2018 AB/BC #1
(calculator-active)

(a)
Since $r(t)$ is the rate that people enter the line, then the number of people that enter the line from $0 \le t \le 300$ would be $\int_0^{300} r(t)\,dt = \boxed{270 \text{ people}}$

(b)
The number of people in line at a time t is the number of people in line at $t = 0$ plus the number of people that enter the line minus the number of people that exit the line: $P(t) = P(0) + \int_0^t r(x)\,dx - 0.7t$

So, $P(300) = 20 + \int_0^{300} r(x)\,dx - 0.7(300) = \boxed{20 + 270 - 0.7(300) \text{ people}}$ or 80 people

(c)
There are no people in line when $P(t) = 20 + 270 - 0.7t = 0$

$\Rightarrow \quad t \approx \boxed{414.2857143 \text{ seconds}}$ or 414.286

(d)
On $[0,300]$, $P(t)$ is a minimum when $t = 0, t = 300,$ or when $P'(t) = 0$.

Solving on the calculator: $P'(t) = r(t) - 0.7 = 0 \ \Rightarrow \ t = 33.013298 \sec = a$

$t = 166.57472 \sec = b$

$P(0) = 20$

$P(300) = 80$

$P(a) = 20 + \int_0^a r(x)\,dx - 0.7a \approx 3.803436931$

$P(b) = 20 + \int_0^b r(x)\,dx - 0.7b \approx 158.07014$

The number of people in line is a minimum on the interval when $t = \boxed{a \text{ sec}}$

At this time, there are $\boxed{4}$ people in line.