Question 2

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Question 2 (8.1)

$$\frac{d[E]}{dt} = (k_2 + k_3)[ES] - k_1[E][S]$$

$$\frac{d[S]}{dt} = k_2[ES] - k_1[E][S]$$

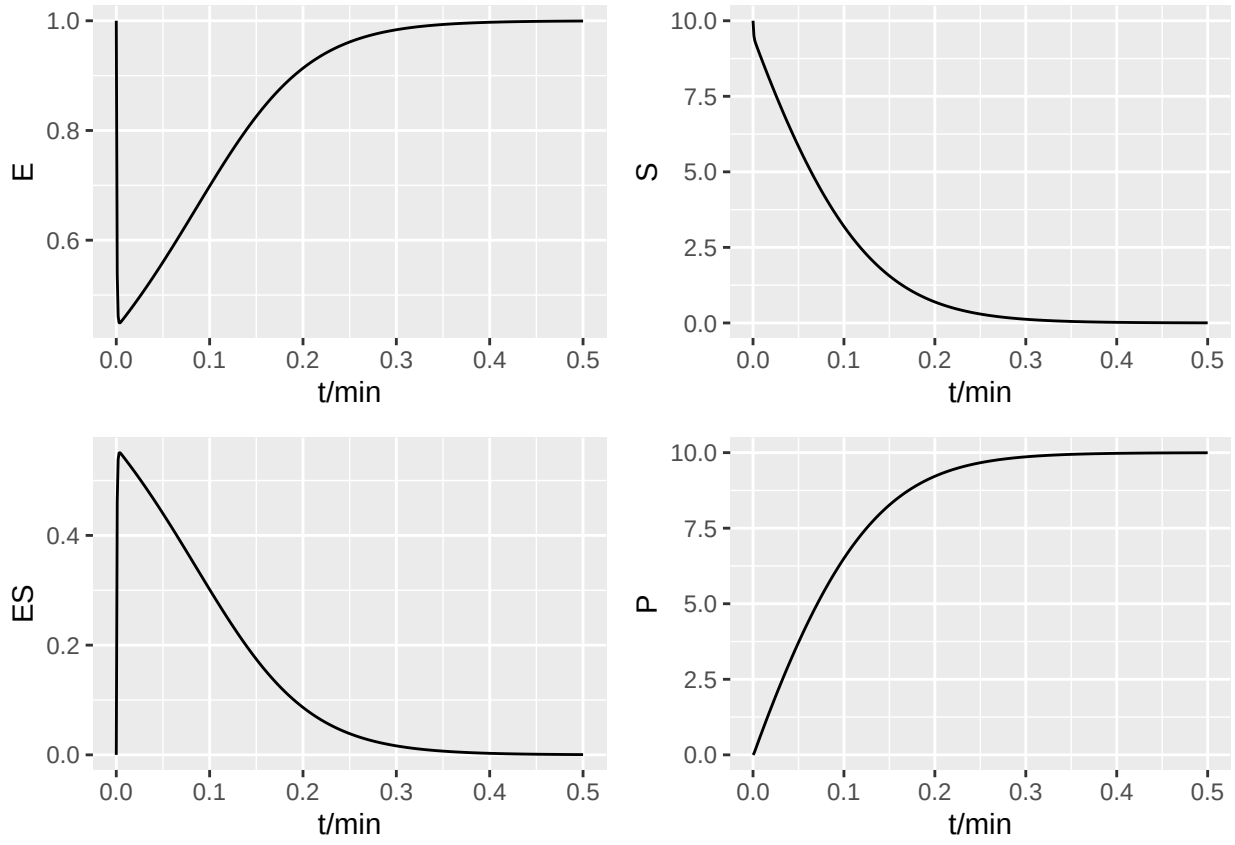
$$\frac{d[ES]}{dt} = k_1[E][S] - (k_2 + k_3)[ES]$$

$$\frac{d[P]}{dt} = k_3[ES]$$

Question 2 (8.2)

