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கல்விப் பொதுத் தராதர பத்திர (உயர் தர)ப் பரீட்சை, 2018 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2018

15.08.2018 / 0830 – 1030

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

02 E I

පැය දෙකයි
இரண்டு மணித்தியாலம்
Two hours

Instructions:

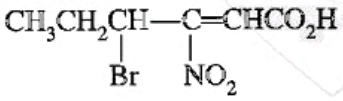
* *Periodic Table is provided.*
* *This paper consists of 09 pages.*
* *Answer **all** the questions.*
* ***Use of calculators is not allowed.***
* *Write your **Index Number** in the space provided in the answer sheet.*
* *Follow the instructions given on the back of the answer sheet carefully.*
* *In each of the questions 1 to 50, pick one of the alternatives from (1), (2), (3), (4), (5) **which is correct or most appropriate and mark your response on the answer sheet with a cross (×) in accordance with the instructions given on the back of the answer sheet.***

Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$
Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$
Planck's constant $h = 6.626 \times 10^{-34}\ J\,s$
Velocity of light $c = 3 \times 10^{8}\ m\,s^{-1}$

1. The number of unpaired electrons present in a gaseous Co^{3+} ion in its ground state is,
(1) 1 (2) 2 (3) 3 (4) 4 (5) 5

2. Which quantum number(s) (n, l, m_l, m_s) is/are associated with the shape of an atomic orbital of an atom?
(1) l (2) m_l (3) n and l (4) n and m_l (5) l and m_l

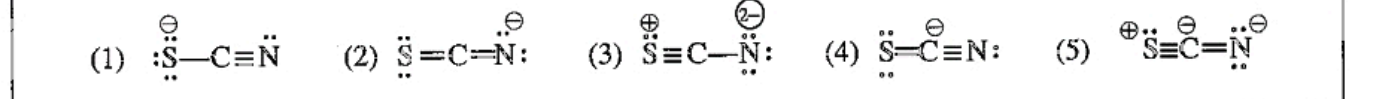
3. What is the IUPAC name of the compound shown below?



(1) 4–bromo–3–nitro–2–hexenoicacid
(2) 4–bromo–3–nitro–2–hexenoic acid
(3) 3–nitro–4–bromo–2–hexenoicacid
(4) 3–nitro–4–bromo–2–hexenoic acid
(5) 3–bromo–4–nitro–4–hexenoic acid

4. The correct answer when the molecules O_2, H_2O, H_2O_2, OF_2 and O_2F_2 (structure similar to H_2O_2) are arranged in the decreasing order of the oxidation state of oxygen (O) is,
(1) $O_2F_2 > OF_2 > O_2 > H_2O > H_2O_2$
(2) $H_2O > H_2O_2 > O_2 > O_2F_2 > OF_2$
(3) $H_2O_2 > O_2F_2 > O_2 > OF_2 > H_2O$
(4) $OF_2 > O_2F_2 > O_2 > H_2O > H_2O_2$
(5) $OF_2 > O_2F_2 > O_2 > H_2O_2 > H_2O$

5. The most acceptable Lewis structure for the thiocyanate ion SCN^- is,



6. The molarity (mol dm^{-3}) of a NaI solution which has a density of 1.03 g cm^{-3} and is 3% NaI by mass is,
(Na = 23, I = 127)
(1) 0.21 (2) 0.23 (3) 0.25 (4) 0.28 (5) 0.30

[See page two

7. Precipitates of AgI and AgBr were added to a small amount of distilled water. This mixture was allowed to reach equilibrium at 25 °C. It was observed that both the solids were present in the system at equilibrium. Which of the following relations is applicable to this solution?
($K_{sp(AgI)} = 8.0 \times 10^{-17}$ mol^2 dm^{-6}, $K_{sp(AgBr)} = 5.0 \times 10^{-13}$ mol^2 dm^{-6} at 25 °C)

(1) $[Br^-] = \sqrt{5.0 \times 10^{-13}}$ mol dm^{-3} and $[I^-] = \sqrt{8.0 \times 10^{-17}}$ mol dm^{-3}

