Determine the number of annual run hours based on hours per day and days per week for one year.

$$\left(\frac{12hr}{day}\right)\left(\frac{5days}{wk}\right)(52wks) = 3120hrs$$

Calculate the annual running cost based on demand, annual run hours, and the cost of electricity.

$$Cost = (2.057KW)(3120hrs)\left(\frac{\$0.12}{kWhr}\right) = \$770$$

Answer C

47.65 A continuously running $460V$ 3-phase motor draws $23A$. The motor has a power factor of 0.91 and an efficiency of 88% and drives a centrifugal pump with an efficiency of 77%. The pump supplies $300gpm$ of water against $200ft$ of head. To save energy and avoid cost, operators determine that the pump may be turned off for $8hours$ per day with no impact to the operation and no change to the operating parameters while in use. Electricity costs $\$0.15/kWh$ for consumption and $\$15/KW$ for peak demand. What are the expected annual savings for this initiative?

A. \$5400

B. \$6200

C. \$7100

D. \$7300

There will be no changes in the demand charge because the operating parameters are the same when the pump is in use. In other words, the maximum power draw is unchanged. Only the reduced electrical consumption will drive savings.

Calculate the input power demand to run the motor using the fourth formula on the right side of the table under Power for Different Motor Phases. There is no need to work backwards from water horsepower and apply the pump and motor efficiencies since the current, voltage, and power factor are all given.

$$P_{KW} = \frac{\sqrt{3}IV(pf)}{1000} = \frac{\sqrt{3}(23)(460)(0.91)}{1000} = 16.67KW$$

Multiply the electrical demand by time and the unit rate for electricy to determine the annual savings.

$$Savings = (16.67KW)\left(\frac{8hr}{day}\right)(365days)\left(\frac{\$0.15}{kWh}\right) = \$7304$$

Answer D

47.66 Decane ($C_{10}H_{22}$) undergoes complete, stoichiometric combustion in air. What is the mass fraction of carbon dioxide in the product gas?

A. 13%

B. 19%

C. 49%

D. 69%

Decane is not listed in the table Combustion Reactions of Common Fuel Constituents. Therefore, it is necessary to write the balanced reaction. Since the combustion is stoichiometric, there is no excess air. Start by writing the products and reactants using arbitrary constant coefficients. For the reactants, there are 3.77 nitrogen molecules per oxygen molecule in air. The products are carbon dioxide, water vapor, and nitrogen. Nitrogen does not participate in the reaction.

$$C_{10}H_{22} + x\left(O_2 + 3.77N_2\right) \rightarrow aCO_2 + bH_2O + cN_2$$

Balance the carbon.

$$a = 10$$

Balance the hydrogen.

$$22 = 2b \rightarrow b = 11$$

Balance the oxygen.

$$2x = 2a + b = 2\left(10\right) + 11 = 31$$

$$x = \frac{31}{2} = 15.5$$

Balance the nitrogen.

$$2c = 2\left(3.77\right)x = 2\left(3.77\right)\left(15.5\right) = 116.87$$

$$c = \frac{116.87}{2} = 58.435$$

Re-write the product side of the reaction with all known coeffients.

$$Reactants \rightarrow 10CO_2 + 11H_2O + 58.435N_2$$

Determine the Mass Fraction of carbon dioxide in the product gas. Use the Periodic Table to look up atomic weights as required. The mass of each constiuent is the product of the number of moles and the molecular weight.

$$y_{CO_2} = \frac{m_{CO_2}}{\sum m_i} = \frac{m_{CO_2}}{m_{CO_2} + m_{H_2O} + m_{N_2}}$$