GIVEN

* Piston-cylinder
  - » initially $P_0 = P_{atm} = 100\ kPa$
  - » initial vol $V_0 = 32\ cm^3 = 32 \times 10^{-6}\ m^3$
  - » spring attached to piston
  - » Area A of piston $A = 0.0004\ m^2 = 4.00\ cm^2$
  - » $\dot{Q}$ to gas moves piston up distance $x = 2.0\ cm = 0.02\ m$
  - » spring constant $k = 20\ N/cm = 2000\ N/m$

FIND

(a) final absolute pressure (kPa) of gas
(b) final vol of gas (cm^3)
(c) show expansion process on P-V diagram
(d) calculate expansion process

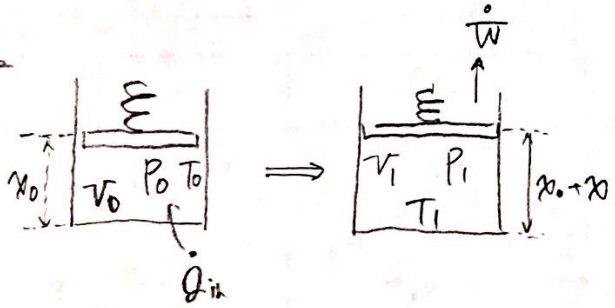
EQUATION

$PV = nRT$, $W = \frac{1}{2}kx^2$
$F = kx$, $\Delta U = Q - W$

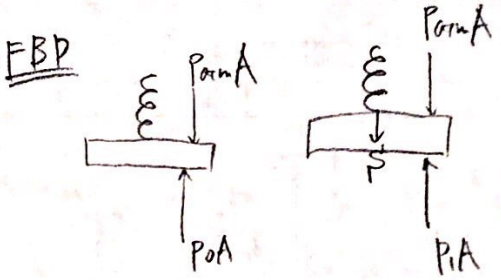
ASSUMPTION

- ideal gas
- Quasiequilibrium
- steady state
- closed system

FFD



FBD



SOLN

(a) $P_1A = P_0A + kx$

$$P_1 = P_0 + \frac{kx}{A} = 100\ kPa + \left(\frac{20\ N}{cm}\right)(2\ cm)\left(\frac{1}{0.0004\ m^2}\right)$$

$$= 100\ kPa + 100000\ Pa = \boxed{200\ kPa}$$

(b) $V_1 = V_0 + xA = 32\ cm^3 + (2.0\ cm)(4.00\ cm^2)$

$$= \boxed{40\ cm^3}$$