PS1 SOLUTION 10.213

a) $W = E_p = mzg$ (S+VN 1.7)

$z = \frac{W}{mg}$ hint: solve algebraically for unknown before substituting #'s

$m = 990g + 10g = 1000g \times \frac{1\,kg}{g} = 1\,kg$

$z = \frac{100\,J}{1\,kg\,(9.8\,\frac{m}{s^2})} \quad \frac{1\,kg\,\frac{m^2}{s^2}}{J}$ } UNITS App A S+VN p 632-633

more examples 10.213 website

$\boxed{z = 10.2\,m}$

assumes no friction or mass associated with pulleys and ropes or other elevation mechanism

b) $W = E_K = \frac{1}{2}mu^2$ (S+VN 1.5)

$u = \left(\frac{2W}{m}\right)^{1/2}$

$u = \left(\frac{2 \cdot 100\,J}{kg} \cdot \frac{1\,kg\,m^2}{s^2} \cdot \frac{1}{J}\right)^{1/2}$

$\boxed{u = 14.1\,\frac{m}{s}}$

assumes no friction, air resistance or mass associated with acceleration apparatus

c) $W = -\int_{V_1}^{V_2} P\,dV$ (S+VN 1.3)

$W = -\int_{V_1}^{V_2} \frac{nRT}{V} dV$ ideal gas law $P = \frac{nRT}{V}$

$W = -nRT \int_{V_1}^{V_2} \frac{dV}{V}$ T = constant for isothermal process

$W = -nRT \ln \frac{V_2}{V_1}$ $\frac{V_2}{V_1} = \frac{P_1}{P_2}$

$W = -nRT \ln \frac{P_1}{P_2}$ $-\ln \frac{1}{x} = \ln x$

$\frac{W}{nRT} = \ln \frac{P_2}{P_1}$

$P_1 e^{\frac{W}{nRT}} = P_2$

$n = 10\,g\ \text{air} \cdot \frac{\text{mol}}{.8(28g\,N_2) + .2(32g\,O_2)} = .347\ \text{mol}$

$\frac{W}{nRT} = \frac{100\,J}{(.347\,\text{mol})\ 8.314 \frac{J}{\text{mol}\,K}\ (25+273)K} = 0.116$

↑ use absolute temperature!

$P_2 = 1\ \text{bar}\ e^{0.116} = 1.123\ \text{bar}$

$\boxed{P_2 = 1.123\ \text{bar}}$

assumes frictionless piston, reversible process