

Network Systems Assessment Development Guide

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Introduction

This Development Guide provides suggestions and information that will help you develop and improve knowledge needed for successful performance in various Technician positions in Verizon. This group of positions includes, but is not limited to, the following job titles:

- Central Office Technician
- Transmission Technician
- Systems Technician Radio
- Network Systems Technician
- Senior Special Services Provisioning Technician
- COE Installer
- COE Technician
- Customer Zone Tech I
- Customer Service Tech I
- Equip Installer Technician
- Equipment Installer
- Equipment Maintainer
- Equipment Technician
- PBX Installer Repairer
- Span Technician
- Switchperson
- Transmission Technician

Knowledge necessary to enter these positions is assessed by a job knowledge test entitled "Network Systems Assessment," which must be passed to be considered for hire in the job titles listed above at Verizon. The Network Systems Assessment consists of 50 multiple-choice questions, covering six broad knowledge areas. The number of items devoted to each knowledge area on the test varies. Each multiple-choice question will have four possible responses, with one correct answer. These knowledge areas are described in this Development Guide.

Using the Guide

Read the Test Information, Test-Preparation Tips, and Test-Taking Tips sections on pages 4-9. Then, review the section on Ways to Improve Your Score on the Test. Also, read the suggested activities that may help you further develop your knowledge, tailoring the suggestions to fit your specific work style and situation.

The knowledge areas measured on the test are each described in this Guide. First, a brief description of the knowledge area is provided. This description is not a complete tutorial on the knowledge area; it simply indicates what the knowledge area means for purposes of this test. Following the brief description, a number of relevant aspects of the knowledge area are listed. These are the things you should be sure to learn about when studying for the test. Then, suggested resources (primarily books and websites) are provided, where applicable, to help you learn about the knowledge area. Most of the books can be found at local libraries and bookstores.

You might want to read relevant portions of the books and websites listed in the suggested readings and resources. You do not need to read every book and website that is listed, nor do you necessarily need to read them in their entirety. The books and websites listed are just *examples* of the type of things that you should read. It is the *content* of these reference sources, not specific titles, that is important. You may therefore want to seek out other references that cover the content included in the test.

Included in the description of each knowledge area is a sample question from the practice test at the end of this Guide that represents the knowledge area, together with an explanation that indicates which of the four possible answers is correct, and why. You may also want to complete the practice test questions at the end of this Guide. Check your answers against the answers provided after the practice questions. An explanation of why the answers identified are correct is also provided for each question. Use this information to understand why the answers are correct and the other answers are incorrect.

Using this Guide does not guarantee that you will pass the Network Systems Assessment. Your performance will depend on your initial knowledge and ability level, the effort you put into improving your knowledge, and the effectiveness of the knowledge development activities you undertake.

Test Information

The goals in developing the Network Systems Assessment were to ensure that the test is job-related, fair, and accurate. These goals were accomplished by working closely with a large number of subject matter experts (SMEs). Job-relatedness was established by asking the SMEs: (1) to identify the knowledge elements required to perform the targeted Technician positions listed earlier in this Guide, (2) to review the test questions to make sure they tap those required knowledge elements, and (3) to evaluate whether they are relevant to the targeted positions. Fairness was established by asking SMEs to review all knowledge elements and test questions to ensure that they represent knowledge that is required on the job and is not specific to Verizon. Accuracy was established by asking SMEs to review each test question for technical accuracy and to make sure there is only one, clearly correct, answer.

As described above, all of the questions will be multiple-choice with four alternatives; there will be no “trick” questions. The Network Systems Assessment requires some knowledge of electronics and other technical topics as they relate to the telecommunications industry. The test does not, however, require any knowledge of specific Verizon policies, practices, instrumentation, or tools. The type of knowledge measured by this test can be acquired either inside or outside of Verizon. The number of items devoted to each knowledge element on the test will vary, according to its breadth and importance.

Test-Preparation Tips

This section provides information about how to study effectively and how to apply your knowledge effectively during the test.

General Suggestions

- Study to learn the key concepts now, permanently, rather than putting off the real learning for later.
- Don't focus simply on rote memorization; work on finding patterns in, drawing connections between, and understanding the principles underlying the information presented in the study materials.
- Cultivate interest in the material and confidence in your ability to master it; both improve learning.
- Avoid cramming just before you take the test; cramming will reduce your concentration and increase your confusion.
- Develop an organized "plan of attack" for learning the material that fits your learning style; for example, don't skip ahead to more advanced concepts until you've learned the more basic concepts (unless you've already learned the basic concepts).

