NATIONAL VOCATIONAL TRAINING INSTITUTE

TESTING DIVISION

TRADE TESTING REGULATIONS AND SYLLABUS

TRADE: REFRIGERATION AND AIRCONDITIONING SERVICING

LEVEL: CERTIFICATE ONE

Revised – December 2010.

A. INTRODUCTION

i. The review of this syllabus has been generally influenced by the demands of industries due to its continuous change as a result of technological advancement and the changing needs of society.

It was also influenced by the TVET reforms under the directions of the new educational reforms with the view to opening up further education and training opportunities to TVET graduates.

The certificate ONE syllabus is designed to respond to the following level descriptors:

QUALIFICATION	KNOWLEDGE LEVEL	SKILLS AND ATTITUDE:
Certificate 1	1. To demonstrate a broad knowledge base incorporating some technical concepts. 2. To demonstrate knowledge of the theoretical basis of practical skills. 3. To demonstrate knowledge in numeracy, literally, IT and Entrepreneurial skills	1. Require a wide range of technical skills 2. Are applied in a variety of familiar and complex contexts with minimum supervision. 3. Require collaboration with others n a team

ii. The syllabus is aimed at providing Knowledge in the safe handling and uses of Refrigeration and Air-conditioning tools and equipments, materials and gasses, troubleshooting, energy saving methods and also uses of environmentally friendly substances.

B. GENERAL OBJECTIVES

On completion of this course, the trainee should be able to understand and apply:

i) general workshop practice and safety precautions
ii) the handling and use of oxygen/acetylene torch
iii) safe work practice and electrical codes
iv) the principles in Refrigeration/Air-conditioning Installation
v) the principles of food preservation
vi) the safe handling of refrigerants and its uses
vii) and appreciate cleanliness after service

C. THE COURSE COMPONENTS

Trade Theory
Science and Calculation
Trade Drawing
General Paper
Trade Practical

EXAMINATION: The candidates would be examined in the FIVE components listed in 'C' above.

Practical work must be carefully planned to illustrate application of the theory and to provide maximum opportunity for shop practice, laboratory work and demonstration.

D. KNOWLEDGE AND SKILLS REQUIREMENT

The prime objective of the programme is to provide knowledge and skills of the trade in a manner that will best meet the needs of the trade as well as industries using professional equipments

E. ENTRY TO THE COURSE

Minimum education : Must have passed JHS or SHS examination. However, the selection of the students for the course is within the discretion of the head of the institution.

F. ELIGIBILITY FOR ENTRY TO EXAMINATION

Candidates may enter for examination only as internal candidate; that is those who at the time of entry to the examination are undertaking (or) have already completed the course at an approved establishment.

G. EXTERNAL EXAMINERS

The practical work of candidates will be assessed by an external examiner appointed by the Trade Testing Commissioner.

H. EXAMINATION RESULTS AND CERTIFICATES

Each candidate will receive record of performance given the grade of performance for the components Taken. These are:

i) Distinction
ii) Credit
iii) Pass
iv) Referred/Failure

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Certificates would be issued to candidates who pass in all the components.

NOTE:

All Technical and Vocational trainees who aspire to take advantage of the opportunities opened to them in the educational reforms should NOTE that, for a trainee to progress to certificate Two (2) a pass in Certificate One (1) is compulsory.

I. APPROVAL OF COURSE

Institutions or other establishments intending to prepare trainees for the Examination must apply to:

THE COMMISSIONER
TESTING DIVISION
NVTI HEAD OFFICE
P. O. BOX MB 21, ACCRA

J. ACKNOWLEDGEMENT

NVTI wishes to acknowledge the preparatory material done by the team of Experts, which have been incorporated into this syllabus.

Ms. Lydia Toku – Diploma (Ed.) Ref.III
Mr. Frank Davies Agamah (B Tech. Ed) UK
Mr. Robert Amontcho (F.T.C.)

Government's desire to improve the lot of Technical/Vocational Training, which led to the preparation of this syllabus, is hereby acknowledged.

K. RECOMMENDED BOOKS

1. Principles of Refrigeration by C. Thomas Oliver
2. Ref and Air-conditioning Tech. (MOTIVATE.) By N. Cook
3. Fundamentals of Refrigeration & Air-conditioning by Billy Langley
4. Refrigeration and Air-conditioning Technology: by William C. Whitman
5. Processes and Materials by Chapman
6. Tropical Refrigeration & Airconditioning by L.W. Cottel and S. Olarewaju
7. Refrigeration & Airconditioning and Cold Storage by Raymond Gunther

8. Engineering Science by Hughes and Hughes
9. Fundamentals of Automotive Air Conditioning by Boyce H. Dwiggins
10. Engineering Drawing and Construction by L.C. Mott
11. Internet

LIST OF TOOLS AND EQUIPMENT

1. Long Nose Plier
2. Plier (Combination
3. Side Cutting Plier
4. Hacksaw Frame and Blades
5. Hammer (Ball pein)
6. Hammer (Claw)
7. Mallet
8. Flare Nut Wrench
9. Ratchet Box Wrenches
10. Tube Cutter
11. Set of Flaring Tools
12. Set of Swaging Tools
13. Tube Bender (Mechanical)
14. Bending Springs / All Sizes
15. Manifold Gauge /Hoses
16. Ohmmeter
17. Voltmeter
18. Clamp-on ammeter
19. Set of screw drivers
20. Set of hexagonal wrenches
21. Set of adjustable wrenches
22. Electric hand drill (power)
23. Oxy-acetylene welding set/nozzles
24. Vacuum pump
25. Recovery machine
26. Charging scale
27. Leak detectors
28. Belt tension gauge