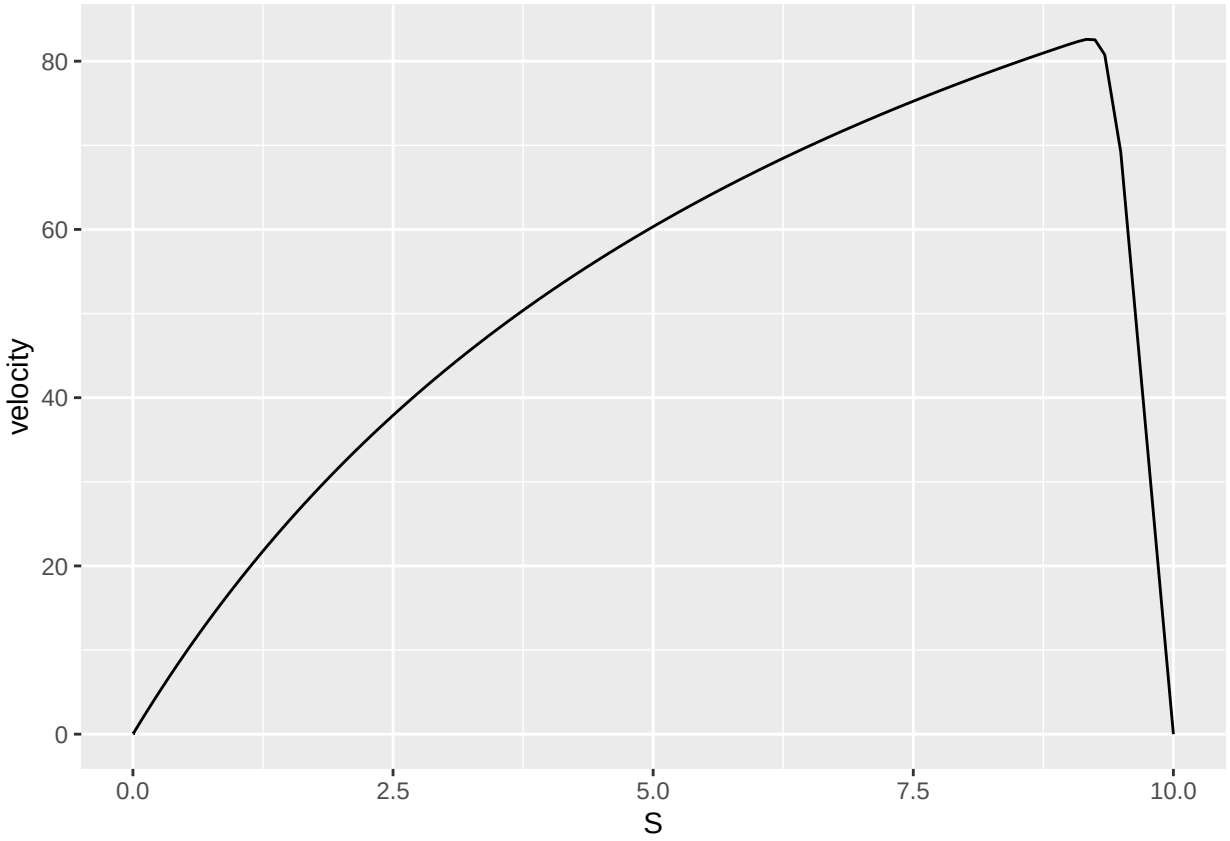
```
library(deSolve)
library(ggplot2)
library(ggpubr)

k1 = 100
k2 = 600
k3 = 150
E0 = 1
S0 = 10

F = function(t, V, parms) {
  with(as.list(c(V, parms)), {
    dE = - k1*E*S + (k2+k3)*ES
    dS = - k1*E*S + k2*ES
    dES = k1*E*S - (k2+k3)*ES
    dP = k3*ES
    return(list(c(dE, dS, dES, dP)))
  })
}

t_eval = seq(0, 0.5, 0.001)
parms = c(k1 = k1, k2 = k2, k3 = k3)
V0 = c(E = E0, S = S0, ES = 0, P = 0)
```

```
sol = as.data.frame(ode(y = V0, times = t_eval, func = F, parms = parms))

E <-ggplot(sol, aes(x = time, y = E)) + geom_line() + xlab("t/min") + ylab("E")
S <- ggplot(sol, aes(x = time, y = S)) + geom_line() + xlab("t/min") + ylab("S")
ES <- ggplot(sol, aes(x = time, y = ES)) + geom_line() + xlab("t/min") + ylab("ES")
P <- ggplot(sol, aes(x = time, y = P)) + geom_line() + xlab("t/min") + ylab("P")
ggarrange(E, S, ES, P, ncol = 2, nrow = 2)
```



Question 2 (8.3)

```
ggplot(sol, aes(x = S, y = k3*ES)) + geom_line() + xlab("S") + ylab("velocity")
```


80
60
40
20
0
velocity
0.0
2.5
5.0
7.5
10.0
S