PS2

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1.) Thermometers are small compared to the system of interest because the change in temperature occurs faster, compared to if it were larger.

2.) The triple point of water is used to calibrate thermometer because it doesn't depend on pressure, where as the freezing and boiling temperatures do.

3.)a.) $\left(P + \frac{N^2}{V^2}a\right)(V - Nb) = NkT$

$$P + \frac{N^2 a}{V^2} = \frac{NkT}{V - Nb}$$

$$P = \frac{NkT}{V - Nb} - \frac{N^2 a}{V^2}$$

for $\frac{N}{V} \ll 1 \rightarrow P = NkT\left[\frac{1}{V\left(1 - \frac{Nb}{V}\right)}\right] - 0$

$$P = NkT\left\{\frac{1}{V}\left[1 + \frac{Nb}{V} + \left(\frac{Nb}{V}\right)^2 + \dots\right]\right\}$$

$$= NkT\left(\frac{1}{V} + \frac{Nb}{V^2}\right)$$

$$dW = -P\,dV$$

$$\int_0^W dW' = -NkT\int_{V_1}^{V_2}\left(\frac{1}{V} + \frac{Nb}{V^2}\right)dV$$

$$W = -NkT\left[\ln(V)\Big|_{V_1}^{V_2} + Nb\left(\frac{-1}{V}\right)\Big|_{V_1}^{V_2}\right]$$

$$= -NkT\left\{\ln\left(\frac{V_2}{V_1}\right) + Nb\left(\frac{-1}{V_2} + \frac{1}{V_1}\right)\right\}$$

b.) $PV = NkT$

$$P = \frac{NkT}{V} \quad \text{when } \frac{N}{V} \ll 1 \rightarrow P = 0$$

$$W = 0$$

c.) $W_{VDW} - W_{IG} = W_{VDW}$

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4)a.) $R = [m]$ $M = [kg]$

$$G = \left[\frac{m^3}{kg\,s^2}\right] \qquad c = \left[\frac{m}{s}\right]$$

$$R = GM = \left[\frac{m^3}{\cancel{kg}}\right]\left[\cancel{kg}\right]\left[\frac{s}{m}\right] = m$$

$$\frac{}{c^2} \quad [\cancel{kg}\,\cancel{s^2}] \quad [\quad] \quad [\cancel{m^2}]$$

b.) $h = \left[\frac{m^2 kg}{s}\right]$ $\quad k = \left[\frac{kg\,m^2}{s^2 T}\right]$

$$S = \frac{kg\,m^2}{s^2\,T}$$

$$S = \frac{k\,c\,M}{G\,h} \quad (?)$$

c.) Entropy of black hole increases as mass increases.

d.) $S = \frac{k\,c^3}{G\,\hbar} A$

e.) $E = mc^2$

$$S = \frac{kc}{Gh}\frac{E}{c^2} = \frac{kE}{Ghc}$$