Gaseous State & Thermodynamics & Equilibrium

1. 0.5 moles of gas A and x moles of gas B exert a pressure of $200 Pa$ in a container of volume $10\ m^3$ at $1000\ K$.
   Given R is the gas constant in $JK^{-1}\ mol^{-1}$, x is:

   A. $\dfrac{2R}{4+12}$

   B. $\dfrac{2R}{4-R}$

   C. $\dfrac{4-R}{2R}$

   D. $\dfrac{4+R}{2R}$

2. The volume of gas A is twice than that of gas B. The compressibility factor of gas A is thrice than that of gas B at same temperature. The pressures of the gases for equal number of moles are:

   A. $2P_A = 3P_B$

   B. $2P_A = 3P_B$

   C. $P_A = 2P_B$

   D. $3P_A = 2P_B$

3. An open vessel at 27°C is heated until two fifth of the air (assumed as an ideal gas) in it has escaped from the vessel. Assuming that the volume of the vessel remains constant, the temperature at which the vessel has been heated is:

   A. 750°C

   B. 500°C

   C. 750 K

   D. 500 K

4. Consider the van der Waals constants, a and b, for the following gases.

Gas	Ar	Ne	Kr	Xe
a (atm $dm^6\ mol^{-2}$)	1.3	0.2	5.1	4.1
b ($10^{-2} dm^3 mol^{-1}$)	3.2	1.7	1.0	5.0

    Which gas is expected to have the highest critical temperature?

    A. Xe

    B. Ne

    C. Kr

    D. Ar

5. At a given temperature T, gases Ne, Ar, Xe and Kr are found to deviate from ideal gas behaviour. Their equation of state is given as $P = \dfrac{RT}{V - b}$ at T. Here, b is the van der Waals constant. Which gas will exhibit steepest increase in the plot of Z (compression factor) vs P?

    A. Kr

    B. Ar

    C. Xe

    D. Ne

6. Consider the following table:

Gas	$a\ (kPa\ dm^6\ mol^{-2})$	$b\ (dm^3\ mol^{-1})$
A	642.32	0.05196
B	155.21	0.04136
C	431.91	0.05196
D	155.21	0.4382

a and b are vander waals constant. The correct statement about the gases is:

A. Gas C will ocupy lesser volume than gas A; gas B will be lesser compressible than gas D

B. Gas C will occupy more volume than gas A; gas B will be lesser compressible than gas D

C. Gas C will occupy more volume than gas A; gas B will be more compressible than gas D

D. Gas C will occupy lesser volume than gas A; gas B will be more compressible than gas D

7. Points I, II and III in the following plot respectively correspond to u_{mp} (most probable velocity).
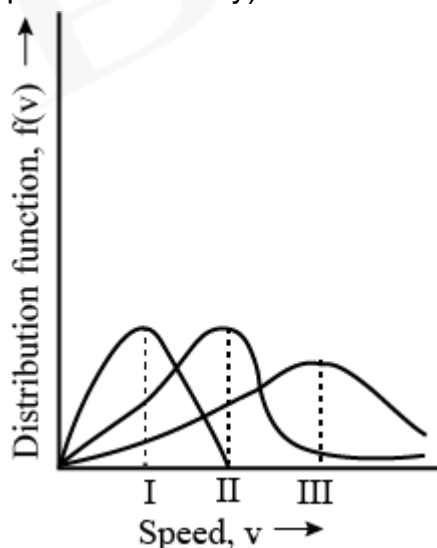
Choose the correct order in increasing order of their most probable velocity.

A. u_{mp} of $N_2(300K)$; u_{mp} of $H_2(300K)$; u_{mp} of $O_2(400K)$

B. u_{mp} of $H_2(300K)$; u_{mp} of $N_2(300K)$; u_{mp} of $O_2(400K)$

C. u_{mp} of $O_2(300K)$; u_{mp} of $N_2(300K)$; u_{mp} of $H_2(400K)$

D. u_{mp} of $N_2(300K)$; u_{mp} of $O_2(400K)$; u_{mp} of $H_2(300K)$

8. Which one of the following statements is incorrect?

   A. Bond dissociation enthalpy of H_2 is highest among diatomic gaseous molecules which contain a single bond

   B. Atomic hydrogen is produced when H_2 molecules at a high temperature are irradiated with UV radiation

   C. At around $2000\ K$, the dissociation of dihydrogen into its atoms is nearly 8.1%

   D. Dihydrogen is produced on reacting zinc with HCl as well as $NaOH\ (aq)$

9. The incorrect expression among the following is:

   A. For isothermal process $w_{reversible} = -nRT\ ln\dfrac{V_f}{V_i}$

   B. $\dfrac{\Delta G_{system}}{\Delta S_{Total}} = -T_{(at\ constant\ P)}$

   C. $lnK = \dfrac{\Delta H^o - T\Delta S^o}{RT}$

   D. $K = e^{-\Delta G^o/RT}$

10. Enthalpy of sublimation of iodine is $24\ cal\ g^{-1}$ at 200^0C. If specific heat $I_2(s)$ and $I_2(vap)$ are $0.055\ and\ 0.031\ cal\ g^{-1}K^{-1}$ respectively, then enthalpy of sublimation of iodine $250^0C\ in\ cal\ g^{-1}$ is :