(2) $[Br^-]\,[I^-] = [Ag^+]^2$

(3) $\left[Ag^+\right] = \left(\sqrt{5.0 \times 10^{-13}} + \sqrt{8.0 \times 10^{-17}}\right)$ mol dm^{-3}

(4) $\frac{[Br^-]}{[I^-]} = \frac{5.0}{8.0} \times 10^4$

(5) $[Ag^+] = [Br^-] = [I^-]$

8. Which of the following statements is false?
(1) Although the carbonates of all the group two metals in the Periodic Table are insoluble in water, their bicarbonates are soluble.
(2) The hydroxides of all the group two metals in the Periodic Table are soluble in water.
(3) The nitrates of all the group two metals in the Periodic Table are soluble in water.
(4) The oxides and hydroxides of Na and Mg show basic properties whereas the oxide and hydroxide of Al show amphoteric properties.
(5) The hydrides of Si and S show weakly acidic properties.

9. In which list are the elements given in the order of **increasing** (left to right) atomic radii?
(1) Li, Na, Mg, S (2) C, Si, S, Cl (3) B, C, N, P
(4) Li, Na, K, Ca (5) B, Be, Na, K

10. Liquids A and B form an ideal solution. Consider a mixture of liquids A and B in equilibrium with the vapour in a closed rigid container at constant temperature. P_A^o and P_B^o respectively are the saturated vapour pressures of A and B while P is the total pressure of the container and X_A^g is the mole fraction of A in the vapour phase. Which of the following is correct about this system?

(1) $P = \left(P_A^o - P_B^o\right) X_A^g + P_B^o$ (2) $\frac{1}{P} = \left(\frac{1}{P_A^o} - \frac{1}{P_B^o}\right) X_A^g + \frac{1}{P_B^o}$

(3) $P = \left(P_A^o + P_B^o\right) X_A^g - P_B^o$ (4) $\frac{1}{P} = \left(\frac{1}{P_B^o} - \frac{1}{P_A^o}\right) \frac{1}{X_A^g}$

(5) $\frac{1}{P} = \left(\frac{1}{P_A^o} - \frac{1}{P_B^o}\right) \frac{1}{X_A^g}$

11. The **increasing** order of boiling points of the following substances is,
He, CH_4, CCl_4, CBr_4, SiH_4
(1) $CH_4 < He < SiH_4 < CCl_4 < CBr_4$ (2) $He < SiH_4 < CH_4 < CCl_4 < CBr_4$
(3) $He < CH_4 < SiH_4 < CCl_4 < CBr_4$ (4) $CH_4 < He < SiH_4 < CBr_4 < CCl_4$
(5) $He < CH_4 < CCl_4 < SiH_4 < CBr_4$

12. Identify the correct statement from the following.
(1) Among the electronic transitions $n=2 \longrightarrow n=1$, $n=3 \longrightarrow n=2$ and $n=4 \longrightarrow n=3$ in a hydrogen atom, most energy is released in $n=3 \longrightarrow n=2$.
(2) Among the species OF_2, OF_4 and SF_4, the least stable is SF_4.
(3) Among the elements Li, C, N, Na and P, the least electronegative element is Li.
(4) In the following pairs (Li & F), (Li^+ & F^-), (Li^+ & O^{2-}) and (O^{2-} & F^-), the difference in radii is greatest between Li^+ and O^{2-}.
(5) The only type of intermolecular force present in CH_2Cl_2 in the liquid phase is dipole-dipole forces.

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13. Consider the reaction: $CH_4(g) \longrightarrow CH_3(g) + H(g)$
The standard change in enthalpy of the above reaction is,
(1) the standard enthalpy change for the dissociation of the first C—H bond in methane.
(2) the standard atomisation enthalpy change of methane.
(3) the standard first ionisation enthalpy change of methane.
(4) the standard bond dissociation enthalpy change of methane.
(5) the standard radical formation enthalpy change of methane.

14. The elementary reaction $2A(g) \longrightarrow B(g)$ occurs in a closed rigid container at a constant temperature. Initial pressure of the container is P_o and the pressure when the rate of reaction is 50% of the initial value is P_t. Which of the following gives the correct value for $\frac{P_t}{P_o}$?