29. Revit gun
30. Bench vice
31. Various hand files
32. Pinch-off tool
33. Set of allen wrenches
34. Junior hacksaw
35. Thermometer (calibrated and digital)
36. Sling psychrometer
37. Cold chisel (all sizes)
38. Tap /die stocks
39. Wire brush
40. Concrete Cutting machine/Cutting disk

CERTIFICATE ONE – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0.	GENERAL WORKSHOP PRACTICE	Rules and regulations	• Safety precautions • First Aid • Electric shock • Burns • Workshop arrangement and cleanliness	• Discussion on workshop safety rules and regulations
2.0	TOOLS, INSTRUMENTS AND EQUIPMENT	Common tools, instruments and equipment	• Identification • Selection • Uses • Care • Maintenance	• Discussion on uses of common tools, equipment and instrument
3.0	OXY-ACETYLENE EQUIPMENT	Handling of oxy-acetylene equipment • Transporting • Processes	• Hose colour code • Opening and closing of the regulators • Purpose of check valve • Set the flames i.e. o Neutral flame o Carbonizing flame o Oxidizing flame	• Explain parts and functions, • Demonstrate various processes
4.0.	PHYSICAL PROPERTIES OF METALS	Properties of metal • Ferrous metal • Non ferrous metal	• Elasticity • Ductility • Toughness • Brittleness etc. E.g. of ferrous metal • Steel, high carbon-steel etc. E.g. Non ferrous metal • Aluminium • Lead • Copper etc.	• Identification of ferrous/ non ferrous materials • Laboratory experiment on properties of materials

CERTIFICATE ONE – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
5.0.	PLASTICS	Plastic materials	Differentiate between • Thermoplastic plastics • Thermosetting plastics	Discussion with trainee on different types of plastics and uses
6.0.	ELECTRICAL COLOUR CODING	Importance of colour coding	Explain • Colour coding • Single phase • Three phase	Lecture/discussion on colour coding of electrical wires
7.0.	TERMINAL IDENTIFICATION	Identify terminals Live, Neutral and Earth (L. N. E.)	Terminals of : i. Single phase motors ii. Three phase motors	Lecture and discussions
8.0	OVERLOAD PROTECTORS	Working principle of overload protectors	• Explain the work of overload protectors • Types of overload protectors	Lecture/Discussion Using Chart or real object
9.0	COMPRESSORS	• Types • Classification	Distinguish between • Reciprocating compressor • Rotary compressor • Hermetic compressor • Semi-hermetic compressor	Explain/discuss using real objects as in sub point
10.0	EVAPORATORS	• Types • Classification Types	Distinguish between: • Flooded • Dry or direct Forms or styles: • Bare tube • Plate surface • Finned	Explain/discuss using chart or real objects
11.0	CONDENSERS	Type of condensers	Distinguish among • Air cooled • Water cooled • Evaporative	Lecture/discussions with chart or real objects.

CERTIFICATE ONE – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
12.0	FLOW CONTROLS	Types of flow controls	Explain the various types of flow controls: • Capillary tube • A.E.V • T.E.V. • Hand expansion valve	• Lecture/discussion with real objects
13.0	COOLING TOWERS	The function of a cooling tower	Explain the types: • Natural • Induced or forced	• Lecture/discussion and plant tour to industrial site
14.0	REFRIGERANTS	Handling and storage of refrigerants	Explain the following refrigerants: • Hydro carbons • Azeotropic mixtures. • Ozone friendly refrigerants • Cylinder colour code of refrigerants • Properties of refrigerants • Specific uses • Chemical name of refrigerant • Chemical formulae of refrigerants • Boiling and freezing point of refrigerants • State the EPA regulations on venting refrigerant vis-à-vis penalty there of.	• Lecture and discussion as in sub points

CERTIFICATE ONE – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
15.0	BASIC REFRIGERATION CYCLE	The working principles of refrigeration cycle	The basic principles of refrigeration • Explain refrigeration cycle • Determine the state and conditions of refrigerant at various points in the system	• Lecture/Demonstration
16.0	REFRIGERATION ACCESSORIES	The function of the various accessories	The function of the various refrigeration accessories: • Driers • Accumulators • Mufflers • Oil separators • Sight glasses • Check valve • Etc	• Lecture/discussion with real objects
17.0	CHARGING OF OIL	The importance of oil in the compressor	• The methods of charging oil • The purpose of oil in the compressor	Lecture/discussion
18.0	DEHYDRATION	Understand dehydration	The purpose of: • Adsorption Desiccants • Absorption Desiccants	Lecture / discussion
19.0	LEAK DETECTION	The various leak detection methods	Explain methods of leak detection: • Soap solution • Halide torch • Litmus paper • Electronic leak detector	Lecture/discussion
20.0	EVACUATION	Methods of evacuation	• The methods of evacuation • The importance of evacuation	Lecture/demonstration

