BITSAT - Paper 2023 Shift 1

Solved Paper

Question 1

An object moves with speed v_1, v_2 and v_3 along a line segment AB, BC and CD respectively as shown in figure. Where AB = BC and AD = 3 AB, then average speed of the object will be:

Options:

A. $\frac{v_1v_2v_3}{3(v_1v_2 + v_2v_3 + v_3v_1)}$

B. $\frac{3v_1v_2v_3}{(v_1v_2 + v_2v_3 + v_3v_1)}$

C. $\frac{(r^2 + r_2 + r_3)}{3}$

D. $\frac{(v_1 + v_2 + v_3)}{3v_1v_2v_3}$

Answer: B

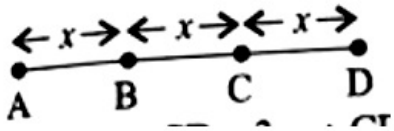
Solution:

Solution:

Consider,

$AB = x$

$BC = x$



$2x + CD = 3x \Rightarrow CD = 3x - 2x = x$

Average speed of the object $\langle v \rangle$

$= \frac{\text{Total distance}}{\text{Total time}}$

$$< v > = \frac{3x}{\frac{x}{v_1} + \frac{x}{v_2} + \frac{x}{v_3}} = \frac{3v_1v_2v_3}{v_2v_3 + v_1v_3 + v_1v_2}$$

Question 2

The effect of increase in temperature on the number of electrons in

conduction band (n_e) and resistance of a semiconductor will be as:

Options:

A. Both n_e and resistance decrease

B. Both n_e and resistance increase

C. n_e increases, resistance decreases

D. n_e decreases, resistance increases

Answer: C

Solution:

Solution:

When temperature increases, more electrons excite to conduction band and hence conductivity increases, therefore resistance decreases.

Question 3

A radio-active material is reduced to 1 / 8 of its original amount in 3 days. If 8×10^{-3} kg of the material is left after 5 days. The initial amount of the material is

Options:

A. 700 gm

B. 900 gm

C. 475 gm

D. 256 gm

Answer: D

Solution:

Solution:

$N = N_0\left(\frac{1}{2}\right)^n \quad N = \frac{N_0}{8}$

$\frac{N_0}{8} = N_0\left(\frac{1}{2}\right)^n \Rightarrow \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n$

$n = 3$

3 half lives $= 3$ days

1 half life $= 1$ day

5 days $= 5$ half life

$N = N_0\left(\frac{1}{2}\right)^n \Rightarrow 8 \times 10^{-3} = N_0\left(\frac{1}{2}\right)^5$

$\Rightarrow N_0 = 2^5 \times 8 \times 10^{-3} = 256\,\text{gm}$

Question 4

A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. The number of spectral lines emitted will be:

Options:

A. 2

B. 1

C. 3

D. 4

Answer: C

Solution:

Solution:

If we assume electron in hydrogen atom takes energy 12.09 eV from the incoming radiation, the maximum excited state of electron will be n = 3. So, number of spectral lines is $\frac{3(3-1)}{2} = 3.$

Here we assume some part of energy $12.5\,\text{eV} - 12.09\,\text{eV} = 0.41\,\text{eV}$ get lost due to collision.

Question 5

If 1000 droplets of water of surface tension 0.07 N / m. having same radius 1 mm each, combine to from a single drop. In the process the released surface energy is-

$\left(\text{Take } \pi = \frac{22}{7}\right)$

Options:

A. $7.92 \times 10^{-6}\text{J}$

B. $7.92 \times 10^{-4}\text{J}$

C. 9.68×10^{-4}J

D. 8.8×10^{-5}J

Answer: B

Solution:

Solution:

We have

$V_f = V_i$

$\Rightarrow \frac{4}{3}\pi r_f^3 = 1000 \times \frac{4}{3}\pi r_i^3 \Rightarrow r_f^3 = 1000 r_i^3$

$\Rightarrow r_f = 10 r_i$

So, released energy

= Initial surface energy − final surface energy

$= 1000 \times T \times 4\pi r_i^2 - T \times 4\pi r_f^2$

$= 4\pi T(1000 r_i^2 - r_f^2)$

$= 4\pi \times 0.07(1000 r_i^2 - 100 r_i^2)$

$= 4\pi \times 0.07 \times 900 r_i^2$

$= 4\pi \times 63 \times 10^{-6} = 7.92 \times 10^{-4}$J

Question 6

The force between two small charged spheres having charges of 1×10^{-7}C and 2×10^{-7}C placed 20 cm apart in air is

Options:

A. 4.5×10^{-2}N

B. 4.5×10^{-3}N

C. 5.4×10^{-2}N

D. 5.4×10^{-3}N

Answer: B

Solution:

Solution:

Here, $q_1 = 1 \times 10^{-7}$C, q_2 and 2×10^{-7}C,

$r = 20\,\text{cm} = 20 \times 10^{-2}\text{m}$

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} = \frac{9 \times 10^9 \times 1 \times 10^{-7} \times 2 \times 10^{-7}}{(20 \times 10^{-2})^2}$$

$= 4.5 \times 10^{-3}\text{N}$

Question 7

The work done in placing a charge of 8×10^{-18} coulomb on a condenser of capacity 100 microfarad is

Options:

A. 3.1×10^{-26} joule

B. 4×10^{-10} joule

C. 32×10^{-32} joule

D. 16×10^{-32} joule

Answer: C

Solution:

Solution:

$$\text{Work done} = \frac{1}{2}\frac{q^2}{C} = \frac{(8 \times 10^{-18})^2}{2 \times 100 \times 10^{-6}} = 32 \times 10^{-32}\text{J}$$

Question 8

The resistance of a wire is 5Ω. It's new resistance in ohm if stretched to 5 times of its original length will be :

Options:

A. 625

B. 5

C. 125

D. 25

Answer: C

Solution:

Solution:

Let resistance of a wire R and length l.

$$R = \frac{\rho \ell}{A} = 5\Omega$$

$\therefore$ Volume of wire is constant in stretching

$$V_i = V_f \Rightarrow A_i \ell_i = A_f \ell_f$$

$$A\ell = A'(5\ell) \Rightarrow A' = \frac{A}{5}$$

$$R_f = \frac{\rho \ell_f}{A_f} = \frac{\rho(5\ell)}{\left(\frac{A}{5}\right)} = 25\left(\frac{\rho \ell}{A}\right) = 25 \times 5 = 125\Omega$$

Question 9

A charge particle is moving in a uniform magnetic field $\left(2\hat{i} + 3\hat{j}\right)$T. If it has an acceleration of $\left(\alpha\hat{i} - 4\hat{j}\right)$m / s^2, then the value of α will be :

Options:

A. 3

B. 6

C. 12

D. 2

Answer: B

Solution:

Solution:

(b) Given that uniform magnetic field, $\vec{B} = \left(2\hat{i} + 3\hat{j}\right)T$

Acceleration $\vec{a} = \left(\alpha\hat{i} - 4\hat{j}\right)\text{m}/s^2$

We know that

$$F = q\left(\vec{v} \times \vec{B}\right) \Rightarrow ma = q\left(\vec{v} \times \vec{B}\right)$$

Here, $\vec{a} \perp \vec{B}$, so, $\vec{a} \cdot \vec{B} = 0$

$$\left(\alpha\hat{i} - 4\hat{j}\right)\left(2\hat{i} + 3\hat{j}\right) = 0 \Rightarrow 2\alpha - 12 = 0 \Rightarrow \alpha = 6$$

Question 10

Proton (p) and electron (e) will have same de-Broglie wavelength when

the ratio of their momentum is (assume, $m_n = 1849m_e$)

Options:

A. 1:43

B. 43 : 1

C. 1 : 1849

D. 1 : 1

Answer: D

Solution:

Solution:

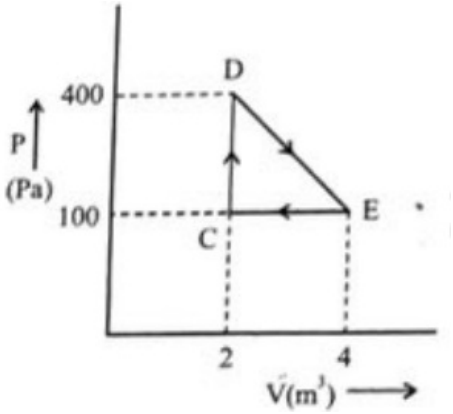
De Broglie wavelength is $\lambda = \frac{h}{mv}$

$$\lambda_p = \lambda_e \Rightarrow \frac{h}{m_p v_p} = \frac{h}{m_e v_e}$$

$$m_e v_e = m_p v_p \Rightarrow p_e = p_p \quad \therefore \frac{p_p}{p_e} = \frac{1}{1}$$