(1) $\frac{P_t}{P_o} = \frac{1}{2}$ (2) $\frac{P_t}{P_o} = \frac{1}{\sqrt{2}}$ (3) $\frac{P_t}{P_o} = \frac{1 \div \sqrt{2}}{2\sqrt{2}}$ (4) $\frac{P_t}{P_o} = \frac{\sqrt{2}}{1+\sqrt{2}}$ (5) $\frac{P_t}{P_o} = \frac{\sqrt{2}-1}{1+\sqrt{2}}$

15. An equimolar aqueous solution of the weak acids HA and HB (1.0 mol dm^{-3} in each acid) with pK_a values 4.7 and 5.0 respectively is at equilibrium. The value of $\log\left(\frac{[A^-]}{[B^-]}\right)$ is approximately equal to,

(1) 23.5 (2) −0.3 (3) 0.3 (4) 0.94 (5) 1.06

16. Which of the following statements about C_6H_5OH is false?
(1) Reacts with CH_3COCl to form a phenyl ester.
(2) Reacts with bromine water to give a white precipitate.
(3) Evolves CO_2 gas when treated with $NaHCO_3$.
(4) Gives a coloured compound when treated with $C_6H_5N_2^+Cl^-$ in the presence of NaOH.
(5) Gives a coloured (purplish) solution when treated with neutral $FeCl_3$.

17. The half life of a reaction is,
(1) always independent of the initial concentration of reactants.
(2) always dependent on the rate constant.
(3) always independent of the order of the reaction.
(4) always independent of temperature.
(5) equal to twice the total reaction time.

18. Electromotive force of an electrochemical cell does not depend on,
(1) the nature of the electrolytes.
(2) temperature.
(3) the concentrations of the electrolytes.
(4) the surface areas of the electrodes.
(5) the types of metals that form the electrodes.

19. IO_3^- (iodate ion) oxidizes the SO_3^{2-} ion to SO_4^{2-} in acidic medium. The mass of KIO_3 required to totally oxidize the amount of Na_2SO_3 present in 25.0 cm^3 of a solution of Na_2SO_3 (0.50 mol dm^{-3}) to Na_2SO_4 is 1.07 g. (O = 16, K = 39, I = 127)
The final oxidation state of iodine after the completion of the reaction is,
(1) −1 (2) 0 (3) +1 (4) +2 (5) +3

20. Which of the following statements is false with regard to the *s*-block elements in the Periodic Table?
(1) All elements in group I react with water liberating H_2 gas.
(2) All elements in group I except Li react with N_2 gas.
(3) All elements in group II react with N_2 gas.
(4) Na reacts with excess O_2 to give Na_2O_2 whereas K gives KO_2.
(5) All elements in the *s*-block are good reducing agents.

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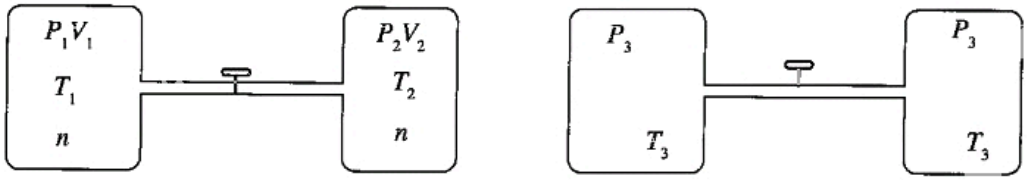
21. A system consisting of two rigid containers containing an ideal gas is shown in the diagram. The containers can be connected to each other by opening the tap. The system changes from configuration A to configuration B when the tap is opened. In general n, P, V and T represent number of moles, pressure, volume and temperature respectively.



configuration A (tap closed) configuration B (tap opened)

Which of the following relations is correct about this system?

