Core

Ozone

1. What is the ozone layer and why is it important to us on Earth?
    a) This ozone layer extends about 6 to 30 miles above earth and creates a protective shield for Earth from the sun's harmful ultraviolet (UV) rays.
2. What is an ozone molecule made of?
    a) Ozone is a naturally occurring gas molecule that is made up of three oxygen atoms (O3).
3. What is the name of the atom that attacks ozone molecules?
    a) Ozone can be destroyed by chlorine and bromine atoms emitted into the atmosphere.
4. Why are refrigerants that are released into the atmosphere depleting ozone?
    a) Because CFCs will not dissolve in water or break down into compounds that dissolve in water, CFCs remain in the atmosphere and do not "rain out" easily, which allows them to reach the stratosphere over time.
5. Describe how one chlorine atom can destroy 100,000 ozone molecules.
    a) When chlorine monoxide meets ozone, it releases its oxygen atom and forms two O2 oxygen molecules, leaving the chlorine molecule free to attack another ozone molecule and repeat the process. It is estimated that a single chlorine atom can destroy 100,000 ozone molecules.
6. Name the refrigerant types that belong to CFCs, HCFCs and HFCs.
    a) Gas: CFC Example: R-11, R-12, R-500 Elements: Chlorine, Fluorine, Carbon ODP: Higher.
    b) Gas: HCFC Example: R-22, R-123 Elements: Hydrogen, Chlorine, Fluorine, Carbon ODP: Lower.
    c) Gas: HFC Example: R-134a Elements: Hydrogen, Fluorine, Carbon ODP: None.
7. What do the letters in HCFC stand for?
    a) HCFCs (hydrochlorofluorocarbons)
8. What is ODP and what gas has the highest ODP rating? What gas has the lowest?
    a) Ozone depletion potential (ODP) is the measurement of the ability of CFCs and HCFCs to destroy the ozone. CFCs have the highest ODP, followed by HCFCs. HFCs do not contain any chlorine and therefore do not have an ODP.
9. Name the health and environmental effects of ozone depletion.
    a) Depletion of ozone allows more of the sun's harmful UV rays to reach the earth resulting in the following problems:
        - Increased temperature of the earth
        - Increased cases of skin cancer
        - Increased numbers of cataracts in the eyes
        - Increased ground level ozone
        - Crop and vegetation loss
        - Reduced marine life
10. What evidence do we have that CFCs and HCFCs are depleting the ozone?
    a) The supporting studies revealed the following:

- The rise in the amount of chlorine measured in the stratosphere over the past two decades matches the rise in the amount of fluorine, which has different natural sources than chlorine, over the same period.
- The rise in the amount of chlorine measured in the stratosphere over the past two decades matches the rise in CFC emissions over the same period.
- Samples of air taken from the stratosphere over erupting volcanoes show that volcanoes contribute a small quantity of chlorine to the stratosphere compared to CFCs.

11. What characteristics make it easy for CFCs to reach the stratosphere and how do they get there?
    a) Despite being heavier than air, CFCs reach the stratosphere through wind motions that carry them upwards. Because CFCs will not dissolve in water or break down into compounds that dissolve in water, CFCs remain in the atmosphere and do not "rain out" easily, which allows them to reach the stratosphere over time. When CFCs and HCFCs reach the atmosphere, they are broken apart, releasing their chlorine atoms, starting the process of attacking ozone molecules
12. Why do we now use R-134A refrigerant?
    a) They do not contain any chlorine and therefore do not have an ODP

Clean Air Act

1. What is the purpose of the CAA?
    a) The purpose of the CAA is to limit how much of a pollutant can be in the air anywhere in the US. Section 608 of the CAA focuses on capturing and ultimately eliminating the use of chlorofluorocarbons.
2. What three things is the CAA doing to control chlorofluorocarbon emissions?
    a) In particular, the CAA calls for the following to limit chlorofluorocarbons damage to the atmosphere:
        i. Phase-out: Set dates to phase out CFCs and HCFCs.
        ii. Prohibit venting: Prohibit venting of CFC and HCFC refrigerants and their substitutes.
        iii. Disposal requirements: Require the EPA to set standards for recovery of refrigerants prior to appliance disposal.
3. What can states do in addition to the CAA?
    a) While the CAA is a federal law, the states do most of the work to carry out the program and create their own laws to comply with CAA. The state laws must comply with the CAA and in some cases are as strict or stricter than the CAA laws.
4. What three things can happen if you violate the CAA?
    a) Technicians and the companies they work for who violate the CAA face harsh penalties, including:

iv. Up to $27,500 per day, per violation
v. Losing one's certification to handle refrigerants
vi. Appearing in US Federal Court for the charges

5. What incentive do others have to turn you in for violating the CAA?
    a) An award of up to $10,000 is offered by the EPA to those individuals who supply information leading to a penalty against a technician that intentionally vents.
6. Who can purchase refrigerants and what size cylinders can be purchased?
    a) Only certified technicians may purchase refrigerants. The smallest cylinder a 608-certified technician may purchase is 20 pounds. Only a 609-certified technician (automotive) may purchase smaller containers.
7. What is the Montreal Protocol?
    a) The Montreal Protocol on Substances That Deplete the Ozone Layer (commonly known as the Montreal Protocol) is a treaty among nations designed to protect the stratospheric ozone layer.
8. What chemicals does the Montreal Protocol control?
    a) The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere: chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform, were phased out by 2000 (2005 for methyl chloroform).

