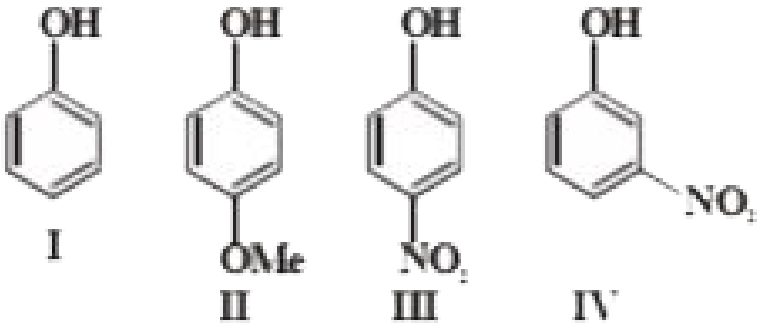
CHEMISTRY

BOOKS - KVPY PREVIOUS YEAR

QUESTION PAPER 2020

Part I Chemistry

1. The acidity of



Follows the order

A. $I > II > III > IV$

B. $IV > III > II > I$

C. $III > IV > I > II$

D. $III > II > IV > I$

Answer: C

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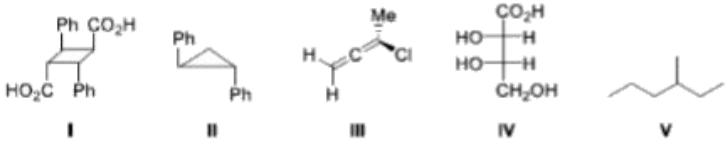
2. Among the following



the compound which can exhibit optical activity are :

A. only II, IV and V

B. only IV and V

C. only I, II and V

D. only I, II and IV

Answer: A

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3. A molecule which has 1°, 2° and 3° carbon atom is :

A. 2,3,4-trimethylpentane

B. chlorocyclohexane

C. 2,2-dimethylcyclohexane

D. methylcyclohexane

Answer: D

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4. Which of the following can be purified by steam distillation?

A. acetone

B. aniline

C. glucose

D. ethanol

Answer: B

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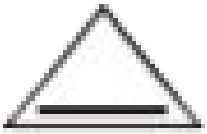
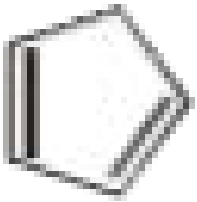
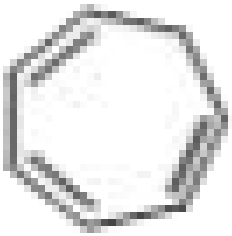
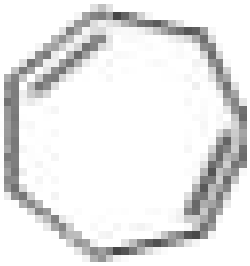
5. Among the following the most acidic compound is :

A. 

B. 



C.



D.

Answer: B

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6. A closed 10 L vessel contains 1 L water gas (1:1 $CO:H_2$) and 9 L air (20% O_2 by volume) at STP. The

contents of the vessel are ignited. The number of moles of CO_2 in the vessel is closest to :

A. 0.22

B. 0.022

C. 0.9

D. 3.6

Answer: B

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7. A certain metal has a work function of $\Phi = 2$ e V . It is irradiated first with 1 W of 400 nm light and later

with 1 W of 800 nm light . Among the following , the correct statement is :

[Given : Planck constant (h) = $6.626 \times 10^{-34} m^2 kgs^{-1}$, Speed of light (e) = $3 \times 10^8 ms^{-1}$]

A. Both colors of light give rise to same number of photoelectrons.

B. 400 nm light gives rise to less energetic photoelectrons than 800 nm light.

C. 400 nm light leads to more photoelectrons.

D. 800 nm light leads to more photoelectrons.

Answer: C

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8. Among the following, the correct statement about the chemical equilibrium is :

A. Equilibrium constant is independent of temperature.

B. Equilibrium constant tells us how fast the reaction reaches equilibrium.

C. At equilibrium, the forward and the backward reactions stop so that the concentrations of reactants and products are constant.

D. Equilibrium constant is independent of whether you start the reaction with reactants or products.

Answer: D

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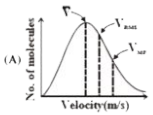
9. Among the following , the plot that shows the correct marking of most probable velocity (V_{MP}) average velocity $\left(\overrightarrow{V}\right)$ and root mean square velocity (V_{RMS}) is :

A. 