(1) $P_1V_1 = P_2V_2$ (2) $\frac{P_3T_1}{P_1} + \frac{P_3T_2}{P_2} = 2T_3$ (3) $\frac{T_1}{P_1} = \frac{T_2}{P_2}$

(4) $P_1T_1 = P_2T_2$ (5) $P_1V_1 + P_2V_2 = P_3(V_1 + V_2)$

22. Which of the following statements is false with regard to 3*d*-elements of the Periodic Table?
(1) Atomic radii are smaller than the atomic radii of the *s*-block elements in the same period.
(2) Densities are higher than the densities of the *s*-block elements in the same period.
(3) V_2O_5, CrO_3 and Mn_2O_7 are acidic oxides.
(4) First ionization energies are less than the first ionization energies of the *s*-block elements in the same period.
(5) The most common oxidation states of cobalt in cobalt compounds are +2 and +3.

23. Standard Gibbs energy changes for the reaction, $MO(s) \rightarrow M(s) + \frac{1}{2}O_2(g)$ at two different temperatures are given below.

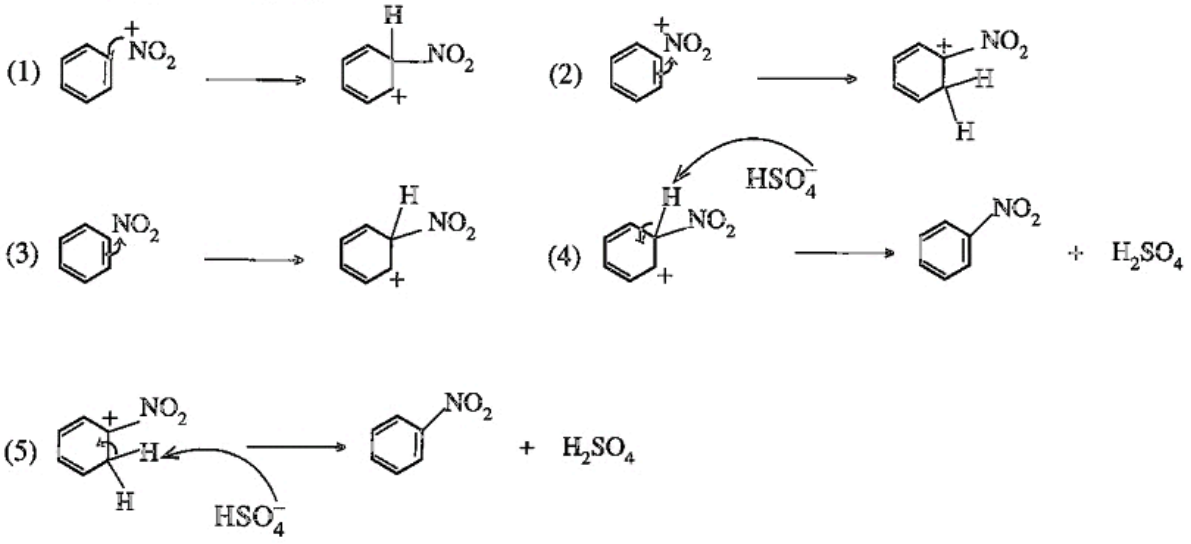
T/K	$\Delta G°$/kJ mol^{-1}
1000	−100.2
2000	−148.6

The standard entropy change of the reaction is,

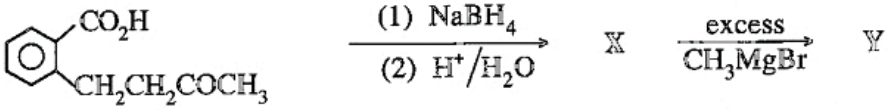
(1) 248.8 J K^{-1} mol^{-1} (2) −248.8 J K^{-1} mol^{-1} (3) −48.4 J K^{-1} mol^{-1}

(4) 348.4 J K^{-1} mol^{-1} (5) 48.4 J K^{-1} mol^{-1}

24. Which of the following represents a correct step in the mechanism of nitration of benzene with conc. HNO_3 / conc. H_2SO_4?

