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අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2001 අගෝස්තු
கல்விப் பொதுத் தராதரப்பத்திர(உயர் தர)ப் பரீட்சை, 2001 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2001

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රසායන විද්‍යාව I
இரசாயனவியல் I
Chemistry I

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02
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පැය දෙකයි /இரண்டு மணித்தியாலம்/ *Two hours*

Important :

This question paper consists of 08 pages.

Enter your Index Number in the space provided on the answer sheet.

Use of calculators is not allowed.

*You should answer **all** the questions in this paper. For each question there are five responses of which only **one** is correct. When you have selected the response which you consider to be the best answer to a question, mark your response on the answer sheet in accordance with the instructions given therein.*

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

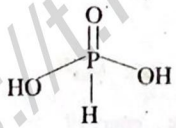
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1. **A**, **B** and **C** are three non transition elements in the same period of the Periodic Table.
   A is a nonmetal
   B is a metal.
   C shows properties of both metals and non-metals.
   Which one of the following represents the order in which these three elements occur in the Periodic Table?
   (1) **A, C, B** (2) **B, A, C** (3) **B, C, A** (4) **C, A, B** (5) **C, B, A**

2. **X**, **Y** and **Z** are three consecutive elements in the same period of the Periodic Table. **Z** is a gas under standard conditions. The first standard ionisation enthalpy $\left(\Delta H_1^\circ\right)$ of these elements is in the order **X** < **Y** < **Z**. The electronic configuration of **X** is of the form
   (1) $ns^2\ np^1$ (2) $ns^2\ np^2$ (3) $ns^2\ np^3$ (4) $ns^2\ np^4$ (5) $ns^2\ np^5$

3. Under the same conditions, which one of the following atoms will liberate the largest amount of energy when it gains an electron?
   (1) Na(g) (2) Ar(g) (3) Li(g) (4) N(g) (5) Mg(g)

4. The name of the compound



   is
   (1) phosphoric(V) acid.
   (2) phosphoric(III) acid.
   (3) phosphoric(I) acid.
   (4) metaphosphoric(V) acid.
   (5) hypophosphorous acid.

5. Cobalt is present as Co^{3+} in a complex compound. A mole of this compound contains five moles of ammonia and one mole of cobalt. Chlorine is the only other element present in this compound. The chemical formula of this complex is
   (1) $\left[Co(NH_3)_5Cl\right]Cl_2$ (2) $\left[Co(NH_3)_5Cl\right]$ (3) $\left[Co(NH_3)_5Cl_3\right]$
   (4) $\left[Co(NH_3)_5Cl_2\right]Cl$ (5) $\left[Co(NH_3)_5Cl\right]Cl$

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6. The IUPAC name for $\left[Fe(CN)_3(NH_3)_3\right]$ is

(1) tricyanotriammineiron(III) (2) tricyanotriammineiron(II)
(3) triamminetricyanoiron(III) (4) triamminetricyanoferrate(III)
(5) triamminetricyanoferrate(II)

7. Which one of the following inorganic salts is mostly responsible for the hygroscopic nature of common salt?

(1) $CaCl_2$ (2) $Ca(NO_3)_2$ (3) $MgCl_2$ (4) $CaSO_4$ (5) NaI

8. Which one of the following groups of substances found in a laboratory contains only covalent compounds?

(1) steam, calcium oxide, sodium, graphite
(2) potassium chloride, propane, ethanol, hydrogen
(3) water, hydrogen, sodium chloride, diamond
(4) carbon dioxide, oxygen, chlorine, water
(5) steam, sodium, propane, hydrogen

9. Which one of the following molecules is non-polar (i.e. possesses zero dipole moment)?

(1) $BeCl_2$ (2) NH_3 (3) CO (4) H_2O (5) $CHCl_3$

10. The order of molar solubility in water of the hydroxides of Mg, Al, Ca and Ba is

(1) $Ca(OH)_2 > Ba(OH)_2 > Al(OH)_3 > Mg(OH)_2$.
(2) $Ba(OH)_2 > Ca(OH)_2 > Mg(OH)_2 > Al(OH)_3$.
(3) $Al(OH)_3 > Mg(OH)_2 > Ca(OH)_2 > Ba(OH)_2$.
(4) $Mg(OH)_2 > Ca(OH)_2 > Ba(OH)_2 > Al(OH)_3$.
(5) $Ba(OH)_2 > Mg(OH)_2 > Al(OH)_3 > Ca(OH)_2$.