CERTIFICATE ONE – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
21.0	Charging of Refrigerant	The methods of charging refrigerant	Ways of introducing refrigerant into the system	Lecture /demonstration
22.0	Scope of Refrigeration	The various applications of refrigeration	The following refrigeration applications • Domestic • Commercial • Industrial • Transport • Air conditioning • Automobile airconditioning	Lecture/Field trips
23.0	AIRCONDITIONING	The basic principles of air conditioning	Basic principles of air conditioning • Distinguish between the various types of air-conditioning systems • Identify various components and their functions	Discussion/Lecture
24.0	FOOD PRESERVATION	Methods of food preservation	Methods of food preservation • Refrigeration • Drying • Salting • Smoking • Frying • Storage temperature • Freezing temperature	Lecture / Discussion
25.0	CLEAN-UPS	Importance of keeping a working area clean	the need of cleaning the customer's premises after work. • Floors • Walls • Ceilings • General working area	Lecture/discussion

CERTIFICATE ONE – TRADE SCIENCE AND CALCULATIONS

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0	PROCESSES OF REFRIGERATION	Processes of refrigeration cycle	• Define a process • The four processes i. Compression ii. Condensation iii. Expansion iv. Evaporation	Lecture Discussion
2.0.	MATTER	Forms of matter and its properties	The various forms of matter and • Liquids • Solids • Gas • Atom • Molecules • Electrons • Elements etc.	*Lecture*
3.0.	BEHAVIOUR OF MATTER	The behaviour of matter	• Define energy • Types of energy Force, motion, work power, horse power, density, volume, mass, specific volume, specific gravity, acceleration, time, velocity	Lecture and laboratory exercise
4.0.	HEAT	The Movement and calculation of heat	• Definition of heat • Transfer of heat conduction, radiation Convection • Kinds of heat sensible heat,Latent heat, specific heat	Lecture and laboratory exercise
5.0.	INTENSITY OF HEAT	Conversion and measurement of temperature	Temperature scales Temperature conversion Types of thermometer	Lecture/Discussion /Demonstration

CERTIFICATE ONE – TRADE SCIENCE AND CALCULATION

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
6.0.	PRESSURE	The various forms of pressure applied to refrigeration and airconditioning	Explain Pressures: • Atmospheric • Gauge • Absolute • Critical	Discuss/Lecture
7.0.	LAWS AFFECTING PRESSURE	Calculate laws affecting refrigeration system	Pressure laws • Boyles • Charles • Dalton's • Pascal • General gas	Discuss lecture
8.0.	INTRODUCTION TO PRESSURE HEAT DIAGRAM	The basic application of Mollier chart	i. Define mollier chart ii. The lines on the mollier chart iii. Mollier chart to represent the refrigeration cycle	Define mollier chart and discuss with diagram
9.0.	PSYCHROMETRY	The basic application of psychrometer	• The lines on the psychrometric chart • The sling psychrometer • Psychrometric chart to determine the followings: i. a relative humidity ii. wet bulb temperature iii. dry bulb temperature iv. dew point etc.	Lecture/Discussions/Demonstration

CERTIFICATE ONE – TRADE SCIENCE AND CALCULATION

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
10.0	PRINCIPLES OF ELECTRICITY	The basic principles of electricity	• Describe the structure of an atom • Identify negative and positive charges • Explain conductors and insulators • Describe magnetism • Differentiate between direct and alternating current • List unit for i. Current ii. Voltage iii. Resistance • Differentiate between the following circuits: i. Series ii. Parallel • State Ohm's Law • Calculate for electrical power	Lecture/ Discussion/ Demonstration/ Illustration
11.0	CAPACITORS	The function of capacitors	• Define capacitor • Types of capacitors • Calculate capacitance in both series and parallel Circuits • Unit and rating of capacitor	Discussion/ Lecture
12.0	ELECTRONIC TOOLS	Common tools	Explain the functions of tools: • Screw drivers • Soldering iron • Analogue/digital meters	Lecture/Discussion

CERTIFICATE ONE – SCIENCE AND CALCULATION

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
13.0	ELECTRONIC COMPONENTS	Test and re-place electronic components	Components: • Resistors • Transistors • Transformers • I.Cs • Printed circuits • Diodes etc.	Discussions and demonstration with real objects
14.0	SOLDERING AND DE-SOLDERING	Use soldering iron to solder or desolder Leads	Explain how to use soldering iron and sucker to remove or fix electronic components	Discussions/ demonstration
15.0.	CHILLERS	The function of chillers	• Explain the work of chillers • Types of chillers • Application	Lecture Discussion Demonstration with site visits.