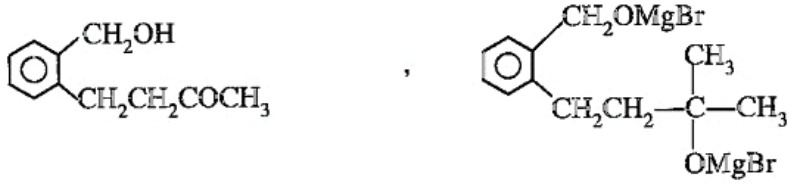


[See page five

25. 

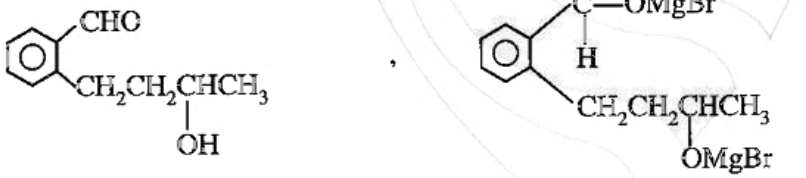
In the reaction sequence given above, the structures of X and Y respectively are,

(1) 

(2) 

(3) 

(4) 

(5) 

26. When $(NH_4)_2CO_3(s)$, $(NH_4)_2Cr_2O_7(s)$ and $NH_4NO_3(s)$ are heated, the nitrogen containing compounds obtained are respectively,

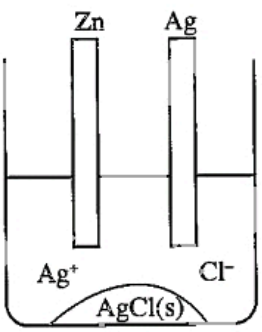
(1) NH_3, N_2 and NO_2 (2) N_2O, N_2 and NH_3 (3) NH_3, N_2 and N_2O
(4) N_2, N_2O and NH_3 (5) N_2, NH_3 and N_2O

27. Which of the following would occur soon after connecting a rod of Zn and a rod of Ag immersed in a saturated solution of AgCl and AgCl(s) kept in a beaker as shown in the diagram, by a conductor?

$Zn^{2+}(aq) + e \longrightarrow Zn(s)$ $E^\circ = -0.76$ V

$Ag^+(aq) + e \longrightarrow Ag(s)$ $E^\circ = 0.80$ V

(1) Zn dissolves, Ag deposits, AgCl(s) dissolves.
(2) Zn dissolves, Ag dissolves, AgCl(s) dissolves.
(3) Zn dissolves, Ag dissolves, AgCl(s) deposits.
(4) Zn deposits, Ag dissolves, AgCl(s) dissolves.
(5) Chloride concentration in the solution decreases.



[See page six

28. In the reaction sequence given below, the structures of ℙ and ℚ respectively are,

$$C_6H_5C{\equiv}CH \xrightarrow{Hg^{2+}/\text{dil. } H_2SO_4} \mathbb{P} \xrightarrow[\text{conc. HCl}]{Zn/Hg} \mathbb{Q}$$

(1) $C_6H_5\underset{\underset{OH}{|}}{C}{=}CH_2$, $C_6H_5CH{=}CH_2$ (2) $C_6H_5CH{=}\underset{\underset{OH}{|}}{C}H$, $C_6H_5CH{=}CH_2$

(3) $C_6H_5{-}\overset{\overset{O}{\|}}{C}{-}CH_3$, $C_6H_5{-}\underset{\underset{H}{|}}{\overset{\overset{OH}{|}}{C}}{-}CH_3$ (4) $C_6H_5{-}\overset{\overset{O}{\|}}{C}{-}CH_3$, $C_6H_5CH_2CH_3$

(5) $C_6H_5\underset{\underset{OH}{|}}{C}{=}CH_2$, $C_6H_5\underset{\underset{OH}{|}}{C}HCH_3$

29. Which of the following statements is incorrect regarding polymers?
(1) Bakelite is a thermosetting polymer.
(2) Teflon is a thermoplastic polymer.
(3) Nylon 6,6 is formed by addition polymerisation between 1,6–diaminohexane and hexanedioic acid.
(4) Terelene is formed by condensation polymerisation between ethylene glycol and terephthalic acid.
(5) Natural rubber consists of *cis*-polyisoprene chains.

