

Curriculum
Basics of HVACR
GRADE X
2020



GOVERNMENT OF PAKISTAN
Ministry Of Federal Education and Professional Training, ISLAMABAD
in Collaboration with
National Vocational and Technical Training Commission

Contents

Introduction.....	3
Rationale	Error! Bookmark not defined.
Aims and Objectives	4
Aims	4
Objectives	Error! Bookmark not defined.
LEARNING THEMES AND STUDENTS' LEARNING OUTCOMES .	Error! Bookmark not defined.
Grade-X	15
Assessment and Evaluation	10
Formative (Internal) Assessment	11
Methods for Internal/Formative Assessment	11
Summative /External Assessment	12
1) Theory Assessment /Written examination:.....	12
2) Practical Assessment/Practical examination:.....	12
Guidelines for Writing a Textbook.....	12
Guideline for planning and writing a chapter	13
Guidelines for Writing Learner Workbook	13
Basic Requirements for Lab (Tools/Equipment)	14
Curriculum Development Committee for HVACR(IX-X)	16

Introduction

INTRODUCTION

Pakistan is a developing country with 5th largest population in the world. 64% of our population is below 30 years of age which makes it second youngest country in South Asia. This “youth bulge” provides unique challenges as well as opportunities for the country’s social and economic development. The only remedy is to develop youth of Pakistan through education and training. To control the increasing un-employment, promoting entrepreneurship (self-employment), alleviate poverty and provide skilled manpower for industrial/economic growth, The Govt. of Pakistan has decided to introduce Technical Scheme at Secondary School Certificate (SSC) Level. For this purpose a stream of technical subjects has been selected including HVACR as one of the elective subjects to be taught at that level.

HVACR is a sub discipline of Mechanical Engineering that makes it possible for us to live comfortably in air-conditioned spaces and enjoy a wide variety of foods. HVACR technology is still growing and will continue to grow far into the future. New technicians will need to be aware of the fact that change is inevitable which requires a complete look at the industry.

The curriculum of HVACR is designed to produce middle level human resources in the form of skilled work force equipped with knowledge, skills and attitudes related to the field of HVACR so as to meet the demand of such workforce in the country and abroad to contribute in the national streamline of poverty reduction of Pakistan.

HVACR Technician is a trade person specializing in the installation, repairing and maintenance of Heating Ventilation , Air conditioning and Refrigeration system and the related equipment. HVACR Technician may seek a job or become an entrepreneur. HVACR Technicians work in a variety of settings, including homes, industries, schools, hotels, workshops and hospitals-any type of facility that needs a HVACR system to function.

Working conditions for a HVACR technician may vary by specialization. Generally an HVACR Technician’s work is physically demanding such as climbing ladders and lifting tools and supplies. Occasionally an HVACR technician must work in a cramped space or on scaffolding, and may frequently be bending, or kneeling, to make /connections in awkward locations. He may spend much of their days in outdoor or semi-outdoor noisy and dirty worksites. He may be exposed to the heat, dust, and noise of an industrial plant. He may be called to work in all kinds of adverse weather to make emergency repairs.

Rationale

The Trade of HVACR is a profession that is increasingly getting attention in Pakistan because of the population growth and the resultant immense opportunities in the field not only among the youth, seeking to enter the industry, but also among the adults who wish to polish their skills to develop a career out of it.

On completing the curriculum/course, students should have acquired a set of knowledge and concepts, and have developed a range of technical, personal, interpersonal, organizational and generic skills, that can be applied in various contexts, both within and related to trade of HVACR. Furthermore, this course will stimulate the learners towards entrepreneurship in the industry.

Within this qualification relating to HVACR Technician's interventions in schools, there are important interventions that integrated within school settings. The purpose of this qualification is to strengthen connections between schools and trade, and drawing on the concept of the socio technical network, theories the interactions between the relevant market and school contexts.

HVACR Technician, Matric Tech (9th&10th)

Aims and Objectives

The specific objectives of developing these qualifications are as under:

- Provide students with a smooth transition to work.
- Develops job-readiness & enhance students' trade-specific employable skills and provide opportunities for the development of new skills.
- Provide students with the opportunity to obtain from Level II -IV technical training certification or equivalent in a given trade.
- To set high profile standard professions for the industry to generate standard outputs.
- To validate an individual skill, knowledge and understanding regarding relevant occupations.
- Provide flexible pathways and progressions in training and assessment field.

