

How an Air Conditioner Moves Heat: the Refrigeration Cycle

YES Electric • Arc Workforce Academy HVAC Apprenticeship

Draft 1 (October 2026). This lesson is under review. Videos are made by other companies, not YES Electric; follow this lesson and your journeyman where they differ. Boxes marked "Shop photo coming" will get real photos from our shop in a later version.

Unit 1 • HVAC Fundamentals • Appendix A Competency 3 — "Identify the four components of the refrigeration cycle and their function" **Class time:** ~4 hrs (1.5 video/discussion + 2.5 bench)

1. What you'll be able to do

By the end of this lesson you will be able to:

- Stand at any split system and **point to all four components in order**, and say what the refrigerant is doing inside each one (pressure, temperature, and state: liquid/vapor/mix).
- Explain, in customer-plain English, that **an air conditioner doesn't make cold — it moves heat** from inside the house to outside.
- **Touch-trace the cycle** on a running unit and predict which lines are hot, warm, and cold — before you touch them.
- Recite the cycle's two pressures and two phase changes from memory.

This is the single most important lesson in the program. Every charging, diagnostic, and repair skill that follows sits on top of this mental model. If the cycle isn't automatic for you, every gauge reading later will be a mystery number.

2. Tools & materials

- A running split system or bench trainer (the shop unit)
- Infrared thermometer or temp clamp
- Laminated refrigeration cycle poster (one per student)
- Safety glasses — unit panels will be open
- NO gauges yet. This lesson is eyes and hands only. Gauges come in Lesson 1.3.

3. Watch first

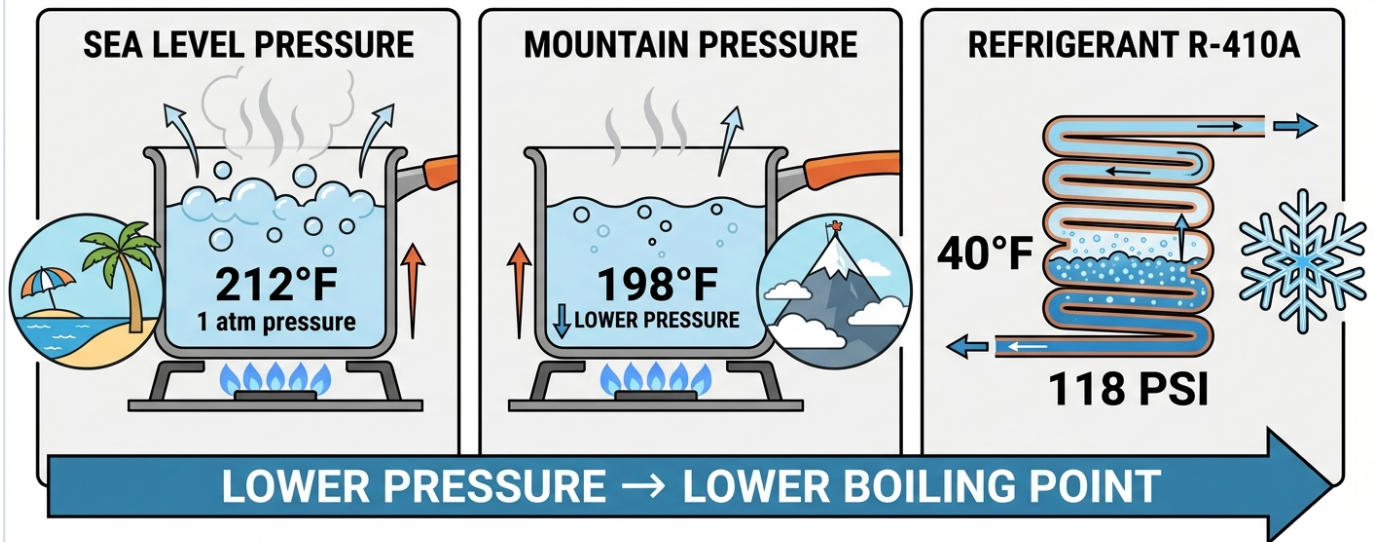
Order	Video	Channel	Length	Why
1	3D How Refrigeration and Air Conditioning Works P1 — Components	HVAC School	9:47	See inside the pipes — the 3D animation of the whole loop
2	Refrigeration Cycle Training Class! Superheat, Subcooling, Saturation, Components	AC Service Tech	19:04	The field version with real temps and pressures
3	Refrigeration Cycle of an AC Using R-32 Temps	AC Service Tech	21:23	Same cycle on the refrigerant you'll actually see in new equipment
Optional deep-dive	HVAC 1st Year Apprenticeship Class w/ Bryan Orr	ACST × HVAC School	36:28	Both of our backbone instructors teaching this exact lesson together
Quick review	The Refrigeration Cycle Explained Step By Step	AC Service Tech	4:26	Rewatch the night before the quiz

