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2002 original

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

02/1

1. A certain sample of CO has only $^{14}C_6$ and $^{16}O_8$ isotopes. Another sample of CO has $^{12}C_6$ and $^{18}O_8$ isotopes only. The property that shows a significant difference between the two samples is
   (1) chemical reactivity.
   (2) molar mass.
   (3) molar volume.
   (4) density at S.T.P.
   (5) percentage compositions of C and O by mass.

2. **W**, **X**, **Y** and **Z** are four non transition elements with consecutive atomic numbers. The first ionization enthalpies of **W**, **X** and **Y** are in the order **W** < **X** < **Y**. The oxide formed by **Z** is basic. The electronic configuration of the outermost shell of **Z** is of the type
   (1) $ns^1\ np^0$ (2) $ns^2\ np^1$ (3) $ns^2\ np^2$
   (4) $ns^2\ np^3$ (5) $ns^2\ np^4$

3. The element with the highest first ionization enthalpy out of the following is
   (1) C (2) N (3) Si (4) O (5) P

4. Which is the smallest ion out of the following ions in the gaseous state?
   (1) O^{2-} (2) F^- (3) Na^+ (4) Mg^{2+} (5) N^{3-}

5. The electronic configuration of the valence shell of the element that has the least tendency to form a diatomic molecule is
   (1) $s^1\ p^0$ (2) $s^2\ p^0$ (3) $s^2\ p^3$
   (4) $s^2\ p^4$ (5) $s^2\ p^5$

6. Which of the following statements is correct regarding the atomic emission spectrum of hydrogen?
   (1) The radiation corresponding to the n = 2 to n = 1 transition has the longest wavelength.
   (2) The n = 3 to n = 2 transition corresponds to the H_α line.
   (3) The first series of lines (Lyman) occurs in the infra-red region.
   (4) In a given series, the separation between adjacent lines increases in the direction of increasing energy.
   (5) Emission of radiation occurs when electrons undergo transition to higher levels from lower levels.

7. In the reaction between $Cr_2O_7^{2-}$ and H_2O_2 in an acidic medium, H_2O_2 is **oxidised** to O_2 and $Cr_2O_7^{2-}$ is converted to Cr^{3+}. The correct equation for this reaction is
   (1) $Cr_2O_7^{2-} + 8H^+ + H_2O_2 \longrightarrow 2Cr^{3+} + 5H_2O + O_2$
   (2) $Cr_2O_7^{2-} + 8H^+ + 3H_2O_2 \longrightarrow 2Cr^{3+} + 7H_2O + 3O_2$
   (3) $Cr_2O_7^{2-} + 8H^+ + 5H_2O_2 \longrightarrow 2Cr^{3+} + 9H_2O + 5O_2$
   (4) $Cr_2O_7^{2-} + 8H^+ + 7H_2O_2 \longrightarrow 2Cr^{3+} + 11H_2O + 7O_2$
   (5) $Cr_2O_7^{2-} + 8H^+ + 9H_2O_2 \longrightarrow 2Cr^{3+} + 13H_2O + 9O_2$

8. The ion / molecule which has a shape significantly different from the SO_4^{2-} ion is
   (1) NH_4^+ (2) BCl_4^- (3) SF_4 (4) $S_2O_3^{2-}$ (5) CH_4

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2 Chemistry I
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9. The products of dissociation of HOBr are most **unlikely** to be
(1) H^+ and OBr^- (2) OH^- and Br^+ (3) HO^+ and Br^-
(4) $HO^{\cdot}$ and $^{\cdot}Br$ (5) $H^{\cdot}$ and $^{\cdot}OBr$

10. A white inorganic salt was dissolved in dilute HCl. This solution when basified with excess NH_4OH, gave a colourless clear solution. One part of this solution when treated with H_2S gave a white precipitate. The other part of the solution, when treated with aqueous $Ba(OH)_2$, also gave a white precipitate. The salt is
(1) $ZnCl_2$ (2) $AlCl_3$ (3) $MgSO_4$
(4) $ZnSO_4$ (5) $NaAlO_2$

