AL/2017/02/E-I

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கல்விப் பொதுத் தராதர (உயர் தர)ப் பரீட்சை, 2017 ஓகஸ்ட்
General Certificate of Education (Adv. Level) Examination, August 2017

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இரசாயனவியல்	I	02 E I	இரண்டு மணித்தியாலம்
Chemistry	I		Two hours

Instructions:

* Periodic Table is provided.
* This paper consists of 08 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 $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
Avogadro constant $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$
Planck's constant $h = 6.626 \times 10^{-34} \text{ J s}$
Velocity of light $c = 3 \times 10^8 \text{ m s}^{-1}$

1. The scientist who disproved Thomson's 'plum pudding' model of the atomic structure is,
    (1) Ernest Rutherford.   (2) Robert Millikan.   (3) Niels Bohr.
    (4) Eugen Goldstein.   (5) Henry Moseley.

2. Which of the following statements is false with regard to the following molecules?
    CO_2, BF_3, PF_3, CF_4, XeF_4, SF_6
    (1) All molecules have polar covalent bonds.
    (2) All molecules have different shapes.
    (3) All molecules do not obey the octet rule.
    (4) All molecules are nonpolar.
    (5) Only two molecules possess lone pairs of electrons on their central atoms.

3. What is the IUPAC name of the following compound?

$$H-C\equiv C-CH-CH-CH_2CH_3$$

with CHO on the CH and OH on the adjacent CH

    (1) 4-formylhex-1-yn-3-ol   (2) 4-formyl-3-hydroxyhex-1-yne
    (3) 2-ethyl-3-hydroxy-4-ynepentanal   (4) 3-hydroxy-4-ethyl-1-ynepentanal
    (5) 2-ethyl-3-hydroxypent-4-ynal

4. The oxidation state of nitrogen is -1 in,
    (1) N_2O_4 (2) N_2O (3) NO_2F (4) NH_3 (5) NH_2OH

5. Several shapes of molecules originate based on the trigonal bipyramidal electron pair geometry around the central atom. They are,
    (1) linear, angular, see-saw.
    (2) linear, T-shape, see-saw.
    (3) linear, trigonal pyramidal, T-shape.
    (4) trigonal planar, angular, T-shape.
    (5) linear, trigonal planar, see-saw.

6. Ammonium nitrate decomposes explosively at high temperature to form nitrogen gas, oxygen gas and water vapour. The total number of litres of gases formed at standard temperature and pressure when 240 g of ammonium nitrate is decomposed is,
    (H = 1, N = 14, O = 16, At standard temperature and pressure one mole of gas occupies 22.4 litres)
   (1) 33.6   (2) 67.2   (3) 100.8   (4) 134.4   (5) 235.2

[See page two

7. AX and BX_2 are two sparingly soluble salts in water. At room temperature, their solubility products are K_{sp_1} and K_{sp_2} respectively. Solubility of AX is p while that of BX_2 is q. When each salt is in equilibrium with its saturated solution, if $\dfrac{K_{sp_1}}{\left[A^+_{(aq)}\right]}=\dfrac{K_{sp_2}}{\left[B^{2+}_{(aq)}\right]}$, which of the following is correct?

    (1) $p = q^2$ (2) $p^2 = q$ (3) $4p = q^2$ (4) $p = 4q^2$ (5) $p = 2q^2$

8. Which of the following statements is false with regard to alkali and alkaline earth metals?
   (1) All alkaline earth metals react with N_2 gas at high temperature.
   (2) The melting points of alkaline earth metals are higher than the melting points of alkali metals in the same period.
   (3) Second ionization energies of alkali metals are much higher than those of alkaline earth metals in the same period.
   (4) All hydroxides formed by alkaline earth metals are strong bases.
   (5) The solubility of alkali metal hydroxides increases down the group.

9. The effective nuclear charge felt by the valence electron in lithium (Li) is,
   (Li, Z = 3 and relative atomic mass = 7)
   (1) equal to +3   (2) less than +3   (3) greater than +3
   (4) equal to +7   (5) less than +7

10. The following equilibrium exists in a closed-rigid container at a given temperature.
    $$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$
    An extra amount of $O_2(g)$ is added into the container at the same temperature. After the equilibrium is re-established, which of the following has a lower value compared to its value at the initial equilibrium?
    (1) Equilibrium constant of the reaction.   (2) The total pressure of the system.
    (3) The amount of $SO_2(g)$ in the system.   (4) The amount of $SO_3(g)$ in the system.
    (5) The amount of $O_2(g)$ in the system.

11. Which of the following is true regarding the O—N—O angle of the nitrogen species?
    (1) $NO_2^+ > NO_2^- > NO_2 > NO_4^{3-}$ (2) $NO_4^{3-} > NO_2^+ > NO_2 > NO_2^-$
    (3) $NO_2^+ > NO_2 > NO_2^- > NO_4^{3-}$ (4) $NO_4^{3-} > NO_2 > NO_2^- > NO_2^+$
    (5) $NO_2^+ > NO_2^- > NO_4^{3-} > NO_2$

12. A lamp produces 6.0 J of energy per second in the blue region (470 nm) of the visible light. For how long should the lamp be lit to generate 1.0×10^{20} photons?
    (1) 2.4 s   (2) 7.1 s   (3) 8.5 s   (4) 9.2 s   (5) 10.5 s

13. A reaction is spontaneous at 298 K and 100 kPa pressure, while it is non-spontaneous at high temperature and the same pressure. Which of the following is true for this reaction at 298 K and 100 kPa pressure?

	ΔG	ΔH	ΔS
(1)	positive	positive	positive
(2)	negative	negative	negative
(3)	negative	negative	positive
(4)	negative	positive	negative
(5)	positive	positive	negative

14. The following procedure was used to determine the molar mass of an unknown gas X. First, the mass of a rigid container of volume V containing dry air was measured as m_1. Then the dry air was removed and the container was filled with an unknown gas X and the mass was measured as m_2. Both the dry air and unknown gas, were at the same temperature (T) and pressure (P). Density of dry air is d. Which of the following expressions gives the molar mass of the unknown gas?

  (1) $\dfrac{dRT}{P}$ (2) $\dfrac{\left[m_2 - (m_1 - dV)\right]RT}{PV}$ (3) $\dfrac{(m_1 - m_2)RT}{PV}$

  (4) $\dfrac{(m_2 - m_1)RT}{PV}$ (5) $\dfrac{\left[m_1 - (m_2 - dV)\right]RT}{PV}$

15. A buffer solution is prepared by mixing a volume V_1 of a monobasic weak acid with a volume V_2 of a monoacidic strong base. The initial concentrations of the weak acid and the strong base are C_1 and C_2, respectively. The acid dissociation constant of the weak acid is K_a. If the pH of the buffer solution is to be maintained between $pK_a - 1$ and $pK_a + 1$, which of the following expressions gives the correct relationship for C_1, C_2, V_1 and V_2?

   (1) $\dfrac{1}{10} < \dfrac{C_2 V_2}{C_1 V_1 - C_2 V_2} < 10$ (2) $\dfrac{1}{10} < \dfrac{C_1 V_1}{C_1 V_1 - C_2 V_2} < 10$ (3) $\dfrac{1}{10} < \dfrac{C_2 V_2}{C_1 V_1} < 10$

   (4) $\dfrac{1}{10} < \dfrac{C_1 V_1 - C_2 V_2}{C_2 V_2} < 10$ (5) $1 < \dfrac{C_1 V_1}{C_2 V_2} < 10$

16. Which of the following is not a resonance structure of aniline?

   (1)   (2)   (3)   (4)   (5)
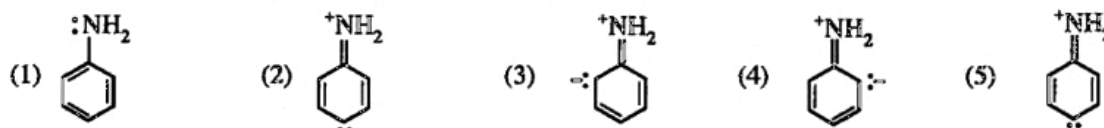
17. The initial rate of a zero-order reaction is R_0 and its rate constant is k. The rate of the reaction when the initial concentration is reduced by 50% is,

   (1) k (2) $\dfrac{1}{k}$ (3) $\dfrac{k}{2}$ (4) $\dfrac{R_0}{2}$ (5) $\dfrac{R_0}{4}$

18. An electrochemical cell was constructed by connecting half-cells of $Ni^{2+}(aq, 1.0\,M)/Ni(s)$ and $Cu^{2+}(aq, 1.0\,M)/Cu(s)$ with a voltmeter and a salt bridge. The overall cell reaction and the initial reading of the voltmeter when the half-cells are connected are,

   $$\left(E^o_{Ni^{2+}/Ni} = -0.24V \quad \text{and} \quad E^o_{Cu^{2+}/Cu} = +0.34V \right)$$

   (1) $Ni^{2+}(aq) + Cu(s) \longrightarrow Ni(s) + Cu^{2+}(aq)$;   0.00 V

   (2) $Cu^{2+}(aq) + Ni(s) \longrightarrow Cu(s) + Ni^{2+}(aq)$;   +0.58 V

   (3) $Cu^{2+}(aq) + Ni(s) \longrightarrow Cu(s) + Ni^{2+}(aq)$;   −0.58 V

   (4) $Cu^{2+}(aq) + Ni(s) \longrightarrow Cu(s) + Ni^{2+}(aq)$;   0.00 V

   (5) $Cu(s) + Ni(s) \longrightarrow Cu^{2+}(aq) + Ni^{2+}(aq) + 4e$;   +0.58 V

19. Solid diiodine pentoxide (I_2O_5) reacts with carbon monoxide at room temperature to give carbon dioxide and iodine. This can be used to measure the amount of carbon monoxide in a sample of air. An air sample of $5.0\,dm^3$ was passed through a tube containing I_2O_5 and the liberated iodine was collected in an aqueous KI solution (KI in excess). The resulting solution was titrated with $0.005\,mol\,dm^{-3}$ $Na_2S_2O_3$ solution using starch as the indicator. The volume of $Na_2S_2O_3$ required was $10.00\,cm^3$. The concentration (in ppm) of carbon monoxide in the air sample is, ($C=12$, $O=16$, density of the air sample $= 1.40 \times 10^{-3}\,g\,cm^{-3}$)

   (1) 100   (2) 250   (3) 500   (4) 700   (5) 1000

20. Which of the following statements is false with regard to sulfur and its compounds?
   (1) S is a non metal with oxidation states in the range −2 to +6.
   (2) S reacts with conc. H_2SO_4 giving SO_3 as one of the products.
   (3) SO_2 can act both as an oxidizing agent and as a reducing agent.
   (4) Burning large quantities of S contributes to acid rain.
   (5) Concentrated H_2SO_4 can act as a strong acid, an oxidizing agent and a dehydrating agent.

21. At 298 K, for the reaction $N_2(g) + 3F_2(g) \longrightarrow 2NF_3(g)$, $\Delta H° = -263\,kJ\,mol^{-1}$. Bond dissociation enthalpies of $N \equiv N$ and $N - F$ are $946\,kJ\,mol^{-1}$ and $272\,kJ\,mol^{-1}$, respectively. The value (in $kJ\,mol^{-1}$) of the bond dissociation enthalpy of the $F - F$ bond is,
   (1) −423   (2) −393   (3) −141   (4) 141   (5) 423

22. Which of the following statements is false with regard to 3d-block elements?
   (1) Sc, Ti and Zn do not exhibit variable valency.
   (2) 3d-block elements are good industrial catalysts.
   (3) Mn forms acidic, amphoteric and basic oxides.
   (4) Zn has the lowest melting point among all 3d-block elements.
   (5) Positive oxidation states of V range from +2 to +5.

[See page four

23. The following thermochemical data are given for the reaction.

$$3NO(g) \rightleftharpoons NO_2(g) + N_2O(g)$$
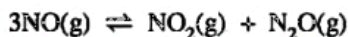
$$\Delta H^\circ_{f_{NO_2(g)}} = 35 \text{ kJ mol}^{-1}, \quad \Delta H^\circ_{f_{N_2O(g)}} = 80 \text{ kJ mol}^{-1}, \quad \Delta H^\circ_{f_{NO(g)}} = 90 \text{ kJ mol}^{-1}$$
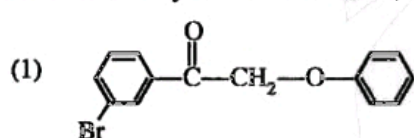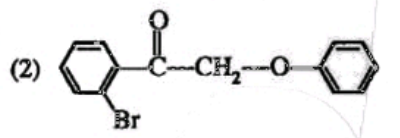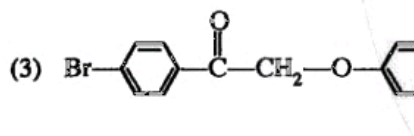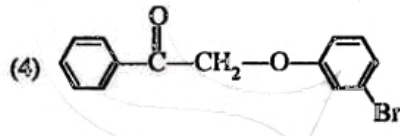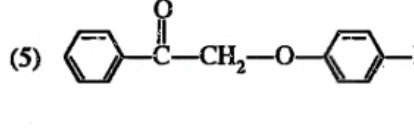
Which of the following statements is true for the reaction above?

(1) $\Delta H^\circ = -155 \text{ kJ mol}^{-1}$ while the value of the equilibrium constant of the reaction decreases with increasing temperature.

(2) $\Delta H^\circ = 155 \text{ kJ mol}^{-1}$ while the value of the equilibrium constant of the reaction decreases with increasing temperature.

(3) $\Delta H^\circ = -25 \text{ kJ mol}^{-1}$ while the value of the equilibrium constant of the reaction decreases with increasing temperature.

(4) $\Delta H^\circ = 25 \text{ kJ mol}^{-1}$ while the value of the equilibrium constant of the reaction decreases with increasing temperature.

(5) $\Delta H^\circ = -155 \text{ kJ mol}^{-1}$ while the value of the equilibrium constant of the reaction increases with increasing temperature.
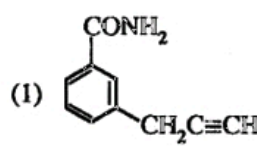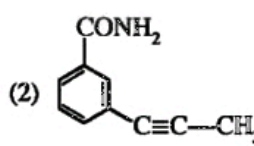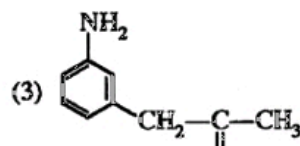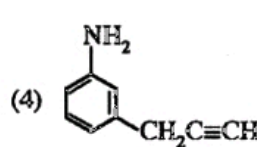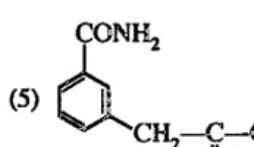
24. Consider the following reaction.
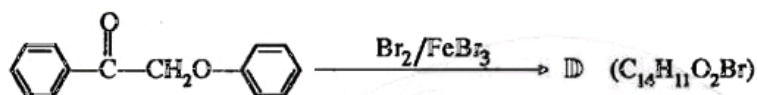
The most likely structure of D is,

25. Compound A reacts with $LiAlH_4$ to give B. B is more basic than A. B liberates N_2 when treated with $NaNO_2/HCl$ at $0-5\,^\circ C$. Both A and B react with ammoniacal $AgNO_3$ to give precipitates. The structure of A could be,

26. Which of the following statements is true with regard to ozone layer depletion?

(1) Chlorofluorocarbons (CFCs) react directly with ozone and deplete the ozone layer.

(2) Falling of IR radiation on the earth surface is encouraged by the depletion of the ozone layer.

(3) Hydrofluorocarbons (HFCs) contribute to ozone layer depletion.

(4) Ozone in the ozone layer undergoes natural decomposition in the presence of ultraviolet radiation.

(5) Ozone layer depletion takes place only by $ClO^{\bullet}$ free radicals.

27. Which of the following is true about the half-reaction,

$AlF_6^{3-}(aq) + 3e \longrightarrow Al(s) + 6\ F^-(aq)$, that occurs in an electrolytic cell?
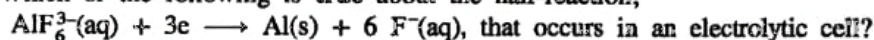
  (1) Al is oxidized.
  (2) AlF_6^{3-} is reduced.
  (3) Oxidation state of Al is changed from −3 to 0.
  (4) F^- acts as a reducing agent.
  (5) F^- is reduced.

28. $CH_3CHO \xrightarrow{\ OH^-\ } P \xrightarrow{\ H^+\ } Q \xrightarrow[\text{(2) } H^+]{\text{(1) } CH_3MgBr} R$
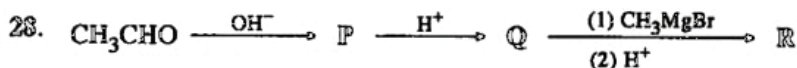
In the reaction scheme given above, the structures of P, Q and R respectively are,

(1) $CH_3CH_2\overset{\overset{\displaystyle OH}{|}}{C}HCHO$, $CH_3CH{=}CHCHO$, $CH_3CH{=}CH{-}\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}{-}OH$

(2) $CH_3\overset{\overset{\displaystyle OH}{|}}{C}HCH_2CHO$, $CH_3CH{=}CHCHO$, $CH_3CH{=}CH{-}\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}{-}OH$

(3) $CH_3\overset{\overset{\displaystyle OH}{|}}{C}HCH_2CHO$, $CH_2{=}CHCH_2CHO$, $CH_2{=}CH{-}CH_2{-}\overset{\overset{\displaystyle CH_3}{|}}{C}HOH$

(4) $CH_3\overset{\overset{\displaystyle OH}{|}}{C}HCH_2CHO$, $CH_3CH{=}CHCHO$, $CH_3CH{=}CH{-}\overset{\overset{\displaystyle CH_3}{|}}{C}HOH$

(5) $CH_3CH_2\overset{\overset{\displaystyle OH}{|}}{C}HCHO$, $CH_3CH{=}CHCHO$, $CH_3CH{=}CH{-}\overset{\overset{\displaystyle CH_3}{|}}{C}HOH$

29. The repeating unit of natural rubber is,

30. The phase diagram of an element is shown in the figure. Which of the following statements is false with regard to the phase diagram of this element?

  (1) There is one T, P condition at which the phases S_1, S_2 and G are in equilibrium.
  (2) There is one T, P condition at which the phases S_1, S_2 and L are in equilibrium.
  (3) There is one T, P condition at which the phases S_2, L and G are in equilibrium.
  (4) There is one T, P condition at which the phases S_1, L and G are in equilibrium.
  (5) Three T, P conditions at which more than two phases are in equilibrium are shown in the phase diagram.
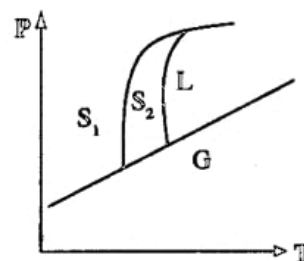
○ For each of the questions 31 to 40, one or more responses out of the four responses (a), (b), (c) and (d) given is/are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark
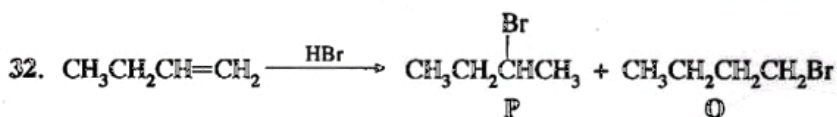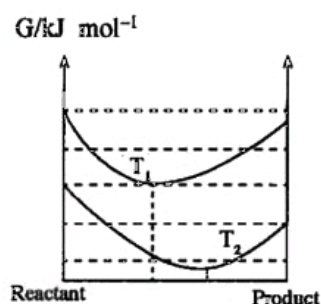
(1) if only (a) and (b) are correct.
(2) if only (b) and (c) are correct.
(3) if only (c) and (d) are correct.
(4) if only (d) and (a) are correct.
(5) if any other number or combination of responses is correct.

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. The variation of standard Gibbs energy of $A(g) \rightleftharpoons B(g)$ with the extent of reaction at two temperatures T_1, T_2 $(T_2 > T_1)$ and constant pressure is shown in the figure. Which of the following statements is/are correct for this reaction?
    (a) Equilibrium constant at T_2 is greater than that at T_1.
    (b) The reaction is endothermic.
    (c) The reaction has a positive ΔS° value.
    (d) The reaction is exothermic.

32. $CH_3CH_2CH=CH_2 \xrightarrow{HBr} CH_3CH_2\overset{\overset{\displaystyle Br}{|}}{C}HCH_3 + CH_3CH_2CH_2CH_2Br$
    $\qquad\qquad\qquad\qquad\qquad\qquad\quad P \qquad\qquad\qquad\qquad Q$

    Which of the following statements is/are correct regarding the above reaction?
    (a) This reaction is a nucleophilic addition reaction.
    (b) P is the major product.
    (c) A carbocation is formed in the first step of the reaction.
    (d) Q is the major product.

33. The following statements refer to certain industrial processes. Which of the following statements is/are correct?
    (a) Baby soap is manufactured using KOH.
    (b) Reaction of SO_2 with O_2 to give SO_3 in the contact process is favoured under low pressures.
    (c) K_2CO_3 can be synthesised using the Solvay process.
    (d) Cathode and anode compartments are separated by a diaphragm to prevent the reaction between Na and chlorine gas in the manufacture of Na using the Down's cell.

34. Which of the following is/are always correct for the slowest step of a multi-step reaction?
    (a) Its molecularity is an integer.
    (b) Its molecularity is higher than the overall order of the reaction.
    (c) Overall rate of the reaction depends on its rate.
    (d) Its molecularity is equal to the number of steps in the reaction.

35. Which of the following reaction steps is/are most unlikely to take place, when Cl_2 reacts with CH_4 in the presence of light?
    (a) $\overset{\displaystyle \cdot}{C}H_3 + Cl_2 \longrightarrow CH_3Cl + \overset{\displaystyle \cdot}{C}l$
    (b) $\overset{\displaystyle \cdot}{C}H_3 + \overset{\displaystyle \cdot}{C}l \longrightarrow CH_3Cl$
    (c) $CH_4 + \overset{\displaystyle \cdot}{C}l \longrightarrow CH_3Cl + \overset{\displaystyle \cdot}{H}$
    (d) $\overset{\displaystyle \cdot}{C}l + \overset{\displaystyle \cdot}{H} \longrightarrow HCl$

36. Which of the following statements is/are correct with regard to NH_3 and NF_3?
    (a) Bonded pair repulsions are weaker in NF_3 than in NH_3.
    (b) NF_3 has a higher dipole moment than NH_3.
    (c) NF_3 is a stronger Lewis base than NH_3.
    (d) The electronegativity difference between N and H in NH_3 and that between N and F in NF_3 are nearly equal.