4. The idea (short version — then we go to the bench)

Rule 1: Heat always moves from hotter to colder. That's physics; no machine changes it. So how do you push heat from a 75°F house into a 95°F backyard — "uphill"? You use a refrigerant and you cheat with pressure:

- **Pressure controls boiling point.** Water boils at 212°F at sea level, but at ~150°F on a tall mountain. Refrigerant is just a fluid with a very low boiling point that we squeeze and release to move its boiling point wherever we want it.
- Make the refrigerant **colder than the indoor air** (drop its pressure) → heat flows from the house into the refrigerant.
- Make the refrigerant **hotter than the outdoor air** (raise its pressure) → heat flows from the refrigerant out to the yard.

PRESSURE CONTROLS BOILING POINT

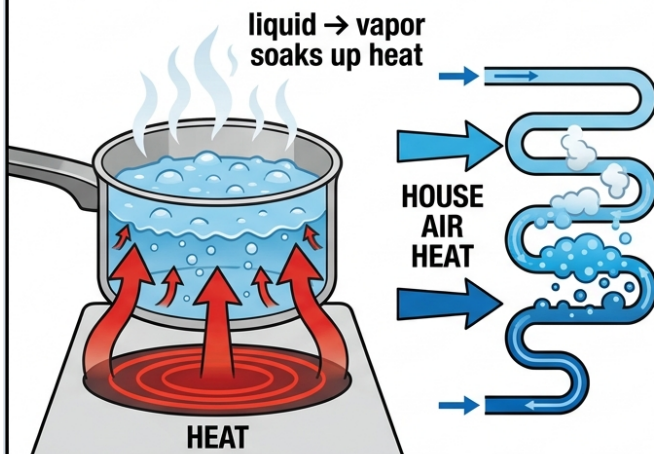


We squeeze and release refrigerant to put its boiling point wherever we want it

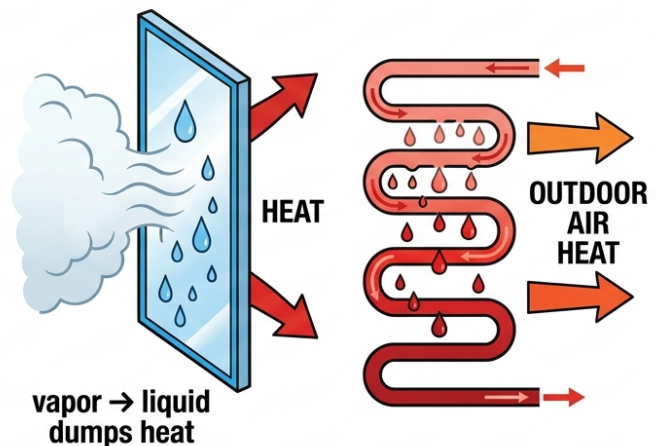
Rule 2: Phase changes carry the load. Boiling liquid into vapor absorbs a huge amount of heat; condensing vapor back to liquid dumps it. The cycle boils refrigerant inside and condenses it outside, over and over. That's the whole machine.

