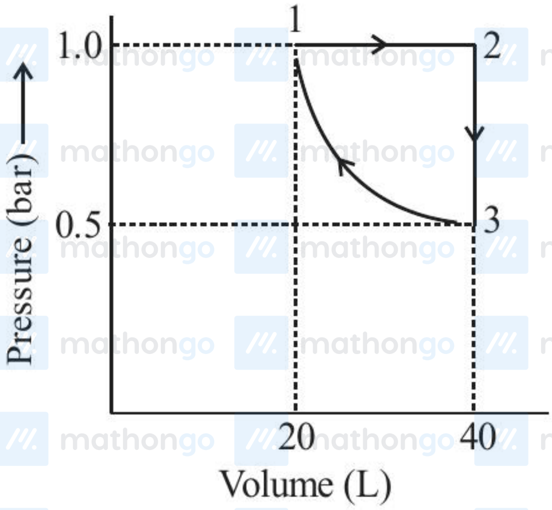
Q1 - 24 January - Shift 2

One mole of an ideal monoatomic gas is subjected to changes as shown in the graph. The magnitude of the work done (by the system or on the system) is ________ J (nearest integer).



Given : $\log 2 = 0.3$, $\ln 10 = 2.3$

Space for your notes:

Q2 - 25 January - Shift 1

An athlete is given 100 g of glucose ($C_6H_{12}O_6$) for energy. This is equivalent to 1800 kJ of energy. The 50% of this energy gained is utilized by the athlete for sports activities at the event. In order to avoid storage of energy, the weight of extra water he would need to perspire is_______g (Nearest integer)

Assume that there is no other way of consuming stored energy.

Given : The enthalpy of evaporation of water is 45 kJ mol^{-1}

Molar mass of C, H & O are 12. 1 and 16 g mol^{-1}.

Space for your notes:

Q3 - 25 January - Shift 2

28.0 L of CO_2 is produced on complete combustion of 16.8 L gaseous mixture of ethene and methane at 25ºC and 1 atm. Heat evolved during the combustion process is _________ kJ.

Given : $\Delta H_C (CH_4) = -900$ kJ mol^{-1}
$\Delta H_C (C_2H_4) = -1400$ kJ mol^{-1}

Space for your notes:

Q4 - 29 January - Shift 2

Which of the following relations are correct?

(A) $\Delta U = q + p\Delta V$ (B) $\Delta G = \Delta H - T\Delta S$

(C) $\Delta S = \frac{q_{rev}}{T}$ (D) $\Delta H = \Delta U - \Delta nRT$

Choose the most appropriate answer from the options given below :

(1) C and D only (2) B and C only

(3) A and B only (4) B and D only

Space for your notes:

Q5 - 30 January - Shift 1

When 2 litre of ideal gas expands isothermally into vacuum to a total volume of 6 litre, the change in internal energy is ______ J. (Nearest integer)

Space for your notes:

Q6 - 30 January - Shift 2

1 mole of ideal gas is allowed to expand reversibly and adiabatically from a temperature of 27°C. The work done is 3 kJ mol^{-1}. The final temperature of the gas is ________K (Nearest integer). Given C_v=20 J $mol^{-1}K^{-1}$.

Space for your notes:

Q7 - 31 January - Shift 1

The enthalpy change for the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$ is (-) ____________ kJ mol^{-1} (Nearest integer)

Given : $\Delta_{dis}H^o_{Cl_{2(g)}} = 240 kJmol^{-1}$.

$\Delta_{eg}H^o_{Cl_{(g)}} = -350 kJmol^{-1}$,

$\Delta_{hyd}H^o_{Cl^-_{(g)}} = -380 kJmol^{-1}$

Space for your notes:

Q8 - 31 January - Shift 2

Enthalpies of formation of $CCl_4(g), H_2O(g), CO_2(g)$ and $HCl(g)$ are $-105, -242, -394$ and -92 kJ mol^{-1} respectively. The magnitude of enthalpy of the reaction given below is ______ kJ mol^{-1} (nearest integer)

$$CCl_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 4HCl(g)$$

Space for your notes:

Q9 - 01 February - Shift 2

0.3 g of ethane undergoes combustion at 27°C in a bomb calorimeter. The temperature of calorimeter system (including the water) is found to rise by 0.5°C. The heat evolved during combustion of ethane at constant pressure is ________ kJ mol^{-1}. (Nearest integer)

[Given : The heat capacity of the calorimeter system is $20\ \text{kJ K}^{-1}$, $R = 8.3\ \text{JK}^{-1}\ \text{mol}^{-1}$.

Assume ideal gas behaviour.