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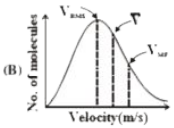

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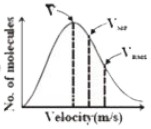
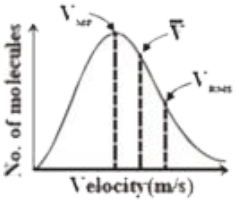


D.



Answer: D

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10. The correct set of quantum numbers for the unpaired electron of Cu atom is :

A. n = 3, l = 2, m = –2, s = +1/2

B. n = 3, l = 2, m = +2, s = –1/2

C. n = 4, l = 0, m = 0, s = +1/2

D. n = 4, l = 1, m = +1, s = +1/2

Answer: C

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11. Among the following, the most polar molecule is :

A. $AlCl_3$

B. CCl_4

C. $SeCl_6$

D. $AsCl_3$

Answer: D

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12. The covalent characters of $CaCl_2BaCl_2$, $SrCl_2$ and $MgCl_2$ follow the order :

A. $CaCl_2 < BaCl_2 < SrCl_2 < MgCl_2$

B. $BaCl_2 < SrCl_2 < CaCl_2 < MgCl_2$

C. $CaCl_2 < BaCl_2 < MgCl_2 < SrCl_2$

D. $SrCl_2 < MgCl_2 < CaCl_2 < BaCl_2$

Answer: B

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13. Among the following, the correct statement is :

A. 100. has four significant figures

B. 1.00×10^2 has four significant figures

C. 2.005 has four significant figures

D. 0.0025 has four significant figures

Answer: C

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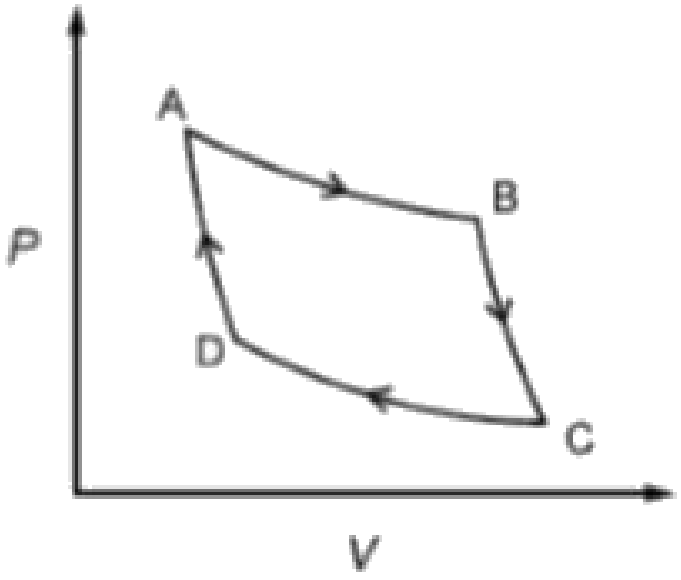
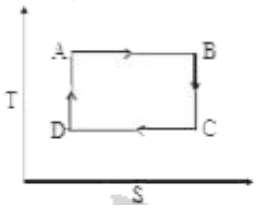
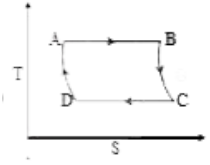
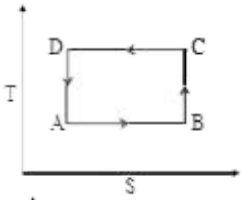
14. A thermodynamic cycle in the pressure (P) - volume (V) plane is given below :

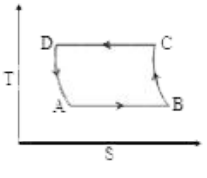


AB and CD are isothermal processes while BC and DA are adiabatic processes. The same cycle in the temperature (T) - entropy (S) plane is :

A. 

B. 

C. 

D. 

Answer: A

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15. The first ionization potential (IP) of the elements Na, Mg, Si, P, Cl and Ar are 5.14, 7.65, 8.15, 10.49, 12.97 and 15.76 eV, respectively. The IP (in eV) of K is closest to :

A. 13.3

B. 18.2

C. 4.3

D. 6.4

Answer: C

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Part Ii Chemistry

1. A hydrocarbon X with molecular fomula C_4H_6 decolorizes bromine water and forms a white precipitate in ethanolic $AgNO_3$ solution. Treatment of

X with $HgCl_2$ in aqueous H_2SO_4 produces a compounds, which gives a yellow precipitate when treated with I_2 and NaOH. The structure of X is :

A. 

