

**Study Guide
for
Heating, Ventilation and Air
Conditioning Technician**

Test No. 2732 & 4707

Human Resources
Performance Assessment Services
Southern California Edison
An Edison International Company

0309

Introduction

The purpose of this Test Information Guide is to familiarize you with the Heating, Ventilation, and Air Conditioning Technician Knowledge and Performance Tests. The knowledge test consists of multiple choice questions designed to measure your knowledge in areas critical to the job. The performance test consists requires you to demonstrate your performance skill level as it pertains to troubleshooting, operation, and maintenance of a chilled water system with a single duct system featuring an in-line variable air volume damper and an electric resistance reheater zone control.

Test Scheduling

You will first have to pass the HVAC Knowledge Test #2732 before you can be scheduled to take the System Operator Performance Test #4707.

Employees who apply for positions, bids, and transfers requiring testing before March 9, 2009, will be scheduled for testing by their Supervisor through Human Resources. For those who apply after March 9, 2009, both the employee and their Supervisor will be notified of a scheduled test date by Human Resources. Test times and dates for positions requiring testing will be specified in the bid/transfer/requisition/job posting. Employees should be prepared to test on the specified dates. Only employees who apply for positions requiring testing, and who meet basic qualifications, will be invited to test. Applicants will be scheduled through the recruiter. If you have any questions, please call 626-302-9830.

Test Session

It is important that you follow the directions of the Test Administrator exactly. If you have any questions about the testing session, be sure to ask the Test Administrator before the testing begins. During testing, you may not leave the room, talk, smoke, eat, or drink. Since some tests take several hours, you should consider these factors before the test begins.

General Information About the HVAC Knowledge Test #2732

All questions on this test are multiple-choice with four possible answers. Prior to March 9, 2009, your answers to the questions are indicated by filling in a circle on an answer sheet with a special mark-sense pencil. For your answers to be read accurately by the scanner, you must fill in the circles completely and erase completely any answer you wish to change. After March 9, 2009 you will take the exam on a computer. For more information on this, please see the next section of this study guide, Computer Based Testing.

The test has a 3 hour time limit. You may use a non-programmable scientific calculator when taking this test. Calculators will be provided by the Test

Administrator, and will be one of the following three models: Casio fx-250HC, Texas Instruments TI-30XA, TI 36-X.

You will receive a Test Comment form so that you can make comments about test questions. Write any comments you have and turn it in with your test when you are done.

General Information About the HVAC Performance Test #4707

In this test you will be required to demonstrate your performance skill level as it pertains to troubleshooting, operation, and maintenance of a chilled water system with a single duct system featuring an in-line variable air volume damper and an electric resistance reheater zone control.

You will have 6 hours to complete the test. This time limit includes time for you to familiarize yourself with the test. There is no smoking, eating, drinking or leaving the test area during the test.

Throughout this test you are expected to use safe working procedures. The test will be stopped if you do not work safely. You must wear safety goggles and/or safety glasses throughout this test. If you do not have them they will be provided to you.

The correct diagnosis(es) in this test are such that the unit(s) will operate safely and properly when corrective action(s) is taken.

You will receive a Test Comment form so that you can make comments about test questions. Write any comments you have and turn it in with your test when you are done.

Study Guide Feedback

At the end of this *Guide* you have been provided with a Study Guide Feedback page. If a procedure or policy has changed, making any part of this Guide incorrect, your feedback would be appreciated so that corrections can be made.

Computer Based Testing

Effective **March 9, 2009**, all knowledge tests will be administered on the computer. This information will help prepare you for a knowledge test taken on or after **March 9, 2009**.

Taking an SCE knowledge test on the computer is simple. You do not need any computer experience or typing skills. You will only use the keyboard to enter your candidate ID and password. You'll answer all questions by pressing a single button on the mouse.

Log in Screen

You will be seated at a testing station. When you are seated, the computer will prompt you to enter the candidate ID and password you received in your invitation e-mail. You **MUST** have your candidate ID and password or you will be unable to take the test. Once you have confirmed your identity by entering this information, you will see a list of tests available to you.

