Answer on Question \#60517, Physics /
a closed vesswl having capacity200ml is filled with hydrogen gas STP.
calculate:
number of moles of hydrogen gas filled in the vessel
pressure of hydrogen gas in the vessel ai 273 degree c
root mean square velocity of hydrogen gas at STP
the value of Cp and Cv for hydrogen gas
Find: u-? p-? u-? Cp - ? Cv- ?

## Given:

$\mathrm{V}=200 \times 10^{-6} \mathrm{~m}^{3}$
$\mathrm{M}=2 \times 10^{-3} \mathrm{~kg} / \mathrm{m}^{3}$
$\mathrm{T}_{0}=273 \mathrm{~K}$
$\mathrm{P}_{0}=10^{5} \mathrm{~Pa}$
$\mathrm{R}=8,31 \mathrm{~J} / \mathrm{mol}$
$\mathrm{T}=273+273 \mathrm{~K}=546 \mathrm{~K}$
$N_{A}=6,02 \times 10^{23} \mathrm{~mol}^{-1}$
$\mathrm{k}=1,38 \times 10^{-23} \mathrm{~J} / \mathrm{K}$
i=5

## Solution:

Equation of state for ideal gas:
$\mathrm{p}_{0} \mathrm{~V}=\frac{\mathrm{m}}{\mathrm{M}} \mathrm{RT}_{0}$ (1)
Number of moles:
$u=\frac{\mathrm{m}}{\mathrm{M}}(2)$,
where M - molar mass
Of (1) and (2) $\Rightarrow u=\frac{\mathrm{p}_{0} \mathrm{~V}}{\mathrm{RT}_{0}}$ (3)
Of (3) $\Rightarrow \mathrm{u}=8,8 \times 10^{-3} \mathrm{~mol}$
Pressure of hydrogen gas:
$\mathrm{p}=\mathrm{nkT}$ (4)
Concentration:
$\mathrm{n}=\frac{\mathrm{N}}{\mathrm{V}}(5)$
Number of molecules:
$N=u N_{A}(6)$
Of (6) $\Rightarrow \mathrm{N}=53 \times 10^{20}(7)$

Of (5) $\Rightarrow \mathrm{n}=0,26 \times 10^{26} \frac{1}{\mathrm{~m}^{3}}(8)$
(7) and (8) in (4): $\mathrm{p}=200 \times 10^{3} \mathrm{~Pa}$

Root mean square velocity:
$u=\sqrt{\frac{3 \mathrm{RT}_{0}}{\mathrm{M}}}$ (9),
where $\mathrm{T}_{0}=273 \mathrm{~K}$ (gas at STP)
Of (9) $\Rightarrow \mathrm{u}=1840 \mathrm{~m} / \mathrm{s}$
Molar heat of the gas at constant volume:
$C_{\mathrm{v}}=\frac{\mathrm{i}}{2} \mathrm{R}(10)$,
where i - number of degrees of freedom
Of (10) $\Rightarrow C_{v}=20,78 \mathrm{~J} / \mathrm{K}$
Molar heat of gas at constant pressure:
$C_{p}=\frac{i+2}{2} R(11)$
Of (11) $\Rightarrow C_{p}=29,08 \mathrm{~J} / \mathrm{K}$

## Answer:

number of moles: $u=8,8 \times 10^{-3} \mathrm{~mol}$
pressure of hydrogen gas in the vessel ai 273 degree $c: p=200 \times 10^{3} \mathrm{~Pa}$ root mean square velocity of hydrogen gas at STP: $u=1840 \mathrm{~m} / \mathrm{s}$ the value of $C p$ and $C_{v}$ for hydrogen gas: $C_{v}=20,78 \mathrm{~J} / \mathrm{K}, C_{p}=29,08 \mathrm{~J} / \mathrm{K}$