11. Zn reacts with H_2SO_4 acid diluted with an equimolar mixture of H_2O and D_2O. The gaseous product(s) liberated is / are

(1) H_2 only. (2) a mixture of H_2 and D_2. (3) D_2 only.
(4) a mixture of H_2, HD and D_2. (5) HD only.

(D ≡ Deuterium)

12. An ammonium salt undergoes complete thermal decomposition giving water and a gas as the only products. The gas liberated is neither nitrogen nor ammonia. The anion in the ammonium salt is

(1) SO_4^{2-} (2) NO_3^- (3) $Cr_2O_7^{2-}$ (4) NO_2^- (5) CO_3^{2-}

13. The number of atoms in 0·0240 g of the ^{12}C isotope is

(1) $12{\cdot}044 \times 10^{15}$ (2) $12{\cdot}044 \times 10^{20}$ (3) $12{\cdot}044 \times 10^{21}$
(4) $6{\cdot}022 \times 10^{19}$ (5) $6{\cdot}022 \times 10^{20}$

14. The cation which will give

(i) a blue solution with excess NH_4OH,
(ii) no precipitate with H_2S in dilute HCl and
(iii) a yellow-brown solution with concentrated HCl

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

15. Which one of the following compounds can be expected to have the highest lattice energy?

(1) MgO (2) Na_2O (3) NaF (4) $MgCl_2$ (5) CaO

16. The number of moles of $KMnO_4$ that is required to react completely with 1 mole of iron(II) oxalate (FeC_2O_4) in acidic medium is

(1) 5 (2) 3 (3) $\frac{5}{3}$ (4) $\frac{3}{5}$ (5) $\frac{1}{5}$

17. An aqueous solution of $K_2SO_4.Cr_2(SO_4)_3.12H_2O$ contains 1·04 g dm^{-3} of Cr^{3+} ions. What is the SO_4^{2-} concentration, in units of mol dm^{-3}, in this solution?

(relative atomic masses : H = 1; O = 16; S = 32; K = 39; Cr = 52)

(1) 0·01 (2) 0·02 (3) 0·03 (4) 0·04 (5) 0·05

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18. A solution **S** was prepared by complete dissolution of pure $CaCl_2$ and pure $Ca(OH)_2$ in chemically pure water (pH = 7·0) at 25°C. The concentration of **each** solute in **S** is 0·005 mol dm^{-3}.
What is the pH of the solution **S** ? (at 25°C, $K_w = 1 \times 10^{-14}$ $mol^2\ dm^{-6}$)
(1) 2·0 (2) 2·3 (3) 7·0 (4) 11·7 (5) 12·0

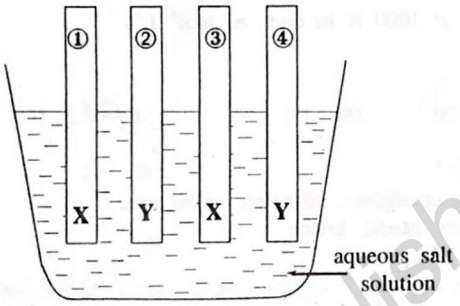
19. Iodine is produced when 10·0 cm^3 of a 0·010 mol dm^{-3} solution of $K_2S_2O_8$ is added to a solution containing I^- ions according to the equation

$$S_2O_8^{2-} + 2\ I^- \longrightarrow 2\ SO_4^{2-} + I_2$$

The minimum volume of 0·015 mol dm^{-3} solution of $Na_2S_2O_3$ required to completely react with the iodine so produced in cm^3 is
(1) 5·0 (2) 6·7 (3) 13·3 (4) 20·0 (5) 26·7