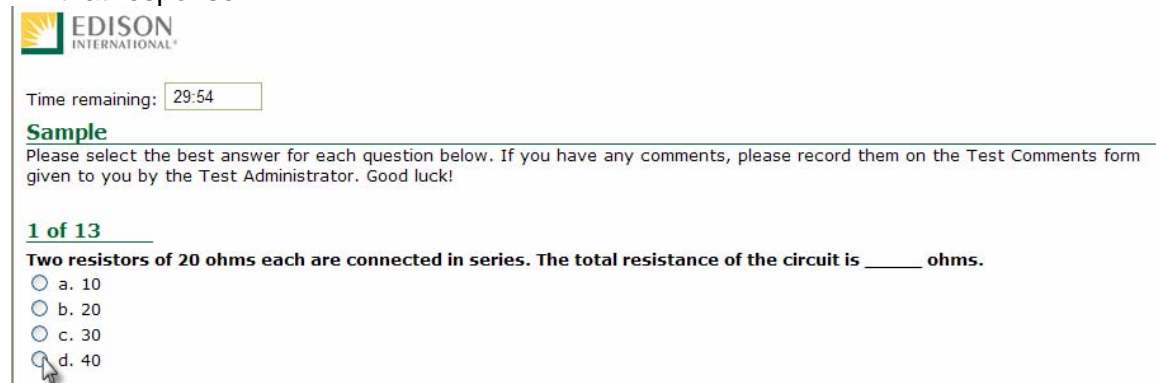
Sample/Tutorial

Before you start your actual test, a Sample/Tutorial Test is provided to help you become familiar with the computer and the mouse. From the list of exams that appear when you complete the log in, you will select Sample/Tutorial. You will have up to 10 minutes to take the Sample/Tutorial Test. The time you spend on this Sample Test DOES NOT count toward your examination time. Sample questions are included so that you may practice answering questions. In the Sample/Tutorial Test, you will get feedback on your answers. You will not receive feedback on your actual test.

Example

During the test, to answer each question, you should move the mouse pointer over the circle (radio button) next to the answer of your choice, and click the left mouse button. The amount of time you have remaining to take the test will always be shown in the top left corner of the screen. A sample is show below:

1. When you begin the test, you can see the total time allowed for completion displayed at the top of the screen. You can scroll up to see that information at any time during the test.
2. In order to answer each question, first read the question and determine the response that best answers the question. Put the mouse pointer directly over the circle corresponding to that response.



The screenshot shows the Edison International test interface. At the top left is the Edison International logo. Below it, a timer displays "Time remaining: 29:54". A section titled "Sample" contains the instruction: "Please select the best answer for each question below. If you have any comments, please record them on the Test Comments form given to you by the Test Administrator. Good luck!". Below this, it indicates "1 of 13" questions. The question text is "Two resistors of 20 ohms each are connected in series. The total resistance of the circuit is _____ ohms." and there are four radio button options: a. 10, b. 20, c. 30, and d. 40. A mouse cursor is pointing at option d.

3. While the pointer is over the circle corresponding to the best answer, click the left mouse button.



Click the left button when the pointer icon is over your answer choice.

- The answer you selected should now have a green dot in the circle. If you need to select an alternate answer, simply move the pointer over that circle, and click again.



Time remaining:

Sample

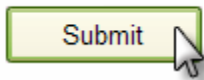
Please select the best answer for each question below. If you have any comments, please record them on the Test Comments form given to you by the Test Administrator. Good luck!

1 of 13

Two resistors of 20 ohms each are connected in series. The total resistance of the circuit is _____ ohms.

- a. 10
- b. 20
- c. 30
- d. 40

- You can change your answers at any time during the test until the time runs out, or you click the "Submit" button.



Test Taking Strategies

Introduction

Your emotional and physical state during the test may determine whether you are prepared to do your best. The following list provides common sense techniques you can use before the test begins.