11. 5·0 g of the anhydrous chloride of a monovalent metal when completely converted to its anhydrous sulphate, gave 6·0 g of the anhydrous sulphate. (H = 1; Cl = 35·5; S = 32, O = 16)
The relative atomic mass of the metal is
(1) 20 (2) 24 (3) 27
(4) 35 (5) 43

12. **A**, **B**, **C** are three cations which form precipitates with NH_4OH. These precipitates are soluble in excess NH_4OH.
A, **B**, **C** are
(1) Cu^{2+}, Ni^{2+}, Cr^{3+}
(2) Cu^{2+}, Ni^{2+}, Al^{3+}
(3) Zn^{2+}, Cu^{2+}, Ni^{2+}
(4) Zn^{2+}, Cu^{2+}, Cr^{3+}
(5) Ag^+, Zn^{2+}, Al^{3+}

13. The molar ratio NaOH : Na_2CO_3 in an aqueous solution of NaOH and Na_2CO_3 is 1 : 2. When 25·00 cm^3 of this solution is titrated with 0·1 mol dm^{-3} HCl with phenolphthalein as indicator, the end point is 15·00 cm^3. When the same titration is repeated using methyl orange instead of phenolphthalein as indicator, the end point (cm^3) is
(1) 15·00 (2) 20·00 (3) 25·00
(4) 30·00 (5) 40·00

14. The solubility of KNO_3 in water at 25°C is 300 g per kilogramme of water. If a hot solution containing 540 g KNO_3 in 600 g water is cooled the maximum mass of KNO_3 that would crystallise out of the solution at 25°C is
(1) 40 g (2) 180 g (3) 240 g
(4) 360 g (5) 540 g

15. The number of moles of ions present in a solution made by mixing 125 cm^3 of 0·2 mol dm^{-3} NaOH and 125 cm^3 of 0·1 mol dm^{-3} H_2SO_4 is
(1) 0·0375 (2) 0·0625 (3) 0·0875
(4) 0·15 (5) 0·30

16. Which one of the following chlorides in 1·0 mol dm^{-3} aqueous solution shows the highest pH value?
(1) $AlCl_3$ (2) HCl (3) PCl_3
(4) $MgCl_2$ (5) NH_4Cl

17. Acidified MnO_4^- reacts with H_2O_2 producing O_2, Mn^{2+} and H_2O only. The number of moles of MnO_4^- required for the complete reaction of one mole of H_2O_2 in an acidified medium is
(1) 0·4 (2) 0·8 (3) 2·0
(4) 2·5 (5) 5·0

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18. A dilute HCl solution of salt **A**
(i) is colourless.
(ii) gives an orange precipitate with H_2S, and
(iii) forms a white precipitate when added to water

The cation contained in salt **A** is
(1) Cd^{2+} (2) Sb^{3+} (3) Pb^{2+} (4) Bi^{3+} (5) Sn^{2+}

19. Which one of the following would represent the formation of covalent bonds?
(1) A non-metal taking electrons from a metal
(2) A non-metal taking electrons from another non-metal
(3) A metal giving a pair of electrons to a non-metal
(4) A non-metal giving a pair of electrons to a metal
(5) A metal and non-metal sharing electrons

20. At a temperature of 27°C and a pressure of 10^5 Pa, air contains 21% by volume of oxygen. 10 m^3 of this air is compressed to 1 m^3 at the same temperature. The partial pressure of oxygen in the compressed air is (in units of Pa)
(1) $1{\cdot}0 \times 10^4$ (2) $2{\cdot}1 \times 10^4$ (3) $2{\cdot}1 \times 10^5$ (4) $1{\cdot}0 \times 10^6$ (5) 21×10^5

21. At 25°C, the standard cell e.m.f. $\left(E^\circ_{cell}\right)$ values for two electrochemical cells are given below :

$A/A^{2+}(aq) \,\|\, B^{2+}(aq)/B \qquad E^\circ_{cell} = 1{\cdot}8\,V$

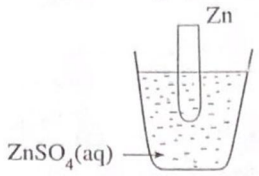
$C/C^{2+}(aq) \,\|\, B^{2+}(aq)/B \qquad E^\circ_{cell} = 2{\cdot}7\,V$