CERTIFICATE ONE – TRADE DRAWING

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0.	INTRODUCTION TO TRADE DRAWING	The importance of trade drawing	Explain the importance of drawing: • Tools • Components • Various symbols	Demonstration with real objects.
2.0.	FREEHAND DRAWING	Capable of sketching	Sketching of: <u>Tools</u> • Plier • Hacksaw blade • Tube cutter • Tube bender • Screw drivers etc. <u>Equipment</u> • Vacuum pump • Air blower • Welding equipment etc. <u>Instruments</u> • Voltmeter • Ohmmeter • Ammeter • Sling psychrometer, etc.	Demonstration and guide trainees to practice free hand sketching as in sub point
3.0.	DRAWING OF REFRIGERATION COMPONENTS	The various components	Draw: • Compressors • Condensers • Expansion valves • Evaporators	Demonstration and Practice
4.0.	ACCESSORIES	The various accessories	Draw: • Dehydrators • Sight glass • Heat exchangers • Accumulator • Liquid receivers etc.	Demonstration and practice

CERTIFICATE ONE – TRADE DRAWING

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
5.0.	Symbols of Refrigeration	Types of symbols	Mechanical symbols Electrical symbols	Demonstration/ Illustration
6.0.	Basic Gauge Manifold	Gauge manifold parts	Draw gauge manifold and label the internal parts.	Demonstration
7.0.	Basic Refrigeration Cycle	Refrigeration cycle	Draw the basic refrigeration cycle Indicate the flow of refrigerant	Demonstration
8.0.	Refrigeration Cycle	Refrigeration cycle	Draw refrigeration cycle and Incorporate accessories: • Drier • Sight glass • Accumulator • Muffler etc.	Demonstration
9.0.	Connecting Gauge Manifold	The gauge manifold to refrigeration system	• Refrigeration cycle • Manifold gauge • Vacuum pump • Refrigeration cylinder	Demonstration
10.0	Refrigeration Cycle Using Symbols	Symbols of Refrigeration cycle	Refrigeration circuit using symbols	Demonstration
11.0	Electrical Refrigeration Circuit	Circuit with symbols	Draw electrical circuit of: • Refrigerators • Air conditioners • Using symbols	Demonstration

CERTIFICATE ONE – TRADE PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
1.0	GENERAL WORKSHOP PRACTICE	Understand the various workshop safety practice	First aid for: • Burns • Electric shock • Frozen eyes • Gas poisoning	Discuss the various safety measures and practices
2.0.	TOOLS, EQUIPMENT AND INSTRUMENT	Tools for Refrigeration and Airconditioning Servicing	Maintenance of the following tools, equipment and instrument: • tube cutter • vacuum pump • set of pliers • set of adjustable wrenches • oxy-acetylene welding set • voltmeter etc.	Demonstrate the uses and maintenance of the following tools, equipment and instrument
3.0.	TUBE CUTTING	Know how to cut tube	• Measurement of tube • Cutting of tubes • Reaming of tubes	Demonstrate the cutting of tubes
4.0.	BENDING OF COPPER AND STEEL PIPES	Techniques of bending copper and steel pipes	Purpose of copper and steel pipes	Demonstrate the technique of bending
5.0.	FLARING AND SWEDGING OF COPPER PIPES	• Flaring tools • Swedging tools	Handle and use the flaring and swedging tools	Demonstrate safe use of flaring and swedging
6.0.	Hard and Soft Soldering and Brazing Alloys/ Flux or Borax	• Oxy-acetylene set-up • Undersatand Techniques in the application of flux	• Set up and operate oxy-acetylene equipment in a given situation • Adjust the flame: • Carbonizing • Oxidizing • Neutral • Safety precaution should be observed • Apply flux	Demonstrate the use of oxy-acetylene equipment. Sketch different types of flames and its application

CERTIFICATE ONE – TRADE PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
7.0.	CUTTING AND THREADING PIPES	Types of screw thread, taps and dies	Explain and state the functions of: • Taps (taper tap, second tap, plug/button tap) • Tap wrench • Dies and dies stock	• Demonstrate thread cutting and cutting with trainee activity
8.0	PARTS OF REFRIGERATION COMPRESSORS	Parts of refrigeration compressors	Visualize hermetic compressor parts • Reciprocating • Rotary	Demonstrate with real object the parts of hermetic compressor
9.0.	REFRIGERATION SYSTEM	Evacuation methods	Deep evacuation Triple evacuation	Demonstrate with vacuum pump how to evacuate
10.0	CHARGING OF REFRIGERATION SYSTEM	Charge the refrigeration system with refrigerant and oil	Charge the system with the following: • Refrigerant • Oil	Demonstrate the charging of refrigerant and oil
11.0	LEAK DETECTION	Various methods of leak detection	Methods: • Immersion • Soap solution • Litmus paper • Halide torch • electronic	Demonstrate various methods
12.0	THE USE OF GAUGE MANIFOLD	Functions of gauge manifold	• Connect the low and the high pressure gauges • Readings on the compound and pressure gauges	Demonstrate how to use the manifold gauge
13.0	CONNECTING OF PRESSURE CONTROLS	The connecting of pressure control	• Connect L.P.C in a circuit • Connect H.P.C. in a circuit • Connect dual pressure control	Demonstrate with real object the connection of pressure controls

