wag flashers</li> <li>(3) Load managers</li> <li>(4) Auto throttle</li> <li>(5) Diodes, capacitors, resistors, circuit breakers, etc</li> <li>(6) Proximity Switches</li> <li>(7) LED Lights</li> <li>(8) Halogen lights</li> <li>(9) Low voltage circuit breaker                   <ul style="list-style-type: none"> <li>(a) Types I, II, &amp; III</li> </ul> </li> </ul> </li> <li>c. System requirements and performance evaluation</li> <li>d. Evaluation of wire size, insulation, and circuit</li> <li>e. Proper wire repair procedures and proper routing techniques, installation procedures</li> </ul> | <ul style="list-style-type: none"> <li>f. Equipment &amp; component protection &amp; installation               <ul style="list-style-type: none"> <li>(1) uninterruptable chassis power supply and grounds</li> <li>(2) Proper welding practices</li> </ul> </li> <li>g. Function, operation, &amp; testing               <ul style="list-style-type: none"> <li>(1) Shunts</li> <li>(2) Gauges</li> <li>(3) Warning devices</li> <li>(4) Hall effect current sensors</li> </ul> </li> <li>h. 115 VAC electrical systems               <ul style="list-style-type: none"> <li>(1) Types of circuit breakers</li> <li>(2) Auto reset</li> <li>(3) Manual reset</li> <li>(4) Outlet installation</li> </ul> </li> <li>i. Multiplexing circuitry</li> <li>j. Engine Controls</li> <li>k. Schottky isolation diode</li> <li>l. Cot location</li> </ul> |
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#### 3. Use of Diagnostic Equipment

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| <ul style="list-style-type: none"> <li>a. Describe diagnostic equipment used to measure voltage, current, and resistance               <ul style="list-style-type: none"> <li>(1) Digital and analog meters</li> <li>(2) Scan tools and oscilloscopes</li> <li>(3) Volt, amp, and ohm meters, multimeters</li> <li>(4) Load tester (carbon piles)</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>b. Correct application of diagnostic equipment               <ul style="list-style-type: none"> <li>(1) Scan tools</li> <li>(2) Oscilloscopes</li> <li>(3) Volt, amp, and ohm meters                   <ul style="list-style-type: none"> <li>(a) Minimum Input Impedance</li> </ul> </li> <li>(4) Load testers (carbon pile)</li> <li>(5) Test lights</li> <li>(6) Voltage drops, positive and negative side</li> <li>(7) Ammeter</li> <li>(8) Ohmmeter</li> <li>(9) Voltmeter</li> </ul> </li> </ul> |
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#### 4. Vehicle Batteries-Describe and Identify:

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| <ul style="list-style-type: none"> <li>a. Battery construction and performance               <ul style="list-style-type: none"> <li>(1) test for CCA- Cold Cranking Amps Rating</li> <li>(2) RC-Reserve Capacity Rating</li> </ul> </li> <li>b. How to evaluate battery requirement</li> <li>c. Proper battery charging procedures</li> </ul> | <ul style="list-style-type: none"> <li>d. Proper battery testing procedures               <ul style="list-style-type: none"> <li>(1) minimum charge</li> </ul> </li> <li>e. Interpreting charging system volt readings</li> <li>f. Multiple battery systems</li> <li>g. Jump starting procedures</li> <li>h. Maintenance free, low maintenance</li> </ul> |
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**5. Cranking Systems-Understand construction and operation of cranking system components**

- a. Starting system
  - (1) Types of starting motors
  - (2) Construction
  - (3) Operation
- b. Cranking system diagnosis and testing
  - (1) Connections and grounds
  - (2) Starter draw
- c. Identify proper repair procedures

**6. Charging Systems-Understand construction and operation of charging system and components**

- a. Alternators
  - (1) Component definitions
  - (2) Component functions
  - (3) Construction, operation, and performance
- b. Alternator
  - (1) Proper maximum output test
  - (2) Radio noise
  - (3) Diagnosis and testing
  - (4) Single and dual alternator systems
  - (5) Effects of Diode Failure
- c. Repair
  - (1) Belt adjustments
  - (2) Proper procedure
- d. Voltage sensing auto-throttle
  - (1) Component operation
  - (2) Troubleshooting
- e. Voltage regulator
  - (1) Adjustments
  - (2) A & B circuits
  - (3) Field relay
  - (4) Function and operation
- f. Charging system circuitry
  - (1) Schematics and symbols
  - (2) System troubleshooting
- g. Maintenance free batteries
- h. Ambulance electrical load

**7. Troubleshooting-Understand accepted practices used to diagnose and repair electrical circuits**

- a. Voltage drops in components & cabling; Positive & negative
- b. Auto-throttle systems
- c. Strobe light systems
- d. Schematic drawings
  - (1) Symbols
  - (2) Relays and switches
- e. Suction aspirator systems
- f. Relays, components, solenoids
- g. Proper grounding techniques
- h. Battery drain and key off current
- i. Air bag systems
- j. On board computer sensors
- k. ABS
- l. On board computers

**8. Vehicle Computer Controls**

- a. Definitions
  - (1) Active and passive sensors
  - (2) Sensor operation
  - (3) Analog and digital signals
  - (4) Computer memory operation
  - (5) Diagnostic trouble codes (DTC)
  - (6) VREF
  - (7) Actuators
  - (8) Open & closed loop
- b. Engine controls
  - (1) Glow plug operation and circuits
- c. Transmission controls
  - (1) Speed sensors
- d. Brake controls