Which one of the following is true for the cell with $A^{2+}(aq)/A$ and $C^{2+}(aq)/C$ as electrodes at 25°C?
(1) E°_{cell} = 4·5 V ; **C** electrode negative
(2) E°_{cell} = 4·5 V ; **A** electrode negative
(3) E°_{cell} = 0·9 V ; **C** electrode negative
(4) E°_{cell} = 0·9 V ; **A** electrode negative
(5) E°_{cell} = −0·9 V ; **C** electrode negative

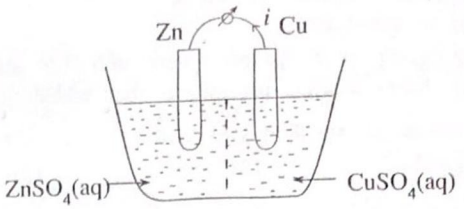
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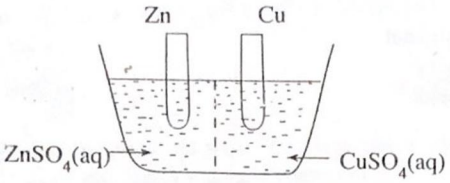
22. Consider the following systems (a) to (e)



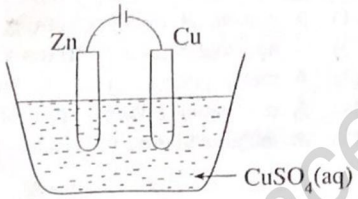
(a)



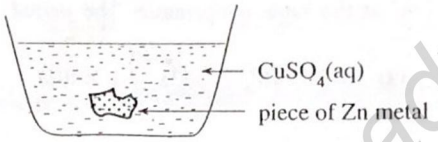
(b)



(c)



(d)



(e)

Which of the following pairs can be considered equilibrium systems?
(1) (a) and (b) (2) (b) and (c) (3) (a) and (c) (4) (d) and (e) (5) (c) and (e)

23. The following thermochemical data is available in units of kJ mol^{-1} :

Lattice enthalpy of AgI (s)	= –876
Standard hydration enthalpy of $Ag^+(g)$	= –464
Standard hydration enthalpy of $I^-(g)$	= –293

The standard enthalpy of solution of AgI(s) in water as represented by

$$AgI(s) + aq \longrightarrow AgI(aq)$$

in units of kJ mol^{-1} is
(1) +238 (2) +119 (3) –119 (4) –1633 (5) +1633

24. In a particular reaction involving two reactants **P** and **Q**, experimental data obtained at 353 K are given below.

Initial concentration of **P**/mol dm^{-3}	Initial concentration of **Q**/mol dm^{-3}	Initial reaction rate / mol dm^{-3} $minute^{-1}$
$3{\cdot}2 \times 10^{-3}$	$2{\cdot}5 \times 10^{-2}$	$1{\cdot}74 \times 10^{-5}$
$3{\cdot}2 \times 10^{-3}$	$5{\cdot}0 \times 10^{-2}$	$3{\cdot}48 \times 10^{-5}$
$1{\cdot}6 \times 10^{-3}$	$2{\cdot}5 \times 10^{-2}$	$8{\cdot}70 \times 10^{-6}$

The relevant rate equation for the reaction is
(1) rate α [**P**] (2) rate α [**Q**] (3) rate α [**P**] [**Q**]
(4) rate α [**P**][**Q**]^2 (5) rate α [**P**]^2[**Q**]

● **Questions 25 and 26 refer to the following data :**

One gas bulb contains gas **A** and another gas bulb contains gas **B**. Both gas bulbs are at the same temperature. The density of gas **A** is half that of gas **B**. The mean square speed of gas **B** is twice the mean square speed of gas **A**. Pressure of gas **A** = 1000 kPa .

