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ABSTRACT

The two courses of study described and outlined here are offered at Burr D. Coe Vocational and Technical High School in East Brunswick, New Jersey, for students wishing to prepare for a career in air conditioning and refrigeration. Section 1 deals with a 4-year high school course, Section 2 with a 1-year course for those who have completed high school or its equivalent. Each section includes a job description for the airconditioning and refrigeration mechanic, a course description and notes on length of course, entrance requirements, diploma, and equipment and facilities, with most of the section being devoted to a course outline which lists objectives, course content, and text and reference books for each unit. The shop practice outlines are set up in parallel columns to clarify the dual role of the teacher responsible for teaching both the tools of the trade and related trade information. Left columns list operations to be performed by the student while parallel right columns list related information required. The courses stress the basic jobs, operations, and skills needed in the servicing, repairing and installation, of air conditioning and refrigeration units. Related subject matter, consisting of mathematics, science, and drawing related to the air conditioning and refrigeration trade is an integral part of the course for high school students; for post high school students related subject matter requirements will depend upon the student's educational background. (HD)

MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL HIGH SCHOOLS

and

MIDDLESEX COUNTY ADULT TECHNICAL SCHOOLS

*****

AIR CONDITIONING AND REFRIGERATION

*****

Volume XXVI

1975 Edition of

COURSE OF STUDY OUTLINES

*****

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The Board of Education is very grateful to the following members of this committee for their assistance and interest in our program.

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TABLE OF CONTENTS

MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL HIGH SCHOOLS

Air Conditioning and Refrigeration

D.O.T. 637-281: 0101-014

Job Description

The work of the air-conditioning and refrigeration mechanic is varied since he installs, maintains, and repairs different types of equipment in many places and situations.

The equipment to be installed, repaired and maintained by this mechanic ranges from small wall units, either water or air cooled, to large central plant type systems.

He may work on commercial refrigeration fixtures used in super markets, hotels and restaurants, i.e., display cases, walk-in coolers and frozen food plants. Evaporators, compressors and motors installed in locker plants are also covered in this line of work.

His job may take the air-conditioning and refrigeration mechanic to private homes, stores, hotels, factories and restuarants. At times he may have to go to new construction sites to install the various motors, condensers and fans. Some of these mechanics, however, concentrate on the heating and cooling accessory units used in automobiles and buses.

In the installation of new air-conditioning or refrigeration equipment, the mechanic must be a good welder, solderer and pipe-fitter. He must be able to connect ducts, water and electric work. After completing his installation, the mechanic must check his work: often he uses a halide leak detector to check the lines for leaks; he may also use test bulbs and probes to check for continuity of an electric circuit and location of grounds.

The mechanic inspects and examines the various parts of the system to detect leaks and other faults. He must adjust compressors and motors as well as thermostatic controls to keep temperatures at a specified level.

The repair work of the air-conditioning and refrigeration mechanic commences with the diagnosis of the cause of the breakdown. In doing so he often disassembles brushes, valves, springs and connections to inspect their condition. After the trouble is located, the reassembly may include the installation of such things as new piping, packing, valves or the complete overhauling of a pump or a compressor, which will put the equipment into working order.

Many different tools are used by the air-conditioning and refrigeration mechanic ranging from simple hand tools like wrenches, pliers, hammers and screw drivers to such expensive equipment as electric drills, soldering torches, leak detectors and pressure gauges.

Course Description

The course stresses the basic jobs, operations, and skills needed in the servicing, repair and installation of air-conditioning and refrigeration units. The student will gain a thorough knowledge of the materials and equipment used by the air-conditioning and refrigeration mechanic. He will learn to use meters, measuring instruments, tools and equipment; learn to interpret sketches, schematics and diagrams and use shop manuals and other source materials.

Each student will have an opportunity to use hand tools of the air-conditioning and refrigeration trade and learn how to perform the operations of the trade, including the evaluation of the completed work.

The student will have shop experiences not only in the mastery of manipulative skills but also related information or technology. Under the direction of the shop instructor, the student will learn related information in order that he may have a complete understanding of why he performs the operations of the trade in certain ways.

The course will include related subjects consisting of mathematics, science and drawing related to the air-conditioning and refrigeration trade. Here emphasis will be placed on the mastery of fundamental concepts and principles as well as the ability to solve practical problems. Those related subjects will help to provide the foundation which makes the shop work meaningful and functional.

It is expected that the student will have sufficient knowledge of the trade to enable him to enter into satisfactory employment upon completion of the course.

Length of Course

The complete course provides for four (4) years of instruction. The first half-year is for orientation; 3-1/2 years are for specific trade training. A minimum of 180 days per school year is required, with three clock hours per day of shop instruction and three clock hours per day of academic and related instruction.

Entrance Requirements

Pupils who enter this course must have completed the eighth grade, have the ability to profit from the instruction and have an interest in the air-conditioning and refrigeration trade in terms of vocational goal upon completing high school.

Diploma

The student may earn a high school diploma provided he has been in the shop program for a minimum of two years and satisfactorily meets all of the other requirements for a high school diploma. Transfer credit will be allowed for appropriate work satisfactorily completed in other high schools.

Where Offered

Burr D. Coe Vocational & Technical High School
112 Rues Lane
East Brunswick, New Jersey 08816

Equipment and Facilities Available

The schools in the Middlesex County Vocational system are well equipped with text and laboratory books that cover every phase of the trade.

As each lesson and skill is taught, it is practiced in a shop that contains all the necessary materials and equipment that are required to learn the trade thoroughly.

There is a continuous effort to secure the latest equipment available to keep up with the ever increasing progress in the air-conditioning and refrigeration field.

Program of Studies

AIR CONDITIONING AND REFRIGERATION

Time Allotments in 45 Minute Periods Per Week

Subject	Grade Level 9	10	11	12	Total Periods
Shop Practice	20	20	20	20	80
Academic Subjects					
English	5	5	5	5	20
American History			5	5	10
Health and Physical Education	4	4	4	4	16
Occupations	1				1
Related Subjects					
Science	5				5
Physics		4			4
Chemistry of Materials			3		3
Basic Mathematics	5				5
Algebra		4			4
Geometry			3		3
Applied Mathematics				3	3
Related Drawing		3		3	6
Totals	40	40	40	40	160

Course of Study Outline

The following outlines include the shop practice outlines for the high school courses in grades 9 through 12 and for the one year adult technical school course. The outlines for mathematics, science and drawing related to the air-conditioning and refrigeration trade are included in this volume. They cover the grades of the high school program and the adult technical school courses.

The shop practice outlines are set up in parallel columns in order to clarify the dual role of the shop teacher. He is responsible for teaching the skills of the trade and also the related trade information. "Operations" stress HOW things are done and "Related Trade Information" stresses WHY operations are performed as they are.

The teacher of related subjects is primarily concerned with the principles, fundamentals and basic skills of mathematics, science and drawing. He uses applications from the shop to motivate, stimulate and facilitate transfer of mathematics, science or drawing skills to the shop situation. There is a shift of emphasis as pupil progresses from ninth through twelfth grade. At tenth grade there is heavy emphasis on mastery of fundamentals; by the end of the twelfth grade there is heavy emphasis on applications.

Example: Using the compressor and condenser as a typical and commonly used application, the science teacher teaches the principles of change of state.

The shop teacher applies to real situations in his trade the principles of mathematics, science or drawing and teaches the student how and why of the application.

Example: The air-conditioning and refrigeration teacher not only teaches the boys how to repair the compressor but how the compressor operates.

There always will be a certain amount of overlapping and reinforcement between what the related subjects teacher covers and what the shop teacher covers.

The overall curriculum pattern; philosophy, teaching and evaluation methods, curriculum development procedures, requirements for the diploma, and supervisory policies are described in detail in Volume 1 of the complete set of course of study outlines.

The course of study outline is only the beginning of a complete course of study. The outline merely shows the content covered at the various grade levels. The complete course of study includes all of the various instructional manuals and materials which spell out what is to happen in the classroom or shop during the process of teaching and learning. They describe the learning experiences which are planned to give the outlines substance and meaning. These materials are available or are in preparation as supplements to the outlines. Many of them are referred to in the bibliographies given at the end of each outline.

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Safety

Objectives:

1. To learn how to work safely and how to prevent accidents.
2. To learn how to care for machinery and equipment so as to reduce the possibility of accidents.
3. To develop habits of good housekeeping, proper storage and handling of materials, and sanitation.
4. To become familiar with personal protective devices and the proper clothing to be worn for safety purposes.
5. To develop skills in the safe use of hand and portable tools.
6. To learn how to cooperate with others in the promotion and operation of a safety program in a school shop.

UNIT I ACCIDENTS AND ACCIDENT PREVENTION

A. Causes of Accidents
B. Prevention of Accidents
C. Accident Prevention and Safety Programs in Industry
D. Accident Prevention as a Responsibility of All
E. Importance of Proper Conduct and Attitude
F. Dangers in Horseplay and Carelessness

Unit II MAKING THE SHOP A SAFE PLACE TO WORK

A. Shop Layout
B. Painting
C. Lighting
D. Ventilation
E. Floors
F. Fire Prevention and Drills
G. Sanitation and Personal Hygiene

UNIT III MACHINE GUARDING

A. Purpose of Guards
B. Types of Guards
C. Use of Guards
D. Care and Maintenance of Guards

UNIT IV MAINTAINING A SAFE PLACE TO WORK

A. Housekeeping

1. Floors
2. Stairs
3. Loose objects
4. Materials
5. Rags and Waste
6. Lockers and cabinets

B. Storage of Tools
C. Storage of Materials and Supplies
D. Shop Cleanliness
E. Dust, Fumes and Gases
F. Electrical Hazards
G. Soldering and Welding Hazards

UNIT V PERSONAL PROTECTIVE DEVICES

A. Eye Protection
B. Protective Clothing
C. Foot Protection
D. Respirators
E. Dollies

UNIT VI HAND AND PORTABLE TOOL SAFETY

A. Use of Correct Tools
B. Correct Use of Tools
C. Defective Tools
D. Hazards in Use of Specific Tools
E. Portable Electric Hand Tools

UNIT VII SHOP SAFETY PROGRAM

A. Shop Safety Organizations
B. Shop Rules and Regulations
C. Analysis of Shop Jobs for Safety Content
D. Job Safety Instruction

   1. Group
   2. Individual

E. Safety Meetings and Assemblies
F. Posters and Bulletin Boards
G. Films and Other Visual Aids
H. Safety Tests
I. Safety Contests
J. Shop Safety Surveys
K. Safety Pledge

UNIT VIII ACCIDENT INVESTIGATION AND REPORTING

A. First Aid
B. Accident Reports
C. Student Insurance
D. Protection of Teacher by "Safe Harmless Law"

UNIT IX SAFE PRACTICES IN REFRIGERATION SHOP
"Horseplay is Prohibited"

A. Do not operate any equipment until you are instructed in its use.
B. Do not use any tool until you have been instructed in its use.
C. Shop coveralls shall be worn in the shop.
D. Use good housekeeping methods.
E. Use waste rags to wipe oil from tools and hands.
F. Use proper tools for a specific job.
G. File burrs left on pipe from wrenches or vises.
H. Use goggles for all jobs that create eye hazards.
I. Do not ascend a ladder without someone holding the bottom.
J. Do not leave tools on the top of a ladder.
K. Be careful when working with open flames.

UNIT IX SAFE PRACTICES IN REFRIGERATION SHOP - (Cont'd)

L. Know the location of the fire extinguishers and learn how to use them.
M. When an alert or fire drill signal is given follow prescribed procedures.
N. Report defective tools and equipment to the instructor.
O. Observe all personal safety rules when lifting anything heavy.
P. Leather top shoes must be worn in the shop.
Q. Do not use the top rung of a ladder.
R. Inspect all ladders before using them.
S. Use proper size ladder for each job.
T. Keep floors, benches and machines free from scrap to prevent injury.
U. Do not clean or repair moving equipment.

UNIT X EYE PROTECTIVE DEVICES

A. Clear goggles are to be worn at all times when observing, aiding, or performing operations dealing with refrigerants.
B. Wear safety glasses when soldering or welding.
C. Safety goggles must be worn when grinding or chipping.
D. Wear goggles when striking a punch or chisel with a hammer. Steel chips can cause eye injury.

UNIT XI SAFE PRACTICES IN THE HANDLING OF REFRIGERANTS

A. Always wear goggles when observing, aiding or performing operations dealing with refrigerants.
B. Liquid refrigerant, if allowed to strike the eye, can cause blindness. If allowed to strike the body, can cause frostbite.
C. Always use gauges and scales to indicate weight and pressures within a cylinder.
D. If refrigerant is allowed to come in contact with an open flame or heated metal, a poisonous gas will be created. Inhalation of this gas can cause you to become violently ill.
E. Never fill a cylinder beyond its capacity. When the surrounding temperature rises, bursting can result.
F. Never use a torch to speed up emptying of cylinders. Fusible caps let go and dangerous conditions are created.

UNIT XI SAFE PRACTICES IN THE HANDLING OF REFRIGERANTS (Cont'd)

G. High pressure tanks should be securely fastened because if they fall, the valves break and they will be propelled like a rocket.
H. Refrigerant cylinders should never be heated to temperatures above 125°F.
I. Other rules recommended for the safe handling of refrigerant cylinders include

1. Open valves slowly
2. Replace outlet caps when finished
3. Never force connections
4. Do not tamper with safety devices
5. Do not alter cylinders
6. Do not drop, dent or abuse

J. Remember - Refrigerants can be dangerous. They should only be used and handled by a trained refrigeration serviceman.

UNIT XII SAFETY IN WORKING WITH ELECTRICAL CIRCUITS

A. Keep hands off all equipment unless assigned to work with it.
B. De-energize all circuits before making repairs.
C. Use lockout switches and danger signs when working on circuits.
D. Test a circuit before working on it.
E. Use fuse pullers for removing and replacing cartridge fuses.
F. Repair all circuit defects before replacing fuses.
G. Never leave untaped wires in junction boxes.
H. Ground all portable electrical equipment.
I. Make sure all equipment, tools and machinery have good wiring connections and a ground wire at all times.
J. Always use a three-pronged male plug on a 112/220 volt circuit. The U-prong is the ground.
K. Any frayed wire or strands should be replaced or repaired immediately.
L. Avoid entering areas that have wiring or power if you are perspiring or if any water is present.
M. Stay away from wet surfaces when using an electrical tool or appliance.

UNIT XIII SOLDERING SAFETY

A. Always set tank securely on the floor near a supporting wall.
B. Never set a tank in an aisle or work area. Someone may walk into it and cause tank to fall over.
C. Never pick up or attempt to touch a piece of tubing you have just finished soldering without using pliers.
D. Always be sure that both ends of the tubing being soldered are open. Any residue of gases can cause explosions.
E. Always use a flint lighter when lighting torch tips. Lighted matches have been thrown into combustible areas.
F. Always solder where protection against fire is evident by the use of asbestos or tin.
G. Keep a fire extinguisher handy on all soldering jobs.
H. Any burns received while soldering should be taken care of immediately by applying a crushed ice pack to the burnt area.

UNIT IVX SAFETY PRECAUTIONS FOR OXYACETYLENE WELDING

A. Setting up Precautions

1. Open slightly (crack) cylinder valves to free accumulated dust and dirt.
2. Connect regulators to cylinders, making sure the connecting nuts are secured tightly to prevent leaks.
3. Turn out the pressure adjusting screw of the regulators until it is loose to avoid pressures rupturing the diaphragms.
4. Always stand to one side of and away from the gauge face of the regulators when opening cylinder valves.
5. Never open the cylinder valves suddenly, as the rush of high pressure may injure the regulator mechanism.
6. When oxygen cylinders are in use, the cylinder should be <u>opened all the way</u> to prevent leaks.
7. When acetylene cylinders are in use, the cylinder valve <u>must not</u> be opened over <u>one-half turn</u> so it can be secured quickly.
8. Always leave the "T" wrench in place while the acetylene cylinder is in use so the cylinder can be secured quickly in an emergency.

9. Never interchange oxygen and acetylene hoses as it may create fires and explosion.
10. When damaged nuts or connections are found, they shall be removed from service.
11. When testing equipment for leaks, use soapy water ("Ivory" soap is recommended).

B. General Operating Precautions

1. Never allow oil or grease to come in contact with oxygen under pressure.
2. Never use oxygen as a substitute for compressed air.
3. Before starting to weld or braze make certain there is no material that flame or spark might ignite.
4. Always use the proper size tip and the proper gas pressure.
5. Always wear goggles when working with a lighted torch.
6. Be sure to keep a clear space between cylinders and work.
7. Never use matches for lighting torches.
8. Never use acetylene at pressures above 15 PSI.
9. Do not hang the torch and hose on regulators or cylinder valves.
10. Never release acetylene where it may cause a fire or explosion.
11. Do not experiment with regulators or torches and do not alter them in any way.
12. Never connect an oxygen regulator to a cylinder containing combustible gas.
13. Store extra cylinders away from conjested areas and excessive heat.
14. When welding near materials that will burn be ready to put out any fire promptly with fire extinguishers, water or sand.
15. When welding close to wooden construction protect it from direct heat.

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COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Practice

Exploratory Class

Objectives:

1. To enable the student to explore the job opportunities, working conditions, financial gains and security in the air-conditioning and refrigeration trades.
2. To provide the student with a background of knowledge and experience which will enable him to understand and appreciate some of the complexities of industrial life.
3. To assist the student to discover his capacities and desire for learning a skilled craft.
4. To provide the student with an opportunity to learn what is required to become an air-conditioning and refrigeration mechanic.
5. To teach certain basic skills that are of value regardless of the trade ultimately studied.
6. To develop a knowledge of related information.
7. To develop an appreciation and pride in craftmanship.
8. To develop through shop experience and technical instruction, the operations, skills and knowledge necessary for successful employment in the field of air-conditioning and refrigeration.
9. To learn and carry out safe trade practices.
10. To acquaint the student with the history of refrigeration.
11. To familiarize students with the basic refrigeration cycle, terminology, components and tubing in a refrigeration system.
12. To teach the proper use and care of tools, parts and equipment used on refrigeration systems.
13. To develop proper attitudes in the safe use of tools and equipment used on refrigeration systems.

UNIT I OVERVIEW OF THE AIR-CONDITIONING AND REFRIGERATION TRADE

A. History of the Refrigeration Trade

B. Jobs in the Refrigeration Trades

1. Refrigeration Mechanic - Domestic (637.281)
2. Refrigeration Mechanic - Commercial (637.281)
3. Air-Conditioning Mechanic - Domestic (637.281)
4. Air-Conditioning Mechanic - Commercial (637.281)
5. Refrigeratin-Machine Operator (919.782)
6. Refrigeration-Equipment Erector (637.281)
7. Refrigeration System Installer (827.381)
8. Refrigeration Unit Repairman (637.381)
9. Refrigerator Inspector (723.387)
10. Refrigerator Tester (827.387)
11. Refrigeration Foreman (950.132)
12. Refrigeration Engineer (007.081)
13. Refrigeration Mechanic Helper (637.887)
14. Automobile-Refrigeration Mechanic (620.281)
15. Air-Conditioning Mechanic Industrial (637.281)
16. Air-Conditioning Installer (827.884)
17. Air-Conditioning Unit Tester (827.381)
18. Air-Conditioning Assembler (706.884)
19. Aircraft Air-Conditioning-Truck Operator (912.782)
20. Air-Conditioning Engineer (007.081)

C. Guidance Implications

UNIT II SHORT ORIENTATION

A. Shop Rules and Procedures

B. Shop Vocabulary and Terminology

1. Hand tools
2. Materials
3. Equipment
4. Machines

C. Shop Clothing

D. Shop Safety

E. Shop Hygiene

UNIT III HOUSEKEEPING

A. Care of Hand Tools

B. Care of Power Tools

C. Care of Equipment

D. Care of Work Space

E. Care and Storage of Materials

F. Care of Tool Crib

G. Clean-up Duties

UNIT IV MATERIALS

Operations	Related Information
A. How to Select Proper Tools for the Job	1. What are the various types of hand tools.
1. Selecting proper hand tools. 2. Selecting proper electrical tools. 3. Selecting proper bench tools. 4. Location of all tools and equipment. 5. Use, purpose and description of hand tools. 6. Care and cleaning of hand tools.	1. Screw drivers, flat blade, assorted sizes. 2. Screw drivers, Phillips #1,#2. 3. Screw drivers, Offset. 4. Wrenches, socket: with attachments. 5. Wrenches, crescent. 6. Wrenches, box end. 7. Wrenches, pipe. 8. Wrenches, Allen. 9. Wrenches, torque. 10. Hammer, ball peen. 11. Hammer, claw. 12. Hammer, plastic. 13. Mallet, rawhide, rubber. 14. Pliers, diagonal cutting. 15. Pliers, long nose. 16. Shears, tinners. 17. Square, combination set. 18. Scribes, Awls, Drift pins. 19. Chisels. 20. Files: Coarse, smooth, bastard. 21. Hack saws, blades & teeth. 22. Tap and Die (small set)

UNIT IV MATERIALS (Cont'd)

Operations	Related Information (Cont'd)
	23. Calipers 24. Rulers (Scales) 25. Tubing cutters 26. Bending springs 27. Pinch off block 28. Tube benders 29. Flaring tools 30. Gauge, screw pitch
	2. Safety Precautions
B. How to Select the Proper Material for a Job	1. Types of Copper Tubing
1. Selecting proper type of tubing for a Freon system 2. Selecting material for an ammonia system 3. Selecting material for a water cooled system 4. Selecting material for an air cooled system	a. ACR - "K" - "L" - "M" b. Hard drawn tubing c. Soft drawn tubing (annealed)
	2. Sizes of Copper Tubing
	3. Types of Pipe
	a. Black pipe b. Galvanized pipe c. Cast iron pipe
	4. Sizes of Pipe
	5. Aluminum Tubing
	6. Safety Precautions

UNIT V MEASUREMENTS

Operations	Related Information
A. How to Take Measurements	1. What is meant by a fitting 2. Fitting Allowances 3. Types of Fittings
1. Taking end-to-end measurements 2. Taking end-to-center measurements 3. Taking end-to-back measurements 4. Taking center-to-center measurements 5. Taking back-to-back measurements	a. Flared fittings b. Copper-sweat fittings c. Compression joint fittings d. Flare to sweat fittings

UNIT VI CUTTING COPPER TUBING

Operations	Related Information
A. How to Prepare Copper Tubing 1. Unrolling tubing from master roll. 2. Handling tubing with precaution. 3. Selecting proper size and type of tubing before cutting.	1. Removing and Replacing Seals 2. Proper Method of Uncoiling Tubing from Roll 3. Effects on Tubing of Improper Unrolling 4. Effects of Selecting Improper Siz and Type 5. Safety Precautions
B. How to Use Cutting Tools 1. Using tubing cutter 2. Using hacksaw 3. Using tube reamer 4. Using a pinch-off block 5. Using tube cleaning brushes 6. Using a refacing tool 7. Using a file	1. Importance of Using Proper Tools 2. Types of Tube Cutters. 3. Types of hacksaws 4. Types of hacksaw blades 5. Types of Tubing Reamers 6. Types of Cleaning Brushes 7. Types of Refacing Tools 8. Types of Files 9. Purpose of Tube Cutter 10. Purpose of Tube Reamer 11. Purpose of Cleaning Brushes 12. Purpose of Refacing Tools 13. Purpose of Filing 14. Safety Precautions
C. How to Cut Copper Tubing 1. Using a vise 2. Using a flare block 3. Using a reamer 4. Using a pinch-off tool	1. Techniques in Cutting Tubing with a Tubing Cutter 2. Techniques in Cutting with a Hacksaw 3. Technique in Reaming of Tubing 4. Purpose of Using a Pinch-off Tool 5. Safety Precautions

UNIT VII FLARING COPPER TUBING

Operations	Related Information
A. How to Flare Copper Tubing 1. Preparing copper tubing a. Square tubing b. Remove burrs c. Install proper flare fitting 2. Insert tubing into proper hole or flare block	1. Definition of Flaring 2. Kinds of Flare Fittings 3. Types of Flaring Tools 4. Parts of Flaring Tools 5. Purpose of Using Oil 6. Importance of Positioning Tubing in Flare Block 7. Causes of Flares Splitting and Cracking

UNIT VII FLARING COPPER TUBING (Cont'd)

Operations (cont'd)

3. Applying oil to spinner
4. Tighten spinner
5. Removing tubing
6. Checking angle of flare

Related Information (Cont'd)

8. Causes of Flares Being Too Large or Too Small
9. Safety Precautions

UNIT VIII SWAGING COPPER TUBING

Operations

A. How to Swage Copper Tubing

1. Preparing copper tubing
   a. Square ends of tubing
   b. Remove burrs
2. Insert tubing into proper hole on flare block
3. Using proper size swaging tool
4. Applying oil to swaging tool
5. Proper method of striking swaging tool
6. Checking tubing for proper fit

Related Information

1. Definition of Swaging
2. Purpose of a Swage Fitting
3. Importance of Positioning Tubing in Flare Block
4. Purpose of Using Oil
5. Causes of Improper Swage Fittings
6. Safety Precautions