Technique	Remarks
<i>Be confident</i>	<ul style="list-style-type: none">• If you feel confident about passing the test, you may lessen your anxiety.• Think of the test as a way of demonstrating how much you know, the skills you can apply, the problems you can solve, and your good judgment capabilities.
<i>Be punctual</i>	<ul style="list-style-type: none">• Arrive early enough to feel relaxed and comfortable before the test begins.
<i>Concentrate</i>	<ul style="list-style-type: none">• Try to block out all distractions and concentrate only on the test. You will not only finish faster but you will reduce your chances of making careless mistakes.• If possible, select a seat away from others who might be distracting.• If lighting in the room is poor, sit under a light fixture.• If the test room becomes noisy or there are other distractions or irregularities, mention them to the Test Administrator <i>immediately</i>.
<i>Budget your time</i>	<ul style="list-style-type: none">• Pace yourself carefully to ensure that you will have enough time to complete all items and review your answers.

Read critically

- Read all directions and questions carefully.
- Even though the first or second answer choice looks good, be sure to read all the choices before selecting your answer.
- Choose the BEST of the available answers!

Make educated guesses

- Make an educated guess if you do not know the answer or if you are unsure of it.

Changing answers

- If you need to change an answer, be sure to erase your previous answer completely. On the computer, be sure that the new answer is selected instead of the old one.

Return to difficult questions

- If particular questions seem difficult to understand, make a note of them, continue with the test and return to them later.

Double check mathematical calculations

- Use scratch paper to double check your mathematical calculations.

Review

- If time permits, review your answers.
- Do the questions you skipped previously.
- Make sure each answer bubble is *completely* filled in. Erase any stray marks on your answer sheet. When testing on the computer, make sure each question has a green dot next to the correct answer.

Remember, the techniques described in this section are only suggestions. You should follow the test taking methods that work best for you.

Additional strategies and test taking information can be obtained by purchasing the following book:

Test-Taking Strategies (2004); J. Kesselman-Turkel & F. Peterson

HVAC Knowledge Test Study Guide Outline Job Knowledge Categories

Below are the major job knowledge categories that are covered on the HVAC Knowledge Test #2732.

A. Controls, Troubleshooting, Repair and Mechanical Tools

Involves principles, knowledge, troubleshooting & repair of flow control devices, expansion valves, capillary tubes, bulbs, low side/high side floats cooling tower float controls, motor wiring and air volume controllers. Involves compressor types, compression ratios, compressor efficiency, evaporator types, condenser types, system capacities, system pressures and secondary refrigerant systems. Involves refrigerant charges, leak detection, restrictions, oil separators, filter dryers, sightglasses, compound gages and short cycling. involves mechanical soldering and tube bending.

B. Refrigeration, Fluid Flow and Heat Transfer Theory

Involves principles of refrigeration cycle, compression, vaporization, condensation. Involves types of valves, driers, tubing/piping, semiconductors, compressors, equalizers, chill water cooling towers and motor protection. Involves principles of conduction, convection, enthalpy, and refrigerants. Involves thermostat control mechanisms, operating, sequential and hydronic controls, cut out adjustments, AEV physics, and pressure testing.

C. Filters and Charcoal Absorbers

Involves types of filters, purposes, and regeneration needs. Involves replaceable filters, replacement schedules, and causes for replacement. involves electronic air filters and associated schematics. Involves carbon filters, charcoal absorbers, and HEPA systems.

D. Electrical Theory, Motors, Instruments and Tools

Involves AC and DC theory, wiring and circuit diagrams, electrical symbols and terminology. Involves motors, external, hermetic, induction, capacitor, and motor protection. Use of ammeters, voltmeters, test lights, ohmmeters. Electrical recording instrumentation. Involves motor protection timers and thermistors. Measuring devices, pressure, temperature, flow, level, gages, switches (thermometer, manometer, barometer, pitot tube, anemometer).

E. Operations and Safety

Involves knowledge of safety procedures as specified by the SCE Accident and Fire Prevention Manual. Involves knowledge of electrical and other precautions and hazards. Involves working with hand tools and near energized motors. Involves causes of compressor damage and short cycling.

HVAC Knowledge Test #2732 Study References

Below is a listing of the study references for materials covered on the test. The materials listed in this Guide are available from public/university libraries, general bookstores, university or technical bookstores.