25. The pressure of gas **B** in kPa is
(1) 4000 (2) 2000 (3) 1000 (4) 500 (5) 250

26. If the volumes of the two gas bulbs are the same, the ratio of the number of molecules of gas **A** : number of molecules of gas **B** is
(1) 4 : 1 (2) 2 : 1 (3) 1 : 1 (4) 1 : 2 (5) 1 : 4

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27. Which of the following is **not a characteristic** of catalysts?
(1) Catalysts are chemically unchanged at the end of the reaction
(2) Catalysts are specific in action
(3) Catalysts reduce the enthalpy change accompanying a reaction
(4) Catalysts provide an alternative route for a reaction
(5) Catalysts lower the activation energy barrier of a reaction

28. Which one of the following polymers,
(i) is thermoplastic,
(ii) has no cross-links and
(iii) is a product of addition polymerisation?

(1) Nylon
(2) Polyester
(3) Polyvinyl chloride
(4) Urea-formaldehyde
(5) Vulcanised rubber

29. Which of the following statements is correct regarding $\left[Co(NH_3)_5Cl\right]Cl_2$?
(1) It has only co-ordinate and covalent bonds.
(2) Its IUPAC name is pentamminechlorocobalt(II) chloride.
(3) It has co-ordinate, covalent and ionic bonds.
(4) Its IUPAC name is pentamminechlorocobalt(III) dichloride.
(5) It does not give a precipitate with aqueous $AgNO_3$.

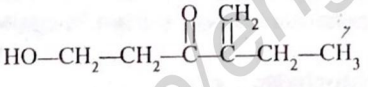
30. Which one of the following compounds reacts with H_2S in acidic solution and does **not produce** sulphur as one of the products?
(1) $FeCl_3$ (2) Na_3AsO_4 (3) $NaAsO_2$ (4) K_2CrO_4 (5) Na_2SO_3

31. The standard enthalpies of combustion (kJ mol^{-1}) of gaseous acetylene and liquid benzene at 25°C are x and y respectively.
The standard enthalpy change (kJ mol^{-1}) for the reaction

$$3\ C_2H_2(g) \rightleftharpoons C_6H_6(l) \quad \text{is}$$

(1) 3(y –x) (2) 3y – x (3) 3x – y (4) y – 3x (5) x – 3y

32. The IUPAC name of the compound



is

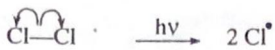
(1) 4-ethyl-3-oxopent-4-en-1-ol.
(2) 2-ethyl-5-hydroxy-3-oxo-pent-1-ene
(3) 4-ethyl-1-hydroxypent-4-en-3-one
(4) 2-ethyl-5-hydroxypent-1-en-3-one
(5) 2-ethyl-1-ene-5-hydroxy-3-pentanone

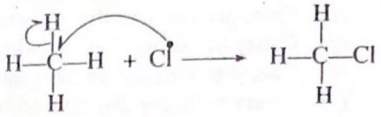
33. Which of the following statements is **incorrect**?
(1) Amides are less basic than ammonia.
(2) Phenol readily reacts with formaldehyde in an alkaline medium.
(3) Phenols are more acidic than alcohol.
(4) Phenol readily undergoes an addition reaction with Br_2/H_2O to give a white precipitate.
(5) Boiling points of carboxylic acids are higher than those of aldehydes with comparable relative molecular masses.

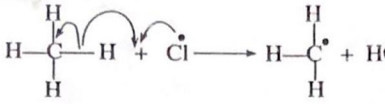
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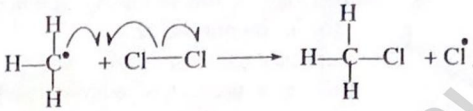
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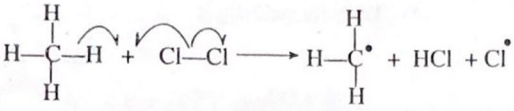
34. Which of the following most correctly depicts a step in the reaction of Cl_2 with methane in the presence of sunlight?

