

Topic and Subject#	Subjects	Slides	Review Questions
ACR1 Fundamentals			
ACR1 S1	Basic Math & Measurement		
	Title Slide	1	
	2-3 Basic Math And Measurement Intro	2	
	4-7 Addition	4	
	8-10 Signs	3	
	11-15 Practical Examples	5	
	16-21 Word Problems	6	3
	22-27 Calculators and Estimating	6	1
	28-31 Fractions	4	1
	32-42 Decimals	11	5
	43-45 Division	3	1
	46-52 Measurements	7	1
	53-71 Area and Volume	19	5
	72 End Slide	1	
ACR1 S2	Basic Tools		
	Title Slide	1	
	2-3 Basic Tools Intro	2	
	4-10 Starter Kit	7	
	11-27 Piping Tools	17	
	28-35 Wiring Tools	8	
	36-39 Hammers and Drill Bits	4	
	40-41 Sheet Metal	2	
	42-46 Miscellaneous	5	
	47-56 Refrigeration	10	
	57-66 Thermometers	10	
	67-71 Duct Pressure	5	
	72-74 Safety	3	
	75-79 Technology as Tools	5	
	80 Questions Intro	1	
	81-99 Review Questions (16)	19	19
	100 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR1 Fundamentals			
ACR1 S3	Temperature, Pressure & Heat Transfer		
	Title Slide	1	
	2 History of Refrigeration	1	
	3-10 Heat and Cold Facts	8	
	11-16 Temperatures	6	
	17-18 Heat Transfer	2	
	19-20 Barometric Pressure	2	
	21-27 Pressure and Boiling Points	7	
	28-29 Absolute pressures	2	
	30-37 Pressure Gauges	8	
	38-41 Pressure / Temperature & Charts	4	
	42-65 Sensible and Latent Heat	24	
	66-74 Pressure	9	
	75-79 Density and Specific Gravity	5	
	80-83 Ice	4	
	84-88 Humidity	5	
	89 Questions Intro	1	
	90-111 Review Questions (22)	22	22
	112 End Slide	1	
ACR1 S4	Introduction to Refrigeration Systems		
	Title Slide	1	
	2-11 Elementary A/C System	10	
	12-17 Four Components	6	
	18-19 Simple A/C System	2	
	20-26 Basic A/C System	7	
	27-32 Terminology of Pressure and Temp	6	
	33-47 Examples of A/C and Refrig Systems	15	
	48 Questions Intro	1	
	49-66 Review Questions (18)	18	18
	67 End Slide	1	
ACR1 S5	Recovery		
	Title Slide	1	
	2-6 Gauges	5	
	7-18 Recovery Equipment	12	
	19-23 Vapor Recovery	5	
	24-26 Push-Pull Recovery	3	
	27-29 Evacuated Tank Recovery	1	
	30-36 Recovery Machines	9	
	37 Questions Intro	1	
	38-45 Review Questions (8)	8	8
	46 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR1 Fundamentals			
ACR1 S6	Leak Check And Evacuation		
	Title Slide	1	
	2-11 Introduction	1	
	12-15 Standing Pressure Test	8	
	16-17 Using R22 as a Tracer	8	
	18-22 Leak Detectors	6	
	23-26 Isolating to Find Leaks	3	
	27-41 Required Leak Repairs	1	
	42 Evacuation	5	
	43-55 Vacuum Pumps and Equipment	13	
	56-62 Evacuation Procedures	16	
	63 Questions Intro	1	
	64-72 Review Questions (9)	9	9
	73 End Slide	1	
ACR1 S7	Charging		
	Title Slide	1	
	2-3 Charging Intro	2	
	4 Disposable Tanks	1	
	5-15 Charging Procedures	11	
	16-21 Condenser Split	6	
	22-26 Subcooling	5	
	27-34 Condenser Diagram During Charging	8	
	35-41 Superheat	7	
	42-43 Effects of Low Charge	2	
	44-47 Effects of Overcharge	4	
	48-55 Charging Charts	8	
	56 Questions Intro	1	
	57-68 Review Questions (12)	12	12
	62 End Slide	1	
ACR1 S8	Coil Cleaning		
	Title Slide	1	
	2-3 Coil Cleaning Intro	2	
	4-8 Cleaners	5	
	9-19 Effective Coil Cleaning	11	
	20 "No Rinse" Cleaners	1	
	21-23 Coil Treatments	3	
	24-26 Drain Pan Treatments	3	
	27-34 Coil Cleaning Tips	8	
	35-39 Coil Cleaning Accessories	5	
	41 Questions Intro	1	
	41-47 Review Questions (6)	6	6
