2020

CHEMISTRY (Honours)

Paper Code : III - A & B

[New Syllabus]

Important Instructions
for Multiple Choice Question (MCQ)

- Write Subject Name and Code, Registration number, Session and Roll number in the space provided on the Answer Script.

  Example : Such as for Paper III-A (MCQ) and III-B (Descriptive).

  Subject Code : | III | A | & | B |

  Subject Name :

- Candidates are required to attempt all questions (MCQ). Below each question, four alternatives are given [i.e. (A), (B), (C), (D)]. Only one of these alternatives is 'CORRECT' answer. The candidate has to write the Correct Alternative [i.e. (A)/(B)/(C)/(D)] against each Question No. in the Answer Script.

  Example — If alternative A of 1 is correct, then write :
  1. — A

- There is no negative marking for wrong answer.

মাল্টিপল চয়েস প্রশ্নের (MCQ) জন্য জরুরী নির্দেশাবলী

- উত্তরপত্রে নির্দেশিত স্থানে বিষয়ের (Subject) নাম এবং কোড, রেজিস্ট্রেশন নম্বর, সেশন এবং রোল নম্বর লিখতে হবে।

  উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

  Subject Code : | III | A | & | B |

  Subject Name : [ ]

- পরীক্ষার্থীদের সবগুলি প্রশ্নের (MCQ) উত্তর দিতে হবে। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে তার উত্তরের স্বপক্ষে (A) / (B) / (C) / (D) সঠিক বিকল্পটিকে প্রশ্ন নম্বর উল্লেখসহ উত্তরপত্রে লিখতে হবে।

  উদাহরণ — যদি **1** নম্বর প্রশ্নের সঠিক উত্তর **A** হয় তবে লিখতে হবে :

  1. — A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।

Paper Code : III - A

Full Marks : 10 Time : Twenty Minutes

Answer *all* the Questions.

Choose the Correct Answer.

Each Question Carries 1 Mark.

1. Which of the following properties is an extensive property?

   (i) Specific heat

   (ii) Heat capacity

   (iii) Viscosity coefficient

   (iv) Surface tension

2. $\left(\frac{\partial S}{\partial P}\right)_T =$

   (i) $-\left(\frac{\partial V}{\partial T}\right)_P$

   (ii) $\left(\frac{\partial V}{\partial T}\right)_P$

   (iii) $-\left(\frac{\partial P}{\partial T}\right)_V$

   (iv) $\left(\frac{\partial P}{\partial T}\right)_V$

3. ΔG_{mixing} for two ideal gases vs mole fraction plot —

(i) passes through a maximum

(ii) passes through a minimum

(iii) is parallel to mole fraction axis

(iv) is parabola

4. Which is not true for an ideal gas —

(i) $\left(\frac{\partial E}{\partial V}\right)_T = 0$

(ii) $\left(\frac{\partial H}{\partial P}\right)_T = 0$

(iii) $\left(\frac{\partial E}{\partial T}\right)_V = 0$

(iv) $\left[\frac{\partial (PV)}{\partial P}\right]_T = 0$

5. The square of average velocity $< v_x >$ for a collection of gas molecules obeying Maxwell's velocity distribution is —

(i) $\left(\frac{8kT}{\pi m}\right)$

(ii) $\left(\frac{kT}{m}\right)$

(iii) 0

(iv) $\left(\frac{3kT}{m}\right)$

6. The Boyle temperature for a van der Waals' gas is —

(i) $\dfrac{a}{2Rb}$

(ii) $\dfrac{a}{Rb}$

(iii) $\dfrac{a}{3Rb}$

(iv) $\dfrac{8a}{3Rb}$

7. The excess pressure inside an air cavity in water is —

(i) $\dfrac{\gamma}{r}$

(ii) $\dfrac{4\gamma}{r}$

(iii) $\dfrac{3\gamma}{r}$

(iv) $\dfrac{2\gamma}{r}$

8. If K_1 and K_2 are equilibrium constants for a given exothermic reaction at temperatures T_1 and T_2 where $T_1 < T_2$, the relation between K_1 and K_2 is —

(i). $K_1 < K_2$

(ii). $K_1 > K_2$

(iii). $K_1 = K_2$

(iv). $K_1 \le K_2$

9. At constant temperature the viscosity of a gas depends on pressure (P) as

(i) $\eta \propto P^{1/2}$

(ii) $\eta \propto P$

(iii) η is independent of pressure

(iv) $\eta \propto P^2$

10. The expression for efficiency (η) for a Carnot refrigerator is —

(i) $1\Big/\left(\frac{T_{hot}}{T_{cold}}-1\right)$

(ii) $1-\left(\frac{T_{cold}}{T_{hot}}\right)$

(iii) $1\Big/\left(\frac{T_{hot}}{T_{cold}}+1\right)$

(iv) $\left(\frac{T_{hot}}{T_{cold}}-1\right)$

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CHEMISTRY (Honours)

Paper Code : III - B

[New Syllabus]

Full Marks : 40 Time : One Hour Forty Minutes

The figures in the margin indicate full marks.