Study Schedule and Study Environment Suggestions

- Set aside plenty of study time several weeks before the test.
- Devise a special study schedule by dividing material into organized units, each to be learned by a certain date before the test.
- Let your family and friends know how important it is that you stick to your study schedule.
- Arrange for a distraction-free place to study.

Review Suggestions

- Don't just skim your study materials; strive to *understand* the material as well as memorize for the test.
- Actively review material by writing things down as you study rather than just passively reading/re-reading the material.
- Remember that pattern-finding is very important to learning large amounts of information.
 - Try to impose a pattern on each topic you are studying.
 - Outline material by numbering or lettering important points.
 - Find relationships, concrete examples, and applications that will aid your memory of the study materials.
 - Use mnemonics (that is, memory aids such as using the sentence Every Good Boy Does Fine to remember the correct order of musical notes — EGBDF) when possible to help you learn information.

Test-Taking Tips

Before the Test

- If possible, get a good night's sleep before the test so that you're well rested and alert.
- Go into the test with a positive attitude, determined to do your best. Focus on what you know, rather than worrying about what you don't know.
- Make sure you know the exact location and time of the test. Allow yourself plenty of time to get to the test site, use the restroom, and compose yourself.
- Wear something comfortable. Test sites may be slightly hot or cool, so dress for any temperature.
- Leave behind pagers, cell phones, portable radios, etc.
- Reduce test anxiety and tension by breathing deeply and stretching before the test.
- Try not to discuss the test with other people once you arrive. Generally, this only increases anxiety.

During the Test

- Listen carefully to all of the test administrator's instructions and follow them exactly.
- Be sure you understand the test instructions before you start. If you need to ask questions, do so.
- Read the entire question and all response alternatives before choosing your answer.
 - Read the question and response alternatives carefully to make sure you avoid accidentally adding or deleting words in your head.
 - Pay attention to critical words like NOT and EXCEPT.
 - Do not over-interpret questions or try to find hidden meanings; again, the questions are not designed to be tricky. Take the questions at face value.
- Try to stay relaxed during the test. If you have trouble concentrating or become tense, pause and take a few deep breaths.
- Pay attention to your own work, not to what is going on around you. If you are wondering how other people are doing or how far they have gotten, you are wasting valuable time.

Ways to Improve Your Score on the Test

This section contains development suggestions that should help you improve your technical job-related knowledge. You may find these suggestions helpful in preparing for the Network Systems Assessment.

- Studying books and websites on basic electricity and electronics and basic telecommunications/telephony, including those suggested in this Guide. Relevant books are available in libraries and bookstores. Relevant websites can be found using standard search engines such as Google. If you don't have a computer with Internet access, many public libraries provide this service.
- Answering practice questions found in books and websites on basic electricity and electronics, and on basic telecommunications/telephony.
- Taking courses in basic electricity or electronics, and basic telecommunications/telephony at a community or vocational/technical school.
- Taking formal or self-study training courses in electricity and electronics, or telecommunications/telephony, if you work for an organization that offers them.

Knowledge Areas Covered in Test

The Network Systems Assessment covers six knowledge areas:

- (1) principles of electricity/electronic concepts
- (2) bonding and grounding practices/electrostatic safety
- (3) data circuits and digital carriers
- (4) packet switching principles and concepts
- (5) diagnostics and troubleshooting
- (6) basic computer knowledge

Each of these knowledge areas is described in the following pages. Reference materials are suggested as appropriate. In addition, a sample question which represents the knowledge area is shown, along with an explanation for why the answer is correct.

1. Principles of Electricity/Electronic Concepts

In this test, job candidates will be asked to demonstrate knowledge of fundamental concepts of AC and DC electricity/electronics and their applications in the telephony industry. This will include local loop electrical principles, and understanding and interpretation of common electrical symbols and components.

This knowledge area is made up of the following more specific knowledge elements:

- AC/DC Theory and Practice
- Symbols and Designations (e.g., Electrical)
- Basic Electrical Principles (e.g., Resistance - Continuity, Shorts, Voltage)

Suggested reference materials:

The American Radio Relay League, Inc. (2002). *Understanding basic electronics*. ISBN: 0-87259-398-3

McComb, G., & Boysen, E. (2005). *Electronics for dummies*. Hoboken, NJ: Wiley. ISBN: 0-7645-7660-7

Sample question representing this knowledge area:

The United States standard for an alternating current is:

- a. 36 cycles per second.
- b. 48 cycles per second.
- c. 60 cycles per second.
- d. 72 cycles per second.