	48 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR2 Four Basic System Components			
ACR2 S1	Evaporators		
	Title Slide	1	
	2 Objectives	1	
	3-7 Types of Coils	5	
	8-9 Evaporator Functions	2	
	10-11 Evaporator Terminologies	2	
	12-13 Evaporator Temperature	2	
	14-19 Evaporator TD	6	
	20-22 Humidity	3	
	23-27 TD versus ΔT	5	
	28-30 Superheat	3	
	31-35 Effects of Heat Load	5	
	36 Questions Intro	1	
	36-51 Review Questions (15)	15	15
	52 End Slide	1	
ACR2 S2	Compressors		
	Title Slide	1	
	2 Objectives	1	
	3-4 Compressor Functions	2	
	5-21 Reciprocating Compressor Operation	17	
	22-23 Hermetic Compressor	2	
	24-30 Semi-Hermetic Compressor	7	
	31-36 Lubrication	6	
	37-38 Air-Cooled Compressor	2	
	39-41 Valve Plates	3	
	42-48 Copeland Discus®	7	
	49-55 Suction Service Valves	7	
	56-61 Discharge Service Valves	6	
	62-66 Replacing a Semi-Hermetic Compressor	5	
	67-71 Compression Ratios	5	
	72-75 Scroll Compressors	4	
	76-79 Rotary Compressors	4	
	80-82 Centrifugal Compressors	3	
	83 Screw Compressors	1	
	84-92 Compressor Model Numbers	9	
	93 For More on Compressors	1	
	94 Questions Intro	1	
	95-109 Review Questions (15)	15	15
	110 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR2 Four Basic System Components			
ACR2 S3	Condensers		
	Title Slide	1	
	2 Objectives	1	
	3-5 Condenser Functions	3	
	6-9 Condenser Split	4	
	10-16 Subcooling	7	
	17 Low Ambient Effects on Condensers	1	
	18-20 Fan Cycles	3	
	21-23 Flooded Condensers	3	
	24-27 Condenser Cleaning	4	
	28-29 Micro Channel Technology	2	
	30-38 Water-Cooled Condensers	9	
	39-43 Mineral Deposits	5	
	44-46 Acid Cleaning Water-Cooled Condensers	3	
	47-55 Cooling Towers	9	
	56-59 Condensing Units	4	
	60 Questions Intro	1	
	61-76 Review Questions (16)	16	16
	77 End Slide	1	
ACR2 S4	Metering Devices		
	Title Slide	1	
	2 Functions of Metering Devices	1	
	3-9 Thermostatic Expansion Valves (TEV)	7	
	10-15 Superheat	6	
	16-22 TEV for Multi-Circuited Evaporators	7	
	23-29 TEV Bulb Locations	7	
	30-33 "Reading" a Valve	4	
	34-35 System Affects on TEVs	2	
	36-39 TEV Charts	4	
	40-41 TEV Filter Screens	2	
	42-46 Balanced Port TEV	5	
	47-48 Automatic Expansion Valves (AEV)	2	
	49-55 Electronic Expansion Valves (EEV)	7	
	56-72 Fixed Metering Devices	17	
	73 Questions Intro	1	
	74-85 Review Questions (12)	12	12
	86 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR3 Controls, Valves, Accessories and Heat Pump			
ACR3 S1	Controls		
	Title Slide	1	
	2 Author's Notes	1	
	3-16 Commercial Refrigeration Thermostats	14	
	17-27 Low Pressure Controls	11	
	28-33 High Pressure Controls	6	
	34-38 Fan Cycle Controls	5	
	39-42 Dampers for Head Pressure Control	4	
	43-51 Oil Pressure Safety Controls	9	
	52-56 Current Sensing Relay	5	
	57 Questions Intro	1	
	57-72 Review Questions (15)	15	15
	73 End Slide	1	
ACR3 S2	Valves		
	Title Slide	1	
	2-14 Solenoid Valves	13	
	15-17 Pumpdown	3	
	18-19 Hot Gas Bypass	2	
	20-22 Head Pressure Regulation (HPR) Valve	3	
	23-29 Evaporator Pressure Regulator (EPR) Valve	7	
	30-37 Crankcase Pressure Regulator (CPR) Valve	8	
	38-40 Water Regulating Valves	3	
	41 Ball Valve	1	
	42 Questions Intro	1	
	42-53 Review Questions (11)	11	11
