

Unit Conversions: BTU, Watts, Tons, CFM, Temperature

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 2 • Trade Math for HVAC • RTI: Trade Math (26 hr) Class time: ~3 hrs (1 classroom + 2 drills/bench)

1. What you'll be able to do

- Convert fluently between the units the trade actually mixes daily: **BTU/hr** ↔ **tons** ↔ **watts/kW**, **°F** ↔ **°C**, and use **CFM** correctly as a rate.
- Compute electric heat output from nameplate kW (the strip-heat math you'll use in Unit 8): **kW × 3,412 = BTU/hr**.
- Estimate what a piece of equipment "is" from any one number — a 10 kW heater, a 36,000 BTU/hr coil, a 5-ton RTU — and cross-check them against each other.
- Smell wrong numbers: "that 2-ton unit can't be putting out 60,000 BTU/hr."

The trade speaks three languages (refrigeration tons, gas BTUs, electric kW) about the same physical thing — heat per hour. A tech who converts between them in his head catches mistakes everyone else misses.

2. Tools & materials

- Conversion drill deck + whiteboard
- A toaster, a space heater with a wattage label, an amp clamp (the Ty Branaman demo, live)
- Calculator allowed throughout — speed comes from knowing WHICH conversion, not mental arithmetic heroics

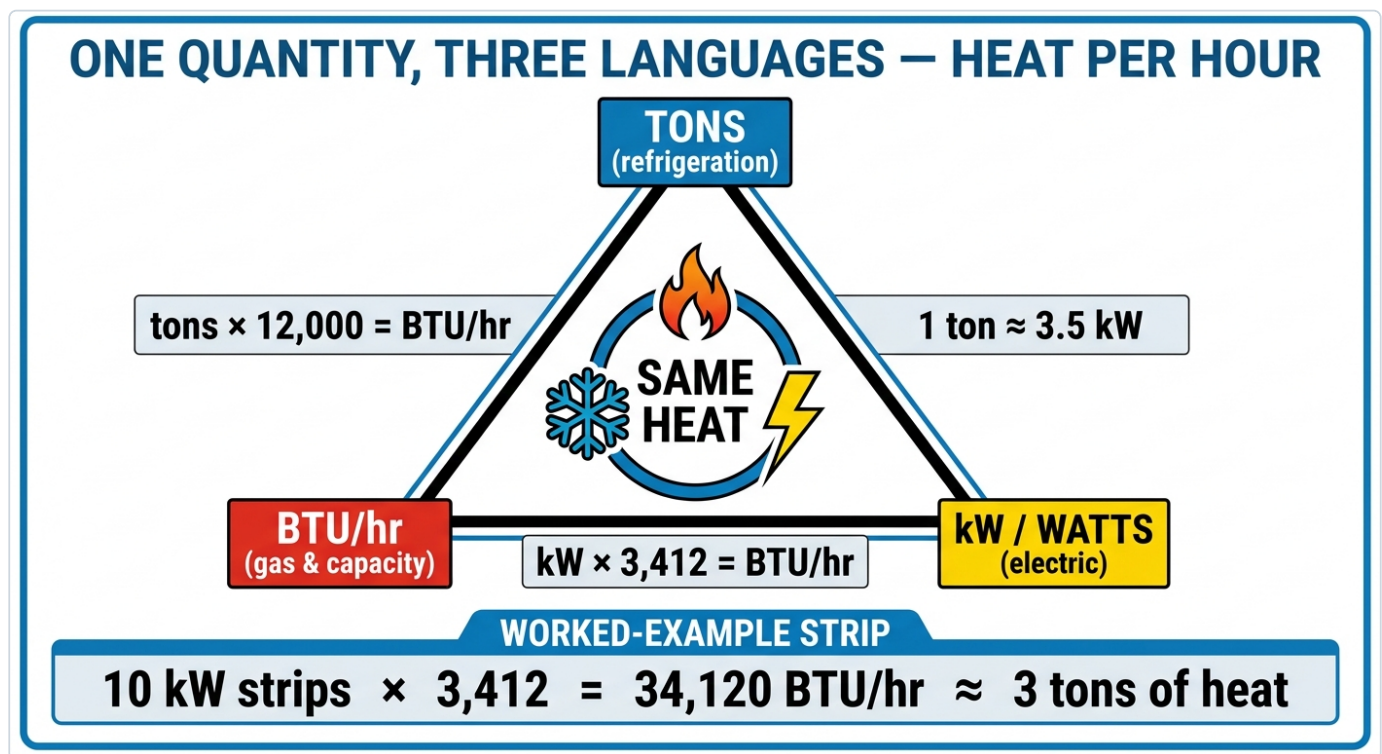
3. Watch first

Order	Video	Channel	Length	Why
1	Learn BTU-Watt Conversion Using a Toaster	HVAC School (Ty Branaman)	14:46	The conversions made physical — we re-run this demo live
2	How to Calculate HVAC System BTU Capacity	HVAC School	3:19	Where the numbers cash out (preview of 11.2)
3	Watt's Law Demonstrated	HVAC School (Ty)	8:21	Bridge to electrical math (2.4)

4. The idea — one quantity, three languages

Everything below is **heat per hour**:

1 ton = 12,000 BTU/hr (Lesson 1.7's ice) **1 kW = 3,412 BTU/hr** **1 W = 3.412 BTU/hr**



The four moves you'll make weekly:

1. **Tons → BTU/hr:** × 12,000. (3 tons = 36,000.)
2. **BTU/hr → tons:** ÷ 12,000. (48,000 = 4 tons.)
3. **kW → BTU/hr:** × 3,412. (10 kW strips = 34,120 BTU/hr ≈ "3 tons of heat" — now you can compare strips to compressor capacity, the Unit 8 balance-point math.)

4. **BTU/hr → kW:** $\div 3,412$. (An 80,000 BTU/hr furnace ≈ 23.4 kW — why gas wins big-heat jobs and why all-electric resistance heat hurts on bills.)

Anchors worth memorizing cold: 12,000 (ton), 3,412 (kW), $3.5 \text{ kW} \approx 1 \text{ ton}$, $5 \text{ kW strips} \approx 17,000 \text{ BTU/hr}$, $10 \text{ kW} \approx 34,000 \text{ BTU/hr}$.

Temperature: two scales, one habit

$^{\circ}\text{F} \leftrightarrow ^{\circ}\text{C}$: **$C = (F - 32) \times 5/9$, $F = C \times 9/5 + 32$** . Anchors: $0\text{C}/32\text{F}$ freeze, $100\text{C}/212\text{F}$ boil, $-40 = -40$, $22\text{C} \approx 72\text{F}$ (comfort). Mini-split menus, A2L specs, and imported equipment will throw $^{\circ}\text{C}$ at you — convert without breaking stride. ΔT differences scale by 9/5 alone (a 10°C rise = 18°F rise) — no "+32" when it's a DIFFERENCE; this trips everyone once.

CFM — a rate, not an amount

CFM = cubic feet per minute — how much air per minute, the airflow language for Units 10–11. The two rules of thumb to park now:

- **~400 CFM per ton** of cooling (the design default; humid-climate setups run 350 — Unit 7.9).
- A 3-ton system therefore wants **~1,200 CFM** through ducts sized for it (Manual D, 10.14).

The full airflow math (temp-rise CFM formula, the 1.08 factor) arrives in 11.2; today you just need the ton $\leftrightarrow$ CFM reflex for sizing sanity checks.

Cross-checking — the superpower

One machine, three name tags, all convertible:

Nameplate says compressor RLA 12.8 A at 230 V $\rightarrow$ roughly $12.8 \times 230 = 2,944 \text{ W} \approx 2.9 \text{ kW}$ input. A 3-ton unit moves $\sim 36,000 \text{ BTU/hr} \approx 10.6 \text{ kW}$ of heat with $\sim 2.9 \text{ kW}$ of electricity.

Moving heat beats making heat ~3.5:1 — that ratio (COP) is why heat pumps exist, and you just derived it with multiplication.

5. Drills & bench

1. **The toaster, live (Ty's demo):** clamp the toaster's amps, compute watts ($V \times A$), convert to BTU/hr. A 1,500 W appliance = $\sim 5,100 \text{ BTU/hr}$ of pure heat — "half a ton of toaster."
2. **Conversion gauntlet (20 Qs):** tons $\leftrightarrow$ BTU, kW $\leftrightarrow$ BTU, mixed. 90% to pass, repeat till everyone clears.
3. **Nameplate cross-check:** every shop unit — convert its tonnage to BTU/hr to kW-of-heat-moved; convert its strip kit (if any) to BTU/hr; write both on the worksheet and circle which is bigger, compressor heat or strip heat (preview of why strips are "auxiliary").
4. **$^{\circ}\text{C}$ ambush round:** mini-split service menu screenshots showing coil temps in $^{\circ}\text{C}$ — convert five readings, including one ΔT (difference!) conversion.

5. **Smell-test round:** ten claims, call BS or plausible. ("This 2-ton puts out 60,000 BTU/hr." "These 5 kW strips add about 17,000 BTU/hr." "That 1,500 W heater = 15,000 BTU/hr.")

Checkout: five conversions cold including one kW→BTU/hr and one °C ΔT, plus one cross-check ("does this claim survive the math?") explained out loud.

6. Field gotchas

- **BTU vs BTU/hr** — capacity is always per hour; dropping the "/hr" is how supply-house misorders happen.
- **Input vs output:** an 80,000 BTU/hr furnace at 80% AFUE delivers 64,000. Gas talks input; cooling talks output. Ask which one the number is.
- **kW on a strip nameplate is at rated voltage** — at 208 V a "10 kW" (240 V-rated) kit makes ~7.5 kW. The voltage-squared effect is Lesson 3.1's homework — flag it now.
- **The °C difference trap:** a "5°C subcool" on an imported spec $\approx$ 9°F, not 41°F.
- **400 CFM/ton is a default, not a law** — humid Alabama often wants 350 (latent!, Lesson 1.5). Defaults start arguments; measurements end them (Unit 11).

7. Competency link

- RTI Trade Math; directly feeds strip-heat sizing (Comp 24, Unit 8), airflow math (Comp 42, Unit 11), gas input clocking (Comp 27, Lesson 7.6), and every capacity conversation.

8. Check yourself

1. 42,000 BTU/hr = how many tons? 2.5 tons = how many BTU/hr?
 2. 7.5 kW of electric strips = how many BTU/hr? About how many "tons of heat"?
 3. A 1,500 W space heater puts out how many BTU/hr?
 4. 80,000 BTU/hr input furnace, 95% AFUE — output?
 5. Mini-split menu shows coil at 7°C. °F?
 6. Spec sheet: "design ΔT 8°C." How many °F of split is that?
 7. Expected airflow for a 4-ton system at the design default?
 8. A unit draws 2.9 kW and moves 10.6 kW of heat. What's that ratio called, roughly what is it, and why does it matter?
 9. "This 10 kW heat kit will keep up with the 3-ton heat pump it backs up." Check it with math.
 10. Supplier quotes a "60,000 BTU" coil for a 3-ton job. What's wrong, and what question do you ask?
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