HVAC TRAINING DIAGRAM: PHASE CHANGE PRINCIPLES

BOILING ABSORBS HEAT



CONDENSING RELEASES HEAT



❄️ THE PHASE CHANGES CARRY THE LOAD ☀️

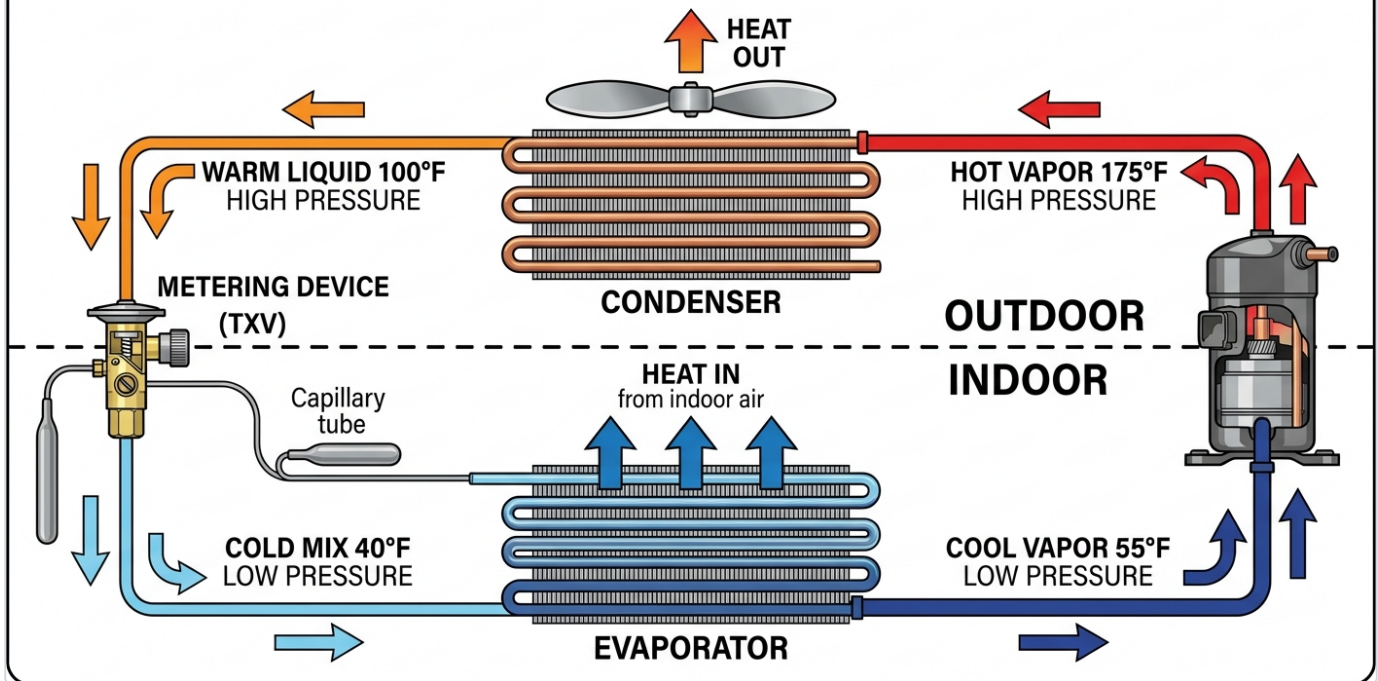
The four components, in order



Shop photo coming: same shot on OUR shop unit when we shoot the bench series

#	Component	Where	What happens inside	Refrigerant in → out
1	Compressor	Outdoor unit	Squeezes low-pressure vapor into high-pressure vapor. Pressure AND temperature jump. The only component that does work.	Cool low-pressure vapor → HOT high-pressure vapor (~150-200°F line)
2	Condenser	Outdoor unit (the big coil + fan)	Outdoor air blows across the coil; refrigerant dumps heat and condenses vapor → liquid. Phase change #1.	Hot vapor → warm high-pressure LIQUID
3	Metering device (TXV, piston, EEV, cap tube)	At the indoor coil	A deliberate restriction. Liquid squirts through a tiny opening; pressure crashes; some flashes to vapor and the mix gets COLD (~40°F).	Warm liquid → cold low-pressure liquid/vapor mix
4	Evaporator	Indoor unit (coil above furnace / in air handler)	Indoor air blows across the cold coil; refrigerant absorbs heat and boils liquid → vapor. Phase change #2. House air leaves ~20°F cooler.	Cold mix → cool low-pressure vapor (back to compressor)