(1) 

(2) 

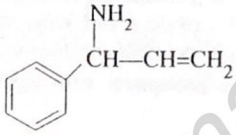
(3) 

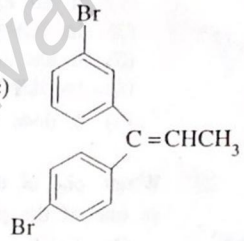
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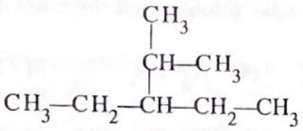
(5) 

35. Which of the following show stereo-isomerism?

(a) $(CH_3)_2C{=}CHCH_2CH_3$

(b) 

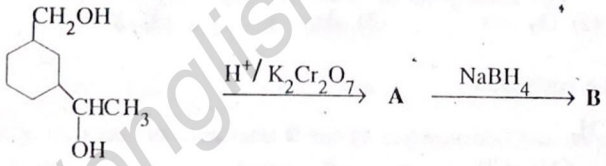
(c) 

(d) 

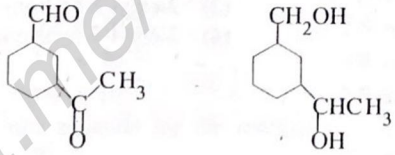
(e) 

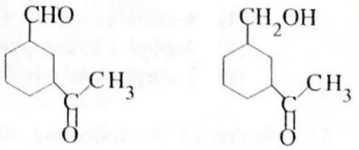
(1) (a), (b) and (c)
(2) (b), (c) and (d)
(3) (c), (d) and (e)
(4) (a), (c) and (d)
(5) (b), (c) and (e)

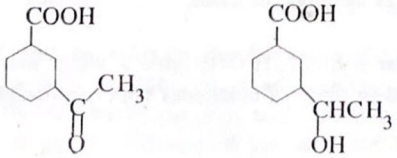
36. Consider the following reaction scheme.

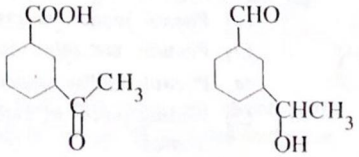


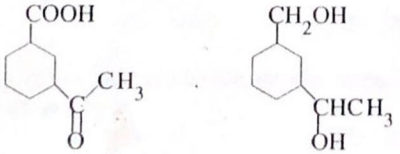
The most likely compounds corresponding to **A** and **B** respectively are :

(1) 

(2) 

(3) 

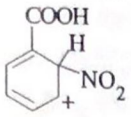
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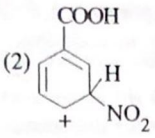
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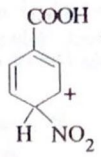
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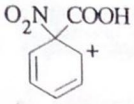
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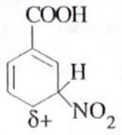
Nitration of benzoic acid is an electrophilic substitution reaction. The intermediate most likely to be formed during the reaction is :

(1) 

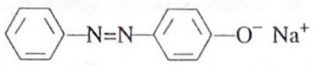
(2) 

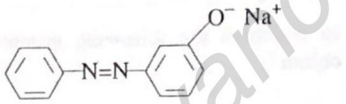
(3) 

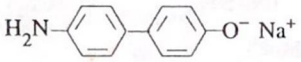
(4) 

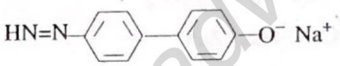
(5) 

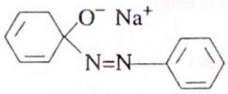
38. When aniline is reacted with $NaNO_2/HCl$ at 5-10°C and the reaction mixture obtained is added to a solution of phenol in aqueous NaOH, the major product formed is :

(1) 

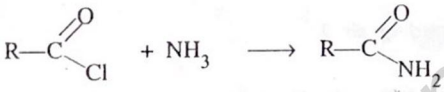
(2) 

(3) 

(4) 

(5) 

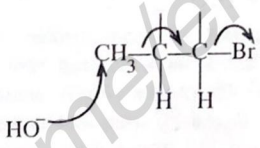
39. The reaction,

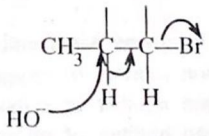


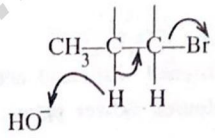
is

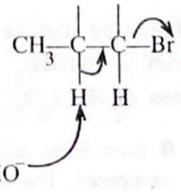
(1) an electrophilic substitution reaction.
(2) an electrophilic addition reaction.
(3) a nucleophilic substitution reaction.
(4) a nucleophilic addition reaction.
(5) an elimination reaction.