CAA Phase-Out, Venting, and Disposal

1. When was the CFC phase-out date?
    a) CFCs were phased out on December 31, 1995.
2. Where do CFC refrigerants come from for equipment servicing of older systems?
    a) Since the phase out, CFC refrigerant for equipment servicing comes from recovery and recycling.
3. When was the HCFC phase-out date?
    a) Since November 15, 1995, knowingly venting any refrigerant is a violation of the CAA. This includes CFC & HCFCs, CFC & HCFCs refrigerant substitutes.
4. For equipment servicing of older systems, where do CFC refrigerants come from?
    a) Since the phase out, CFC refrigerant for equipment servicing comes from recovery and recycling.
5. Is it allowed to release nitrogen into the atmosphere? How about a mixture of nitrogen and refrigerant?
    a) Nitrogen that is used for holding charges or as leak test gases may be released; however, nitrogen may not be added to a fully charged system for the purpose for leak detection and then released.
6. What must be done before scrapping a refrigerant container?

a) The EPA has set standards for recovery of refrigerants prior to appliance disposal, including that all refrigerants in disposable containers have been recovered (0 psig or lower) and rendered useless before recycling the cylinder.

7. What must be done before disposing of an appliance containing CFCs or HCFCs?
    a) Before disposing of any appliance containing a CFC or HCFC refrigerant, the refrigerant must be recovered.
8. Who is responsible for removing refrigerants from a system that is being disposed of?
    a) The person responsible for ensuring that refrigerants have been removed from household refrigerators before they are disposed of is the final person in the disposal chain

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Refrigerant Oils

1. Are there "drop-in" replacements for R-12 systems? Why or why not?
    a) There is no "drop-in" replacement gas for R-12 systems; all replacement refrigerants require additional retrofit procedures. In particular, the new refrigerants are incompatible with the oils and lubricants used in R-12 systems and therefore, oils must be checked and changed out as part of the retrofit procedure.
2. What type of oil is used in R-134a and what oils will it mix with?
    a) The oils used in most R-134A systems are ester based oils and ester based oils do not mix with other oils.
3. What type of lubricant is used with HCFCs?
    a) They are common types of refrigerant blends that contain HCFCs. Ternary blends are used with a synthetic alkylbenzene lubricant.
4. What is the difference between a ternary blend and an azeotropic blend?
    a) Ternary blends are three-part mixtures. They are common types of refrigerant blends that contain HCFCs. Ternary blends are used with a synthetic alkylbenzene lubricant. Alkylbenzene lubricant is hygroscopic, meaning that it absorbs (takes on) moisture.
    b) An azeotropic refrigerant contains fluids that boil out at the same temperatures (do not exhibit temperature glide) and act as a single refrigerant. Azeotropes are blends of two or more compounds that act like a single compound. Azeotropic refrigerants can be charged as a vapor or a liquid.
5. What is the trait of a hygroscopic lubricant?
    a) Alkylbenzene lubricant is hygroscopic, meaning that it absorbs (takes on) moisture.
6. What is temperature glide and which type of blend won't have it?
    a) Temperature glide can also be understood as the difference between the dew point and the bubble point. The dew point occurs when the saturation temperature in the evaporator causes the refrigerant to change from a liquid to a vapor. The bubble point

occurs when the saturation point in the condenser changes the refrigerant from a vapor to a liquid.

   b) An azeotropic refrigerant contains fluids that boil out at the same temperatures (do not exhibit temperature glide) and act as a single refrigerant

7. Will the gases in a ternary blend leak at the same rate? Why or why not?
   a) Because the components have different boiling points, they can leak at an uneven rate.

Refrigeration Process

1. How does refrigerant change states through each of the four major components of the refrigeration cycle?
   a) The vapor-compression refrigeration cycle is a repeating cycle consisting of four main components: evaporator, compressor, condenser and metering device.
   b) The evaporator absorbs heat into the system from the space to be cooled (removes heat from the space). Upon leaving the evaporator, the refrigerant is a low pressure, low temperature vapor.
   c) The compressor takes the low pressure, low temperature vapor and changes it to a high-temperature, high-pressure, superheated vapor and delivers it to the condenser
   d) The condenser rejects the heat from the system and changes the refrigerant from a high-temperature, high-pressure vapor into a high pressure, high temperature liquid.
   e) The metering device reduces the pressure of the refrigerant and changes the high-pressure, high-temperature liquid into a low pressure, low temperature liquid.
2. What does a compressor compress?
   a) It compresses VAPOR. The compressor takes the low pressure, low temperature vapor and changes it to a high-temperature, high-pressure, superheated vapor and delivers it to the condenser
3. Explain how cooling of a space occurs in a refrigeration cycle.
   a) In an air conditioning unit, for example, the heat is removed from inside the building and is deposited outside the building.