Explanation:

The correct answer is "c." There are two worldwide standards that deal with the frequency of commercial alternating current (AC) electrical service: 50 Hz (Hertz, or cycles per second) and 60 Hz. North America, including the United States, is standardized on 60 Hz.

2. Bonding and Grounding Practices/Electrostatic Safety

Grounding is the backbone of effective protection of all networked systems. Bonding is an integral component of effective grounding in that bonding keeps various pieces of conductive equipment at the same potential in order to minimize damage to equipment and injuries to employees. In this test, candidates will be asked to demonstrate knowledge of practices and procedures for bonding and grounding associated with the installation, maintenance, and service of telecommunications equipment. This knowledge area also encompasses electrostatic discharge. Many electrical components are sensitive to this type of damage. Electrostatic discharge normally takes place when a worker comes in contact with an electronic component or circuit board. In this test, candidates will be asked to demonstrate knowledge of safe handling procedures and practices to reduce the potential for damage to equipment caused by electrostatic discharge.

This knowledge area is made up of the following more specific knowledge elements:

- Electrical Static Discharge Sensitivity (ESDS) to Prevent Damage to Electrical Components
- Bonding and Grounding Principles and Theories

Suggested reference materials:

<http://www.arrl.org/tis/info/pdf/9104019.pdf>

<http://www.arrl.org/tis/info/pdf/9105028.pdf>

<http://resource.intel.com/telecom/support/install/config/esd/esd.pdf>

Simmons, P. (2005). *Electrical grounding and bonding: Based on the 2005 National Electric Code*. Thomson Delmar Learning. ISBN: 1-4018-5938-0

Sample question representing this knowledge area:

A good ground is an important part of an installation for all of the following reasons EXCEPT:

- a. It helps reduce damage in case of a lightning hit.
- b. It eliminates any chance of personnel being electrocuted if a short occurs to a frame or cabinet.
- c. It protects sensitive electronics from electrical static discharge during installation.
- d. It is required by most manufacturers, industry practice, and electrical codes.

Explanation:

The correct answer is "c." A good ground will not protect sensitive electronics from electrical static discharge during installation. Static discharge can, for example, result from handling electronic components or using packaging material improperly, neither of which is related to grounding. By contrast, a good ground will reduce damage in a lightning hit during installation by shunting the voltage from the lightning strike to the ground (since the path to the ground has the least resistance). This will divert most of the energy away from regular wiring. A good ground will also eliminate the chance of electrocution if a short occurs during installation by diverting the stray voltage to the ground. Finally, most manufacturers, industry standards, and electrical codes require a good ground.

3. Data Circuits and Digital Carriers

Today's telecommunication networks are built upon a digital infrastructure. A digital infrastructure consists of data circuits and digital carriers that transport binary encoded information throughout the networks. In this test, the candidate will be expected to demonstrate knowledge of the carrier hierarchy, encoding/decoding, multiplexing and synchronization, digital cross connect systems, and digital local loops. The test will also encompass copper and optical carriers, SONET, optical transport switching, and channelization.

This knowledge area is made up of the following more specific knowledge elements:

- Data Circuits
- Application of Digital Principles and Concepts
- Analog, Digital, and Fiber Optic Transmission
- Digital Carriers

Suggested reference materials:

Black, U., & Waters, S. (2001). *SONET and T1: Architectures for digital transport network (2nd Ed.)*. Prentice-Hall. ISBN: 0-1306-5416-7

Held, G. (1990). *Digital networking and T-carrier multiplexing*. Chichester, England: John Wiley & Sons. ISBN: 0-4719-2800-3

Held, G. (1999). *High speed digital transmission networking: Covering T/E-carrier multiplexing, SONET and SDH (2nd ed.)*. Chichester, England: John Wiley & Sons. ISBN: 0-4719-8358-6

http://www.iec.org/online/tutorials/fiber_optic/

<http://www.iec.org/online/tutorials/sonet/>

http://www.iec.org/online/tutorials/opt_trans/

Sample question representing this knowledge area:

To carry information in both directions between fiber optic terminals, single wavelength fiber systems use:

- a. one fiber.
- b. two fibers.
- c. three fibers.
- d. two fiber pairs.

Explanation:

The correct answer is "b." A fiber optic using only one wavelength or optical signal can only carry information in one direction. To carry information in both directions, two fiber optics are needed, one for each direction. Therefore, fiber optic systems usually use two fibers, or one fiber pair. It is possible for one fiber optic to carry information in both directions, but this requires the use of more than one wavelength of optical signal and is more expensive.

