

Question 1

Volume of the room = 20000 ft³
Inlet = 600 ft³/min
outlet = 600 ft³/min

$$\frac{dy}{dt} = A_{in} - A_{out}$$

where $A_{out} = \frac{600 \cdot y}{20000}$

$$A_{in} = 600 \text{ ft}^3 \text{ min}^{-1}$$

$$\frac{dy}{dt} = 600 - \left(\frac{600}{20000} y \right)$$

$$\frac{dy}{dt} = (600 - 0.03y)$$

$$\frac{dy}{dt} = -0.03(y - 20000)$$

Collecting like terms.

$$\frac{dy}{(y - 20000)} = -0.03 dt$$

$$(y - 20000)$$

Integrate both sides

$$\int \frac{dy}{(y - 20000)} = \int -0.03 dt$$

$$\ln(y - 20000) = -0.03t + C$$

$$\therefore y - 20000 = e^{-0.03t + C} \quad \text{where } e^C = A$$

$$y - 20000 = e^{-0.03t} \cdot e^C$$

$$y - 20000 = A e^{-0.03t}$$

$$y(t) = 20,000 + A e^{-0.03t}$$

at time $t = 0$, $y(t) = 0$

$$\therefore y(0) = 20,000 + A e^0$$

$$0 = 20,000 + A$$

$$A = -20,000$$

$$y(t) = 20,000 - 20,000 e^{-0.03t}$$

e) the time taken for 70%
 $\frac{70}{100} \times 20,000$
 $y(t) = 18,000$

$$18,000 = 20,000 - 20,000e^{-0.03t}$$

$$-2,000 = -20,000e^{-0.03t}$$

$$0.1 = e^{-0.03t}$$

$$-2.30 = -0.03t$$

$$t = 76.67 \text{ min.}$$

1) Command Window

2) Clc

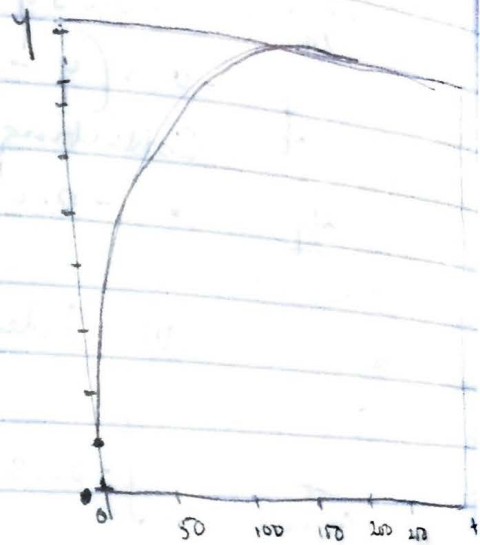
3) Clear

4) Syms y t

5) t = 0:5:360

6) $y = 20000 - 20000 * \exp(-0.03 * t)$

7) plot(t, y)



8) 2 at 180 min

e) at the rate at which fresh air flows into the room
the fresh room will be completely filled with fresh air
about 3 hours.