UNIT IX BENDING COPPER TUBING

Operations

A. How to Bend Copper Tubing

1. Bending hard copper tubing
2. Bending soft copper tubing
3. Preparing and marking copper tubing
4. How to hold hands on bending springs
5. How to position tubing in tube bender
6. How to operate tube bender properly
7. Removing tubing from tube bender

Related Information

1. Types of Tube Benders
   a. Bending springs
   b. Mechanical benders
2. Measurements Involved
3. Meaning of Minimum and Maximum Radius
4. Reasons for Using Different Bending Tools
5. Principle of Stress
6. Definition of Buckle
7. Reasons for Heating Hard Tubing
8. Meaning of Normal Bends, Reverse Bends and 45° Bends
9. Bending Allowances
10. Safety Precautions

UNIT X TOOLS USED IN MAKING COPPER SWEAT JOINTS

Operations

A. How to Use The Tools in Making Copper Sweat Joints

1. Using tubing cutters
2. Using hacksaws
3. Using reamers
4. Using cleaning tools
5. Using heat-generating tools
6. Using torches

Related Information

1. Types of Tubing Cutters
2. Types of Hacksaws
3. Types of Cleaning Tools
4. Types of Reamers
5. Types of Heat-generating Tools
6. Types of Torches
7. Importance of Proper Tool Maintenance
8. Principle of heat-generating Tools
9. Principle of Tubing Cutter
10. Safety Precautions

UNIT XI COPPER SWEAT JOINTS

Operations

A. How to Make A Copper Sweat Joint

1. Preparing copper tubing
   a. Cleaning tubing
   b. Reaming tubing
   c. Applying flux
2. Preparing copper fittings
   a. Cleaning Fitting
   b. Applying flux
3. Applying heat
4. Applying solder
5. Wiping finished joint (removing excess solder)

Related Information

1. Kinds of Tools Used
2. Types of Fittings Used
3. Types of Cleaning Tools Used
   a. Sandpaper
   b. Emery paper
   c. Steel wool
4. Types of Flux
5. Purpose of Flux
6. Types of Solders
7. Composition of Solders
8. Types of Heat
9. Meaning of Wiping
   Reason for removing excess solder
10. Safety Precautions
    a. Burns
    b. Hot solder
    c. Cooling tubing

B. How to Make a Sweat Joint Using theBrazing Method

1. Setting up brazing outfit
2. Selecting proper tip
3. Heating metals
4. Completing job

1. What is meant by brazing
2. Principle of Brazing
3. Composition of Silver Solder
4. Types of Flux
5. Safety Precautions

UNIT XI COPPER SWEAT JOINTS (cont'd)

Operations	Related Information
C. How to Set-up a Brazing Outfit 1. Setting-up tanks 2. Installing regulator on tank 3. Connecting hoses 4. Connecting torch 5. Selecting tips	1. Construction of Acetylene Tank 2. What is meant by Single-stage Pressure 3. Principle of Heat 4. Safety Precautions
D. How to Prepare a Soldering Iron 1. Heating soldering iron 2. Cleaning soldering iron 3. Shaping soldering iron 4. Tinning soldering iron	1. Types of soldering irons a. Copper iron b. Electric iron c. Soldering gun 2. Types of Points or Tips 3. Purpose of Cleaning Iron 4 Heat effects on soldering a. Warm iron b. Hot iron 5. Differences in methods of Heating 6. Definition of Tinning and Shaping 7. Purpose of Flux 8. Types of Flux 9. Types of Solder 10. Safety Precautions
E. How to Solder with a Soldering Iron 1. Preparing metal to be soldered 2. Soldering brass 3. Soldering copper 4. Soldering galvanized iron	1. Types of Flux to be Used 2. Purpose of Flux 3. Kinds of Cleaning Materials 4. Importance of Proper Heat 5. Types of Solder to be Used 6. Differences in Methods of Heating different Metals 7. Principles Involved in Soldering 8. Safety Precautions

UNIT XII PRINCIPLES OF REFRIGERATION THEORY

Operations	Related Information
A. How the Application of Refrigeration Has Aided Mankind 1. History of Refrigeration 2. Progress of Refrigeration 3. Refrigeration in Industry	1. Use of snow and Ice in Early Civilization 2. Manufacture of Ice by Natural Refrigeration 3. Shipping of Ice by Clipper Ship 4. Modern-day Usage of Refrigeration

UNIT XII PRINCIPLES OF REFRIGERATION THEORY (cont'd)

Operations (cont'd)	Related Information (cont'd)
4. Refrigeration in manufacturing 5. Refrigeration in construction 6. Refrigeration in medicine 7. Refrigeration for comfort 8. Refrigeration in food preserving and processing	5. Using it for Preservation of Drugs and Medicine 6. Using it to Obtain Clean Air and Constant Temperatures
B. How to Become Familiar with the Basic Refrigeration Cycle	1. Evaporation 2. Condensation 3. Compression 4. Heat transmission
C. How to Become Familiar with Basic Refrigeration Terms	1. Definitions a. Heat b. Cold c. Refrigeration d. Mechanical refrigeration
D. How to Identify the Refrigeration Components	1. Evaporator 2. Condenser 3. Compressor 4. Metering device
E. How Refrigeration Systems Vary 1. Domestic Refrigeration and air-conditioning 2. Commercial Refrigeration and Air-Conditioning 3. Industrial Refrigeration and Air-Conditioning 4. Automotive Air-Conditioning 5. Refrigeration a. Absorption b. Evaporative	1. Types of domestic refrigerators and air-conditioners 2. Types of commercial refrigerators and air-conditioners 3. Types of industrial refrigeration and air-conditioners 4. Types of automobile air-conditioners 5. Uses of various types of refrigeration systems

COURSE OF STUDY OUTLINE

Air-Conditioning and Refrigeration Shop

9th Grade Exploratory Class

Typical Shop Jobs

A. Determine tubing sizes

B. Recognition of types of tubing

C. Measuring tubing lengths

D. Measuring tubing diameters

E. Cutting tubing, using different types of tube cutters

F. Cutting tubing using hacksaw

G. Flaring tubing of different sizes using compression type flare block

H. Flaring tubing of different sizes using a double flare type flare block

I. Swaging copper tubing of different sizes

J. Bending tubing of different sizes with a bending spring

K. Bending tubing of different sizes with a mechanical bending tool

L. Bending tubing of different sizes with a gear type tube bender

M. Using inner and outer types of reamers

N. Cleaning tubing

O. Assemble all of the pieces of cut, flared, swaged and bent tubing

P. Solder together all of the assembled pieces of tubing

Q. Pressure test the finished project

R. Disassemble a compressor or refrigerating unit, using the proper hand tools

S. Reassemble a compressor using proper hand tools

T. Work with an electric powered tool

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9th Grade Exploratory Class

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COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Practice

Grade 9

Objectives:

1. To review the principles and practices taught in the exploratory class.
2. To review and put to use the safety rules taught in the exploratory class.
3. To develop an understanding of heat quantity measurements.
4. To learn the use of heat intensity measuring devices.
5. To develop skills in measuring heat intensity and calculating heating quantity.
6. To develop an understanding of the pressures within a refrigeration system.
7. To acquire a knowledge of the instruments which are used in the measurements of pressures in a refrigeration system.
8. To teach the use and care of the gauges and instruments involved in reading pressures.
9. To train students in the use of equipment used in leak detection.
10. To teach students the basic refrigeration fittings and assembly devices used in a refrigeration system.
11. To instruct students on proper use of test manifold, gauges and compressor service valves.
12. To teach the functions of the component parts of a refrigeration system.
13. To increase the manipulative skills in the use of hand tools and equipment.
14. To develop greater skills in soldering procedures.

UNIT I REFRIGERATION FITTINGS

Operations	Related Information
A. How to Install Copper Tubing in a Refrigeration System 1. Planning job 2. Selecting size of tubing 3. Selecting type of fitting 4. Selecting size of fitting 5. Installing a flare type fitting 6. Installing a sweat type fitting 7. Installing a compressor type fitting	1. Type of tubing to be used a. Hard drawn b. Soft (annealed) drawn 2. Types of fitting a. Flare fitting b. Sweat fitting c. Compression fitting 3. Purpose of each type of fitting 4. Types of threads used on flare fittings a. National Fine (N.F.) b. Society of Automotive Engineers (S.A.E.) c. Briggs taper pipe thread (N.P. 5. Protection of fittings 6. Thread lubricants and sealers used with fittings 7. Sizes of flare wrenches to be used. 8. Types of material from which fittings are made a. Copper b. Brass c. Steel d. Aluminum e. Plastic 9. Safety Precautions

UNIT II ASSEMBLY DEVICES

Operations	Related Information
A. How to Install an Evaporator Supporting Bracket 1. Planning job 2. Selecting type of metal to be assembled 3. Selecting type of fastening device to be used a. frequency of dismantling 4. Using gauges to measure threads	1. Methods of fastening a. Soldering b. Brazing c. Welding d. Crimping e. Riveting f. Bolting 2. Devices for fastening metal a. Nuts b. Bolts c. Plugs d. Set screws e. Cap screws f. Machine screws 3. Types of thread gauges 4. Purposes of thread gauges 5. Safety Precautions

UNIT II ASSEMBLY DEVICES (cont'd)

Operations	Related Information
B. How to Make External and Internal Threads 1. Securing die in die stock 2. Chamfering end of work 3. Setting adjusting screws 4. Holding die stock square with work 5. Using proper pressure 6. Reversing stock and die 7. Protecting finished surface 8. Repairing damaged internal and external threads	1. Sizes of drills 2. Sizes and types of taps a. Tapered tap b. Plug tap c. Bottoming tap 3. Techniques in cutting threads with a tap 4. Sizes and types of dies 5. Techniques in cutting threads with a die 6. Thread systems 7. Safety precautions

UNIT III REFRIGERATION SERVICE GAUGES AND TEST MANIFOLD

Operations	Related Information
A. How to Install a Test Manifold to an Open Type Refrigeration Unit to Observe Readings 1. Remove valve caps from service valves 2. Check service valves to determine whether the valve stems are backseated 3. Remove the 1/8" MP plugs from the gauge-ports 4. Install the half unions fittings (1/4 MF x 1/8 MP) into gauge ports 5. Connect flexible charging hose from compound gauge on manifold to Suction Service Valve (SSV) 6. Connect flexible charging hose from pressure gauge on manifold to Discharge Service Valves (DSV) 7. Plug the center charging line on manifold with 1/4 plug 8. Crack open the DSV and use pressure to purge air from the hose lines 9. Crack hose connection at SSV to purge air from hose	1. Types of gauges a. Pressure - High side b. Compound - Low side 2. Parts of a gauge a. Bourden tube b. Linkage c. Gear d. Gauge connection - 1/8 Male pipe thread e. Calibration spring 3. Operation of a gauge a. Internal pressure b. Atmospheric pressure 4. Dial markings and limitations a. Pressure - 0 - 500 b. Compound - 30"-0-200 5. Pressure and vacuum scales 6. Temperature and pressure relationship 7. Types of test manifolds 8. Parts of test manifold a. Compound gauge b. Pressure gauge c. Manifold d. Three charging lines or hoses e. Three flare plugs f. Two 1/4 MF x 1/8 MP half-unions

UNIT III REFRIGERATION SERVICE GAUGES AND TEST MANIFOLD (cont'd)

Operations	Related Information
10. Frontseat the valves on manifold 11. Crack open the SSV 12. Run unit and observe operating pressures on gauges	9. Compressor service valves a. Frontseat - to close b. Backseat - to open c. Crack to open slightly d. Types of service valves used 1. Two-way service valve 2. One-way service valve 3. Liquid line service valve e. Line service valves 1. Compression type 2. Solder type 3. Piercing copper tubing 4. Hermetic charging kits
B. How to Remove Gauges from an Open Type Refrigeration System 1. Backseat DSV at compressor 2. Open valves (backseat) on manifold 3. Operate unit until both gauges are a slightly above zero - 0 4. Close suction service valve (SSV) 5. Shut service valves on test manifold 6. Remove charging lines from compressor 7. Remove fittings from compressor 8. Replace 1/8" plugs 9. Replace valve caps	10. Safety Precautions a. Always wear goggles b. Use 2 wrenches when working c. Keep lines sealed and clean
C. How to evacuate an open type refrigeration unit 1. Install test manifold to unit 2. Connect the high vacuum pump to the center gauge manifold opening 3. Open Suction Service Valve (SSV) at compressor 4. Open compound gauge service valve on manifold 5. Discharge to atmosphere any refrigerant left in system through center gauge port	1. Types of Vacuum pumps 2. Principles of vacuums 3. Why is it necessary to evacuate a system? 4. When is it required to evacuate a system? 5. Proper maintenance of vacuum pump 6. Operation of vacuum pump 7. Methods of evacuating a refrigeration system a. Triple evacuation method b. Low micron-range evacuation c. Vacuum required for moisture removal (dehydration) 8. Safety Precautions

Operations	Related Information
6. Open Discharge Service Valve (DSV) at compressor 7. Open pressure gauge service valve on manifold 8. Open valve at vacuum pump 9. Operate vacuum pump and draw highest vacuum possible 10. Close Discharge Service Valve (DSV) 11. Close Suction Service Valve (SSV) 12. Close valve at vacuum pump 13. Shut off operating switch at vacuum pump 14. Disconnect vacuum pump 15. Leave test manifold connected to unit for next operation	
D. How to Add Refrigerant to an Open Type Unit 1. Install test manifold to unit 2. Connect the refrigerant cylinder to the center gauge manifold opening 3. Open valve on cylinder to purge air from charging line 4. Open Suction Service Valve 5. Test for leaks 6. Turn unit on 7. Add refrigerant to system until desired suction pressure is obtained 8. Shut off valve at cylinder 9. Close manifold valves 10. Close SSV 11. Remove test manifold	1. Types of refrigerants a. R-12 b. R-22 c. R-502 2. Types and sizes of refrigerant cylinders 3. Purging of lines 4. Methods of leak detection 5. Safety precautions a. Always wear goggles b. Avoid getting liquid refrigerant on skin c. Avoid inhalation of vapor or gas
E. How to Check for Leaks in an Open Type Unit 1. Install test manifold to unit 2. Leak test unit using all methods of leak detection	1. Types of leak detectors a. Halide leak detector b. Electronic leak detector c. Soap bubbles d. Vacuum pumps

UNIT III REFRIGERATION SERVICE GAUGES AND TEST MANIFOLD (cont'd)

Operations	Related Information
3. Repair leak 4. Remove test manifold	e. Use of senses 1. Sight 2. Touch 3. Sound 2. Using pressures to locate leaks 3. Safety Precautions a. Never use oxygen, air or any inflamable gas for testing a system

UNIT IV COMPRESSOR SERVICE VALVES

Operations	Related Information
A. How to take apart and identify parts of a compressor service valve 1. Remove a discharge service valve from compressor 2. Take valve apart 3. Clean all parts 4. Identify and indicate the function of each part 5. Reassemble the parts in proper order B. Same procedure with all types of service valves	1. Names and types of compressor service valves a. Discharge Service Valve b. Suction Service Valve c. Liquid Line Valve 2. Other types of valves a. Two-way Service Valve b. One-way Service Valve 3. Operation of service valves a. Front-seat b. Back-seat c. Crack 4. Service valves attached to refrigerant tubing a. Piercing type valve b. Compression type c. Solder type 5. When to use this type of service valve 6. When to use a hermetic service valve kit 7. Parts and functions of each part of service valve 8. Safety precautions

UNIT V REFRIGERATION SYSTEM COMPONENTS

Operations	Related Information
A. How to work with the refrigeration system components and to know their functions	1. Compressors a. Types 1. Open type 2. Sealed or hermetic

UNIT V REFRIGERATION SYSTEM COMPONENTS (cont'd)

Operations	Related Information
1. Compressor 2. Condensers 3. Evaporators 4. Refrigerant controllers 5. Receivers	b. Classification 1. Reciprocating 2. Rotary 3. Centrifugal 2. Condensers a. Types 1. Air cooled 2. Water cooled 3. Evaporative 3. Evaporators a. Types 1. Dry or direct-expansion 2. Flooded type 4. Refrigerant Controllers a. Types 1. Low-pressure float 2. High-pressure float 3. Automatic expansion valve 4. Thermostatic expansion valve 5. Capillary tubing 5. Safety precautions

UNIT VI MATTER AND MOLECULES

Operations	Related Information
A. How to relate matter to Refrigeration 1. The states of matter 2. The changes of state of matter	1. Mass and weight 2. States of matter a. Solid b. Liquid c. Gas 3. Size and shape 4. Change of state 1. Vaporization 2. Condensation 3. Liquification 4. Solidification 5. Sublimation 5. Molecular Movement

UNIT VII HEAT MEASUREMENT

Operations	Related Information
A. How to use the basic principles of temperature measurements in refrigeration 1. Heat intensity 2. Heat quantity 3. Heat energy	1. Measurement of heat intensity a. Unit of intensity 1. Fahrenheit scale 2. Centigrade scale 3. Rankine scale 4. Kelvin scale b. Measuring devices 1. Thermometers 2. Thermocouples c. Fixed references 1. Boiling point 2. Freezing point 3. Absolute zero d. Temperature conversion 2. Measurement of heat quantity a. British thermal unit (BTU) b. Heat equation used in calculations 3. Energy Conversion Units a. Heat energy b. Mechanical energy c. Electrical energy

UNIT VIII HEAT AND PRESSURE IN REFRIGERATION

Operations	Related Information
A. How to use the knowledge of heat and pressures in the refrigeration trade 1. Temperature-pressure relationship 2. Heat in refrigeration 3. Heat in air-conditioning	1. Types of heat a. Specific heat 1. Various metals 2. Variance due to change of state 3. Temperature of mixtures b. Total heat 1. Sensible heat a. Sensible heat equation 2. Latent heat a. Latent heat of fusion b. Latent heat of vaporization 3. Super heat 2. Types of pressures a. Meaning of pressure b. Pressures as applied to refrigeration c. Atmospheric pressure

Operations	Related Information
	3. Measurement of pressures a. Absolute scale b. Standard (gauge) scale c. Compound scale d. Mercury scale e. Small pressures

COURSE OF STUDY OUTLINE

AIR CONDITIONING AND REFRIGERATION SHOP

9th Grade Class

Typical Shop Jobs

A. Identify various types of flare fittings.

B. Identify various types of sweat and pressure fittings.

C. Identify various types of assembly devices.

D. Drill holes in metal plate with different size drills.

E. Make threads in holes with a tap.

F. Measure different lengths of rods.

G. Make threads on rods using a die set.

H. Measure, cut, flare, bend new pieces of copper tubing.

I. Solder together all of the assembled pieces of tubing using different types of solder.

J. Pressure test the finished project, using refrigerant.

K. Install a test gauge manifold on a refrigeration system.

L. Evacuate system using a vacuum pump.

M. Recharge system with refrigerant and adjust charge.

N. Use various types of thermometers and record data.

O. Study the various types of gauges and the construction of service valves installed in an open type system.

P. Use various types of leak detecting devices.

Q. Repair a leak using epoxy compounds.

R. Repair a hole leak in copper tubing using solder.

S. Install a service valve on a hermetic system.

T. Overhaul and identify parts on an open type compressor.

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COURSE OF STUDY OUTLINE

Air-Conditioning and Refrigeration

Shop Practice

Grade 10

Objectives:

1. To continue to use all of the previous safety rules taught.
2. To develop an understanding of the basic concepts of the compression cycle used in refrigeration systems.
3. To teach the principles of subcooling and super heat.
4. To train with the methods of heat transfer which apply to the refrigerant lines.
5. To teach the students on becoming familiar with the heat transfer capacities of some common metals.
6. To train in the tear-down and identification of compressor parts and their purpose.
7. To teach with the different types of components necessary to build a model refrigeration unit.
8. To teach the students the correct methods in the construction, evacuation, charging and testing their lab unit.
9. To train students how to dissemble an open type reciprocating compressor and become acquainted with the construction of it.
10. To teach the construction and function of various types of metering devices.
11. To develop skills in testing efficiency of compressors and correct operation of expansion valves.
12. To develop skill in attaching adapter valves to those hermetic and semi-hermetic units not equipped with service valves.
13. To develop an understanding that some common refrigeration circuit problems might indicate one or more of several causes of trouble and to become proficient in some procedures through repetition.
14. To develop an appreciation of safety precautions in the complete evacuation of a refrigeration system, once it has been exposed to the atmosphere.
15. To develop an appreciation for safety requirements when they are working with refrigeration equipment.

UNIT I COMPRESSORS

Operations

A. How to overhaul an open type compressor
   1. Select proper tools
   2. Remove compressor from unit
   3. Remove fly wheel and key, record data
   4. Remove cylinder head and record data. Mark head.
   5. Remove valve plate and record data. Mark plate.
   6. Remove the crank case, base and seal plate. Record data.
   7. Remove one connecting rod, mark rod, and record data.
   8. Make new gasket
   9. Assemble the compressor
   10. Tighten and torque all assembly devices
   11. Put oil into compressor and remount into unit
   12. Test the compressor for vacuum and pressure.

B. How to overhaul a rotary type compressor
   1. Select proper tools
   2. Dismantle the compressor
   3. Mark all parts
   4. Record all data from parts
   5. Reassemble the compressor
   6. Add oil
   7. Test compressor

C. How to service a hermetic compressor without any service valves
   1. Select proper tools
   2. Select proper material
   3. Install the service valve kit if unit has a valve adapter
   4. Install clamp piercing valve, if unit has no adapter valve
   5. Install gauge manifold
   6. Test the compressor for vacuum and pressures

Related Information

1. Types of compressors
   A. Reciprocating
      1. Accessible or open type
         a. Cylinder construction
         b. Cylinder arrangement
         c. Piston construction
         d. Connecting rod construction
         e. Crankshaft construction
         f. Valve construction
         g. Crankshaft seals
         h. Gaskets
         i. Compressor drives
      2. Hermetic or sealed type
         a. Construction differences
         b. Compressor cooling
         c. Mufflers
   B. Rotating
      1. Accessible or open type
         a. Stationary blade
         b. Rotary blade
         c. Cylinder construction
         d. Rotar construction
         e. Blade construction
         f. Crankshaft construction
         g. Crankshaft seals
         h. Valve construction
      2. Hermetic or sealed type
         a. Construction differences
         b. Operation
   C. Centrifugal
      1. Single stage
      2. Multi-stage
      3. Rotor (impeller)
      4. Stators
         a. Marking of compressor parts
         b. Using a torque wrench
         c. Making a gasket
         d. Using a wheel puller
         e. Hermetic valve kit
         f. Uses of piercing valves
         g. Fan belts types and sizes
         h. Types of flywheels
         i. Alignment of fly wheels and pulleys
         j. Safety precautions

UNIT I COMPRESSORS (cont'd)

Operations	Related Information
7. Remove gauges 8. Remove valve kit or piercing valve adapter	

UNIT II SOLDERING WITH OXYACETYLENE TORCH

Operations	Related Information
A. How to Silver Solder or Braze Refrigerant Lines 1. Select proper material 2. Select proper tools 3. Preparing tubing a. Cleaning tubing b. Reaming tubing c. Applying flux 4. Preparing fitting a. Cleaning fitting b. Applying flux 5. Applying heat 6. Applying solder 7. Wiping finished joint 8. Testing finished joint	1. Kinds of tools used 2. Types of tubing or material used 3. Types of solder used 4. Composition of solder 5. Flow temperature of solder 6. Types of flux used 7. Purpose of flux 8. Purpose and use of basic equipment a. Gas supply-oxygen and acetylene b. Gas regulators c. Color code of hoses d. Sizes of tanks 9. Torch construction 10. Types of tips 11. The oxyacetylene flame a. Parts b. Temperature c. Colors 12. Techniques of good brazing a. Selection of tip b. Adjustment of torch c. Angle of torch d. Movement of the filler rod and torch 13. Safety precautions

UNIT III CALIBRATION OF GAUGES

Operations	Related Information
A. How to Calibrate Pressure Gauges by Means of the Dead Weight Tester 1. Fill weight tester with mineral oil (SAE 20) 2. Connect gauge to be tested 3. Make adjustments on dead weight tester 4. Record all data 5. Adjust gauge scales if required 6. Remove calibrated gauge	1. Types of gauge calibrators 2. Construction of dead weight tester 3. Purpose of dead weight tester 4. Construction of gauges 5. Types of gauges a. Compound b. Pressure 6. Safety precautions

