BES702 Air Conditioning

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Chapter One Review Questions

1. Who decides if any physical or health hazards exist in a commercial building?

2. What role do "safe operating limits" play in keeping a building and its occupants safe?

3. What are the Building Operator's responsibilities related to safety?

4. What types of devices are included in the definition of "personal protective equipment?

5. Does PPE promise to eliminate hazards in the workplace? Why/why not?

6. What is the 4 to 1 rule related to ladders?

7. Why is electricity such a hazard in commercial buildings?

8. What can a Building Operator do on the job to minimize hazards related to electricity?

9. What is the purpose of tagout and lockout procedures and how do they work?

10. What are some of the features you might expect to find in your building's fire safety plan?

11. Are all fire hazards visible? Why/why not?

12. What might your role be if there is a false alarm in your building?

13. Why do paints and solvents require special treatment when being stored?

14. What are the main features of WHMIS legislation?

15. Why do Building Operators need to know about the TSSA?

Chapter Two Review Questions

1. What are some of the factors that affect the ability to keep a building at the desired temperature?
2. What's the difference between "heat" and "temperature"?
3. Define the three main mechanisms of heat transfer.
4. Using your own words, compare latent and sensible heat.
5. What is the relevance of the latent heat of vapourization for refrigeration and cooling systems?
6. If you stick a thermometer in a bucket of water, are you measuring latent heat or sensible heat?
7. Why are psychrometric charts not used as often as they once were?
8. What are the critical temperatures (boiling and freezing points of water) in both metric and Imperial systems?
9. What is the relationship between temperature and pressure? Why is this concept important in refrigeration and cooling systems?
10. What is the comfort zone and why is it important?
11. What if the effect of the equipment in a building on the ability to achieve the comfort zone?
12. Identify the main contributors to the internal cooling load of a building.
13. Why does lighting not affect the cooling load as it once did?
14. How does mechanical effect differ from the impact of air leakage?
15. What are several things that you may be responsible for doing to control air leakage in a building?
16. Why are green roofs becoming popular?
17. What are some window treatments that can help control heat gain from solar radiation?

Chapter Three Review Questions

1. What is a refrigerant and what function does it carry out?
2. What are the desirable characteristics of good refrigerants?
3. What types of refrigerants have been found to have high ozone depletion potential?
4. How does ozone depletion differ from global warming potential?
5. What characteristics of refrigerants affect their safe use?
6. How will you know if there are changes to the regulations concerning which refrigerants may be used?
7. Where can you get more information about changing regulations?
8. What limits have been placed on the Building Operator in terms of handling refrigerants?

Test of Understanding Chapters 1, 2, & 3

The following questions are based on the content of Chapters One, Two and Three of this book. Each question calls for either a "true" (T) or "false" (F) answer. Answers are provided at the back of the book but no peeking!

These questions, and the clarification offered with the answers, are meant to give you confidence that you have understood the content and a bit more instruction, if you have not -the answers include an explanation for the correct response.

1		Your regular eyeglass prescription can be changed to impermeable safety lenses so you do not need to wear safety glasses.
2		Cooling systems take advantage of the principle that the lower the pressure, the lower the boiling point (of the refrigerant).
3		As a Building Operator, you will be closely supervised most of the time.
4		Radiation is the transfer of heat by the movement of a substance (gas or liquid) through a medium.
5		Low voltage, because the amount of electricity is not considered "lethal", poses little safety concerns.
6		A piece of equipment (e.g., a fan) is not running so you can assume that it's safe to do maintenance work on it.
7		The optimum dry bulb temperature and relative humidity are the same for every building.
8		The Fahrenheit and Celsius scales never report the same number as the temperature.
9		Some windows in buildings are designed to take advantage of the fact that air is a poor conductor of heat.
10		Firefighters can readily locate hazardous materials such as flammable refrigerants in your building from a review of the building's fire safety plan.
11		You do not need to wear noise protection if you know that your exposure to excessive noise is only occasional and not recurring.
12		This is the formula to convert Celsius (C) to Fahrenheit (F): F = 0.56 X (C-32) .
13		Refrigerants operate in open systems.
14		A Class B fire involves substances that burn slowly.
15		The only impact of equipment in a building, from an energy standpoint, is the impact on the energy consumed in running the equipment.

16		One BTU is the amount of heat needed to lower the temperature of one pound of water one degree Celsius.
17		A hazard analysis conducted in your building would reveal if there are any refrigerants used that are potentially toxic.
18		Convection is the flow of heat through a substance by contact of particles.
19		You are entitled to workers' compensation benefits (WSIB) if you suffer an injury that is work-related.
20		Removing the source of electricity renders a piece of equipment safe to perform maintenance tasks.
21		Convection is the transfer of heat by the movement of a gas or a liquid as a medium.
22		You may be asked not to wear your wedding band but you may choose to continue wearing it because that is your right.
23		An ODP card authorizes its holder to handle refrigerants.
24		You have the right to refuse to work if your work conditions are unsafe.
25		To be effective, a refrigerant must have a high boiling point.
26		Air leakage is a problem in the heating season but not so during the summer.
27		Radiant heat is not affected by the distance from the heat source.
28		One of the principles of safe lifting is to keep the load as far away from your body as possible.
29		Ozone depletion and global warming are the same.
30		If you take some of the heat out of air that has a relative humidity of 35%, some of the moisture in the air will begin to condense from the water vapour in the air.
31		Relative humidity is defined as the amount of water in the air.
32		Halocarbons may contain chlorine.
33		Heat transfer by convection occurs when energy is transferred by direct contact.
34		You are only responsible for your own actions that affect the safety of the building.

35		Your hardhat is of no value if an accident occurs which involves electricity.
36		When water converts from a liquid to a vapour, it absorbs the latent heat of vaporization.
37		Occupational health and safety legislation is concerned with your physical safety.
38		People load refers to the number of people occupying the building at a given time.
39		Hydrocarbons are typically not used to cool commercial buildings.
40		The R-number of a given refrigerant is assigned in order to compare its ozone-depletion capacity to that of other refrigerants.
41		Sensible heat is related to changes in temperature of a gas or object with no change in state.
42		The energy in the form of moisture given off by people occupying a building is latent heat.
43		The building owner is concerned about loss of life due to safety infractions and accidents.
44		The higher the pressure, the higher the boiling point of liquids.
45		The Montreal Protocol was a benchmark in the Canadian history of refrigerant use in this country.
46		The human body is incapable of conducting electricity.
47		Miscible means capable of mixing together.
48		It is the building operator's responsibility to ensure that plumbers hired to work on the premises make the repairs as contracted.
49		If there are two solids side-by-side, heat can always be expected to flow from the warmer one to the cooler one.
50		Refrigerants are usually referred to by their scientific name.
51		To calculate the BTUs involved when a block of ice changes to water, you need only calculate the latent heat involved.
52		"Fenestration" refers to the thermal capacity of windows.
53		"Load" only applies to heating and not cooling systems.

54		You must memorize the Building Code.
55		Units used to define the ability to remove heat are British Thermal Units (BTUs) in the Imperial system and calories, kilojoules or Watts in the metric system.
56		It takes the same amount of energy to lower the temperature of two substances that are the same size, weight and volume.
57		A reading from a wet bulb thermometer takes into account the moisture content of the air.
58		One pound of ice stores 144 BTUs of latent heat.
59		The principles of cooling a residential building are similar to those related to commercial buildings.
60		A relative humidity of 14% means that the air is 14% saturated with water.
61		Although refrigerants in use in Canada in the 1970's were found to be highly toxic, changes to refrigerants due to government regulations have eliminated toxicity as a concern.
62		British Thermal Units (BTUs) are the unit used to define thermal conductivity.
63		An MSDS must be created for each refrigerant used in your building.
64		An insulation material with a low R-value is considered ideal.
65		The only acceptable refrigerant is one that is totally non-toxic and non-flammable.
66		You discover oily rags in a garbage can. You are responsible for reporting your discovery.
67		Low-e window coatings provide more benefit to a building in the winter than in the summer.
68		Refrigerants must have a low dielectric strength.
69		The room temperature is 78 degrees Fahrenheit. Expressed in Celsius, this is 22 degrees C.
70		Lockout procedures prevent the unintended release of stored energy.
71		When setting up an extension ladder, observe the 4 to 1 rule.
72		Latent heat affects the temperature of an object.

73		Low emissivity (low-e) windows are undesirable in a building because they do little to regulate the temperature inside the building.
74		The Canadian government recognized that, to eliminate the use of a particular refrigerant (e.g., Freon), an orderly and phased transition was required.
75		A fire alarm system can never be silenced.
76		The refrigerants in use today are generally accepted as having no harmful effects on the environment.
77		You find that a compressor has been tagged and has a lock on it. Although it would be helpful to know why, you might only guess the reason.
78		Transfer of thermal energy is driven by a difference in pressure.
79		The use of R-22, a commonly used refrigerant, is being phased out in Canada.
80		Dry bulb temperature must be measured on a day when there is no more than 20% moisture in the atmosphere.
81		There is only one range (defined by ASHRAE) of temperatures that make up the comfort zone.
82		A low Latent Heat of Vapourization is ideal for a refrigerant.
83		On a sunny day, metal exposed to the sun will automatically become hot to the touch because of convection.
84		Because refrigerants are in a liquid or gas state, they are typically more ignitable than materials in a solid state.
85		Infiltration is the same as ventilation.
86		All forms of energy can be considered a potential source of explosion.
87		All sources of electrical energy must be considered in lockout procedures.
88		Fire safety is concerned only with preventing the ignition of a fire.
89		PPE gives you complete protection from workplace hazards.
90		You will be provided the PPE necessary to handle refrigerants.
91		HCFCs were introduced to replace highly toxic and flammable refrigerants.