4. Packet Switching Principles and Concepts

Frame relay, ISDN, and packet switching are integral technologies for interfacing customer facilities to the telecommunication networks that span the globe. In this test, candidates will be asked to demonstrate knowledge of concepts and principles of frame relay and ISDN, including BRI (Basic Rate Interface) and PRI (Primary Rate Interface). The test will also encompass knowledge of packet switching as applied to contemporary data networks.

This knowledge area is made up of the following knowledge element:

- Packet Switching Principles and Concepts (e.g., ISDN, Data Transmission, Frame Relay)

Suggested reference material:

Dunsmore, B., & Skandier, T. (2002). *Telecommunications technologies reference*. Cisco Press. ISBN: 1-58705-036-6

Sample question representing this knowledge area:

Which of the following can be used to connect a customer to Frame Relay service?

- a. ISDN
- b. Fractional T1
- c. POTS
- d. Both a and b

Explanation:

The correct answer is "b." Frame Relay is a technology for transporting data over a wide area network (WAN). Customers connect to Frame Relay networks using a variety of digital carriers. The typical circuits used to access a Frame Relay network are T-1, T-3, and fractional services over T-1 or T-3. Neither ISDN nor POTS can be used to connect a customer to Frame Relay service.

5. Diagnostics and Troubleshooting

Maintaining an operational network is critical to customer satisfaction in the telecommunication marketplace. When problems occur, quick response will reduce customer downtime. The formal diagnostic/troubleshooting process starts with the trouble ticket, continues with testing and troubleshooting of the problem, and ends with restoring the operational status of the customer's circuit. In this test, candidates will be asked to demonstrate knowledge of procedures and interpretation of technical documents, operation of testing equipment, and troubleshooting of circuits for both copper and optical carriers.

This knowledge area is made up of the following more specific knowledge elements:

- The Use of Testing Equipment (e.g., Multimeters, Digital Voltmeters)
- How to Troubleshoot Circuits
- Complex Diagnostics and Troubleshooting Techniques
- How to Interpret Technical Documents

Suggested reference materials:

Anderson, D., Johnson, L., & Bell, F. (2004). *Troubleshooting optical fiber networks: Understanding and using optical time-domain reflectometers*. Academic Press. ISBN: 0-1205-8661-4

The American Radio Relay League, Inc. (2002). *Understanding basic electronics*. ISBN: 0-87259-398-3

Sample question representing this knowledge area:

Which of the following is used to measure the output of a battery?

- a. TDR
- b. Wattmeter
- c. Voltmeter
- d. Any of the above

Explanation:

The correct answer is "c." A TDR (Time Domain Reflectometer) measures the length of a cable or the distance to a fault, a wattmeter measures power, and a voltmeter measures electrical potential (voltage). A battery's output is electrical potential, which is measured in volts.

6. Basic Computer Knowledge

Verizon technical positions require new hires to rapidly become familiar with a number of computer systems/applications. It is therefore important that the job candidates possess the basic knowledge needed to learn these systems/applications.

In this test, job candidates will be asked to demonstrate basic knowledge of the Windows operating system and the installation and use of common application software (e.g., Microsoft Excel, Word, Outlook). The purpose of these test questions is not to evaluate candidates' knowledge of specialized telecommunications industry software or advanced knowledge of computer hardware and software. Our purpose is simply to determine whether candidates have had some basic experience working with computers.

Suggested reference sources:

None. To perform well on these questions, you should familiarize yourself with the basic functions and applications of computers.

Sample question representing this knowledge area:

Today's laptop computers primarily use _____ operating systems:

- a. DOS
- b. UNIX
- c. Windows
- d. Excel

Explanation:

The correct answer is "c." The question asks which operating system is PRIMARILY used by today's laptop computers. DOS is sometimes used, but it is an older operating system used only on rare occasions for older programs that were created before the Windows Platform came out. UNIX is used in many engineering systems (and is the base of the MAC OS10 system), but it is not the primary operating system for today's laptop computers. Excel is not an operating system at all, but is instead an application used inside the operating system.