    A. 2.85

    B. 5.7

    C. 22.8

    D. 11.4

11. For silver, $C_p(JK^{-1}mol^{-1}) = 23 + 0.01T$. If the temperature (T) of moles of silver is raised from 300 K to 1000K at 1 atm pressure, the value of ΔH will be close to:

    A. 62 kJ

    B. 16 kJ

    C. 21 kJ

    D. 13 kJ

12. The enthalpy change on freezing of 1 mol of water at 5^0C is ice at -5^0C is :

    (Given$\Delta_{fus}H = 6kJ\ mol^{-1}\ at\ 0^0C$,

    $C_p(H_2O, 1) = 75.3Jmol^{-1}K^{-1}$

    $C_p(H_2O, s) = 36.8J\,mol^{-1}K^{-1}$))

    A. $5.44\,kJ\,mol^{-1}$

    B. $5.81\,kJ\,mol^{-1}$

    C. $6.56\,kJ\,mol^{-1}$

    D. $6.00\,kJ\,mol^{-1}$

13. A gas undergoes change from state A to state B. In this process, the heat absorbed and work done by the gas is 5J and 8J, respectively. Now gas is brought back at A by another process during which 3J of heat is evolved. In this reverse process of B to A:

    A. 10 J of the work will be done by the gas.

    B. 6 J of the work will be done by the gas.

    C. 10 J of the work will be done by the surrounding on gas.

   D. 6 J of the work will be done by the surrounding on gas

14.
$$q_{AB} = 2kJ/mol$$
$$\Delta U_{BC} = -5kJ/mol$$
$$W_{AB} = -5kJ/mol$$
$$W_{CA} = 3kJ/mol$$

Heat absorbed by the system during process CA is:

    A. $-5kJ \ mol^{-1}$

    B. $+5kJ \ mol^{-1}$

    C. $18kJ \ mol^{-1}$

    D. $-18kJ \ mol^{-1}$

15. The equilibrium constant at 298K for a reaction $A + B \rightleftharpoons C + D$ is 100. If the initial concentration of all the four species were 1 M each, then equilibrium concentration of D (in $mol L^{-1}$) will be.

    A. 0.818

    B. 1.818

    C. 1.182

    D. 0.182

16. Two solids dissociated as follows

$$A(s) \rightleftharpoons B(g) + C(g); K_{P1} = x \ atm^2$$
$$D(s) \rightleftharpoons C(g) + E(g); K_{P2} = x \ atm^2$$
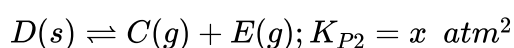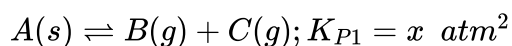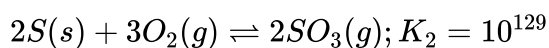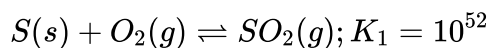
The total pressure when both the solids dissociate simultaneously is:

    A. $x^2 + y^2$

    B. $\sqrt{x^2 + y^2}$

    C. $2(\sqrt{x + y})$

    D. $\sqrt{x + y}$

17. For the following reactions, equilibrium constants are given:

$S(s) + O_2(g) \rightleftharpoons SO_2(g); K_1 = 10^{52}$

$2S(s) + 3O_2(g) \rightleftharpoons 2SO_3(g); K_2 = 10^{129}$
Find the equilibrium constant for
$2SO_2 + O_2(g) \rightleftharpoons 2SO_3(g); K_3$
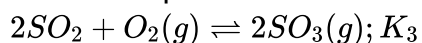
    A. 10^{181}

    B. 10^{154}

    C. 10^{25}

    D. 10^{77}

18. An acid buffer is obtained on mixing :

    A. 100 mL of 0.1 M CH_3COOH and 200 mL of 0.1 M $NaOH$

    B. 100 mL of 0.1 M CH_3COOH and 100 mL of 0.1 M $NaOH$

    C. 100 mL of 0.1 M HCl and 200 mL of 0.1 M CH_3COONa

    D. 100 mL of 0.1 M HCl and 200 mL of 0.1 M $NaCl$

19. Arrange the following solutions in the decreasing order of pOH
    (A) 0.01 M HCl
    (B) 0.01 M $NaOH$
    (C) 0.01 M CH_3COONa
    (D) 0.01 M $NaCl$