Operations	Related Information
A. How to Install or Replace an Evaporator Coil 1. Determine size and type of evaporator coil 2. Select proper tools 3. Select proper type and size of evaporator coil 4. Install gauge manifold, check for leaks 5. Purge refrigerant from system 6. Cut refrigerant lines at the evaporator coil a. Cut lines at a place that will permit brazing or soldering of the lines to new unit b. Allow enough tubing to permit flaring, if brazing or soldering cannot be done 7. Remove the evaporator by unbolting it from the cabinet 8. Install new evaporator 9. Clean the tubing. Braze or solder the connections, using the correct procedure 10. Install a new drier-filter 11. Evacuate, using vacuum pump 12. Charge to a 60 pound gas pressure 13. Test for leaks	1. Types of evaporators A. Bare tube B. Plate type C. Finned D. Air cooling coils 1. Dry coil a. Natural convection b. Forced circulation c. Frosting d. Non-frosting 2. Flooded E. Liquid cooling coils 1. Submerged 2. Shell and tube 3. Tube within a tube
B. How to Install or Replace a Condenser 1. Select proper tools for job 2. Determine size and type of condenser coil 3. Install gauge manifold, check for leaks 4. Purge refrigerant from system 5. Cut refrigerant lines at the condenser coil 6. Remove the condenser coil from cabinet, by unbolting or removing screws 7. Install new condenser coil in proper location 8. Clean the tubing. Braze or solder all refrigerant lines together, using proper procedure	1. Types of condensers A. Air cooled 1. Bare pipe 2. Finned 3. Natural convection 4. Forced circulation B. Water cooled 1. Double pipe 2. Double tube 3. Shell and coil 4. Shell and tube C. Evaporative condensers D. Water towers E. Complete condensing units 1. Compressor 2. Condenser 3. Receiver

UNIT IV COMPONENT PARTS OF REFRIGERATION SYSTEM
(cont'd)

Operations	Related Information
9. Install a new filter-drier 10. Evacuate system using vacuum pump 11. Charge to a 60 pound gas pressure 12. Test for leaks at all connections	F. Knowledge of non-condensable gases G. Safety precautions
C. How to Install, Replace or Repair Capillary Tube 1. Select proper tools for job 2. Remove the capillary tube a. Remove the refrigerant by safely purging(use good ventilation) b. Balance unit pressures, clean the capillary tube connections c. Remove the capillary tube and plug the openings if possible 3. Repair the capillary tube by using a capillary tube cleaner. If necessary replace with new one 4. Install the capillary tube filter-drier into unit a. Clean and dry all connections b. Evacuate system, using vacuum pump c. Charge with refrigerant 5. Test for leaks 6. Charge system with correct amount of refrigerant	1. Types of capillary tubes 2. Purpose of capillary tube 3. Length and inside diameter of capillary tube 4. Capillary tube used as a heat exchanger 5. Capillary tube systems have very critical charge of refrigerant 6. Measuring charge put into a system 7. Drier and filter requirements 8. Other types of metering devices a. High side float b. Low side float c. Manual control valves d. Automatic expansion valves e. Thermostatic expansion valves 9. Trouble shooting system 10. Safety precaution
D. How to Remove, Test, Install and Adjust a Thermostatic Expansion Valve 1. Select proper tools for job 2. Select proper thermostatic expansion valve 3. Install the gauge manifold	1. Types of thermostatic expansion valves a. Diaphragm type-adjustable b. Diaphragm type non-adjustable c. Internal equalizer d. External equalizer e. Bellows type-adjustable

UNIT IV COMPONENT PARTS OF REFRIGERATION SYSTEM
(cont'd)

Operations	Related Information
4. Adjust the service valves-remove refrigerant 5. Remove the thermostatic expansion valve 6. Clean the thermostatic expansion valve, including the screen 7. Test the valve 8. Adjust to a 10°F superheat 9. Reinstall thermostatic expansion valve into system 10. Purge and evacuate system using vacuum pump 11. Build up pressure in system 12. Test for leaks.	2. Automatic valves a. Application b. Selection 3. Thermostatic valves a. Application b. Charge in sensing bulk 1. Gas charged 2. Liquid charged 3. Cross charged c. Selection 4. Trouble shooting system 5. Safety precautions
E. How to Install a Filter-drier 1. Select proper tools for job 2. Select proper filter-drier 3. Install the gauge manifold 4. Adjust the service valve 5. Remove refrigerant from system - ventilate wheel-wear goggles 6. Remove old drier and record the size of the fittings 7. Install the new drier carefully 8. Test for leaks, using a refrigerant cylinder, create a 70 to 90 psig head pressure 9. Charge the system	1. Types of filter-driers a. Liquid line filters b. Suction line filters 2. Desiccants a. Silica gel b. Activated alumina c. "Drierite" 3. Properties of desiccants 4. Function of filter-driers 5. Drier size 6. Drier location 7. Drier cores a. Replaceable b. Non-replaceable 8. Moisture indicators 9. Safety precautions

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration Shop

10th Grade Class

Typical Shop Jobs

A. Construct a refrigeration trainer unit.

B. Install a condensing unit, consisting of compressor, condenser and receiver onto training unit.

C. Install an evaporator on training unit.

D. Install a metering device on training unit.

E. Overhaul an open type compressor.

F. Overhaul a rotary type compressor.

G. Service a hermetic type compressor without any service valves.

H. Soldering with an oxy-acetylene torch.

I. Calibrate gauges with a dead-weight tester.

J. Install a filter-drier on training unit.

K. Use a charging cylinder to measure refrigerant going into training unit.

L. Use a 1 pound can of refrigerant to charge a unit.

M. Replace a capillary tube.

N. Remove, test, and adjust a thermostatic expansion valve.

O. Locate trouble in an ice maker.

P. Dismantle, test, assemble and operate an evaporator fan motor.

Q. Remove and install door hardware and gasket.

R. Add oil to a hermetic system.

S. Locate trouble in a hermetic system.

T. Remove and install a hermetic system.

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10th Grade Class

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Delmar Publishers, Inc., Albany, New York 1966

Handbook of Automatic Refrigerant Controls, Alco Valve Company, 865 Kingland Avenue, St. Louis, Missouri 63141

Copelamatic Condensing Unit and Motor Compressor Service Manual
Copeland Refrigeration Corp., Sidney, Ohio

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Practice

Grade 11

Objectives:

1. To develop personal characteristics and work habits necessary for success in the refrigeration trade.
2. To develop the various skills required to install electrical materials.
3. To learn the fundamentals of basic wiring circuits.
4. To learn the application of theory in analyzing circuit problems.
5. To learn to use meters and testing equipment.
6. To learn the various types of wiring methods.
7. To teach the operation and function of the electrical components normally present in a refrigeration system.
8. To install the electrical components normally found in a refrigeration system.
9. To learn how to trouble shoot the electrical components in a refrigeration system.
10. To teach the fundamentals of motors and their characteristics.
11. To develop knowledge and skill in the measurement and in the connection of wires in electricity.
12. To acquire skills in the soldering of wire.
13. To learn the skills and knowledge necessary for a refrigeration service man to be proficient in the installation of all types of motors, controls and refrigerating and air conditioning systems.
14. To develop an appreciation for safety around electrical equipment.
15. To develop proper attitudes of safety precautions in the handling and usage of any electrical wiring, tools, electric meters and motors.

UNIT I MATERIALS

Operations	Related Information
A. How to identify and prepare wire for use 1. Removing insulation 2. Cleaning wire 3. Handling wire with precaution a. knicking b. cutting strands	1. Types of wire a. Solid b. Stranded c. Copper d. Aluminum 2. Types of insulation a. Thermoplastic b. Rubber c. Asbestos d. Varnish cambric
B. How to splice solid wire 1. Pig tail splicing 2. Tap splicing 3. Western Union splicing 4. Mechanical splicing	1. Purpose of splicing a. Reason for branching wire b. Reason for tapping wire c. Reason for line extentions 2. Importance of using proper tools a. Work knife b. Side cutters c. Diagonals d. Wire strippers 3. Safety precautions
C. How to splice stranded wire 1. Tap splicing 2. Western Union splicing 3. Pigture splicing 4. Extension cord splicing	1. Importance of using proper tools a. Work knife b. Diagonals c. Side cutters d. Wire strippers
D. How to solder splices 1. Preparing soldering iron a. Cleaning iron b. Heating iron c. Tinning iron 2. Heating splice 3. Applying flux 4. Applying solder 5. Removing excess solder 6. Test all wiring for continuity with test light 7. Test all terminals, connections and wiring with ohm meter.	1. Types of soldering irons a. Copper iron b. Electric iron c. Soldering gun d. Propane torch 2. Purpose of cleaning iron 3. Heat effects on soldering a. Warm iron b. Hot iron 4. Purpose of flux 5. Types of solders to use a. Acid core b. Rosin core 6. Reason for removing excess solder 7. Safety precautions a. Overheated iron b. Burns c. Hot solder d. Cooling iron

Operations	Related Information
E. How to insulate splices 1. Using rubber tape 2. Using friction tape 3. Using plastic tape 4. Using wire connectors	1. Purpose of insulation 2. Effects of poor insulation a. Grounds b. Shorts 3. Types of wire connectors
F. How to install armored cable 1. Handling cable 2. Cutting cable 3. Connecting cable to outlet 4. Stapling cable	1. Code requirements 2. Sizes of wire 3. Kinds of cable a. Two-wire b. Three-wire c. Four-wire d. Solid wire e. Stranded wire 4. Types of connectors a. Set screws b. Split c. Duplex d. Angle 5. Types of outlets a. Octagon b. Square box c. Wall case d. Utility box 6. Safety precautions
G. How to install non-metallic cable (Romex) 1. Handling cable 2. Cutting cable 3. Connecting cable to outlet 4. Stapling cable 5. Grounding cable	1. Sizes of cable 2. Code requirements 3. Kinds of cable a. Two-wire b. Three-wire c. Four-wire d. Solid e. Stranded 4. Purpose of a ground wire 5. Types of connectors a. Set screw b. Split c. Duplex d. Angle

UNIT I MATERIALS (cont'd)

Operations	Related Information
	6. Types of outlets a. Octagon b. Square box c. Wall case d. Utility box 7. Safety precautions
H. How to install receptacles, fixtures and controls in a refrigeration system 1. Installing a single pole switch a. Selecting switch b. Wiring switch c. Testing switch 2. Installing double-pole switch 3. Installing three-way switch 4. Installing outlet receptacle 5. Installing fixtures 6. Installing controls a. Selecting control b. Wiring control c. Testing control	1. Types of switches a. Rotary or selector 1. pushbutton 2. stem type b. Push button c. Toggle 2. Principle of the switch 3. Ratings of switches 4. Types of controls 5. Principle of controls 6. Types and sizes of wire required 7. Sizes and fuses required 8. Safety precautions in fusing 9. Safety precautions in wiring

UNIT II CONDUCTORS AND INSULATORS

Operations	Related Information
A. How to use wire gauges and measure sizes of wires, and see how lengths effect conductance 1. Cut several pieces of wire and measure with wire gauge 2. Splice wire 3. Solder wire 4. Connect wire with tape 5. Connect wire with wire-nut 6. Cut wire to several different lengths and measure resistances	1. Conductors have low resistance to current flow a. Copper b. Iron c. Aluminum d. Silver e. Brass f. Zinc 2. Sizes of conductors a. Effect of type b. Resistance c. Load

UNIT II CONDUCTORS AND INSULATORS (cont'd)

Operations	Related Information
	3. Semi-conductors have low resistance to current flow in one direction. High resistance to current flow in other direction. a. Germanium b. Silicon c. Copper oxide d. Copper sulphide e. Lead sulphide 4. Insulators have high resistance to current flow a. Dry air b. Glass c. Rubber d. Asbestos e. Bakelite f. Mica

UNIT III CIRCUIT APPLICATION AND TESTING INSTRUMENTS

Operations	Related Information
A. How to test and analyze effects of voltage, current and resistance changes in electrical circuits 1. Using ohmmeters 2. Using voltmeters 3. Using ammeters 4. Using multi-testers 5. Using watt meters 6. Using voltage testers 7. Using an amprobe	1. Types of current a. Alternating current b. Direct current c. Pulsating 2. Ways of generating voltage a. Mechanical b. Chemical c. Thermal d. Light 3. Ohm's Law and Kirchhoff's Laws 4. Precautions in connecting meters 5. Applying formulas to prove meter readings 6. Determine power factors.
B. How to detect circuit troubles 1. Testing 2. Wiring	1. Principle involved in the short circuit 2. Principle involved in the open circuit 3. Principle involved in grounding

UNIT III CIRCUIT APPLICATION AND TESTING INSTRUMENTS (cont'd)

Operations	Related Information
C. How to work with series circuits 1. Source 2. Load 3. Testing 4. Wiring	1. Definition of circuits a. Series b. Parallel c. Combination 2. Effects of voltage 3. Effects of current 4. Effects of resistance
D. How to work with parallel circuits 1. Source 2. Load 3. Testing 4. Wiring	1. Definition of circuits a. Series b. Parallel c. Combination 2. Effects of voltage 3. Effects of current 4. Effects of resistance
E. How to work with series and parallel circuits 1. Source 2. Load 3. Testing 4. Wiring	1. Definition of circuits a. Series b. Parallel c. Combination 2. Effects of voltage 3. Effects of current 4. Effects of resistance
F. How to measure electrical power and energy 1. Using voltmeter and ammeters 2. Using watt meters 3. Using watt-hour meters	1. Principle of transforming energy a. Generator b. Motor 2. Power formulas 3. Relationship between mechanical and electrical energy 4. Power ratings of equipment 5. Efficiency of operation
G. How to select circuit conductors 1. Measuring sizes 2. Measuring line power losses 3. Measuring line voltage drops 4. Fusing 5. Determining fuse protection	1. Kinds of A.W.G. number markings 2. Code requirements 3. Differences in current carrying capacities 4. Effects of overloading 5. Effects of heat 6. Effects of magnetic induction 7. Safety precautions

UNIT III CIRCUIT APPLICATION AND TESTING INSTRUMENTS (cont'd)

Operations	Related Information
H. How to produce magnetism with electricity and produce electricity with magnetism 1. Electron theory a. Displacement of electrons b. Flow of electrons 2. Use of electricity to create magnetism a. Show polarity using a bar magnet b. Create magnetic lines of force using various magnets and iron filings c. Make permanent magnets d. Make temporary magnets	1. Sources of energy a. Friction b. Magnetism c. Chemical action d. Pressure e. Heat action f. Light action g. Nuclear action 2. Charges a. Positive - Plus - North b. Negative - Minus - South c. Attraction of unlike charges d. Repulsion of like charges 3. Static electricity - electrons at rest 4. Current electricity - electrons in motion

UNIT IV SINGLE PHASE MOTORS

Operations	Related Information
A. How to install single-phase motors 1. Connecting motors 2. Testing motors 3. Trouble shooting	1. Theory of operation a. Phasing or start winding b. Starting torque 2. Construction and uses a. Hermetically sealed b. Open type 3. Types of single-phase motors a. Split phase b. Permanent split capacitors c. Capacitor start-induction run d. Capacitor start-capacitor run 4. Ratings of single phase motors 5. Code rules and regulations
B. How to install a split-phase motor 1. Connecting motor a. Voltage and amperage ratings 2. Testing motors	1. Theory of operation a. Rotor winding b. Stator winding 2. Parts and function of each part a. Rotor b. Stator

UNIT IV SINGLE PHASE MOTORS (cont'd)

Operations	Related Information
a. Excessive wear on shaft, bearings, other b. Freedom of rotation: shaft bearing c. Electrical test 1. Ground 2. Open winding 3. Short 4. Centrifugal switch 3. Trouble shooting motor 4. Reverse rotation of motor	c. End plates d. Centrifugal switch 3. Types of motor a. Two running windings with one starting winding b. Two running windings with two starting windings 4. Ratings of motor a. Single-speed b. Multiple speed 5. Reversing a split-phase motor a. Interchange of running winding leads b. Interchange of starting winding leads 6. Safety precautions
C. How to install a repulsion-induction start motor 1. Connecting motor a. Voltage and amperage rating 2. Testing motors a. Brushes b. Bearings c. End play d. Position of reversing switch e. Centrifugal throwout switch f. Armature 3. Trouble shooting motor a. Use of VOM in checking for starts, open circuits b. Use of tachometer in checking RPM's c. Use of growler in checking armature	1. Theory of operation a. High-starting torque using low starting current 2. Parts and function of each part a. Brush holders and brushes b. Bearings c. Short circuiting necklace and frame d. Governor spring e. Commutator f. Push rods g. Rotor 3. Types of repulsion-induction motors a. 110 volt b. 220 volt c. Reverse rotation 4. Ratings of motors 5. Code rules and regulations 6. Safety precautions
D. How to install a capacitor-start motor 1. Connecting motor a. Voltage and amperage rating 2. Testing motors a. Mechanical tests 1. Excessive wear on shaft, bearings	1. Theory of operation-designed for high starting torque, used on water pumps and compressors on commercial units a. Uses a capacitor in circuit b. Rotor winding c. Stator winding 1. Main 2. Starting

UNIT IV SINGLE PHASE MOTORS (cont'd)

Operations	Related Information
2. Freedom of rotation of shaft, bearing 3. Centrifugal switch 4. Lack of sufficient lubrication 5. Misalignment of parts 6. Excessive end play b. Electrical tests 1. Ground 2. Open winding 3. Short 4. Defective capacitor 3. Trouble shooting motor a. Test capacitor for capacitance valve b. Test stator windings and identify leads c. Check for overload, over voltage, under voltage	2. Parts and function of each part a. Capacitor b. Centrifugal switch c. Rotor d. Windings e. End plates 3. Types of motors a. Capacitor-start, induction-run b. Capacitor-start, capacitor-run 4. Rating of Motor a. Volts b. Amps c. Watts d. Speed e. Horse power or size 5. Safety precautions a. Always discharge a capacitor before testing
E. How to install a PSC motor. "P.S.C. means Permanent Split Capacitor" 1. Connecting motor 2. Testing motor 3. Trouble shooting	1. Theory of operation 2. Parts and function of each part 3. Types of motors 4. Rating of motor 5. Safety precautions

UNIT V POLYPHASE MOTOR

Operations	Related Information
A. How to identify and tag dual voltage motor leads 1. Locating leads with an ohmmeter 2. Using voltmeter 3. Using voltage tester 4. Connecting leads	1. Kinds of standard lead markings 2. Reason for tagging 3. Safety when making tests 4. Types of polyphase motors a. Three-phase b. Two-phase 5. Parts and function of each part
B. How to connect stato-windings 1. Counting the number of coils 2. Calculating coils per pole 3. Calculating coils per phase 4. Soldering leads 5. Applying test voltages 6. Checking speed	1. Types of windings 2. What the winding accomplishes 3. Effects of voltage 4. Why the number of phases affects the winding 5. Why the frequency affects the winding

UNIT V POLYPHASE MOTOR

Operations	Related Information
	6. Less common connections 7. Formulas for new windings 8. How to use schematic and master diagrams 9. Reasons for reconnecting
C. How to locate faults 1. Checking for overload 2. Measuring starting conditions 3. Testing for performance 4. Testing for grounds 5. Testing for short-circuits 6. Checking bearings 7. Reversed phase 8. Defective controller 9. Checking for worn or tight bearings	1. Operation of three phase motor 2. Standard ratings 3. Code rules and regulations 4. Why periodic maintenance is necessary 5. N.E.M.A. standards 6. Safety when making tests

UNIT VI TROUBLE SHOOTING MOTORS

Operations	Related Information
A. How to trouble shoot split-phase and capacitor start motors 1. Analyze problem 2. Locate cause of problem 3. Repair problem 4. Test motor	1. Types of problems a. Mechanical b. Electrical 2. Parts of motors defective 3. Tools required 4. Meters required
B. How to use meters	1. Types of meters 2. Operation of meters 3. Uses of meters 4. Handling meters
C. How to start a compressor D. How to check a capacitor E. How to trouble shoot a relay starter circuit F. How to make a complete electrical check on an air conditioner	

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COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Typical Shop Jobs

11th Grade Class

1. Identify various types and sizes of wire.
2. Measure, cut, prepare, then make various types of spliced connections.
3. Soldering and taping together the spliced connections.
4. Measure, cut and prepare for installation armored cable.
5. Measure, cut and prepare for installation non-metallic cable.
6. Install a receptacle, a junction box, a single pole switch and motor controlling device on training unit.
7. Learn how to connect a series circuit on electrical training board.
8. Learn how to connect a parallel circuit on electrical training board.
9. Learn how to connect equipment in combination circuits, using the electrical training board.
10. Learn how to connect, read and use a voltmeter, an ampmeter and a multi-meter.
11. Learn the construction and uses of an ohmmeter and a wattmeter.
12. Remove old wire and replace with new wire on a domestic type refrigerator.
13. Check out, repair and install a thermal type, current type and a potential type relay in a domestic refrigeration system.
14. Study methods of making and testing electrical connections.
15. Learn how to trace out electrical circuits in a refrigeration system.
16. Learn the various types of fan motors, and study the construction and operation of the open type refrigeration motor.

Typical Shop Jobs (cont'd)

11th Grade Class

17. Dismantle, test, reassemble and operate the various types of motors, using all types of meters to obtain readings.
18. Remove, repair and replace a relay and a motor overload.
19. Learn how to trouble shoot a hermetic (sealed) system.
20. Remove, inspect, reinstall and readjust a temperature and pressure motor control.
21. Learn about, inspect, test and install various types of fuses.
22. Learn about, inspect, test and install various types of capacitors.
23. Learn how to free a stuck motor compressor.
24. Learn about, then install into a refrigeration system, a defrost timer clock.
25. Learn about, then install into a refrigeration system, a selenoid valve, a magnetic starter and a safety switch.
26. Learn about several electrical testing and measuring instruments and safe steps in trouble-shooting, repairing and maintaining different types of equipment used in air-conditioning and refrigeration.

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Air-Conditioning and Refrigeration

11th Grade Shop

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Basic Comfort Heating Principles, Chalmer T. Dempster, Curriculum Laboratory, Vocational-Technical Education Department, Rutgers - The State University 1968

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Practice

Grade 12

Objectives:

1. To continue to develop personal characteristics and work habits necessary for success in the air conditioning and refrigeration field.
2. To learn the basic fundamentals of all types of air conditioning.
3. To develop a knowledge and understanding of proper methods in the selection of cooling coils and condensing units.
4. To learn the cooling cycle of heat pumps and room air conditioners.
5. To teach what calculations are necessary for a thorough check of total heat gain.
6. To teach the methods of formulating air and humidity calculations and to acquire a knowledge of the various properties of air with the aid of a psychrometric chart.
7. To teach what is heat loss and heat gain, and how they can be controlled.
8. To learn how to install a room air conditioner unit.
9. To learn how to install a central air conditioning unit.
10. To learn how to check, calibrate and replace air conditioning operating components.
11. To learn how to use Air Velocity measuring equipment.
12. To learn the construction and operation of the sling psychrometer.
13. To learn how to locate troubles in an air conditioner.
14. To develop an appreciation for safety around air conditioning equipment and material.
15. To develop proper attitudes of safety precautions in the handling and usage of any tools, equipment, meter and other materials used in air conditioning.