General Reference Materials (Relevant to Multiple Knowledge Areas)

Dunsmore, B., & Skandier, T. (2002). *Telecommunications technologies reference*. Cisco Press. ISBN: 1-58705-036-6

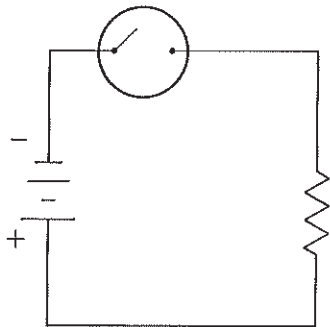
Green, J. H. (2000). *The Irwin handbook of telecommunications (4th ed.)*. McGraw-Hill. ISBN: 0-0713-5554-5

Practice Questions

The following questions are similar to those you will find on the Network Systems Assessment. The questions are grouped according to knowledge area.

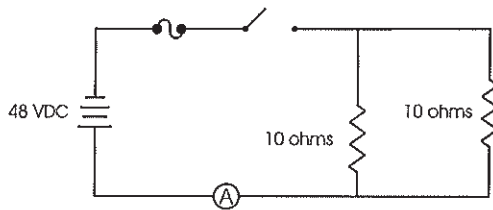
Knowledge Area 1: Principles of Electricity/Electronic Concepts

1. The United States standard for an alternating current is:
 - a. 36 cycles per second.
 - b. 48 cycles per second.
 - c. 60 cycles per second.
 - d. 72 cycles per second.
2. What four factors affect the resistance of a conductor?
 - a. Length, weight, height, and size
 - b. Temperature, length, size, and type of material
 - c. Ground, weight, type of material, and length
 - d. Voltage, size, length, and temperature
3. The unit of measurement for capacitance is the:
 - a. ohm.
 - b. farad.
 - c. watt.
 - d. volt.
4. In the schematic diagram below, the circled symbol represents a:

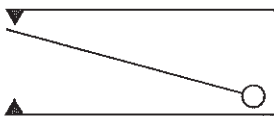


- a. capacitor.
- b. battery.
- c. switch.
- d. resistor.

5. A zener diode is used to:
 - a. regulate voltage.
 - b. amplify current.
 - c. filter audio.
 - d. switch circuits.
6. One of the diodes in a full wave bridge rectifier opens. The DC output voltage will:
 - a. increase.
 - b. cease (no output).
 - c. change polarity.
 - d. be pulsing.
7. Which of the following is the best conductor of electricity?
 - a. Aluminum
 - b. Copper
 - c. Brass
 - d. Silver
8. What is the total current flow reading on the ammeter in this circuit?

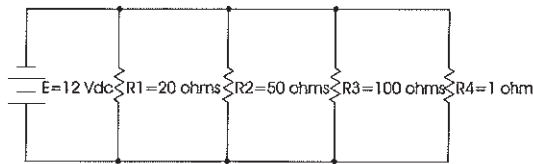


- a. 0 amps
 - b. 4.8 amps
 - c. 6.4 amps
 - d. 9.6 amps
9. The following diagram represents:



- a. a resistor.
- b. a relay.
- c. a transformer.
- d. a connector.

10. What type of circuit is depicted in the figure below?



- a. Series circuit
 - b. Parallel circuit
 - c. Solid state circuit
 - d. Resonant circuit
11. In a closed parallel circuit:
- a. the total current flow will be less than the sum of the individual loop currents.
 - b. the total current flow will equal the sum of the individual loop currents.
 - c. the total current flow will exceed the sum of the individual loop currents.
 - d. None of the above
12. If one conductor of a cable pair comes in contact with another conductor from a second cable pair, this would be known as a(n):
- a. short.
 - b. ground.
 - c. cross.
 - d. open.

Knowledge Area 2: Bonding and Grounding Practices/Electrostatic Safety

13. A Faraday cage is designed to isolate:
- a. passive electronic components.
 - b. static sensitive components.
 - c. wire and connectors.
 - d. dry cell batteries.
14. A good ground is an important part of an installation for all of the following reasons EXCEPT:
- a. It helps reduce damage in case of a lightning hit.
 - b. It eliminates any chance of personnel being electrocuted if a short occurs to a frame or cabinet.
 - c. It protects sensitive electronics from electrical static discharge during installation.
 - d. It is required by most manufacturers, industry practice, and electrical codes.

Knowledge Area 3: Data Circuits and Digital Carriers

15. Which of the following statements about line noise is true?
 - a. Analog transmission is less likely to be influenced by outside noise than ISDN transmission.
 - b. Digital transmission is less likely to be influenced by outside noise than analog transmission.
 - c. Digital and analog transmission facilities are equally likely to be influenced by outside noise.
 - d. Outside noise has no influence on analog or digital transmission facilities.