    A. $(A) > (C) > (D) > (B)$

    B. $(B) > (D) > (C) > (A)$

    C. $(B) > (C) > (D) > (A)$

    D. $(A) > (D) > (C) > (B)$

20. Th solubilty of $Ca(OH)_2$ in water is :

[Given : The solubility product of $Ca(OH)_2$ in water 5.5×10^{-6}]

   A. 1.77×10^{-6}

   B. 1.11×10^{-6}

   C. 1.11×10^{-2}

   D. 1.77×10^{-2}

21. A home owner uses $4.00 \times 10^3 \ m^3$ of methane (CH_4) gas, (assume (CH_4) is an ideal gas) in a year to heat his home. Under the pressure of $1.0 \ atm$ and $300 \ K$, mass of gas used is $x \times 10^5 \ g$. The value of x is_____.(Nearest integer)

   (Given $R = 0.083 \ L \ atm \ K^{-1} \ mol^{-1}$)

22. The pressure exerted by a non- reactive gaseous mixture of $6.4 \ g$ of methane and $8.8 \ g$ of carbon dioxide in a $10 \ L$ vessel at $27°C$ is _____kPa (Round off to the Nearest Integer).

   [Assume gases are ideal, $R = 8.314 \ J \ mol^{-1} \ K^{-1}$

   Atomic masses : $C = 12.0 \ u$, $H : 1.0 \ u$, $O : 16.0 \ u$]

23. An LPG cylinder contains gas at a pressure of $300 \ kPa$ at $27°C$. The cylinder can withstand the pressure of $1.2 \times 10^6 \ Pa$. The room in which the cylinder is kept catches fire. The minimum temperature at which the bursting of cylinder will take place is _____ $°C$. (Nearest Integer)

24. For water at $100°C$ and 1 bar,

   $\Delta H_{vap} - \Delta U_{vap}$ is $x \times 10^2 J \ mol^{-1}$

   The value of x (Round off to the Nearest Integer) is

   [Use : $R = 8.31 \ mol^{-1} K^{-1}$]

   [Assume volume of $H_2O(l)$ is much smaller than volume of $H_2O(g)$. Assume $H_2O(g)$ can be treated as an ideal gas]

25. For water $\Delta_{vap}H = 41 kJ \, \text{mol}^{-1}$ at $373 \, K$ and 1 bar pressure. Assuming that water vapour is an ideal gas the that occupies a much larger volume than liquid water, the internal energy change during evaporation of water is ___ $kJ \, \text{mol}^{-1}$.
[Use : $R = 8.3 \, J \, \text{mol}^{-1} K^{-1}$]

26. 200 mL of $0.2 \, M \, HCl$ is mixed with 300 mL of $0.1 \, M \, NaOH$. The molar heat of neutralization of this reaction is $-57.1 \, kJ$. The increase in temperature in ^{o}C of the system on mixing is $x \times 10^{-2}$. The value of x is (Nearest integer)
[Given: Specific heat of water = 4.18 J $g^{-1} \, K^{-1}$ Density of water = 1.00 g cm^{-3}]
[Assume no volume change on mixing]

27. Assuming that $Ba(OH)_2$ is completely ionised in aqueous solution under the given conditions the concentration of H_3O^+ ions in 0.005 M acqueous solution of $Ba(OH)_2$ at $298K$ is _____ $\times 10^{-12} mol \, L^{-1}$. (Nearest integer)

28. Sulphurous acid (H_2SO_3) has $K_{a1} = 1.7 \times 10^{-2}$ and $Ka2 = 6.4 \times 10^{-8}$. The pH of $0.588 \, M \, H_2SO_3$ is _____ (Round off to the Nearest Integer).

29. Value of f K_p for the equilibrium reaction

$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ at 288 K is 47.9. The K_C for this reaction at same temperature is ....(Nearest integer)

$(R = 0.083 L bar K^{-1} mol^{-1})$

30. For the reaction $A(g) \rightleftharpoons B(g) \, at \, 495K, \quad \Delta rG^o = -9.478 \, kJmol^{-1}$. If we start reaction in a closed container at 495 K with 22 millimoles of A, the amount of B is the equilibrium mixture is .....millimoles. (Round off to the Nearest integer). [R8.314$J \, mol^{-1}K^{-1}$;]~ln10=2.303]