B. 

C. 

D. 

Answer: D

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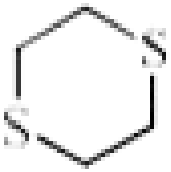
2. 0.102 g of an organic compound X was oxidized with fuming nitric acid. The resulting solution, after reaction with an excess of aqueous $BaCl_2$ produced 0.233 g of $BaSO_4$ as a precipitate , compound X is likely to be :

[Given : Atomic wt. of Ba = 137]

A. 

B. 

C. 

D. 

Answer: D

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3. The specific heat of a certain substance is 0.86 $Jg^{-1}K^{-1}$. Assuming ideal solution behavior. The energy required (in J) to heat 10 g of 1 molal of its aqueous solution from 300 K is closed to :

[Given molar mass of the substance = 58 g mol^{-1}, specific heat of water = $4.2Jg^{-1}K^{-1}$]

A. 401.7

B. 424.7

C. 420

D. 86

Answer: A

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4. Strength of a H_2O_2 solution is labelled as 1.79 N. its strength can also be expressed as closest to :

A. 20 volume

B. 5 volume

C. 10 volume

D. 15 volume

Answer: C

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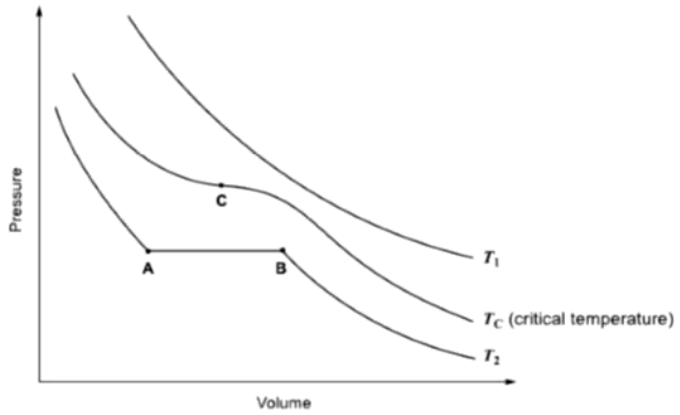
5. The isotherms of a gas are shown below :



Among the following

(i) At T_1 , the gas cannot be liquified

(ii) At point B, liquid starts to appear at T_2

(iii) T_C is the highest temperature at which the gas can

be liquified

(iv) At point A , a small increase in pressure condense the whole system to a liquid.

teh correct statements are :

A. only (i) and (ii)

B. only (i), (iii) and (iv)

C. only (ii), (iii) and (iv)

D. (i), (ii), (iii) and (iv)

Answer: D

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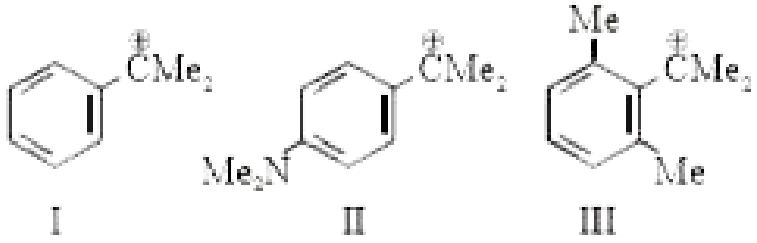
Part I Chemistry

1. The Stability of



Follow the order

A. I gt II gt III

B. II gt I gt III

C. II gt III gt I

D. III gt II gt I

Answer: B

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2. Among the following, the biodegradable polymer is :

A. polylactic acid

B. polyvinyl chloride

C. bakelite

D. teflon

Answer: A

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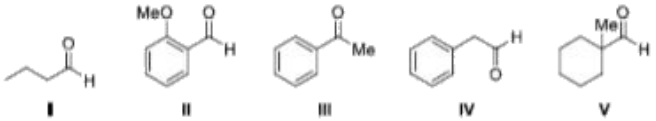
3. Among the following,



the compounds which can be reduced with formaldehyde and conc.aq. KOH, are :

A. only II and V

B. only I and V

C. only II and III

D. only I, II and IV

Answer: A

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4. An organic compound that is commonly used for sanitizing surfaces is :

