Q1 - 24 June - Shift 1

$2O_3(g) \rightleftharpoons 3O_2(g)$

At 300 K, ozone is fifty percent dissociated. The standard free energy change at this temperature and 1 atm pressure is (–) __J mol^{-1} (Nearest integer)

[Given: ln 1.35 = 0.3 and R = 8.3 J K^{-1} mol^{-1}]

Space for your notes:

Q2 - 24 June - Shift 2

The correct order of bound orders of C_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively.

(A) $C_2^{2-} < N_2^{2-} < O_2^{2-}$ (B) $O_2^{2-} < N_2^{2-} < C_2^{2-}$

(C) $C_2^{2-} < O_2^{2-} < N_2^{2-}$ (D) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

Space for your notes:

Q3 - 25 June - Shift 1

The standard entropy change for the reaction $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ is –550 JK^{-1} at 298 K.

[Given : The standard enthalpy change for the reaction is –165 kJ mol^{-1}]. The temperature in K at which the reaction attains equilibrium is _____. (Nearest Integer)

Space for your notes:

Q4 - 25 June - Shift 2

At 25°C and 1 atm pressure, the enthalpy of combustion of benzene (1) and acetylene (g) are –3268 kJ mol^{-1} and –1300 kJ mol^{-1}, respectively. The change in enthalpy for the reaction $3\ C_2H_2(g) \rightarrow C_6H_6(l)$, is

(A) + 324 kJ mol^{-1} (B) +632 kJ mol^{-1}

(C) – 632 kJ mol^{-1} (D) – 732 kJ mol^{-1}

Space for your notes:

Q5 - 26 June - Shift 1

For complete combustion of methanol

$$CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

the amount of heat produced as measured by bomb calorimeter is 726 kJ mol^{-1} at 27°C. The enthalpy of combustion for the reaction is –x kJ mol^{-1}, where x is _____. (Nearest integer)

(Given : R = 8.3 JK^{-1} mol^{-1})

Space for your notes:

Q6 - 26 June - Shift 2

CNG is an important transportation fuel. When 100 g CNG is mixed with 208 oxygen in vehicles, it leads to the formation of CO_2 and H_2O and produces large quantity of heat during this combustion, then the amount of carbon dioxide, produced in grams is_____. [nearest integer]

[Assume CNG to be methane]

Space for your notes:

Q7 - 26 June - Shift 2

A fish swimming in water body when taken out from the water body is covered with a film of water of weight 36 g. When it is subjected to cooking at 100°C, then the internal energy for vaporization in kJ mol^{-1} is _____. [nearest integer]

[Assume steam to be an ideal gas. Given $A_{vap}H^{\ominus}$ for water at 373 K and 1 bar is 41.1 kJ mol^{-1} ; R = 8.31 $JK^{-1}mol^{-1}$]

Space for your notes:

Q8 - 26 June - Shift 2

40° of HI undergoes decomposition to H_2 and I_2 at 300 K. $\Delta G^{\ominus}$ for this decompostion reaction at one atmosphere pressure is_____ J mol^{-1}. [nearest integer]

(Use R = 8.31 J K^{-1} mol^{-1}; log 2 = 0.3010. In 10 = 2.3, log 3 = 0.477)

Space for your notes:

Q9 - 27 June - Shift 1

Match List-I with List-II

	List-I	List-II
(A)	Spontaneous process	(I) $\Delta H < 0$
(B)	Process with $\Delta P = 0$, $\Delta T = 0$	(II) $\Delta G_{T,P} < 0$
(C)	$\Delta H_{reaction}$	(III) Isothermal and isobaric process
(D)	Exothermic process	(IV) [Bond energies of molecules in reactants] - [Bond energies of product molecules

Choose the correct answer from the options given below:

(A) (A) – (III), (B) – (II), (C) – (IV), (D) – (I)

(B) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)

(C) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

(D) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

Space for your notes:

Q10 - 27 June - Shift 2

When 5 moles of He gas expand isothermally and reversibly at 300 K from 10 litre to 20 litre, the magnitude of the maximum work obtained is ____ J. [nearest integer] (Given: R = 8.3 J $K^{-1}mol^{-1}$ and log 2 = 0.3010)

Space for your notes:

Q11 - 28 June - Shift 1

4.0 L of an ideal gas is allowed to expand isothermally into vacuum until the total volume is 20 L. The amount of heat absorbed in this expansion is _____ L atm.

Space for your notes:

Q12 - 28 June - Shift 2

For combustion of one mole of magnesium in an open container at 300 K and 1 bar pressure, $\Delta_C H^{\ominus}$ = –601.70 kJ mol^{-1}, the magnitude of change in internal energy for the reaction is _____ kJ. (Nearest integer)

(Given : R = 8.3 J K^{-1} mol^{-1})

Space for your notes:

Q13 - 29 June - Shift 1

17.0 g of NH_3 completely vapourises at – 33.42°C and 1 bar pressure and the enthalpy change in the process is 23.4 kJ mol^{-1}. The enthalpy change for the vapourisation of 85 g of NH_3 under the same conditions is _____ kJ.

Space for your notes:

Q14 - 29 June - Shift 2

2.2 g of nitrous oxide (N_2O) gas is cooled at a constant pressure of 1 atm from 310 K to 270 K causing the compression of the gas from 217.1 mL to 167.75 mL. The change in internal energy of the process, ΔU is '–x' J. The value of 'x' is __.

[nearest integer]

(Given: atomic mass of N = 14 g mol^{-1} and of O = 16 g mol^{-1}.

