DPP SOLUTION

- **Subject – Physical Chemistry**
- **Chapter – Thermodynamics and Thermochemistry**

DPP No.- 04

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Question-

One mole of an ideal gas at 25°C expands in volume from 1.0 L to 4.0 L at constant temperature. What work (in J) is done if the gas expands against vacuum ($P_{external}$ = 0)?

$n = 1$

$T = 298\,K$

$V_1 = 1\,L$

$V_2 = 4\,L$

Isothermal

$w = -P_{ext}\Delta V$

(1) -4.0×10^2

(2) -3.0×10^2

(3) -1.0×10^2

(4) Zero

Ans. (4)

Question-

The maximum work obtained by an isothermal reversible expansion of 1 mole of an ideal gas at 27°C from 2.24 to 22.4 L is (R = 2 cal K^{-1} mol^{-1})

1. −1381.8cal
2. −600cal
3. −138.18cal
4. −690.9cal

$$W = -2.303 nRT \log \frac{V_2}{V_1}$$

$$= -2.303 \times 1 \times 2 \times 300 \log \frac{\cancel{22.4}^{10}}{\cancel{2.24}}$$

$$= \frac{-2.303 \times 600}{1000}$$

$$= -\frac{13818}{10} = -1381.8 \text{ Cal}$$

$n = 1$
$T = 300K$
$V_1 = 2.24 L$
$V_2 = 22.4 L$
$R = 2$ Cal $K^{-1} mol^{-1}$

Ans. (1)

Question-

2 mole of an ideal gas at 27°C expands isothermally and reversibly from a volume of 4 litres to 40 litres. The work done (in kJ) is:

Rev. iso

1. $w = -28.72$ kJ
2. $w = -11.488$ kJ
3. $w = -5.736$ kJ
4. $w = -4.988$ kJ

$n = 2$

$T = 300\,K$

$R \approx \frac{25}{3}\ J\,K^{-1}\,mol^{-1}$

$V_1 = 4\,L$

$V_2 = 40\,L$

$$\omega = -\frac{2.3 \times 2 \times 25 \times \cancel{300}^{100}}{\cancel{3}} \log \frac{\cancel{40}^{10}}{\cancel{4}}$$

$$= -\frac{23}{\cancel{10}} \times 500\cancel{0}\ J$$

$$= \frac{-23 \times 5\cancel{00}}{\cancel{1000}\,2}\ kJ = -11.5\ kJ$$

Ans. (2)

Question-

The work done on the system when one mole of an ideal gas at 500 K is compressed isothermally and reversibly to ½th of its original volume (R = 2 cal)

1. 500 kcal
2. 15.1 kcal
3. 25.03 kcal
4. 2.303 kcal

$n = 1$

$T = 500\ K$

$V_1 = V\ L$

$V_2 = \frac{V}{2}\ L$

Rev. iso. Compression.

$$w = 2.303 \times 1 \times 2 \times 500 \log \frac{V}{2 \times V}\ \text{Cal}$$

$$= \frac{2.303 \times 1000}{1000} \log \frac{1}{2}\ \text{KCal}$$

$$= 2.303 (\log 1 - \log 2)$$

$$= 2.303 \times -0.3\ \text{K Cal}$$

$$= -0.693\ \text{K Cal}$$

Ans. (4)

Question-

$1 dm^3 = 1 L$

The maximum work done in expanding 16 g oxygen at 300 K and occupying a volume of 5 dm³ isothermally until the volume becomes 25 dm³ is:

(1) -2.01×10^3 J

(2) 2.81×10^{-3} J

(3) 2.01×10^{-6} J

(4) -2.01×10^{-6} J

$w = ?$ $w_{O_2} = 16 g$ $T = 300 K$ $n_{O_2} = \frac{16}{32} = \frac{1}{2}$

$V_1 = 5 L$ $V_2 = 25 L$

$$W = -2.303 nRT \log \frac{V_2}{V_1}$$

$$= -2.303 \times \frac{1 \times 25 \times \cancel{300}^{100}}{2 \times 3} \log \frac{\cancel{25}^{5}}{\cancel{5}}$$

$$= -\frac{230.3 \times 25 \times 0.7}{2}$$

$$= -230.3 \times 8.75$$

$$= -2015.125$$

$$= -2.015 \times 10^3 J$$

Ans. (1)

Question-

Isothermal free expansion of an ideal gas correspond to

1. $q = 0$
2. $W = 0$
3. None of these
4. Both (1) and (2)

Ans. (4)

Question-

The temperature of 1 mole of a gas is increased by 1°C at constant pressure. The work done is:

1. $-R$
2. $2R$
3. $R/2$
4. $3R$

$n = 1$, $\Delta T = 1\,K$

$W = -P_{ext}\Delta V = -nR\Delta T$

$W = -1 \times R \times 1 = -R$

Ans. (1)

Question-

ΔU ΔH ω

The relation of internal energy, enthalpy and work done can be represented by

1. $\Delta E = \Delta H + W$
2. $\Delta E = W - \Delta H$
3. $\Delta H = \Delta E + W$
4. $W = \Delta E + \Delta H$

$\Delta H = \Delta U + \Delta n_g RT / nR\Delta T / P\Delta V$

$\Delta H = \Delta U + P\Delta V$

$\omega = -P\Delta V$

$\Delta H = \Delta U - \omega$

$\Delta U = \Delta H + \omega$

$\Delta U \downarrow \Delta E$

Ans. (1)

Question-

A gas expands isothermally against a constant external pressure of 1 atm from a volume of 10 dm^3 to a volume of 20 dm^3. It absorbs 800 J of thermal energy from its surroundings. The ΔU is

1. -312 J
2. $+123$ J
3. -213 J
4. $+231$ J

Iso. $P_{ext.} = 1atm$ $\quad V_1 = 10\,L, \quad V_2 = 20\,L$

$q = +800\,J \qquad \Delta U = q + w$

$w = -P\Delta V$
$= -1(20-10)$
$= -10\,L\,atm$
$= -10 \times 101.3\,J$
$= -1013\,J$

$\Delta U = q + w$
$= 800 - 1013$
$= -213\,J$

Ans. (3)

Question-

A system absorb 20 kJ heat and does 10 kJ work then internal energy of system will be-

1. Decreases by 10 kJ
2. Increases by 10 kJ
3. Increases by 30 kJ
4. Decreases by 30 kJ

$q = +20\ kJ$

$w = -10\ kJ$

$\Delta U = 20 - 10 = +10\ kJ$

Ans. (2)

Question-

5 mol of ideal gas expands isothermally and irreversibly from a pressure of 10 atm to 1 atm against constant external pressure of 1 atm work at 300 K will be

1. −15.921 kJ
2. −11.224 kJ
3. −110.83 kJ
4. None of these

$n=5$ iso. irr. exp.

$P_1 = 10 atm$

$P_2 = 1 atm$

$P_2 = 1 atm$

$T = 300K$

$w = -P_{ext}\Delta V$

$= -P_{ext}(V_2 - V_1)$

$= -P_2\left(\frac{nRT}{P_2} - \frac{nRT}{P_1}\right)$

$V_2 = \frac{nRT}{P_2}$

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

$w = -nRT\left(\frac{\cancel{P_2}}{\cancel{P_2}} - \frac{P_2}{P_1}\right)$

$w = -nRT\left(1 - \frac{P_2}{P_1}\right)$

$w = \frac{-5 \times 25 \times \cancel{300}^{100}}{\cancel{3}}\left(1 - \frac{1}{10}\right)$

$w = -1250\cancel{0}\left(\frac{\times 9}{1\cancel{0}}\right)$

$w = -11250\ J$

$w = -11.25\ kJ$

Ans. (2)

Question-

Which of the following is correct for free expansion of ideal gas under isothermal condition

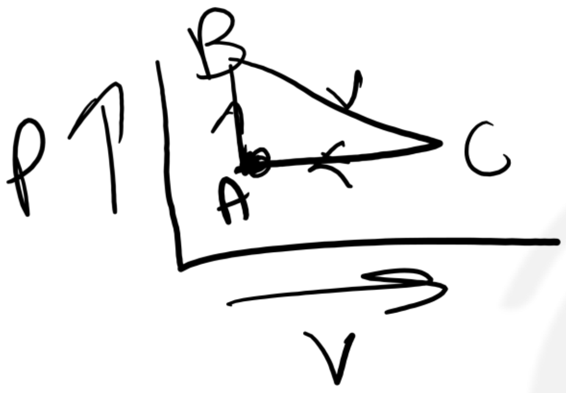
$q = 0$
$\Delta T = 0$
$w = 0$

1. $q = 0, \Delta T < 0, w < 0$
2. $q = 0, \Delta T = 0, w = 0$
3. $q \neq 0, \Delta T = 0, w = 0$
4. $q \neq 0, \Delta T = 0, w \neq 0$

Ans. (2)

Question-

Net work done by the system in a cyclic process is equal to:



1. Zero
2. ΔU
3. ΔH
4. q

$\Delta U = 0$

$\Delta U = q + w$

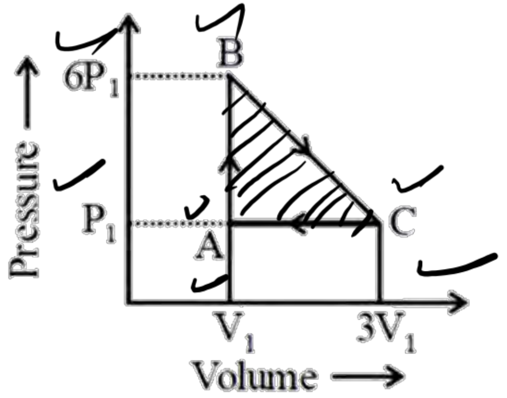
$|q| = |-w|$

$w = q$

Ans. (4)

Question-

An ideal gas is taken around the cycle ABCA as shown in P – V diagram. The net work done during the cycle is equal to:



1. $12P_1 V_1$
2. $6P_1 V_1$
3. $5P_1 V_1$
4. $P_1 V_1$

$W =$ Area of ΔABC

$W = \frac{1}{2} \times AC \times AB$

$= \frac{1}{\cancel{2}} \times \cancel{2}V_1 \times 5P_1$

$= 5P_1 V_1$

Ans. (3)

Question-

For monoatomic ideal gas, the exact value of the ratio of $C_{p,m}$ and $C_{v,m}$ is:

(1) 5/3

$$\gamma = \frac{C_{p,m}}{C_{v,m}} = \frac{\frac{5\cancel{R}}{\cancel{2}}}{\frac{3\cancel{R}}{\cancel{2}}} = \frac{5}{3} = 1.66$$

(2) 7/5

(3) 9/7

(4) 9/11

Ans. (1)

Question-

Molar heat capacity of water in equilibrium with ice at constant pressure is:

$C_{p,m} = s \times M_{H_2O}$

(1) Zero

(2) Infinity

(3) 40.45 kJ K^{-1} mol^{-1}

(4) 75.48 JK^{-1} mol^{-1}

$H_2O(l) \rightleftharpoons H_2O(s)$

Water $0^\circ C$ Ice $0^\circ C$

$q = m s \Delta T$

$s = \frac{q}{m \Delta T}$

$s = \frac{q}{0}$

$s = \infty$

$C_{p,m} = \infty$

Ans. (2)

Question-

How many calories are required to heat 40 grams of argon from 40°C to 100°C at constant volume? (R = 2cal/molK)

1. 120
2. 2400
3. 1200
4. 180

$q = ?$

$w_{Ar} = 40g$

$T_1 = 40^\circ C$

$T_2 = 100^\circ C$

$\Delta T = 60^\circ C = 60K$

$n_{Ar} = \frac{40}{40} = 1$

Ar

$C_{v,m} = \frac{3}{2}R$

$q_v = nC_{v,m}\Delta T = \Delta U$

$\Delta U = 1 \times \frac{3}{\cancel{2}} \times \cancel{2} \times 60$

$= 180$

Ans. (4)

Question-

4.48 L of an ideal gas at STP requires 12.0 calories to raise its temperature by 15°C at constant volume. The C_p of the gas is:

1. 3 cal
2. 4 cal
3. 7 cal
4. 6 cal

$V = 4.48\ L$ at STP

$q_v = 12\ Cal$, $\Delta T = 15^\circ C$

$\Delta U = n C_{v,m} \Delta T$

$12 = \frac{1}{5} C_{v,m} \times \cancel{15}^{3}$

$C_{v,m} = \frac{12}{3} = 4\ Cal$

$n = \frac{4.48}{22.4} = \frac{1}{5}$

$C_{p,m} = C_{v,m} + R$

$C_{p,m} = 4 + 2$

$= 6\ Cal$

Ans. (4)

Question-

Calculate the amount of heat required to raise the temperature of 5 g of iron from 25°C to 75°C . The specific heat capacity of iron is 0.45 J/g.

1. 112.1
2. 112.5
3. 112.9
4. 112

$q = ?$ $m = 5g$ $\Delta T = T_2 - T_1 = 75 - 25 = 50$

$s = 0.45\ J/g$

$q = m s \Delta T$

$= \frac{5 \times 0.45 \times 5\cancel{0}}{\cancel{100}\ 2}$

$= \frac{225}{2} = 112.5$

Ans. (2)

Question-

For two mole of an ideal gas

$C_{p,m} - C_{v,m} = R$

$C_p - C_v = nR$

$C_p - C_v = 2R$

1. $C_v - C_p = R$
2. $C_p - C_v = 2R$
3. $C_p - C_v = R$
4. $C_v - C_p = 2R$

Ans. (2)

Thank You...