16. To learn the principles, fundamentals and operation of automobile air conditioning.

17. To repair and install automobile air conditioners, and any of their components.

18. To learn all of the safety habits required when working with automotive air conditioning.

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Typical Shop Jobs

12 Grade Class

UNIT I INTRODUCTION

Operations	Related Information
A. How to understand what air-conditioning is 1. Introduction to air-conditioning a. Introduction b. Body comfort 1. Temperature 2. Humidity 3. Air Movement c. Air cycle 1. Cooling and heating coil a. Winter operation (Heating Coil) b. Summer operation (Cooling coil) c. Cooling and removing moisture d. Refrigeration cycle 1. Cooling coil (Evaporator) 2. Compressor 3. Condenser 4. Expansion valve e. Heat pumps	1. Types of air-conditioning systems a. Heating-Cooling systems 1. Gas burning units 2. Oil burning units b. Cooling systems 1. Air cooled units 2. Water cooled units 3. Forced-circulation air units c. Humidifiers 1. Cold water humidifiers 2. Chemical humidifiers d. Cooling towers e. Self-contained units f. Portable units
B. To understand how psychrometrics is involved with air-conditioning 1. How to use a sling psychrometer a. Construction and operation of the sling psychrometer b. Construction and operation of a wall type humidity indicator 2. How to determine the wet and dry bulb temperature of a room using a sling psychrometer	1. Types of psychrometrics charts a. Dry bulb lines b. Wet bulb lines c. Dew-point lines d. Relative humidity lines 2. Properties of air 3. Air and humidity calculations a. Heating b. Cooling c. Heating and humidification d. Cooling and humidification e. Cooling and dehumidification 4. Safety precautions a. Care in handling sling psychrometers b. Wetting wick on wet bulb thermometer with room temperature water

UNIT II AIR CONDITIONING UNITS

Operations	Related Information
A. How to install a window type comfort cooler 1. Installation of base a. Install unit base on window sill b. Locate center of window, place the base in place c. Level the base and mark screw holes d. Drill the screw marks e. Install the rubber gasket on the window sill f. Fasten the mounting base to window sill g. Adjust the leveling bolts and lock 2. Installation of unit a. Prepare comfort cooler for operation b. Loosen the hold down bolts c. Inspect the unit for condition d. Mount the unit on the base e. Fasten the unit to the base f. Install the spacers between each side of the unit and the window frame g. Install the rubber gasket along the top of the unit h. Install the gasket between the inner double hung window and the outer one i. Operate the unit j. Check damper adjustments for unit noise	1. Selection of proper size unit for the application a. Heat transfer 1. Heat loss 2. Infiltration 3. Heat gain 4. Ventilation air b. Air and Humidity calculations c. Sensible heat calculations d. Latent heat calculations e. Solar heat calculations f. Moisture calculations 2. Types of window air conditioners a. Casement windows b. Double hung windows c. Wall units d. Console or portable units e. Heat pump conversions f. Voltage characteristics g. Current characteristics 3. Selection of proper tools for installation a. Screw drivers b. Socket set c. Twist drill d. Electric drill e. Sprit level f. 10" straight tin snips g. Sealing compound 4. Safety in installation
B. How to locate trouble in a window type comfort cooler 1. Test the external circuit first a. Power in b. Thermostat c. Motor compressor relay and overload protector d. Filters e. Air flow	1. Mechanical troubles a. Test for air in system b. Test for dirt and moisture in system c. Purging a system with air, moisture or dirt in it d. Checking and repairing a hermetic unit e. Checking and repairing an open type unit

Operations	Related Information
2. Install gauges a. Operate unit b. Test for leaks 3. If the unit has no or little charge in it 4. If unit is frosting or sweating down the suction line-unit may be overcharged 5. If the screen or drier is clogged with dirt or moisture 6. Repair what is necessary 7. Remove refrigerant where necessary 8. Replace any worn part 9. Reassemble the unit 10. Evacuate system with vacuum pump, recharge system with proper charge 11. Test for leaks	f. Detecting and correcting a unit with leak g. Detecting and correcting a unit with noise problems h. Loose blower or fans i. Repairing and replacing a capillary tube j. Installing a filter-drier in system k. Remove, test, install and adjust a thermostat expansion valve l. Remove, test, install and adjust a water valve m. Checking fan motor CFM n. Checking fan motor for proper rotation o. Safety requirements
C. How to locate trouble in a self-contained comfort cooler 1. Test the external circuit first a. Power in b. Thermostat c. Motor compressor, relay and overload protectors d. Filters and air flow e. Water connections and water valves if water cooled f. Air supply if air cooled g. Condensate drain 2. Install gauges a. Operate unit b. Check pressures c. Test for leaks 3. Replace Thermostatic Expansion Valve, if one is used 4. If unit is frosting on coil a. TE valve is leaking b. Thermostat is not shutting off c. TEV bulb is loose	2. Electrical and wiring defects a. Check motor wiring for sufficient voltage capacity b. Detect and correct improper control wiring in a self-contained unit c. Knowing how to use electrical testing equipment d. Knowing about many types of motors used in air conditioning units e. Reading schematic drawings f. Repairing and adjusting fan controls g. Repair and adjust a heating and cooling thermostat h. Measuring volts and resistance using a voltmeter and ammeter i. Using a wattmeter to calculate unit power factor j. Checking relay circuits operation for component part failure k. Checking the operation of a thermostat

UNIT II AIR CONDITIONING UNITS (cont'd)

Operations

5. If system is undercharged
   a. TE valve screen is partially clogged with moisture
   b. Dirt is in screen
6. Repair what is necessary
7. Remove refrigerant where necessary
8. Replace any worn parts
9. Reassemble the unit
10. Evacuate system with vacuum pump.

Related Information

l. Checking an electronic thermostat against a conventional thermostat
m. Knowing how to calibrate a thermostat
n. Safety requirements

UNIT III SERVICE PROBLEM

Operations

A. Installations
   1. How to understand the codes applicable to air-conditioning
   2. How to acquire an understanding of good installing practices
   3. How to develop an attitude for good workmanship in the installation of air conditioning and the copper tubing going to the units

Related Information

1. State and local codes
   a. Safety codes for commercial and industrial air conditioning
   b. Purpose of codes
   c. Applications
2. Self-contained units
   a. Conventional or open type units
   b. Hermetic units
   c. Compressor ventilation requirements
      1. Air-cooled
      2. Water-cooled
      3. Manufacturer's recommendations
3. Remote condensing units
   a. Accessible location
   b. Noise factors
   c. Protection for unit
4. Cooling coils
   a. Air circulation and distribution
   b. Careful mounting
   c. Supports and hangers
5. Tubing
   a. Type used
   b. Support for tubing
   c. Accessories-Valve, drier sight glass

UNIT III SERVICE PROBLEM (cont'd)

Operations	Related Information
	d. Vibration absorbers and loops e. Condensate drains f. Slope of vapor lines
B. Initial Start-up 1. How to take proper steps that are required for the initial start up of a commercial air conditioning unit 2. How to develop the attitude of the occurance of possible future troubles in an air conditioning system if a satisfactory operational check is not completed on initial start-up	1. Evacuation a. On all new systems, except those that are precharged b. On all systems that have been open c. The use and operation of a vacuum pump d. Extent and importance of vacuum 2. Charging a. Critical charge systems-self contained 1. Manufacturers recommendations 2. Portable charging equipment b. Non-critical charge systems 1. Liquid charging 2. Vapor charging-sight glass 3. Operational check a. Remove shipping bolts and/or blocks b. Oil all motor bearings c. Check operation pressures 1. Suction 2. Discharge 3. Compressor oil d. Pressure controls e. Electrical check out 1. Volts 2. Amperage 3. Correct fuse size f. Adjust super heat g. Adjust motor control h. Adjust evaporator and condensor fans
C. Diagnosing Service Problems 1. How to diagnose the numerous problems that may arise when servicing an air conditioning system	1. Entire unit will not run a. No power at compressor 1. Check disconnect switch 2. Check fuse or circuit breaker 3. Check source of main power 4. Broken wire or loose connection

NIT III SERVICE PROBLEM (cont'd)

Operations	Related Information
2. How to look for any signs that something is wrong in an air-conditioning system 3. Diagnosing must be made to find the source of the trouble 4. How to develop an attitude that even in trouble-shooting service problems, safety precautions should be taken for the protection of equipment and personnel	b. Power at compressor 1. Compressor motor 2. Overload 3. Control wiring and control 2. Unit runs - no cooling a. Loss of refrigerant b. Inefficient compressor c. Restriction in tubing or accessories 3. Unit runs - insufficient cooling a. Shortage of refrigerant b. Inefficient compressor c. Obstruction in lines 1. Refrigerant control 2. Drier d. Control setting 4. Unit noisy a. Vibration in lines b. Surplus of oil c. Defective compressor valves d. Refrigerant overcharge e. High head pressure f. Loose components or compressor mounts 5. Unit short cycles a. Partial obstruction in lines b. Leaky power element c. Improper adjustment of refrigerant control device

IIT IV LOAD CALCULATIONS

Operations	Related Information
Heat gain calculations 1. How to understand the many miscellaneous heat gains that must be taken into consideration when selecting a proper air-conditioning unit. 2. How to develop a knowledge and understanding of room heat	1. Sources of heat a. Transmission-sensible heat 1. Conduction a. Walls, ceiling and floors b. Time of year and day c. Types of insulation d. Thickness of insulation e. External area f. Temperature difference 2. Radiation a. Type of glass b. Other transparent materials

Operations

3. How to make a complete survey of the area to be conditioned
   a. Obtain all the room dimensions
   b. Note the windows, walls, ceiling and floor construction
4. How to make a floor plan of area to be conditioned
5. How to become familiar with the different types of construction in residences and commercial buildings and the importance of this information for calculation and installation purposes
   a. Heat Loss Calculation
      1. How to become familiar with the various methods of heat movement or transfer through building materials
      2. How to know the difference between heat gain and heat loss in a building
      3. How to control the heat gain and heat loss in a building
      4. How, with the use of calculations, it will help in the selection of cooling coils and condensing units
      5. How to know and understand the various instruments and their use in taking measurements for correct air distribution
         a. Pitot tube
         b. U-tube Manometer
         c. Inclined manometer or draft gauge
         d. Velocities
            1. Velometer
            2. Anemometer
            3. Anemotherm air meter

Related Information

      3. Solar
         a. Time of year and day
         b. Exposure
         c. Latitude
         d. Shading
      4. Product
         a. Sensible heat
         b. Latent heat
         c. Respiration
      5. Appliances, gas or electric
      6. Lights
         a. Fluorescent
         b. Incandescent
      7. Machines
      8. Motors
      9. People-Degree of activity
      10. Air Changes
         a. Inside volume
         b. Type of usage
      11. Duct work
         a. Supply-air heat gain
         b. Return-air duct gain
      12. Ventilation air
         a. CFM per person
         b. CFM per square of floor space
   b. Transmission-Latent heat
      1. Internal
         a. Appliances
         b. People-degree of activity
      2. External-ventilation air
         a. Desired resulting conditions
         b. Air mixture proportions
         c. Sensible heat ratio
2. Insulation
   a. Purpose or need
      1. Prevention against heat transfer
      2. Humidity control
   b. Thermal insulation
   c. Water vapor barriers
   d. Economic considerations
   e. Building insulation
3. Building construction
   a. Exterior walls
   b. Interior walls
   c. Floors and ceilings
   d. Insulation

UNIT V AUTOMOTIVE AIR CONDITIONING

Operations

A. How to install belts, align adjust the tension and operate an automobile air conditioning unit
   1. Engine off, check belt tension, loosen adjustment bolts, remove belt
   2. Inspect and measure belt
   3. Replace or install new belt
   4. Carefully check the alignment of the pulleys and their shafts, realign if necessary
   5. Apply lever pressure on the compressor or idler pulley until the correct belt tension is obtained
   6. Tighten the adjustment bolts
   7. Recheck the belt tension
   8. Install the fan guard and run engine. Recycle several times
   9. Recheck the belt tension
   10. Shut down the system

3. How to install a compressor on an automobile air conditioning system
   1. Check the compressor oil level
   2. Check the magnetic clutch operation
   3. Install the compressor
      a. Install belt
      b. Check belt for correct alignment and tension
   4. Install the refrigerant lines
   5. Install gauge manifold
   6. Check for leaks at 25 psig then at 70 psig
   7. Evacuate the system
   8. Operate the system
      a. Charge system
      b. Check sight glass
      c. Test for leaks

Related Information

1. Introduction to automotive air conditioning
   A. Automotive air-conditioning principles
   B. Development of auto. air-conditioning
   C. Operating conditions
      1. Idling engine
      2. Fresh air ducts closed
      3. Operating engine
      4. Heat load
   D. Performance of system
   E. Types of systems
      1. Pressure operated low side pressure regulators
      2. Pressure operated bypass
      3. Solenoid operated bypass
      4. Electro-magnetic clutch
         a. Revolving magnetic coil
         b. Stationary magnetic coil
   F. Types of compressors
   G. Compressor seals
   H. Belts
      1. Belt tensions-new and used belts
   I. Condenser (air-cooled)
   J. Receiver-Drier
   K. Refrigerant lines
      1. Flared fittings
      2. O ring fittings
      3. Hose clamp fittings
   L. Evaporators
   M. Expansion Valves
   N. Suction pressure control valves
      1. Suction throttling valves (STV)
      2. Evaporator pressure regulator (EPR)
      3. Pressure operated altitude Valve (POA)
   O. Service valves

Operations

9. Check operating pressures and the evaporator outlet temperature
10. Remove the gauge manifold and shut down system

C. How to install an evaporator on an automotive air conditioning system
1. Select proper cooling coil
2. Mount the thermostatic expansion valve on the evaporator and install the suction and liquid lines
3. Mount the evaporator, level nnect the refrigerant lines and drain hose
4. Complete the electrical wiring and connect the gauge manifold
5. Test for leaks
6. Evacuate the system, using the deep vacuum procedure
7. Operate the system, charge it, check its operation
8. Seal the tubing opening in the firewall, install the evaporator housing

D. Locate and repair trouble in an automobile air-conditioning system
1. Install the gauge manifold
2. Check the compressor belt tightness
3. Check for leaks
4. Check oil charge
5. Operate the system
6. Check the operating pressures, temperatures and quantity of refrigerant
7. Replace, repair or adjust the system until normal operation is obtained

E. How to install, test and adjust the clutch

F. How to install, test and adjust the thermostatic expansion valve (TEV)
1. Install gauge manifold

Related Information

2. Air distribution
A. Duct system
1. Fresh air inlet
2. Return air inlet
3. Evaporator housing
4. Drain pan and drain connections
5. Plenum chamber
6. Conditioned air outlets
7. Dampers
B. Fans
1. Radial flow
2. Squirrel cage
3. Centrifugal
C. Fan motors
1. 6 volts
2. 12 volts
D. Insulation
1. Types
2. Areas

3. Special tools and equipment for working on automotive air-conditioning
A. Gauge manifold test unit
B. Two-way valve
C. Three way tee
D. 90° gauge line adapter
E. Puller and puller pilot
F. Multi-opener (4 cans)
G. Non-magnetic clutch shims
H. #21 Snap Ring pliers
I. #26 Snap Ring pliers
J. Compressor holding fixture
K. Compressing fixture
L. Clutch hub holding tool
M. Hub and drive plate assembly remover and installer
N. Seal and seal seat removers - pulley bearing remover
O. Shaft seal protector
P. Pressure test connector

4. Functions of component parts
A. The drive belt
1. Used to drive the compressor
2. Belt adjustment
3. Belt tension gauge

Operations

2. Discharge the system
3. Remove the thermostatic expansion valve from the liquid line and evaporator. Remove the thermal bulb. Disconnect the equalizer tube.
4. Test the thermostatic expansion valve
5. Reinstall the TEV. Tighten all fittings. Connect the equalizer tube and mount the thermal bulb securely
6. Replace all insulation
7. Install the gauge manifold, pressurize to 25 psig, test for leaks, pressurize to 70 psig and test for leaks
8. Charge to clear sight glass-test for leaks
9. Operate the system
10. Check operating pressures, refrigerant quantity and evaporator outlet air temperatures
11. Check the sweat back on the suction line
12. Remove the gauge manifold

Related Information

B. The electro-magnetic clutch
   1. Operates the compressor
   2. Operates by the principle of magnetic attraction
C. The compressor
   1. Purpose of compressor is to pump refrigerant into the condenser
D. The condenser
   1. Purpose of condenser is to dissipate heat
E. The receiver-drier
   1. The receiver-drier has four functions
      a. Storage
      b. Moisture absorption
      c. Filtration
      d. Trouble diagnosis
F. The thermostatic expansion valve (TEV)
   1. The TEV meters liquid refrigerant as needed to the evaporator
G. The evaporator
   1. The purpose of the evaporator core is to cool and remove moisture from the air flowing through it

5. The electrical control system
   A. The thermostatic switch
   B. Blower motor
   C. Control switch
   D. Rheostat
   E. Clutch field

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Kaberlein, Joseph J., Air Conditioning Metal Layout, The Bruce Publishing Company, Milwaukee, Wisconsin

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Safety Precautions

Grade 12

1. Do not operate water-cooled unit without water running.
2. Check fans for proper rotation.
3. Exercise care in handling psychrometers.
4. Do not put air filters in backwards.
5. Exercise care when climbing ladders.
6. Check all voltages before making any connections.
7. Shut off power when working on high voltage lines.
*8. Wear goggles when handling refrigerant or breaking any tubing connections.
9. Check voltages when working with low voltage controls.
10. Avoid using improper tools.
11. Handle high voltage and sensitive equipment with care.
12. When removing a valve from a system, one should always use two wrenches to avoid twisting the valve or the tubing.
13. Use a fan guard whenever possible.
14. Carefully avoid touching the pulleys, fans, or belts with one's hand, tools or clothing.
15. Use gauge and service manifold when servicing automobile air conditioning systems.
16. Be sure that the gauge manifold lines do not come in contact with the fan or pulleys.
17. When it is necessary to make air conditioning adjustments with the engine running, be sure the transmission control lever is in "Park" position.
18. Protect the hands with a wiping cloth when removing the radiator pressure cap or refrigerant service caps to prevent burning or freezing one's hand.

19. Never apply heat from a torch to a sealed refrigeration system. Refrigerant will expand rapidly and could cause an explosion.

20. Refrigerant 12 in the presence of an open flame produces phosgene gas. It is very toxic. Never breathe it.

*NOTE: FOR YOUR OWN PROTECTION, WEAR GOGGLES WHEN OPENING ANY REFRIGERANT SYSTEM.

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Typical Shop Jobs

Grade 12

1. Residential Air Conditioning

   A. Window Units

      1. Install a window unit
      2. Install a service-valve attachment
      3. Check the refrigerant charge on a hermetic unit
      4. Trouble shoot a capillary-tube system on a hermetic unit
      5. Test and/or replace a capacitor and relay on a hermetic unit
      6. Make electrical checks of motors on air-conditioning units containing different types of electric motors
      7. Check CFM and clean condenser and evaporator
      8. Check, calibrate, or replace thermostatic control
      9. Replace a hermetic compressor
      10. Make a complete electrical check on a complete window unit

   B. Central Systems

      1. Measure relative humidity, dew point and air velocity
      2. Install a self contained comfort cooler
      3. Install a residential central cooling system
      4. Install a heat pump
      5. Calculate the comfort cooling heat load for an assigned area
      6. Locate trouble in a self contained comfort cooler system
      7. Locate trouble in a residential central comfort cooling system
      8. Locate trouble in a water chiller
      9. Trouble shoot the electrical circuits of a central system
      10. Install, test and operate a 24 volt and a 120 volt heating control system

2. Automotive Air Conditioning

   A. Basic Service Procedures

      1. Evacuating an automobile air-conditioning system
      2. Install refrigerant lines and test system for leaks
      3. Charging the system
      4. Putting a partial charge into system
      5. Remove and reinstall the compressor and return it to service
      6. Checking and adding oil to the compressor

2. Automotive Air Conditioning (cont'd)

A. Basic Service Procedures (cont'd)

7. Checking and isolating the compressor
8. Replace a compressor seal
9. Install belts, align, adjust the tension on a system
10. Connect a one pound can of R-12 to the gauge manifold, system off and system running

B. Advanced Service Procedures

1. Install an evaporator on an automobile air con ing system
2. Remove, service and reinstall a condenser
3. Install an "Add On" Automobile air cooling sys
4. Locate and remove trouble from an "Add-On" system
5. Remove, test, reinstall and adjust a thermostatic expansion valve
6. Dismantle, replace worn parts, assemble and test compressor
7. Locate and repair trouble in an automobile air conditioning system
8. Test system pressures with engine off, and engine running
9. Check out an automotive air conditioning system's electrical circuit
10. Test the operation of an evaporator pressure regulator valve

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Typical Jobs

Grade 12

Air Conditioning - Cooling

Air Conditioning - Heating

Air Conditioning - Automotive

A. Theory - Air Conditioning - Cooling and Heating

1. Review of general safety rules
2. Introduction to air conditioning
3. Humidity
4. Psychrometric chart
5. Comfort cooling systems
6. Window comfort coolers
7. Self-contained comfort coolers
8. Residential central systems
9. Heat loads
10. Load calculations
11. Air distribution
12. Air cleaning, dehumidifiers
13. Heat pump systems
14. Electrical circuits
15. Electrical controls

B. Shop Jobs

1. Installing window systems
2. Installing self-contained systems
3. Installing residential control systems
4. Installing heat pumps
5. Replacing fans and fan motors
6. Trouble-shooting above units
7. Calculating heat loads
8. Checking duct systems
9. Measuring relative humidity
10. Measure air velocities using an Anemometer Pitot Tube and Velocimeter

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Typical Jobs (cont'd)

Grad 12

A. Theory - Automotive Air Conditioning

1. Safety around automotive equipment
2. Introduction to automotive air conditioning systems
3. Compressors, compressor drives
4. Condensers, receivers, sight glasses
5. Thermostatic expansion valves
6. Evaporators, blowers and motors
7. Thermostats
8. Electrical circuits
9. All of the different manufacturer's motor systems
10. Independent systems
11. Air distribution

B. Shop Jobs

1. Install belts, align, adjust the tension and operate an automobile air conditioning system
2. Install a two cylinder compressor
3. Install an evaporator
4. Remove and reinstall a condenser
5. Remove, test, reinstall and adjust a thermostatic expansion valve
6. Install refrigerant lines and test for leaks
7. Locate and remove trouble from an"Add-On" system
8. Evacuate, then recharge system with two cylinder compressor
9. Replace compressor seal
10. Dismantle, replace worn parts, assemble and test a compressor

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COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Applied Physics

Grade 10

OBJECTIVES:

1. To learn some fundamental concepts of the physical laws of nature.
2. To learn how some of these physical laws apply to the air conditioning and refrigeration trade.
3. To learn how these laws may aid in solving problems found in this trade.

UNIT I. MATTER

A. Structure of Matter
   1. Molecules
   2. Atoms
B. Measurement of Matter
   1. Density
   2. Specific gravity
C. Physical States of Matter
   1. Solid
      a. Density of copper
      b. Density of aluminum
      c. Density of steel
   2. Liquid
      a. Special properties
         1. Under pressure
         2. Under different temperatures
         3. Effect of pressure on boiling point
      b. Specific gravity
         1. Of water
         2. Of certain common acids
         3. Of oils
   3. Gas
      a. Special properties
         1. Under pressure
         2. Under different temperatures
         3. Charles' Law
         4. Boyles' Law
         5. Dalton's Law
      b. Density of gases
         1. Oxygen
         2. Helium
         3. Carbon dioxide
         4. Freon

UNIT II. MEASUREMENT

A. English System
   1. Linear
      a. Inches, feet, yards
   2. Area
      a. Square inches, square feet, square yards
   3. Volume
      a. Cubic inches, cubic feet, cubic yards
B. Metric System
   1. Linear
      a. Centimeter, meter
   2. Area
      a. Square centimeters, square meters
   3. Volume
      a. Cubic centimeters, cubic meters, liters
   4. Weight
      a. Gram, kilogram

UNIT III. FORCES

A. Kinds of Forces
B. Effects of Forces
C. Mechanical Advantage
D. Work, Power and Efficiency
E. Balance and Equilibrium
F. Vectors
G. Pressure
   1. Atmospheric pressure
   2. Measuring devices
      a. Bourdon gauge
      b. Manometer
      c. Barometer
   3. Absolute pressure

UNIT IV. SIMPLE MACHINES

A. Levers
   1. Hand tools
   2. Mechanical advantage
B. Inclined planes
   1. Wedges
   2. Mechanical advantage
C. Pulleys
   1. Fixed, moveable
   2. Pully systems
D. Wheels and Axles
E. Screw Threads
F. Power Transmission
   1. Belts, V-belt drives
   2. Coupling
   3. Measurement using horsepower
G. Friction
   1. Causes and reduction
   2. Coefficients of friction

UNIT IV. (continued)

H. Lubrication
   1. Types of lubrication
      a. Gravity
      b. Pressure
      c. Splash
   2. Types of lubricants

UNIT V. HEAT

A. Sources of Heat
   1. Solar (sun's rays)
   2. Electrical
   3. Atomic
   4. Frictional
   5. Chemical and other
B. Measurement of Heat
   1. Specific heat
   2. Latent heat
      a. Fusion
      b. Evaporation
   3. Calorie and B.T.U.
C. Transfer of Heat
   1. Radiation
   2. Conduction
   3. Convection
   4. Evaporation
D. Boiling Points of Liquids and Gases
   1. Refrigerant 12
   2. Refrigerant 22
   3. Alcohol
   4. Water
E. Change of State of Heat as in Refrigerators
F. Temperature
   1. Measurement of
   2. Kinds of thermometers
      a. Fahrenheit
      b. Centigrade
   3. Kelvin scale
G. Humidity
   1. What is humidity?
   2. Measurement of
   3. Effect on human body
H. Expansion and Contraction of Matter
   1. Peculiar action of water at 4°C.
I. Methods of Heating Homes and Other Buildings
   1. Steam Heat
   2. Hot Water
      a. Forced and Convection Methods
   3. Hot Air
      a. Gravity
      b. Forced air
      c. Hot and cold air ducts

UNIT V. (Continued)

J. Insulation
   1. Common kinds used in refrigerators, freezers, air conditioners
   2. Common insulating materials used in buildings

UNIT VI. MAGNETISM

A. Nature and Theory of Magnetism
B. Laws of Magnetism
C. Kinds of Magnets
   1. Natural
   2. Permanent
   3. Electro-magnet
D. Magnetic Effects of an Electric Current
E. Electro-magnetic Induction

UNIT VII. ELECTRICITY

A. Static Electricity
B. "Moving" Electricity
C. Simple circuits
   1. Series
   2. Parallel
   3. Combination
D. Direct Current
   1. Generation
      a. Parts of generators
   2. D.C. motors
      a. Parts
E. Alternating Current
   1. Generation
      a. Parts of generators
   2. A.C. Motors
      a. Parts
F. Transformers
   1. Primary coil
   2. Secondary coil
   3. Function

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Air Conditioning and Refrigeration

Related Physics

Grade 10

TEXT:

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Turner, Carpenter Discovery Problems in Physics College Entrance Book Co. 1970

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Applied Chemistry

Grade 11

Objectives:

1. To understand the importance of chemistry in our modern world.
2. To learn some fundamental principles of chemistry and how to apply these principles in solving problems of the air conditioning and refrigeration trade.
3. To learn certain important special applications of chemistry in the operation and construction of refrigeration units and refrigerants.