	54 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR3 Controls, Valves, Accessories and Heat Pump			
ACR3 S3	Accessories		
	Title Slide	1	
	2 Accessories Intro	1	
	3-13 Liquid Line Filter Drier	11	
	14-17 Suction Line Filter Drier	4	
	18-20 Sight Glass	3	
	21-29 Receiver	9	
	30-36 Suction Line Accumulator	7	
	37-41 Oil Separator	5	
	42-45 Heat Exchanger	4	
	46-48 Vibration Absorber	3	
	49-59 Crankcase Heater	11	
	60 Questions Intro	1	
	60-76 Review Questions (16)	16	16
	77 End Slide	1	
ACR3 S4	Heat Pumps		
	Title Slide	1	
	2 Heat Pump Basics	1	
	3-5 A Really Basic A/C - Heat Pump System	3	
	6-8 Reversing Valve	3	
	9-12 Heat Pump with Piston	4	
	13-16 Heat Pump with TEV	4	
	17-21 Heat Pump Outdoor Unit	5	
	22-24 Heat Pump Filter Drier	3	
	25 Questions Intro	1	
	26-30 Review Questions (5)	5	5
	31 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions	Diagnostic Problems
ACR4 Troubleshooting				
ACR4 S1	Enthalpy, Dirty Condensers, Subcooling			
	Title Slide	1		
	2-5 Enthalpy, Dirty Condensers, Subcooling In	4		
	6-8 Basic Enthalpy Chart	3		
	9-10 Add Superheat and Subcooling	2		
	11-13 High Condensing Temperature	3		
	14 Questions Intro	1		
	15-20 Review Questions (6)	6	6	
	21 End Slide	1		
ACR4 S2A	Diagnosing A/C Systems			
	Title Slide	1		
	2-6 Diagnosing A/C Systems Intro	5		
	7-12 What is "Normal"?	6		
	13 Evaporator Temperature	1		
	14-22 Superheat Diagnosis - FM & TEV	9		
	23-34 Condenser Temperature Diagnosis	12		
	35 Dianosing 9 A/C System Problems Intro	1		
	36-41 Normal Operation	6		
	42-44 Flooding TEV	3		
	45-46 Undercharge	2		
	47-50 Dirty or Iced Evap, or Low Air Flow	4		
	51-53 Restriction After Condenser	3		
	54-56 Low Ambient Control	3		
	57-60 Inefficient Compressor	4		
	61-64 Dirty Condenser	4		
	65-69 Overcharge	5		
	70 Questions Intro	1		
	71-98 Review Questions (27)	28	27	
	99-115 Service Diagnostic Problems Intro	17		
	116 End Slide	1		
ACR4 S2B	A/C Systems Exercises			
	Title Slide	1		
	2 Diagnosing A/C Systems Intro	1		
	3 Review	11		
	14-44 A/C Diagnostic Exercises (15)	31		15
	45 There's an App for This	1		
	46 End Slide	1		

Topic and Subject#	Subjects	Slides	Review Questions	Diagnostic Problems
ACR4 Troubleshooting				
ACR4 S3A	Diagnosing Commercial Refrigeration Systems			
	Title Slide	1		
	2-6 Diagnosing Comm Refrig Systems Intro	5		
	7-10 What is "Normal"?	4		
	11 Using Medium Temp for Examples	1		
	12 Procedures for Troubleshooting	1		
	13-18 Evaporator Temperature & Superheat	6		
	19-21 High Load Effect on Evaporator	3		
	22-24 Low Load Effect on Evaporator	3		
	25-28 Overcharge Effect on Evaporator	4		
	27-28 Low Charge Effect on Evaporator	2		
	31-34 Condensing Temps & Subcooling	4		
	35-37 High Condensing Temperatures	3		
	38-41 Low Condensing Temperatures	4		
	42-47 Diagnosing Comm Refrig Problems Intro	6		
	48-51 Normal Operation	4		
	52-55 TEV Flooding	4		
	56-58 Low Charge	3		
	59-64 Dirty or Iced Evap - Low Air Flow	6		
	65-69 Restriction After Condenser	5		
	70-73 Low Ambient Control	4		
	74-78 Inefficient Compressor	5		
	79-84 Dirty Condenser or Low Air Flow	6		
	85-90 Overcharge	6		
	91-93 Noncondensables (Air) in the System	3		
	94-95 Final Notes	2		
	96-126 Review Questions (30)	31	30	