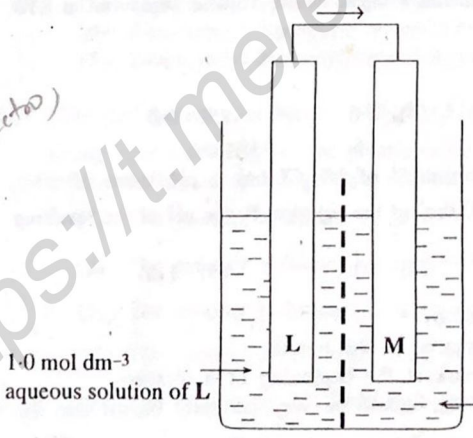
20. The constituent elements most likely to be present in a stainless steel are
(1) Pb, C, Cr, Ni. (2) Fe, C, Cr, Ni. (3) Fe, Cr, Ni, Mn.
(4) Fe, C, Si, Cu. (5) Fe, C, Cu, Zn.

21. Two argon gas atoms travelling at speeds of 7·0 $m\,s^{-1}$ and 6·0 $m\,s^{-1}$ respectively undergo a perfectly elastic collision. Possible values for the speeds of the two atoms immediately after the collision are respectively
(1) 9·0 $m\,s^{-1}$ and 2·0 $m\,s^{-1}$ (2) 6·0 $m\,s^{-1}$ and 5·0 $m\,s^{-1}$
(3) 8·0 $m\,s^{-1}$ and 5·0 $m\,s^{-1}$ (4) 6·5 $m\,s^{-1}$ and 6·5 $m\,s^{-1}$
(5) 8·0 $m\,s^{-1}$ and 3·0 $m\,s^{-1}$

22. 

The electrochemical system involving metals **X** and **Y** were set up by a student and potential differences measured. The potential difference between electrodes ① and ② was 0·75 V and the potential difference between electrodes ③ and ④ was 0·75 V.

The potential difference between electrodes ① and ④ should be
(1) 1·50 V. (2) 0 V.
(3) 3·00 V. (4) 0·75 V.
(5) 2·25 V.

23. 

A student uses pairs of different metals **L** and **M** to produce electricity. A schematic diagram of the apparatus used is given.

Which of the pairs of metals indicated in the table below should be used in order to produce initially an electron flow in the direction indicated by the arrow?

	(1)	(2)	(3)	(4)	(5)
L	Pb	Sn	Zn	Pb	Cu
M	Zn	Ni	Sn	Ni	Zn

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24. The mean square speed $\left(\overline{c^2}\right)$ of ideal gas molecules (relative molecular mass = M) at temperature T is given by the expression

$$\overline{c^2} = \frac{3RT}{M} = \frac{3pV}{mN}$$

The mean square speed $\left(\overline{c^2}\right)$ in SI units $\left(m^2 s^{-2}\right)$ at 227°C of a diatomic ideal gas whose relative molecular mass is 50 is

(1) 0·249 (2) $2{\cdot}49 \times 10^5$ (3) $4{\cdot}99 \times 10^5$ (4) $4{\cdot}99 \times 10^2$ (5) $2{\cdot}49 \times 10^2$

25. The rate determining step in a certain reaction has been found to be

$$2\ X \longrightarrow Y + Z$$

When the concentration of **X** is 0·60 mol dm^{-3}, the rate of the reaction is r mol dm^{-3} s^{-1}. Therefore, when the concentration of **X** is 0·12 mol dm^{-3}, the rate of the reaction (in mol dm^{-3} s^{-1} units) is

(1) 0·04 r (2) 0·02 r (3) 0·40 r (4) 0·20 r (5) 0·50 r

26. Which one of the following will conduct electricity significantly by the movement of ions?

(1) copper wire (2) solid NaCl (3) graphite
(4) polyvinyl chloride (5) molten NaOH

27. For the equilibrium in a gas system represented by

$$2\ P(g) + 3\ Q_2(g) \rightleftharpoons P_2Q_6(g)$$

what is the ratio of the equilibrium constants $\left(K_p / K_c\right)$ at 1000 K in units of $mol^4\ J^{-4}$?

Assume ideal behaviour for the gas system.