CERTIFICATE ONE – TRADE PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
14.0	INSTALLATION OF EXPANSION VALVES	Expansion valve connection	Connect or join: • Capillary tube • A.E.V • T.E.V.	Demonstrate how to connect or join: • Capillary tube • A.E.V • T.E.V
15.0.	HANDLING OF REFRIGERANT OIL	Safe handling of refrigerant oil	• Dryness of the oil • Prevention of contaminants • Storage of oil in a clean and dry container	Explain the handling of refrigerant oil
16.0	COMPRESSOR TERMINAL IDENTIFICATION	• Single phase compressor • Three phase compressor	Identify terminal of i. single phase compressor ii. three phase compressor	Practice with the ohmmeter Identification of terminals
17.0	ELECTRICAL SYMBOLS FOR REFRIGERATION	Electrical Symbols	• Symbols of the various electrical components • Fixing of plug tops	Practice the drawing of electrical symbols using the real component.
18.0	DRAWING OF SIMPLE REFRIGERATION CIRCUIT SYMBOLS	Symbols of refrigeration circuit	• Use symbols to draw refrigeration circuit	Practical drawing using symbols (Schematic drawings)
19.0	ELECTRICAL INSTRUMENT	Common electrical instruments	Type of electrical instruments: • Ammeter • Voltmeter • Ohmmeter	Demonstrate with real object the use of the instrument
20.0	CONNECTION OF CAPACITORS	The two methods of capacitor connections	Series and parallel connections	Explain with real object the two connections of capacitors.

CERTIFICATE ONE – TRADE PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
21.0	MAINTENANCE OF FAULTY FINS	Maintenance of faulty fins	• Cleaning and straightening of fins using fin comb • Burglar proof to protect the fins	Illustrate how to clean, straightening with fin comb
22.0	MAINTENANCE OF OXY-ACETYLENE TORCH	Oxy-acetylene equipment Parts and care	• Changing of tip • Cleaning hoses • Testing of leaks on the hoses • Cleaning of tips	Explain the maintenance of oxy-acetylene equipment
23.0	FREEHAND SKETCHING OF COMPONENTS	Refrigeration components	• Draw components of compressor • Condenser • Expansion valve • Evaporator etc.	Practice the drawing of various components

LEVEL – CERTIFICATE ONE – TEST SPECIFICATION TABLE
TRADE THEORY (OBJECTIVE)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Tools, Instruments and Equipment	1	1	2	4
2.	Physical Properties of Metals	2		2	4
3.	Terminal Identification	1	1	1	3
4.	Compressors	1	1	1	3
5.	Condensers	1		1	2
6.	Flow Controls	1		1	2
7.	Evaporators	1		1	2
8.	Refrigerants	1		1	2
9.	Accessories	1	1	1	3
10.	Evacuation		1		1
					25

LEVEL – CERTIFICATE ONE – TEST SPECIFICATION TABLE
TRADE THEORY (SUBJECTIVE)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Airconditioning	1	2	2	5
2.	Charging	1	1	2	4
3.	Basic Refrigeration Cycle	1	2	2	5
4.	Food Preservation	2	1		3
5.	Dehydration	1	1	3	5
					22

LEVEL – CERTIFICATE ONE – TEST SPECIFICATION TABLE
TRADE SCIENCE AND CALCULATIONS (OBJECTIVES)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Processes of Refrigeration	1	1	1	3
2.	Matter	2	1	1	4
3.	Heat	2	1	1	4
4.	Pressure	1	1	2	4
5.	Psychrometry	1	-	1	2
6.	Principle of Electricity	1	1	2	4
7.	Capacitors	1	-	1	2
8.	Electronics	1	-		1
9.	Chillers	1	-		1
					25

LEVEL – CERTIFICATE ONE – TEST SPECIFICATION TABLE
TRADE SCIENCE AND CALCULATIONS (SUBJECTIVES)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Matter	2	2	1	5
2.	Heat	2	1	2	5
3.	Pressure	1	1	1	3
4.	Psychrometery	2	1	1	4
5.	Electricity and Electronics	2	2	1	5
6.	Chillers	1	1	1	3
7.					25

LEVEL – CERTIFICATE ONE – TEST SPECIFICATION TABLE
TRADE DRAWING

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Introduction to Drawings	1	2	2	4
2.	Freehand Sketches	1		3	3
3.	Refrigeration Components	1	1	2	3
4.	Symbols	2		2	4
5.	Refrigeration Cycle	1	2	2	5
6.	Electrical Circuit	1	2	2	6
7.					25

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TRADE: REFRIGERATION AND AIRCONDITIONING SERVICING

LEVEL: CERTIFICATE TWO

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The certificate TWO syllabus is designed to respond to the following level descriptors:

QUALIFICATION	KNOWLEDGE LEVEL	SKILLS AND ATTITUDE:
Certificate II	1. To demonstrate broad knowledge base with substantial depth in area(s) of study. 2. To demonstrate a command of analytical interpretation of range of data. 3. To present results of study accurately and reliably.	1. Needs varied skills and competencies in different tasks under various contexts. 2. Require a wide range of technical and supervisory skills. 3. Would be employed in different contexts.

ii. The syllabus is aimed at providing advance knowledge in the safe handling and uses of Refrigeration and Air-conditioning tools and equipments, materials and gasses, troubleshooting, energy saving methods and also uses of environmentally friendly substances.