A. acetylsalicylic acid

B. chloramphenicol

C. aspartame

D. cetyltrimethyl ammonium bromide

Answer: D

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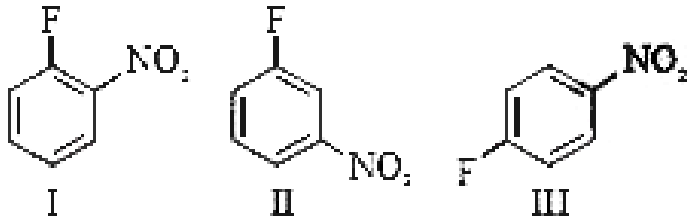
5. The rates of reaction of NaOH with



follow the order :-

A. $II > I > III$

B. $II > III > I$

C. $I > III > II$

D. $III > II > I$

Answer: C

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6. The most suitable reagent for the conversion of 2-phenylpropanamide into 1-phenylethylamine is :-

A. H_2Pd/C

B. $Br_2, NaOH$

C. $LiAilH_4, Et_2O$

D. $NaBH_4, MeOH$

Answer: B

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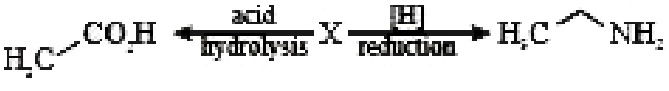
7. The compound X in the following reaction scheme :



A. acetonitrile

B. methyl isocyanide

C. acetaldehyde

D. nitromethane

Answer: A

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8. A nucleus X captures a β particle and then emits a neutron and γ ray to form Y.

A. isomorphs

B. isotopes

C. isobars

D. isotones

Answer: D

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9. The boiling point (in $^{\circ}$C) of 0.1 molal aqueous solution of $CuSO_{4.5}H_2O$at 1 bar is closest to: [Given: Ebullioscopic (molal boiling point elevation) constant of water, $K_b = 0.512KKgmol^{-1}$] :-

A. 100.36

B. 99.64

C. 100.10

D. 99.90

Answer: C

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10. A weak acid is titrated with a weak base. Consider the following statmenets regarding the pH of the solution at the equivalence point :

(i) pH depends on the concentration of acid and base.

(ii) pH is independent of the concentration of acid and base.

(iii) pH depends on the pK_a of acid and pK_b of base.

(iv) pH is independent of the pK_a of acid and pK_b of base.

The correct statments are :

A. only (i) and (iii)

B. only (i) and (iv)

C. only (ii) and (iii)

D. only (ii) and (iv)

Answer: C

11. Products are favored in a chemical reaction taking place at a constant temperature and pressure. Consider the following statements :

(i) The change in Gibbs energy for the reaction is negative.

(ii) the total change in Gibbs energy for the reaction and the surroundings is negative.

(iii) The change in entropy for the reaction is positive.

(iv) The total change in entropy for the reaction and the surrounding is positive.

The statments which are ALWAYS true are :

A. only (i) and (iii)

B. only (i) and (iv)

C. only (ii) and (iv)

D. only (ii) and (iii)

Answer: B

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12. A mixture of toluene and benzene forms a nearly ideal solution. Assume P_B° and P_T° to be the vapor pressures of pure benzene and toluene, respectively. The slope of the line obtained by plotting the total vapor pressure to the mole fraction of benzene is :

A. $P_B^\circ - P_T^\circ$

B. $P_T^\circ - P_B^\circ$

C. $P_B^\circ + P_T^\circ$

D. $\left(P_B^\circ + P_T^\circ\right)/2$

Answer: A

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13. Upon dipping a copper rod, the aqueous solution of the salt that can turn blue is :-

A. $Ca(NO_3)_2$

B. $Mg(NO_3)_2$

C. $Zn(NO_3)_2$

D. $AgNO_3$

Answer: D

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14. Treatment of alkaline $KMnO_4$ solution with KI solution oxidizes iodide to:

A. I_2

B. IO_4^-

C. IO_3^-

D. IO_2^-

Answer: C

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15. If an extra electron is added to the hypothetical molecule C_2 this extra electron will occupy the molecular orbital:

A. π_{2p}^*

B. π_{2p}

C. σ_{2p}^*

D. σ_{2p}

Answer: D

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16. Among the following the square planar geometry is exhibited by:

A. $CdCl_4^{2-}$

B. $Zn(CN)_4^{2-}$

C. $PdCl_4^{2-}$

D. $Cu(CN)_4^{3-}$

Answer: C

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17. The correct pair of orbitals involved in t-bonding between metal and CO in metal carbonyl complexes is:

A. metal d_{xy} and carbonyl π_x^*

B. metal d_{xy} and carbonyl π_x

C. metal $d_{x^2-y^2}$ and carbonyl π_x^*

D. metal $d_{x^2-y^2}$ and carbonyl π_x

Answer: A

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18. The magnetic moment (in μ_B) of [Ni(dimethylglyxoimate)$_2$] complex is closest to:

A. $5:37$

B. 0.00

C. 1.73

D. 2.25

Answer: B

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19. A compound is formed by two elements M and N. Element N forms hexagonal closed pack array with 2/3 of the octahedral holes occupied by M. The formula of the compound is:

A. M_4N_3

B. M_2N_3

C. M_3N_2

D. M_3N_4

Answer: B

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20. If the velocity of the revolving electron of He^+ in the first orbit (n= 1) is v. the velocity of the electron in the second orbit is:

A. v

B. 0.5 v

C. 2 v

D. $0.25v$

Answer: B

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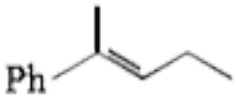
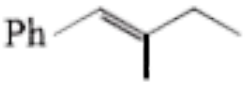
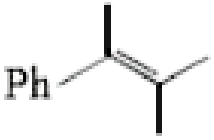
Part Ii Chemistry

1. An organic compound X with molecular formula $C_{11}H_{14}$ gives an optically active compound on hydrogenation. Upon ozonolysis, X produces a mixture of compunds - P and Q, Compund P gives a yellow precipitate when treated with I_2 and NaOH bu does no reduce Tollens' reagent. Compound Q does not gives any yellow precipitate with I_2 and NaoH but gives Fehling 's test. The compund X Q does not give any yellow precipitate with I_2 and NaOH but gives Fehling 's test . The compund X is

A. 

B. 

C. 

D. 

Answer: A

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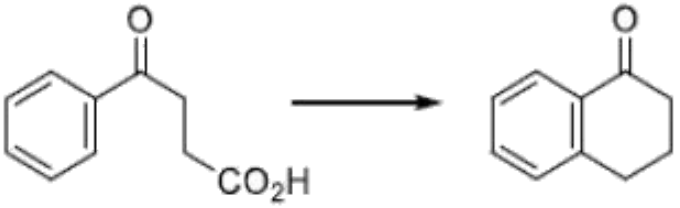
2. The following transformation



can be carried out in three sptes. The reagents

required for these three steps in their correct order.

Are :

A. $(i) NaBH_4, (ii) PCl_5, (iii) anh AlCl_3$

B. $(i) SOCl_2, (ii) anh AlCl_3 : (iii) Zn(Hg) / HCl$

C. $(i) Zn(Hg) / HCl, (ii) SOCl_2, (iii) anh.\ AlCl_3$

D.

$(i) conc,\ H_2SO_4, (ii) H_2N - NH_2.\ H_2O (iii) KOH,$

ethylene glycol ,Δ

Answer: C

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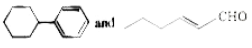
3. In the following reaction

X and Y respectively are :

A. 

B. 

C. 

D. 

Answer: D

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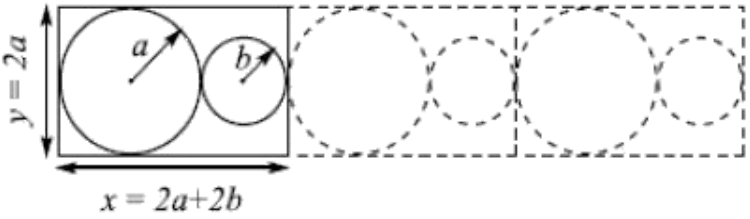
4. A two- dimensional solid is made by alternating circles with radius a and b such that the sides of the circles touch. The packing fraction is defined as the ratio of the are under the circles to the area under the rectangle with sides of the length x and y.