Molar heat capacity of N_2O is 100 JK^{-1} mol^{-1})

Space for your notes:

Answer Key

Q1 (747) **Q2** (C) **Q3** (300) **Q4** (C)

Q5 (727) **Q6** (143) **Q7** (38) **Q8** (2735)

Q9 (B) **Q10** (8360) **Q11** (0) **Q12** (600)

Q13 (117) **Q14** (195)

Q1 (747)

$$2O_3 \rightleftharpoons 3O_2(g)$$

$$\frac{2}{5} \qquad \frac{3}{5}$$

$$k_p = \frac{P_{O_2}^3}{P_{O_3}^2}$$

$$k_p = 1.35$$

$$\Delta G^\circ = -RT \ln k_p$$

$$= -8.3 \times 300 \times \ln 1.35$$

$$= -747 \text{ J/mol}$$

Q2 (C)

$$C_2H_6(g) + \frac{7}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$$

$$\Delta_C H(C_2H_6) = 2\Delta_f H\, CO_2(g) + 3\Delta_f H(H_2O,\ell)$$

$$- \Delta_f H(C_2H_6,g)$$

$$-1560 = 2(-394) + 3\,(-286) - \Delta_f H(C_2H_6,g)$$

$$\Delta_f H(C_2H_6,g) = -86 \text{ kJ/mole}$$

Q3 (300)

$\Delta G = \Delta H - T\Delta S = 0$ at equilibrium

$\Rightarrow -165 \times 10^3 - T \times (-505) = 0$

$\Rightarrow T = 300K$

The answer is 300

Q4 (C)

$\Delta H = \sum \Delta H_{Combustion}$ (Reactant) - $\sum \Delta H_{Combustion}$ (Product)

$= 3 \times (-1300) - [-3268]$

$= -632$ kJ mol^{-1}

Q5 (727)

$\Delta U = -726$ KJ/mol

$\Delta ng = 1 - 3/2 = \frac{-1}{2}$

$\Delta H = \Delta U + \Delta ngRT$

$= -726 - \frac{1}{2} \times \frac{8.3 \times 300}{1000}$

$= -727.245$

Q6 (143)

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

Mole	$\frac{100}{16}$	$\frac{208}{32}$	
	$= 6.25$	$= 6.5$	
$\frac{\text{Mole}}{\text{Stoi. Coeff.}}$	$\frac{6.25}{1}$	$\frac{6.5}{2}$	$= 3.25$

So, O_2 is limiting reagent

Mole – Mole analysis

$$\frac{n_{O_2}}{2} = \frac{n_{co_2}}{1}$$

$$\frac{6.5}{2} = n_{co_2}$$

$$\text{Mass of } CO_2 = \frac{6.5}{2} \times 44 = 143 \text{ gm}$$

Q7 (38)

$$H_2O\ (l) \rightarrow H_2O(g)$$

$$n = \frac{36}{18} = 2 \text{ mol}$$

$$\Delta U = \Delta H - \Delta n_g RT$$

$$= 41.1 - \frac{1 \times 8.31 \times 373}{1000} \text{kJ/mol}$$

$$= 38 \text{ kJ/mol}$$

Q8 (2735)

$$HI \rightleftharpoons \frac{1}{2}H_2 + \frac{1}{2}I_2$$

t_i 1

teq $1-0.4$ $\frac{0.4}{2}$ $\frac{0.4}{2}$

$$K_p = \frac{(0.2)^{\frac{1}{2}}(0.2)^{\frac{1}{2}}}{1-0.4} = \frac{0.2}{0.6} = \frac{1}{3}$$

$$\Delta G = \Delta G^\circ + RT \ln K = 0$$

$$\Delta G^\circ = -RT \ln K \Rightarrow -8.31 \times 300 \times 2.3 \times \log\left(\frac{1}{3}\right)$$

$= 2735$ J/mol

Q9 (B)

(A) For a spontaneous process $\Delta G_{T,P} < 0$

(B) $\Delta P = 0 \rightarrow$ Isobaric process

$\Delta T = 0 \rightarrow$ Isothermal process

(C) $\Delta H_{reaction}$ = (Σ Bond energies of reactants) -

(Σ bond energies of products)

(D) $\Delta H < 0$ is for exothermic reaction

Q10 (8360)

$$n = 5\ mol$$

$$T = 300\ K$$

$$V_1 = 10\ L$$

$$V_2 = 20\ L$$

$$w = -nRT\ell n\frac{V_2}{V_1}$$

$$= -5 \times 8.3 \times 300 \times \ell n\frac{20}{10}$$

$$= -8630.38\ J$$

Q11 (0)

For free expansion: $P_{ext} = 0$, $w = P_{ext}(-) = 0$, $w = 0$

$q = 0$, $\Delta U = 0$ $q = 0$, $\Delta U = 0$

Ans. 0

Q12 (600)

$$Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$$

$$\Delta H = \Delta U + \Delta n_g RT$$

$$-601.70 \times 10^3 = \Delta U - \frac{1}{2} \times 8.3 \times 300$$

$$-601.70\,kJ = \Delta U - 1.245\,kJ$$

$$\Delta U = -600.455\,kJ$$

Ans. 600

Q13 (117)

Given data is for 1 moles and asked for 5 moles so
value is 23.4 × 5 = 117 kJ

Q14 (195)

$$N_2O \text{ moles} = \frac{2.2}{44} = \frac{1}{20}$$

$$\Delta H = nC_p\Delta T = \frac{1}{20} \times 100(-40) = -200J$$

$$\Delta U = q_p + w$$

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

$$W = -1\frac{(167.75 - 217.1)}{1000} \times 101.3J$$

$$w = +5J$$

$$\Delta U = -200 + 5 = -195J$$