92		Refrigerants tend to absorb moisture.
93		The temperature of one substance, as measured by a dry bulb thermometer, is 23°C. A second substance has a temperature of 73.4°F. The difference in temperature of these two substances is referred to as delta t.
94		If there is a difference in the pressure inside the building and outside the building, this difference will drive a transfer of thermal energy.
95		Latent heat is associated with changes of state between liquids, gases and solids.
96		The latent heat of vapourization of water is lower than the amount of heat required to change its temperature.
97		Refrigerants that have been found to be highly flammable are also not good for the environment.
98		Fires need fuel and oxygen to exist.
99		It is safe to pull on an electrical cord to shut off a piece of equipment in an emergency.
100		Inorganic types of refrigerants are not typically used today.
101		The heat that causes an object to change from a liquid to a vapour is called latent heat.
102		TSSA stands for the Technical Standards System of America.
103		To calculate the BTUs involved when a block of ice changes to water, you need only calculate the latent heat involved.
104		The annunciator panel will indicate if the cooling system is functioning normally.
105		Safe use of a ladder requires that you keep both hands on the ladder at all times.
106		Ideally, a refrigerant takes up as little space as possible.
107		Fairly recent changes to lighting loads in commercial buildings resulted in higher costs for energy used in cooling systems.
108		A 2-ton refrigerator has a cooling capacity of 288 BTUs per hour.

Chapter Four Review Questions

1. What is the function of the compressor?
2. What is the role of the condenser?
3. Where are air-cooled condensers normally located?
4. Define superheat. Is it sensible or latent heat?
5. What is sub-cooling?
6. How does an evaporative condenser work?
7. What is the function of the evaporator?
8. Compare flooded and direct expansion evaporators.
9. Explain the function of a metering device.
10. Define refrigeration effect.
11. What changes in temperature and pressure does the refrigerant go through as it travels through the vapour compression cycle?

Chapter Five Review Questions

1. What are the principles of absorption cooling?
2. What is capacity control? Why are capacity controls necessary?
3. What prevents compressor operation in a centrifugal system if the oil pressure is inadequate?
4. What distinguishes centrifugal chillers from other vapour compression refrigeration systems?
5. What are the main differences between hermetically sealed and open-type centrifugal compressors?
6. What is the most common type of condenser used in chiller systems?
7. What is the function of an economizer?
8. What is surge and what causes it?
9. Beginning at the evaporator, describe the path of the refrigerant. What pressure and temperature changes take place along the way?
10. Why are water-cooled condensers the type typically used in hydronic systems?
11. Explain the principle of operation of a cooling tower.
12. Why is water treatment necessary at the cooling tower for water-cooled condensers?
13. What is a cooling coil and where is it located?
14. State the principles of operation of a heat pump.
15. Describe the various configurations of ground and water source heat pump collectors.
16. How difficult would it be to exploit free cooling in an existing commercial building?
17. Explain the basic principle of deep water cooling.
18. What is thermal energy storage? What benefits does it offer?

Chapter 6 Review Questions

1. Why is it important to maintain equipment records and when should this be done?

2. Why is water treatment necessary?

3. What housekeeping and low cost measures are within your control to improve the efficiency of your cooling system?

4. What does oil leaked around the components of the chiller indicate?

5. What are the restrictions on a Building Operator related to refrigerants and refrigerant handling?

6. What does a water treatment specialist do?

7. What kinds of tasks does a Building Operator do to maintain the cooling system?

Test of Understanding Chapters 4, 5, & 6

The following questions are based on the content of Chapters Four, Five and Six of this book. Again, each question calls for either a "true" (T) or "false" (F) answer. Answers are provided at the back of the book and include clarification of the correct response.

If you are unable to answer these questions with a high degree of correct responses, you may be advised to do further study in preparation for the final exam for this course.

1		The amount of cooling that a chiller achieves depends on how much refrigerant it moves though the evaporator.
2		Surging of the compressor is an indication that there is a crisis.
3		You will need to call a water treatment specialist if your tests of the water's conductivity reveal that there's a problem.
4		The only difference among systems that are based on the refrigeration cycle is the choice of refrigerant used.
5		The BAS can control the hydronic cooling system by opening and closing valves, and by modulating the fow of water in the system.
6		Vapour compression systems are also called absorption refrigeration systems.
7		Liquid refrigerant going into the compressor is to be avoided.
8		You will sometimes manually open the drain to the cooling tower if the need presents itself.
9		The purge unit on a cooling tower purges air from the water.
10		The chilled water loop is an open loop.
11		Heated air holds more moisture than cool air.
12		Refrigeration units add to the heat gain in a building while, at the same time, removing the heat from a given space.
13		The role of the compressor is to receive the refrigerant as a vapour and compress it into a liquid.
14		In a vapour compression system, the refrigerant enters the compressor as a vapour.
15		Ground-source heat pumps always move heat from the building to the ground.
16		Deep lake cooling increases the amount of electricity used to cool a building.

17		Expect a chiller to be scheduled for shut down once a year.
18		Deep lake cooling undertaken in Toronto is an application of district cooling.
19		The purge unit will look after removing all unwanted air in the refrigeration system.
20		Cooling coils are very low maintenance.
21		The refrigeration cycle consists of the following components: condenser, compressor, metering device and evaporator.
22		Condenser water picks up heat from the compressor.
23		Drift means the same as windage.
24		Refrigerants absorb heat when they change state from a liquid to a gas.
25		If the pumps are not operating properly, it will be your job to fix and or replace them.
26		Cooling towers have a sight glass on them that reveals the amount of water inside.
27		You will be reponsible for recording the OAT and relative humidity on a daily basis.
28		You will likely be responsible for purging any unwanted air from the chiller.
29		Refrigerators are designed to create cold, whereas heat pumps are designed to create heat.
30		In order not to waste energy by running the compressor at full load, a "false load" is sometimes imposed on it.
31		Chilled water is no longer called chilled water, once it has taken on the heat from the occupied space.
32		Water in the refrigerant is a problem because it can freeze.
33		Wet insulation on the condenser loop is a concern because the source of the leak needs to be identified.
34		When a liquid refrigerant changes to a gas, it absorbs the latent heat of fusion.
35		It will be your reponsibility to check the chiller to determine if oil needs to be added to the refrigerant.

36		Filters on the bank of pumps on both the chilled water loop and the condenser loop pick up foreign material.
37		If, when you test the water in the condenser loop via the cooling tower, the strength of the chemicals in the water is abnormal, you will need to make adjustments to the chemicals.
38		Cooling towers are always turned off in the winter.
39		The refrigeration cycle describes the changes that take place in the refrigerant as it absorbs and rejects heat while circulating through a refrigeration device.
40		Heat pumps can be called geothermal when the source of heat is the ground.
41		As the Building Operator, you will be required to lubricate the compressor.
42		Chilled water return refers to chilled water that is returning to the chiller.
43		Some of the water going to the cooling tower evaporates.
44		Once the head pressure of a chiller is too high, the chiller will automatically shut down.
45		If there is a significant leak of refrigerant, the BAS will sense it and shut the chiller down.
46		A suitable water treatment program is critical to the achievement of effective heat transfer in the condenser.
47		All the components of a chiller can be called "machines".
48		Balancing valves, located in the evaporator and condenser pipes, ensure an adequate flow of water going through them.
49		Water is called "process water" once it leaves the cooling tower.
50		The receiver temporarily stores refrigerant until it is needed. It is basically a tank in the mechanical room.
51		Thermal storage is an energy efficient means to store heat or cold.
52		During the evaporation stage of the refrigeration cycle, heat passes from the substance to be cooled into the refrigerant.
53		"Sink" is a term used in both ground-source and air-source heat pump systems.
54		The role of the condenser on a chiller is to reject the heat that the refrigerant had absorbed.

55		Refrigerant must be expanded from a liquid to a vapour at the metering device
56		When the Building Operator charges the chiller with refrigerant, the safety guidelines stated in the Environmental Protection Act must be followed.
57		Performance of the cooling tower can be measured by comparing the amount of makeup water with the amount of the blowdown water.
58		Packing on pumps can disintegrate over time and you may need to replace the packing.
59		The Coefficient of Performance measures the performance of the chiller.
60		Screens on cooling towers will require your attention because they can become clogged with foreign material.
61		When a refrigerant in its gas state rejects heat, it condenses and releases its heat.
62		Coils in the ductwork operate like terminals.
63		Dampers is another name for grills in the AHU.
64		Chilled water and condenser water travel in the same pipes.
65		You will become aware of short cycling of the compressor when you hear it shutting on and off in quick succession.

Test of Understanding Answers

Chapters 1,2,&3		
#	Question	Answer
1	Your regular eyeglass prescription can be changed to impermeable safety lenses so you do not need to wear safety glasses.	**FALSE** Your prescription may be incorporated into the safety glasses you are required to wear or you can wear the protective eyewear over your normal eyeglasses. Eyewear is particularly important when working around refrigerants because a leak can result in eye irritation or corneal damage.
2	Cooling systems take advantage of the principle that the lower the pressure, the lower the boiling point (of the refrigerant).	**TRUE**
3	As a Building Operator, you will be closely supervised most of the time.	**FALSE** As a Building Operator, you will work with limited supervision most of the time.
4	Radiation is the transfer of heat by the movement of a substance (gas or liquid) through a medium.	**FALSE** Convection is the transfer of heat by the movement of a substance (gas or liquid) through a medium such as air or water.
5	Low voltage, because the amount of electricity is not considered "lethal", poses little safety concerns.	**FALSE** Issues associated with low voltage contact may take months to detect and can include speech impairment, irregular heartbeat, difficulty walking, numbness, memory loss and weakness.
6	A piece of equipment (e.g., a fan) is not running so you can assume that it's safe to do maintenance work on it.	**FALSE** The piece of equipment might actually still be fully on but only operate intermittently. Even if it has been shut down, it is only safe to do work on it if, after being shut down, it is tagged and locked out, ensuring that someone else can't inadvertently start it up again while you're doing maintenance work on it.
7	The optimum dry bulb temperature and relative humidity are the same for every building.	**FALSE** Some buildings require more and some less dry bulb temperature and relative humidity in order to achieve the purpose of the building.
8	The Fahrenheit and Celsius scales never report the same number as the temperature.	**FALSE** The Fahrenheit and Celsius scales both report the same temperature when the temperature is -40°.
9	Some windows in buildings are designed to take advantage of the fact that air is a poor conductor of heat.	**TRUE** These windows have multiple panes or a vacuum between the panes.
10	Firefighters can readily locate hazardous materials such as flammable refrigerants in your building from a review of the building's fire safety plan.	**TRUE** Firefighters should be able to readily locate hazardous materials such as flammable refrigerants from a review of the building's fire safety plan. The plan also provides them an understanding of other hazards such as structural ones.

11	You do not need to wear noise protection if you know that your exposure to excessive noise is only occasional and not recurring.	**FALSE** The need for noise protection is determined by legislation that identifies permissible exposure limits. It is not up to you to decide when it is needed.
12	This is the formula to convert Celsius (C) to Fahrenheit (F): F = 0.56 X (C-32)	**FALSE** The formula to convert Celsius to Fahrenheit is:F = (1.8XC) + 32
13	Refrigerants operate in open systems.	**FALSE** Refrigerants operate in closed systems, also called "hermetic" systems.
14	A Class B fire involves substances that burn slowly.	**FALSE** A Class B fire is characterized by the involvement of substances that Boil or Bubble (flammable liquids such as gasoline, oil, grease andacetone).
15	The only impact of equipment in a building, from an energy standpoint, is the impact on the energy consumed in running the equipment.	**FALSE** Equipment in a building also gives off heat energy that either reduces the overall heating requirement or places an additional load on the building's cooling system.
16	One BTU is the amount of heat needed to lower the temperature of one pound of water one degree Celsius.	**FALSE** One BTU is the amount of heat needed to lower the temperature of one pound of water one degree Fahrenheit.
17	A hazard analysis conducted in your building would reveal if there are any refrigerants used that are potentially toxic.	**TRUE** Such an analysis is would reveal any physical as well as health-related hazards – conditions that can affect workers.
18	Convection is the flow of heat through a substance by contact of particles.	**FALSE** Conduction is the flow of heat through a substance by contact of particles.
19	You are entitled to workers' compensation benefits (WSIB) if you suffer an injury that is work-related.	**FALSE** You may be entitled to receive such benefits but only following an investigation and a determination by WSIB.
20	Removing the source of electricity renders a piece of equipment safe to perform maintenance tasks.	**FALSE** All sources of energy (electrical, mechanical and hydraulic) are potentially hazardous and must be disconnected or isolated. "Energy isolating" devices are used for this purpose.
21	Convection is the transfer of heat by the movement of a gas or a liquid as a medium.	**TRUE** Convection is the transfer of heat by the actual moving of a heated fluid from one place to another. The fluid can be in a vapour or liquid state.
22	You may be asked not to wear your wedding band but you may choose to continue wearing it because that is your right.	**FALSE** Wearing metal jewellery may be prohibited because of the risks inherent in your position. The wearing of jewellery may be covered in the safety requirements of your position. If so, you have no choice but to comply.
23	An ODP card authorizes its holder to handle refrigerants.	**FALSE** An ODP card DOES NOT authorize its holder to handle refrigerants. Building Operators complete training and obtain an ODP card upon its successful completion but only licensed Refrigeration Mechanics or Refrigeration Operators may handle refrigerants.

24	You have the right to refuse to work if your work conditions are unsafe.	**TRUE** The Ontario Ministry of Labour provides you this right.
25	To be effective, a refrigerant must have a high boiling point.	**FALSE** To be effective, a refrigerant must have a low boiling point (a boiling point that is below the temperature of the air to be cooled - the target temperature). In other words, the refrigerant turns into a vapour at a low temperature.
26	Air leakage is a problem in the heating season but not so during the summer.	**FALSE** Air leakage is a problem during the cooling season as well. Warm air from outside the building that is allowed to leak into the building must be replaced by conditioned air. This adds to the energy costs involved.
27	Radiant heat is not affected by the distance from the heat source.	**FALSE** Radiant heat diminishes the further away from the source. (Otherwise, the sun's heat would burn us up!)
28	One of the principles of safe lifting is to keep the load as far away from your body as possible.	**FALSE** One of the principles of safe lifting is to keep the load close to your body.
29	Ozone depletion and global warming are the same.	**FALSE** Ozone (O3) depletion refers to the reduction in the earth's upper atmosphere of ozone. Ozone provides protection from the sun's damaging radiation. Global warming, on the other hand, refers to the greenhouse gases that accumulate in the atmosphere where they tend to trap heat from the sun, resulting in higher global temperatures.
30	If you take some of the heat out of air that has a relative humidity of 35%, some of the moisture in the air will begin to condense from the water vapour in the air.	**TRUE** This is a fundamental aspect of cooling systems – they dehumidify the air while cooling it.
31	Relative humidity is defined as the amount of water in the air.	**FALSE** "Humidity" is the amount of moisture in the air but "relative" humidity is the amount of moisture in an air-water vapour mixture compared to the amount of moisture that the air could hold at that temperature if it were saturated.
32	Halocarbons may contain chlorine.	**TRUE** Halocarbons contain one or more of the halogens (bromine, chlorine, fluorine, and/or iodine). Some halocarbons contain chlorine and some do not. HFCs, which are halocarbons, do not contain chlorine.
33	Heat transfer by convection occurs when energy is transferred by direct contact.	**FALSE** Heat transfer by conduction occurs when energy is transferred by direct contact. The energy travels from one molecule to another. The higher the temperature, the faster the molecules move.
34	You are only responsible for your own actions that affect the safety of the building.	**FALSE** You are responsible for reporting defects and safety infractions of others.

35	Your hardhat is of no value if an accident occurs which involves electricity.	**FALSE** Some hardhats, by design, offer voltage protection. The hardhat must be specifically designed to do so (not all hardhats are so designed).
36	When water converts from a liquid to a vapour, it absorbs the latent heat of vapourization.	**TRUE**
37	Occupational health and safety legislation is concerned with your physical safety.	**TRUE** While this is true, the legislation is also concerned with your emotional wellbeing. It covers harassment in the workplace, for example.
38	People load refers to the number of people occupying the building at a given time.	**FALSE** People load refers to the quantity of energy given off by people into the building space; the people load varies depending on the body mass of the people, their level of activity and their style of dress.
39	Hydrocarbons are typically not used to cool commercial buildings.	**TRUE** Propane, for example, which is a hydrocarbon, is used primarily in domestic refrigerators.
40	The R-number of a given refrigerant is assigned in order to compare its ozone-depletion capacity to that of other refrigerants.	**FALSE** The R-number of a given refrigerant is assigned, based on its molecular structure. All refrigerants with a number in the 100's, for example, are part of the ethane series of refrigerants; those with a number in the 400's are refrigerant blends. A different number assigned, the ODP number, allows for a comparison of the ozone-depletion capacity to that of other substances.
41	Sensible heat is related to changes in temperature of a gas or object with no change in state.	**TRUE** Think of sensible heat as the energy measured by a thermometer. It can be sensed.
42	The energy in the form of moisture given off by people occupying a building is latent heat.	**TRUE**
43	The building owner is concerned about loss of life due to safety infractions and accidents.	**TRUE** The building owner is also concerned about any losses to his/her investment in the property and its assets, as well as any liability that may result from an accident.
44	The higher the pressure, the higher the boiling point of liquids.	**TRUE** The higher the pressure, the higher the boiling point.
45	The Montreal Protocol was a benchmark in the Canadian history of refrigerant use in this country.	**TRUE** The Montreal Protocol is also a benchmark in the worldwide history of refrigerant use. Over twenty nations from around the world came together to recognize that the ozone layer needs to be protected and that steps needed to be taken to do so.
46	The human body is incapable of conducting electricity.	**FALSE** The human body can conduct electricity. Workers who disregard electrical safety requirements sometimes find themselves as part of a live electrical circuit.

47	Miscible means capable of mixing together.	**TRUE** Refrigerants and lubricating oils need to stay mixed together and not separate into layers.
48	It is the building operator's responsibility to ensure that plumbers hired to work on the premises make the repairs as contracted.	**TRUE** This is a typical responsibility of a Building Operator. Be clear on your duties as defined in your job description. Appreciate the need to develop a rapport with the building's contractors.
49	If there are two solids side-by-side, heat can always be expected to flow from the warmer one to the cooler one.	**TRUE** Heat can always be expected to flow from a warmer to a cooler substance, be it a solid, liquid or gas.
50	Refrigerants are usually referred to by their scientific name.	**FALSE** Refrigerants are usually referred to by their R-number. R-134a is an example. The scientific name of R-134a is Tetrafluoroethane.
51	The total BTUs involved in changing steam to ice are 1294 BTUS	**FALSE** To calculate the BTUs involved when a block of ice changes to water, you need to calculate both the sensible and latent heat involved as follows: The total BTUs involved in changing steam to ice are 1294 BTUS To change the ice at 212°F to liquid at 212 °F 970 BTUs (latent heat) To change the water at 32°F to water at 212°F 180 BTUs (sensible heat) To change the liquid at 32°F to vapour at 32°F 144 BTUs (latent heat)
52	"Fenestration" refers to the thermal capacity of windows.	**FALSE** "Fenestration" refers to the design and position, not only of windows, but also of doors and other structural openings in a building.
53	"Load" only applies to heating and not cooling systems.	**FALSE** Load also applies to cooling systems. The cooling load represents the amount of heat that must be removed from the interior of the building in order to achieve and maintain the comfort zone.
54	You must memorize the Building Code.	**FALSE** As a Building Operator, you must be aware of the Building Code and your requirement to comply with it. You should have a copy of the Code so you can find information in it when you need to.
55	Units used to define the ability to remove heat are British Thermal Units (BTUs) in the Imperial system and calories, kilojoules or Watts in the metric system.	**TRUE** One BTU is the amount of heat that must be removed from one pound of water to lower its temperature one degree F. Note that the unit used in air conditioning is one ton of refrigeration – the same amount of cooling as melting one ton of ice over a twenty-four hour period.
56	It takes the same amount of energy to lower the temperature of two substances that are the same size, weight and volume.	**FALSE** It takes different amounts of energy to lower the temperature of different materials.