16. Which of the following statements about T-1s is true?
 - a. They can only be used to carry video signals.
 - b. They can be used to carry both voice and data signals.
 - c. They can only be used to carry optical signals.
 - d. They cannot be used to carry analog voice signals.

17. To carry information in both directions between fiber optic terminals, single wavelength fiber systems use:
 - a. one fiber.
 - b. two fibers.
 - c. three fibers.
 - d. two fiber pairs.

18. Which of the following statements about a coaxial cable transmission line is true?
 - a. It is less susceptible to interference than the twisted pair transmission line.
 - b. It cannot be installed in metal structures.
 - c. It cannot be buried underground.
 - d. An OTDR can be used to measure its length.

19. Serial data is typically transmitted over:
 - a. one pair of wires.
 - b. a single wire.
 - c. more pairs of wires than parallel data.
 - d. eight pairs of wires.

20. A 56k data circuit is most suitable for:
 - a. low bandwidth applications.
 - b. high bandwidth applications.
 - c. either low bandwidth or high bandwidth applications.
 - d. neither low bandwidth nor high bandwidth applications.

21. Which of the following is NOT a stage in the analog-to-digital conversion process?
- a. Sampling
 - b. Encoding
 - c. Decoding
 - d. Quantizing
22. How many bits in a DS1 frame are available for data?
- a 191
 - b 192
 - c 193
 - d 194

Knowledge Area 4: Packet Switching Principles and Concepts

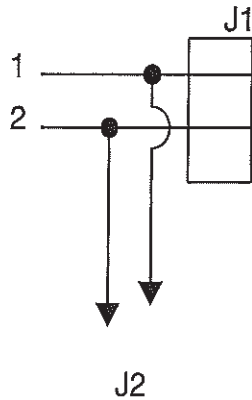
23. Which of the following can be used to connect a customer to Frame Relay service?
- a. ISDN
 - b. Fractional T1
 - c. POTS
 - d. Both a and b

Knowledge Area 5: Diagnostics and Troubleshooting

24. Which of the following is used to measure the output of a battery?
- a. TDR
 - b. Wattmeter
 - c. Voltmeter
 - d. Any of the above
25. Which meter will be used when measuring the signal-to-noise ratio on a DSL circuit?
- a. Subscriber Loop Analyzer
 - b. OTDR
 - c. T-BERD
 - d. Cable Hound
26. Which of the following describes a foreign exchange line?
- a. Dial tone from one Central Office, customer in another Central Office
 - b. Customer and dial tone in the same Central Office
 - c. Tie line between two customers
 - d. Tie line between two Central Offices

27. Which of the following procedures is used to raise the priority level of a customer problem or outage?
- Alert
 - Rush
 - Escalation
 - Conditional

28. Which of the following statements about the figure shown below is true?



- Wire 1 is shorted to wire 2.
 - Wires 1 and 2 also go to connector J2.
 - Wires 1 and 2 go to a ground.
 - Wires 1 and 2 only go to connector J1.
29. When using an Ohmmeter to measure a properly functioning component:
- a short will be measured across a ceramic capacitor.
 - an open will be measured across a mylar capacitor.
 - an open will be measured across a power transformer primary.
 - an open will be measured across loud speaker terminals.

Knowledge Area 6: Basic Computer Knowledge

30. Today's laptop computers primarily use ____ operating systems:
- DOS
 - UNIX
 - Windows
 - Excel

Answers to Practice Questions with Explanations

Knowledge Area 1: Principles of Electricity/Electronic Concepts

1. The correct answer is "c." There are two worldwide standards that deal with the frequency of commercial alternating current (AC) electrical service: 50 Hz (Hertz, or cycles per second) and 60 Hz. North America, including the United States, is standardized on 60 Hz.
2. The correct answer is "b." The resistance of a conductor: (a) decreases as the temperature decreases, (b) increases as the length of the conductor increases, and (c) decreases as the size (cross sectional area) of the conductor increases. Some types of materials are better conductors than others and, as such, have less resistance. For example, copper has less resistance than gold, and gold has less resistance than aluminum. The weight of a conductor, the voltage run through a conductor, the grounding of a conductor, and the height of a conductor (without knowledge of its width) are unrelated to resistance.
3. The correct answer is "b." The unit of measurement for capacitance is farads (named for the 19th-century scientist Michael Faraday). The Ohm is a measure of resistance, the Watt is a measure of power, and the Volt is a measure of electrical potential.
4. The correct answer is "c." This question represents several electrical symbols, each with well-established meanings, according to telecommunications industry standards, and their use in a schematic diagram of a circuit. The circled symbol is used to represent a switch.
5. The correct answer is "a." Zener diodes are widely used to regulate voltage across a circuit. A zener diode conducts once the voltage reaches the diode's reverse breakdown voltage (assuming it is connected in parallel with a variable voltage source so that it is reverse biased). The zener diode then maintains the voltage at that value.
6. The correct answer is "d." A full wave bridge rectifier is composed of four diodes configured to convert AC to DC. If one of the diodes should open, the DC output will lose part of the AC phase conversion to DC, resulting in a period of zero DC output during each cycle of the AC (as would be produced by a half wave rectifier circuit). This is observable on an oscilloscope as a pulsing output with the voltage falling to zero and remaining there for a half wave period.
7. The correct answer is "d." Of the four conductors listed, silver has the least resistance, followed by copper, aluminum, and brass. As such, silver is the best conductor. It is also, however, the most expensive. Because of the cost factor, copper is the most commonly used conductor.
8. The correct answer is "a." Since the switch is open, no current can flow and the ammeter measuring the total current flow in the circuit will read 0 amps. It is impor-