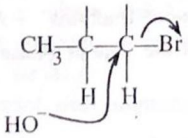
40. Consider the reaction between alkyl halides and alcoholic KOH, which produces alkenes. Using your knowledge of principles of reaction mechanisms, select which of the following correctly depicts the mechanism of this reaction.

(1) 

(2) 

(3) 

(4) 

(5) 

[see page nine

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Instructions for question 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. In which of the following groups of compounds / ions do all members of the group have nearly the same colour?

(a) CdS, AgI, K_2CrO_4 (b) $[Co(NH_3)_6]^{2+}$, $[Ni(NH_3)_6]^{2+}$, $[CoCl_4]^{2-}$

(c) CuS, NiS, ZnS (d) $CuCl_2$, $NiCl_2$, $MnCl_2$

42. Which of the following statement(s) is/are true regarding calcium carbide?
(a) It can be produced by heating CaO and carbon.
(b) It is used in the commercial manufacture of bleaching powder.
(c) It is used as a fertilizer.
(d) It decolorises aqueous $KMnO_4$.

43. Which of the following statement(s) is/are true regarding air ?
(a) It contains more H_2 than Ar.
(b) It contains, approximately, 78 mole percent of N_2 and 21 mole percent of O_2.
(c) It contains more Ar than CO_2.
(d) It contains more He than Ar.

44. By treating industrial waste water with OCl^- in alkaline medium, cyanide ions in waste water are converted to N_2 and carbonate ions according to the following equation.

$$2\ CN^- + 5\ OCl^- + 2\ OH^- \longrightarrow 2\,CO_3^{2-} + N_2 + 5\ Cl^- + H_2O$$

Which of the following statement(s) is/are true regarding this reaction ?
(a) Oxidation number of oxygen in OCl^- is changed from 0 to –2 .
(b) Oxidation number of carbon is changed from +2 to +4 .
(c) Oxidation number of nitrogen is changed from –3 to 0 .
(d) Oxidation number of chlorine is changed from + 1 to –1 .

45. Which of the following may be used to distinguish between SO_2 and CO_2?
(a) A solution of $Ba(OH)_2$ (b) A filter paper moistened with lead acetate
(c) A solution of $K_2Cr_2O_7$ (d) A piece of red-coloured flower petal

46. Liquids **A** and **B** form ideal solutions with each other. One mole each of **A** and **B** are mixed in a bottle and the bottle is stoppered. The vapour pressures of pure **A** and pure **B** under the conditions of the experiment are 120 mm Hg and 140 mm Hg respectively. At equilibrium, the mole fractions of **A** and **B** in the liquid phase are X_A and X_B respectively; the mole fractions of **A** and **B** in the vapour phase are then Y_A and Y_B respectively.
Which of the following expression(s) is/are true?
(a) $X_A = X_B$ (b) $Y_B > Y_A$ (c) $X_A > X_B$ (d) $Y_A > Y_B$

[see page ten

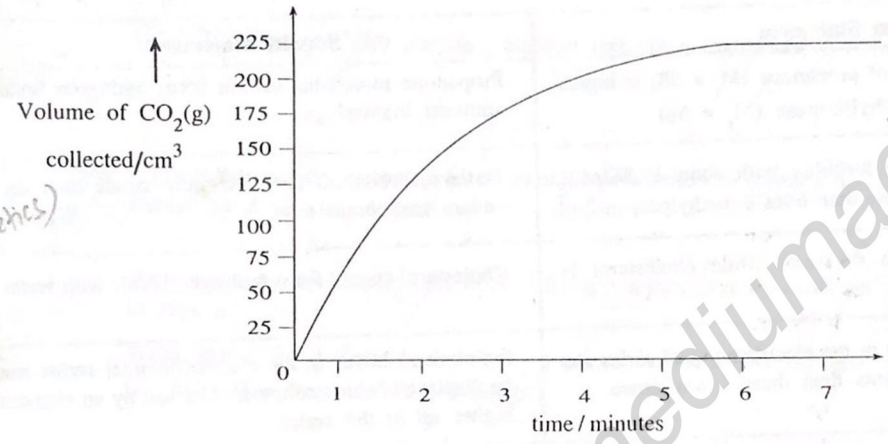
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47. **MX** and NX_2 are ionic compounds of which the solubility products at 300 K are 1×10^{-8} mol^2 dm^{-6} and 4×10^{-12} mol^3 dm^{-9} respectively. Here, **M** is a univalent metal and **N** is a divalent metal.