57	A reading from a wet bulb thermometer takes into account the moisture content of the air.	**TRUE**
58	One pound of ice stores 144 BTUs of latent heat.	**TRUE** This latent heat is available when the ice melts.
59	The principles of cooling a residential building are similar to those related to commercial buildings.	**TRUE** The principles are similar but the systems and their components may differ significantly.
60	A relative humidity of 14% means that the air is 14% saturated with water.	**TRUE**
61	Although refrigerants in use in Canada in the 1970's were found to be highly toxic, changes to refrigerants due to government regulations have eliminated toxicity as a concern.	**FALSE** Refrigerants in use today may still be toxic, especially when exposed to heat or flame. Toxicity is indicated on the MSDS for a given refrigerant.
62	British Thermal Units (BTUs) are the unit used to define thermal conductivity.	**TRUE** BTUs are the unit used in the Imperial system. The unit used in the metric system is the kilojoule.
63	An MSDS must be created for each refrigerant used in your building.	**TRUE** An MSDS must be created AND must be readily available so you can refer to it in the event of an accident.
64	An insulation material with a low R-value is considered ideal.	**FALSE** An insulation material with a high R-value is considered ideal. The better its thermal resistance properties, the better the insulation.
65	The only acceptable refrigerant is one that is totally non-toxic and non-flammable.	**FALSE** A balance is needed between the safety and usefulness of a refrigerant. Given the proper safety measures, for example, a refrigerant that is somewhat toxic under certain conditions can still be acceptable for use.
66	You discover oily rags in a garbage can. You are responsible for reporting your discovery.	**TRUE** You must identify and document any fire hazards that you observe. In the case of oily rags, you should also remove them and place them in a sealed container.
67	Low-e window coatings provide more benefit to a building in the winter than in the summer.	**FALSE** Low-e window coatings provide more benefit in the summer because this coating enables the surface of the window to radiate solar energy back into the atmosphere, instead of absorbing it.
68	Refrigerants must have a low dielectric strength.	**FALSE** Refrigerants must have a high dielectric strength, meaning that they are poor conductors of electricity.
69	The room temperature is 78 degrees Fahrenheit. Expressed in Celsius, this is 22 degrees C.	**FALSE** C = 0.56 X (F – 32) C = 0.56 X (78-32) C = 25.8
70	Lockout procedures prevent the unintended release of stored energy.	**TRUE** Lockout procedures address both the source of electricity and the stored energy. Addressing only the source of electricity means that stored energy may still be present and continue to be a hazard.

71	When setting up an extension ladder, observe the 4 to 1 rule.	**TRUE** For every 4 feet of height, place the base of the ladder 1 foot from the wall or upper support against which it rests.
72	Latent heat affects the temperature of an object.	**FALSE** Latent heat does not affect the temperature of an object. For example, ice remains at 0 degrees F when frozen. The heat removed to keep the water in a solid state is latent heat.
73	Low emissivity (low-e) windows are undesirable in a building because they do little to regulate the temperature inside the building.	**FALSE** Low-e means that there are low levels of emissivity – the coating on the windows helps to reduce the heat flow through the glass (especially heat gain in summer due to radiation).
74	The Canadian government recognized that, to eliminate the use of a particular refrigerant (e.g., Freon), an orderly and phased transition was required.	**TRUE** Regulations have been introduced in Canada that name types of refrigerants and define timelines for their removal, replacement and their manufacture.
75	A fire alarm system can never be silenced.	**FALSE** A fire alarm system can be and is silenced - for example, when emergency work is being done such as on elevator service. Although the alarm itself is silenced, the other functions of the control system continue to operate.
76	The refrigerants in use today are generally accepted as having no harmful effects on the environment.	**FALSE** Although refrigerants with ozone-depleting potential have been or are being phased out, a concern still exists about the global warming potential of refrigerants currently being used. The GWP of HFCs is under discussion. These refrigerants may need to be replaced by less harmful ones in the future.
77	You find that a compressor has been tagged and has a lock on it. Although it would be helpful to know why, you might only guess the reason.	**FALSE** As part of the tag out and lock out procedure, the tag must indicate the reason for the lockout. The tag is applied specifically to any energy isolating device(s) of the equipment and includes additional information such as the time it was applied and the name of the person who applied the tag.
78	Transfer of thermal energy is driven by a difference in pressure.	**FALSE** Transfer of thermal energy is driven by a difference in temperature.
79	The use of R-22, a commonly used refrigerant, is being phased out in Canada.	**TRUE** The use of R-22, a commonly used HCFC refrigerant, is being phased out in Canada. As of January 2030, it can no longer be manufactured in Canada or imported.
80	Dry bulb temperature must be measured on a day when there is no more than 20% moisture in the atmosphere.	**FALSE** Dry bulb temperature is the measure of the sensible temperature of air (the temperature taken using an ordinary thermometer).
81	There is only one range (defined by ASHRAE) of temperatures that make up the comfort zone.	**FALSE** There are actually two ranges, one for summer and one for winter.

82	A low Latent Heat of Vapourization is ideal for a refrigerant.	**FALSE** A high Latent Heat of Vapourization is ideal for a refrigerant because the higher the Latent Heat of Vapourization, the more heat will be absorbed when the refrigerant changes from a liquid to a vapour.
83	On a sunny day, metal exposed to the sun will automatically become hot to the touch because of convection.	**FALSE** On a sunny day, metal exposed to the sun will automatically become hot to the touch because of radiation.
84	Because refrigerants are in a liquid or gas state, they are typically more ignitable than materials in a solid state.	**TRUE** Substances in a liquid or gas (i.e., vapour) state are more ignitable than substances in a solid state.
85	Infiltration is the same as ventilation.	**FALSE** Infiltration is the natural flow of air through cracks and holes in the building envelope. Ventilation is the intentional and controlled flow of air using mechanical systems such as kitchen and washroom fans.
86	All forms of energy can be considered a potential source of explosion.	**TRUE** All forms of energy, from open flames to chemical reactions to gas compression, are a potential source of explosion.
87	All sources of electrical energy must be considered in lockout procedures.	**TRUE** True, but ALL sources of any form of energy including potential and residual energy must be considered (for example hydraulic and pneumatic energy must be bled off by opening pressure relief valves, potential mechanical energy must be released by blocking parts that may move, chemical energy must be removed by closing valves).
88	Fire safety is concerned only with preventing the ignition of a fire.	**FALSE** Fire safety is concerned with preventing the ignition of a fire, as well as limiting the effects of a fire once started, and controlling its development.
89	PPE gives you complete protection from workplace hazards.	**FALSE** PPE gives you some protection but does not eliminate the hazards.
90	You will be provided the PPE necessary to handle refrigerants.	**FALSE** You are unable, by law, to handle refrigerants unless you are a licensed Refrigeration Mechanic or Refrigeration Operator. These trained professionals will bring their own PPE (personal protective equipment).
91	HCFCs were introduced to replace highly toxic and flammable refrigerants.	**FALSE** CFCs were introduced to replace highly toxic and flammable refrigerants. Unfortunately, CFCs, containing chlorine, were found to be harmful to the environment.
92	Refrigerants tend to absorb moisture.	**TRUE** Refrigerants tend to absorb moisture, which can combine with the refrigerant to create an acid that will corrode the materials around it.

93	The temperature of one substance, as measured by a dry bulb thermometer, is 23°C. A second substance has a temperature of 73.4°F. The difference in temperature of these two substances is referred to as delta t.	**TRUE** The difference in temperature between two substances is referred to as delta t. These two temperatures, however, are the same.
94	If there is a difference in the pressure inside the building and outside the building, this difference will drive a transfer of thermal energy.	**FALSE** If there is a difference in the temperature inside the building and outside the building, this difference will drive a transfer of thermal energy.
95	Latent heat is associated with changes of state between liquids, gases and solids.	**TRUE**
96	The latent heat of vapourization of water is lower than the amount of heat required to change its temperature.	**FALSE** The latent heat of vapourization of water is higher than the amount of heat required to change its temperature.
97	Refrigerants that have been found to be highly flammable are also not good for the environment.	**FALSE** Refrigerants that are flammable have low global warming potential. The challenge is to find refrigerants that both are non-flammable and have a low GWP.
98	Fires need fuel and oxygen to exist.	**TRUE** Fires also need heat in adequate supply to raise the material to its ignition temperature and a chemical, exothermic reaction. In order to be effective, fire extinguishers must remove one or more of these elements.
99	It is safe to pull on an electrical cord to shut off a piece of equipment in an emergency.	**FALSE** Pulling an electrical cord while under load can create arcing or an explosion.
100	Inorganic types of refrigerants are not typically used today.	**FALSE** Inorganic types of refrigerants are used in industrial cooling system applications (e.g., CO2 is used in blast chillers and food processing, Ammonia, another inorganic refrigerant, is used in arenas and meat packing plants).
101	The heat that causes an object to change from a liquid to a vapour is called latent heat.	**TRUE** The heat is latent or hidden.
102	TSSA stands for the Technical Standards System of America.	**FALSE** TSSA stands for Technical Standards and Safety Authority
103	To calculate the BTUs involved when a block of ice changes to water, you need only calculate the latent heat involved.	**FALSE** To calculate the BTUs involved when a block of ice changes to water, you need to calculate both the sensible and latent heat involved as follows:
104	The annunciator panel will indicate if the cooling system is functioning normally.	**TRUE** The annunciator panel will also indicate when conditions related to the cooling system are abnormal.
105	Safe use of a ladder requires that you keep both hands on the ladder at all times.	**FALSE** You must have a three-point contact, which could mean two feet and one hand.

