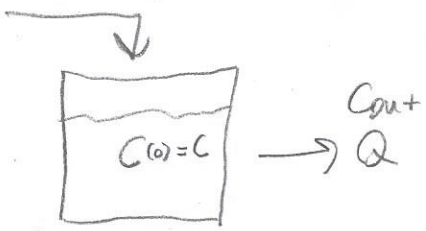
Problem set #3

12.



$A = KC$

$C(t) = ?$

$$V\frac{dC}{dt} = C_{in}Q - C_{out}Q$$

It is called an exponential dilution flask because the concentration decrease exponentially.

$$\int_{C}^{C(t)} \frac{dC}{C_{out}} = \int_{0}^{t} -Q/V\,dt$$

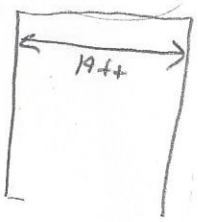
$$\ln\left(\frac{C(t)}{C}\right) = -Q/V\,t$$

$$\boxed{C(t) = Ce^{-Q/V\,t}}$$

13.

H_2 gas

$P = 15$ psig $\quad Q = 5\ ft^3/min$ $\quad$ room Temperature $= 70°F = 529.6\ °R$



$$V = \frac{1}{3}\cdot\pi(10)^3 = 1.05\times10^3\ ft^3$$

$15\ psig + 14.7 = 29.7\ psia$

$$29.7\frac{lb}{in^2}\times\left(\frac{12\ in}{1\ ft}\right)^2 = 4276.8\frac{lb}{ft^2}$$

$PV = nRT$

a) $V = \frac{1}{3}\pi\left(\frac{19\ ft}{2}\right)^3 = 897.8\ ft^3$

$t = ?$ $\quad V = 1047.2\ ft^3 \rightarrow 897.8\ ft^3$

$\Delta V = 1047.2\ ft^3 - 897.8\ ft^3 = 149.4\ ft^3$

$$\frac{\Delta V}{\Delta t} = Q$$

$$\Delta V = Q\Delta t$$

$$149.4\ ft^3 = 5\frac{ft^3}{min}\Delta t$$

$$\boxed{\Delta t = 29.9\ s}$$

b) $Q = -KV$ $\quad Q_0 = 5\ ft^3/min$ $\quad 5\ ft^3/min = K(1047.2\ ft^3)$ $\quad K = .0048\ 1/min$

$$\frac{dV}{dt} = -KV \qquad \int_{1047.2}^{897.8}\frac{dV}{V} = \int_0^t (.0048\ 1/min)\,t$$

$$\ln\left(\frac{897.8\ ft^3}{1047.2\ ft^3}\right) = -(.0048\ 1/min)\,t$$

$$\boxed{t = 32.1\ s}$$

c) $\frac{dV}{dt} = K(P_{inside} - 14.7\ psia)$