AERODYNAMICS AND PERFORMANCE: OPERATIONAL PLANNING

OBJECTIVE

Students will conduct preflight performance calculations related to density altitude. Formulas are included for reference.

MATERIALS

- Ruler (or straight edge)

DIRECTIONS

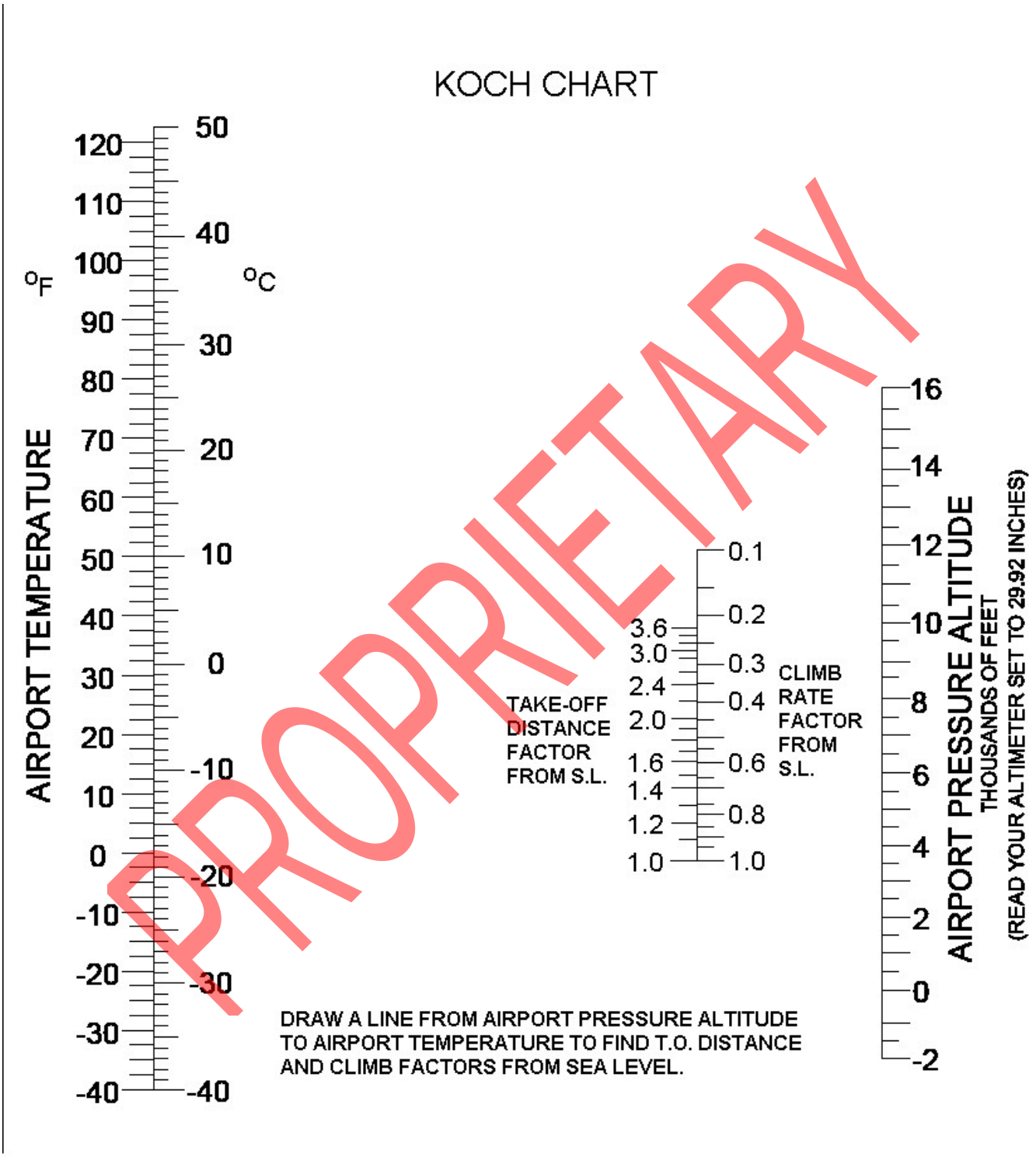
Ensure students complete the given questions, and remind them to mark the Koch chart for Scenario 2.

Distribute rulers or straight edges to students as needed.

REFERENCES

Pressure altitude = (standard pressure – current pressure) x 1,000 + field elevation

Density altitude = pressure altitude + [120 x (current temperature – ISA temperature for your elevation)]



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SCENARIOS

FLIGHT SCENARIO 1

- Field elevation: 2,000 ft MSL
- Current Pressure: 30.10”Hg
- Temperature: 30°C
- Wind: Calm
- Small, 20-ft round landing and takeoff area surrounded by tall trees and swamps
- Configuration: Quadcopter
- You have a waiver for altitude limits and airspace use.
- Your UAV is rated to fly up to 3,000 ft MSL in standard conditions.

FLIGHT SCENARIO 2

- Field Elevation: 2,000 ft MSL
- Current Pressure: 29.90”Hg
- Temperature: 18°C
- Wind: 090° at 2 knots
- Configuration: Fixed-Wing
- You have a waiver for altitude limits and airspace use.
- Your UAV is rated to fly to 3,000 ft MSL in standard conditions.
- Under standard conditions, takeoff distance for this fixed-wing UAV is 300 ft, and you have a 1,000 ft runway at your disposal.

PERFORMANCE CALCULATIONS

1. Flight Scenario 1

   PRESSURE ALTITUDE: (29.92 – 30.10) x 1,000 + 2,000 ft = ***1,820 ft***

   DENSITY ALTITUDE: 1,820 + [120 x (30 – 11)] = ***4,100 ft***

   a. Max flight altitude AGL: ***700 ft*** *(3,000 ft rated – 2,300 ft density altitude at takeoff)*

      i. ***NONE ft*** *(3,000 ft rated – 4,100 ft density altitude at takeoff means the UAV will not ascend)*

   b. Expected performance (better or worse than sea level performance): ***Worse*** *(The UAV is expected to perform at an altitude above its rated maximum, so no flight will occur.)*

2. Flight Scenario 2

PRESSURE ALTITUDE: (29.92 – 29.90) x 1,000 + 2,000 ft = ***2,020 ft***

DENSITY ALTITUDE: 2,020 + [120 x (18 – 11)] = ***2,860 ft***

   a. Max flight altitude AGL: ***140 ft*** *(3,000 ft rated – 2,860 ft density altitude at takeoff)*
   b. Takeoff distance: ***420 ft*** (Using the Koch Chart, 18°C @ 2,020 ft yields a factor of 1.4; 300 ft takeoff rating x 1.4 = 420 ft)
   c. Expected performance (better or worse than sea level performance): **Worse** (Lower than standard pressure adds to the fact that the UAV is already flying at an effective altitude of 2,500 ft which is far above sea level.)

d. Potential for carburetor icing?: **Maybe** (Depending on the humidity, carburetor icing could form at this temperature; however, if the UAV uses an electrically-powered propeller, then carburetor icing is not a factor.)
e. Preferred direction of takeoff: ***090°*** (Or west, into the easterly headwind)
f. Preferred direction of landing: ***090°*** (Or west, into the easterly headwind)
g. Approx. climb rate factor (from Koch chart): ***0.7*** *(This number, derived from the Koch chart, means that the climb rate is only 70% of what is expected on a standard day. For example, if the published climb rate on a standard day at this altitude was 300 ft/min, then the pilot would expect a climb rate of 210 ft/min in this scenario).*