(4.3) Assuming that in the fission of a uranium atom an energy amount of 200 MeV is released, how far would 1 g of ^{235}U drive a car which consumes 1 liter of gasoline (density 0.70 g cm^{-3}) for each 10 km? The combustion heat of octane is 5500 kJ $mole^{-1}$, and the combustion engine has an efficiency of 18%.

We assume 100% efficiency for energy from uranium. In reality it would probably be more like the ~35% achieved in nuclear ships.

The molar weight of n-octane (C_8H_{18}) can be estimated as:

$MeV := 1.60217733\cdot 10^{-13}\cdot joule$ $\quad M_C := 12.01\cdot gm\cdot mole^{-1}$ $\quad M_H := 1.008\cdot gm\cdot mole^{-1}$

$M_{oct} := 8\cdot M_C + 18\cdot M_H$ $\quad M_{oct} = 114.224\cdot gm\cdot mole^{-1}$

Its combustion energy, H_{oct}, is then:

$H_{comb} := 5500\cdot 10^3\cdot joule\cdot mole^{-1}$ $\quad \rho_{oct} := 0.7\cdot gm\cdot mL^{-1}$

$H_{oct} := \dfrac{\rho_{oct} H_{comb}}{M_{oct}}$ $\quad H_{oct} = 3.371\cdot 10^7 \cdot joule\cdot liter^{-1}$ (1 liter can move the car 10 km)

Approximating the fission energy of 1 ^{235}U atom by 200 MeV, eqn. (19.1), the nuclear energy, Q, is:

$M_{U235} := 235\cdot gm\cdot mole^{-1}$ $\quad N_A := 6.0221367\cdot 10^{23}\cdot mole^{-1}$ $\quad Q_{fiss} := 200\cdot MeV$

$Q := Q_{fiss}\cdot \dfrac{1}{M_{U235}}\cdot N_A$ $\quad Q = 8.212\cdot 10^{10} \cdot joule\cdot gm^{-1}$ $\quad H_{oct} = 3.371\cdot 10^7 \cdot joule\cdot liter^{-1}$

$dist := \dfrac{1\cdot gm\cdot Q}{1\cdot liter\cdot H_{oct}\cdot 0.18}\cdot 10\cdot km$ $\quad dist = 135347\cdot km$

(In case we use the nuclear thermal efficiency producing electricity, 35%, we would instead get:

$\dfrac{1\cdot gm\cdot Q\cdot 0.35}{1\cdot liter\cdot H_{oct}\cdot 0.18}\cdot 10\cdot km = 47371\cdot km$)