(1) $4{\cdot}8 \times 10^{15}$ (2) $2{\cdot}1 \times 10^{-16}$ (3) $1{\cdot}2 \times 10^{-2}$ (4) 1·0 (5) $6{\cdot}0 \times 10^{-5}$

28. Which of the following groups consists of SI units only?

(1) square metre, kelvin, gram (2) degrees centrigade, kilogram, cubic metre
(3) atmospheres, litres, pascal (4) kilogram, pascal, kelvin
(5) kelvin, atmospheres, newton

29. The density of an ideal gas is 1·20 kg m^{-3} at a pressure of 10^5 N m^{-2} and a temperature of 727 °C. The relative molecular mass of the gas is

(1) 96 (2) 98 (3) 100 (4) 102 (5) 104

30. 164·6 g of sodium amalgam on complete reaction with water liberates a gas whose volume measured at STP is 2·24 dm^3. Assume that the gas behaves ideally.
(Relative atomic masses : Na = 23; Hg = 200)
The mole fraction of Na in the amalgam is

(1) 0·1 (2) 0·2 (3) 0·4 (4) 0·6 (5) 0·8

31. Solution **P** containing 0·55 mol dm^{-3} of NH_4OH and 0·10 mol dm^{-3} of NH_4Cl has a pH value of 10·0. If 1·0 cm^3 of a 0·1 mol dm^{-3} solution of NaOH was added to 1·0 dm^3 of the solution **P**, the pH of the resulting solution would be

(1) 9·0 (2) 9·5 (3) 10·0 (4) 10·5 (5) 11·0

32. Which one of the following statements is true regarding titrations?

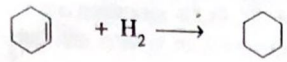
(1) In an acid base titration, the acid should always be placed in the burette.
(2) The burette should always be filled up to the zero mark at the beginning of a titration.
(3) The solution remaining at the pipette tip after delivering, should be very carefully blown into the titration flask.
(4) Some titrations do not require an indicator to be added to detect the end-point.
(5) For the calculation, the average of the two burette readings at the end point should be taken if those two readings are widely different to each other.

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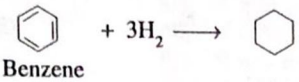
33. The heat given out in the reaction



cyclohexene

is 121 kJ mol^{-1}.

If, under the same conditions, the heat given out in the reaction



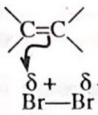
Benzene

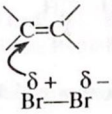
is x kJ mol^{-1}, then

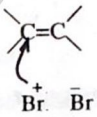
(1) $x < 121$ (2) $363 > x > 121$ (3) $x = 363$
(4) $726 > x > 363$ (5) $x = 726$

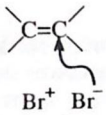
34. Which of the following can 4-chloro-2-pentene exhibit?
(1) only geometrical isomerism. (2) only optical isomerism.
(3) both geometrical and optical isomerism. (4) only chain isomerism.
(5) only structural isomerism.

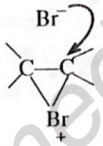
35. Which of the following best represents the first step in the mechanism of addition of Br_2 to an alkene?

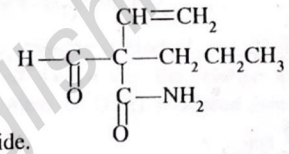
(1) 

(2) 

(3) 

(4) 

(5) 

36. The IUPAC name of the molecule  is

(1) 2-ethenyl-2-formylpentanamide.
(2) 2-formyl-2-propyl-3-butenamide
(3) 3-carbamoyl-3-formylhexene.
(4) 2-carbamoyl-2-propyl-3-butenaldehyde.
(5) 2-carbamoyl-2-ethenylpentanaldehyde.

37. Consider the reaction between CH_3CH_2I and CH_3CH_2MgBr.

Using your knowledge of the principles of organic reaction mechanisms, indicate which one of the following statements regarding the product and the mechanism of this reaction is most accurate.

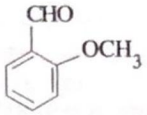
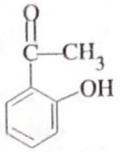
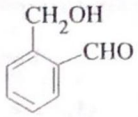
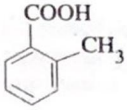
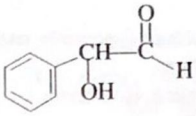
(1) The product is butane. It is formed by $CH_3CH_2^-$ reacting as an electrophile with CH_3CH_2I.
(2) The product is butane. It is formed by $CH_3CH_2^-$ reacting as a nucleophile with CH_3CH_2MgBr.
(3) The product is butane. It is formed by $CH_3CH_2^-$ reacting as a nucleophile with CH_3CH_2I.
(4) The product is 2-butene. It is formed by $CH_3CH_2^-$ reacting as a nucleophile with CH_3CH_2I.
(5) The product is 2-butene. It is formed by $CH_3CH_2^-$ reacting as an electrophile with CH_3CH_2I.

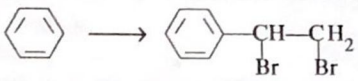
38. The compound **X** (C_7H_8) has neither cyclic groups nor double bonds. How many triple bonds does **X** have?
(1) 3 (2) 2 (3) 4 (4) 1 (5) 6

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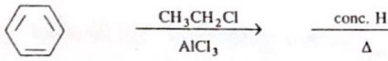
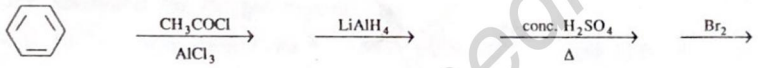
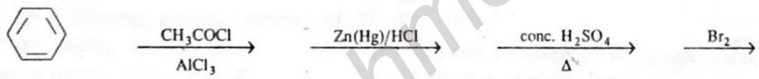
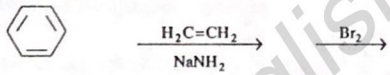
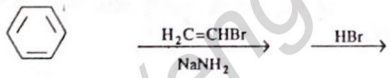
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39. An organic compound **X** of molecular formula $C_8H_8O_2$
(i) produces a gas on reaction with Na metal.
(ii) gives an orange coloured precipitate with Brady's reagent.
(iii) gives an aromatic dicarboxylic acid on strong oxidation.
(iv) does not produce a gas when mixed with aqueous Na_2CO_3.
The compound **X** is

(1) 
(2) 
(3) 
(4) 
(5) 

40. 

Which of the reaction schemes given below would be most suitable to carry out the above conversion?

(1) 
(2) 
(3) 
(4) 
(5) 

41. Acetylene reacts with ammoniacal silver nitrate to give a precipitate whereas ethylene does not. Which of the following statements best explains this difference?
(1) The K_a of acetylene is lower than the K_a of ethylene.
(2) The K_a of acetylene is higher than the K_a of ethylene.
(3) The carbon atoms in acetylene are sp^2 hybridized whereas those of ethylene are sp hybridized.
(4) Acetylene can form a monovalent ion whereas ethylene can only form a divalent ion.
(5) Ethylene is more soluble in aqueous ammonia than acetylene.

42. Which of the following polymers is most likely to produce HCN during combustion?
(1) polyisopropylene
(2) nylon
(3) polyvinyl chloride
(4) polyester
(5) polystyrene

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Instructions for question No. 43 to 50 :
For each of the questions **43** 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

43. Which of the following get(s) deflected when moving across a magnetic field?
(a) neutrons (b) cathode rays (c) protons (d) helium atoms

44. Which of the following statement(s) is/are true about the nitronium ion $\left(NO_2^+\right)$?
(a) It is linear in shape. (b) There are only σ bonds in it.
(c) It is angular in shape. (d) valence shell of N has less than 8 electrons.

45. Which of the following compound(s) when dissolved in pure distilled water form solutions which will turn red litmus blue?
(a) LiF (b) CH_3COOLi (c) LiCl (d) $LiNO_3$

46. The following reaction is used in submarines to generate O_2 from CO_2 in exhaled air.

$$4KO_2 + 2CO_2 \longrightarrow 2K_2CO_3 + 3O_2$$

Which of the following statement(s) is/are correct in regard to this reaction?
(a) no oxidation or reduction occurs
(b) carbon is oxidised
(c) oxygen is subjected to oxidation as well as reduction
(d) the oxidation state changes only in O of KO_2

47. When an aqueous 0·1 mol dm^{-3} Na_2SO_4 solution is electrolysed, $12{\cdot}044 \times 10^{22}$ $H_2(g)$ molecules were produced. $O_2(g)$ is the only other product formed. Given that the relative atomic mass of oxygen is 16·0, the other information required to calculate the mass of $O_2(g)$ produced is/are
(a) Faraday's Laws of electrolysis. (b) Avogadro constant.
(c) Universal gas constant. (d) Faraday constant.

