37.36 During winter operation, a cooling plant reduces energy use by using a parallel flow plate and frame heat exchanger instead of its chillers. The system consists of two loops, (1) an open condenser water loop which is fed by cooling towers outside, and (2) a closed chilled water loop which is distributed throughout the facility. If the condenser water enters the heat exchanger at $40°F$ and leaves at $46°F$ and the chilled water enters at $60°F$ and leaves at $48°F$, what is the log mean temperature difference?

A. $8°F$

B. $9°F$

C. $10°F$

D. $11°F$

Look up Log Mean Temperature Difference or LMTD in the Reference Handbook. Consider memorizing the simpler version below rather than using either of the two equations shown, and learning how to apply it rather than risking a mistake when assigning the variables to the given information. Recall:

$$\Delta T_{lm} = \frac{\Delta T_A - \Delta T_B}{ln\left(\frac{\Delta T_A}{\Delta T_B}\right)}$$

where ΔT_A is the temperature difference between the two fluids on one side of the heat exchanger and ΔT_B is the temperature difference between the two fluids on the other side of the heat exchanger.

Since this is a parallel flow heat exchanger, the temperature difference between the two fluids upon entering, ΔT_A, is as large as it is ever going to be; i.e. the warm fluid is at its warmest and the cold fluid is at its coldest. Therefore:

$$\Delta T_A = 60°F - 40°F = 20°F$$

The temperature difference between the two fluids upon leaving, ΔT_B, is as small as it is ever going to be; i.e. the warm fluid has cooled, the cool fluid had warmed, and the temperatures *approach* one another from either side, never crossing for a parallel flow heat exchanger, but potentially becoming quite close.

$$\Delta T_B = 48°F - 46°F = 2°F$$

Solve for the $LMTD$. It may be faster and easier to use the natural log, ln, rather than $2.3 \times log_{10}$ as suggested in the handbook. (Mathematically they are equivalent.)

$$T_{lm} = \frac{20°F - 2°F}{ln\left(\frac{20°F}{2°F}\right)} = \frac{18°F}{ln\,(10)} = 7.8°F$$

Answer A