Question 11

A thermodynamic system is taken through cyclic process. The total work done in the process is :



Options:

A. 100J

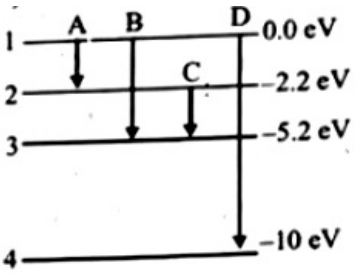
B. 300J

C. Zero

D. 200J

Answer: B

Solution:



Options:

A. B

B. A

C. C

D. D

Answer: D

Solution:

Solution:

As $E(eV) = \frac{1240}{\lambda(nm)} = \frac{1240}{124.1} \simeq 10\,eV$ Only is transition (D), the energy gap is $10\,eV$ So, option (d) is correct

$$K_a = 0.001\left(\frac{\alpha^2}{1-\alpha}\right) = \frac{0.001 \times \left(\frac{2}{19}\right)^2}{1-\left(\frac{2}{19}\right)}$$

Question 31

Frenkel and Schottky defects are :

Options:

A. nucleus defects

B. non-crystal defects

C. crystal defects

D. nuclear defects

Answer: C

Solution:

Solution:

Frenkel and Schottky defects are crystal defects. It arises due to dislodgement of cation or anion from their places in the crystal lattice.

Question 32

The Bohr orbit radius for the hydrogen atom (n = 1) is approximately 0.530Å. The radius for the first excited state (n = 2) orbit is (in Å)

Options:

A. 0.13

B. 1.06

C. 4.77

D. 2.12

Answer: D

Solution:

Solution:

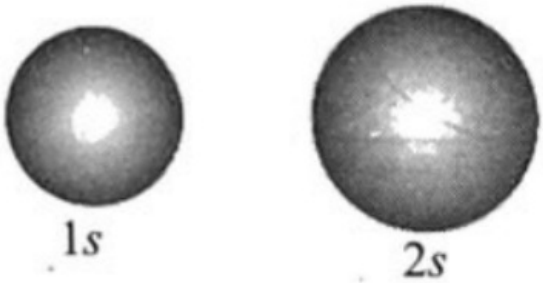
Given : Radius of hydrogen atom $= 0.530\ \mathring{A}$, Number of excited state (n) = 2 and atomic number of hydrogen atom (Z) = 1. We know that the Bohr radius

$$(r) = \frac{n^2}{Z} \times \text{ radius of atom } = \frac{(2)^2}{1} \times 0.530$$

$$= 4 \times 0.530 = 2.12\mathring{A}$$

Question 33

The probability density plots of 1s and 2s orbitals are given in figure.'



The density of dots in a region represents the probability density of finding electrons in the region.
On the basis of above diagram which of the following statements is incorrect?

Options:

A. 1s and 2s orbitals are spherical in shape.

B. The probability of finding the electron is maximum near the nucleus.

C. The probability of finding the electron at a given distance is equal in all directions.

D. The probability density of electrons for 2s orbital decreases uniformly as distance from the nucleus increases.

Answer: D

Solution:

Solution:

The probability density of electrons in $2s$ orbital first increases then decreases and after that it increases again as distance increases from nucleus.

Question 34

Element with electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^3$ belongs to the following group of the periodic table

Options:

A. 5 th

B. 15 th

C. 3rd

D. 17 th

Answer: B

Solution:

Solution:

Its valence shell has 5 electrons (ns^2, np^3). It belongs to 15 th group of the periodic table.

Question 35

Which of the following pairs will form the most stable ionic bond?

Options:

A. Na and Cl

B. Mg and F

C. Li and F

D. Na and F

Answer: B

Solution:

Solution:

The stability of the ionic bond depends upon the lattice energy which is expected to be more between Mg and F due to +2 charge on Mg atom.