Objectives

After completing this, the students will be able to:

- Perform routine skilled and semi-skilled tasks to carry out a variety of HVACR installations
- Repair of equipment, facilities and system.
- Perform maintenance jobs and assist other team members in the assigned preventive maintenance.
- Perform their duties in an efficient manner
- Establish a standardized and sustainable system of Refrigeration and Air conditioning training in the institutes / colleges / schools of Pakistan
- Improve the professional competence of Refrigeration and Air conditioning industry

Grade - X

Chapter 1

Perform Basic Electric Operations

54= Periods 18=(T), 36= (P)

Theme/Content	Student Learning Outcome	Activities/Practical	Duration	Tools	Workplace
Basic Concept of Electricity	<p>The Student will be able to:</p> <ul style="list-style-type: none"> • define Electricity • know about the difference between electrical and electronics • know about current, voltage and resistance • know about conductor, insulator, semiconductor, capacitor • know about electrical hazards • understand electrical symbols • understand electrical units(resistance, power) • understand resistor color coding 	<ul style="list-style-type: none"> • Identify electrical units(Resistance) • Recognize electrical symbols (Resistor, Capacitor, Battery) • Use multimeter • Calculate resistor's value using color coding • Identify the possible electric hazards 	<p>Periods(T) Periods(P)</p>	Resistor, Capacitor, Battery, Multimeter	Classroom/ Labs
Electrical Material	<p>The Student will be able to:</p> <ul style="list-style-type: none"> • know about wires and cables • know about types of wire joints • recognize insulation materials • understand cable materials (Copper, Aluminum, Sliver etc.) • understand standard specification of cables • understand techniques for making cable joints, insulation and testing of cables. 	<ul style="list-style-type: none"> • Identify various types of cable and cable joints • Perform cable joints • Perform insulation of cables • Perform testing of cable joints 	<p>Periods(T) Periods(P)</p>	Cable, Wire, Insulation, Plier, Wire Cutter, PVC Tape, Insulation remover, AVO meter, Insulation tester, Insulation sleeves, Soldering iron, Solder wire	Classroom/ Labs
Control devices used in Domestic HVACR Systems	<ul style="list-style-type: none"> • know about basic symbols of electric control devices used in domestic HVACR systems • recognize the various types of electrical 	<ul style="list-style-type: none"> • Identify basic symbols of electric control devices used in domestic HVACR systems • Identify the electrical control devices in electrical circuit of 	<p>Periods(T) Periods(P)</p>	AVO meter, Relays, Overload protectors, Wire, Capacitor, Thermostat	Classroom/ Labs <ul style="list-style-type: none"> •

	<p>control devices used in domestic HVACR systems</p> <ul style="list-style-type: none"> understand the working principle of electrical control devices used in HVACR 	domestic HVACR systems			
Measurement of Electrical Quantities (AVO)	<ul style="list-style-type: none"> define ohm's law understand ohm's law apply ohm's law for calculating current, voltage, resistance describe circuit & its types understand construction of series and parallel circuits 	<ul style="list-style-type: none"> Calculate current Calculate voltage Calculate resistance Construct series and parallel circuit and calculate load in the circuits 	Periods(T) Periods(P)	lamp, Resistor, Power supply, Wires, AVO meter, Switches	Classroom/ Labs
Electrical Devices & Components	<ul style="list-style-type: none"> define capacitors know types of capacitors understand working of capacitor understand series & parallel combinations of capacitor understand testing techniques of capacitor define transformer know types of transformer define electric motors understand function of electric motor know types of electric motor 	<ul style="list-style-type: none"> Identify various types capacitors Perform testing of capacitor 	Periods(T) Periods(P)	Capacitor, Motor, Transformer , Wires,	Classroom/ Labs

Chapter 2

HVACR Accessories & Control Devices

36 = Periods 12=(T), 24= (P)