48. Which of the following industrial process(es) use(s) limestone in at least one of its steps in the production process?
(a) Manufacture of triple superphosphate
(b) Extraction of iron using a blast furnace
(c) Solvay process for the manufacture of Na_2CO_3
(d) Manufacture of cement

49. Consider the following reaction :

$$R{-}\overset{\overset{O}{\|}}{C}{-}Cl + R'NH_2 \longrightarrow R{-}\overset{\overset{O}{\|}}{C}{-}NHR' + HCl$$

Which of the following statement(s) is/are true?
(a) In this reaction, $R'NH_2$ acts as a nucleophile.
(b) The reaction is an electrophilic substitution reaction on $R{-}\overset{\overset{O}{\|}}{C}{-}Cl$.
(c) In this reaction $R{-}\overset{\overset{O}{\|}}{C}{-}Cl$ acts as a nucleophile.
(d) The reaction is a nucleophilic substitution reaction on $R{-}\overset{\overset{O}{\|}}{C}{-}Cl$.

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50. Consider the following molecule :–

$$H_2C^v = C^w\left(C^xH_3\right)C^y \equiv C^zH$$

The superscripts v, w, x, y and z are used to label the C atoms.
Which of the following statement(s) is/are true?

(a) $\overset{\wedge}{C^yC^wC^x}$ angle is approximately 120°.
(b) All the C atoms of this molecule lie on the same plane.
(c) All the H atoms of this molecule lie on the same plane.
(d) The carbon atoms C^v, C^w, C^y and C^z lie on a straight line.

● **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.	Reaction of aniline with aqueous nitrous acid at 20°C produces phenol, whereas reaction of ethylamine with aqueous nitrous acid at 20°C produces ethanol.	Benzenediazonium chloride is more stable than ethanediazonium chloride.
52.	CH_3CONH_2 is a stronger base than CH_3NH_2.	The lone pair electrons of the N atom in CH_3CONH_2 are delocalized due to the interaction with the π–electrons of the carbonyl group.
53.	The equilibrium $N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$ can be shifted to the right at constant temperature by increasing the partial pressures of N_2 and H_2.	According to the equation $pV = \frac{1}{3} m N \overline{c^2}$, the average kinetic energy of ideal gas molecules can be increased by increasing the pressure of the gas at constant temperature.
54.	Coagulation of natural rubber latex is promoted by dilute acids but retarded by bases such as ammonia.	In natural rubber latex, the rubber particle is enclosed by a protein layer, which has a negative charge.
55.	The density of a gas at a given temperature is always directly proportional to its molar mass.	At the same temperature and pressure, the volume of a gas per molecule takes approximately the same value for different gases.
56.	Cu(I) is more stable than Cu(II) in aqueous solution.	The electronic configuration of Cu(I) is of the form ..... $3d^{10}\ 4s^0$ while that of Cu(II) is of the form ..... $3d^9\ 4s^0$.
57.	Aqueous solutions of compounds containing a d-block element are always coloured.	Ions formed by a d-block element always have a partially filled d level.
58.	$MgCl_2(aq)$ gives a precipitate of $Mg(OH)_2$ with excess NH_4OH but $NiCl_2(aq)$ does not give a permanent precipitate of $Ni(OH)_2$ with excess NH_4OH.	Ni^{2+} forms a water soluble ammine complex with excess NH_4OH but Mg^{2+} does not do so.
59.	Both sucrose $(C_{12}H_{22}O_{11})$ and KI readily dissolve in H_2O.	H_2O forms strong hydrogen bonds with both sucrose $(C_{12}H_{22}O_{11})$ and KI.
60.	Methyl orange (pH range 3·1 – 4·4) gives the correct end point for the titration of 1×10^{-3} mol dm^{-3} solution of NaOH with 1×10^{-3} mol dm^{-3} solution of HCl.	For the titration of 0·1 mol dm^{-3} solution of NaOH with 0·1 mol dm^{-3} solution of HCl, any acid-base indicator can be used.

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