Question 36

How much ethyl alcohol must be added to 1 litre of water so that the solution will freeze at 14˚C ?
(K_f. for water = 1.86˚C / mol)

Options:

A. 7.5 mol

B. 8.5 mol

C. 9.5 mol

D. 10.5 mol

Answer: A

Solution:

Solution:

7.5 mol

$$\Delta T_f = K_f m$$

$$\Delta T_f = K_f \frac{n_2 \times 1000}{w_1}$$

$$\Rightarrow 14 = 1.86 \times \frac{n_2 \times 1000}{1000}$$

$$n_2 = 7.5 \text{ mol}$$

Question 37

The conductivity of a weak acid HA of concentration $0.001\,\text{mol}\,L^{-1}$ is $2.0 \times 10^{-5} Scm^{-1}$.
If Λ_m°(HA) = $190 Scm^2 mol^{-1}$, the ionization constant (K_a) of HA is equal to _____ 10^{-6}. ×

Options:

A. 24

B. 48

C. 12

D. 45

Answer: C

Solution:

Solution:

$$\Lambda_m = 1000 \times \frac{\kappa}{M}$$

$$= 1000 \times \frac{2 \times 10^{-5}}{0.001} = 20 Scm^2 mol^{-1}$$

$$\Rightarrow \alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{20}{190} = \left(\frac{2}{19}\right)$$

$$\underset{0.001(1-\alpha)}{HA} \rightleftharpoons \underset{0.001\alpha}{H^+} + \underset{0.001\alpha}{A^-}$$

$$K_a = 0.001\left(\frac{\alpha^2}{1-\alpha}\right) = \frac{0.001 \times \left(\frac{2}{19}\right)^2}{1-\left(\frac{2}{19}\right)}$$

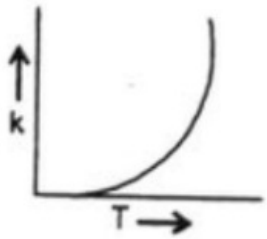
$$= 12.3 \times 10^{-6}$$

Question 38

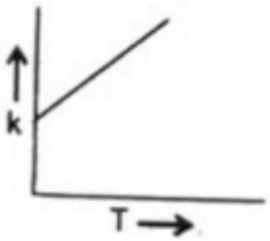
Plots showing the variation of the rate constant (k) with temperature (T) are given below. The plot that follows Arrhenius equation is

Options:

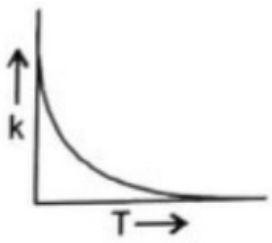
A.



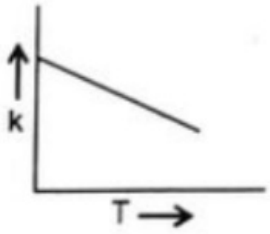
B.



C.



D.



Answer: A

Solution:

Solution:

As per Arrhenius equation $\left(k = Ae^{-E_a/RT}\right)$, the rate constant increases exponentially with temperature.

Question 39

Which of the following method is used for coagulation of the sol?

Options:

A. By mixing two oppositely charged sols.

B. By electrophoresis.

C. By addition of electrolytes.

D. All of the above.

Answer: D

Question 40

The reaction that does NOT take place in a blast furnace between 900K to 1500K temperature range during extraction of iron is :

Options:

A. $Fe_2O_3 + CO \rightarrow 2\,FeO + CO_2$

B. $FeO + CO \rightarrow Fe + CO_2$

C. $C + CO_2 \rightarrow 2\,CO$

D. $CaO + SiO_2 \rightarrow CaSiO_3$

Answer: A

Solution:

Solution:

At $900-1500K$ (higher temperature range in the blast furnace)

Reaction which take place are:

$C + CO_2 \rightarrow 2CO$

$FeO + CO \rightarrow Fe + CO_2$

$CaO + SiO_2 \rightarrow CaSiO_3$ (Slag formation)

$Fe\,O_3 + CO \rightarrow 2\,FeO + CO_2$ at $500-800K$.

Question 41

Kinetic theory of gases proves

Options:

A. only Boyle's law

B. only Charles' law

C. only Avogadro's law

D. all of these

Answer: D

Solution:

Solution:

Kinetic theory of gases proves all the given gas laws.

Question 42

If enthalpies of formation of $C_2H_4(g)$, $CO_2(g)$ and $H_2O(l)$ at $25^{\circ}C$ and $1\,atm$ pressure are 52 , 394 and $-286\,kJ/mol$ respectively, the change in enthalpy for combustion of C_2H_4 is equal to

Options:

A. $-141.2\,kJ/mol$

B. $-1412\,kJ/mol$

C. $+14.2\,kJ/mol$

D. $+1412\,kJ/mol$

Answer: B

Solution:

Solution:

Enthalpy of formation of C_2H_4, CO_2 and H_2O are 52, -394 and $-286\,kJ/mol$ respectively. (Given)

The reaction is

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

change in enthalpy,

$$(\Delta H) = \Delta H_{products} - \Delta H_{reactants}$$

$$= 2 \times (-394) + 2 \times (-286) - (52 + 0)$$

$$= -1412\,kJ/mol$$

Question 43

The photochemical smog does not generally contain:

Options:

A. NO

B. SO_2

C. NO_2

D. HCHO

Answer: C

Solution:

Solution:

Photochemical smog contains nitrogen dioxide (NO2), Ozone (O3), PAN (peroxyacetylnitrate), and compounds containing $-CHO$ group.

Question 44

Geometrical isomerism is not shown by

Options:

A. $CH_3CH_2\overset{CH_3}{\overset{|}{C}} = \underset{CH_3}{\underset{|}{C}}CH_2CH_3$

B. $C_2H_5 - \underset{H}{\underset{|}{C}} = \underset{H}{\underset{|}{C}} - CH_2I$

C. $CH_2 = C(Cl)CH_3$

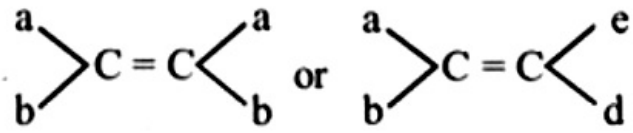
D. $CH_3 - CH = CH - CH = CH_2$

Answer: C

Solution:

Solution:

The condition for geometrical isomerism is



$CH_2 = C(Cl)CH_3$ does not follow above mention condition.

Question 45

For the separation of two immiscible liquids which method is used?

Options:

A. Chromatography

B. Fractionating column

C. Fractional distillation

D. Separating funnel

Answer: D

Solution:

Solution:

Separating funnel is used when the two liquids are immiscible.

Question 46

What is x in the following reaction?
$Al(s) + NaOH(aq) + H_2O(l) \rightarrow x + H_2(g)$

Options:

A. $Na_2[Al(OH)_4]^-$

B. $Na^+[Al(OH)_4]^-$

C. $Na_2[Al(OH)_6]^-$

D. $Na^+[Al(OH)_6]^-$

Answer: B

Solution:

Solution:

$$2\,Al(s) + 2\,NaOH(aq) + 6H_2O(l) \rightarrow$$

$$2Na^{+}[Al(OH)_4]^{-}(aq) + 3H_2(g)$$

Question 47

Which of the following will precipitate first when aqueous solution containing sulphate ions are added?

Options:

A. Mg^{2+}

B. Ca^{2+}

C. Sr^{2+}

D. Ba^{2+}

Answer: D

Solution:

Solution:

Down the group solubility of sulphate decreases. Thus, Ba^{2+} ions will precipitate out most easily.

Question 48

Ionic hydrides reacts with water to give

Options:

A. acidic solutions

B. hydride ions

C. basic solutions

D. electrons

Answer: C

Solution:

Solution:

Ionic hydrides give the basic solution when it reacts with water, e.g.,

$LiH + H_2O \rightarrow LiOH + H_2$

Question 49

The drug used as an antidepressant is

Options:

A. Luminol

B. Tofranil

C. Mescaline

D. Sulphadiazine

Answer: B

Solution:

Solution:

Tofranil is used for the treatment of antidepressant.

Question 50

Melamine plastic crockery is a copolymer of:

Options:

A. HCHO and melamine

B. HCHO and ethylene

C. melamine and ethylene

D. None of these

Answer: A

Solution:

Solution:

Melamine plastic crockery is a copolymer of HCHO and Melamine.

Question 51

The helical structure of protein is stabilized by

Options:

A. dipeptide bonds

B. hydrogen bonds

C. ether bonds

D. peptide bonds

Answer: B

Solution:

Solution:

The α-helix structure is formed when the chain of α-amino acids coils as a right handed screw (called α-helix) because of the formation of hydrogen bonds between amide groups of the same peptide chain, i.e., NH group in one unit is linked to carbonyl oxygen of the third unit by hydrogen bonding. This hydrogen bonding between different units is responsible for holding helix in a position.

