(1)

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Date: 05/12/2021

PHYS-230

TEST-4

05/12/2021

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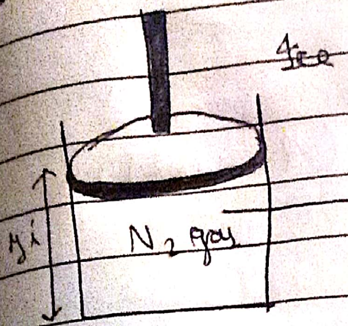
Q.



$p_i = ?$

$V_i = A \times h = \pi (0.125)^2 \times (0.085)$

$= 4.17 \times 10^{-3} m^3$

$m_i = ?$

$T_i = 273 K$

(a) gauge pressure $= \frac{0.145 \times 9.8}{\pi (0.125)^2}$

$= 28.96 \ N/m^2$

(b) $n = \frac{pV}{RT} = \frac{28.96 \times 4.17 \times 10^{-3}}{8.314 \times 273}$

$= 5.3 \times 10^{-5}$ moles

(c) $\frac{y_f}{y_i} = \frac{T_f}{T_i}$

$T_f = \frac{y_f}{y_i} \times T_i$

$= \frac{9.5 cm}{8.5 cm} \times 273 K$

$= 305.12 K$

$\approx 32° C$

P.T.O

Q2 Ans Given: Diatomic oxygen gas $\left(\gamma = \frac{C_p}{C_v} = \frac{7}{5}\right)$

$n = 3.4$ mol
$P_1 = 101325$ Pa
$T_1 = 22°C = 295$ K

(a) $T_2 = 120°C = 393$ K

$V_1 = V_2 = V$

Ideal gas equation $(PV = nRT)$

$P_1 V = nRT_1 \rightarrow (1)$
$P_2 V = nRT_2 \rightarrow (2)$

(1)/(2)

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$P_2 = \frac{T_2}{T_1} \times P_1$$

$$P_2 = \frac{393}{295} \times 101325$$

$$P_2 = 134985.508 \text{ Pa}$$

(b) $P_1 V_1 = nRT_1$

$$V_1 = \frac{nRT_1}{P_1}$$

$$= \frac{3.4 \times 8.314 \times 295}{101325}$$

P.T.O

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$V_1 = 0.0823 \, m^3 = V_2$

(c) Adiabatic expansion, $V_2 = 0.095 \, m^3$

considering V_2 here as V_3 because V_2 was used in part (b).

$\therefore V_3 = 0.095 \, m^3$

$PV^{\gamma} = \text{constant}$.

$P_2 V_2^{\gamma} = P_3 V_3^{\gamma}$

$134985.508 \times (0.0823)^{7/5} = P_3 \times (0.095)^{7/5}$

$P_3 = 134985.508 \times \left(\frac{0.0823}{0.095}\right)^{7/5}$

$P_3 = 134985.508 \times 0.818$

$P_3 = 110418.146 \, Pa$

(d) Molar mass, $M = 32 \, g/mol$

$= 32 \times 10^{-3} \, kg/mol$

$V_{rms} = \sqrt{\frac{3RT}{M}}$

at $T = 120°C = 393 \, K$

$V_{rms} = \sqrt{\frac{3 \times 8.314 \times 393}{32 \times 10^{-3}}}$

$V_{rms} = \sqrt{306318.938}$

$V_{rms} = 553.46 \, m/s$

P.T.O

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Date: 9/1

Q5 Ans:- If the lucite temperature comes down to 0°C from 120°C, the amount of heat released by it would be:-

$$m_l \times \Delta T \times C_l = 4.15\,kg \times (0-120)\,K \times 1460\,\frac{J}{kg \times K}$$

$$= -727.08\,KJ$$

The amount of heat absorbed if the entire ice melts :-

$$m_i \times L_{melting} = 1.75\,kg \times 335\,KJ/kg$$

$$= 586.25\,KJ$$

Heat released by cooling lucite from 120°C to 0°C > Heat absorbed by entire 1.75kg of ice melting.

∴ Entire mass of ice will melt into water before lucite reaches 0°C.

∴ The lucite releases heat (H_{lucite}) by coming down from a temperature of 120°C to T°C & the ice absorbs heat (H_{ice}) by completely melting & increasing its temperature from 0°C to T°C.

∴ $H_{lucite} = H_{ice}$

$$\therefore m_l \times (120-T) \times C_l = m_i \times L_{melting} + m_i \times (T-0) \times C_i$$

P.T.O

$m_l = 4.15$ kg (given)

$C_l = 1460$ J/kg.K

$= 1.46$ KJ/kg.K

$m_i = 1.75$ kg (given)

$L_{melting} = 335$ KJ/kg

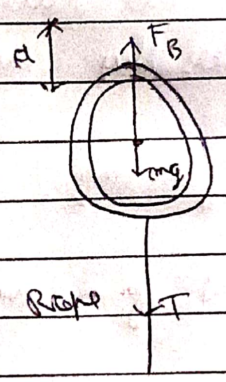
$C_i = 4.2$ KJ/kg.K

$\therefore 4.15 \times (120 - T) \times 1.46 = 1.75 \times 335 + 1.75 \times (T - 0) \times 4.2$

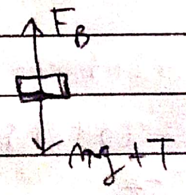
$\therefore T = 10.503°C$

$\therefore$ The equilibrium temperature is 10.503°C

Q4. Ans:



(a) Free body diagram:-



mg = weight ; T = Tension in rope ; F_B = Buoyant force due to water.

P.T.O

(b) Given:- $r_i = 41.47\ cm$
$r_o = 46.83\ cm$
$d = 27.90\ m$
$m = 355.0\ kg$

Density, $d = \frac{m}{V}$

$$= \frac{m}{\frac{4}{3}\pi(r_o^3 - r_i^3)}$$

$$= \frac{355}{\frac{4}{3}\pi \times 10^{-6} \times [(46.83)^3 - (41.47)^3]}$$

$\therefore d = 10,802\ kg/m^3$

$\therefore$ ρ according to table 13.1 in Giancoli, makes this material lead.

(c) Tension, $T = F_B - mg$

$T = \rho_w V_i g - mg$

$T = 1000 \times \frac{4}{3}\pi(46.83 \times 10^{-2})^3 \times 9.8 - 355 \times 9.8$

$T = 4213.73 - 3479$
$T = 734.73\ N$

(d) On cutting the rope, $F_{net} = F_B - mg$

$ma = 734.73\ N$
$a = \frac{734.73}{355}$

$a = 2.09\ m/s^2$

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(e) At surface = floating condition

$$F_B = mg$$

$$\rho_w V_i \cancel{g} = m\cancel{g}$$

$$V_i = \frac{m}{\rho_w}$$

$$= \frac{355}{1000}$$

$$= 0.355$$

$$V_i = 3.55 \times 10^{-1} \, m^3$$

fraction of volume below the surface

$$= \frac{V_i}{\frac{4}{3}\pi r_0^3} = \frac{355 \times 10^{-3}}{\frac{4}{3}\pi (46.83)^3 \times 10^{-6}}$$

=> 0.825 of the total volume of the sphere remains below the surface