106	Ideally, a refrigerant takes up as little space as possible.	**TRUE** This means that the ideal refrigerant has a "low specific volume".
107	Fairly recent changes to lighting loads in commercial buildings resulted in higher costs for energy used in cooling systems.	**FALSE** Fairly recent changes to lighting loads in commercial buildings resulted in lower costs for energy used in cooling systems because these changes have decreased the lighting load.
108	A 2-ton refrigerator has a cooling capacity of 288 BTUs per hour.	**FALSE** A 2-ton refrigerator has a cooling capacity of 24,000 BTUs per hour.

Chapters 4, 5, 6		
#	Question	Answer
1	The amount of cooling that a chiller achieves depends on how much refrigerant it moves though the evaporator.	**TRUE** The greater the volume of refrigerant moving through the evaporator, as the load requires, the more cooling takes place.
2	Surging of the compressor is an indication that there is a crisis.	**TRUE** Surging is an indication that there is a crisis if the surging goes on more than a moment or two. The chiller should automatically shut the chiller down if surging goes on for longer than that.
3	You will need to call a water treatment specialist if your tests of the water's conducitivity reveal that there's a problem.	**TRUE** The water treatment specialist will review your findings and investigate.
4	The only difference among systems that are based on the refrigeration cycle is the choice of refrigerant used.	**FALSE** The differences among systems based on the refrigeration cycle are not only the refrigerants used but also the size and type of the equipment involved.
5	The BAS can control the hydronic cooling system by opening and closing valves, and by modulating the fow of water in the system.	**TRUE** The BAS can also control the temperature of the supply water and start/ stop pumps.
6	Vapour compression systems are also called absorption refrigeration systems.	**FALSE** These two systems are different. Vapour compression systems involve a refrigerant such as R-134-a; absorption refrigeration systems use a brine solution as the refrigerant. They are similar in that they both involve a chiller, but differ in that absorption refrigeration systems derive their energy from steam or hot water – not electricity.
7	Liquid refrigerant going into the compressor is to be avoided.	**TRUE** Only a vapour can be compressed.

8	You will sometimes manually open the drain to the cooling tower if the need presents itself.	**TRUE** Cooling towers have automatic bleedoff but you may need to to temporarily isolate one section of the cooling tower to drain and clean that section or drain the whole cooling tower under these conditions: When you visually inspect the water level in the sump, if the water levels are too high, To do annual cleaning, If you see water overflowing onto the sides of the cooling tower, If the BAS indicates that more water is being sent to the cooling tower than is normal. In that case, you would inspect the cooling tower, isolate it and drain it.
9	The purge unit on a cooling tower purges air from the water.	**FALSE** The purge unit is on the chiller. It purges any non-condensables - air, as well as moisture in the air, from the refrigerant in the chiller.
10	The chilled water loop is an open loop.	**FALSE** The chilled water loop is a closed loop. The condenser loop is open because it is open to the atmosphere (at a cooling tower, for example) in order to reject heat in the chilled water.
11	Heated air holds more moisture than cool air.	**TRUE** Warm air has a greater capacity to hold moisture.
12	Refrigeration units add to the heat gain in a building while, at the same time, removing the heat from a given space.	**TRUE** Refrigeration units, like computers, other mechanical equipment and food courts, add to the heat gain in the building.
13	The role of the compressor is to receive the refrigerant as a vapour and compress it into a liquid.	**FALSE** The role of the condenser is to change the refrigerant from a gas to a liquid.
14	In a vapour compression system, the refrigerant enters the compressor as a vapour.	**TRUE** Only a vapour may be compressed.
15	Ground-source heat pumps always move heat from the building to the ground.	**FALSE** Heat pumps, in cooling mode, move heat from the building to the ground. In heating mode, the pumps move heat from the ground to the building.
16	Deep lake cooling increases the amount of electricity used to cool a building.	**FALSE** Deep lake cooling actually decreases the amount of electricity used to cool a building – by as much as 90%.
17	Expect a chiller to be scheduled for shut down once a year.	**TRUE** A chiller is scheduled to shut down annually to be inspected by the refrigeration mechanic; cleaning inside the chiller typically takes place at the same time. The chiller may be shut down at other times as required – if a leak is found in the evaporator or the condenser, if refrigerant needs to be added, or the oil in the compressor needs to be changed, for example.
18	Deep lake cooling undertaken in Toronto is an application of district cooling.	**TRUE** The Enwave plant in Toronto provides cooling to several buildings in the area.
19	The purge unit will look after removing all unwanted air in the refrigeration system.	**TRUE** The purge unit, when functioning properly willl look after removing all unwanted air, as well as moisture, in the refrigeration system.

20	Cooling coils are very low maintenance.	**FALSE** Cooling coils require regular cleaning and draining in order to ensure the maximum heat exchange.
21	The refrigeration cycle consists of the following components: condenser, compressor, metering device and evaporator.	**TRUE** The refrigeration cycle consists of the following components, which may be listed in this order: compressor, metering device, condenser and evaporator.
22	Condenser water picks up heat from the compressor.	**FALSE** Condenser water picks up the heat from the refrigerant. The refrigerant has picked up heat from both the compressor and the evaporator.
23	Drift means the same as windage.	**TRUE** Both terms refer to the percentage of warm water droplets that escape by being carried out of the cooling tower in the air. This water must be made up.
24	Refrigerants absorb heat when they change state from a liquid to a gas.	**TRUE** Refrigerants absorb heat when they change state from a liquid to a gas.
25	If the pumps are not operating properly, it will be your job to fix and or replace them.	**TRUE** The job of ensuring that pumps are operating properly may be assigned to the Building Operator or may belong to the refrigeration mechanic. In that case, the notes that you make in your daily log will assist the refrigeration mechanic to locate, identify and fix the problem.
26	Cooling towers have a sight glass on them that reveals the amount of water inside.	**FALSE** Expansion tanks have a sight glass on them that indicates the level of water inside.
27	You will be reponsible for recording the OAT and relative humidity on a daily basis.	**TRUE** You will be responsible for recording the outside air temperature (OAT) and relative humidity on a daily basis.
28	You will likely be responsible for purging any unwanted air from the chiller.	**FALSE** The chiller has a purge unit on it that removes unwanted air from the chiller.
29	Refrigerators are designed to create cold, whereas heat pumps are designed to create heat.	**FALSE** The purpose of refrigerators is to remove heat (the cooling load) from a low temperature space. The purpose of heat pumps is to move heat.
30	In order not to waste energy by running the compressor at full load, a "false load" is sometimes imposed on it.	**TRUE** The false load keeps the compressor from turning on and off frequently; the portion of the chiller output that is not needed is thrown away.
31	Chilled water is no longer called chilled water, once it has taken on the heat from the occupied space.	**FALSE** Chilled water is always called chilled water, even when its temperature is raised.
32	Water in the refrigerant is a problem because it can freeze.	**TRUE** The water can create "freezeups", which prevent the refrigerant from travelling through the system. The water can also contribute to corrosion of the internal parts of the chiller.
33	Wet insulation on the condenser loop is a concern because the source of the leak needs to be identified.	**TRUE** Further to that, failed insulation may cause the condenser water to freeze, causing damage to the pipes and the valves.

34	When a liquid refrigerant changes to a gas, it absorbs the latent heat of fusion.	**FALSE** When a liquid refrigerant changes to a gas, it absorbs the latent heat of vapourization.
35	It will be your reponsibility to check the chiller to determine if oil needs to be added to the refrigerant.	**FALSE** The refrigeration mechanic or manufacturer's representative is responsible.
36	Filters on the bank of pumps on both the chilled water loop and the condenser loop pick up foreign material.	**TRUE** Filters on the chilled water loop and the condenser loop all pick up scale, rust and dirt.
37	If, when you test the water in the condenser loop via the cooling tower, the strength of the chemicals in the water is abnormal, you will need to make adjustments to the chemicals.	**TRUE** If, when you test the water in the condenser loop, the strength of the chemicals in the water is abnormal, you will need to make adjustments to the chemicals. You cannot allow the water in the cooling tower to grow bacteria, fungus, and so on.
38	Cooling towers are always turned off in the winter.	**FALSE** Some cooling towers operate in the winter. If they do not operate in the winter, they must be drained and cleaned.
39	The refrigeration cycle describes the changes that take place in the refrigerant as it absorbs and rejects heat while circulating through a refrigeration device.	**TRUE** The refrigerant absorbs heat from the water in the chilled water loop and rejects it in the condenser.
40	Heat pumps can be called geothermal when the source of heat is the ground.	**TRUE** Heat pumps can also be called geothermal when they carry heat from building to the ground.
41	As the Building Operator, you will be required to lubricate the compressor.	**FALSE** You will be required to record the temperature and pressure of the lubricating oil.
42	Chilled water return refers to chilled water that is returning to the chiller.	**TRUE** Chilled water return refers to chilled water that has picked up heat and is returning to the chiller to repeat the cycle.
43	Some of the water going to the cooling tower evaporates.	**TRUE** Some of the water is collected in a sump but some evaporates and needs to be replaced.
44	Once the head pressure of a chiller is too high, the chiller will automatically shut down.	**TRUE** The built-in safety checks within a chiller prevent it from operating if unsafe conditions are present.
45	If there is a significant leak of refrigerant, the BAS will sense it and shut the chiller down.	**FALSE** A sensor at the chiller and an alarm system in the mechanical room will shut the equipment down. A dedicated exhaust fan will be automatically activated to remove the refrigerant from the mechanical room.
46	A suitable water treatment program is critical to the achievement of effective heat transfer in the condenser.	**TRUE** A suitable water treatment program, combined with annually cleaning the condenser tubes should ensure effective heat transfer in the condenser.
47	All the components of a chiller can be called "machines".	**FALSE** Only the compressor is a machine.