RESIDENTIAL AIR CONDITIONING REFRIGERATION CYCLE

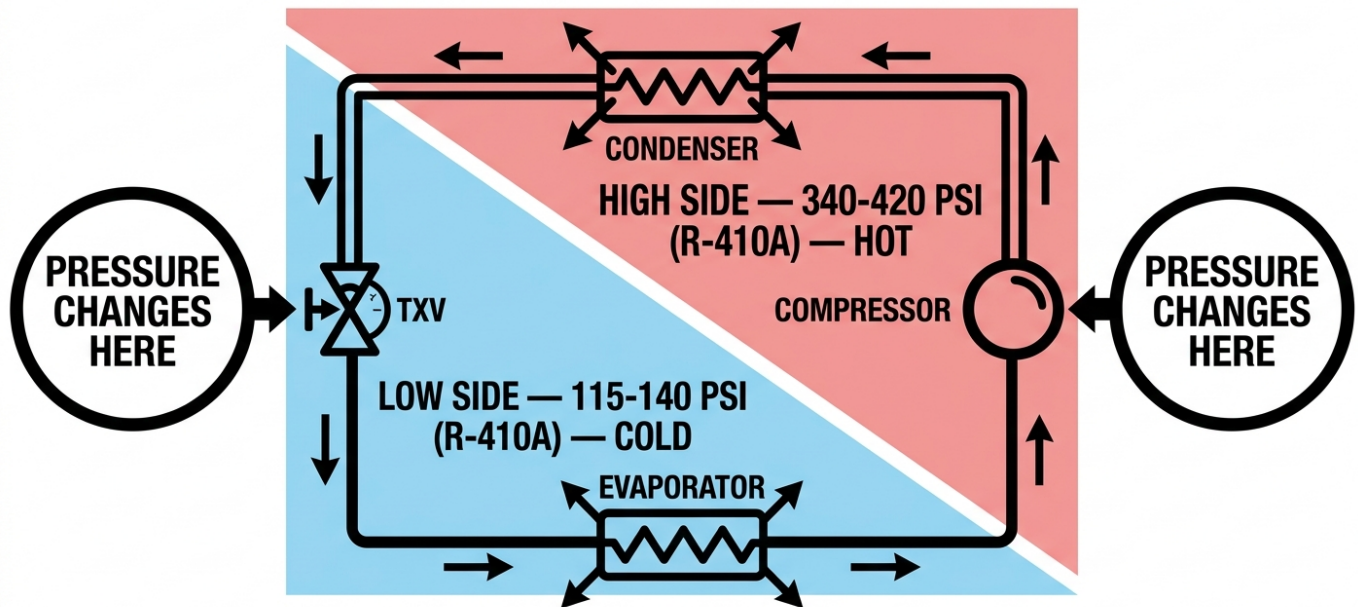


The two sides

Draw a line through the compressor and metering device — they're the only two places pressure changes:

- **High side** (compressor discharge → condenser → liquid line → metering device): high pressure, hot/warm. R-410A on a 95°F day ≈ **340-420 psi**.
- **Low side** (metering device → evaporator → suction line → compressor): low pressure, cold/cool. R-410A ≈ **115-140 psi**.

THE TWO SIDES OF THE SYSTEM

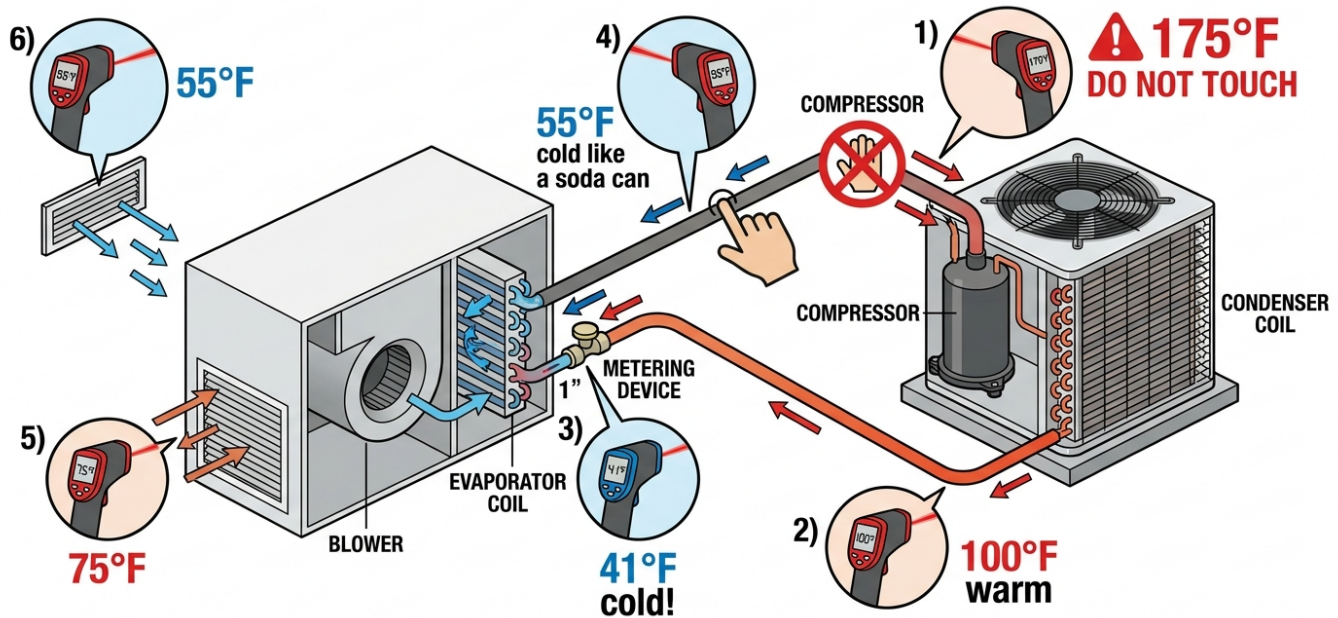


Memorize cold (we'll drill this):

Compressor → Condenser → Metering Device → Evaporator. "Squeeze it, cool it, choke it, boil it." Boil inside, condense outside. Pressure picks WHERE it boils.