Modern Refrigeration & Air Conditioning (1992) by Althouse, Turnquist, and Bracciano, published by Goodheart & Wilcox Co., Illinois

KNOWLEDGE CATEGORY A -Controls, Troubleshooting, Repair and Mechanical Tools

- Fundamentals of Refrigeration (Ch. 1)
- Refrigeration Tools and Materials (Ch. 2)
- Basic Refrigeration Systems (Ch. 3) Compression Systems and Compressors (Ch. 4) Refrigerant Controls (Ch. 5) Electric Motors (Ch. 7)
- Electric Circuits and Controls (Ch. 8)
- Refrigerants (Ch. 9)
- Installing and Servicing Small Hermetic Systems (Ch. 11)
- Commercial Systems Installing and Servicing (Ch. 14)
- Fundamentals of Air Conditioning (Ch. 18)
- Basic Air Conditioning Systems (Ch.19)
- Air Conditioning Systems, Distributing, Cleaning and Instruments (Ch. 22)
- Air Conditioning and Heating Control Systems (Ch. 25)

KNOWLEDGE CATEGORY B - Refrigeration, Fluid Flow and Heat Transfer Theory

- Fundamentals of Refrigeration (Ch. 1)
- Refrigeration Tools and Materials (Ch. 2)
- Basic Refrigeration Systems (Ch. 3)
- Compression Systems and Compressors (Ch. 4)
- Refrigerant Controls (Ch. 5)
- Electrical Magnetic Fundamentals (Ch. 6)
- Electric Motors (Ch. 7)
- Electric Circuits and Controls (Ch. 8)
- Domestic Refrigerators and Filters (Ch. 10)
- Installing and Servicing Small Hermetic Systems (Ch. 11)
- Commercial Systems (Ch. 12)
- Commercial Systems Installing and Servicing (Ch. 14)
- Fundamentals of Air Conditioning (Ch. 18)
- Air Conditioning Systems:Distributing, Cleaning and Instruments (Ch. 22)
- Air Conditioning and Heating Control Systems (Ch. 25)

KNOWLEDGE CATEGORY C - Filters and Charcoal Absorbers

- Air Conditioning Systems:Distributing, Cleaning and Instruments (Ch 22)

KNOWLEDGE CATEGORY D - Electrical Theory, Motors, Instruments and Tools

- Refrigeration Tools and Materials (Ch. 2)
- Refrigerant Controls (Ch. 5)
- Electrical Magnetic Fundamentals (Ch. 6)
- Electric Motors (Ch. 7)
- Basic Air Conditioning Systems (Ch.19)

KNOWLEDGE CATEGORY E - Operations and Safety

- Refrigeration Tools and Materials (Ch. 2)
- Refrigerant Controls (Ch. 5)
- Electric Motors (Ch. 7) Commercial Systems (Ch. 12)
- Air Conditioning Systems:Distributing, Cleaning and Instruments (Ch 22)

HVAC Knowledge Test #2732

Sample Questions

The following are samples of the type of questions that you will encounter in this test. They include a reference for each question to show you the appropriate section to study. An answer page follows the questions.

KNOWLEDGE CATEGORY A -Controls, Troubleshooting, Repair and Mechanical Tools

1. In Troubleshooting a hermetic refrigeration unit, a technician must always remember that cooling takes place only when the is low enough and if there is present.
 - a. temperature; refrigerant liquid
 - b. pressure; refrigerant gas (vapor)
 - c. pressure; refrigerant liquid
 - d. temperature; refrigerant gas (vapor)