B. GENERAL OBJECTIVES

On completion of this course, the trainee should be able to understand and apply:

i) the safe methods of defrosting and draining of condensate water from evaporator surfaces
ii) skills to insulate suction lines.
iii) methods of cleaning the system by dehydration
iv) the systematic method of installing split Air-conditioner and troubleshooting them
v) the functions of transformers
vi) skills for charging of refrigerant and oil in the system
vii) customer service skills and ensure cleanliness

C. THE COURSE COMPONENTS

Trade Theory
Science and Calculation
Trade Drawing
Trade Practical
General Paper

EXAMINATION: The candidates would be examined in the FIVE components listed in 'C' above.

EXAMINATION:
Practical work must be carefully planned to illustrate application of the theory and to provide maximum opportunity for shop practice, laboratory work and demonstration.

D. KNOWLEDGE AND SKILLS REQUIREMENT

The prime objective of the programme is to provide knowledge and skills of the trade in a manner that will best meet the needs of the trade as well as industries using professional equipments

E. ENTRY TO THE COURSE

Minimum education: Must have passed the Certificate One (I) examination.

F. ELIGIBILITY FOR ENTRY TO EXAMINATION

Candidates may enter for examination only as internal candidate that is those who at the time of entry to the examination are undertaking (or) have already completed the Foundation level and Certificate One at an approved establishment).

G. EXTERNAL EXAMINERS

The practical work of candidates will be assessed by an external examiner appointed by the Trade Testing Commissioner.

H. EXAMINATION RESULTS AND CERTIFICATES

Each candidate will receive record of performance given the grade of performance for the components Taken. These are:

ii) Distinction
iii) Credit
iv) Pass
v) Referred/Failure

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All Technical and Vocational trainees who aspire to take advantage of the opportunities opened to them in the educational reforms should NOTE that, for a trainee to progress to certificate Two (2) a pass in Certificate One (1) is compulsory.

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K. RECOMMENDED BOOKS

1. Principles of Refrigeration by C. Thomas Oliver
2. Ref and Air-conditioning Tech. (MOTIVATE) By N. Cook
3. Fundamentals of Refrigeration & Air-conditioning by Billy Langley
4. Refrigeration and Air-conditioning Technology: by William C. Whitman
5. Processes and Materials by Chapman
6. Tropical Refrigeration & Air-conditioning by L.W. Cottel and S. Olarewaju
7. Refrigeration & Air-conditioning and Cold Storage by Raymond Gunther
8. Engineering Science by Hughes and Hughes
9. Fundamentals of Automotive Air Conditioning by Boyce H. Dwiggins
10. Engineering Drawing and Construction by L.C. Mott
11. Internet

L. LIST OF TOOLS AND EQUIPMENT

1. Long Nose Plier
2. Plier (Combination)
3. Side Cutting Plier
4. Hacksaw Frame and Blades
5. Hammer (Ball Pein)
6. Hammer (Claw)
7. Mallet
8. Flare Nut Wrench
9. Ratchet Box Wrenches
10. Tube Cutter
11. Set Of Flaring Tools
12. Set Of Swaging Tools
13. Tube Bender (Mechanical)
14. Bending Springs / All Sizes
15. Manifold Gauge/ Hoses
16. Ohmmeter
17. voltmeter
18. clamp-on ammeter
19. set of screw drivers
20. set of hexagonal wrenches
21. set of adjustable wrenches
22. electric hand drill (power)
23. oxy-acetylene welding set/nozzles
24. vacuum pump
25. recovery machine
26. charging scale
27. Leak detectors
28. belt tension gauge
29. revit gun
30. bench vice
31. various hand files
32. pinch-off tool
33. set of allen wrenches
34. junior hacksaw

35. thermometer (calibrated and digital)
36. sling psychrometer
37. cold chisel (all sizes)
38. tap /die stocks
39. wire brushes
40. Concrete Cutting Machine/Cutting Disk

CERTIFICATE TWO – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0.	CLEANING	Know how to remove contaminants	Explain how to remove contaminants: • Solids • Liquid and gases	• Lecture • Discussion
2.0.	DEHYDRATION	The purpose of dehydration	Explain the purpose of drying the system: Type of driers • Adsorption Absorption	• Lecture • Demonstration • Discussion
3.0.	CHARGING A SYSTEM	The process of charging a system with refrigerant.	Show the correct procedure of charging a system • Refrigeration oil • Refrigerant	• Lecture • Demonstration
4.0.	DEFROSTING	The methods of defrosting	Identify the methods of defrosting: • Manual • Electric • Hot gas • Water • Hot-gas thermo bank	• Lecture, • Demonstration • Discussion
5.0	DRAINAGE	The angle at which condensate water flows into drain	Illustrate how to install drain lines on: Split unit	• Lecture • demonstration
6.0.	INSULATION	The purpose of insulation	• Identify insulation materials. • Purpose of insulation on pipes, walls and ducts	Demonstration/ Discussion
7.0.	INSTALLATION OF AIRCONDITIONERS	How to install air conditioners	Illustrate the procedure for installing air-conditioning: • Split unit • Central unit • Automobile • Package units	• Lecture • Discussion • Site visits