Question 52

Which of the following factors affect the basic strength of amine?
(i) Inductive effect
(ii) Steric hinderance
(iii) Solvation effect
(iv) Solubility in organic solvents.

Options:

A. (i) and (iv)

B. (i), (ii) and (iii)

C. (ii) and (iii)

D. (ii) and (iv)

Answer: B

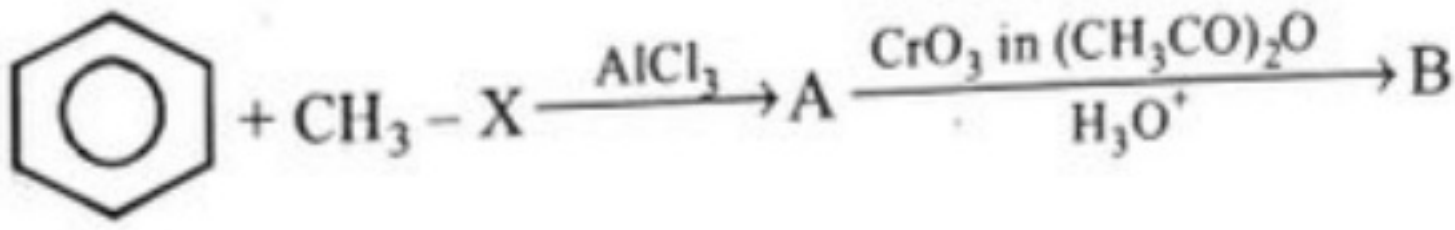
Solution:

Solution:

Inductive effect, steric hinderance and solvation effect the basic strength of amines.

Question 53

Find out B in the given reactions



Options:

A. acetophenone

B. benzaldehyde

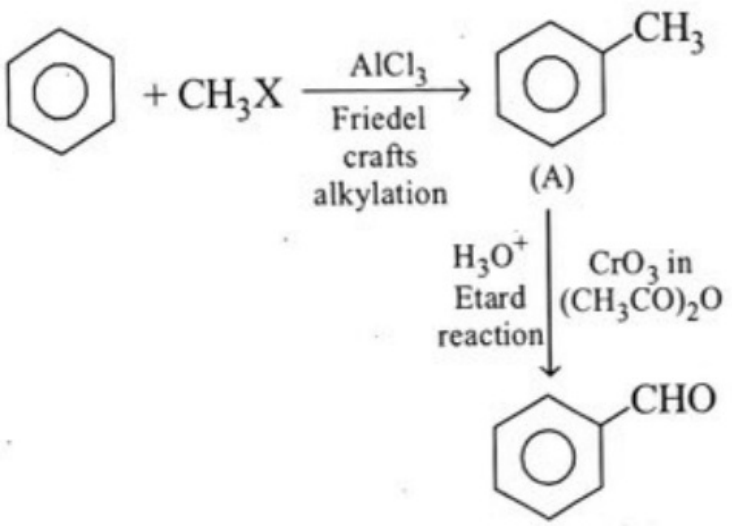
C. cyclohexyl carbaldehyde

D. benzoic acid

Answer: B

Solution:

Solution:

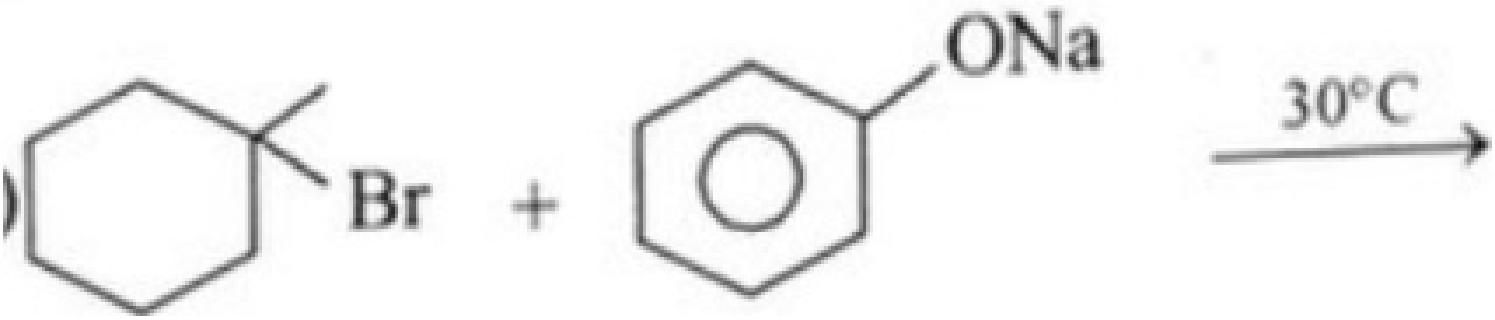


Question 54

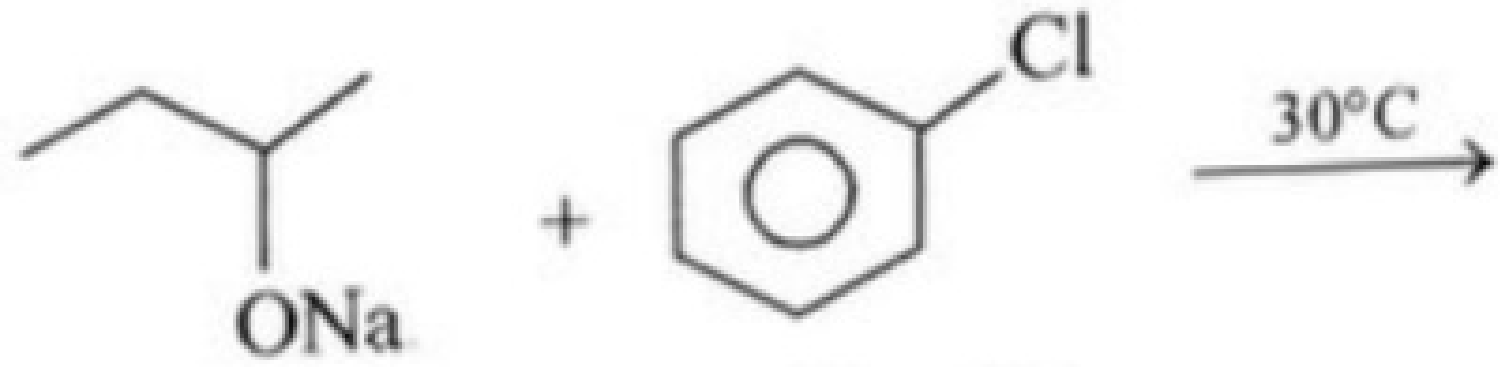
Which method is useful for the synthesis of ether?

Options:

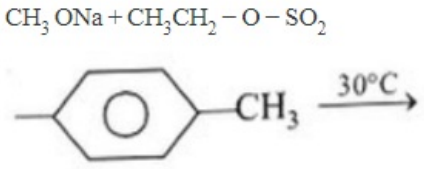
A.



B.



C.



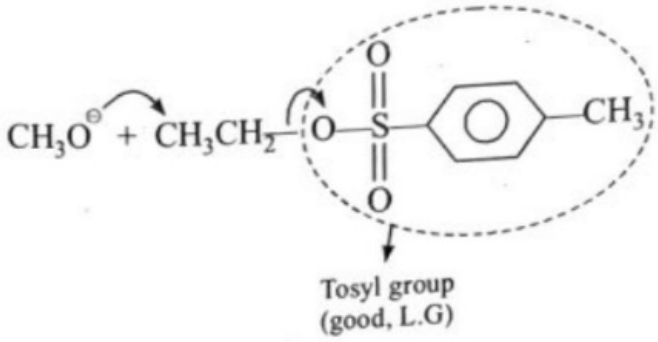
D. $CH_3CH - OH \xrightarrow[[443K]]{H_2SO_4}$

Answer: C

Solution:

Solution:

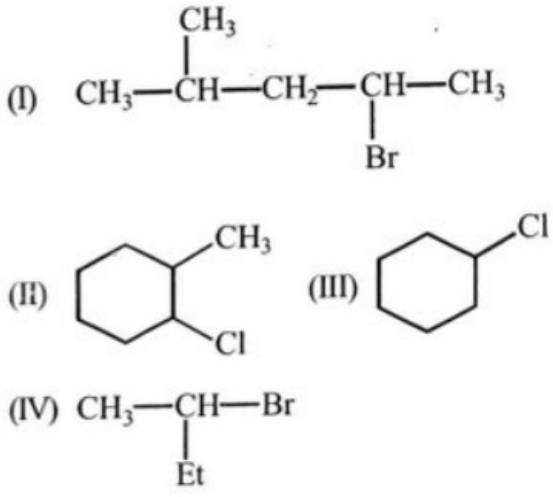
At 443K compound in (d) will produce propene. In (a) alkene will be produced as tertiary halide and strong base favours elimination. In (b) reaction is not possible at room temperature as due to resonance C − Cl bond has partial double bond character which is very difficult to break.



$\rightarrow OTs^{\ominus} + CH_3OCH_2CH_3$

Question 55

Among the given halides, which one will give same product in both S_N1 and S_N2 reactions.



Options:

A. (III) only

B. (I) and (II)

C. (III) and (IV)

D. (I), (III) and (IV)

Answer: C

Solution:

Solution:

S_N2 and S_N1 same, if $C^{\oplus}$ not rearrange.

Question 56

Among the ligands NH_3, en, $CN^-$and CO the correct order of their increasing field strength, is :

Options:

A. NH_3< en <CN^- < CO

B. CN^- < NH_3 < NH_3< en

C. en <CN^- < NH_3 < CO

D. CO < NH_3< en <CN^-

Answer: A

Solution:

Solution:

Ligands can be arranged in a series in the orders of increasing field strength as given below:

Weak field ligands :

$I^- < Br^- < S^{2-} < SCN^- < Cl^- < N_3^-, F^-$

$< Urea, OH^- <$ oxalate

Strong field ligands

$O^{--} < H_2O < NCS^- < EDTA < Py, NH_3 <$

$en = SO_3^- <$ bipy, Phen $< NO_2^- < CH_3^-$

$< C_6H_5^- < CN^- < CO$

Such a series is termed as spectrochemical series. It is an experimentally determined series based on the absorption of light by complexes with different ligands.

Question 57

S − S bond is not present in

Options:

A. $S_2O_4^{2-}$

B. $S_2O_5^{2-}$

C. $S_2O_3^{2-}$

D. $S_2O_7^{2-}$

Answer: D

Solution:

Solution:

Due to some backbonding by sidewise overlapping between d-orbitals of metal and p orbital of carbon, the $Fe-C$ bond in $[Fe(CO)_5]$ hasboth σ and π character.

Question 58

In the laboratory, manganese (II) salt is oxidised to permanganate ion in aqueous solution by

Options:

A. hydrogen peroxide

B. conc. nitric acid

C. peroxy disulphate

D. dichromate

Answer: C

Solution:

Solution:

In laboratory, manganese (II) ion salt is oxidised to permanganate ion in aqueous solution by peroxodisulphate.

$$2Mn^{2+} + \underset{\text{peroxodisulphate ion}}{5S_2O_8^{2-}} + 8H_2O \rightarrow$$

$$2MnO_4^- + 10SO_4^{2-} + 16H^+$$

Question 59

Which one of the following molecular hydrides acts as a Lewis acid?

Options:

A. NH_3

B. H_2O

C. B_2H_6

D. CH_4

Answer: C

Solution:

Solution:

Boron in B_2H_6 is electron deficient

Question 60

Electrode potential data are given below:

$Fe^{+3}(aq) + e^- \rightarrow Fe^{+2}(aq)$; $E^\circ = +0.77V$

$Al^{3+}(aq) + 3e^- \rightarrow Al_{(s)}$; $E^\circ = -1.66V$

$Br_2(aq) + 2e^- \rightarrow 2Br^-(aq)$; $E^\circ = +1.08V$

Based on the data, the reducing power of Fe^{2+}, Al and Br^-will increase in the order

Options:

A. $Br^- < Fe^{2+} < Al$

B. $Fe^{2+} < Al < Br^-$

C. $Al < Br^- < Fe^{2+}$

D. $Al < Fe^{2+} < Br$

Answer: A

Solution:

Solution:

	Fe	Al	Br
E_{Red}°	0.77	−1.66	1.08
E_{Oxi}°	−0.77	1.66	−1.08

Hence, reducing power $Al > Fe^{2+} > Br^-$
