EXERCISE

A home swimming pool contains 155 m^3 of water. At the beginning of swimming season, the water must be heated from 21 to 31 °C.

a) How much heat energy must be supplied?

b) If this energy is supplied by a natural gas heater with an 80% heat transfer efficiency, how many grams of methane must be burned?

The heat of combustion of methane is −803 kJ/mol

Specific Heat Capacity of water... 4180 $J/kg\,K$

Atomic Weights: C = 12; H = 1

SOLUTION

a) The heat needed is

$$Q = m \times c \times \Delta T$$

$$m = 155\ m^3 \times \frac{1000\ kg}{1\ m^3} = 1.55 \times 10^5\ kg$$

$$c = 4180\ \frac{J}{kg \cdot K}$$

$$\Delta T = T_f - T_i = 31°C - 21°C = 10°C = 10\ K$$

$$Q = 1.55 \times 10^5\ kg \times 4180\ \frac{J}{kg \cdot K} \times 10\ K = 6.48 \times 10^9\ J$$

$$\boxed{Q = 6.48 \times 10^6\ KJ}$$

b) The heat needed to produce

$$Q = 6.48 \times 10^6\ KJ \times \frac{100\ J}{80\ J} = 8.1 \times 10^6\ KJ$$

efficiency 80%

The molar mass of methane is:

$M\ (CH_4) = 12 + (4 \times 1) = 16\ g/mol$

The mass of methane needed:

$$m = 8.1 \times 10^6\ KJ \times \frac{1\ mol}{803\ KJ} \times \frac{16\ g\ CH_4}{1\ mol} = \boxed{1.6 \times 10^5\ g\ CH_4}$$