Which of the following statement(s) is/are true regarding a saturated solution of **MX** (solution **A**) and a saturated solution of NX_2 (Solution **B**) at 300 K?

(a) Concentration of M^+ in solution **A** is equal to the concentration of N^{2+} in solution **B**.
(b) Concentration of X^- in solution **A** is twice the concentration of X^- in solution **B**.
(c) Concentration of N^{2+} in solution **B** is twice the concentration of M^+ in solution **A**.
(d) Concentration of X^- in solution **B** is twice the concentration of X^- in solution **A**.

48. 1·0 g of uniformly powdered $CaCO_3$ (relative molecular mass = 100) was reacted with 100 cm^3 of 0·2 mol dm^{-3} HCl solution. When the volume of CO_2 collected was plotted against time, the following graph was obtained:



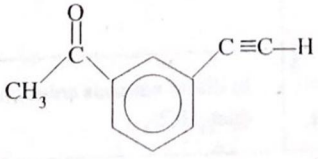
According to this graph

(a) the rate at which $CO_2(g)$ is liberated decreases with time.
(b) Approximately 6 minutes after starting the reaction, an equilibrium is reached.
(c) the rate at which $CO_2(g)$ is liberated increases with time.
(d) Approximately 6 minutes after starting the reaction, the concentrations of different species present in the solution become constant.

49. Correct statement(s) regarding benzene is/are

(a) benzene has six π electrons.
(b) benzene readily undergoes reaction with nucleophiles.
(c) benzene has three localized π bonds.
(d) benzene characteristically undergoes substitution reactions.

50. The compound,



(a) gives a silver mirror with ammoniacal silver nitrate and an orange precipitate with Brady's reagent.
(b) reacts with ammoniacal silver nitrate but **does not** give a silver mirror.
(c) decolorises Br_2/H_2O.
(d) **does not** react with ammoniacal silver nitrate.

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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.	The boiling point of propanone (M_r = 58) is higher than that of 2-methylpropane (M_r = 58).	Propanone molecules cannot form hydrogen bonds amongst themselves.
52.	Butan-2-ol gives a turbidity with conc. HCl/$ZnCl_2$ within a shorter time than does 2-methylpropan-2-ol	Tertiary carbonium ions are more stable than secondary carbonium ions.
53.	Glucose is soluble in water while cholesterol is insoluble in water.	Cholesterol cannot form hydrogen bonds with water.
54.	Elements higher up in the electrochemical series are better reducing agents than those lower down.	An element lower in the electrochemical series can be displaced from a solution of its salt by an element higher up in the series.
55.	Graphite anodes are used in one of the electrolytic processes for the manufacture of caustic soda.	Graphite is a good electrical conductor and is not corroded by caustic soda.
56.	Water boiling in a kettle and its vapour form an equilibrium system.	At a constant external pressure, the temperature of **any** boiling liquid is a constant.
57.	CO contains 0·430 g of carbon per gram of oxygen whereas CO_2 contains 0·215 g of carbon per gram of oxygen. (C = 12 ; O = 16)	If two elements can combine to form more than one compound, they do so in simple atomic ratios.
58.	Phosphorus is stored under water to prevent its reaction with atmospheric O_2.	O_2 dissolved in water does not react with phosphorus.
59.	A Ni^{2+} solution in dilute HCl does not give a black precipitate of NiS with H_2S.	NiS is easily soluble in dilute HCl.
60.	The pH of a 0·01 mol dm^{-3} solution of H_2SO_4 is lower than that of a 0·01 mol dm^{-3} solution of HCl.	In dilute aqueous solutions, H_2SO_4 is a stronger acid than HCl.

* * *

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