UNIT I INTRODUCTION

A. Role of chemistry in our daily lives

B. Chemical symbols

C. Definition of terms

D. Laboratory apparatus

UNIT II SAFETY IN THE LABORATORY AND CLASSROOM

A. Horseplay

B. Housekeeping

C. Glassware

D. Chemicals

E. Water

F. Fire

G. Organic solvents

H. Electrical equipment

UNIT III STRUCTURE OF MATTER

A. Matter

1. Composition

a. Molecule
b. Atom

B. Elements

C. Compounds and mixtures

D. Solids, liquids, gases

UNIT IV LIQUIDS

A. Solutions and suspensions

B. Distillation of liquids

C. Liquids used in air conditioning and refrigeration trade

UNIT V MATTER

A. Physical change

B. Chemical change

1. Examples of each

UNIT VI OXYGEN

A. Properties

1. Physical
2. Chemical

B. Preparation

1. In laboratory
2. Commercially

C. Oxidation

1. Of iron
2. Of copper and aluminum
3. Other metals

D. Ozone

UNIT VII HYDROGEN

A. Properties

1. Physical
2. Chemical

UNIT VII HYDROGEN (cont'd)

B. Preparation

1. In laboratory
2. Commercially

C. Safety precautions to follow when using

D. Reduction

E. Commercial uses

UNIT VIII NITROGEN

A. Properties

1. Physical
2. Chemical

B. Preparation

1. Commercially

C. Common compounds

1. Nitrous oxide
2. Nitric acid
3. Ammonia

D. Commercial uses

UNIT IX ACIDS, BASES AND SALTS

A. Properties of each

1. Physical
2. Chemical

B. Action on litmus paper.

C. Common acids

1. Hydrochloric
2. Sulfuric
3. Nitric
4. Acetic
5. Others

D. Common bases

1. Sodium hydroxide
2. Calcium hydroxide
3. Aluminum hydroxide

UNIT IX ACIDS, BASES AND SALTS (cont'd)

E. Common salts

1. Sodium chloride
2. Potassium chloride
3. Sodium sulfate
4. Zinc chloride
5. Sodium nitrate

F. Neutralization of an acid and a base

1. Resulting products

G. Commercial uses of acids, bases and salts

UNIT X COMMON METALS

A. Ferrous metals

1. Iron and steel

a. Kinds
b. Manufacture
c. Use in air conditioning and refrigeration

B. Non-ferrous metals

1. Aluminum

a. Occurrence in the earth
b. Manufacture
c. Properties
d. Uses in air conditioning and refrigeration

2. Copper

a. Manufacture
b. Properties
c. Common alloys
d. Uses in air conditioning and refrigeration

3. Zinc

a. Manufacture
b. Properties
c. Uses in air conditioning and refrigeration

4. Chromium, nickel, tin, silver

a. Manufacture
b. Properties
c. Uses in air conditioning and refrigeration

UNIT XI CARBON AND CARBON COMPOUNDS

A. Carbon

1. Occurrence
2. Common compounds

a. Carbon monoxide
b. Carbon dioxide
c. Graphite
d. With calcium and sodium to form carbonates
e. Coal, coke, petroleum
f. Carbonic acid and "dry ice"
g. Hydrocarbons

UNIT XII ADSORPTION AND ABSORPTION

A. Definition and meaning

B. Absorption

1. Air in water
2. Ammon absorption system in a refrigerator
3. Lithium chloride in water
4. Water by calcium chloride and calcium sulfate

C. Adsorption

1. In solids
2. Silica gel
3. Activated alumina
4. Importance of temperature and pressure in adsorption

UNIT XIII REFRIGERANTS

A. Physical and chemical properties of

1. Ethane
2. Carbon dioxide
3. Propane
4. Refrigerant 11
5. Refrigerant 12
6. Refrigerant 500
7. Refrigerant 22
8. Refrigerant 113 and 114
9. Refrigerant 502
10. Ammonia
11. Methyl chloride
12. Sulfur dioxide
13. Butane
14. Ethyl chloride
15. Methyl formate
16. Methylene chloride

BIBLIOGRAPHY OF TEXTS AND REFERENCE BOOKS

Air Conditioning and Refrigeration

Applied Chemistry

Grade 11

Text: Boylan. Elements of Chemistry. Allyn and Bacon 1969

References:

Althouse, Turnquest, Bracciano, Modern Refrigeration and Air Conditioning. Goodheart Wilcox Publishers 1970

Marsh and Olivo. Principles of Refrigeration. Delmar Publishers 1966

Refrigeration Compressors and Their Lubrication. Mobil Oil Corp.

Refrigerants and Service Pointers Manual. E. I. DuPont de Nemours

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Related Algebra

Grade 10

Objectives:

1. To review the basic concepts of arithmetic.
2. To learn the basic concepts oi algebra.
3. To learn how to use algebra to solve problems related to air conditioning and refrigeration.

UNIT I REVIEW OF ARITHMETIC

A. Whole numbers, fractions, decimals

1. Addition
2. Subtraction
3. Multiplication
4. Division

B. Measurement - English and Metric

1. Linear
2. Square
3. Cubic
4. Temperature and heat
5. Measuring instruments used in trade

C. Percentage

1. Trade applications

D. Graphs and charts

1. Development and interpretation

E. Ratio and proportion

1. Trade application

UNIT II ALGEBRAIC SYMBOLS

A. Using symbols

UNIT III ALGEBRAIC EVALUATION

A. Simple expressions
B. Expressions involving parentheses
C. Expressions involving exponents
D. The meaning of formulas

1. Evaluation of formulas

a. Algebraically
b. Algebraically with units of measure, mass and energy as related to Air-Conditioning and Refrigeration

UNIT IV EQUATIONS

A. Solution by subtraction axiom
B. Solution by addition axiom
C. Solution by division axiom
D. Solution by multiplication axiom
E. Mixed equations
F. Evaluation of equations

a. Algebraically
b. Algebraically with units of measure, mass and energy as related to Air-Conditioning and Refrigeration

G. Problems solved by formulas

1. Geometric (covering squares, rectangles, rectangular solids, circles and cylinders)
2. Gears, pulleys, and sprockets
3. Electricity
4. Levers
5. Temperature

UNIT V POSITIVE AND NEGATIVE NUMBERS

A. Meaning of signed numbers
B. Comparison of signed numbers
C. Addition of signed numbers
D. Subtraction of signed numbers
E. Multiplication of signed numbers
F. Division of signed numbers
G. Evaluation of simple expressions
H. Evaluation of expressions involving parentheses
I. Evaluation of expressions involving exponenets

UNIT VI FUNDAMENTAL OPERATIONS

A. Addition of monomials
B. Addition of polynomials
C. Subtraction of monomials

UNIT VI FUNDAMENTAL OPERATIONS (cont'd)

D. Subtraction of polynomials
E. Removing parentheses by addition or subtraction
F. Inclosing terms within parentheses
G. Multiplication of monomials
H. Division of monomials

UNIT VII FRACTIONS

A. Reduction of fractions
B. Multiplication of fractions
C. Division of fractions
D. Addition and subtraction of monomial denominators
E. Addition and subtraction of like denominators

UNIT VIII REARRANGING AND EVALUATION OF FORMULAS

A. Rearranging formulas
B. Evaluation of formulas

UNIT IX POWERS AND ROOTS

A. Powers of monomials
B. Roots of monomials
C. Square roots

BIBLIOGRAPHY OF TEXT AND REFERENCE BOOKS

Air Conditioning and Refrigeration

Related Algebra

Grade 10

King, Guy R. Modern Refrigeration Practice N. Y. McGraw Hill, 1971

Marsh, W., Olivo, T. Principles of Refrigeration Albany, N.Y. Delmar Publishers 1966

Stein, Edwin I. Algebra in Easy Steps with Modern Units Princeton D. Van Nostrand, 1961

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Related Geometry

Grade 11

Objectives:

1. To learn the basic principles of geometry.
2. To learn how to construct basic geometric shapes.
3. To learn how to solve problems in air conditioning and refrigeration dealing with geometry.

UNIT I POINTS, LINES, PLANES AND SPACE

A. Naming points, lines and planes
B. Kinds of lines
C. Intersecting, parallel and perpendicular lines
D. Scales (and drawing by scale)

UNIT II ANGLES

A. Naming angles
B. Kinds of angles
C. Measuring angles
D. Drawing angles

UNIT III GEOMETRIC FIGURES

A. Simple closed plane figures

1. Traingles
2. Quadrilaterals
3. Circles
4. Solid or space figures

UNIT IV CONSTRUCTIONS

A. Triangles
B. Regular polygons
C. Bisecting line segments
D. Bisecting an angle
E. Constructing a perpendicular to a line at a point on the line
F. Constructing a perpendicular to a line from a point outside the line
G. Constructing an angle equal to a given angle
H. Constructing a line parallel to a given line through a point outside the given line

UNIT IV CONSTRUCTIONS (cont'd)

I. Pairs of angles
J. Parallel lines and angle relationships
K. Congruent triangles
L. Similar triangles

UNIT V INDIRECT MEASUREMENT

A. By rule of Pythagoras
B. By similar triangles

UNIT VI PERIMETER AND CIRCUMFERENCE

A. Perimeter of a rectangle
B. Perimeter of a square
C. Perimeter of a triangle
D. Circumference of a circle

UNIT VII AREA

A. Area of a rectangle
B. Area of a square
C. Area of a parallelogram
D. Area of a triangle
E. Area of a trapezoid
F. Area of a circle
G. Total area of a rectangular solid and a cube
H. Lateral area and total area of a right circular cylinder

UNIT VIII VOLUME - MEASURE OF SPACE

A. Volume of a rectangular solid
B. Volume of a cube
C. Volume of a right circular cylinder
D. Volume of a sphere, right circular cone, and a pyramid.

N.B. Trade applications for individual lessons are numerable. Rather than specify individual applications, the instructor is encouraged to employ those applications that are of immediate interest.

BIBLIOGRAPHY OF TEXT AND REFERENCE BOOKS

Air Conditioning and Refrigeration

Related Geometry

Grade 11

Stein, Edwin I. Fundamentals of Mathematics. Rockleigh, N.J.: Allyn & Bacon, 1968

Slade, Margolis, Boyce. Mathematics for Technical and Vocational Schools. New York: Wiley & Sons, 1968

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Applied Mathematics

Grade 12

Objectives:

1. To learn how to use the psychrometric chart as applied to the air conditioning and refrigeration field.
2. To learn the principles of load estimating and to be able to apply these principles in estimating heating and cooling loads.
3. To learn the principles involved in designing a direct expansion cooling system for residences.

UNIT I PROBLEMS INVOLVING PSYCHROMETRICS AND THE PSYCHROMETRIC CHART

A. Psychrometrics

1. Its meaning
2. Relation to air conditioning and refrigeration as a useful tool

B. The psychrometric chart

1. Psychrometric terms and the location of scales and lines for these terms on the chart

   a. Dry bulb temperature
   b. Wet bulb temperature
   c. Relative humidity
   d. Grains of moisture per pound of dry air
   e. Dew point
   f. Specific volume

2. Relationship of terms as determined by the intersecting of lines on the chart

   a. Wet bulb and dry bulb for relative humidity
   b. Dry bulb and relative humidity for wet bulb
   c. Wet bulb and dry bulb for dewpoint
   d. Wet bulb and relative humidity for dewpoint
   e. Dry bulb and relative humidity for dewpoint
   f. Dry bulb and wet bulb for grains of moisture

UNIT I PROBLEMS INVOLVING PSYCHROMETRICS AND THE PSYCHROMETRIC CHART (cont'd)

C. Application of psychrometric terms

1. Practical application of the term humidity in -

a. Winter air conditioning
b. Summer air conditioning

2. Practical application of the term dewpoint

a. Condensation in winter
b. Condensation in unconditioned spaces

3. Practical application of the term wet bulb

a. The use of wet bulb to determine moisture content of air and its dew point

D. Psychrometric processes

1. Latent heating and cooling
2. Sensible heating and cooling
3. Latent and sensible heating and cooling

a. Heating and humidifying
b. Cooling and dehumidifying

4. Sensible heat factor and its applications
5. Air mixtures
6. Bypass air for a coil and the bypass factor

E. Advanced psychrometrics

1. Specific volume
2. Enthalpy
3. Spray coil operations
   a. Cooling and humidifying
   b. Cooling and dehumidifying
   c. Heating and humidifying

UNIT II PRINCIPLES AND PROBLEMS OF LOAD ESTIMATING

A. Cooling load heat sources

1. Outdoor heat sources
2. Indoor heat sources
3. Heating load heat losses

B. Cooling and heating load estimating guides

1. The heat transfer factor ("U") for glass, walls, roofs, etc.

UNIT II PRINCIPLES AND PROBLEMS OF LOAD ESTIMATING (cont'd)

2. The effects on cooling and heating loads

a. Ventilation
b. Materials
c. Light
d. People
e. Equipment

C. Estimating the air conditioning load

1. The survey pattern of a structure to be conditioned

a. Building orientation

1. Size
2. Shape
3. Materials of construction
4. Glass areas
5. Infiltration
6. People occupancy
7. Appliances
8. Lights
9. Ventilation
10. Utility services
11. Local and State codes

2. Load estimate forms

a. Residential cooling load estimates
b. Residential heating load estimates
c. Commercial cooling load estimates
d. Commercial heating load estimates

UNIT III PROBLEMS INVOLVING AIR DISTRIBUTION

A. Air distribution - ducts

1. Circular, rectangular or square shaped ducts and materials used.
2. Duct systems

a. Loop perimeter
b. Radial perimeter
c. Extended plenum

B. Air distribution - outlets

1. Types of outlets

a. Supply
b. Return
c. Ceiling diffusers
d. Grilles and Registers

UNIT III PROBLEMS INVOLVING AIR DISTRIBUTION (cont'd)

C. Direct expansion cooling system design for residences

1. Determining cooling load and temperature swing
2. Determining type of cooling unit and its location
3. Determining CFM per BTUh, CFM for each room and entire house
4. Layout of duct system
5. Calculation of CFM load for extended plenums (and respective static pressures)
6. Size of plenum and branches
7. Size of return ducts
8. Selecting diffusers, grilles, etc.

BIBLIOGRAPHY OF TEXT AND REFERENCE BOOKS

Air Conditioning and Refrigeration

Applied Mathematics

Grade 12

Lang, V. Paul. Principles of Air Conditioning. Albany, N. Y.: Delmar Publishers, 1972

King, Guy R. Modern Refrigeration Practices. N. Y.: McGraw Hill, 1971

Althouse, Tourquist, Bracciano. Modern Refrigeration and Air Conditioning. Homewood, Ill.: Goodheart-Willcox, 1968

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Related Drawing

Grade 10

Objectives:

1. To learn the basic fundamentals of blueprint reading and drawing as applied to the air conditioning and refrigeration trade.
2. To learn how to make sketches and drawings of air conditioning ducts and simple equipment layouts.
3. To learn how to read and interpret trade diagrams.

UNIT I USE OF DRAWING INSTRUMENTS

A. Drawing board and T-square

B. Scales

C. Triangles

D. Compass and dividers

E. Protractors

UNIT II BASIC DRAWING

A. Standards and principles

B. Lettering

C. Orthographic projection

1. Object
2. Point of sight
3. Projection lines
4. Projection plane
5. Angles of projection

UNIT III WORKING DRAWINGS

A. Pictorial drawings

1. Isometric drawings
2. Oblique drawings

B. Slanting surfaces

C. Invisible edges

D. Half-size scale

E. Cylindrical objects

F. Two-view drawings

G. Dimensioning holes

UNIT IV SYMBOLS AND CONVENTIONS

A. Materials in section

1. Wood
2. Stone
3. Brick
4. Concrete

B. Symbols

1. Doors
2. Windows

a. Double hung
b. Single sash
c. Casement

C. Built-in fixtures

UNIT V STRUCTURAL MEMBERS OF A FRAME STRUCTURE

A. Foundations

B. Sills and gutters

C. Vertical framing

D. Openings

1. Doors
2. Windows
3. Stair-well
4. Dormers
5. Porches and breezeways

UNIT V STRUCTURAL MEMBERS OF A FRAME STRUCTURE (cont'd)

E. Studding

F. Sheathing

UNIT VI INTERPRETING RESIDENTIAL BLUEPRINTS

A. Sewage system and house drain system

B. Stack and vent piping

C. Hot and cold water piping

D. Fuel storage and supply lines

UNIT VII INTERPRETING COMMERCIAL BLUEPRINTS

A. Plot plans and the engineers scale

B. Elevations and plumbing installations

C. Soil stack, waste and vent piping

D. Hot and cold water piping

BIBLIOGRAPHY OF TEXT AND REFERENCE BOOKS

Air Conditioning and Refrigeration

Related Drawing

Grade 10

French, Thomas E. & Svensen, Carl L. Mechanical Drawing. New York: McGraw-Hill, 1966

Sundberg, Elmer W. Building Trades Blueprint Reading. Chicago, American Technical Society, 1967

Folena, Bruce. Drafting - 1. New Brunswick; Curriculum Laboratory, Rutgers University 1970

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Related Drawing

Grade 12

Objectives:

1. The students will be able to apply the principles of orthographic projection by developing two and three-view drawings.
2. To demonstrate the ability to visualize one or more views.
3. To develop skill in drawing plan and elevation views.
4. To practice reading architectural drawings related to air-conditioning and refrigeration systems.

UNIT I REVIEW OF BASIC DRAWING TECHNIQUES

UNIT II ARCHITECTURAL DRAFTING SYMBOLS

A. Plumbing symbols

B. Electrical symbols for architectural plans

C. Welding symbols

D. Sheet metal ductwork symbols

UNIT III WARM-AIR HEATING SYSTEMS

A. Loop perimeter system

B. Radial perimeter system

C. Crawl space plenum

D. Extended plenum

E. Overhead radial

F. Graduated plenum

UNIT IV LAYOUT OF A RADIAL HEATING PLAN

UNIT V SINGLE LINE AND CONVENTIONAL METHODS OF HEATING PLAN LAYOUT

UNIT VI VENTILATION SYSTEMS

A. Ducts, dampers and casings

B. Fans

C. Air-cleaning devices - filters and washers

D. Intake and discharge ventilators

E. Registers, grilles

F. Unit heaters

G. Humidifiers

H. Temperature and humidity controls

UNIT VII MULTIZONE VENTILATION SYSTEMS

UNIT VIII AIR-CONDITIONING SYSTEMS

A. Involving several duct systems

UNIT IX EXHAUST SYSTEMS

BIBLIOGRAPHY OF TEXT AND REFERENCE BOOKS

Air Conditioning and Refrigeration

Related Drawing

Grade 12

Text: Zinngrabe, Claude J. Sheet Metal Blueprint Reading for the Building Trades. Delmar Publishers, Inc. 1971

References:

King, Guy R. Modern Refrigeration Practice. McGraw-Hill Book Company, 1971

Faris, Kamil J. Electricity in Refrigeration and Air Conditioning Part II. Curriculum Laboratory - Rutgers, 1968

Trade Catalogs:

American Standard Commercial Air Conditioning Div.
Baltimore Aircoil Company, Inc.

MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL HIGH SCHOOLS

Air Conditioning and Refrigeration

D.O.T. 637-281: 0101-014

Job Description

The work of the air-conditioning and refrigeration mechanic is varied since he installs, maintains, and repairs different types of equipment in many places and situations.

The equipment to be installed, repaired and maintained by this mechanic ranges from small wall units, either water or air cooled, to large central plant type systems.

He may work on commercial refrigeration fixtures used in super markets, hotels and restaurants, i.e., display cases, walk-in coolers and frozen food plants. Evaporators, compressors and motors installed in locker plants are also covered in this line of work.

His job may take the air-conditioning and refrigeration mechanic to private homes, stores, hotels, factories and restaurants. At times he may have to go to new construction sites to install the various motors, condensers and fans. Some of these mechanics, however, concentrate on the heating and cooling accessory units used in automobiles and buses.

In the installation of new air-conditioning or refrigeration equipment, the mechanic must be a good welder, solderer and pipe-fitter. He must be able to connect ducts, water and electric work. After completing his installation, the mechanic must check his work: often he uses a halide leak detector to check the lines for leaks; he may also use test bulbs and probes to check for continuity of an electric citcuit and location of grounds.

The mechanic inspects and examines the various parts of the system to detect leaks and other faults. He must adjust compressors and motors as well as thermostatic controls to keep temperatures at a specified level.

The repair work of the air-conditioning and refrigeration mechanic commences with the diagnosis of the cause of the breakdown. In doing so he often disassembles brushes, valves, springs and connections to inspect their condition. After the trouble is located the reassembly may include the installation of such things as new piping, packing, valves or the complete overhauling of a pump or a compressor, which will put the equipment into working order.

Many different tools are used by the air-conditioning and refrigeration mechanic ranging from simple hand tools like wrenches, pliers, hammers and screw drivers to such expensive equipment as electric drills, soldering torches, leak detectors and pressure gauges.

Course Description

The course stressed the basic jobs, operations, and skills needed in the servicing, repair and installation of air-conditioning and refrigeration units. The student will gain a thorough knowledge of the materials and equipment used by the air-conditioning and refrigeration mechanic. He will learn to use meters, measuring instruments, tools and equipment; learn to interpret sketches, schematics and diagrams; and use shop manuals and other source materials.

Each student will have an opportunity to use hand tools of the air-conditioning and refrigeration trade and learn how to perform the operations of the trade, including the evaluation of the completed work.

The student will have shop experiences not only in the mastery of manipulative skills but also related information or technology. Under the direction of the shop instructor the student will learn related information in order that he may have a complete understanding of why he performs the operations of the trade in certain ways.

The course will include related subjects consisting of mathematics, science and drawing related to the air-conditioning and refrigeration trade. Here emphasis will be placed on the mastery of fundamental concepts and principles as well as the ability to solve practical problems. Those related subjects will help to provide the foundation which makes the shop work meaningful and functional.

It is expected that the student will have sufficient knowledge of the trade to enable him to enter into satisfactory employment under completion of the course.

Academic Subjects

Since it is expected that entrants will be high school graduates or the equivalent, it is assumed that they will have a sufficient background of general education and mastery of fundamentals to enable them to concentrate on shop practice and related theory. If deficiences do exist or needs become apparent, students will be scheduled to appropriate high school classes or special classes will be organized.

Related Subjects

The amount of time the student will spend on the study of the related science, math and drawing will depend somewhat on the educational background and experiences of the student. Special classes and schedules may be set up according to an analysis of individual needs. In some cases the shop instructor may be able to teach the related subject matter; in other cases the student may be assigned to a regularly scheduled high school class. Regardless of how this is set up, the subject matter content is the same as that shown in the course of study outlines for the high school courses in related mathematics, related science or related drawing.

Length of Course

The course provides for one (1) year of instruction. A minimum of 180 days per school year is required. New pupils normally begin with the opening of school in September but entrants may be accepted at other times if openings are available.

Entrance Requirements

Pupils who enter this course normally are high school graduates or the equivalent. They should have the ability to profit from the instruction and have an interest in the air-conditioning and refrigeration trade in terms of a vocational goal upon completing the program. Applicants must be 17 years of age, or older upon entrance.

Diploma

The student may earn a Middlesex County Adult Technical School Diploma provided he satisfactorily meets all of the requirements. If the adult is not a high school graduate upon entering the course, he may earn a high school diploma, provided he is in the shop program for a minimum of two years and meets all the requirements for a high school diploma. Transfer credit will be allowed for appropriate work satisfactorily completed in other high schools.

Where Offered

Burr D. Coe Vocational & Technical High School
112 Rues Lane
East Brunswick, New Jersey 08816

Equipment and Facilities Available

The schools in the Middlesex County Vocational system are well equipped with text and laboratory books that cover every phase of the trade.

As each lesson and skill is taught, it is practiced in a shop that contains all the necessary materials and equipment that are required to learn the trade thoroughly.

There is a continuous effort to secure the latest equipment available to keep up with the ever increasing progress in the air-conditioning and refrigeration field.

Program of Studies

Air Conditioning and Refrigeration

Subjects	Hours
Shop Practice	540 or more*
Related Science-Physics, Chemistry	324 or less*
Related Math-Algebra, Geometry	108 or less*
Related Drawing	108 or less*

*If less time is needed in the related subject areas, the extra hours may be devoted to shop.

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Practice

One Year Course for Adults

Objectives:

1. To assist the student to discover his capacities and desire for learning a skilled craft.
2. To provide the student with an opportunity to learn what is required to become an air-conditioning and refrigeration mechanic.
3. To learn how to work safely and how to prevent accidents
4. To enable the student to explore the job opportunities, working conditions, financial gains and security in the air-conditioning and refrigeration trades.
5. To develop personal characteristics and work habits necessary for success in the refrigeration trade.