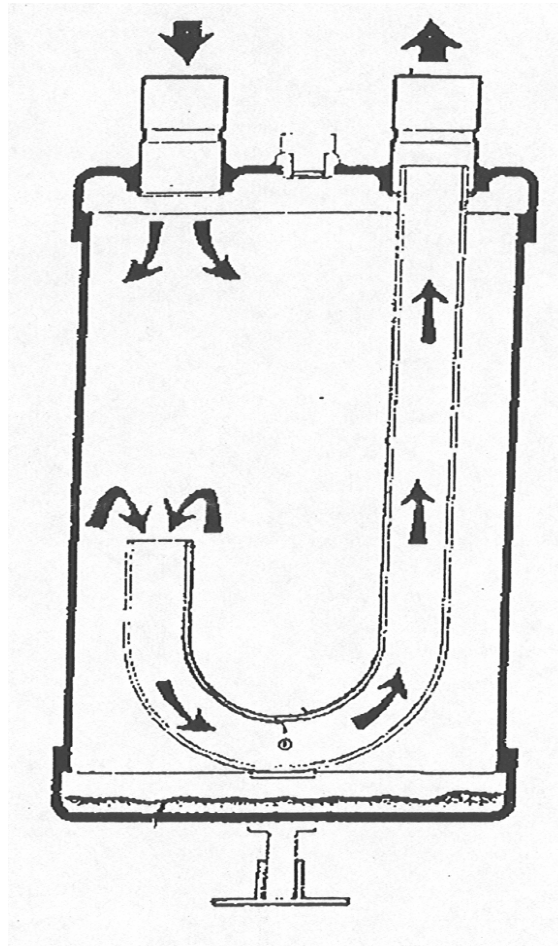
2. The term "superheat", as used with thermostatic expansion valves, refers to the difference in temperature between the vapor in the low side and in the
 - a. sensing bulb.
 - b. high side.
 - c. compressor.
 - d. evaporator.

KNOWLEDGE CATEGORY B -Refrigeration, Fluid Flow and Heat Transfer Theory

3. When a technician is using carbon dioxide (CO₂) or nitrogen to pressure test a hermetic system, if a test pressure is not specified on the name plate, what is the maximum pressure that never should be exceeded:
 - a. 150 psi
 - b. 160 psi
 - c. 170 psi
 - d. 180 psi

4. The illustration shown below is an example of what refrigeration component?

- a. Condensor.
- b. Evaporator.
- c. Accumulator.
- d. Expansion tank.



KNOWLEDGE CATEGORY C - Filters and Charcoal Absorbers

5. What is the purpose of a filter-drier in a commercial refrigeration unit?
 - a. To dry and clean the refrigerant only.
 - b. To dry and clean the lubricating oil only.
 - c. To remove dirt particles from the system.
 - d. To dry and clean the refrigerant and lubricating oil.

6. A suction line filter-drier on a low temperature refrigeration unit using R-12 or R-500 refrigerant should be replaced if the pressure drop exceeds what amount?
 - a. 2 psi
 - b. 3 psi.
 - c. 6 psi.
 - d. 9 psi.

KNOWLEDGE CATEGORY D - Electrical Theory, Instruments and Tools

7. A hermetic capacitor-start-capacitor-run electric motor uses how many capacitors in the start winding?
 - a. 1
 - b. 2
 - c. 3
 - d. 4

8. An electrical device called a ground fault protector or circuit interrupter (GFCI) will open an electrical supply circuit if it detects a ground of what amount?
 - a. 2 milliamperes (.002 amps)
 - b. 3 milliamperes (.003 amps)
 - c. 4 milliamperes (.004 amps)
 - d. 5 milliamperes (.005 amps)

KNOWLEDGE CATEGORY E - Operations and Safety

9. Why is it important not to come in direct contact with the oil from burned-out motor compressor.
 - a. It may be too hot.
 - b. It may contain acid.
 - c. It may stain your clothing.
 - d. It may contain carbon and sludge.

10. Which of the following devices is not used to collect the oil and return it to the compressor in an industrial HVAC system.
 - a. Oil separator.
 - b. Oil strainer.
 - c. Oil lead regulator.
 - d. Oil reservoir.

HVAC Knowledge Test #2732 Answers to Sample Questions

The following are answers to the sample questions on the previous pages.

1. c
2. a
3. c
4. c
5. d
6. a
7. b
8. d
9. b
10. b

HVAC Performance Test #4707

Additional Study References

1. Brochure on Carrier Product Data, Flotronic Air-Cooled Reciprocating Liquid Chillers (Model 30GB-040-6), Form 30G-1PD, 30GB.
2. Brochure on Carrier Flotronic Liquid Chillers, Controls and Troubleshooting (Model 30GB-040-6), Form 30GB, GT-3T.
3. Brochure on Carrier Modular central Station Air-Handling Units, Installation, Start-Up and Service Instructions (Model 39LA1031AB1121-L), Form 39L-2S1
4. Brochure on Delta Flo Electric Duct Heaters and Remote Control Panels (Model EH-5N-346), Delta Flow Manufacturing Co. Inc., June 1990 -1992-3M.