	127-139 Intro to Service Diagnostic Problems	13		
	140 Instructor Note and End Slide	1		
	141 End Slide	1		
ACR4 S3B	Commercial Refrigeration Exercises			
	Title Slide	1		
	2 Diagnosing Comm Refrig Systems Intro	1		
	3-13 Review	11		
	14-36 Comm Refrig Diagnostic Exercises (11)	23		11
	37 There's an App for This	1		
	38 End Slide	1		

Topic and Subject#	Subjects	Slides	Review Questions	Diagnostic Problems
ACR4 Troubleshooting				
ACR4 S4	Diagnosing Compressor Problems			
	Title Slide	1		
	2 Compressor Problems Intro	1		
	3-6 Slugging	4		
	7-9 Flooding on Air Cooled Compressor	3		
	10-17 Flooding on Suction Cooled Compressor	8		
	18-20 Suction Line Frost	3		
	21-25 Flooded Start	5		
	26-30 Overheating	5		
	31-35 Inefficient Compressor	5		
	36-50 Blow By	15		
	51-56 Diagnostic Chart	6		
	57 Questions Intro	1		
	58-72 Review Questions (15)	15	15	
	73 End Slide	1		
ACR4 S5	Diagnosing HPR Valves			
	Title Slide	1		
	2 Diagnosing HPR Valves Intro	1		
	3-10 Normal HPR Operations	8		
	11-12 HPR Stuck Closed	2		
	13-14 HPR Stuck Open	2		
	15 How an Undercharge Affects the HPR	1		
	16-18 HPR Diagnostic Chart	3		
	19 Questions Intro	1		
	20-25 Review Questions (6)	6	6	
	26 End Slide	1		
ACR4 S6	Diagnosing Reach-Ins			
	Title Slide	1		
	2-3 Diagnosing Reach-Ins Intro	2		
	4-5 Operation of Typical Reach-ins	2		
	6-12 Diagnosing with Thermometers	7		
	13-14 Troubleshooting a Reach-in	2		
	15 Questions Intro	1		
	16-22 Review Questions (7)	7	7	
	23 End Slide	1		
ACR4 S7	Diagnosing Noncondensables			
	Title Slide	1		
	2-3 Diagnosing Noncondensables Intro	2		
	4-5 Overcharge or Noncondensables?	2		
	6-8 Compare Pressure and Temperature	3		
	9 Questions Intro	1		
	10-18 Review Questions (9)	9	9	
	19 End Slide	1		
ACR4	Diagnostic App demo - RefTech		18	

Topic and Subject#	Subjects	Slides	Review Questions
ACR5 Advanced Refrigeration			
ACR5 S1	Retrofit Refrigerants & Charging Flooded		
	Title Slide	1	
	2 Intro and Objectives	1	
	3-6 General Retrofitting Guidelines	4	
	7-18 Glide, Bubble and Dew	12	
	19-27 PT Charts, Interpolation, & Glide	9	
	28-32 Using Apps for PT Charts	5	
	33-34 Charging Flooded Condensers	2	
	35-41 RTS "Rule of Thumb" Method	7	
	42-44 Charging at 70° Ambient	3	
	45-47 Charging at 40° Ambient	3	
	48-49 Charging at 10° Ambient	2	
	50-52 Charging a Freezer	3	
	53-54 Exercise in Calculations	2	
	55-61 Condenser Fill	7	
	62-63 Charging Chart	2	
	64 Questions Intro	1	
	65-74 Review Questions (10)	10	10
	75 End Slide	1	
ACR5 S2	Compressor Capacity Controls		
	Title Slide	1	
	2 Intro	1	
	3-7 Unloading	5	
	8-11 Copeland Unloader	4	
	12-15 Carlyle Unloader	4	
	16-19 Compression Ratio & Discharge Temp	4	
	20-27 Two Stage Compound System	8	
	28-29 Carlyle Compound Compressor	2	
	30-31 Demand Cooling	2	
	32-34 Copeland Ultra Tech™ Scroll	3	
	35-37 Copeland Digital™ Scroll	3	
	38-39 Multi-Rack Compressors	2	
	40-44 Hot Gas Bypass	5	
	45-48 Varying Compressor Speeds	4	
	49 Questions Intro	1	
	50-60 Review Questions (11)	11	11
	61 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR5 Advanced Refrigeration			
ACR5 S3	Supermarket Refrigeration		
	Title Slide	1	
	2 Intro	1	
	3-4 Product Temperatures	2	
	5-8 Parallel Rack Systems	4	
	9-26 Rack Oil Systems	18	
	27-41 Oil Problems from Blow By	15	
	42-43 Case Temperature Control	2	
	44-58 Rack System Controllers	15	
	59-62 Simple Controllers	4	
	63-71 Input Sensors	9	
	72 HVAC Controllers	1	
	73-77 Emerson Rack Controllers	5	
	78-80 Controller Outputs	3	
	81-89 Types of Control Boards	9	
	90-91 Controller Display in Office	2	
	92-97 Head Pressure Control	6	
	98-102 Evaporator Defrosting	5	
	103-107 Mechanical Subcooling	5	
	108-110 Heat Reclaim	3	
	111-113 Open Display Cases	3	
	114-115 Gravity Coils	2	
	116-119 Installation	4	
	120-121 Leak Detection	2	
	122-123 Large Receivers - Emergency Backup	2	
	124-126 Electric Expansion Valves (EEV)	3	
	127-128 ECM Motors	2	
	129-130 LED Lighting	2	
	131-136 Secondary Refrigerant Systems	6	
	137-139 CO2 Secondary Refrigerant Systems	3	
	140-142 CO2 Cascade System	3	
	143-144 CO2 as a Refrigerant	2	
	145-148 Important Terms of CO2 Systems	4	
	149-158 CO2 Phase Diagrams	10	
	159-162 Transcritical Systems	4	
	163-164 Functions of a Flash Tank	2	
	165-172 Five (5) Hazards of CO2	8	
	173-179 Final Notes on CO2	7	
	180 Questions Intro	1	
	181-218 Review Questions (38)	38	38
	219 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR5 Advanced Refrigeration			
ACR5 S4	Walk-In Refrigerators and Freezers		
	Title Slide	1	
	2 Intro	1	
	3-15 Walk-in Walls, Floors, and Doors	13	
	16-25 Refrigeration Equipment Selection	10	
	26-36 System TD	11	
	37-42 Pipe Sizing Charts	6	
	43-47 Piping Suction Lines	5	
	48-49 Piping Discharge Lines	2	
	50-54 Capacity Control, Oil Return, Double Rise	5	
	55-56 Drain Piping	2	
	57-61 Diagnosing Evaporator Frost Patterns	5	
	62-64 Door Curtains	3	
	65-66 Warm Product and Air Flow	2	
	67-68 Glass Door Condensation	2	
	69-78 Medium Temperature Air Defrost	10	
	79-85 Low Temperature Defrost	7	
	86-94 Freezer Defrost Clocks	9	
	95-98 Defrost Termination and Fan Delay	4	
	99-102 Electronic Defrost Clocks	4	
	103-109 Electronic Sensors & Smart Controllers	7	
	110-115 Basic Hot Gas Defrost	6	
	116 Questions Intro	1	
	117-138 Review Questions (22)	22	22
	139 End Slide	1	
ACR5 S5	Ice Machines		
	Title Slide	1	
	2 Intro	1	
	3-4 Commercial Ice	2	
	5-7 Basic Cube Ice Machine Operation	3	
	8-13 Manitowoc Sequence of Operation	6	
	14-15 Hoshizaki Ice Maker	2	
	16-17 Flake Ice Machine	2	
	18-23 Vogt Ice Machine	6	
	24-25 Remote Condenser Piping	2	
	26-28 Ice Machine Cleaning	3	
	29-30 Water Filters	2	
	31-34 Condenser Maintenance	4	
	35 Ice Machine Warranties	1	
	36-47 Troubleshooting Ice Machines	12	
	48 Questions Intro	1	
	49-58 Review Questions (10)	10	10
	59 End Slide	1	

Topic and Subject#	Subjects	Slides	Review Questions
ACR5 Advanced Refrigeration			
ACR5 S6	Chillers		
	Title Slide	1	
	2-3 Intro	2	
	4-5 Chiller Evaporator	2	
	6-8 Water-Cooled Condenser	3	
	9-15 Chiller Compressors	7	
	16-20 Centrifugal Compressor System	5	
	21-28 Chiller Condensers	8	
	29-30 Variable Frequency Drives	2	
	31-36 Absorption Systems	6	
	37 Questions Intro	1	
	38-47 Review Questions (10)	10	10
	48 End Slide	1	
ACR5 S7	Pumpdown		
	Title Slide	1	
	2-8 Automatic or Continuous Pumpdown	7	
	9-14 One Time or Non-Recycling Pumpdown	6	
	15 Questions Intro	1	
	16-20 Review Questions (5)	5	5
	21 End Slide	1	