48	Balancing valves, located in the evaporator and condenser pipes, ensure an adequate flow of water going through them.	**TRUE** Balancing valves are located in the evaporator pipes to ensure sufficient water flowto achieve the desired temperature; balancing pipes are located in the condenser pipes to ensure sufficient water going to the cooling tower.
49	Water is called "process water" once it leaves the cooling tower.	**FALSE** Once city water is being used for heating or cooling, it is called process water.
50	The receiver temporarily stores refrigerant until it is needed. It is basically a tank in the mechanical room.	**FALSE** The receiver does temporarily store refrigerant until it is needed, but It is attached to the chiller - although not every chiller has one.
51	Thermal storage is an energy efficient means to store heat or cold.	**FALSE** Thermal storage is used more to save costs than to improve energy efficiency. It involves storing chilled water or ice for use when required. It is not used to store heat.
52	During the evaporation stage of the refrigeration cycle, heat passes from the substance to be cooled into the refrigerant.	**TRUE** During the evaporation stage of the refrigeration cycle, the heat is absorbed by the refrigerant and the liquid refrigerant is vapourized.
53	"Sink" is a term used in both ground-source and air-source heat pump systems.	**TRUE** The sink in ground source sytems is the outdoor environment. The sink in air-source systems is the outdoor air.
54	The role of the condenser on a chiller is to reject the heat that the refrigerant had absorbed.	**TRUE** The refrigerant gives up its heat, and therefore condenses to a liquid.
55	Refrigerant must be expanded from a liquid to a vapour at the metering device	**TRUE** Refrigerant must be expanded from a liquid to a vapour. Some of the refrigerant flashes to a vapour, which cools the remaining refrigerant that passes through the metering device.
56	When the Building Operator charges the chiller with refrigerant, the safety guidelines stated in the Environmental Protection Act must be followed.	**FALSE** Building Operators do not charge the chiller with refrigerant - only licensed refrigeration mechanics may do so. According to the Environmental Protection Act, only those who are licensed and certified to do so may charge the chiller with refrigerant.
57	Performance of the cooling tower can be measured by comparing the amount of makeup water with the amount of the blowdown water.	**TRUE** But there are two additional measures of performance: 1) comparing the temperature of the water leaving the tower and the wet bulb temperature of the ambient air and 2) comparing the water temperature of the water entering the tower and the water leaving the tower.
58	Packing on pumps can disintegrate over time and you may need to replace the packing.	**FALSE** While it is true that packing on pumps can disintegrate, modern pumps typically do not involve packing.
59	The Coefficient of Performance measures the performance of the chiller.	**TRUE** The COP measures the performance of any electrical/mechanical device, including chillers and heat pumps, for example.
60	Screens on cooling towers will require your attention because they can become clogged with foreign material.	**TRUE** Screens on cooling towers keep the foreign material from entering the water stream. You will likely be required to clean the screens whenever the tower is drained.

61	When a refrigerant in its gas state rejects heat, it condenses and releases its heat.	**TRUE** When a refrigerant in its gas state rejects heat, it condenses and releases its heat.
62	Coils in the ductwork operate like terminals.	**TRUE** They take heat out of the air.
63	Dampers is another name for grills in the AHU.	**FALSE** Grills are screens that cover dampers in the AHU to keep out foreign material such as insects and birds.
64	Chilled water and condenser water travel in the same pipes.	**FALSE** Chilled water travels in the piping for the chilled water loop. Condenser water travels in the piping for the condenser loop. The pipes are in different locations and are sized differently.
65	You will become aware of short cycling of the compressor when you hear it shutting on and off in quick succession.	**TRUE** Your response to short cycling should be to shut down the chiller, put a different chiller online and notify your refrigeration mechanic.

Glossary

Absolute pressure
The total pressure, that is gauge pressure plus atmospheric pressure; expressed in kPa - the "a" standing for absolute

Absolute zero temperature
The temperature at which, theoretically, all molecular motion ceases; cannot exist except in a lab environment

Absorption Refrigeration
A refrigeration system that uses a water solution as the refrigerant; the solution, e.g., of lithium bromide (LiBr), absorbs water vapour thereby removing not only the Latent Heat of Vapourization, but also the Heat of Solution

Absorber
The solution in an absorption refrigeration system that absorbs cold water vapour from the evaporator

Actuator
A ring that controls the guide vanes at the compressor inlet

Air barrier
Installed in a building to stop the exfiltration of air from inside the building to the outside

Air changes
The total replacement of air in an occupied space

Air conditioning
Thought of as the movement of heat from a cooler space to a warmer space but is, in fact more than that; means the heating, cooling, filtering, humidification/dehumidication, ventilation and movement of air

Air handling unit (AHU)
Also called fresh air unit or makeup air unit; draws air into the building from outside

Air leakage
The natural, uncontrolled flow of air into and out of a building through openings and cracks for example

Ambient temperature
The temperature of the air in the surroundings; may refer to air in the outside environment or air in a given room

Approach
The difference between the temperature of the water leaving the cooling tower and the wet bulb temperature of the ambient air, also called the approach to the wet bulb

Automatic expansion valve
A valve that maintains a constant pressure at the entrance to the evaporator

Boiling point
The temperature at which the vapour pressure of a liquid is equal to the external pressure on the surface of the liquid. Referred to as the "normal boiling point" when the applied pressure is 1 atmosphere. Increased atmospheric pressure or enclosing the liquid under pressure in a sealed container raises the boiling point of the liquid

British thermal unit (BTU)
A unit of energy in the Imperial system. One British Thermal Unit is the amount of heat required to raise the temperature of one pound of water by one Fahrenheit degree at normal atmospheric pressure

BTUh
British Thermal Units (BTUs) per hour

Building automation system (BAS)
A computerized system that automatically controls building systems in order to achieve and maintain the building's setpoints - temperature, humidity and ventilation, for example

Building Control Centre (BCC)
The typical location of the BAS

Building envelope
The term given to designate all parts of the building that separate the interior of the building from the exterior environment

Building Management System (BMS)
See BAS

Butterfly valve
A type of gate valve that fully starts or fully stops the flow

C
Abbreviation that indicates Celsius, temperature in the metric system

Calorie
A unit of energy in the metric system. One calorie is the amount of heat required to raise the temperature of one gram of water by one Celsius degree

Celsius
The name given to the metric temperature scale having a lower fixed point of 0°C for the freezing point of water, and an upper fixed point of 100°C for the normal boiling point of water

Centrifugal pump
A pump using a rotor or impeller whose spinning action throws the fluid outwards to an exit pipe. Centrifugal means "centre fleeing"

CFC
Chlorofluorocarbon- based refrigerants that are non-corrosive, low in toxicity, nonflammable, non-explosive but are major causes of ozone depletion; no longer allowed for use in commercial buildings

CFM
Cubic feet per minute. May indicate the performance of a compressor - as cubic feet per minute per pound/ton of refrigerant. Also refers to the volume of air coming out of a diffuser. HVAC systems use Imperial measurements

Check valve
A type of valve, used to control the direction of flow; not typically found on a cooling system

Chiller
A type of refrigeration unit in which the water to be cooled is passed over the coils of the evaporator

Coefficient of Performance (COP)
The heat removed from the refrigeration system divided by the energy required to run it - in other words, the relationship between the heat moved and the work done. The less energy required, the better the performance of the system. The COP of a refrigeration systems is almost always greater than 1

Coil
Also called a pipe; water is sent through it to cool the building

Comfort zone
The range of conditions - that is, temperature, humidity and ventilation, that most people find comfortable, as defined by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

Commercial building
Distinguished from a residential building; more than 50% of its floor space is used for commercial activities. Includes buildings used for industrial purposes

Common areas
Areas in a building that are shared spaces (foyers, hallways, elevators, stairwells)

Compressor
A mechanical device used to increase pressure; to compress means to squeeze

Compressor – Centrifugal
A mechanical device that uses centrifugal force to compress refrigerant vapours

Compressor – Hermetic
A compressor that is enclosed, that is welded together; found on a refrigerator or a freezer

Compressor – Multi-Stage
A compressor in which compression of the refrigerant vapour takes place in multiple stages; each stage takes place in a different chamber of the compressor

Concentrator
The part of an absorption refrigeration system in which the lithium bromide solution is heated in order to drive off absorbed water vapour

Condensate
The liquid formed when a liquid condenses to a vapour

Condensation
The process in which a vapour becomes a liquid, by extracting heat or by increasing pressure

Condense
The act of a vapour giving up its heat and changing to a liquid; the heat given up is called the Latent Heat of Vapourization

Condenser
A heat exchanger in which the refrigerant is condensed and gives up its heat

Condensing Pressure
The pressure at which a refrigerant changes from a vapour to a liquid; an ideal refrigerant has a high condensing pressure

Condensing Temperature
The temperature at which a refrigerant changes from a vapour to a liquid; an ideal refrigerant has a high condensing temperature; the goal of a compressor is to get the condensing temperature of the refrigerant to be higher than that of the condensing medium

Conduction
The transfer of heat through or along a substance by direct physical contact.