tant to study a complete circuit before beginning to calculate voltages and current flows. If the switch were closed, Ohm's law could be used to calculate an answer.

9. The correct answer is "b." The diagram represents a relay. A relay is comprised of contacts that are switched using a magnetic coil that, when energized, will move the switch between one set of contacts and the other.
10. The correct answer is "b." In the circuit above, all of the elements connect to the same two wires from the battery. The symbol used for the elements is that of a resistor. Since there are no capacitors or inductors shown, it cannot be a resonant circuit. Since there are no solid-state devices such as diodes or transistors, it cannot be a solid-state circuit. The resistors are arranged in parallel (that is, side-by-side with all elements connecting to the same upper and lower wires), not in series.
11. The correct answer is "b." It is a fundamental law of electrical theory that, in a closed parallel circuit, the total current flow is equal to the sum of the individual loop currents.
12. The correct answer is "c." A cross occurs when one or both wires (which serve as conductors of electricity) from one cable pair come in contact with wires from another cable pair. A short is a connection between the wires of the same signal pair. A ground is a connection from either or both wires of a signal pair to a ground point or connection. An open is a break or a disconnect of one or both wires of a pair.

Knowledge Area 2: Bonding and Grounding Practices/Electrostatic Safety

13. The correct answer is "b." A Faraday cage is an enclosure formed by conductive material (usually metal screens) that is designed to isolate static sensitive electronic components and devices from potentially damaging external static electrical fields.
14. The correct answer is "c." A good ground will not protect sensitive electronics from electrical static discharge during installation. Static discharge can, for example, result from handling electronic components or using packaging material improperly, neither of which is related to grounding. By contrast, a good ground will reduce damage in a lightning hit during installation by shunting the voltage from the lightning strike to the ground (since the path to the ground has the least resistance). This will divert most of the energy away from regular wiring. A good ground will also eliminate the chance of electrocution if a short occurs during installation by diverting the stray voltage to the ground. Finally, most manufacturers, industry standards, and electrical codes require a good ground.

Knowledge Area 3: Data Circuits and Digital Carriers

15. The correct answer is "b." Analog signals travel along lines as electromagnetic waves. As they travel on these lines, the signals pick up electrical interference (noise) from outside sources such as power lines, lights and electrical machinery. As an analog signal loses strength and fades over distance, an amplifier strengthens the signal. In doing so, however, the amplifier strengthens both the signal and the noise. The outside noise is therefore preserved when the analog transmission is received. Digital signals are transmitted in the form of binary bits (zeros and ones). When digital signals lose strength and fade over distance, equipment on the digital line regenerates the signal and, in the process, discards outside noise. As such, much less noise is preserved when the digital transmission is received than when an analog transmission is received.
16. The correct answer is "b." T-1s can carry multiple digital signals, including both voice and data signals. This eliminates responses "a" and "c." T-1s can carry analog voice signals that have been converted to digital form, which eliminates response "d."
17. The correct answer is "b." A fiber optic using only one wavelength or optical signal can only carry information in one direction. To carry information in both directions, two fiber optics are needed, one for each direction. Therefore, fiber optic systems usually use two fibers, or one fiber pair. It is possible for one fiber optic to carry information in both directions, but this requires the use of more than one wavelength of optical signal and is more expensive.
18. The correct answer is "a." The outer braided jacket of a coaxial cable protects the inner conductor from outside interference. This makes coaxial cable less susceptible to interference than twisted-pair transmission lines because twisted pair wire does not have a shield around it to block electrical interference. There are no characteristics of coaxial cable that prevent it from being installable in metal structures, and coaxial cable can be buried, provided it has been coated with weather-resistant material or placed inside a conduit. Finally, coaxial cable is not optical, so an OTDR (Optical Time Domain Reflectometer) cannot be used to measure its length.
19. The correct answer is "a." Serial data most often consists of individual digital signal elements such as binary ones and zeros that are encoded into electrical signals. These individual data elements are sent one following the other on a pair of wires. Sending serial data on a single wire has not been used since the era of the telegraph. When multiple pairs of wires are used, the transmission of data is called parallel.
20. The correct answer is "a." In the past, a 56k data circuit was considered fast. Today, however, high-bandwidth applications run at speeds ranging from 500,000 to millions of bits per second. A 56k data circuit is now considered useful only for low-speed or low bandwidth applications. Broadband or high-bandwidth applications require much higher speeds.

