Universal gas constant, R	$= 8{\cdot}314\ \text{J K}^{-1}\ \text{mol}^{-1}$
Avogadro Constant, N_A	$= 6{\cdot}022 \times 10^{23}\ \text{mol}^{-1}$

1. The element that shows the maximum valency of 7 and the maximum oxidation number of +7 is
(1) Cr (2) Mn (3) N (4) Fe (5) Se

2. The molecule / ion that has a shape different to that of the PO_4^{3-} ion is
(1) $POCl_3$ (2) $SiCl_4$ (3) CH_4 (4) ICl_4^- (5) SO_4^{2-}

3. $O_2(g)$ in a glass vessel is partially converted to $O_3(g)$ by means of an electric discharge, according to the following equation,

$$3\,O_2(g) \rightarrow 2\,O_3(g)$$

When 30% of $O_2(g)$ is converted to $O_3(g)$, the reduction in the pressure inside the vessel is
(1) 5% (2) 10% (3) 15% (4) 20% (5) 25%

4. Which of the following arrangements gives the correct increasing order of boiling points of the compounds?
(1) $C_2H_5OH < C_2H_6 < C_2H_5F < H_2O$ (2) $C_2H_6 < C_2H_5F < H_2O < C_2H_5OH$
(3) $C_2H_5F < C_2H_6 < C_2H_5OH < H_2O$ (4) $C_2H_6 < C_2H_5F < C_2H_5OH < H_2O$
(5) $C_2H_6 < C_2H_5OH < C_2H_5F < H_2O$

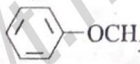
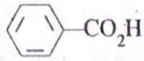
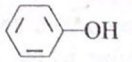
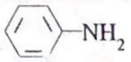
5. 70·0 cm^3 of a 0·1 mol dm^{-3} aqueous HCl solution is mixed with 30·0 cm^3 of a **X** mol dm^{-3} aqueous NaOH solution. If the pH of the resulting solution is 2, the value of **X**, in mol dm^{-3} is
(1) 0·3 (2) 0·2 (3) 0·02 (4) 0·5 (5) 0·05

6. Which of the following aqueous solutions **does not** give sulphur as one of the products when reacted with H_2S?
(1) $FeCl_3$ (2) Br_2 water (3) $Pb(CH_3COO)_2$
(4) HNO_3 (5) H_2SO_3

7. When one mole of gaseous XY is heated in a closed vessel at 750 K, 50% of the gas is dissociated at equilibrium according to the following equation,

$$2\,XY(g) \rightleftharpoons X_2(g) + Y_2(g)$$

K_c for the equilibrium at 750 K is,
(1) 1·0 (2) 0·125 (3) 2·5 (4) 0·25 (5) 0·5

8. Which one of the following compounds has the lowest solubility in water at room temperature?
(1)  (2) CH_3OH (3)  (4)  (5) 

9. When an aqueous solution 1·0 mol dm^{-3} in $K^{127}I$ and 0·1 mol dm^{-3} in $K^{129}I$ is electrolyzed, the composition of the iodine discharged is
(1) $^{127}I_2$ (2) $^{129}I_2$ (3) $^{127}I^{129}I$
(4) a mixture of $^{127}I_2$ and $^{129}I_2$ (5) a mixture of $^{127}I_2$, $^{129}I_2$ and $^{127}I^{129}I$.

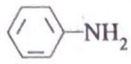
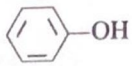
10. 1·92 g of the hydrocarbon C_9H_{20} gave on complete combustion, 5·94 g of $CO_2(g)$ and 2·70 g of water vapour. The mass of oxygen reacted is (H = 1, C = 12, O = 16)
(1) 6·72 g (2) 4·02 g (3) 3·86 g (4) 8·64 g (5) 3·24 g

11. Which of the following molecules has four atoms in a single plane?
(1) SF_4 (2) BCl_3 (3) PCl_3 (4) NH_3 (5) SiH_4

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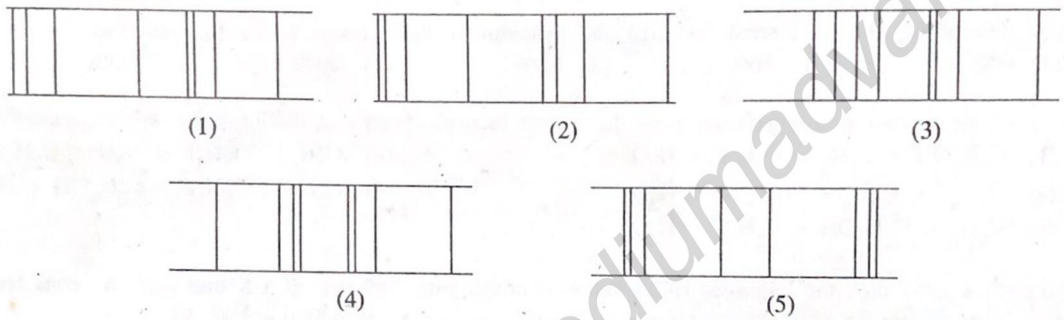
12. Which arrangement given below gives the correct increasing order of basicity of the following compounds A, B, C and D?

(A)  (B) CH_3NH_2 (C) CH_3CH_2OH (D) 

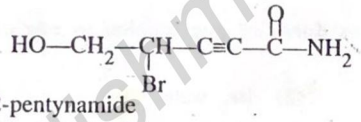
(1) A < B < C < D (2) C < D < A < B (3) D < C < A < B
(4) C < D < B < A (5) A < B < D < C

13. The number of moles of oxidant required to oxidize a given amount of KI to I_2 is lowest for
(1) $K_2Cr_2O_7$ (2) $KMnO_4$ (3) $FeCl_3$ (4) K_2CrO_4 (5) MnO_2

14. Which of the following correctly represents the arrangement of the emission lines in two consecutive series in the atomic spectrum of hydrogen?



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



(1) 4-Bromo-5-hydroxy-2-pentynamide
(2) 2-Bromo-4-carboxamide-3-butynol
(3) 1-Aminocarboxy-3-bromo-4-hydroxybutyne
(4) 4-Bromo-5-hydroxy-1-oxo-2-ynepentamine
(5) 1-Amino-4-bromo-5-hydroxy-2-ynone

16. A primary standard is a solid of exactly known composition, which can be obtained in a high level of purity and which is stable when stored either as a solid or as a solution. The substance suitable as a primary standard for the standardization of an acid is
(1) $Mg(OH)_2$ (2) $MgCO_3$ (3) NaOH (4) Na_2CO_3 (5) KOH

17. Which is the cation that
(a) gives a yellow-brown solution in conc. HCl,
(b) turns CCl_4 layer purple, when shaken with CCl_4 and a solution of KI, and
(c) gives no precipitate when H_2S is passed into an acidified solution?

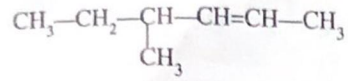
(1) Cr^{3+} (2) Ni^{2+} (3) Cu^{2+} (4) Fe^{3+} (5) Mn^{2+}

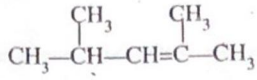
18. When a finely ground mixture of Cu metal and a metal **X**, is placed in a 0·01 mol dm^{-3} aqueous solution of HCl, the pH of the solution increases with time. When the same mixture is placed in 0·01 mol dm^{-3} aqueous solution of NaOH, the pH of the solution decreases with time. **X** is most likely to be,
(1) Hg (2) Fe (3) Zn (4) Mg (5) Ag

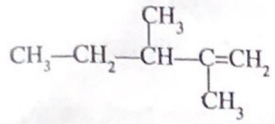
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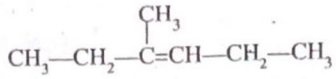
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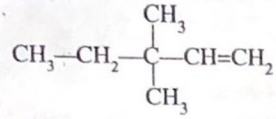
Which of the following molecules will show both optical isomerism and geometric isomerism?

(1) 

(2) 

(3) 

(4) 

(5) 

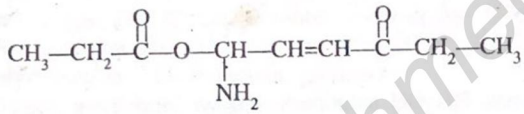
20. **X**, **Y** and **Z** are three consecutive non-transition elements in the Periodic Table. The 1st and 3rd ionization enthalpies of the elements are

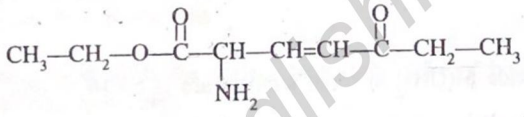
	X	Y	Z
1st ionization enthalpy/kJ mol^{-1}	1012	999	1251
3rd ionization enthalpy/kJ mol^{-1}	2912	3361	3822

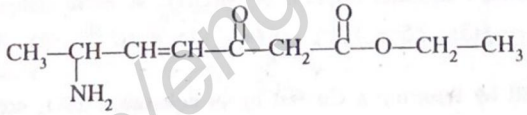
The element **X** belongs to the following group in the Periodic Table

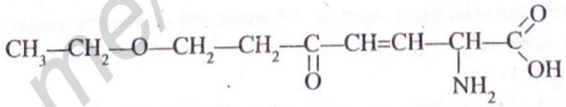
(1) I (2) II (3) III (4) IV (5) V

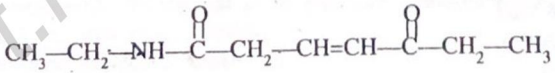
21. Choose the structure which corresponds to the IUPAC name, ethyl 2-amino-5-oxohept-3-enoate.

(1) 

(2) 

(3) 

(4) 

(5) 

22. A weak monobasic acid HA has a dissociation constant of 1×10^{-4} mol dm^{-3} at 25 °C, in aqueous solution. The solutions **B**, **C** and **D** are prepared by mixing separately 10·0 cm^3 portions of **P**, a 0·02 mol dm^{-3} aqueous solution of HA, with other reagents as given below.

10·0 cm^3 of solution **P** + 10·0 cm^3 of water = solution **B**.
10·0 cm^3 of solution **P** + 10·0 cm^3 of 0·004 mol dm^{-3} aqueous HCl solution = solution **C**
10·0 cm^3 of solution **P** + 10·0 cm^3 of 0·004 mol dm^{-3} aqueous NaOH solution = solution **D**

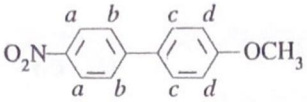
At 25 °C, the decreasing order of concentration of A^- ion in the solutions is

(1) **B** > **C** > **D** (2) **B** > **D** > **C** (3) **D** > **B** > **C** (4) **D** > **C** > **B** (5) **C** > **D** > **B**

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23. Consider the following compound :



At what positions will bromination occur when the above compound is treated with $Br_2 / FeBr_3$?

(1) *a* and *b* (2) *b* and *c* (3) *a* and *c* (4) *c* (5) *d*

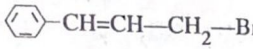
24. Which of the following oxides reacts with water giving a mixture of two acids?

(1) CO_2 (2) NO_2 (3) SO_2 (4) P_2O_5 (5) ClO_2

25. Which of the following compounds will give a Grignard reagent by reacting with Mg in dry ether?

(1) $CH_3—\underset{\displaystyle Br}{\underset{|}{CH}}—CH_2—CH_2—OH$

(2) $CH_3—\underset{\displaystyle Br}{\underset{|}{CH}}—CH_2—NH—CH_3$

(3)  $—CH=CH—CH_2—Br$

(4) $HC\equiv C—CH_2—CH_2—Br$

(5) $CH_3—CH_2—\underset{\displaystyle Br}{\underset{|}{CH}}—CHO$

26. Which of the following tests can be used to distinguish between aqueous solutions of $NiCl_2$ and $CuSO_4$?

(1) Addition of excess NH_4OH solution
(2) Addition of conc. HCl
(3) Passing SO_2 through the solution
(4) Passing H_2S after addition of excess NH_4OH solution
(5) Adding $AgNO_3$ dropwise

27. The solubility product of the ionic hydroxide $M(OH)_2$ at room temperature is 5×10^{-10} $mol^3\,dm^{-9}$. The OH^- ion concentration in mol dm^{-3}, of a saturated aqueous solution of $M(OH)_2$ at room temperature is,

(1) 5×10^{-4} (2) 1×10^{-3} (3) $2{\cdot}5 \times 10^{-5}$ (4) 125×10^{-30} (5) 5×10^{-3}

28. A student prepared an electrochemical cell by inserting a Cu rod in an aqueous $CuSO_4$ solution, a Ag rod in an aqueous $AgNO_3$ solution and making electrical contact between the solutions using a salt bridge. A representation of the cell in standard notation is

(1) $Cu^{2+}(aq)$ / Cu(s) | Ag(s) / $Ag^+(aq)$
(2) Cu(s) / $Cu^{2+}(aq)$ || Ag(s) / $Ag^+(aq)$
(3) $Cu^{2+}(aq)$ / Cu(s) | $Ag^+(aq)$ / Ag(s)
(4) Cu(s) / $Cu^{2+}(aq)$ || $Ag^+(aq)$ / Ag(s)
(5) not possible since the electrodes on the right and left hand sides are not given.

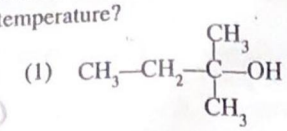
29. The rate of a chemical reaction occurring at constant temperature decreases as the reaction continues because,

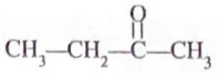
(1) the percentage of reactant molecules having energy in excess of the activation energy decreases.
(2) the rates of the forward and reverse reactions decrease to zero as equilibrium is approached.
(3) the activation energy of the reaction increases.
(4) the concentrations of the reactants decrease with time.
(5) the enthalpy change of the reaction decreases as it proceeds.

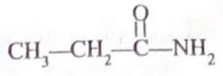
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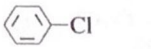
30. Which of the following compounds will turn an acidified solution of sodium dichromate green at room temperature?

(1) 

(2) 

(3) 

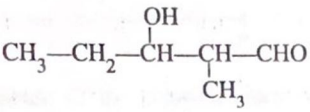
(4) CH_3CH_2OH

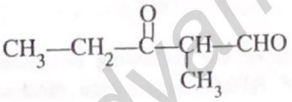
(5) 

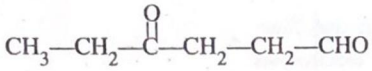
31. The average bond energies of C≡C and C=C bonds are 835 kJ mol^{-1} and 610 kJ mol^{-1} respectively. The most reasonable value of the average bond energy of the C—C bond in kJ mol^{-1} is,

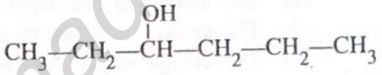
(1) 835–610 (2) 835/3 (3) 610/2
(4) 610–(835–610) (5) (835 + 610)/5

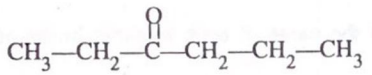
32. Treatment of propanal, CH_3CH_2CHO, with dil. NaOH gives,

(1) 

(2) 

(3) 

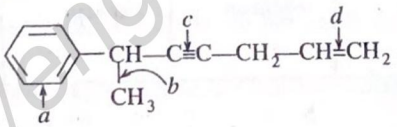
(4) 

(5) 

33. Which of the following statements pertaining to polymers is correct?

(1) Each repeat unit of natural rubber contains two C=C bonds.
(2) PVC is a thermosetting polymer.
(3) Polystyrene is a condensation polymer.
(4) Proteins are formed by the reaction of between diamines and dicarboxylic acids.
(5) Nylon is a polyamide.

34. Which arrangement gives the correct increasing order of bond lengths, of the bonds labelled *a*, *b*, *c* and *d* in the following molecule?



(1) $a < b < c < d$ (2) $a < c < b < d$ (3) $c < a < d < b$
(4) $c < d < a < b$ (5) $d < c < b < a$

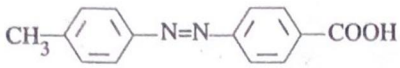
35. Any two compounds having the same empirical formula should have,

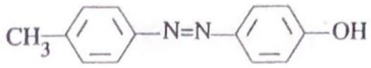
(1) the same molecular formula.
(2) the same molecular mass.
(3) the same percentage composition of elements.
(4) the same number of atoms per molecule in each compound.
(5) the same number of bonds per molecule in each compound.

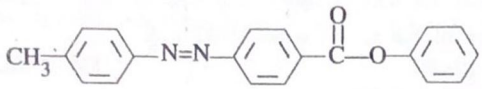
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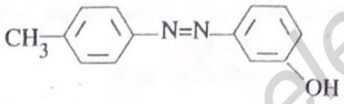
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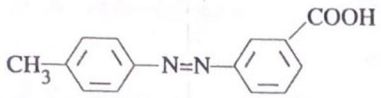
36. The compound  is treated with nitrous acid at 0 – 5 °C and the resultant solution is added to a solution of phenol (C_6H_5OH) and benzoic acid (C_6H_5COOH) in aqueous NaOH at 0 – 5 °C. The major organic product in the reaction is

(1) 

(2) 

(3) 

(4) 

(5) 

37. Which of the following best describes the Faraday Constant?
(1) The charge of an electron.
(2) The charge of one mole of protons.
(3) The current required to discharge one mole of Ag in one hour.
(4) The charge required to produce one mole of H_2 by electrolysis.
(5) The charge of one mole of NaCl.

38. Which one of the following columns 1 to 5 correctly matches the name of each scientist in the column with the activities in the activity column.

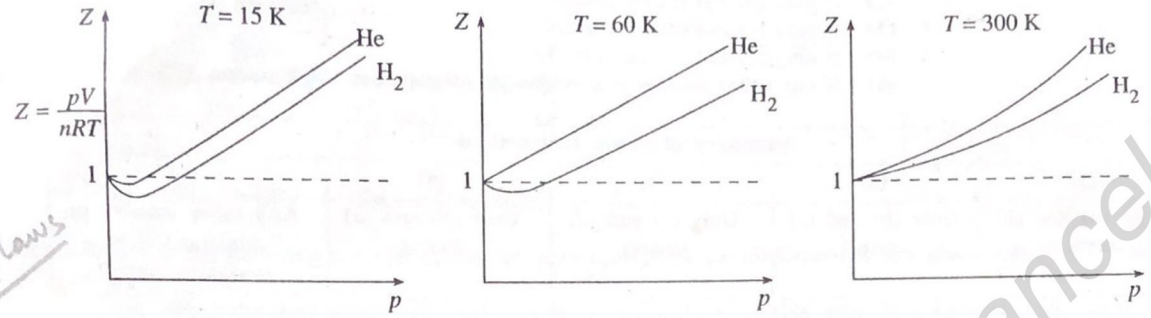
Columns					Activity
1	2	3	4	5	
Bohr	Rutherford	Rutherford	Bohr	Thompson	Proposed the nuclear model of the atom
Rutherford	Bohr	Thompson	Thompson	Bohr	Interpreted the atomic spectrum of hydrogen
Thompson	Thompson	Millikan	Millikan	Faraday	Determined the charge to mass ratio of the electron

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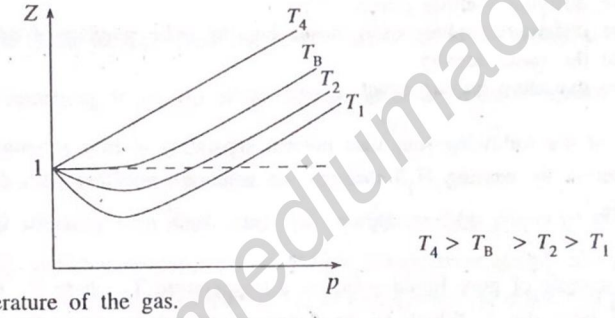
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Use the information given below and your knowledge of chemistry to answer questions **39** and **40**.

The variation of the compressibility Z, of gaseous hydrogen and helium, with pressure p at various temperatures T can be expressed using the graphs below. When $Z < 1$, a gas is more easily compressed than an ideal gas, and when $Z > 1$, a gas is less easily compressed than an ideal gas.



The variation of the compressibility with pressure at various temperatures for any gas is shown below.

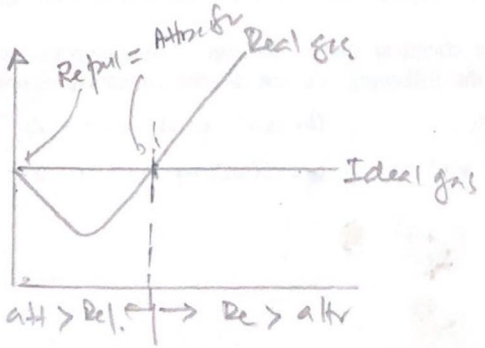


$T_4 > T_B > T_2 > T_1$

T_B is known as the Boyle temperature of the gas.

39. Which one of the following statements is correct?
    (1) As the temperature is increased, H_2 and He tend to behave as ideal gases.
    (2) As the temperature is decreased, H_2 and He tend to depart from the behaviour of ideal gases at all pressures.
    (3) At any given temperature, H_2 and He are less easily compressed than ideal gases when the pressure is low.
    (4) At any given temperature, H_2 and He are less easily compressed than ideal gases when the pressure is high.
    (5) At the Boyle temperature, T_B, both H_2 and He behave as ideal gases for the largest range of pressure.

40. Which one of the following statements is **incorrect**?
    (1) When $Z < 1$, there is an overall attraction between molecules, due to intermolecular forces.
    (2) When $Z > 1$, there is an overall repulsion between molecules, due to intermolecular forces.
    (3) Gaseous H_2 and He will show ideal gas behaviour whenever intermolecular forces are absent.
    (4) As p tends to zero ($p \rightarrow 0$), gaseous H_2 and He tend to behave more and more as ideal gases.
    (5) Irrespective of the individual nature of H_2 and He, their pattern of compressibility behaviour is basically similar.



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Instructions for questions No. 41 to 50

For each of the questions **41** to **50**, four responses (*a*), (*b*), (*c*) and (*d*) are given. One or more of these 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/are correct.

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

41. An element may exist in two or more different forms called allotropes. White Sn and grey Sn are two such allotropes of Sn. The two allotropes
(*a*) have different melting points.
(*b*) have different numbers of neutrons but the same number of protons in their nuclei.
(*c*) have the same density.
(*d*) have the same boiling point.

42. Which two of the following four ions present separately in four aqueous solutions, **cannot** be distinguished from each other by passing H_2S through the solutions acidified with dilute HCl?
(*a*) Sb^{3+} (*b*) AsO_4^{3-} (*c*) AsO_3^{3-} (*d*) Cd^{2+}

43. Consider a sample of pure liquid water at a temperature T, where the ionic product of water K_w, is equal to 1×10^{-12} mol^2 dm^{-6}. Which of the following statements about the above sample of water is/are true?
(*a*) The pH is 6.
(*b*) The sample is acidic.
(*c*) The OH^- ion concentration is not equal to the H^+ ion concentration.
(*d*) The OH^- ion concentration is 1×10^{-6} mol dm^{-3}.

44. You are provided with 3 standard metal / metal ion electrodes, whose standard electrode potentials are –2·7 V, –1·7 V and 0·8 V. Which of the following statement/s is/are true for all the electrochemical cells that can be constructed, taking the electrodes pairwise?
(*a*) Only 4 different electrochemical cells can be constructed.
(*b*) Only one of the above electrodes appears as the anode in two different cells.
(*c*) Only one of the above electrodes appears as the anode in one cell and as the cathode in another.
(*d*) Each of the above electrodes acts as the anode in at least one cell.

45. Which of the following statements pertaining to polymers is/are **correct**?
(*a*) All polymers have large relative molecular masses.
(*b*) All polymers melt when heated.
(*c*) All polymers have a high degree of elasticity.
(*d*) All polymer chains with double bonds can be cross linked with sulphur.

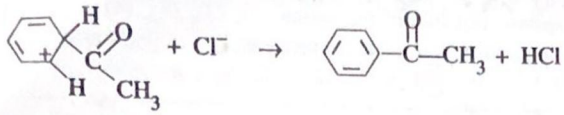
46. A reaction in which the same chemical species undergoes simultaneous reduction and oxidation, is called disproportionation. Which of the following is a/are disproportionation/disproportionations?
(*a*) $2H_2O_2 \rightarrow 2H_2O + O_2$ (*b*) $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$
(*c*) $Cl_2 + OH^- \rightarrow HOCl + Cl^-$ (*d*) $2CuCl \rightarrow CuCl_2 + Cu$

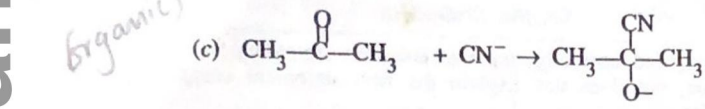
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Which of the following mechanistic steps is/are feasible?

(*a*) $CH_3CH_3 + \dot{Cl} \rightarrow CH_3\dot{C}H_2 + HCl$

(*b*) 

(*c*) 

(*d*) $CH_3CH{=}CH_2 + HBr \rightarrow CH_3\overset{+}{C}HCH_3 + Br^-$

48. Which of the following is a correct step/are correct steps, in the measurement of a given volume of solution using a pipette?

(*a*) When the level of solution in the pipette is adjusted to coincide with the graduated mark, the tip of the pipette must be held immersed in the solution.

(*b*) In transferring the solution to the titration flask the pipette tip should be held against the inner surface of the titration flask.

(*c*) In transferring the solution to the titration flask the pipette should be held vertical and the flask held inclined.

(*d*) The little bit of solution remaining in the tip of the pipette, after the transfer, should be blown into the flask.

Questions **49** and **50** are based on the following passage.

Two liquids A and B form ideal solutions with each other. The normal boiling points of pure A and pure B are 80 °C and 50 °C respectively, and their vapour pressures at room temperature are p_A^0 and p_B^0 respectively. An equimolar mixture of A and B is placed in an evacuated vessel and allowed to reach equilibrium at room temperature. At equilibrium, the mole fractions of A and B in the liquid phase are X_A and X_B respectively, while their values in the vapour phase are Y_A and Y_B respectively. The partial vapour pressures of A and B in the equilibrium vapour phase is p_A and p_B respectively.

49. Which of the following expressions is/are correct?

(*a*) $X_A > 0{\cdot}5 > X_B$ (*b*) $Y_A < 0{\cdot}5 < Y_B$

(*c*) $Y_A > 0{\cdot}5 > X_B$ (*d*) $X_A > 0{\cdot}5 > Y_B$

50. Which of the following expressions is/are correct?

(*a*) $p_A > p_B$ (*b*) $p_B > p_A$

(*c*) $p_A + p_B > p_A^0$ (*d*) $p_A + p_B - p_B^0 > 0$

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- **Instructions for questions No. 51 to 60**

In questions No. **51** to **60**, 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 given for each of the questions 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
51.	In a reaction consisting of several elementary steps, the step with the highest activation energy is the slowest step.	Reactions with different activation energies cannot have the same rate.
52.	Certain salts are insoluble in cold water but dissolve on warming.	The enthalpy of solution increases with increasing temperature.
53.	ICl_2^- and NO_2 are both linear in shape.	Molecules/ions that have the same number of atoms generally have the same shape.
54.	The pH of rain drops is less than 7, in general.	All rain drops contain dissolved CO_2.
55.	The solubility of $PbCl_2$ in conc.HCl is less than its solubility in cold water.	The presence of a common ion generally changes the solubility of a salt.
56.	For a given chemical equilibrium the ratio of the concentration terms of the products to the concentration terms of the reactants is constant at constant temperature and pressure.	At equilibrium the rate of formation of products is always equal to the rate of formation of reactants.
57.	Cinnamon oil is obtained by steam distillation of cinnamon leaf.	Cinnamon oil is more volatile than water.
58.	Since the mass of the deuterium molecule (D_2) is larger than that of a hydrogen molecule (H_2), the pressure of $D_2(g)$ in a vessel at a given temperature is larger than the pressure at the same temperature, if the vessel instead contained the same number of H_2 molecules.	When the velocities of molecules are the same, the kinetic energy of a D_2 molecule is higher than that of a H_2 molecule.
59.	Ethanoyl chloride (CH_3COCl) reacts with water more readily than chloroethane (CH_3CH_2Cl).	Chloroethane is covalent.
60.	The rate of an exothermic reaction increases with temperature.	The fraction of molecules with energy above a certain value, increases with temperature.

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