Consumption (energy)
The amount of energy used in a building in a given period; may be tracked for a specific energy user. Does not include fuel or energy used for transportation

Contractor
A person or organization brought in to perform specific tasks in a building such as repairs

Controller
A device that controls one aspect of the operation of a cooling system

Convection
The transfer of heat by means of the bulk movement of a gas (e.g., air) or liquid (e.g., water)

Cooling coil
Cooling coils carry liquid, usually water or brine, which has been cooled in a chiller; located in the Air Handling Unit (AHU) or in the ductwork

Cooling load
The heat generated by people, lighting, equipment and solar effect

Cooling water
Water that is used to cool a process or a condenser

Corrosion
The oxidation of a substance because of interaction with its environment, usually with the dissolution of the material into an electrolyte. Rusting of iron is a common example of corrosion

CSA
Canadian Standards Association, a not-for-profit association dedicated to safety

Damper
An adjustable device located in the ductwork that controls the flow of air or other fluid

Decibel
The unit used to measure noise. A whisper, for example, is 30 decibels

Deep lake cooling
Cooling that uses cold water from the deep part of a lake in heat exchangers that cool the water in the building

delta T (Δt)
The temperature difference between two substances. Three examples are: the difference in the temperature of a refrigerant as it enters and leaves a system; the difference between the temperature of the outside air and the ambient air in the building; and the difference in temperature of the water coming in and leaving the evaporator or the condenser

Dew point (DP)
The temperature at which a vapour condenses when it is cooled at constant pressure

Differential
Difference, such as the pressure differential between the high and low side of a cooling system

Differential pressure valve
A globe-type valve that senses the pressure of the chilled water in the piping system in the building

Diffuser
A device on the floor or ceiling through which cooled air is released; a type of terminal

District cooling
A system in which chilled water is produced outside the building for use by more than one building or more than one enterprise; the chilled water is piped into the building

Domestic water
Water used in a building for food preparation, washrooms, and drinking (for domestic purposes)

Drift
The percentage of warm water leaving a cooling tower that is carried away

Dry bulb (DB) temperature
The temperature of air measured with a dry sensing device (so that the effects of humidity are not captured)

Duct
A tube (may be round or rectangular) for distributing air

Economizer
A component of an HVAC system that uses outside air to reduce the amount of mechanical cooling required

Electromagnetic waves
The basis for radiation such as X rays, light rays, radio waves and microwaves

Emittance (of radiation)
The emitting of thermal radiation back - radiating it to other bodies instead of the radiation being absorbed

Energy
The ability to do work, a quantity that takes several different, but interchangeable forms, including thermal energy (heat), kinetic energy (motion), and electrical energy (electron flow under and potential difference or voltage). Energy is measured in various ways, including in gigajoules (GJ), cubic meters (m3) and cubic feet (ft3)

Energy efficiency
A measure of the extent to which the energy input results in the desired output, for example, cooling

Energy Management System (EMS)
Also called a Building Automation System (BAS), Building Management System (BMS) or Energy Control Centre (ECC). A computerized system that monitors and adjusts heating, cooling and ventilation to match requirements in specific areas of a building

Energy Star
A tool used to monitor and assess energy and water usage

Energy source
Energy or fuel consumed in a building; includes electricity, natural gas, diesel fuel, district hot water or steam

Environment
The total surroundings, usually referring to the natural environment such as air, water, plants and animals

Environmentally friendly
An action is said to be environmentally friendly if it benefits or does no harm to the natural environment

Equipment load
The demand placed on a building's heating and cooling systems by equipment in the building

Evaporator
One of the components of the refrigeration system: a heat exchanger in which the refrigerant, a liquid, is evaporated by absorbing heat

Evaporator coil
Copper tubes in the evaporator that provide a continuous flow through of the refrigerant

Evaporator Pressure Regulator (EPR)
A pressure regulating valve that maintains a minimum pressure condition in the evaporator, no matter how low the load may be

Evaporative Cooler
A type of cooling system in which warm air is drawn through water-moistened filters so that the air is cooled as a result of the evaporation of the moisture

Exhaust air (EA)
Refers to air made to leave the building by mechanical means

Expansion Valve(TXV)
The type of metering device used in a chiller to throttle the flow of refrigerant

Exfiltration
The natural flow of air out of a building through cracks and holes in the building envelope

Fahrenheit
The Imperial temperature scale with the lower fixed point is set at 32°F (the freezing point of water) and the upper fixed point at 212°F (the normal boiling point of water)

Fail-safe device
A device that automatically shuts down an operation should there be any failure of a crucial function of a mechanism

Fan coil unit
A heating terminal used for both heating and cooling

Fenestration
The design and position of windows, doors and other structural openings in a building

Filter
A device used to remove solids from a fluid such as liquid refrigerant or compressor lubricating oil

Flash
The instantaneous evaporation of a portion of a liquid when the pressure on it is reduced; the remaining liquid is therefore cooled

Flash steam
The steam produced by water that is above the saturation (i.e., boiling) point for a given pressure

Flooded system
A system in which the heat transfer surfaces are literally "flooded" with liquid refrigerant. As the liquid boils, the vapour that is created rises up and out of the heat exchanger. A centrifugal chiller has a flooded evaporator, for example

Forced convection
A convection current induced by pumps or fans

Gas, hot
The vapour discharged from the compressor. This gas is hot because of the compression process

Gate valve
A type of valve that fully starts or fully stops flow of a liquid

Gauge pressure
The extent to which the pressure being measured by the gauge differs from atmospheric pressure; not to be confused with gauge pressure absolute, which is just the atmospheric pressure

Gigajoule (gj)
One billion joules; one joule corresponds to the energy produced by a power of one watt flowing for one second

Gland
A form of seal designed to stop the leakage of a fluid past the stem of a valve or the shaft of a pump

Global warming potential (GWP)
The potential which a substance has to contribute to global warming - the increase in global temperatures as a result of the increase of gases such as carbon dioxide in the atmosphere"; the

amount of GWP of a gas is compared to the GWP of carbon dioxide, which was assigned the number 1

Globe valve
A type of valve that regulates flow by throttling it

Grease
A semi-solid lubricant that is essentially a liquid lubricant combined with a solidifying agent

Halocarbon
The scientific name given to a substance that contains the element carbon and one or more of the halogens - bromine, chlorine, fluorine, or iodine

Hazard
A threat to safety; may include electrical hazards, fire hazards, and so on

Header
A large pipe connecting a series of smaller pipes

Heat of compression
Heat gained by a vapour when it is compressed

Heat
Thermal energy flowing from one place to another, stored in the movement of molecules in a substance

Heat of Fusion
The latent heat involved in a change of state from a solid to a liquid

Heat of Vaporization
The latent heat involved in a change of state from a liquid to a gas

Heat exchanger (HEX)
A device designed to transfer heat from one fluid to another without the fluids coming in contact with each other; may also be called a converter

Heating load
The amount of energy required to maintain the indoor temperature at the desired level for the comfort of the building occupants; called the cooling load when the energy is used to keep the building cool

Heat pump
A compressor that works mechanically to extract heat from one environment and pump it into a second environment that is at a higher temperature - that is, in a direction opposite to the spontaneous flow of heat from higher to lower temperature. The direction of heat transfer within the system is usually reversible. A heat pump may also be called a reversible AC system

Heat of Fusion
The latent heat involved in a change of state from a solid to a liquid

Heat of Vapourization
The latent heat involved in a change of state from a liquid to a gas

Heat transfer
The transfer of heat from a warmer substance or object to a cooler one

HCFC
Stands for hydrochlorofluorocarbon. A scientific term used to describe substances that contain hydrogen, chlorine, fluorine and carbon

Hermetic compressor
A compressor in which the motor is totally enclosed and whose halves are welded together

HFC
Stands for hydrofluorocarbons. A scientific term used to describe substances that contain hydrogen, fluorine and carbon

High side
Used to identify the the high pressure side of the vapour compression system; includes all components operating at or above condensing pressure - in other words, more than 14.7 psi

Humidify
To add water vapour to air, in order to improve occupant comfort

Humidity
The amount of moisture in the air, generally measured as relative humidity: the ratio of the amount of water vapour in the air at a specific temperature to the maximum amount of water vapour that could be carried in the air at that temperature.

HVAC
Heating, Ventilation and Air Conditioning; refers to the system that performs these functions

Hydrocarbon
A type of refrigerant. Propane, isobutene and propylene are hydrocarbons. These substances are not used to cool commercial buildings. R-290, a hydrocarbon (Propane), is used primarily in domestic refrigerators

IAQ
Indoor Air Quality; the definition has been broadened to include factors such as noise, vibration and odours – in which case, it is referred to as Indoor Environmental Quality (IEQ)

Infiltration
The natural flow of air into a building through cracks and holes in the building envelope; the opposite of exfiltration

Infrared thermometer
A device that measures the temperature by being directed at a specific space. When discussing heat, we call this device a "heat gun"

Institutional building
A building that has more than 50% of its floor space used for institutional or not-for-profit activities (e.g., schools, residential facilities, healthcare facilities)

Insulation
Material with a high resistance to heat transfer, designed to reduce the flow of heat from one side of the insulation to the other

Kelvin scale
An absolute temperature scale used in scientific and engineering applications

Kilopascal
A metric unit of pressure in which standard atmospheric pressure (1 atm) equals 101.3 Kpa.