The ratio r = b/a for which the packing fraction is minimized is closed to :

A. 0.41

B. 1.0

C. 0.50

D. 0.32

Answer: A

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5. Consider a reaction that is first order in both direction

$$A \underset{k_b}{\overset{k_f}{\rightleftharpoons}} B$$

Initially only A is present , and its concentration is A_0. Assume A_t and A_{eq} are the concentrations of A at time 't' and at equilibrium, respectively. The time 't at which $A_t = (A_0 + A_{eq})/2is,$

A. $t = \frac{In\left(\frac{3}{2}\right)}{(K_f + k_b)}$

B. $t = (In)\frac{\left(\frac{3}{2}\right)}{(k_f - k_b)}$

C. $t = \frac{In2}{(k_f + K_b)}$

D. $t = \frac{In2}{(K_f - K_b)}$

Answer: C

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6. The reaction

$CaCO_3 \Leftrightarrow CaO(s) + CO_2(g)$

is in equilibrium in a closed vessel at 298 K . The partial pressure (in atm) of CO_2 (g) in the reaction vessel is

closest to :

[Given : the change in Gibbs energies of formation at 298 K and 1 bar for

$CaO(s) = -603.501 kJmol^{-1}$

$CO_2(g) = -394.389 kJmol^{-1}$

$CaCO_3(s) = -1128.79 kJmol^{-1}$

Gas constant $R = 8.314 JK^{-1}mol^{-1}$]

A. 1.13×10^{-23}

B. 0.95

C. 1.05

D. 8.79×10^{23}

Answer: A

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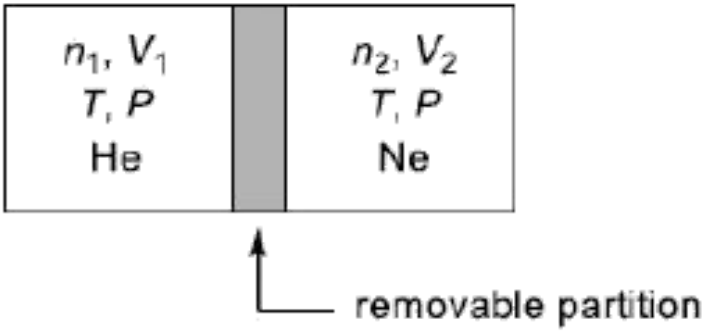
7. A container is divided into two compartments by a removable partition as shown below :



In the first compartment n_1 moles of ideal gas He is present in a volume V_1 . In the second compartment, n_2 moles of ideal gas Ne is present in a volume V_2. The temperature and pressure in both the compartments are T and P repectively. Assuming R is the gas constant.

the total change is entropy upon removing the partition when the gases mix irreversibly is :

A. $n_1 R ln \frac{V_1}{V_1 + V_2} + n_2 R ln \frac{V_2}{v_1 + V_2}$

B. $n_1 R ln \frac{V_1 + V_2}{V_1} + n_2 R \frac{\ln(V_1 + V_2)}{V_2}$

C. $(n_1 + n_2) R ln \frac{n_1 V_1}{n_2 V_2}$

D. $(n_1 + n_2) R \frac{\ln(n_2 V_2)}{n_1 V_1}$

Answer: B

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8. Number of stereoisomers possible for the octahedral complex $[Co(NH_3)_3 Cl_3]$ and $[Ni(en)_2 Cl_2]$

respectively , are :

[en = 1,2 ethylenediamine]

A. 2 and 4

B. 4 and 3

C. 3 and 2

D. 2 and 3

Answer: D

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9. When a mixture of NaCl, $K_2Cr_2O_7$ and conc. H_2SO_4 is heated in a dry test tube, a red vapour (X) is evolved.

This vapour (X) turns an aqueous solution of NaOH yellow due to the formation of Y. X and Y. respectively. are:

A. $CrCl_3$ and $Na_2Cr_2O_7$

B. $CrCl_3$ and Na_2CrO_4

C. CrO_2Cl_2 and Na_2CrO_4

D. $Cr_2(SO_4)_3$ and $Na_2Cr_2O_7$

Answer: C

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10. Sodium borohydride upon treatment with iodine produces a Lewis acid (X), which on heating with ammonia produces a cyclic compoud (Y) and a colorless gas (Z). X, Y and Z are:

A. $X = BH_3, Y = BH_3.NH_3, Z = N_2$

B. $X = B_2H_6, Y = B_3N_3H_6, Z = H_2$

C. $X = B_2H_6, Y = B_6H_6, Z = H_2$

D. $X = B_2H_6, Y = B_3N_3H_6, Z = N_2$

Answer: B

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