5. Bench procedure — touch-trace the cycle

TOUCH-TRACE THE CYCLE



With the unit running 10+ minutes, panels open under instructor supervision:

1. **Find the compressor.** Listen — that hum is the heart. Do NOT touch the discharge line yet — it runs 150–200°F. Hold your hand near it and feel the radiant heat. IR-gun it and write the number down.
2. **Follow the discharge line into the condenser coil.** IR the coil at the top, middle, bottom. It gets cooler as you go — that's heat leaving. Feel the air the fan blows out the top: hotter than the yard. **That's your house's heat, leaving.** Say it out loud — that sentence is also your customer explanation.
3. **Find the liquid line** (small copper line leaving the condenser). Grab it — warm, not scalding (~95–110°F). It's now liquid.
4. **Follow it inside to the metering device** at the evaporator. IR one inch before and one inch after. Before: warm. After: COLD. That two-inch jump is the whole trick of the trade. [PHOTO: IR readings before/after the TXV]
5. **The evaporator coil** — cold and probably sweating. Why the condensate? (The coil is below the air's dew point — links to Lesson 1.6.)
6. **Find the suction line** (big, insulated, cold). Grab it — cold like a soda can. It must return as cool VAPOR — liquid would slug and kill the compressor (foreshadows superheat, Lesson 1.4).
7. **Now run the loop blind.** Instructor points anywhere on the circuit; student states: component, pressure (high/low), temperature (hot/warm/cold), state (liquid/vapor/mix). Repeat until automatic.

Checkout (graded, pass/redo): Student walks the instructor through the full cycle on the shop unit unprompted, all four components, both phase changes, both pressures, with correct touch predictions. This demonstrates Competency 3 at the "completed under mentor guidance" level.

6. Field gotchas

- **"It's low on freon" is not a diagnosis.** Refrigerant doesn't get used up — the loop is sealed. If it's low, there's a leak. You'll hear customers (and bad techs) say "it just needs a top-off every spring." That's a leak with a subscription plan.
- **Cold suction line $\neq$ healthy system.** A line can be cold for the wrong reasons. The cycle tells you what should happen; gauges + superheat/subcool (Lessons 1.3–1.4) tell you what IS happening.
- **The discharge line will burn you.** New techs get branded exactly once. IR first, then touch.
- **Heat pumps run this same loop backwards** (Unit 8). Learn it cold in cooling mode first; the reversing valve will make sense later instead of melting your brain.
- **R-32 / R-454B (A2L) equipment runs the same cycle** with slightly different temps and pressures — the physics doesn't change with the refrigerant (full A2L handling in Lesson 5.8).

7. Competency link

- **Competency 3** — identify the four components and their function: this lesson, checkout in §5.
- **Competency 4** — identify components on real equipment: reinforced here, completed in Lesson 1.2.
- Feeds directly into: P/T chart (1.3), superheat/subcool (1.4), every charging lesson in Unit 5, every diagnostic lesson in the program.

8. Check yourself

1. Name the four components in flow order, starting at the compressor.
2. Which TWO components change the refrigerant's pressure?
3. Where in the cycle does refrigerant boil? Where does it condense? Which one absorbs heat from the house?
4. The big insulated line at the outdoor unit — high side or low side? Liquid or vapor? Hot or cold?
5. A customer asks "how does it make cold air?" Give the two-sentence answer.
6. Why does dropping the pressure of a liquid refrigerant make it cold?
7. True or false: an air conditioner consumes refrigerant the way a car consumes oil. What do you tell a customer who believes this?
8. On the bench unit, the line right after the metering device reads 41°F and the line right before it reads 102°F. Is that normal? What just happened in those two inches?
9. Which component is the only one doing mechanical work?

10. What state MUST refrigerant be in when it enters the compressor, and why?

Arc Workforce Academy · YES Electric LLC Apprenticeship 2026-AL-141731 · Lesson 1.1 v1.0
(2026-06-10)