UNIT I

Review Course of Study on Shop Safety

UNIT II SHORT ORIENTATION

A. Shop Rules and Procedures

B. Shop Vocabulary and Terminology

1. Hand tools
2. Materials
3. Equipment
4. Machines

C. Shop Clothing

D. Shop Safety

E. Shop Hygiene

UNIT III MATERIALS

Operations

A. How to Select Proper Tools for the Job

1. Selecting proper hand tools
2. Selecting proper electrical tools
3. Selecting proper bench tools
4. Location of all tools and equipment
5. Use, purpose and description of hand tools
6. Care and cleaning of hand tools

B. How to Select the Proper Material for a Job

1. Selecting proper type of tubing for a Freon system
2. Selecting material for an ammonia system

Related Trade Information

1. What are the various types of hand tools

1. Screw drivers, flat blade, assorted sizes
2. Screw drivers, Phillips #1,#2
3. Screw drivers, offset
4. Wrenches, socket: with attachments
5. Wrenches, crescent
6. Wrenches, box end
7. Wrenches, pipe
8. Wrenches, Allen
9. Wrenches, torque
10. Hammer, ball peen
11. Hammer, claw
12. Hammer, plastic
13. Mallet, rawhide, rubber
14. Pliers, diagonal cutting
15. Pliers, long nose
16. Shears, tinners
17. Square, combination set
18. Scribes, awls, drift pins
19. Chisels
20. Files: coarse, smooth, bastard
21. Hack saws, blades and teeth
22. Tap and die (small set)
23. Calipers
24. Rules (scales)
25. Tubing cutters
26. Bending springs
27. Pinch off block
28. Tube benders
29. Flaring tools
30. Gauge, screw pitch

2. Safety Precautions

1. Types of copper tubing

a. ACR - "K" - "L" - "M"
b. Hard drawn tubing
c. Soft drawn tubing (annealed)

UNIT III MATERIALS (cont'd)

Operations

3. Selecting material for a water cooled system
4. Selecting material for an air cooled system

Related Trade Information

2. Sizes of copper tubing
3. Types of pipe
   a. Black pipe
   b. Galvanized pipe
   c. Cast iron pipe
4. Sizes of pipe
5. Aluminum tubing
6. Safety precautions

UNIT IV MEASUREMENTS

Operations

A. How to Take Measurements

1. Taking end-to-end measurements
2. Taking end-to-center measurements
3. Taking end-to-back measurements
4. Taking center-to-center measurements
5. Taking back-to-back measurements

Related Trade Information

1. What is meant by a fitting
2. Fitting allowances
3. Types of fittings
   a. Flared fittings
   b. Copper-sweat fittings
   c. Compression joint fittings
   d. Flare to sweat fittings

UNIT V CUTTING COPPER TUBING

Operations

A. How to Prepare Copper Tubing

1. Unrolling tubing from master roll
2. Handling tubing with precaution
3. Selecting proper size and type of tubing before cutting

Related Trade Information

1. Removing and replacing seals
2. Proper method of uncoiling tubir from roll
3. Effects on tubing of improper unrolling
4. Effects of selecting improper size and type
5. Safety precautions

B. How to Use Cutting Tools

1. Using tubing cutter
2. Using hacksaw
3. Using tube reamer
4. Using a pinch-off block
5. Using tube cleaning brushes
6. Using a refacing tool
7. Using a file

1. Importance of using proper tools
2. Types of tube cutters
3. Types of hacksaws
4. Types of hacksaw blades
5. Types of tubing reamers
6. Types of cleaning brushes
7. Types of refacing tools
8. Types of files

UNIT V CUTTING COPPER TUBING (cont'd)

Operations	Related Trade Information
	9. Purpose of tube cutter 10. Purpose of tube reamer 11. Purpose of cleaning brushes 12. Purpose of refacing tools 13. Purpose of filing 14. Safety precautions
C. How to Cut Copper Tubing	
1. Using a vise 2. Using a flare block 3. Using a reamer 4. Using a pinch-off tool	1. Techniques in cutting tubing with a tubing cutter 2. Techniques in cutting with a hacksaw 3. Technique in reaming of tubing 4. Purpose of using a pinch-off tool 5. Safety precautions

UNIT VI FLARING COPPER TUBING

Operations	Related Trade Information
A. How to Flare Copper Tubing	
1. Preparing copper tubing a. Square tubing b. Remove burrs c. Install proper flare fitting 2. Insert tubing into proper hole or flare block 3. Applying oil to spinner 4. Tighten spinner 5. Removing tubing 6. Checking angle of flare	1. Definition of flaring 2. Kinds of flare fittings 3. Types of flaring tools 4. Parts of flaring tools 5. Purpose of using oil 6. Importance of positioning tubing in flare block 7. Causes of flares splitting and cracking 8. Causes of flares being too large or too small 9. Safety precautions

UNIT VII COPPER TUBING

A. How to Swage Copper Tubing	
1. Preparing copper tubing a. Square ends of tubing b. Remove burrs 2. Insert tubing into proper hole on flare block 3. Using proper size swaging tool 4. Applying oil to swaging tool	1. Definition of swaging 2. Purpose of a swage fitting 3. Importance of positioning tubing in flare block 4. Purpose of using oil 5. Causes of improper swage fittings 6. Safety precautions

UNIT VII COPPER TUBING (cont'd)

Operations	Related Trade Information
5. Proper method of striking swaging tool	
6. Checking tubing for proper fit	
B. How to Bend Copper Tubing	
1. Bending hard copper tubing	1. Types of tube benders a. Bending springs b. Mechanical benders
2. Bending soft copper tubing	2. Measurements involved
3. Preparing and marking copper tubing	3. Meaning of minimum and maximum radius
4. How to hold hands on bending springs	4. Reasons for using different bending tools
5. How to position tubing in tube bender	5. Principle of stress
6. How to operate tube bender properly	6. Definition of buckle
7. Removing tubing from tube bender	7. Reasons for heating hard tubing
	8. Meaning of normal bends, reverse bends and 45° bends
	9. Bending allowances
	10. Safety precautions

UNIT VIII COPPER SWEAT JOINTS

Operations	Related Trade Information
A. How to Use the Tools in Making Copper Sweat Joints	
1. Using tubing cutters	1. Types of tubing cutters
2. Using hacksaws	2. Types of hacksaws
3. Using reamers	3. Types of cleaning tools
4. Using cleaning tools	4. Types of reamers
5. Using heat-generating tools	5. Types of heat-generating tools
6. Using torches	6. Types of torches
	7. Importance of proper tool maintenance
	8. Principle of heat-generating tools
	9. Principle of tubing cutter
	10. Safety precautions
B. How to Make a Copper Sweat Joint	
1. Preparing copper tubing a. Cleaning tubing b. Reaming tubing c. Applying flux	1. Kinds of tools used 2. Types of fittings used 3. Types of cleaning tools used a. Sandpaper b. Emery paper c. Steel wool

Operations	Related Trade Information
2. Preparing copper fittings a. Cleaning fitting b. Applying flux 3. Applying heat 4. Applying solder 5. Wiping finished joint (removing excess solder)	4. Types of flux 5. Purpose of flux 6. Types of solders 7. Composition of solders 8. Types of heat 9. Meaning of wiping Reason for removing excess solder 10. Safety precautions a. Burns b. Hot solder c. Cooling tubing
C. How to Make a Sweat Joint Using the Brazing Method	1. What is meant by brazing 2. Principle of brazing 3. Composition of silver solder 4. Types of flux 5. Safety precautions
1. Setting up brazing outfit 2. Selecting proper tip 3. Heating metals 4. Completing job	
D. How to Set-up a Brazing Outfit	1. Construction of acetylene tank 2. What is meant by Single-stage pressure 3. Principle of heat 4. Safety precautions
1. Setting-up tanks 2. Installing regulator on tank 3. Connecting hoses 4. Connecting torch 5. Selecting tips	
E. How to Prepare a Soldering Iron	1. Types of soldering irons a. Copper iron b. Electric iron c. Soldering gun 2. Types of points or tips 3. Purpose of cleaning iron 4. Heat effects on soldering a. Warm iron b. Hot iron 5. Differences in methods of heating 6. Definition of tinning and shaping 7. Purpose of flux 8. Types of flux 9. Types of solder 10. Safety precautions
1. Heating soldering iron 2. Cleaning soldering iron 3. Shaping soldering iron 4. Tinning soldering iron	

UNIT VIII COPPER SWEAT JOINTS (cont'd)

Operations	Related Trade Information
F. How to Solder with a Soldering Iron	
1. Preparing metal to be soldered 2. Soldering brass 3. Soldering copper 4. Soldering glavanized iron	1. Types of flux to be used 2. Purpose of flux 3. Kinds of cleaning materials 4. Importance of proper heat 5. Types of solder to be used 6. Differences in methods of heatin different metals 7. Principles involved in soldering 8. Safety precautions

UNIT IX ASSEMBLY DEVICES

Operations	Related Trade Information
A. How to Install an Evaporator Supporting Bracket	
1. Planning job 2. Selecting type of metal to be assembled 3. Selecting type of fastening device to be used a. Frequency of dismantling 4. Using gauges to measure threads	1. Methods of fastening a. Soldering b. Brazing c. Welding d. Crimping e. Riveting f. Bolting 2. Devices for fastening metal a. Nuts b. Bolts c. Plugs d. Set screws e. Cap screws f. Machine screws 3. Types of thread gauges 4. Purposes of thread gauges 5. Safety precautions
B. How to Make External and Internal Threads	
1. Securing die in die stock 2. Chamfering end of work 3. Setting adjusting screws 4. Holding die stock square with work 5. Using proper pressure 6. Reversing stock and die 7. Protecting finished surface 8. Repairing damaged internal and external threads	1. Sizes of drills 2. Sizes and types of taps a. Tapered tap b. Plug tap c. Bottoming tap 3. Techniques in cutting threads with a tap 4. Sizes and types of dies 5. Techniques in cutting threads with a die 6. Thread systems 7. Safety precautions

UNIT X REFRIGERATION SERVICE GAUGES AND TEST MANIFOLD

Operations

A. How to Install a Test Manifold to an Open Type Refrigeration Unit to Observe Readings

1. Remove valve caps from service valves
2. Check service valves to determine whether the valve stems are backseated
3. Remove the 1/8" MP plugs from the gauge-ports
4. Install the half unions fittings (1/4 MF x 1/8 MP) into gauge ports
5. Connect flexible charging hose from compound gauge on manifold to Suction Service Valve (SSV)
6. Connect flexible charging hose from pressure gauge on manifold to Discharge Service Valves (DSV)
7. Plug the center charging line on manifold with 1/4 plug
8. Crack open the DSV and use pressure to purge air from the hose lines
9. Crack hose connection at SSV to purge air from hose
10. Frontseat the valves on manifold
11. Crack open the SSV
12. Run unit and observe operating pressures on gauges

Related Trade Information

1. Types of gauges
   a. Pressure - high side
   b. Compound - low side
2. Parts of a guage
   a. Bourden tube
   b. Linkage
   c. Gear
   d. Gauge connection - 1/8 male pipe thread
   e. Calibration spring
3. Operation of a gauge
   a. Internal pressure
   b. Atmospheric pressure
4. Dial markings and limitations
   a. Pressure - 0 - 500
   b. Compound - 30"-0-200
5. Pressure and vacuum scales
6. Temperature and pressure relationship
7. Types of test manifolds
8. Parts of test manifold
   a. Compound gauge
   b. Pressure gauge
   c. Manifold
   d. Three charging lines or hoses
   e. Three flare plugs
   f. Two 1/4 MF x 1/8 MP half-unions
9. Compressor service valves
   a. Frontseat - to close
   b. Backseat - to open
   c. Crack to open slightly
   d. Types of service valves used
      1. Two-way service valve
      2. One-way service valve
      3. Liquid line service valve
   e. Line service valves
      1. Compression type
      2. Solder type
      3. Piercing copper tubing
      4. Hermetic charging kits
10. Safety precautions
    a. Always wear goggles
    b. Use 2 wrenches when working
    c. Keep lines sealed and clean

Operations	Related Trade Information
B. How to Remove Gauges from an Open Type Refrigeration System 1. Backseat DSV at compressor 2. Open valves (backseat) on manifold 3. Operate unit until both gauges are at slightly above zero - 0 4. Close suction service valve (SSV) 5. Shut service valves on test manifold 6. Remove charging lines from compressor 7. Remove fittings from compressor 8. Replace 1/8" plugs 9. Replace valve caps	
C. How to Evacuate an Open Type Refrigeration Unit 1. Install test manifold to unit 2. Connect the high vacuum pump to the center gauge manifold opening 3. Open Suction Service Valve (SSV) at compressor 4. Open compound gauge service valve on manifold 5. Discharge to atmosphere any refrigerant left in system through center gauge port 6. Open Discharge Service Valve (DSV) at compressor 7. Open pressure gauge service valve on manifold 8. Open valve at vacuum pump 9. Operate vacuum pump and draw highest vacuum possible 10. Close Discharge Service Valve (DSV) 11. Close Suction Service Valve (SSV) 12. Close valve at vacuum pump	1. Types of vacuum pumps 2. Principles of vacuums 3. Why is it necessary to evacuate a system? 4. When is it required to evacuate a system? 5. Proper maintenance of vacuum pump 6. Operation of vacuum pump 7. Methods of evacuating a refrigeration system a. Triple evacuation method b. Low micron-range evacuation c. Vacuum required for moisture removal (dehydration) 8. Safety precautions

UNIT X REFRIGERATION SERVICE GAUGES AND TEST MANIFOLD (cont'd)

Operations	Related Trade Information
13. Shut off operating switch at vacuum pump 14. Disconnect vacuum pump 15. Leave test manifold connected to unit for next operation	
D. How to Add Refrigerant to an Open Type Unit 1. Install test manifold to unit 2. Connect the refrigerant cylinder to the center gauge manifold opening 3. Open valve on cylinder to purge air from charging line 4. Open Suction Service Valve 5. Test for leaks 6. Turn unit on 7. Add refrigerant to system until desired suction pressure is obtained 8. Shut off valve at cylinder 9. Close manifold valves 10. Close SSV 11. Remove test manifold	1. Types of refrigerants a. R-12 b. R-22 c. R-502 2. Types and sizes of refrigerant cylinders 3. Purging of lines 4. Methods of leak detection 5. Safety precautions a. Always wear goggles b. Avoid getting liquid refrigerant on skin c. Avoid inhalation of vapor or gas
E. How to Check for Leaks in an Open Type Unit 1. Install test manifold to unit 2. Leak test unit using all methods of leak detection 3. Repair leak 4. Remove test manifold	1. Types of leak detectors a. Halide leak detector b. Electronic leak detector c. Soap bubbles d. Vacuum pumps e. Use of senses 1. Sight 2. Touch 3. Sound 2. Using pressures to locate leaks 3. Safety precautions a. Never use oxygen, air or any inflammable gas for testing a system

UNIT XI COMPRESSORS

Operations	Related Trade Information
A. How to Overhaul an Open Type Compressor	1. Types of compressors

Operations

1. Select proper tools
2. Remove compressor from unit
3. Remove fly wheel and key, record data
4. Remove cylinder head and record data. Mark head
5. Remove valve plate and record data. Mark plate
6. Remove the crank case, base and seal plate. Record data
7. Remove one connecting rod, mark rod, and record data
8. Make new gasket
9. Assemble the compressor
10. Tighten and torque all assembly devices
11. Put oil into compressor and remount into unit
12. Test the compressor for vacuum and pressure

B. How to Overhaul a Rotary Type Compressor

1. Select proper tools
2. Dismantle the compressor
3. Mark all parts
4. Record all data from parts
5. Reassemble the compressor
6. Add oil
7. Test compressor

C. How to Service a Hermetic Compressor Without Any Service Valves

1. Select proper tools
2. Select proper material
3. Install the service valve kit if unit has a valve adapter
4. Install clamp piercing valve, if unit has no adapter valve
5. Install gauge manifold
6. Test the compressor for vacuum and pressures

Related Trade Information

A. Reciprocating

1. Accessible or open type
   a. Cylinder construction
   b. Cylinder arrangement
   c. Piston construction
   d. Connecting rod construction
   e. Crankshaft construction
   f. Valve construction
   g. Crankshaft seals
   h. Gaskets
   i. Compressor drives
2. Hermetic or sealed type
   a. Construction differences
   b. Compressor cooling
   c. Mufflers

B. Rotating

1. Accessible or open types
   a. Stationary blade
   b. Rotary blade
   c. Cylinder construction
   d. Rotor construction
   e. Blade construction
   f. Crankshaft construction
   g. Crankshaft seals
   h. Valve construction
2. Hermetic or sealed type
   a. Construction differences
   b. Operation

C. Centrifugal

1. Single stage
2. Multi-stage
3. Rotor (impeller)
4. Stators
   a. Marking of compressor parts
   b. Using a torque wrench
   c. Making a gasket
   d. Using a wheel puller
   e. Hermetic valve kit
   f. Uses of piercing valves
   g. Fan belts types and sizes

UNIT XI COMPRESSORS (cont'd)

Operations

7. Remove gauges
8. Remove valve kit or piercing valve adapter

Related Trade Information

h. Types of flywheels
i. Alignment of fly wheels and pulleys
j. Safety precautions

UNIT XII SOLDERING WITH OXYACETYLENE TORCH

A. How to Silver Solder or Braze Refrigerant Lines

1. Select proper material
2. Select proper tools
3. Preparing tubing
   a. Cleaning tubing
   b. Reaming tubing
   c. Applying flux
4. Preparing fitting
   a. Cleaning fitting
   b. Applying flux
5. Applying heat
6. Applying solder
7. Wiping finished joint
8. Testing finished joint

1. Kinds of tools used
2. Types of tubing or material used
3. Types of solder used
4. Composition of solder
5. Flow temperature of solder
6. Types of flux used
7. Purpose of flux
8. Purpose and use of basic equipment
   a. Gas supply-oxygen and acetylene
   b. Gas regulators
   c. Color code of hoses
   d. Sizes of tanks
9. Torch construction
10. Types of tips
11. The oxyacetylene flame
    a. Parts
    b. Temperature
    c. Colors
12. Techniques of good brazing
    a. Selection of tip
    b. Adjustment of torch
    c. Angle of torch
    d. Movement of the filler rod and torch
13. Safety precatuions

UNIT XIII HEAT AND PRESSURE

Operations

A. How to use the basic principles of temperature measurements in refrigeration

1. Heat intensity
2. Heat quantity
3. Heat energy

Related Trade Information

1. Measurement of heat intensity
   a. Unit of intensity
      1. Fahrenheit scale
      2. Centigrade scale
      3. Rankine scale
      4. Kelvin scale

UNIT XIII HEAT AND PRESSURE (cont'd)

Operations	Related Trade Information
	b. Measuring devices 1. Thermometers 2. Thermocouples c. Fixed references 1. Boiling point 2. Freezing point 3. Absolute zero d. Temperature conversion 2. Measurement of heat quantity a. British thermal unit (BTU) b. Heat equation used in calculations 3. Energy conversion units a. Heat energy b. Mechanical energy c. Electrical energy
B. How to Use the Knowledge of Heat and Pressures in the Refrigeration Trade 1. Temperature-pressure relationship 2. Heat in refrigeration 3. Heat in air-conditioning	1. Types of heat a. Specific heat 1. Various metals 2. Variance due to change of state 3. Temperature of mixtures b. Total heat 1. Sensible heat a. Sensible heat equation 2. Latent heat a. Latent heat of fusion b. Latent heat of vaporization 3. Super heat 2. Types of pressures a. Meaning of pressure b. Pressures as applied to refrigeration c. Atmospheric pressure 3. Measurement of pressures a. Absolute scale b. Standard (gauge) scale c. Compound scale d. Mercury scale e. Small pressures

UNIT XIV CALIBRATION OF GAUGES

Operations	Related Trade Information
A. How to Calibrate Pressure Gauges by Means of the Dead Weight Tester	1. Types of gauge calibrators

UNIT XIV CALIBRATION OF GAUGES

Operations

1. Fill weight tester with mineral oil (SAE 20)
2. Connect gauge to be tested
3. Make adjustments on dead weight tester
4. Record all data
5. Adjust gauge scales if required
6. Remove calibrated gauge

Related Trade Information

2. Construction of dead weight tester
3. Purpose of dead weight tester
4. Construction of gauges
5. Types of gauges
   a. Compound
   b. Pressure
6. Safety precautions

UNIT XV COMPONENT PARTS OF REFRIGERATION SYSTEM

Operations

A. How to Install or Replace an Evaporator Coil

1. Determine size and type of evaporator coil
2. Select proper tools
3. Select proper type and size of evaporator coil
4. Install gauge manifold, check for leaks
5. Purge refrigerant from system
6. Cut refrigerant lines at the evaporator coil
   a. Cut lines at a place that will permit brazing or soldering of the lines to new unit
   b. Allow enough tubing to permit flaring, if brazing or soldering cannot be done
7. Remove the evaporator by unbolting it from the cabinet
8. Install new evaporator
9. Clean the tubing. Braze or solder the connections, using the correct procedure
10. Install a new drier-filter
11. Evacuate, using vacuum pump
12. Charge to a 60 pound gas pressure
13. Test for leaks

Related Trade Information

1. Types of evaporators
   a. Bare tube
   b. Plate type
   c. Finned
   d. Air cooling coils
      1. Dry coil
         a. Natural convection
         b. Forced circulation
         c. Frosting
         d. Non-frosting
      2. Flooded
   e. Liquid cooling coils
      1. Submerged
      2. Shell and tube
      3. Tube within a tube

IT X V COMPONENT PARTS OF REFRIGERATION SYSTEM

Operations	Related Trade Information
How to Install or Replace a Condenser 1. Select proper tools for job 2. Determine size and type of condenser coil 3. Install gauge manifold, check for leaks 4. Purge refrigerant from system 5. Cut refrigerant lines at the condenser coil 6. Remove the condenser coil from cabinet, by unbolting or removing screws 7. Install new condenser coil in proper location 8. Clean the tubing. Braze or solder all refrigerant lines together, using proper procedure 9. Install a new filter-drier 10. Evacuate system using vacuum pump 11. Charge to a 60 pound gas pressure 12. Test for leaks at all connections	1. Types of condensers a. Air cooled 1. Bare pipe 2. Finned 3. Natural convection 4. Forced circulation b. Water cooled 1. Double pipe 2. Double tube 3. Shell and coil 4. Shell and tube c. Evaporative condensers d. Water towers e. Complete condensing units 1. Compressor 2. Condenser 3. Receiver f. Knowledge of non-condensable gases g. Safety precautions
How to Install, Replace or Repair Capillary Tube 1. Select proper tools for job 2. Remove the capillary tube a. Remove the refrigerant by safely purging (use good ventilation) b. Balance unit pressures, clean the capillary tube connections c. Remove the capillary tube and plug the openings if possible 3. Repair the capillary tube by using a capillary tube cleaner. If necessary replace with new one 4. Install the capillary tube filter-drier into unit	1. Types of capillary tubes 2. Purpose of capillary tube 3. Length and inside diameter of capillary tube 4. Capillary tube used as a heat exchanger 5. Capillary tube systems have very critical charge of refrigerant 6. Measuring charge put into a system 7. Drier and filter requirements 8. Other types of metering devices a. High side float b. Low side float c. Manual control valves d. Automatic expansion valves e. Thermostatic expansion valves

Operations	Related Trade Information
a. Clean and dry all connections b. Evacuate system, using vacuum pump c. Charge with refrigerant 5. Test for leaks 6. Charge system with correct amount of refrigerant	9. Trouble shooting system 10. Safety precaution
D. How to Remove, Test, Install and Adjust a Thermostatic Expansion Valve 1. Select proper tools for job 2. Select proper thermostatic expansion valve 3. Install the gauge manifold 4. Adjust the service vales - remove refrigerant 5. Remove the thermostatic expansion valve 6. Clean the thermostatic expansion valve, including the screen 7. Test the valve 8. Adjust to a 10°F superheat 9. Reinstall thermostatic expansion valve into system 10. Purge and evacuate system using vacuum pump 11. Build up pressure in system 12. Test for leaks	1. Types of thermostatic expansion valves a. Diaphragm type-adjustable b. Diaphragm type non-adjustable c. Internal equalizer d. External equalizer e. Bellows type-adjustable 2. Automatic valves a. Application b. Selection 3. Thermostatic valves a. Application b. Charge in sensing bulk 1. Gas charged 2. Liquid charged 3. Cross charged c. Selection 4. Trouble shooting system 5. Safety precautions
E. How to Install a Filter-drier 1. Select proper tools for job 2. Select proper filter-drier 3. Install the gauge manifold 4. Adjust the service valve 5. Remove refrigerant from system - ventilate wheel-wear goggles 6. Remove old drier and record the size of the fittings 7. Install the new drier carefully 8. Test for leaks, using a refrigerant cylinder, create a 70 to 90 psig head pressure 9. Charge the system	1. Types of filter-driers a. Liquid line filters b. Suction line filters 2. Desiccants a. Silica gel b. Activated alumina c. "Drierite" 3. Properties of desiccants 4. Function of filter-driers 5. Drier size 6. Drier location 7. Drier cores a. Replaceable b. Non-replaceable 8. Moisture indicators 9. Safety precautions