37. The equilibrium constant for the reaction $2NO(g) + Br_2(g) \rightleftharpoons 2NOBr(g)$ at $1000\,K$ is $1.25 \times 10^{-2}\,mol^{-1}\,dm^3$. At this temperature, which of the following statements is/are correct?
    (a) Equilibrium mixture consists mainly of $NO(g)$ and $Br_2(g)$ and the equilibrium constant for the reverse reaction is $80\,mol\,dm^{-3}$.
    (b) Equilibrium mixture consists mainly of $NOBr(g)$ and the equilibrium constant for the reverse reaction is $80\,mol\,dm^{-3}$.
    (c) Equilibrium mixture consists mainly of $NO(g)$ and $Br_2(g)$ and the equilibrium constant for the reverse reaction is $1.25 \times 10^{-2}\,mol^{-1}\,dm^3$.
    (d) Equilibrium mixture consists mainly of $NOBr(g)$ and the equilibrium constant for the reverse reaction is $1.25 \times 10^{-2}\,mol^{-1}\,dm^3$.

38. Which of the following statements is/are correct regarding an elementary bimolecular reaction in the gas phase?
    (a) The experimentally determined order of the reaction is two only when the concentrations of reactants are equal.
    (b) The experimentally determined order of the reaction becomes three when the concentrations of reactants are in the $1:3$ ratio.
    (c) When the concentration of one of the reactants is in large excess compared to the other, the rate of the reaction becomes independent of the concentration of that reactant.
    (d) When the volume of the container containing reactants is reduced at a constant temperature, the rate of collision between reactant molecules increases.

39. Which of the following statements regarding methyl benzene (toluene) is/are correct?

Toluene
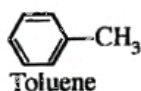
    (a) All carbon atoms lie in the same plane.
    (b) Lengths of all carbon carbon bonds are equal to each other.
    (c) Lengths of all carbon hydrogen bonds are equal to each other.
    (d) Any C—C—C bond angle is $120°$.

40. Which of the following statements is/are correct regarding air pollution?
    (a) Sulphates in water bodies is a source of atmospheric H_2S.
    (b) Conversion of $SO_2(g)$ to $SO_3(g)$ is accelerated by $NO(g)$.
    (c) $NO(g)$ emitted during fossil fuel combustion is not considered as an air pollutant.
    (d) $SO_2(g)$ in the atmosphere is removed by lightning.

○ 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.	C—O bonds in the bicarbonate ion are identical.	Bicarbonate ion is a resonance hybrid of three stable resonance structures.
42.	It is not possible to prepare a Grignard reagent by reacting $HOCH_2CH_2Br$ with Mg in dry ether.	Grignard reagent does not react with compounds having a hydroxyl group.
43.	Increasing the pressure of the equilibrium mixture $2H_2(g) + CO(g) \rightleftharpoons CH_3OH(g)$ at constant temperature shifts the position of equilibrium to the right.	When the pressure of a gas mixture at chemical equilibrium is increased at constant temperature, the reaction occurs in such a way as to decrease the number of moles.

	First Statement	Second statement
44.	Solubility of group II sulphates and carbonates decreases down the group whereas the opposite is observed for hydroxides.	Solubility of an ionic compound depends only on its hydration energy.
45.	The reactivity of alkanes with electrophiles is less than that of alkenes.	The C—H bonds in hydrocarbons have a low polarity due to the small difference in electronegativity between carbon and hydrogen atoms.
46.	The entropy of the surroundings increases when water vapour in a closed container undergoes condensation.	Heat absorbed by a closed system increases the thermal motion of surroundings.
47.	The cathode compartment and anode compartment of the membrane cell used in the manufacture of NaOH are separated by an ion selective membrane.	The ion selective membrane used in the membrane cell does not allow the transfer of cations.
48.	2–butene shows diastereoisomerism.	There are two possible structures for 2-butene, which are not mirror images of each other.
49.	Solubility of $MnS(s)$ in water at room temperature does not depend on pH.	$S^{2-}(aq)$ is the conjugate base of a weak acid.
50.	The melting points of d-block elements are higher than the melting points of s-block elements.	d and s electrons are available to take part in delocalization in forming metallic bonds in d-bolck elements.

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The Periodic Table

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

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