30. An experiment was carried out to find the order (m) with respect to $S_2O_3^{2-}$ of the reaction $S_2O_3^{2-}(aq) + 2H^+(aq) \longrightarrow H_2O(l) + SO_2(g) + S(s)$. Initial rate of the reaction (R) was measured by adding different volumes (v) of 0.01 mol dm^{-3} $S_2O_3^{2-}$ into a solution of an acid. The H^+ concentration of the reaction mixture was kept constant, but the total volume (V) was allowed to vary. Which of the following relations regarding the initial rate of the reaction is correct?

(1) $R \propto \left(\frac{v}{V}\right)^m$ (2) $R \propto v^m$ (3) $R \propto v^{\frac{1}{m}}$ (4) $R \propto \left(\frac{v}{V}\right)^{\frac{1}{m}}$ (5) $R \propto V^m$

○ For each of the questions 31 to 40, one or more responses out of the four responses (*a*), (*b*), (*c*) and (*d*) given is/are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark
(1) if only (*a*) and (*b*) are correct.
(2) if only (*b*) and (*c*) are correct.
(3) if only (*c*) and (*d*) are correct.
(4) if only (*d*) and (*a*) are correct.
(5) if any other number or combination of responses is correct.

Summary of above Instructions

(1)	(2)	(3)	(4)	(5)
Only (*a*) and (*b*) are correct	Only (*b*) and (*c*) are correct	Only (*c*) and (*d*) are correct	Only (*d*) and (*a*) are correct	Any other number or combination of responses is correct

31. Consider a titration between a weak acid (fixed volume) and a strong base. Which of the following is/are independent of the weak acid concentration?
(*a*) pH at the equivalence point.
(*b*) Volume of the strong base required to reach the end point.
(*c*) Dissociation constant of the weak acid.
(*d*) Value of $[H^+] \times [OH^-]$ of the solution in the titration flask.

[See page seven

32. Which of the following statements is/are true regarding the molecule given below?

$$\underset{a}{CH_3}-\underset{b}{C}\equiv\underset{c}{C}-\underset{d}{CHO}$$

(*a*) All four carbon atoms lie in the same plane.
(*b*) The angle between C_d-H and the C_d-C_c bonds is approximately 120°.
(*c*) Between C_b and C_c, there are two σ-bonds and one π-bond.
(*d*) Between C_b and C_c, there is one σ-bond and two π-bonds.

33. Which of the following statement/s is/are true with regard to the manufacture of Na_2CO_3?
(*a*) CO_2 is one of the raw materials used.
(*b*) The reaction between CO_2 and aqueous NaCl saturated with NH_3 is endothermic.
(*c*) The manufacturing process involves five stages.
(*d*) Most of the NH_3 used in the process can be recovered.

34. Temperature must be maintained at a constant value during the experimental determination of the order of an elementary reaction, because,
(*a*) the order of the reaction depends on temperature.
(*b*) the activation energy changes with temperature.
(*c*) the mechanism of the reaction changes with temperature.
(*d*) the rate constant changes with temperature.

35. Which of the following statement/s is/are true regarding ethene and ethyne?
(*a*) CaC_2 reacts with water to form ethyne.
(*b*) CaC_2 reacts with water to form ethene.
(*c*) Ethene reacts with ammoniacal $AgNO_3$ to give a precipitate.
(*d*) Ethyne reacts with ammoniacal Cu_2Cl_2 to give a precipitate.

36. Which of the following statement/s is/are true with regard to halogens?
(*a*) The boiling points of halogens increase down the group.
(*b*) Unlike other halogens, fluorine always has an oxidation state of (–1) except in F_2.
(*c*) All halogens are good reducing agents.
(*d*) Although fluorine is the most reactive of all the elements in the Periodic Table, it does not react with inert gases.