CERTIFICATE TWO – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
8.0.	TROUBLESHOOTING	The ability to diagnose a unit	Interpret the procedures of diagnosing faults on: • Refrigerating units • Air-conditioning units	• Discussion • Lecture
9.0.	ROUTINE SERVICING	Routine servicing	Servicing plan for: • Refrigerators • Airconditioners	• Discussion
10.0	TRANSFORMERS	The functions of transformers	• Explain the work of a transformer • Step-down • Step-up • Stabilizer	
11.0	FOOD PRESERVATION	The importance of food preservation	State various methods of food preservation. • Refrigeration • Drying • Blanching etc. • Freezing temperature • Storage temperature	• Lecture • Discussion
12.0	MICRO-ORGANISMS	The effect of micro-organisms	Elaborate on the types of micro-organisms: Bacteria Moulds Enzymes	• Discussion • Lecture
13.0	CLEAN-UPS	The purpose of cleaning	Clean up all working area after installation and servicing: • Floors • Walls • Ceilings • Etc.	• Discussion

CERTIFICATE TWO – TRADE SCIENCE AND CALCULATION

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0.	PRESSURE LAWS	The effect of pressure law on refrigeration system	State and calculate the various pressure laws: Boyles Charles Pascals Dalton's General gas	• Illustrations • Discussions
2.0.	AIRCONDITIONING PROCESSES	The air-conditioning processes	• Humidification • Dehumidification • Filtration • Air movement • Cooling/heating etc	• Discussions
3.0.	PRESSURE HEAT DIAGRAM	Use the mollier chart in calculation	Calculate for the following parameters: • Refrigeration effect • Heat of compression • Heat absorbed in the evaporator • Heat rejected in the condenser • Sensible heat • Latent heat etc.	
4.0.	EXPANSION	The expansion of solids, liquids and gases	• Linear expansion • Superficial expansion • Cubical expansion	• Illustration • Discussion
5.0.	PSYCHOMETRIC CHART	Plot and determine the properties of air	• Humidity • Dew point • Grains of moisture • Enthalpy • Relative humidity etc.	• Illustration • Discussion

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
6.0	HEAT LOAD	The estimation of heat load	• Load sources • Product load • Wall gain load • Supplementary load • Air change load etc.	• Illustration • Discussion
7.0.	ELECTRICAL CIRCUITS	Calculate the resistance of various circuits	Define resistance Calculate the resistance in series, parallel and both series and parallel	• Illustration • Discussion
8.0.	ELECTRICAL CIRCUITS	Define and calculate	Electrical power Electrical energy Inductance Transformer	
9.0.	CAPACITORS	Know the function of capacitor	• Define capacitor • Types of capacitor • Calculate for capacitance i. Series ii. Parallel	• Illustration • Discussion
10.0	ELECTRONIC TOOLS	Know the work of tools	Explain the functions of tools: • Screw drivers • Soldering iron • Analogue/digital meters	• Discussion
11.0	SOLDERING AND DESOLDERING	Use the soldering iron to solder or desolder	Explain how to use soldering iron and sucker to remove or fix electronic components	• Discussion
12.0.	ELECTRONIC COMPONENTS	Test and replace electronic components	Components • Resistors • Capacitors • Transformers • ICS • Printed circuit • Diodes etc.	• Discussion
13.0	CHILLERS	Understand the function of chillers	Explain the purpose of chillers: • Application of chillers • Types of chillers	• Discussion • Plan site visits

CERTIFICATE TWO –TRADE DRAWING

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
1.0	INTRODUCTION TO TRADE DRAWING	The importance of trade drawing	• Explain the importance of drawings • Identification of components • Identification of symbols	• Demonstration
2.0.	FREEHAND DRAWING	Capable of Drawing and Labelling	Tools: • Equipment • Instruments	• Demonstration
3.0.	REFRIGERATION COMPONENTS	Capable of drawing and labeling	• Components • Accessories • Humidifiers • Dehumidifiers	• Demonstration
4.0.	SYMBOLS OF REFRIGERATION	Show and interpret drawing	• Mechanical symbols • Electrical symbols	• Discussions
5.0.	GAUGE MANIFOLD	Drawing and labeling	Sketch and label the internal construction of a gauge manifold digital or analogue .	
6.0.	COMMERCIAL REFRIGERATION	Sketch refrigeration cycle	Draw refrigeration cycle incorporating: • Evaporative condenser • Cooling tower Flooded evaporator, etc.	
7.0.	ELECTRICAL REFRIGERATION CIRCUITS	Capable of drawing circuit with symbols	Draw electrical circuits • Refrigerators • Airconditioners • Three phase Refrigeration wirings Three phase air conditioning wirings	• Demonstration
8.0.	ELECTRICAL COMPONENTS	Draw various components	Drawing of the followings: • Thermostat • Overload protector • Fuse • Breaker etc.	