UNIT XVI MATERIALS

Operations	Related Trade Information
A. How to Identify and Prepare Wire For Use	
1. Removing insulation 2. Cleaning wire 3. Handling wire with precaution a. Knicking b. Cutting strands	1. Types of wire a. Solid b. Stranded c. Copper d. Aluminum 2. Types of insulation a. Thermoplastic b. Rubber c. Asbestos d. Varnish cambric
B. How to Splice Solid Wire	
1. Pig tail splicing 2. Tap splicing 3. Western Union splicing 4. Mechanical splicing	1. Purpose of splicing a. Reason for branching wire b. Reason for tapping wire c. Reason for line extentions 2. Importance of using proper tools a. Work knife b. Side cutters c. Diagonals d. Wire strippers 3. Safety precautions
C. How to Splice Stranded Wire	
1. Tap splicing 2. Western Union splicing 3. Fixture splicing 4. Extension cord splicing	1. Importance of using proper tools a. Work knife b. Diagonals c. Side cutters d. Wire strippers
D. How to Solder Splices	
1. Preparing soldering iron a. Cleaning iron b. Heating iron c. Tinning iron 2. Heating splice 3. Applying flux 4. Applying solder 5. Removing excess solder 6. Test all wiring for continuity with test light 7. Test all terminals, connections and wiring with ohmmeter.	1. Types of soldering irons a. Copper iron b. Electric iron c. Soldering gun d. Propane torch 2. Purpose of cleaning iron 3. Heat effects on soldering a. Warm iron b. Hot iron 4. Purpose of flux 5. Types of solders to use a. Acid core b. Rosin core 6. Reason for removing excess solder 7. Safety precautions a. Overheated iron b. Burns c. Hot solder d. Cooling iron

UNIT XVI MATERIALS (cont'd)

Operations	Related Trade Information
E. How to Insulate Splices	
1. Using rubber tape 2. Using friction tape 3. Using plastic tape 4. Using wire connectors	1. Purpose of insulation 2. Effects of poor insulation a. Grounds b. Shorts 3. Types of wire connectors
F. How to Install Armored Cable	
1. Handling cable 2. Cutting cable 3. Connecting cable to outlet 4. Stapling cable	1. Code requirements 2. Sizes of wire 3. Kinds of cable a. Two-wire b. Three-wire c. Four-wire d. Solid wire e. Stranded wire 4. Types of connectors a. Set screws b. Split c. Duplex d. Angle 5. Types of outlets a. Octagon b. Square box c. Wall case d. Utility box 6. Safety precautions
G. How to Install Non-metallic cable (Romex)	
1. Handling cable 2. Cutting cable 3. Connecting cable to outlet 4. Stapling cable 5. Grounding cable	1. Sizes of cable 2. Code requirements 3. Kinds of cable a. Two-wire b. Three-wire c. Four-wire d. Solid e. Stranded 4. Purpose of a ground wire 5. Types of connectors a. Set screw b. Split c. Duplex d. Angle

UNIT XVI MATERIALS (cont'd)

Operations	Related Trade Information
	6. Types of outlets a. Octagon b. Square box c. Wall case d. Utility box 7. Safety precautions
H. How to Install Receptacles, Fixtures and Controls in a Refrigeration System	1. Types of switches a. Rotary or selector 1. Pushbutton 2. Stem type b. Push button c. Toggle 2. Principle of the switch 3. Ratings of switches 4. Types of controls 5. Principle of controls 6. Types and sizes of wire required 7. Sizes and fuses required 8. Safety precautions in fusing 9. Safety precautions in wiring
1. Installing a single pole switch a. Selecting switch b. Wiring switch c. Testing switch 2. Installing double-pole switch 3. Installing three-way switch 4. Installing outlet receptacle 5. Installing fixtures 6. Installing controls a. Selecting control b. Wiring control c. Testing control	

UNIT XVII CONDUCTORS AND INSULATORS

Operations	Related Trade Information
A. How to Use Wire Gauges and Measure Sizes of Wires, and See How Lengths Effect Conductance	1. Conductors have low resistance to current flow a. Copper b. Iron c. Aluminum d. Silver e. Brass f. Zinc 2. Sizes of conductors a. Effect of type b. Resistance c. Load 3. Semi-conductors have low resistance to current flow in one direction. High resistance to current flow in other direction
1. Cut several pieces of wire and measure with wire gauge 2. Splice wire 3. Solder wire 4. Connect wire with tape 5. Connect wire with wire-nut 6. Cut wire to several different lengths and measure resistances	

UNIT XVII CONDUCTORS AND INSULATORS (cont'd)

Operations	Related Trade Information
	3. a. Germanium b. Silicon c. Copper oxide d. Copper sulphide e. Lead sulphide 4. Insulators have high resistance to current flow a. Dry air b. Glass c. Rubber d. Asbestos e. Bakelite f. Mica

UNIT XVIII CIRCUIT APPLICATION AND TESTING INSTRUMENTS

Operations	Related Trade Information
A. How to Test and Analyze Effects of Voltage, Current and Resistance Changes in Electrical Circuits	1. Types of current a. Alternating current b. Direct current c. Pulsating 2. Ways of generating voltage a. Mechanical b. Chemical c. Thermal d. Light 3. Ohm's Law and Kirchhoff's Laws 4. Precautions in connecting meters 5. Applying formulas to prove meter readings 6. Determine power factors
1. Using ohmmeters 2. Using voltmeters 3. Using ammeters 4. Using multi-testers 5. Using watt meters 6. Using voltage testers 7. Using an amprobe	
B. How to Detect Circuit Troubles	1. Principle involved in the short circuit 2. Principle involved in the open circuit 3. Principle involved in grounding
1. Testing 2. Wiring	

UNIT XVIII CIRCUIT APPLICATION AND TESTING INSTRUMENTS
(cont'd)

Operations	Related Trade Information
C. How to Work with Series Circuits 1. Source 2. Load 3. Testing 4. Wiring	1. Definition of circuits a. Series b. Parallel c. Combination 2. Effects of voltage 3. Effects of current 4. Effects of resistance
D. How to Work with Parallel Circuits 1. Source 2. Load 3. Testing 4. Wiring	1. Definition of circuits a. Series b. Parallel c. Combination 2. Effects of voltage 3. Effects of current 4. Effects of resistance
E. How to Work with Series and Parallel Circuits 1. Source 2. Load 3. Testing 4. Wiring	1. Definition of circuits a. Series b. Parallel c. Combination 2. Effects of voltage 3. Effects of current 4. Effects of resistance
F. How to Measure Electrical Power and Energy 1. Using voltmeter and ammeters 2. Using watt meters 3. Using watt-hour meters	1. Principle of transforming energy a. Generator b. Motor 2. Power formulas 3. Relationship between mechanical and electrical energy 4. Power ratings of equipment 5. Efficiency of operation
G. How to Select Circuit Conductors 1. Measuring sizes 2. Measuring line power losses 3. Measuring line voltage drops 4. Fusing 5. Determining fuse protection	1. Kinds of A.W.G. number markings 2. Code requirements 3. Differences in current carrying capacities 4. Effects of overloading 5. Effects of heat 6. Effects of magnetic induction 7. Safety precautions

UNIT XVIII CIRCUIT APPLICATION AND TESTING INSTRUMENTS (cont'd)

Operations	Related Trade Information
H. How to Produce Magnetism With Electricity and Produce Electricity with Magnetism 1. Electron theory a. Displacement of electrons b. Flow of electrons 2. Use of electricity to create magnetism a. Show polarity using a bar magnet b. Create magnetic lines of force using various magnets and iron filings c. Make permanent magnets d. Make temporary magnets	1. Sources of energy a. Friction b. Magnetism c. Chemical action d. Pressure e. Heat action f. Light action g. Nuclear action 2. Charges a. Positive - Plus - North b. Negative - Minus - South c. Attraction of unlike charges d. Repulsion of like charges 3. Static electricity - electrons at rest 4. Current electricity - electrons in motion

UNIT XIX SINGLE PHASE AND POLYPHASE MOTORS

Operations	Related Trade Information
A. How to Install Single-phase Motors 1. Connecting motors 2. Testing motors 3. Trouble shooting	1. Theory of operation a. Phasing or start winding b. Starting torque 2. Construction and uses a. Hermetically sealed b. Open type 3. Types of single- phase motors a. Split phase b. Permanent split capacitors c. Capacitor start-induction run d. Capacitor start-capacitor run 4. Ratings of single phase motors 5. Code rules and regulations
B. How to Install a Split-phase Motor 1. Connecting motor a. Voltage and amperage ratings 2. Testing motors	1. Theory of operation a. Rotor winding b. Stator winding 2. Parts and function of each part a. Rotor b. Stator

Operations	Related Trade Information
a. Excessive wear on shaft, bearings, other b. Freedon of rotation: shaft bearing c. Electrical test 1. Ground 2. Open winding 3. Short 4. Centrifugal switch 3. Trouble shooting motor 4. Reverse rotation of motor	c. End plates d. Centrifugal switch 3. Types of motor a. Two running windings with one starting winding b. Two running windings with two starting windings 4. Ratings of motor a. Single-speed b. Multiple speed 5. Reversing a split-phase motor a. Interchange of running windin leads b. Interchange of starting winding leads 6. Safety precautions
C. How to Install a Repulsion-induction Start Motor 1. Connecting motor a. Voltage and amperage rating 2. Testing motors a. Brushes b. Bearings c. End play d. Position of reversing switch e. Centrifugal throwout switch f. Armature 3. Trouble shooting motor a. Use of VOM in checking for starts, open circuits b. Use of tachometer in checking RPM's c. Use of growler in checking armature	1. Theory of operation a. High-starting torque using low starting current 2. Parts and function of each part a. Brush holders and brushes b. Bearings c. Short circuiting necklace and frame d. Governor spring e. Commutator f. Push rods g. Rotor 3. Types of repulsion-induction motors a. 110 volt b. 220 volt c. Reverse rotation 4. Ratings of motors 5. Code rules and regulations 6. Safety precautions
D. How to Install a Capacitor-start Motor 1. Connecting motor a. Voltage and amperage rating 2. Testing motors a. Mechanical tests 1. Excessive wear on shaft, bearings	1. Theory of operation-designed for high starting torque, used on water pumps and compressors on commercial units a. Uses a capacitor in circuit b. Rotor winding c. Stator winding 1. Main 2. Starting

Operations	Related Trade Information
2. Freedom of rotation of shaft, bearing 3. Centrifugal switch 4. Lack of sufficient lubrication 5. Misalignment of parts 6. Excessive end play b. Electrical tests 1. Ground 2. Open winding 3. Short 4. Defective capacitor 3. Trouble shooting motor a. Test capacitor for capacitance valve b. Test stator windings and identify leads c. Check for overload, over voltage, under voltage	2. Parts and function of each part a. Capacitor b. Centrifugal switch c. Rotor d. Windings e. End plates 3. Types of motors a. Capacitor-start, induction-run b. Capacitor-start,capacitor-run 4. Rating of Motor a. Volts b. Amps c. Watts d. Speed e. Horse power or size 5. Safety precautions a. Always discharge a capacitor before testing
E. How to Install a PSC Motor "P.S.C. means Permanent Split Capacitor" 1. Connecting motor 2. Testing motor 3. Trouble shooting	1. Theory of operation 2. Parts and function of each part 3. Types of motors 4. Rating of motor 5. Safety precautions
F. How to Identify and Tag Dual Voltage Motor Leads 1. Locating leads with an ohmmeter 2. Using voltmeter 3. Using voltage tester 4. Connecting leads	1. Kinds of standard lead markings 2. Reason for tagging 3. Safety when making tests 4. Types of polyphase motors a. Three-phase b. Two-phase 5. Parts and function of each part
G. How to Connect Stato-windings 1. Counting the number of coils 2. Calculating coils per pole 3. Calculating coils per phase 4. Soldering leads 5. Applying test voltages 6. Checking speed	1. Types of windings 2. What the winding accomplishes 3. Effects of voltage 4. Why the number of phases affects the winding 5. Why the frequency affects the winding

UNIT XIX SINGLE PHASE AND POLYPHASE MOTORS (cont'd)

Operations	Related Trade Information
	6. Less common connections 7. Formulas for new windings 8. How to use schematic and maste diagrams 9. Reasons for reconnecting
C. How to Locate Faults	1. Operation of three phase motor 2. Standard ratings 3. Code rules and regulations 4. Why periodic maintenance is necessary 5. N.E.M.A. standards 6. Safety when making tests
1. Checking for overload 2. Measuring starting conditions 3. Testing for performance 4. Testing for grounds 5. Testing for short-circuits 6. Checking bearings 7. Reversed phase 8. Defective controller 9. Checking for worn or tight bearings	

UNIT XX TROUBLE SHOOTING MOTORS

Operations	Related Trade Information
A. How to Trouble Shoot Split-phase and Capacitor Start Motors	1. Types of problems a. Mechanical b. Electrical 2. Parts of motors defective 3. Tools required 4. Meters required
1. Analyze problem 2. Locate cause of problem 3. Repair problem 4. Test motor	
B. How to Use Meters	1. Types of meters 2. Operation of meters 3. Uses of meters 4. Handling meters
C. How to start a compressor D. How to check a capacitor E. How to trouble shoot a relay starter circuit F. How to make a complete electrical check on an air conditioner	

Operations

A. How to Install a Window Type Comfort Cooler

1. Installation of base
   a. Install unit base on window sill
   b. Locate center of window, place the base in place
   c. Level the base and mark screw holes
   d. Drill the screw marks
   e. Install the rubber gasket on the window sill
   f. Fasten the mounting base to window sill
   g. Adjust the leveling bolts and lock
2. Installation of unit
   a. Prepare comfort cooler for operation
   b. Loosen the hold down bolts
   c. Inspect the unit for condition
   d. Mount the unit on the base
   e. Fasten the unit to the base
   f. Install the spacers between each side of the unit and the [illegible] frame
   g. Install the rubber gasket along the top of the unit
   h. Install the gasket between the inner double hung window and the outer one
   i. Operate the unit
   j. Check damper adjustments for unit noise

B. How to Locate Trouble in a Window Type Comfort Cooler

1. Test the external circuit first
   a. Power in
   b. Thermostat
   c. Motor compressor relay and overload protectors
   d. Filters
   e. Air flow

Related Trade Information

1. Selection of proper size unit for the application
   a. Heat transfer
      1. Heat loss
      2. Infiltration
      3. Heat gain
      4. Ventilation air
   b. Air and humidity calculations
   c. Sensible heat calculations
   d. Latent heat calculations
   e. Solar heat calculations
   f. Moisture calculations
2. Types of window air conditioners
   a. Casement windows
   b. Double hung windows
   c. Wall units
   d. Console or portable units
   e. Heat pump conversions
   f. Voltage characteristics
   g. Current characteristics
3. Selection of proper tools for installation
   a. Screw drivers
   b. Socket set
   c. Twist drill
   d. Electric drill
   e. Sprit level
   f. 10" straight tin snips
   g. Sealing compound
4. Safety in installation

1. Mechanical troubles
   a. Test for air in system
   b. Test for dirt and moisture in system
   c. Purging a system with air, moisture or dirt in it
   d. Checking and repairing a hermetic unit
   e. Checking and repairing an open type unit

Operations	Related Trade Information
2. Install guages a. Operate unit b. Test for leaks 3. If the unit has no or little charge in it 4. If unit is frosting or sweating down the suction line-unit may be over charged 5. If the screen or drier is clogged with dirt or moisture 6. Repair what is necessary 7. Remove refrigerant where necessary 8. Replace any worn part 9. Reassemble the unit 10. Evacuate system with vacuum pump, recharge system with proper charge 11. Test for leaks	f. Detecting and correcting a unit with leak g. Detecting and correcting a unit with noise problems h. Loose blower or fans i. Repairing and replacing a capillary tube j. Installing a filter-drier in system k. Remove, test, install and adjus a thermostat expansion valve l. Remove, test, install and adjus a water valve m. Checking fan motor CFM n. Checking fan motor for proper rotation o. Safety requirements
C. How to Locate Trouble in a Self-Contained Comfort Cooler 1. Test the external circuit first a. Power in b. Thermostat c. Motor compressor, relay and overload protectors d. Filters and air flow e. Water connections and water valves if water cooled f. Air supply if air cooled g. Condensate drain 2. Install gauges a. Operate unit b. Check pressures c. Test for leaks 3. Replace thermostatic expansion valve, if one is used 4. If unit is frosting on coil a. TE valve is leaking b. Thermostat is not shutting off c. TEV bulb is loose	2. Electrical and wiring defects a. Check motor wiring for sufficient voltage capacity b. Detect and correct improper control wiring in a self-contained unit c. Knowing how to use electrical testing equipment d. Knowing about many types of motors used in air conditioning units e. Reading schematic drawings f. Repairing and adjusting fan controls g. Repair and adjust a heating and cooling thermostat h. Measuring volts and resistance using a voltmeter and ammeter i. Using a wattmeter to calculate unit power factor j. Checking relay circuits operation for component part failur k. Checking the operation of a thermostat

UNIT XXI AIR CONDITIONING UNITS (cont'd)

Operations

5. If system is undercharged
   a. TE valve screen is partially clogged with moisture
   b. Dirt is in screen
6. Repair what is necessary
7. Remove refrigerant where necessary
8. Replace any worn parts
9. Reassemble the unit
10. Evacuate system with vacuum pump

Related Trade Information

l. Checking an electronic thermostat against a conventional thermostat
m. Knowing how to calibrate a thermostat
n. Safety requirements

UNIT XXII SERVICE PROBLEM

Operations

A. Installations

1. How to understand the codes applicable to air-conditioning
2. How to acquire an understanding of good installing practices
3. How to develop an attitude for good workmanship in the installation of air conditioning and the copper tubing going to the units

Related Trade Information

1. State and local codes
   a. Safety codes for commercial and industrial air conditioning
   b. Purpose of codes
   c. Applications
2. Self-contained units
   a. Conventional or open type units
   b. Hermetic units
   c. Compressor ventilation requirements
      1. Air-cooled
      2. Water-cooled
      3. Manufacturer's recommendations
3. Remote condensing units
   a. Accessible location
   b. Noise factors
   c. Protection for unit
4. Cooling coils
   a. Air circulation and distribution
   b. Careful mounting
   c. Supports and hangers
5. Tubing
   a. Type used
   b. Support for tubing
   c. Accessories-valve, drier sight glass

Operations	Related Trade Information
	d. Vibration absorbers and loops e. Condensate drains f. Slope of vapor lines
B. Initial Start-up	
1. How to take proper steps that are required for the initial start up of a commercial air conditioning unit 2. How to develop the attitude of the occurance of possible future troubles in an air conditioning system if a satisfactory operational check is not completed on initial start-up	1. Evacuation a. On all new systems, except those that are precharged b. On all systems that have been open c. The use and operation of a vacuum pump d. Extent and importance of vacuum 2. Charging a. Critical charge systems - self contained 1. Manufacturers recommendation 2. Portable charging equipment b. Non-critical charge systems 1. Liquid charging 2. Vapor charging-sight glass 3. Operational check a. Remove shipping bolts and/or blocks b. Oil all motor bearings c. Check operation pressures 1. Suction 2. Discharge 3. Compressor oil d. Pressure controls e. Electrical check out 1. Volts 2. Amperage 3. Correct fuse size f. Adjust super heat g. Adjust motor control h. Adjust evaporator and condensor fans
C. Diagnosing Service Problems	
1. How to diagnose the numerous problems that may arise when servicing an air conditioning system	1. Entire unit will not run a. No power at compressor 1. Check disconnect switch 2. Check fuse or circuit breake 3. Check source of main power 4. Broken wire or loose connection

UNIT XXII SERVICE PROBLEM (cont'd)

Operations	Related Trade Information
2. How to look for any signs that something is wrong in an air-conditioning system 3. Diagnosing must be made to find the source of the trouble 4. How to develop an attitude that even in trouble-shooting service problems, safety precautions should be taken for the protection of equipment and personnel	b. Power at compressor 1. Compressor motor 2. Overload 3. Control wiring and control 2. Unit runs - no cooling a. Loss of refrigerant b. Inefficient compressor c. Restriction in tubing or accessories 3. Unit runs - insufficient cooling a. Shortage of refrigerant b. Inefficient compressor c. Obstruction in lines 1. Refrigerant control 2. Drier d. Control setting 4. Unit noisy a. Vibration in lines b. Surplus of oil c. Defective compressor valves d. Refrigerant overcharge e. High head pressure f. Loose components or compressor mounts 5. Unit short cycles a. Partial obstruction in lines b. Leaky power element c. Improper adjustment of refrigerant control device

UNIT XXIII LOAD CALCULATIONS

Operations	Related Trade Information
A. Heat Gain Calculations 1. How to understand the many miscellaneous heat gains that must be taken into consideration when selecting a proper air-conditioning unit. 2. How to develop a knowledge and understanding of room heat	1. Sources of heat a. Transmission-sensible heat 1. Conduction a. Walls, ceiling and floors b. Time of year and day c. Types of insulation d. Thickness of insulation e. External area f. Temperature difference 2. Radiation a. Type of glass b. Other transparent materials

Operations

3. How to make a complete survey of the area to be conditioned
   a. Obtain all the room dimensions
   b. Note the windows, walls, ceiling and fllor construction
4. How to make a floor plan of area to be conditioned
5. How to become familiar with the different types of construction in residences and commercial buildings and the importance of this information for calculation and installation purposes
   a. Heat loss calculation
      1. How to become familiar with the various methods of heat movement or transfer through building materials
      2. How to know the difference between heat gain and heat loss in a building
      3. How to control the heat gain and heat loss in a building
      4. How, with the use of calculations, it will help in the selection of cooling coils and condensing units
      5. How to know and understand the various instruments and their use in taking measurements for correct air distribution
         a. Pitot tube
         b. U-tube Manometer
         c. Inclined manometer or draft gauge
         d. Velocities
            1. Velometer
            2. Anemometer
            3. Anemotherm air meter

Related Trade Information

3. Solar
   a. Time of year and day
   b. Exposure
   c. Latitude
   d. Shading
4. Product
   a. Sensible heat
   b. Latent heat
   c. Respiration
5. Appliances, gas or electric
6. Lights
   a. Fluorescent
   b. Incandescent
7. Machines
8. Motors
9. People - degree of activity
10. Air changes
    a. Inside volume
    b. Type of usage
11. Duct work
    a. Supply-air heat gain
    b. Return-air duct gain
12. Ventilation air
    a. CFM per person
    b. CFM per square of floor space

b. Transmission-latent heat
   1. Internal
      a. Appliances
      b. People-degree of activity
   2. External-ventilation air
      a. Desired resulting conditions
      b. Air mixture proportions
      c. Sensible heat ratio

2. Insulation
   a. Purpose or need
      1. Prevention against heat transfer
      2. Humidity control
   b. Thermal insulation
   c. Water vapor barriers
   d. Economic considerations
   e. Building insulation
3. Building construction
   a. Exterior walls
   b. Interior walls
   c. Floors and ceilings
   d. Insulation

Operations

A. How to Install Belts, Align Adjust the Tension and Operate an Automobile Air Conditioning Unit

1. Engine off, check belt tension, loosen adjustment bolts, remove belt
2. Inspect and measure belt
3. Replace or install new belt
4. Carefully check the alignment of the pulleys and their shafts, realign if necessary
5. Apply lever pressure on the compressor or idler pulley until the correct belt tension is obtained
6. Tighten the adjustment bolts
7. Recheck the belt tension
8. Install the fan guard and run engine. Recycle several times
9. Recheck the belt tension
10. Shut down the system

B. How to Install a Compressor on an Automobile Air Conditioning System

1. Check the compressor oil level
2. Check the magnetic clutch operation
3. Install the compressor
   a. Install belt
   b. Check belt for correct alignment and tension
4. Install the refrigerant lines
5. Install gauge manifold
6. Check for leaks at 25 psig then at 70 psig
7. Evacuate the system
8. Operate the system
   a. Charge system
   b. Check sight glass
   c. Test for leaks

Related Information

1. Introduction to automotive air conditioning
   a. Automotive air-conditioning principles
   b. Development of automotive air-conditioning
   c. Operating conditions
      1. Idling engine
      2. Fresh air ducts closed
      3. Operating engine
      4. Heat load
   d. Performance of system
   e. Types of systems
      1. Pressure operated low side pressure regulators
      2. Pressure operated bypass
      3. Solenoid operated bypass
      4. Electro-magnetic clutch
         a. Revolving magnetic coil
         b. Stationary magnetic coil
   f. Types of compressors
   g. Compressor seals
   h. Belts
      1. Belt tensions-new and used belts
   i. Condenser (air-cooled)
   j. Receiver-drier
   k. Refrigerant lines
      1. Flared fittings
      2. 0 ring fittings
      3. Hose clamp fittings
   l. Evaporators
   m. Expansion valves
   n. Suction pressure control valves
      1. Suction throttling valves (STV)
      2. Evaporator pressure regulator (EPR)
      3. Pressure operated altitude valve (POA)
   o. Service valves

Operations

9. Check operating pressures and the evaporator outlet temperature
10. Remove the gauge manifold and shut down the system

C. How to Install an Evaporator on an Automotive Air Conditioning System

1. Select proper cooling coil
2. Mount the thermostatic expansion valve on the evaporator and install the suction and liquid lines
3. Mount the evaporator, level connect the refrigerant lines and drain hose
4. Complete the electrical wiring and connect the gauge manifold
5. Test for leaks
6. Evacuate the system, using the deep vacuum procedure
7. Operate the system, charge it, check its operation
8. Seal the tubing opening in the firewall, install the evaporator housing

D. Locate and Repair Trouble in an Automobile Air-Conditioning System

1. Install the gauge manifold
2. Check the compressor belt tightness
3. Check for leaks
4. Check oil charge
5. Operate the system
6. Check the operating pressures, temperatures and quantity of refrigerant
7. Replace, repair or adjust the system until normal operation is obtained

E. How to Install, Test and Adjust the Clutch

F. How to Install, Test and Adjust the Termostatic Expansion Valve (TEV)

1. Install gauge manifold

Related Trade Information

2. Air distribution
   a. Duct system
      1. Fresh air inlet
      2. Return air inlet
      3. Evaporator housing
      4. Drain pan and drain connections
      5. Plenum chamber
      6. Conditioned air outlets
      7. Dampers
   b. Fans
      1. Radial flow
      2. Squirrel cage
      3. Centrifugal
   c. Fan motors
      1. 6 volts
      2. 12 volts
   d. Insulation
      1. Types
      2. Areas
3. Special tools and equipment for working on automotive air-conditioning
   a. Gauge manifold test unit
   b. Two-way valve
   c. Three-way tee
   d. 90° gauge line adapter
   e. Puller and puller pilot
   f. Multi-opener (4 cans)
   g. Non-magnetic clutch shims
   h. #21 snap ring pliers
   i. #26 snap ring pliers
   j. Compressor holding fixture
   k. Compressing fixture
   l. Clutch hub holding tool
   m. Hub and drive plate assembly remover and installer
   n. Seal and seal seat removers-pulley bearing remover
   o. Shaft seal protector
   p. Pressure test connector
4. Functions of component parts
   a. The drive belt
      1. Used to drive the compressor
      2. Belt adjustment
      3. Belt tension gauge

Operations

2. Discharge the system
3. Remove the thermostatic expansion valve from the liquid line and evaporator. Remove the thermal bulb. Disconnect the equalizer tube
4. Test the thermostatic expansion valve
5. Reinstall the TEV. Tighten all fittings. Connect the equalizer tube and mount the thermal bulb securely
6. Replace all insulation
7. Install the gauge manifold, pressure to 25 psig, test for leaks, pressurize to 70 psig and test for leaks
8. Charge to clear sight glass-test for leaks
9. Operate the system
10. Check operating pressures, refrigerant quantity and evaporator outlet air temperatures
11. Check the sweat back on the suction line
12. Remove the gauge manifold

Related Trade Information

b. The electro-magnetic clutch
   1. Operates the compressor
   2. Operates by the principle of magnetic attraction
c. The compressor
   1. Purpose of compressor is to pump refrigerant into the condenser
d. The condenser
   1. Purpose of condenser is to dissipate heat
e. The receiver-drier
   1. The receiver-drier has four functions
      a. Storage
      b. Moisture absorption
      c. Filtration
      d. Trouble diagnosis
f. The thermostatic expansion valve (TEV)
   1. The TEV meters liquid refrigerant as needed to the evaporator
g. The evaporator
   1. The purpose of the evaporator core is to cool and remove moisture from the air flowing through it

5. The electrical control system
   a. The thermostatic switch
   b. Blower motor
   c. Control switch
   d. Rheostat
   e. Clutch field

BIBLIOGRAPHY OF TEXT AND REFERENCE BOOKS

Air Conditioning and Refrigeration

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Althouse, Andrew, Turnquist, Carl and Bracciano, Alfred, Job Sheets for use with the Modern Refrigeration and Air Conditioning Book. The Goodheart-Wilcox Company, Inc., South Holland, Illinois 1971

Faris, Kamil J., Refrigeration I and II, Vocational-Technical Curriculum Laboratory, Rutgers - The State University, Bldg. 4103, Kilmer Campus, New Brunswick, New Jersey 1971

Golibar, Paul F., Refrigeration Servicing - Laboratory Manual, Delmar Publishers, Inc., Albany, New York 1966

Faris, Kamil J., Electricity in Refrigeration and Air Conditioning, Vocational-Technical Curriculum Laboratory, Rutgers, The State University, Bldg. 4103, Kilmer Campus, New Brunswick, New Jersey 1968

Automotive Air-Conditioning Service Manual, Refrigeration and Air-Conditioning Division, Parker-Hannifin, 17325 Euclid Avenue, Cleveland, Ohio 44112 1967

Tricomi, Ernest, ABC's of Air Conditioning, Howard W. Sams & Co., Inc., Indianapolis, Indiana 46206 1970

Czinkota, Michael, Sands, Leo G., How to Select, Install and Service Air Conditioners, Chilton Book Company, Philadelphia, Penna. 1969

Dwiggins, Boyce H., Automotive Air Conditioning, Delmar Publishers, Inc., Albany, New York 1967

Brown, Samuel P., Air Conditioning and Elements of Refrigeration, McGraw-Hill Book Company, Inc., New York, New York 1967

Air Conditioning and Heating Technology II, Gattone, Felix, Dept. of Vocational-Technical Education, Rutgers-The State University, New Brunswick, New Jersey 1965

Carmody, John F., Basic Automotive Air Conditioning, Vocational-Technical Curriculum Laboratory, Rutgers - The State University, Bldg. 4103, Kilmer Campus, New Brunswick, New Jersey 1971

Kaberlein, Joseph J., Air Conditioning Metal Layout, The Bruce Publishing Company, Milwaukee, Wisconsin

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Shop Vocabulary

absorption
acetylene
alumina
aluminum
ammeter
ampere
armature
asbestor
assembly
atmospheric
automatic
automobile
bearings
bellows
Bourdon
bracket
brazing
British thermal unit
buckle
calculate
calibrate
caliper
capacitor
capillary
casement
centrifugal
Centigrade
circuit
comfort
commutator
compressor
conditioner
condensate
condenser
console
controller
convection
copper
current
cycle
cylinder
damper
dehumidify
desiccant
detector
dew point
diaphragm
discharge
dismantle
drier
dry-bulb
duct
electricity
emery
evacuate
evaporator
expansion
Fahrenheit
fitting
flaring
flux
freezing
frosting
fuse
galvanized
gasket
gauge
generator
grounding

hacksaw
hangers
hermetic
horsepower
humidity
impeller
induction
inflammable
inspect
install
instrument
insulation
joint
Kelvin
latent
liquid
liquification
magnet
maintenance
manifold
measurement
mercury
mica
micron
moisture
motor
mounting
negative
neutral
nitrogen
oxygen
parallel
plastic
plenum
portable
positive
pressure
propane
psychrometric
pulley
purge
pushbutton
reamer
reciprocating
refrigerant
relative
relay
residence
rheostat
rivet
rosin
rotary
rotor
schematic
screen
series
shaft
silica
solar
solder
solenoid
splice
stationary
stator
sublimation
suction
swaging
sweat
switch
tachometer
tension
thermocouple
thermometer
thermostat
toggle
torch
torque
transmission
tubing
utility
vacuum

valve

vapor

ventilation

vibration

voltage

voltmeter

wattmeter

welding

wet-bulb

wrench

zinc

COURSE OF STUDY OUTLINE

Air Conditioning and Refrigeration

Suggested Teaching Aids

Catalogs

The Harry Alter Co. -"Dependabook"- Refrigeration and Air Conditioning Parts
General Headquarters - 2399 S. Archer Ave., Chicago, Ill. 60616
Local - 49-01 Maspeth Ave., Maspeth, Queens, N.Y. 11378

W. W. Grainger, Inc.
55 Jackson Drive, Cranford, N.J. 07016

Tesco Distributors, Inc.
300 Nye Ave., Irvington, N.J. 07111

Luce, Schwab and Kase, Inc.
9 Gloria Lane, Fairfield, N.J. 07006

Charts

Sporlan Valve Company, Education and Training Dept.
7525 Sussex Ave., St. Louis, Missouri 63143

Alco Controls Division - Emerson Electric Co.,Marketing Services Dept.
Box 12700, St. Louis, Missouri 63141

E. I. DuPont de Nemours and Co., Inc. "Freon" Products Division
Wilmington, Delaware 19898

Field Trips

Emerson "Quiet Kool" Air Conditioning Mfg. Co.
St. George and Woodbine Ave., Woodbridge, N.J.

Fedders Air Conditioner Mfg. Co., Woodbridge Ave., Edison, N.J.

Singer Climate Control Products
1300 Federal Boulevard, Carteret, N.J.

Tri-Con Service Inc., Industrial Air Conditioning and Heating
2208 Hamilton Boulevard, South Plainfield, N.J.

Films

General Motors Corporation, Public Relations Film Library
General Motors Building, Detroit, Michigan 48202

Frigidaire Division, Public Relations Dept.
300 Taylor St., Dayton, Ohio 45401

United Delco Division
3044 West Grand Boulevard, Detroit, Michigan 48202

Association of Home Appliance Manufacturers
20 North Wacker Drive, Chicago, Illinois 60606

Filmstrips

Whirlpool Corporation, Service Training Center
Benton Harbor, Michigan 49022

Carrier Air Conditioning Co.
Carrier Parkway, Syracuse, N.Y. 13201

Lennox Industries, Inc., Educational Division
Dept. A-15, P.O. Box 250
Marshalltown, Iowa 50158

Periodicals

Air Conditioning and Refrigeration Business
614 Superior Avenue West, Cleveland, Ohio 44113

Heating, Piping, Air Conditioning
25 Sullivan St., Westwood, N.J. 07675

Appliance Manufacturer
270 St. Paul St., Denver, Col. 80206

Refrigeration Service and Contracting
2720 Des Plaines Ave., DesPlaines, Ill. 60018

A.S.H.R.A.E. Journal
345 E. 47th St., New York, N.Y. 10017

Transparencies

Curriculum Laboratory
Dept. of Vocational-Technical Education
Building 4103 - Kilmer Campus
New Brunswick, N.J. 08903

DCA Educational Products, Inc.
4865 Stenton Avenue
Philadelphia, Pa. 19144

NOTE: Additional material can be obtained from the following catalogs.

Bibliography of Training Aids, 3rd Edition
Compiled by: Air Conditioning and Refrigeration Institute
1815 North Fort Myer Drive
Arlington, Virginia 22209

AHAM - Educational Activities and Teaching Aids
Association of Home Appliance Manufacturers
20 North Wacker Drive, Chicago, Illinois 60606

MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL HIGH SCHOOLS

___New Brunswick ___Perth Amboy ___Woodbridge ___East Brunswick

FINAL EXAMINATION

REFRIGERATION AND AIR CONDITIONING

Grade 10

RELATED THEORY (SHOP)

_____ DATE_____

	SECTION	POSSIBLE SCORE	SCORE
I	True-False	20	_____
II	Multiple Choice	20	_____
III	Completion	10	_____
IV	Matching	10	_____
V	Sequence	20	_____
VI	Problems	20	_____
		100	_____ = _____%
			100

SCORED BY _____

MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL HIGH SCHOOLS

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FINAL EXAMINATION - REFRIGERATION

RELATED THEORY (SHOP) 10

NAME _____ DATE _____ SCORE _____

PART I
TRUE - FALSE
(Value: 1 Point Each; Total 20 Points)

DIRECTIONS: Examine each statement below and decide whether it is true or false. If true, put a T on the line to the left of the exercise. If false, put an F on the line to the left of the exercise.

SAMPLE PROBLEM:

F A. Refrigeration has little effect upon the standards of living or industrial processes.

___ 1. The capacity of a compressor is affected by its speed.

___ 2. Purging increases pressure in the line and helps to add air to the line.

___ 3. The refrigerant absorbs heat in the condenser section of the system.

___ 4. Selection of the proper evaporator depends primarily upon the application of the system.

___ 5. Heat energy that causes change in temperature is sensible heat.

___ 6. Reamers are used for removing metal from outside of a metal tube.

___ 7. The evaporator is sometimes called the high side of the system.

___ 8. Since earliest recorded history, ice was used by some men for preserving food.

___ 9. A good refrigerant should be nonflammable and nonexplosive as a gas, as a liquid, and when mixed with oil.

___ 10. The refrigerant is a liquid as it leaves the condenser.

___ 11. Precooling or subcooling of the liquid refrigerant has the same meaning.

___ 12. High electrical resistance is unnecessary in a refrigerant.

(Con't)

___ 13. Temperature rise is accompanied by a decrease in the speed of molecules.

___ 14. A hermetic unit may be either a reciprocating or rotary type compressor.

___ 15. The freezing of a refrigerant in the evaporator is desirable.

___ 16. A liquid exerts force when heated.

___ 17. Heating copper tubing until it is a dark purple color softens or anneals it.

___ 18. An unfilled space must be left on the top of a cylinder of refrigerant as a safety precaution.

___ 19. The evaporator is a device to reject heat from the refrigeration system.

___ 20. Sensible heat is removed from the refrigerant by the condenser.

PART II
MULTIPLE CHOICE
(Value: 1 Point Each; Total 20 Points)

IRECTIONS: Each of the following statements can be correctly completed by one and only one of the lettered expressions. You are to write the letter which stands for the correct expression on the line to the left of the exercise.

AMPLE PROBLEM:

a A. Refrigeration is
(a) the removing of heat
(b) the adding of heat
(c) the adding of heat and cold
(d) the removing of heat and cold

__ 1. The compressor located in the refrigeration cycle is

(a) between the condenser and receiver
(b) in the liquid line between the receiver and the metering device
(c) between the evaporator and condenser
(d) between the metering device and the evaporator

__ 2. Liquid slugging in the compressor is a result of

(a) excessive compressor speeds
(b) liquid refrigerant or oil in the clearance space of the compressor
(c) incorrect oil in system
(d) wrong refrigerant

__ 3. Hidden heat in refrigeration work is referred to as

(a) intensity of heat
(b) dynamic heat
(c) latent heat
(d) heat a thermometer can "sense"

__ 4. The cooling component of a refrigeration system is called

(a) a valve
(b) a compressor
(c) an evaporator
(d) a condenser

__ 5. For practical purposes, the high side of a refrigeration system includes

(a) the metering device
(b) the compressor
(c) the evaporator
(d) none of the above

(Con't)

____ 6. A mechanical shaft seal is necessary in a

(a) semi-hermetic compressor
(b) hermetic reciprocating compressor
(c) hermetic rotary compressor
(d) open type compressor

____ 7. The main purpose of a condenser is to

(a) store liquid refrigerant
(b) remove heat from the refrigerant
(c) remove impurities from the refrigerant system
(d) add heat to the refrigerant

____ 8. The evaporator is a device to

(a) store liquid refrigerant
(b) absorb heat into the refrigeration system
(c) remove heat from the refrigeration system
(d) none of the above

____ 9. The metering device is designed to

(a) keep the evaporator as cold as possible
(b) to control evaporator superheat
(c) control the flow of refrigerant
(d) to keep a constant evaporator pressure

____10. The Fahrenheit scale is based on boiling water having a sea level temperature of

(a) 459°
(b) 180°
(c) 212°
(d) 100°

____11. A ton of refrigeration is equal to

(a) 2,880,000 BTU per day
(b) 12,000 BTU per hour
(c) 2,000 lbs. per hour
(d) 180 BTU per hour

____12. Superheat is heat added

(a) in changing liquid to vapor
(b) in raising temperature of water
(c) after all liquid has been changed to vapor
(d) to decrease pressure

(Con't)

____ 13. A receiver is used

(a) to condense the refrigerant
(b) to cool the hot gas
(c) to separate the oil
(d) to store refrigerant

____ 14. A capillary is located

(a) in the liquid line feeding the evaporator coil
(b) at the leaving side of the evaporator coil
(c) in the hot gas line
(d) at the condenser inlet

____ 15. The type of threads used on flare fittings are

(a) National Fine
(b) National Coarse
(c) U.S.S.
(d) Briggs Standard Pipe Thread

____ 16. Tubing may be safely bent to the desired radius by use of

(a) pliers
(b) vise
(c) bending springs
(d) none of the above

____ 17. Tubing, after being cut, must be sealed

(a) reasonably soon
(b) immediately
(c) never
(d) within twenty-four hours

____ 18. The tool that is used to clean internal threads is

(a) knife
(b) file
(c) tap
(d) die

____ 19. The purpose of flux, when soldering, is

(a) as a binder
(b) to reduce the melting temperature
(c) used to prevent oxidation
(d) to form a different alloy

(Cont'd)

____ 20. "Wiping" a copper tube joint is

(a) building up a pipe joint
(b) removing excess solder
(c) apply the flux
(d) none of the above

PART III
COMPLETION

DIRECTIONS: The words listed below may be used to aid you in filling in the blanks of the "Completion" test on the following page. The words may be used more than once or you may use your own words. All the words needed to fill in the blanks may not be on the list.

WORD LIST

compressor
vacuum pump
electronic detector
condenser
BTU
dissolve
molecules
sensible heat
cooling coil
potential
pounds
remote
metering device
rise
ice and water bath
elements
latent heat
refrigerant
CFM
lower

PART III
COMPLETION

SAMPLE PROBLEM

A. The energy which moves heat from a low to high temperature level is supplied by a compressor.

PROBLEMS

1. The restriction which is included in the line between the condenser and the evaporator is called a _____.
2. Sensible heat, when added to a material causes the temperature to _____ _____.
3. Periodically a thermometer should be checked for accuracy by using an _____.
4. A compound is a combination of _____.
5. The standard unit of heat measurement in the English system is the _____.
6. Heat which causes a change of state is called _____.
7. Another name that is sometimes used for an evaporator is _____ _____.
8. Hermetic motors are cooled by the _____.
9. The best component to use for the evacuation of a new system, is a _____.
10. The device which can be used safely for detecting a leak for any kind of refrigerant is called an _____.

PART IV
MATCHING TEST
(Value: 1 Point Each; Total 10 Points)

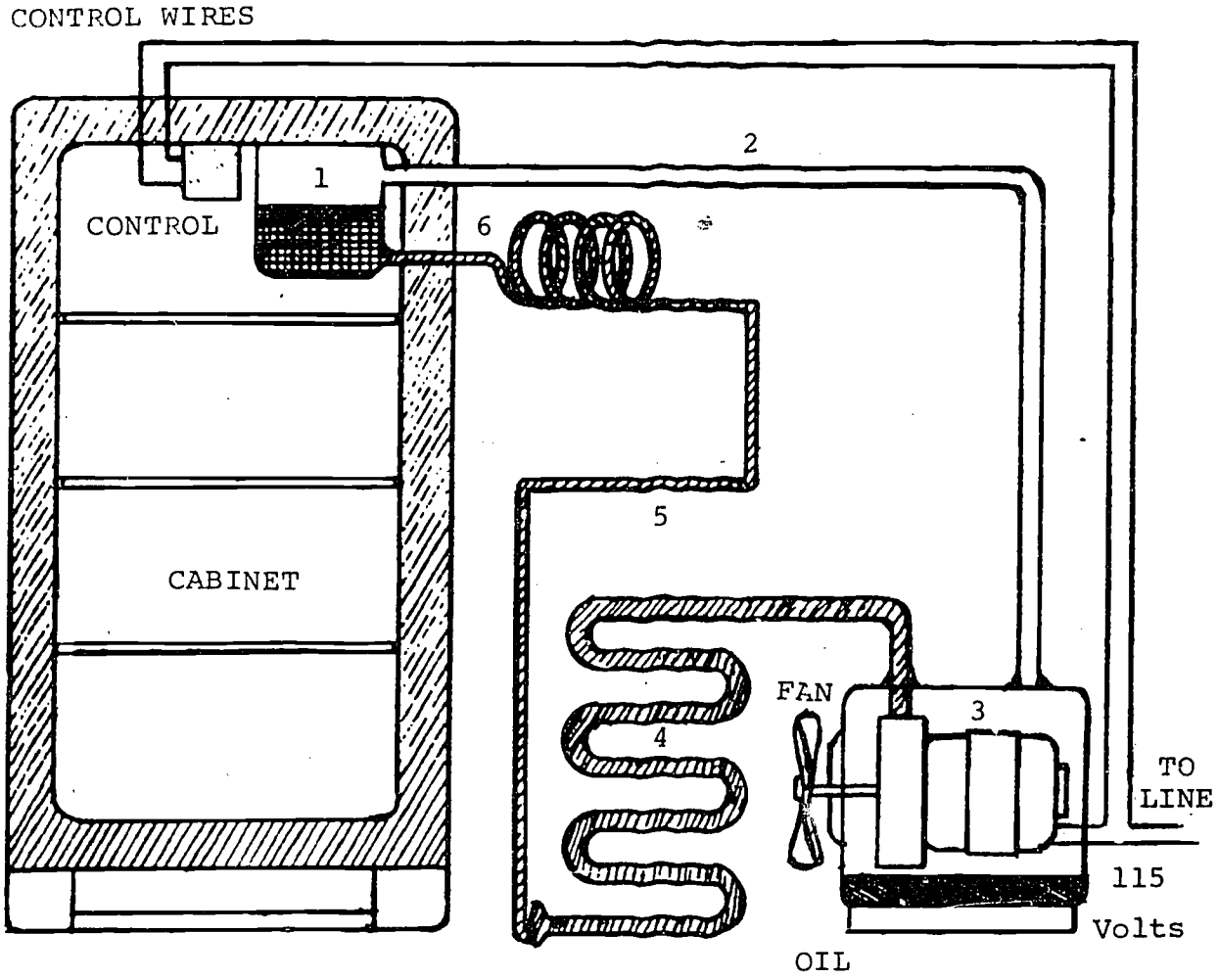
DIRECTIONS: Column A lists some refrigeration terms. Column B contains comparative refrigeration terms. In each blank in Column A place the letter of the answer from Column B you consider correct.

SAMPLE PROBLEM:

COLUMN A	COLUMN B
b 1. The refrigerant is a liquid as it leaves the	(a) water
	(b) condenser
a 2. Requires heating of the drain pan	

COLUMN A	COLUMN B
___ 1. Sensible heat	(a) reciprocating compressor
___ 2. Evaporator	(b) metering device
___ 3. Subtract 32° and multiply by 5/9	(c) removes heat from refrigeration system
___ 4. Has pistons and cylinders	(d) causes a change in temperature
___ 5. Condenser	(e) swaging tubing
___ 6. Capillary tubing	(f) part of the system where the refrigerant absorbs heat
___ 7. Heat required to raise one pound of water, one degree Fahrenheit.	(g) connected to suction service valve
___ 8. Motor surrounded by refrigerant	(h) changing a temperature from F° to C°
___ 9. Compound gauge	(i) Hermetic
___10. Joining tubing without a fitting	(j) BTU

CYCLE OF REFRIGERATION
SCHEMATIC DIAGRAM



1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

PART V
SEQUENCES

DIRECTION: The diagram on the opposite page is the basic refrigeration cycle. Six (6) components are identified by the numbers 1-2-3-4-5-6.

1. On the lines below the sketch write the names of the six components.

2. Indicate the condition or state of the refrigerant in the various components (high or low pressure gas or liquid).

   1. _____

   2. _____

   3. _____

   4. _____

   5. _____

   6. _____

3. Where does the change of state of the refrigerant take place?

   _____

   _____

   _____

4. Indicate the flow of the refrigerant by arrows beside the refrigerant lines.

5. On the blank sheets attached to the booklet describe the function and/or operation of each of the six components.

PART VI
PROBLEMS
(Value: 5 Points Each; Total 20 Points)

DIRECTIONS: There are 10 problems below. You are to answer only four (4) of these problems. Do your calculations on the reverse side of this sheet. Show all calculations in a neat orderly manner. Carry calculations to two decimal places. Write the answers in place or spaces indicated.

The formulas listed below may be used to help solve the following problems.

1. H = (m) (c) (A+)
2. F = c x 9/5 + 32°
3. C = (F-32°) x 5/9
4. R = 460 + F°
5. K = 273 + F°

1. A motor has a rated temperature rise of 50°C. If the ambient temperature is 86°F., what is the continuous running temperature.

Answer (1)_____

2. Change the following

(a) 77°F to C
(b) 35°C to F

Answer (2) a._____
b._____

3. Calculate the compression ratio of the compressor using the data given.

Data
Type refrigerant: R-12 Readings (p.s.i.g.)
Discharge gauge: 150, Suction gauge: 15

Answer (3)_____

4. Name six main parts of a reciprocating compressor.

(a)_____ (d)_____

(b)_____ (e)_____

(c)_____ (f)_____

(Con'td)

5. Give the definition of heat

   Answer (5)

6. What is a B.T.U.?

   Answer (6)

7. Name the three basic methods of heat transfer.

   Answer (7)_____

   _____

   _____

8. What is specific heat?

   Answer (8)

9. A refrigeration system which circulates five pounds of R-12 per minute must subcool the liquid 20°F (from 86°F to 66°F) before it enters the metering device. How many B.T.U.'s are required to secure the results.

   Answer (9)_____

10. Determine the gauge pressure (p.s.i.g.) corresponding to an absolute pressure of 24.7 p.s.i.a.

    Answer (10)_____