Theme/Content	Student Learning Outcome	Activities/Practical	Duration	Tools	Workplace
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Accessories Used in HVACR Systems	The students will be able to: <ul style="list-style-type: none"> know about the accessories used in HVACR system recognize different types of accessories used in HVACR system know about working/function of different accessories 	<ul style="list-style-type: none"> Identify different types of accessories and their symbols 	Periods(T) Periods(P)	stationary	Classroom/ Labs
Control devices used in Industrial HVACR Systems	<ul style="list-style-type: none"> know about basic symbols of electrical and mechanical control devices used in industrial HVACR systems learn about the electrical and mechanical control devices used in industrial HVACR systems recognize the various types of electrical and mechanical control devices used in industrial HVACR systems understand the working principle of electrical and mechanical control devices used in industrial HVACR systems understand specification of the control devices used in industrial HVACR 	<ul style="list-style-type: none"> Identify basic symbols of electrical and mechanical control devices used in HVACR systems Identify the electrical and mechanical control devices in control system of HVACR Perform range adjustment of the control devices in control system for smooth functioning 	Periods(T) Periods(P)	Stationary	Classroom/ Labs

Chapter 3

Psychrometric Properties of Air

36 = Periods 12=(T), 24= (P)

Theme/Content	Student Learning Outcome	Activities/Practical	Duration	Tools	Workplace
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Concept of Psychrometric Properties of Air	The students will be able to: <ul style="list-style-type: none"> define psychrometry define basic psychrometric properties of air (dry bulb, wet bulb, dew point temperature, relative humidity, specific humidity, specific volume, enthalpy) understand different psychrometric properties understand lines & scales on psychrometric chart comprehend the importance of psychrometry 	<ul style="list-style-type: none"> Identify lines scales on psychrometric chart Measure dry bulb temperature and wet bulb temperature using sling psychrometer Measure dry bulb and relative humidity using hygrometer 	Periods(T) Periods(P)		Classroom/ Labs
Measurement of Psychrometric Properties of Air	<ul style="list-style-type: none"> know about measuring techniques of psychrometric properties understand plotting different psychrometric properties on psychrometric chart understand the method of finding unknown property of given air 	<ul style="list-style-type: none"> Plot WBT & DBT on psychrometric chart Calculate unknown properties of given air by psychrometric chart 	Periods(T) Periods(P)	Resistor, Capacitor, Battery, Multimeter	Classroom/ Labs

Chapter 4

Air & Water Distribution System

48= Periods 16=(T), 32= (P)

Theme/Content	Student Learning Outcome	Activities/Practical	Duration	Tools	Workplace
Air Distribution System	The Student will be able to: <ul style="list-style-type: none"> define Air distribution system know about components of air distribution system understand the importance of air distribution system understand air leak testing techniques in ducts (Light Test, Smoke Test) understand importance of ducting in HVACR understand the importance of air filters 	<ul style="list-style-type: none"> Perform Light Test in Given Sample of Duct Identify various types of air control and distribution devices 	Periods(T) Periods(P)		Classroom/ Labs

	<ul style="list-style-type: none"> recognize various types of air control and distribution devices 				
Water Distribution system	<ul style="list-style-type: none"> define water distribution system know about components of water distribution system understand the importance of water distribution system understand the importance of pumps and valves recognize various types of pumps and valves 	<ul style="list-style-type: none"> Carry-out Leak testing of water distribution system Identify various types of pumps Identify various types of Valves 	Periods(T) Periods(P)	Resistor, Capacitor, Battery, Multimeter	Classroom/ Labs
Thermal Insulation	<ul style="list-style-type: none"> know about the basic concepts of thermal insulation understand different types of insulating materials 	<ul style="list-style-type: none"> Recognize different types of insulating materials Perform Insulation on Split AC Piping 	Periods(T) Periods(P)	lamp, Resistor, Power supply, Wires,	Classroom/ Labs

Chapter 5

Digital Communication and Social media

14 Period 05 (T) 09 (P)

Themes	Students' Learning Outcomes	Activities	Duration	Tools	Workplace
Effective email writing	The student will be able to: <ul style="list-style-type: none"> create, access and manage email account learn how to write and respond official email 	<ul style="list-style-type: none"> Create email account Write an official email to school principal on subject of any importance 	Periods(T) Periods(P)	Multimedia System, Internet connection	Classroom/ Labs
Introduction to Social Media Platforms <ul style="list-style-type: none"> Facebook, Instagram Twitter, YouTube, 	<ul style="list-style-type: none"> understand role of social media in marketing and business development learn merits and de-merits of social media 	<ul style="list-style-type: none"> Create social media page for your self 	Periods(T) Periods(P)	System, Internet connection	Classroom/ Labs

Assessment and Evaluation

Assessment is the practice of collecting evidence of student learning. It aims at improving learning and teaching as well as recognizing the achievement of students. It determines students' progression through their learning experiences and enables them to demonstrate that they have achieved the intended learning outcomes. The assessment is aligned with curriculum aims, design and learning processes.