CERTIFICATE TWO – TRADE PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
1.0	DEFROSTING	Methods of defrosting a refrigeration system	Explain the method of defrosting: • manual defrosting • Temperature • Hot gas • Electric • water • Brine	• Discuss the methods of defrosting using real objects
2.0	REFRIGERATION ACCESSORIES	The function and maintenance of accessories	Explain the various accessories • Drier • Strainer • Accumulator • Check valve • Moisture indicator • Sight glass • Solenoid valve etc.	• Discuss the function and maintenance of accessories using real object
3.0	DEHYDRATION	The function of driers	Explain the importance of dehydration • Absorption of moisture • Liquid line driers • Suction line driers	• Demonstrate how to dehydrate the refrigeration system using real objects
4.0	EVACUATION	The methods of evacuation	Emphasize on the methods of evacuation • Deep evacuation • Triple evacuation	• Demonstrate how to evacuate the refrigeration system
5.0	INSTALLATION OF AIRCONDITIONER	The installation of air conditioners	Explain the procedure for installing air conditioners • Package unit • Split unit • Central unit, etc	• Demonstrate the installation of air conditioners. • Plan Site visits

CERTIFICATE TWO - TRADE PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
6.0	INSULATORS	The function of insulators	Identify various type of insulating materials • Cork • Armmaflex • Fibre glass • Insulation of suction pipes • Discharge ducts, etc	• Demonstrate the insulation of suction pipes and ducts using real objects
7.0.	REFRIGERATION WIRING	Refrigeration wiring • Single Phase • Three Phase	Do refrigeration wiring involving the following: • Electric heaters • Timer • H. P. C. • L. P. C. • Thermostat • Relays • Overloads, etc • Door Switch system • Mullion Condensate Heaters	• Demonstrate how to wire a refrigeration
8.0	AIR CONDITIONING WIRING	Air conditioning wiring	Do the wiring of the following: • Packaging unit • Split unit • Central unit • Automobile air conditioners	• Demonstrate how to wire air conditioning unit
9.0	MAINTENANCE OF REFRIGERATING AIR CONDITIONING EQUIPMENT	Routine maintenance of equipment in refrigeration and air conditioning.	Cleaning of the following: • Filters • Condensers • Evaporators • Straightening of fins • Check pressure • Lubricate moving parts • Carry out efficiency test, etc.	• Demonstrate the procedure of maintenance and servicing of Refrigeration/Air conditioning system.

			• Drainage Lines	
10.0	RECOVERY	How to use the recovery machine	Removal of refrigerant from the system • Recovery • Recycling • Reclaiming (R.R.R.)	• Demonstrate the use of recovery machine

CERTIFICATE TWO – TRADE PRACTICALS

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
11.0	RETROFITTING	The change over from one refrigerant to ozone friendly types	• Use of ozone friendly refrigerants in place of hydrocarbons	• Demonstrate how to change over from hydrocarbons to ozone friendly refrigerants
12.0	REPLACEMENT OF FAULTY CIRCUIT BOARD AND REMOTE CONTROL	Replacement of : • circuit board • sensors • Transformers • Thermostats, etc.	Identify, diagnose and replace: • Air conditioner circuit board • Refrigerator circuit board • Remote control etc.	• Demonstrate the replacement of circuit boards and other parts
13.0	CLEAN-UPS CARE OF TOOLS	• Clean the work area after servicing and installation • Clean tools and eqipment	Clean the following areas: • The walls • Floor • Ceiling • General work etc. • Tools and Equipment	• Cleaning-up the work area and packing of tools

LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
TRADE THEORY (OBJECTIVE)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Cleaning	1	1	1	3
2.	Dehydration	1	1	2	4
3.	Charging a System	1	1	2	4
4.	Defrosting		2	1	3
5.	Insulation	1	1	1	3
6.	Installation of Air-conditioners	1	1	2	4
7.	Transformers	1		1	2
8.	Food Preservation and Micro-Organism		1		2
					25

LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
TRADE THEORY (SUBJECTIVE)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Charging	2	1	2	5
2.	Drainage	1	1	2	4
3.	Installation of Airconditioners	1	1	3	5
4.	Troubleshooting		2	3	5
5.	Routine Services	1	1	2	4
6.	Clean-Ups	1		1	2
7.					25

LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(SCIENCE AND CALCULATION - OBJECTIVES)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Pressure Laws	1	1	2	4
2.	Airconditioning Processes	1	1	1	3
3.	Pressure Heat Diagram (Mollier Chart)	1	1	1	3
4.	Expansion of Materials	1	1	1	3
5.	Psychometric Chart	1	1	1	3
6.	Heat Load	1		2	3
7.	Electrical Circuit	1	1	2	4
8.	Capacitors	1		1	2
					25

LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
TRADE SCIENCE AND CALCULATIONS (SUBJECTIVE)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Psychometric Chart	1	1	2	4
2.	P.H. Charts	1	1	2	4
3.	Chillers	1		2	3
4.	Electricity and Electronics	1	2	2	5
5.	Capacitors	1		2	3
6.	Soldering and De-soldering	1		1	2
7.	Pressure Laws	1	1	2	4
					25

LEVEL – CERTIFICATE TWO – TEST SPECIFICATION TABLE
(TRADE DRAWING)

NO	TOPIC	COGNITIVE/ KNOWLEDGE	AFFECTIVE/ UNDERSTANDING	PSYCHOMOTOR/ APPLICATION	TOTAL
1.	Introduction to Drawing	1		2	3
2.	Freehand Drawing	1		2	3
3.	Refrigeration Components	1	1	2	4
4.	Symbols of Refrigeration	1	1	2	4
5.	Gauge Manifold	1	1	2	4
6.	Commercial Refrigeration	1	1	2	4
7.	Electrical Circuits	1	1	1	3
					25