Atomic mass of C and H are 12 and 1 g mol^{-1} respectively]

Space for your notes:

Answer Key

(As per Official NTA Key released on 2 Feb)

Q1 (620)	**Q2** (360)	**Q3** (925)	**Q4** (2)
Q5 (0)	**Q6** (150)	**Q7** (610)	**Q8** (173)
Q9 (1006)			

Q1 (620)

$1 \to 2 \Rightarrow$ Isobaric process

$2 \to 3 \Rightarrow$ Isochoric process

$3 \to 1 \Rightarrow$ Isothermal process

$$W = W_{1\to2} + W_{2\to3} + W_{3\to1}$$

$$= \left(-P(V_2 - V_1) + 0 \left[-P_1 V_1 \ln\left(\frac{V_2}{V_1}\right) \right] \right)$$

$$= \left[-1 \times (40 - 20) + 0 + \left[-1 \times 20 \ln\left(\frac{20}{40}\right) \right] \right]$$

$$= -20 + 20 \ln 2$$

$$= -20 + 20 \times 2.3 \times 0.3$$

$$= -6.2 \text{ bar L}$$

$$|W| = 6.2 \text{ bar l} = 620 \text{ J}$$

Q2 (360)

$C_6H_{12}O_6(s) + 6O_2 \rightarrow 6CO_2(g) + 6H_2O(l)$

Extra energy used to convert $H_2O(l)$ into $H_2O(l)$ into $H_2O(g)$

$$= \frac{1800}{2} = 900\text{kJ}$$

$$\Rightarrow \quad 900 = n_{H_2O} \times 45$$

$$n_{H_2O} = \frac{900}{45} = 20 \text{ mole}$$

$$W_{H_2O} = 20 \times 18 = 360 \text{ g}$$

Q3 (925)

Let, Volume of C_2H_4 is x litre

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

Initial $\quad x$
Final $\quad - \qquad\qquad 2x$

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Initial $\quad (16.8 - x)$
Final $\quad - \qquad\qquad (16.8 - x)$

Total volume of $CO_2 = 2x + 16.8 - x$

$$\Rightarrow \quad 28 = 16.8 + x$$

$$x = 11.2\ L$$

$$n_{CH_4} = \frac{PV}{RT} = \frac{1 \times 5.6}{0.082 \times 298} = 0.229 \text{ mole}$$

$$n_{C_2H_2} = \frac{11.2}{0.082 \times 298} = 0.458 \text{ mole}$$

$\therefore$ Heat evolved = 0.229 × 900 + 0.458 × 1400

= 206.1 + 641.2

= 847.3 kJ

Q4 (2)

Only (B) and (C) are correct.

(B) $G = H - TS$

At constant T

$\Delta G = \Delta H - T\Delta S$

(A) First law is given by

$\Delta U = Q + W$

If we apply constant P and reversible work.

$\Delta U = Q - P\Delta V$

(C) By definition of entropy change

$$dS = \frac{dq_{rev}}{T}$$

At constant T

$$\Delta S = \frac{q_{rev}}{T}$$

(D) $H = U + PV$

For ideal gas

$H = U + nRT$

At constant T

$\Delta H = \Delta U + \Delta nRT$

Q5 (0)

For ideal gas $U = f(T)$

and for isothermal process, $\Delta U = 0$

Q6 (150)

$$q = 0$$

$$\Delta U = w$$

$$1 \times 20 \times [T_2 - 300] = -3000$$

$$T_2 - 300 = -150$$

$$T_2 = 150\text{ K}$$

Q7 (610)

$$\frac{1}{2}Cl_{2(g)} \rightarrow Cl_{(g)} \rightarrow Cl^-_{(g)} \rightarrow Cl^-_{(aq.)}$$

$$\Delta H^o = \frac{1}{2} \times 240 + (-350) + (-380)$$

$$= -610\text{ ans.}$$

Q8 (173)

$$\Delta_r H = \Sigma H_p - \Sigma H_R$$

$$= (-394 + 4 \times -92) - (-105 + (2 \times -242))$$

$$= -173\text{ kJ/mol}$$

Q9 (1006)

(Bomb calorimeter → const volume

Heat released
By combustion of 1 mole

$$C_2H_6\ (\Delta U) = -\frac{20 \times 0.5}{0.3} \times 30 = -1000\ \text{kJ}$$

$$C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

$\Delta ng = 2 - (2 + 7/2) = -(7/2)$
$\Delta H = \Delta U + \Delta nRT$
$= -1000 - 7/2 \times 8.3 \times 300$ kJ

$= -1000 - 6.225$
$= -1006$ kJ
So heat released = 1006 kJ mol^{-1}