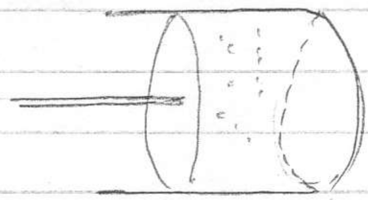
(1)

Gas Processes and Specific Heats (Problems) A Physics

(1)

A. These questions are about a $0.1\ m^3$ volume of ideal gas at $0°C$ and 100 kPa pressure



$C_V = 20\ J\ mole^{-1}\ K^{-1}$

$C_P = 28\ J\ mole^{-1}\ K^{-1}$

1. The gas is heated at constant volume to 100°C

Calculate (a) new pressure 2

(b) heat energy needed 2

(c) work done on the gas 2

(d) gain in internal energy 2

(e) Sketch the P/V graph 4

2. The same gas is slowly compressed at constant pressure to 150 kPa.

(a) Sketch the P/V graph (4)

(b) What must happen to the temperature, to be able to compress the gas at constant pressure? (1)

Calculate ... (c) new volume (2)

(d) work done on gas (2)

(e) Heat energy change - gain or loss? (2)

(f) change in internal energy. (2)

3. The same gas is allowed to expand isothermally to a volume of $0.15\ m^3$

(a) Sketch the P/V graph (4)

(b) What does the gas need from the surroundings to expand like this? (1)

Calculate ... (c) new pressure (2)

(d) new volume. (2)

(e) work done by gas (2)

(f.) heat energy gained by gas (2)

(g) change in internal energy of gas. (2)

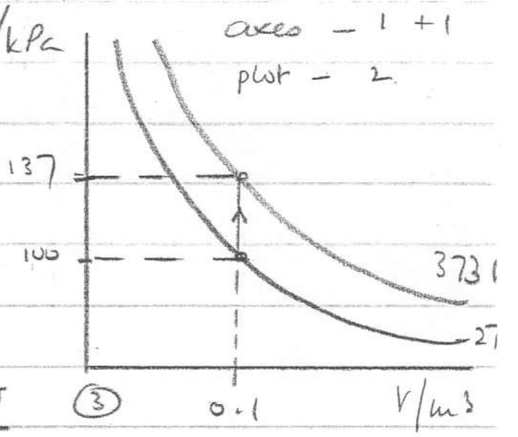
TW 4.98

4. The ratio C_P/C_V is 1.4 for oxygen. Calculate the values of C_p and C_V (the molar specific-heats).

Gas Processes etc – Answers – ① A Physics

Q... 1/13 2/14 3/15 4/3

1 Constant volume



(a) PV/T = konstant so P/T = constant

so $P_1/T_1 = P_2/T_2$ ① $\rightarrow P_2 = \frac{P_1 \times T_2}{T_1}$ = 137 kPa ①

(b) Heat energy $\Delta Q = n C_V \Delta T$ ①

To find n ... $PV = nRT \rightarrow n = PV/RT = \frac{100 \times 10^3 \times 0.1}{8.3 \times 273}$

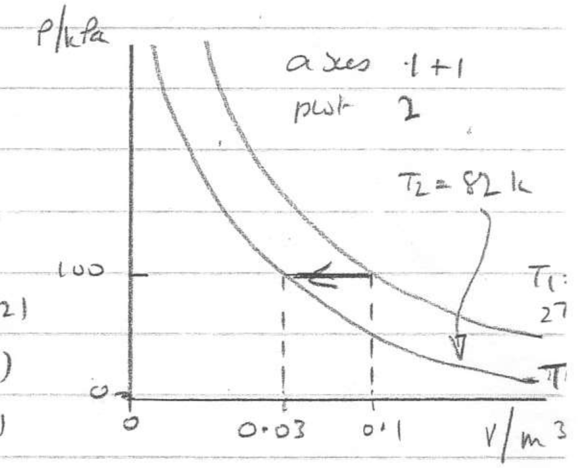
= 4.4 moles ①

then $\Delta Q = n C_V \Delta T = 4.4 \times 20 \times 100$ = 8,830 J ①

(c) work done $W = P \Delta V$ ① = 0 ① J

(d) $\Delta U = Q + W$ ① = 8,830 + 0 = 8,830 ① J (2)   (e) – – (4)   13

2. (a) See plot .... put in numbers later. (4)



(b) the temperature must fall (↓ KE of molecules, to allow gas to contract) (1)

(c) new volume ......er... hmm ... I'll have to think about this... is it 0.03 m³? (2)

(d) Work done .... $W = P\Delta V = 100 \times 10^3 \times (0.1 - 0.03)$

on gas = +7000 J (2)

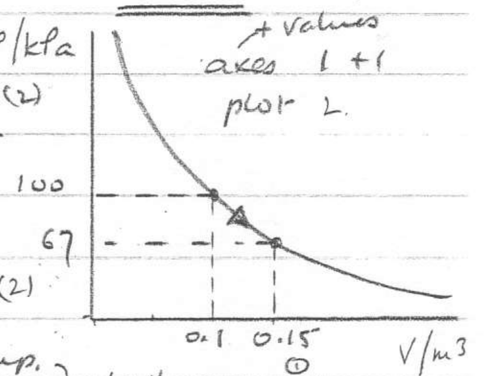
(e) Heat energy change $Q = n C_p \Delta T$ ① need ΔT

use V/T = konstant $\rightarrow V_1/T_1 = V_2/T_2 \rightarrow T_2 = V_2 \times T_1/V_1$ = 81.9 (82) K ① (3

So $Q = 4.4 \times 28 \times (273 - 82)$ = –23,530 ① Joules heat loss to contract

(f) Internal energy.... $\Delta U = Q + W$ = –23,530 + 7000 = 16,530 J (2)

3. (a) graph .... (4) (b) Gas needs heat energy ①



(c) PV = constant $\rightarrow P_1 V_1 = P_2 V_2 \rightarrow P_2 = \frac{P_1 V_1}{V_2}$ = 67 kPa (2)

(d) new Vol = er.... 0.15 m³(?) (2)

(e) Work done = area under graph = □ + ◺

$= (67 \times 10^3 \times 0.05) + (\frac{1}{2} \times 0.05 \times 33 \times 10^3)$ = –4200 J (2)

(g) + (f) You need to realize that $\Delta U = 0$ ① – since gas temp. is the same. ①

Since $\Delta U = Q + W \rightarrow Q = -W$ ① $= -(-4200)$ = +4200 J ie heat gained ① (4

4. C_p/C_v = 1.4 for oxygen .... so $C_p = 1.4 C_v$

But $C_p - C_v = R$ ① therefore $1.4 C_v - C_v = 8.3 \rightarrow C_v(1.4 - 1) = 8.3$

TLH
5.98
≈ 35 mins

So ... C_v = 20.8 J mole⁻¹ ①

So $C_p = R + C_v = 8.3 + 20.8$ = 29.1 ① J/mole