PART A – Answer All Questions (5 x 2 = 10 Marks)

1. What is the primary function of a multistage compressor?
Answer:
The primary function of a multistage compressor is to compress air or gas in multiple stages with intercooling between the stages to improve efficiency, reduce the work input required, and achieve higher pressure ratios.

2. List out components that constitute a sliding vane compressor.
Answer:

- Rotor
- Vanes
- Stator (Casing)
- Inlet and Outlet Ports
- Shaft Bearings
- Lubrication System

3. List the four main components of a vapor compression refrigeration system.
Answer:

- Compressor
- Condenser
- Expansion Device (Capillary tube or Expansion valve)
- Evaporator

4. Apply the concept of superheating to explain its impact on compressor efficiency.
Answer:
Superheating refers to raising the temperature of the refrigerant vapor above its saturation temperature before entering the compressor. While it ensures no liquid enters the compressor (avoiding damage), excessive superheating increases the specific volume of the vapor, requiring more work for compression and thus reducing compressor efficiency.

5. Compare the energy efficiency of vapor compression and vapor absorption refrigeration systems.
Answer:
Vapor compression systems are more energy-efficient with a higher Coefficient of Performance (COP), typically around 3–5. Vapor absorption systems, though having a lower COP (around 0.5–1.5), utilize heat energy instead of high-grade electrical energy, making them suitable for waste heat utilization and where electrical power is limited.

PART B – Answer Any Two (2 x 13 + 1 x 14 = 40 Marks)

6. (a) Explain the working principle of a multistage air compressor with intercooling.
Answer:
In a multistage air compressor, air is compressed in stages rather than in a single stroke. After each stage, the air passes through an intercooler which cools it, reducing its volume and making it easier to compress in the next stage. This process improves the compressor's efficiency by minimizing work input, reducing discharge temperature, and allowing higher pressure ratios.

OR

6. (b) Compare the performance and applications of Roots blower, sliding vane, and screw compressors. Which type would you recommend for a process industry and why?
Answer:

- **Roots Blower**: Positive displacement; simple design; suitable for low-pressure, high-volume applications.
- **Sliding Vane**: Better efficiency; self-adjusting vanes; used in automotive and industrial applications.
- **Screw Compressor**: Continuous flow, high efficiency, reliable for process industries.
  Recommendation: Screw compressor is ideal for process industries due to its high efficiency, continuous operation, and better handling of large flow rates with moderate pressure.

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7. (a) Analyze the working of a lithium bromide-water absorption refrigeration system.
Answer:
In this system, water is the refrigerant and lithium bromide is the absorbent. The **evaporator** allows water to evaporate at low pressure, absorbing heat from the space to be cooled. The **absorber** absorbs the water vapor into lithium bromide, forming a strong solution. This is pumped to the **generator**, where heat separates water vapor. The vapor then goes to the **condenser**, where it is condensed and sent back to the evaporator via a throttle valve. The interaction between these components completes the cycle and facilitates cooling.

OR

7. (b) Explain the working of a room air conditioning system.
Answer:
A room air conditioning system works by circulating a refrigerant through four main components:

- **Compressor**: Compresses the refrigerant vapor.
- **Condenser**: Rejects heat and condenses vapor to liquid.
- **Expansion Valve**: Drops the pressure of the liquid refrigerant.
- **Evaporator**: Absorbs heat from indoor air as refrigerant evaporates.
  The cycle repeats, continuously removing heat and maintaining indoor comfort.

8. (a) Analyze the possible causes for reduced performance in the air compressor.
Answer:
Symptoms: Reduced pressure, high temperature, abnormal noise.
Possible Causes:

- Air leakage in piping or valves
- Dirty or clogged filters
- Worn-out piston rings or valves
- Insufficient lubrication
  Diagnostic Steps:
- Pressure leak test
- Filter inspection and replacement
- Check for overheating and oil level
  Corrective Actions:
- Seal leaks, clean or replace filters
- Repair/replace faulty components
- Ensure proper maintenance schedule

OR

8. (b) Analyze symptoms in a refrigerator system and suggest remedies.
Answer:
Symptoms: Reduced cooling, ice build-up, long running time
Possible Faults:

- **Capillary Tube Blockage**: Results in low refrigerant flow; check for frost near inlet
- **Evaporator Coil Frosting**: Caused by poor defrosting; inspect and initiate defrost cycle
- **Refrigerant Leakage**: Loss of cooling; check for oil spots and pressure drop
  Diagnostic Checks:
- Pressure testing
- Visual inspection
- Leak detection (electronic or soap bubble test)
  Corrective Measures:
- Clean/replace capillary
- Repair defrost system
- Locate and seal leak, recharge refrigerant