Answer any *four* questions taking *two* from each group.

Group - A

1. (a) Starting from Maxwell's velocity distribution in 1 dimension, arrive at the speed distribution function in 2 dimensions. 4

   (b) Explain why the C_v-value for N_2 is always found to be less than that of Cl_2 at ordinary temperature. 2

   (c) The viscosity coefficient of gaseous CO_2 at 27°C is 15×10^{-4} poise. Find the molecular diameter. 4

2. (a) Write down the virial equation of state. Recast the van der Waals' equation as an expansion in terms of 1/V (here, V is the molar volume) and hence predict the second virial coefficient according to it. 1+1+1

   (b) The second virial coefficient of a gas is 13.7 lit mol^{-1} at 273K. Calculate the molar volume of the gas at N.T.P. 2

   (c) Draw the Andrews isotherms for a real gas at different temperatures and identify T_C and $\overline{V}_C$ on the diagram. 2

(d) The behavior of two gases A and B can be approximated by van der Waals' equation. The critical constants of these gases are given below :

Gas	Pc/atm	Vc/cm^{3}mol^{-1}	Tc/K
A	81.5	81.0	324.7
B	2.26	57.76	5.21

Explain :

(i) Which gas has greater intermolecular force of attraction.

(ii) Which gas obeys more closely the van der Waals' equation at critical state? 3

3. (a) Calculate $q, w, \Delta U, \Delta H$ for reversible isothermal expansion at 300K of 5 moles of an ideal gas from 500ml to 1500ml. What would be the w and ΔU if the expansion occurs between the same initial and final states as before, but is done by expanding the gas in vacuum? 4

(b) Give a physical reason of the fact that adiabatic P-V curve of an ideal gas is steeper than the corresponding isothermal curve. Depict it graphically. 3

(c) Show that the work done in a reversible process is numerically greater than that in an irreversible process. 3

4. (a) The heat of formation of NH_3 at 298K is –11.0 cal mol^{-1}. Calculate the heat of reaction,

$N_2 + 3H_2 \rightarrow 2NH_3$ at 400K.

Given : $C_P(N_2) = 6.5 + 10^{-3}\text{T}$ cal mol^{-1}K^{-1},

$C_P(\text{H}_2) = 6.5 + 9\times10^{-4}\text{T}$ cal mol^{-1}K^{-1},

$C_P(\text{NH}_3) = 8.04 + 7\times10^{-4}\text{T} + 5.1\times10^{-6}\text{T}^2$ cal mol^{-1}K^{-1}. 4

(b) Show that for an ideal gas $C_P - C_V = \left[\left(\frac{\partial E}{\partial V}\right)_T + P\right]\left(\frac{\partial V}{\partial T}\right)_P$. 3

(c) A gas is suspected to be Neon or Nitrogen. When a given sample of the gas at 25°C expanded adiabatically from 5 lit to 6 lit, the temperature came down to 4°C. What was the gas? 3

Group - B

5. (a). Prove that $\oint \frac{dq}{T} \leq 0$ and from this expression show that $ds \geq \frac{dq}{T}$. 4

(b) Show that $\mu_{JT} = V(\alpha T - 1)/C_P$, where μ_{JT} is the Joule-Thomson coefficient and α is the temperature coefficient of volume expansion. 3

(c) Derive the relation : $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$ 3

6. (a) Show that $\left(\frac{\partial(G/T)}{\partial(1/T)}\right)_P$ is a state function. 4

(b) Under what conditions is $\Delta S < 0$ for a spontaneous process? 2

(c) Show that $C_P - C_V = \frac{VT}{\beta}\alpha^2$ where, $\alpha =$ coefficient of thermal expansion, $\beta =$ coefficient of compression of gas. 4

7. (a) At 25°C for the reaction : $Br_2(g) = 2Br(g)$, we have $\Delta G^0 = 161.67$ kJ/mol and $\Delta H^0 = 192.81$ kJ/mol. At what temperature will the system contain 10 mol per cent bromine atoms in equilibrium with bromine vapor at $P = 1$ atm. 4

(b) Establish the relation between K_p and K_x. 2

(c) If ξ is the degree of advancement of chemical reaction, then at equilibrium $\left(\frac{\partial G}{\partial \xi}\right)_{P,T} = 0$. Justify. 2

(d) Determine the effect of introducing an inert gas, keeping pressure of the system constant, on the position of the equilibrium of the following reaction: 2

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

8. (a) A steel ball of density 7.9 gm/cc and 4mm diameter requires 55 sec to fall a distance of 1 meter through a liquid of density 1.10gm/cc. Calculate the coefficient of viscosity of the liquid. 3

(b) A spherical air bubble is created within a liquid of surface tension 72 dyne/cm. if the volume of the bubble is $\pi/6$ cm^3, calculate the excess pressure inside the bubble. 3

(c) Comment on the temperature dependence of viscosity coefficients of gases and liquids. Can the mechanisms of flow of the two be interpreted from the character of these temperature dependence? 4