Evaluation is an integral part of teaching-learning process. It involves gathering information through various assessment techniques, making valuable judgment and sound decisions. Assessment provides information and teaching about students' achievement in relation to learning objectives. With this information, the teacher makes informed decisions about what should be done to enhance the learning of students or to improve teaching methods. Assessment must be:

- mainly open-ended, allowing for discussion and revision of new understanding.
- tolerant of divergent thinking of students and promote the notion of no "one right answer".
- presented in alternative mode, not just paper-and-pencil responses to limiting questions.
- designed to foster analysis, comparison, generalization, prediction, and modification according to the grade and development level.
- capable of promoting collaboration and team effort in demonstration of competence.
- ongoing and cumulative, showing growth over time.

Formative (Internal) Assessment

Internal assessment refers to the assessment practices employed as part of the learning and teaching process. It is an ongoing process throughout the session and uses Test — Feedback — Adjust cycle repeatedly to improve students' performance and efficiency in learning and teaching. In designing internal assessment for the subject, teachers should maintain a proper balance between the formative and summative functions of assessment. It should be comprehensive to cover all the objectives as per curriculum. A diversity of assessment modes should be adopted so that students are given opportunities to develop and demonstrate the full range of learning outcomes of the curriculum, including those of knowledge, skills, values and attitudes.

Methods for Internal/Formative Assessment

Following tasks can help in formative assessment.

- Assignments
- Quizzes
- Tests
- Group discussions
- Oral/multimedia presentations
- Worksheets
- Online interactive activities
- Role play
- Demonstration
- Practical exercises

Feedback on students' work in all the above tasks must be prompt, effective, and efficient assessment should have questions setting that specifically help in finding out knowledge, understanding and skills.

Summative /External Assessment

Summative assessment will be managed by concerned Board of Intermediate and Secondary Education. It will be composed of two parts.

1) Theory Assessment /Written examination: The theory examination is suggested to consist of a wide variety of questions. Its overall weight age should be 40 %. It should be based on the curriculum rather than textbook. The assessment should be designed to examine the candidate's understanding of the whole syllabus and should test the range of abilities according to Bloom Taxonomy.

2) Practical Assessment/Practical examination: This is designed to test Practical skills of students. Its overall weight age should be 60%. It will comprise of written exam (10%), practical (70 %) and viva/oral exam (20%).

A standards-referenced approach will be adopted for grading and reporting student performance. The purpose of this approach is to recognize what each student can do in the subject at the end of the 2-year secondary school level education. The performance of each student will be matched against a set of performance standards, rather than comparing to the performance of other students. It makes the implicit standards explicit by providing specific indication of individual student performance. Descriptions will be provided for the set of standards.

Guidelines for Writing a Textbook

A textbook is an important teaching and learning resource and one of the most extensively used resources in classrooms. To reflect national needs and aspirations the needs and aspirations, the textbooks should be written in accordance with this curriculum. This curriculum meets not only the general aims and objectives but also fulfills the specific requirements of the individual subject. As the textbook serves as a framework for teaching, the author/authors should consider the following features:

- A textbook must include an introduction to the textbook, explaining how to use the textbook
- The textbook must be in line with the National Curriculum, covering all SLOs of each theme or concept.
- Content and illustrations must be culturally, contextually and age appropriate.
- All text and material must be accurate, up-to-date and error-free.
- The continuity of the concepts, their integration and logical development should be ensured.
- Horizontal and vertical overlapping of the concepts should be avoided.
- The textbook should be informative and interactive with questions to be put at suitable intervals to provoke the students to think.
- The language used should be simple, clear, straight forward, unambiguous, and easily comprehensible by the students of the level.

- Simple questions may be asked within the chapter, which requires students to recall, think, and apply what they have just learnt as well as to reinforce the learning of the concepts and principle.
- The examples and applications should be from everyday life and be supportive of our cultural values.
- Photographs and illustrations should be clear, labeled, and supportive of the text. Tables, flow charts and graph may be given wherever needed.
- Key points at the end of each chapter should provide a summary of the important concepts and principles discussed in the chapter.
- End-of-the-Chapter exercises must include a variety of assessment styles based on levels of Bloom's Taxonomy. These should encourage students to think, develop skills, and use information for a variety of purposes.
- Textbooks should be free from all kinds of biases including, gender, religion, occupation, social background etc.
- To make the students self-learner use of IT based resources may be encouraged. Relevant internet links and other online resources may be included.
- Glossary of the new vocabulary must be included.

