1) $\lambda = 3/5 = 0,6$ $\quad E[t_s] = 1$ $\quad \rho = \lambda \cdot E[t_s] = 0,6$ $\quad \mu = 1/E[t_s] = 1$

a) $E[t_q] = \frac{1}{\mu - \lambda} = \frac{1}{1-0,6} = 2,5$ minutos

b) $E[w] = \frac{\rho^2}{1-\rho} = \frac{0,6^2}{1-0,6} = 0,9$ carros.

2) $\lambda = 40$ $\quad E[t_s] = n/R = 5 \cdot 10^3 / 500 \cdot 10^3 = 0,01$ $\quad \rho = \lambda \cdot E[t_s] = 0,4$

a) $E[t_w] = \frac{\rho^2}{\lambda(1-\rho)} = \frac{0,4^2}{40(1-0,4)} = 6,6$ ms

b) $E[t_q] = E[t_w] + E[t_s] = 6,6 \cdot 10^{-3} + 0,01 = 16,6$ ms

3) $\lambda = 200$ $\quad E[t_s] = n/R = 128 \cdot 8 / 256 \cdot 10^3 = 0,004$

$\rho = \lambda \cdot E[t_s] = 200 \cdot 0,004 = 0,8$

$\rho / J = 1$:

$E[q] = \frac{0,8}{1-0,8} - \frac{(1+2) \cdot 0,8^3}{1-0,8^3} = 0,8525$ $\quad P_b = 0,2622$

$E[t_q] = \frac{E[q]}{200(1-P_b)} = 5,1$ ms

p/J = 5 :

$P_b = 0,066$ $\quad E[q] = \frac{0,8}{1-0,8} - \frac{7 \cdot 0,8^7}{1-0,8^7} = 2,243$

$E[l_q] = \frac{E[q]}{200(1-P_b)} = 11,47 ms$

p/J = 10 :

$P_b = 0,0184$ $\quad E[q] = \frac{0,8}{1-0,8} - \frac{(12) \cdot 0,8^{12}}{1-0,8^{12}} = 3,11$

$E[l_q] = \frac{E[q]}{200(1-P_b)} = 15,87 ms$

p/J = 15 :

$P_b = 0,006$ $\quad E[q] = \frac{0,8}{1-0,8} - \frac{17 \cdot 0,8^{17}}{1-0,8^{17}} = 3,61$

$E[l_q] = \frac{E[q]}{200(1-P_b)} = 18,15 ms$

4) $\lambda = 1 \quad n = 2000 \quad R = 10\ Kbps$

a) $E[t_s^2] = E[t_s]^2 = 1/\mu^2 \qquad \mu = R/n = 10 \cdot 10^3 / 2 \cdot 10^3 = 5$

$= 1/25$

$\rho = \lambda/\mu = 1/5$

$$E[t_q] = \frac{\lambda \cdot E[t_s^2]}{2(1-\rho)} + \frac{1}{\mu} = \frac{1 \cdot 1/25}{2(1-0,2)} + \frac{1}{5} = 225\ ms$$

b) $E[t_s^2] = 2/\mu^2 = 2/25$

$$E[t_q] = \frac{1 \cdot 2/25}{2(1-0,2)} + \frac{1}{5} = 250\ ms$$