21. The correct answer is "c." The process of converting analog telephone signals to digital signals has three distinct steps. First, the analog signal is sampled. That is, individual values are captured at specified intervals. Second, the individual values are adjusted slightly to fit fixed and predetermined values. This is known as quantizing. Finally, these quantized values are encoded or changed to specific digital codes of ones and zeros that will be transmitted across a digital network. After the analog-to-digital conversion process has been completed, a process called digital-to-analog conversion recreates the original analog signals. That digital-to-analog conversion process also has several steps, one of which is decoding. Since decoding is not part of the analog-to-digital conversion process, "decoding" is the correct answer.
22. The correct answer is "b." The DS1 frame comprises 193 bit positions. The first bit is the frame overhead bit, while the remaining 192 bits are available for data (payload) and are divided into 24 blocks (channels) of eight bits each.

Knowledge Area 4: Packet Switching Principles and Concepts

23. The correct answer is "b." Frame Relay is a technology for transporting data over a wide area network (WAN). Customers connect to Frame Relay networks using a variety of digital carriers. The typical circuits used to access a Frame Relay network are T-1, T-3, and fractional services over T-1 or T-3. Neither ISDN nor POTS can be used to connect a customer to Frame Relay service.

Knowledge Area 5: Diagnostics and Troubleshooting

24. The correct answer is "c." A TDR (Time Domain Reflectometer) measures the length of a cable or the distance to a fault, a wattmeter measures power, and a voltmeter measures electrical potential (voltage). A battery's output is electrical potential, which is measured in volts.
25. The correct answer is "a." The subscriber loop analyzer is designed specifically to test the ratio of signal-to-noise on a DSL circuit. It does so using various test functions built into the equipment that compare the level of the signal to the level of the ambient noise on the circuit.
26. The correct answer is "a." A foreign exchange line provides local telephone service from a Central Office that is outside (or foreign to) the subscriber's exchange area. The user goes off-hook (that is, picks up the telephone to make a call) in one area and receives dial tone from another, more distant, exchange. Calls directed to that subscriber's number will also pass through the foreign Central Office. This is most often used by a subscriber who wishes to have a number that appears local in a specific exchange or city. A tie line between two customers is a private circuit, and a tie line between two Central Offices is most often called an interoffice trunk.

27. The correct answer is "c." The decision to raise the priority level of a customer problem or outage is known as "escalation." The decision to escalate may be based in part on interpretation of information on trouble tickets or other technical documents. An alert is most often a signal indicating an incoming call, and is therefore unrelated to raising the priority level of a customer problem or outage. The terms "Rush" and "Conditional" are not used in this context.
28. The correct answer is "b." Wires 1 and 2 are connected to connector J1 and also connector J2, which is not shown on the drawing. The fact that connector J2 is not shown on the drawing is indicated by the arrows pointing to J2 and the lack of a symbol depicting J2.
29. The correct answer is "b." The Ohmmeter reading of properly functioning ceramic and mylar capacitors will indicate an open circuit. The Ohmmeter reading for both power transformer primaries and loud speaker terminals will show very low resistance, which does not indicate an open circuit.

Knowledge Area 6: Basic Computer Knowledge

30. The correct answer is "c." The question asks which operating system is PRIMARILY used by today's laptop computers. DOS is sometimes used, but it is an older operating system used only on rare occasions for older programs that were created before the Windows Platform came out. UNIX is used in many engineering systems (and is the base of the MAC OS10 system), but it is not the primary operating system for today's laptop computers. Excel is not an operating system at all, but is instead an application used inside the operating system.