Guideline for planning and writing a chapter

The textbook author may decide the titles of each chapter and can choose to cover students' learning outcomes (SLOs) from any themes in developing the content of the chapter. The textbook author must also keep in mind that a number of SLOs cannot be addressed in the text (as if this is done it would lead students to simply memorize the text and not serve the realization of the curriculum). These SLOs could be realized through questions and practical activities within and at the end of the chapter exercises.

- Learning outcomes must be given at beginning of each chapter.
- Decide on key ideas, facts, concepts, skills, and values that can be developed.
- Illustrations must clearly convey the desired concept.
- Activities must demand from students to do inquiry and problem solving according to grade level.
- Ensure that the content is up to date, accurate and developmentally appropriate.
- Contents must be in line with chapter outcomes.
- Language must be consistent, culturally appropriate, and grammatically correct (as if talking to a group).
- Language must engage and hold reader's attention.
- Recall previous learning, where possible.
- Structure the writing so that the sentence is simple, paragraphs deal with single ideas etc.
- Interesting information in the form of tidbits, fact file, point to ponder etc. must be given.
- Write a summary/concept map at end of each chapter, reviewing key knowledge and skills.
- End-of-chapter exercises
- Recall and integrate previous learning
- Engage students and develop their creativity
- Move from lower to higher order thinking
- Focus on multiple intelligences
- Keep the text contextually relevant in line with local teaching and learning.

- Provide website links for further research

Guidelines for Writing Learner Workbook

Workbooks are books that contain writing activities and exercises that build upon each chapter in the textbook. Workbook exercises help students to develop conceptual understanding of the concepts dealt with in the text, to develop skills and to apply knowledge to new situations. Basic features of a workbook A workbook should have:

- Various exercises and activities for each chapter, topic, subtopic.
- Exercises and activities that will enable student to develop and practice the content knowledge, skills and higher order thinking.
- Accurate and variety of exercises.
- Clear illustrations/ examples/ explanations to show what students are supposed to do, and/or what product looks like.
- Exercises and activities with a variety of purposeful, stimulating, challenging and innovative items to encourage students to review and practice the knowledge and skills they have learnt.
- Exercises that include both constructed and restricted response items.
- Activities, which requires readily available, acceptable, and affordable materials and resources.

Basic Requirements for Lab (Tools/Equipment)

Trade: - HVACR (40 Trainee)

1. Gloves
2. Masks
3. Goggles
4. Ear muffs/plugs
5. Shoes
6. Measuring tape
7. Hand drilling machine
8. Extension chords
9. Hand Hacksaw with blades
10. Adjustable screw, wrench,
11. Air Conditioner and its parts,
12. AVO meter, Tool kit
13. Battery,
14. Box spanner screw drivers,
15. Capacitor,
16. Clamp meter, Tool kit.
17. Compressor,
18. Condenser,
19. Copper Tubes,
20. Deep Freezer and its parts,
21. Digital Air Flow / Velocity meter
22. Digital Capacitor analyser,

23. Digital Clamp-on Ampere Meter,
24. Digital Optical Tacho meter,
25. Digital pressure gauges set,
26. Electric Screw driver set,
27. Electronic leak detector,
28. Evaporator,
29. Flaring and swaging tool kit,
30. Flaring Tool,
31. Hammer,
32. Laser temperature measuring device,
33. Leak testing equipment,
34. Locking pliers
35. Manifold,
36. Multi meter
37. Pressure Gauges,
38. Ratchet wrench Open ended spanner set,
39. Reamer,
40. Recovery cylinder,
41. Recovery unit,
42. Refrigerant control Valves
43. Refrigerants Chart
44. Refrigerants,
45. Refrigeration system,
46. Refrigerator
47. Refrigerator and its parts,
48. Resistor,
49. Spirit level,
50. Swaging Tool,
51. Thermometer,
52. Tube Bender,
53. Tube Cutter,
54. Tube Vice
55. Water Cooler and its parts,