37. For the reaction $C(s)+CO_2(g) \rightleftharpoons 2\,CO(g)$ occurring in a closed rigid container, percentage yields of CO(g) at 700 °C and 800 °C are 60% and 80% respectively. Which of the following statement/s is/are correct regarding the above reaction?
(*a*) The reaction is endothermic.
(*b*) The reaction is exothermic.
(*c*) Reverse reaction is favoured by decreasing the temperature.
(*d*) Equilibrium can be shifted towards the reactants by removing C(s).

38. Cyclopropane ⟶ propene is an elementary reaction.
Which of the following statement/s is/are correct regarding the above reaction?
(*a*) Half life of the reaction depends on cyclopropane concentration.
(*b*) Rate of the reaction does not depend on propene concentration.
(*c*) The fraction of cyclopropane molecules having energy greater than the activation energy increases with increasing temperature.
(*d*) Reaction occurs *via* a bimolecular collision (molecularity = 2).

39. Which of the following statement/s is/are true regarding 3–hexene?
(*a*) Does not show geometric isomerism.
(*b*) Shows optical isomerism.
(*c*) The compound obtained when reacted with H_2/Pd does not show optical isomerism.
(*d*) The compound obtained when reacted with HBr shows optical isomerism.

[*See page eight*

40. Which of the following statements is/are **correct** with regard to the nitrogen cycle?
(*a*) N_2 in the atmosphere is fixed only by atmospheric and industrial fixation.
(*b*) N_2 is reduced during atmospheric fixation.
(*c*) N_2 is oxidized during industrial fixation.
(*d*) Nitrates and nitrites formed during atmospheric fixation are utilized by plants to make proteins when the rainfall deposit them on the ground.

○ In question Nos. 41 to 50, two statements are given in respect of each question. From the Table given below, select the response out of the responses (1), (2), (3), (4) and (5) that **best** fits the two statements and mark appropriately on your answer sheet.

Response	First Statement	Second Statement
(1)	True	True, and correctly explains the first statement
(2)	True	True, but does not explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First Statement	Second statement
41.	$BaCO_3$ is more thermally stable than $MgCO_3$.	Polarizing power of group two cations decreases down the group.
42.	The lone pair of electrons on nitrogen in an amine has a lower tendency to form a bond with H^+, than the lone pair of electrons on oxygen in an alcohol.	Nitrogen is less electronegative than oxygen.
43.	A reaction at equilibrium can be driven forward (i.e. shift of equilibrium point to the right) by adding a catalyst.	The catalyst provides a pathway with a low activation energy only to the forward reaction.
44.	CO_3^{2-} and SO_3^{2-} ions have similar shapes.	Central atoms of both CO_3^{2-} and SO_3^{2-} have lone pairs of electrons.
45.	The boiling point of $CH_3CH_2CH_2OH$ is higher than the boiling points of CH_3CH_2CHO and CH_3COCH_3.	The carbon oxygen double bond is stronger than the carbon oxygen single bond.
46.	A reaction occurring spontaneously in an isolated system always has a negative Gibbs energy change.	A process in an isolated system cannot be changed from outside.
47.	Commonly used soap contain the sodium or potassium salts of fatty acids formed by the reaction of NaOH or KOH with oils and fats.	The reaction of an ester with aqueous NaOH or KOH gives the sodium or potassium salt of the carboxylic acid and the alcohol.
48.	C_6H_5Br does not react easily with NaOH to form C_6H_5OH.	The phenyl carbocation is very stable.
49.	When an aqueous solution of a weak acid is diluted, both the fraction of dissociated acid molecules and pH of the medium are increased.	Dissociation of weak acid molecules occur in such a way that the acid dissociation constant K_a remains constant.
50.	In the presence of sunlight CO_2 is fixed in green plants.	Increase of CO_2 level in the atmosphere cannot be controlled by green plants.

***

[*See page nine*

The Periodic Table

	1																2
1	H																He
	3	4											5	6	7	8	9	10
2	Li	Be											B	C	N	O	F	Ne
	11	12											13	14	15	16	17	18
3	Na	Mg											Al	Si	P	S	Cl	Ar
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
	55	56	La-	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
6	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
	87	88	Ac-	104	105	106	107	108	109	110	111	112	113					
7	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Uut	...				

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr