12. The automatic expansion valve is designed to maintain a constant pressure in the evaporator. As the evaporator pressure increases above the setpoint, the valve will close, reducing the amount of refrigerant being introduced into the evaporator. If the evaporator pressure is lower than the setpoint on the valve, the valve will open introducing more refrigerant to the evaporator in an effort to increase the pressure in the evaporator.
13. The thermostatic expansion valve is designed to maintain a constant superheat in the evaporator. As the superheat increases, the TEV will open to feed more refrigerant to the evaporator coil, causing the superheat in the coil to drop. If the superheat is too low, the valve will close, reducing the amount of refrigerant flowing into the evaporator. This will cause the evaporator superheat to rise.
14. The two most important factors that affect the operation of a capillary tube are the bore size and the length of the tube. As the bore size decreases and the length increases, the pressure drop through the capillary tube will increase. Similarly, as the bore size increases and the length decreases, the pressure drop through the capillary tube will decrease.
15. The TEV will be in the open position when the superheat in the evaporator is higher than that at which the valve is set. The bulb pressure will be higher than the sum of the evaporator and spring pressures, causing the valve to open.
16. Answer choice "D" is correct. The purpose of the refrigerant in the evaporator is to remove both latent and sensible heat from the air passing over the coil, making "A," "B," and "C" all correct.
17. Answer choice "C" is correct. Because multicircuit evaporators have numerous paths for refrigerant to take, the resistance to flow through the coil is very low, resulting in a low pressure drop across the coil, eliminating answer choice "D." In order to facilitate the equal feeding of refrigerant to each of the individual circuits in the evaporator, a distributor is required, making "C" correct.
18. Answer choice "D" is correct. The term "mechanical draft" indicates the use of a fan to move air across the coil. The direction of the air is determined by the rotation of both the motor and the fan blade, making the evaporator either induced or forced draft. Because fans are used, they move larger volumes of air than natural draft evaporators.
19. Answer choice "B" is correct. Using the pressure/temperature chart shown in Figure 1-1 in the text, it can be seen that the saturation temperature of R-410A at 118.4 psig is 40˚F.
20. Answer choice "A" is correct. The temperature of the evaporator coil is lower than the temperature of the air surrounding the coil. If the thermal bulb comes loose, it will be exposed to a higher temperature, increasing the pressure in the bulb. This eliminates answer choice "B." Answer choices "C" and "D" can also be eliminated because the closing of the valve and the starving of the coil would be results of a reduction in the bulb pressure, not an increase.

CHAPTER 2

VAPOR-COMPRESSION REFRIGERATION SYSTEM ACCESSORIES AND CONTROLS

FOR DISCUSSION QUESTIONS

1. The purpose of safety controls and devices is to protect the equipment and those around it. Jumping these controls creates a potentially hazardous situation. High-pressure switches, for example, are intended to disable a system if the pressure within rises to an unsafe level. Jumping out the control can result in excessively high pressures that can cause solder joints and piping to burst, potentially damaging the system and causing injury to individuals in close proximity to

the equipment. During the process of troubleshooting a system, however, it may be necessary to jump out a control or safety device for a short period of time in order to determine the cause for system failure. Under no circumstances should a service technician leave these devices jumped when leaving the service call.

2. Pumping a system down is the process by which the system refrigerant is stored in the compressor, condenser, and receiver while a repair is performed on the low pressure side of the system. Pumping down a system eliminates the need to recover the refrigerant from the system. After pump down, the suction service valve on the compressor, as well as the service valve on the receiver, should be in the frontseated position. After the repair, the system should be leak tested and evacuated before introducing the refrigerant back into the system.
3. The answer to this question could be either yes or no. If a system is equipped with a liquid line solenoid or other service valve that will provide a positive shut off to refrigerant flow in the liquid line, the system can be pumped down. Such systems are normally equipped with oversized condensers to store the entire system charge when pumped down. On the other hand, systems without a means by which refrigerant flow in the liquid line can be stopped cannot be pumped down. In these cases, the refrigerant must be recovered from the system prior to repair.
4. In the off cycle, refrigerant migrates to the coldest section of the system, which can very well be the compressor during periods of colder temperatures. In addition, colder temperatures facilitate the mixing of refrigerant oil and refrigerant. The purpose of the crankcase heater is to cause liquid refrigerant in the crankcase to boil off into a vapor, thereby separating the oil and refrigerant. Allowing the refrigerant to boil off from the oil reduces the possibility of introducing liquid refrigerant to the compressor cylinder. Ideally, the crankcase should be energized for a period of at least 24 hours before initial system start-up. Some systems are designed to have the crankcase heaters energized continuously, even when the compressor is operating, while others are designed to have the heaters energized whenever the compressor is not operating.

ANSWERS TO REVIEW QUESTIONS

1. Answer choice “D” is correct. In order to read system operating pressures, gauges must be connected to the system. Access to the refrigerant circuit is also required to adjust the refrigerant charge and to evacuate a system.
2. Answer choice “B” is correct. The frontseated position is typically used to pump down a refrigeration system, eliminating answer choice “A.” The midseated position is used primarily for system evacuation, eliminating answer choice “C.” The cracked off backseat position is used for obtaining system operating pressures during service, eliminating answer choice “D.”
3. Answer choice “B” is correct. Answer choice “A” is incorrect because the strainer’s function is to remove any particulate matter that may be circulating in the system. Answer choices “C” and “D” are simply wrong.
4. Answer choice “B” is correct. A large temperature drop across a liquid line filter drier is an indication that the drier is at least partially blocked. A larger drier will take much longer to clog, but an oversized drier will not cause the temperature drop across the device to increase, eliminating answer choice “A.” Answer choice “C” is incorrect because liquid lines are not normally insulated at all. Answer choice “D” is simply wrong because the sight glass has nothing to do with the functioning of the drier, with the exception of monitoring the moisture level in the system.
5. Answer choice “C” is correct. Refrigerant receivers are located between the condenser and the expansion device, eliminating answer choice “A.” Refrigerant receivers are typically designed to hold at least the entire refrigerant charge of the system, eliminating answer choice “B.” Oil

travels with the refrigerant and typically does not separate from the refrigerant and accumulate in the receiver, eliminating answer choice "D."

6. True. The determination of whether a valve is normally open or normally closed is made by observing the position of the valve when the solenoid coil is in the de-energized position. This position can be either open or closed, making this statement true.
7. Answer choice "C" is correct. The purpose of the solenoid is to start and/or stop the flow of refrigerant in a system, eliminating answer choice "A." Answer choice "B" is simply wrong. The purpose of the expansion valve is to control the amount of refrigerant flowing in to the evaporator, not to remove refrigerant from the oil, eliminating answer choice "D."
8. False. The pressure relief valve is designed to relieve system pressure if it reaches an unsafe level. A pressure slightly higher than the suction pressure is not at a dangerous level.
9. The purpose of the refrigerant distributor is to ensure that equal amounts of refrigerant are fed to each branch of a multicircuit evaporator. The distributor causes the liquid and vapor refrigerant leaving the expansion valve to combine into a homogeneous mixture, ensuring that each circuit of the evaporator is fed the same amount of refrigerant, which is at a constant consistency.
10. Answer choice "D" is correct. High humidity increases the wet bulb temperature of the air. A cooling tower can ideally cool the water coming back to the tower to a temperature within 70˚F of the wet bulb temperature. The higher the wet bulb temperature, the higher the treated water temperature will be, eliminating answer choice "A," making choice "B" a correct statement. One factor that determines the efficiency of a condenser is the amount of subcooling that the condenser operates with. The higher the subcooling, the lower the temperature of the water returning to the tower. The lower the temperature of the water returning to the tower, the more efficiently the cooling tower will operate, making answer choice "C" correct as well. From this we can see that answer choice "D" is the best response to this question.
11. True. Forced draft indicates that a fan is being used to move air through the tower.
12. Answer choice "D" is correct. Sensing bulbs and remote bulbs are the same, eliminating answer choices "A" and "B." Electronic thermostats are solid state devices, eliminating answer choice "C."
13. Answer choice "A" is correct. Low-voltage thermostats are not designed for outdoor use, eliminating answer choices "B" and "D." Low-voltage thermostats are not sealed as line voltage thermostats are, eliminating answer choice "C."
14. Answer choice "D" is correct. Transformers are electric devices that do not function to control or transform pressure, eliminating choice "A." Transformers can be either step-up or step-down devices, indicating that both choices "B" and "C" are correct.
15. Answer choice "C" is correct. Multicircuit is a term used to describe evaporators with more than one path, eliminating answer choice "A." A multimeter is a device used to test electrical circuits, eliminating choice "B." A bimetal thermostat is used to control temperature, eliminating answer choice "D."
16. Answer choice "A" is correct. The cut-out pressure added to the cut-in temperature has no significance regarding the operation of a refrigeration or air-conditioning system, eliminating answer choice "B." The cut-out pressure is simply the cut-out pressure, not the differential, eliminating answer choice "C." The differential refers to a pressure difference on the low side of the system that can never be larger than the high pressure of the system, eliminating choice "D."
17. Answer choice "D" is correct. Low-charge protection is provided by low-pressure controls, eliminating answer choice "A." High-pressure controls function to ensure that the system operates safely below a predetermined high-side pressure. These devices will disable a system if the pressure rises too high, indicating that both "B" and "C" are correct.
18. Answer choice "B" is correct. Water regulating valves are not intended to be used as low ambient controls, although they do function to maintain the head pressure within the desired

range, eliminating answer choices "C" and "D." Although there is a flooded evaporator, evaporator flooding does not relate to low ambient control, eliminating answer choice "A."

19. Answer choice "D" is correct. All contactors are equipped with a holding coil and can have both normally open and normally closed sets of contacts.
20. True. In a series circuit, the current is the same at all points in the circuit.

CHAPTER 3

VAPOR-COMPRESSION HEAT-PUMP COMPONENTS AND ACCESSORIES

FOR DISCUSSION QUESTIONS

1. A heat-pump system that has constant ice formation on the coil may very well have a defrost problem. Depending on the type of defrost method that is being used on the particular system, the cause for the excessive ice buildup may differ from system to system. No matter which type of defrost system is being used, systems located in cold, humid areas typically need to be defrosted more frequently.

   On systems that have a time-terminated/time-terminated defrost system, the time interval between defrost cycles may be too short and the time of the defrost cycle may be too short as well. On systems that have a time and temperature-initiated defrost cycle, the temperature sensor may need to be relocated in order to initiate defrost sooner. Also, the time interval between defrost attempts may need to be shortened. On defrost systems with a pressure-initiated defrost cycle, the pressure differential may need to be reduced in order to initiate defrost sooner. On systems with solid state defrost control boards, relocating the outdoor coil thermistor to the coldest section of the outdoor coil may very well solve the problem.

   In addition to the problems and remedies mentioned above, there could also be a problem with the four-way reversing valve. If the reversing valve fails in the heating mode and is defective, the system will not be able to switch over to the cooling mode and defrost the coil. Before attempting to repair the defrost system, always be sure that the system operates in both the heating and cooling modes first.
2. In respect to heat-pump systems, high heating bills reflect high electric bills. During winter operation, the compressor operates during first-stage heat and the supplementary electric-strip heaters will be energized during defrost and during second-stage heating operation. When utility bills begin to climb during the winter months, the electric-strip heaters are often the cause.

   There are a number of reasons why the electric-strip heaters would be energized more often and for a longer period of time. A few of these reasons are:
   - System remains in defrost too long—If this is the case, the defrost system should be checked and repaired as needed.
   - First-stage heat not satisfying the load—This can be a result of a defective reversing valve, system undercharge, or other system component failure.
   - Defective sail switch or control in the heater circuit—Make certain that all relays and controls in the heater circuit are operating properly. A defective relay or set of contacts could be keeping the strip heaters energized when they should be off.
   - Defective thermostat—Make certain that the thermostat is properly making and breaking the second-stage heating contacts.