Consumable or Training Materials

S.No	Specification	Quantity
1	Filling of oxygen Gas cylinder	3 Cylinder
2	Filling of fan Gas cylinder	28 kg
3	Silver soldering Road (chandi Rod)	02 kg
4	Brass Rod (Petal Rod)	02 kg
5	Copper Tube dia 1"/4 (50 feet / Coil)	04 koil
6	Copper Tube dia 5"/16 (50 feet / Coil)	04 koil

7	Capillary Tube dia 0.031"	02 koil
8	Gastric Sheet (4'x6')	02 sheet
9	Seal Threading Tap	10 nos
10	Majic defoxi (small size)	10 nos
11	wooden Board (10"x12" single)	06 doz
12	single way switch (5A open)	10 doz
13	Two Way Switch (5A Open)	08 doz
14	Batten Holder Baculite	12 doz
15	Two Pin socket (5A open)	08 doz
16	Cut out fuse (10 A Porcelain)	08 doz
17	Electric LAMP (Bulb 100 w)	06 doz
18	Electric Lam (Bulb 200w)	02 doz
19	Electric Call bell (Bizzes 220v/5W)	06 doz
20	Push button (5A open)	06 doz
21	Fuse wire (5A)	06 reel
22	P.V.C WIRE (3/.029")	04 coil
23	P.V.C WIRE (1/.044")	04 coil
24	Insulation Tap (Nitto) 3"/4	30 nos
25	Wooden Screw 1"/2, 3"/4	10 pkt / each
26	Hand Hack Saw Blade (Double Edge)	10 doz
27	M.S Flat (64mmx8mm)	100 kg
28	Mobil Oil	10 Litr
29	Cotton Waist Cleaning Cloth	50 kg
30	Detergent Soap	02 doz
31	Thermostat switch cooler water	12 nos
32	Thermostat for Refrigerator	12 nos
33	Thermostat for A.C	12 nos
34	Amperage type relay Cap type 1/4, 1/3, 1/5, 1/6, 1/8 (6 No each)220v	30 nos
35	Overload 1/8, 1/6, 1/5, 1/4, 1/3 (220v)	30 nos
36	Electronic Relay (Denfas)	12
37	Electronic Relay two point	12
38	Current Relay for 110v Refrig	12
39	Over load for 110v = (1/4, 1/3) Refrig	12
40	starting capacitor 80/110 uf	12
41	Starting capacitor 138/182 uf	12
42	Running capacitor 50 uf	12
43	Running capacitor 60 uf	12
44	Timer for Refrigerator 220v	12
45	Bi metal fuse 12 no 220v Elect	24

46	Timer for 110v Refrigerator	6
47	Fan capacitor 2, 2.5, 3, 3.5 μ F	25
48	copper tub 1 1/2	3 coils (50')
49	Protentional Relay	12
50	Split Control circuit with display	12
51	Sensor for Split A.C	60
52	F-134a Gas cylinder	2 cylinders
53	F-22 Gas	2 Cylinder
54	G-I pipe 1 1/2 dia	4 length
55	G-I pipe 3 3/4 dia	4 length
56	G-I union 1 1/2	12
57	G-I Tee	12
58	G-I Socket	12
59	P.V.C wire 7/044	2 coils
60	Three pin shoe 20 A	12
61	Power Plug 2, A	2 dozen
62	Circuit Breaker 20 A	2 dozen
63	Three Pin Shoe 5A	2 dozen
64	Two Pin Shoe 5A	2 dozen
65	Flair nuts 1/4"	3 nos
66	Union 1/4"	3 nos
67	Flair nuts 5"/16	3 nos
68	union 5/6"	3 nos
69	Flour mint 1 1/2	3 nos
70	union 1/2"	3 nos
71	compressor out 1349	4 lit
72	Kit kat fuse 20 A	2 dozen
73	Liquid service valve 1/4" Split A.C	2 dozen
74	Suction service valve for	2 dozen
75	Filter dryer	3 dozen
76	Nut and Bolt (M10)	2 pkt
77	Nut and Bolt (M12)	3 pkt
78	Nut and Bolt (M14)	3 pkt
79	Flexible cable (copper) wire 110-76	1 coil
80	Arab flax insulation 1 1/4, 1 1/2, 3/8"	3 dozen
81	Arab flax insulation 5/8", 3/4 for tub	3 dozen