Kilowatt
A measure of energy consumption; one kilowatt (kW) equals 1000 watts (W), the energy consumption of 1000 joules per second

Latent heat
The amount of heat that has to be added or taken away from a substance just in order to change its state, from ice to water for example, without any change in temperature

Light emitting diode (LED)
A type of lighting, often used to replace incandescent and compact fluorescent bulbs in order to achieve energy efficiency

Lighting load
The demand placed on a building's heating and cooling systems by lighting in the building

Lithium bromide
An absorbent in an absorption refrigeration system

Local stack effect
A stack effect occurring in part of a building separated from the rest of the building by an air-tight barrier

Lockout and tagout
Placement of a lock and tag on equipment to safely isolate it so it cannot be operated until the lock and tag are removed

Logging, equipment
Recording of inspections, readings, temperature and pressure, for example, irregularities and concerns, follow-up and repairs related to a specific piece of equipment

Logging, operational
Daily recording of irregularities - unusual occurrences and abnormal readings of gauges, temperatures, pressures, for example

Low water cutout (LWCO)
Also called low water cutoff. A fail safe device on a boiler that shuts it down when unsafe low water conditions exist

Low side
Used to identify the the low pressure side of the vapour compression system; includes all components operating at or below evaporating pressure - in other words, at or less than 14.7 psi

Lower fixed point
The lower of two reference points used to "fix" a temperature scale. The melting point of ice is the lower fixed point for the Celsius scale

Mechanical effect
The effect of the building's mechanical systems on infiltration/ exfiltration

Mechanical room
The room in which the equipment used to heat the building is housed

Metering device
A device that controls the rate of flow of refrigerant from the condenser to the evaporator. It also separates the low pressure side of the vapour compression system from the high pressure side of the system. For practical purposes, the metering device is considered part of the low side

Miscible
Capable of mixing and not separating back into distinct layers

Molecule
A combination of atoms that comprises the smallest single unit of any chemical element or compound

MSDS
Material Safety Data Sheet, used to communicate details related to known hazardous substances

Net Refrigeration Effect
The work the refrigeration system is doing - the heat absorbed by the evaporator plus the heat added by the compressor; the Refrigeration Effect is the heat that's been absorbed by the refrigerant and then rejected by the condenser; also called the Refrigeration Effect

Outside air temperature (OAT)
The sensible temperature of the air outside a building

Oxygen
A colourless odourless gas that combines with a fuel to cause combustion. It comprises about 20% of the earth's atmosphere

ODP card
Stands for Ozone Depletion card, a card granted upon successful completion of theoretical training on ozone depletion; does NOT grant the card owner the right to handle refrigerants

Ozone (O3)
Present in the earth's upper atmosphere; provides protection from the sun's damaging radiation. Some substances such as refrigerants, that are emitted to the upper atmosphere result in a thinning of, or the creation of holes in, the ozone layer

Ozone depletion potential (ODP)
The potential of a substance to deplete the ozone layer; the capacity of a substance to contribute to ozone depletion is identified by a number (ODP number), 1 being the highest (worst) value

Ozone layer
A layer of the earth's atmosphere that provides protection to the planet from the sun's damaging radiation

People load
The demand placed on a building's heating and cooling systems by people in the building

Penthouse
The upper floor of a commercial building, typically where the mechanical room is located

Perimeter
Also called perimeter zone; the area of the building that is around the outside of the building envelope

Personal protective equipment (PPE)
Special equipment such as footwear, eye protection and headgear, governed by legislation and designed to minimize exposure to known hazards in the workplace

Plant
The location of chillers and boilers (may be an area of a building or a separate building)

Pressure relief valve (PRV)
A valve on terminals in a heating or cooling system that protect the system from spikes of excess pressure or continuous excess pressure

Pressure regulating device
A fail safe device that stops a piece of equipment from functioning when the maximum allowable working pressure has been exceeded

Preventative maintenance
Performing the periodic maintenance required to ensure that equipment achieves its design life

Propane (C3H8)
A colourless gas that is a hydrocarbon, used primarily in domestic refrigerators

PSI
Stands for pounds per square inch

PSIA
PSI absolute; in other words gauge pressure plus atmospheric pressure

PSIG
Pounds per square inch gauge

Psychrometric chart
A chart that illustrates the relationship between dry bulb temperature, wet bulb temperature, relative humidity, sensible heat, latent heat and other properties of air

Purge unit
A device that removes air that may have leaked into the refrigerant in a refrigeration system

Radiation
Heat transferred by radiation

R-134a
A chlorine-free refrigerant that has an ozone depletion potential (ODP) of 0

R-410-A
A chlorine-free refrigerant that has an ozone depletion potential (ODP) of 0

R-number (refrigerant)
A number assigned to each, unique refrigerant, based on its molecular structure

R-value (insulation)
Also called R-factor. Indicates the resistance to the passage of heat of a particular piece of insulation. A common measure (because insulation comes in different thicknesses) is R-value per inch of thickness

Rankine scale
An absolute temperature scale used in scientific and engineering applications

Reactive maintenance
Run-to-failure maintenance, repairing or replacing equipment only when it fails

Refrigerant
A substance that contributes to cooling because, in a closed circuit, they absorb heat when they change to a gas and they give off heat when they change from a gas to a liquid

Refrigeration capacity
The cooling capacity of a given refrigeration system, expressed in tons of refrigeration

Refrigeration effect
See Net Refrigeration Effect

Refrigeration mechanic
A licensed mechanic whose license allows him/her to handle refrigerants and service refrigeration systems

Relative humidity (RH)
The percentage of moisture in the air at a given temperature compared to the amount of moisture that the air could hold at that temperature if it were saturated

Retrofit
Upgrading an existing facility that is already in place, rather than replacing it with a new one

Return air (RA)
The air that comes from the occupant space and goes back to the Air Handling Unit (AHU)

Rooftop unit
A type of air handler

Saturated air
Air that contains the maximum amount of water vapour at that temperature and pressure

Saturation point
The point at which a given substance boils; also called the boiling point

Saturation pressure
The pressure of a liquid or vapour at saturation conditions; in other words, the relative humidity is 100%

Saturation temperature
The temperature of a liquid or vapour at saturation conditions; in other words, the relative humidity is 100%

Sealant
A type of lubricant that provides a seal to protect a piece of equipment from moisture, dirt and dust and to keep moisture from making contact with metal surfaces

Semi-solid lubricants
A lubricating grease

Sensible heat
Heat that is observed by a temperature change with no change in state; the opposite is latent heat that causes a change of state with no change in temperature

Setpoint temperature
The desired temperature for an area of a building; set into the BAS

Shell and tube
A type of heat exchanger in which refrigerant enters the tube bundle inside a shell, through which water is passing

Short cycling
The frequent turning on and off of a piece of equipment in an inefficient manner; typically caused by components that are improperly sized

SI (Système internationale)
The metric system of measurement

SOL
Safe Operating Limit, also called Standard Operating Limit. Mandated by the Occupational Health and Safety Act and indicated on equipment

Solid lubricant
A lubricant such as powdered soapstone, mica, talc or graphite that is not a liquid or a gas

Specific heat
The amount of heat required to raise the temperature of one unit of mass of a substance by one degree

Stack effect
Convection causing warm air to rise to the top of a building to be exfiltrated, and being replaced by cooler air infiltrating at the foot of the building

States of matter
The three states of matter are solid, liquid and gas; also called phases. Liquids and gases are both considered fluids

Steam
The gas that results from the vapourization of water

Subcooling
Cooling a refrigerant to a temperature that is colder than the minimum temperature required to keep it from boiling

Suction line
The line through which the refrigerant passes to the compressor in order to complete the vapour compression cycle

Superheat
The additional heat contained in a vapour after the vapour has reached its saturation (boiling) point

Supply air (SA)
The air supplied to the building occupants; in other words, the air exiting the air handling unit and going into the occupant space

Surging
The sudden breakdown of flow within the impeller of a centrifugal compressor, during which time no gas is passed on to the condenser

Thermal curtain
A window treatment that contributes to energy savings because it is able to control solar heat gain in the summer and heat loss in the winter

Thermal conductivity
A measure of the ease with which a substance can conduct heat; measured as the rate of heat flow through a specific unit are and unit thickness of a material under (theoretical) constant conditions

Thermal radiation
The emission or transfer of heat by means of electromagnetic waves, such as light

Thermal resistance value
The R-factor or R-value which indicates the resistance to the passage of heat of a particular substance

Thermodynamics
A branch of physics concerned with heat and temperature and their relation to energy and work

Thermostat
A temperature-sensing device that operates appropriate controls automatically if the temperature rises above or falls below designated limits

Thermostatic expansion valve
A device that meters the flow of liquid refrigerant into the evaporator; the thermostatic expansion valve controls the superheating at the evaporator's outlet

Three-port valve

A valve that controls both the flow and the temperature of the water flowing into the terminals. This valve allows for variations in water temperature and variations in water flow

Throttle
To modulate (control gradually) versus to turn on and off

Ton of refrigeration
A measure of refrigeration capacity, equal to 12,000 BTU. This is the equivalent energy required to freeze one ton of water in 24 hours

TSSA
Technical Standards and Safety Authority, a non-government organization focused on safety

Two-port valve
Type of valve that controls the amount of water flowing into a terminal; it does not control the temperature of the supply water

ULC
Underwriters Laboratories of Canada, dedicated to electrical safety

Upper fixed point
The higher of two reference points used to "fix" a temperature scale. The boiling point of water at standard temperature and pressure is the upper fixed point for the Celsius scale

Utility bill
A statement of charges for the delivery and consumption of utilities such as water

Vapour
One of the three states of a substance

Vapourization
The conversion of a liquid into a gas with the absorption of heat

Vapour barrier
A barrier, commonly made of plastic, placed between the interior of a building and the outside insulation in order to prevent the formation of condensation that can damage the insulation

Ventilation
The process of adding and removing air in a building by mechanical means

Viscosity
The thickness or resistance to flow of a liquid

Water, condenser
The cool water circulated through a condenser to condense the refrigerant

Water hammer
The sound made when there is a rapid change in pressure in a pipe or vessel caused by the sudden change in velocity of the liquids inside , because a valve closed too quickly, for example

Weatherstripping
A narrow strip of material placed around the edges of doors or windows to prevent or reduce unwanted leakage of air

Wet bulb (WB) temperature
The temperature measured by a device that takes into account the moisture content of the air

WHMIS
Workplace Hazardous Materials Information System, devised to identify hazardous substances and facilitate safety, training and communications related to them

White roof
A roof that has had solar-reflective paints applied to it to turn it into a "cool roof" or "white roof" that reflects and emits solar radiation and saves cooling costs as a result. The roof is not necessarily white in colour but is still referred to as a white roof

Wind effect
The infiltration/exfiltration caused by wind passing over a building and creating a higher air pressure on the upwind side and a lower air pressure on the downwind side

Work order
A tool used to document and track required and/or requested repairs

WSIB
Workplace Safety and Insurance Board; provides compensation to eligible workers for work-related injuries and illnesses