34.17 Hexane (C_6H_{14}) is combusted with a stoichiometric quantity of dry air at atmospheric pressure. What is the dew point of the product gas?

A. $69°F$

B. $128°F$

C. $155°F$

D. $186°F$

The Combustion Reactions of Common Fuel Constituents table in the reference handbook does not contatin an entry for hexane. Determine the schoichiometric combustion reaction for hexane by defining an arbitrary constant, a, for the quantity of air the fuel will be combusted with, where air is comprised of 3.77 molecules of nitrogen per molecule of oxygen. Define constant b as the quantity of carbon dixide, constant c as the quantity of water vapor, and constant d as the quanity of nitrogen on the product side of the reaction.

$$C_6H_{14} + a\left(O_2 + 3.77N_2\right) \rightarrow bCO_2 + cH_2O + dN_2$$

Balance the carbon.

$$b = 6$$

Balance the hydrogen.

$$14 = 2c$$

$$c = 7$$

Balance the oxygen.

$$2a = 2b + c$$

$$a = \frac{(2)(6) + 7}{2} = 9.5$$

Balance the nitrogen.

$$(3.77)(2)\,a = 2d$$

$$d = \frac{(3.77)(2)(9.5)}{2} = 35.8$$

Update the stoichimetric combustion reaction with constant that have been determined.

$$C_6H_{14} + 15.5\left(O_2 + 3.77N_2\right) \rightarrow 6CO_2 + 7H_2O + 35.8N_2$$

Determine the partial pressure of water vapor by first calculating the mole fraction of water vapor in the products, then multiplying by the total pressure, which is atmospheric pressure.

$$\frac{N_{H_2O}}{N_{products}} = \frac{7}{6+7+35.8} = 0.143$$

$$p_w = 0.143 p_t = (0.143)\,(14.7psia) = 2.11psia$$

Use the properties of Saturated Water and Steam table by pressure to look up the saturation temperature corresponding to the partial pressure of water. Make a simple table and interpolate, or estimate to find the dew point temperature. Recall the definition of the dew point is the saturation temperature at the partial pressure.

$P_{[psi]}$	$T_{[^\circ F]}$
2	126
2.11	T_{dp}
3	141.3

$$\frac{2.11-2}{3-2} = \frac{T_{dp}-126}{141.3-126}$$

$$T_{dp} - 126 = 1.7$$

$$T_{dp} = 127.7^\circ F$$

Answer B