19. Electrochemistry – Multiple Choice Questions

1. Electrolytes and Electrolysis

1. The quantity of charge required to obtain one mole of aluminium from Al_2O_3 is ....

(a) $1\,F$ (b) $6\,F$

(c) $3\,F$ (d) $2\,F$

2. In the electrolysis of aqueous sodium chloride solution which of the half cell reaction will occur at anode

(a) $Na^+(aq) + e^- \rightarrow Na(s); E_{cell} \overset{\ominus}{=} -2.71V$

(b) $2H_2O(l) \longrightarrow O_2(g) + 4H^+(aq) + 4e^- E_{cell} \overset{\ominus}{=} 1.23\,V$

(c) $H^+(aq) + e^- \longrightarrow \frac{1}{2}H_2(g); E_{cell} \overset{\ominus}{=} 0.00\,V$

(d) $Cl^-(aq) \longrightarrow \frac{1}{2}Cl_2(g) + e^-; E_{cell} \overset{\ominus}{=} 1.36V$

3. During the electrolysis of an electrolyte, the number of ions produced, is directly proportional to the

(a) Time consumed

(b) Electro chemical equivalent of electrolysis

(c) Quantity of electricity passed

(d) Mass of electrons

4. Electrolysis of aqueous HCl solution produces

(a) H_2 gas at the anode

(b) H_2 gas at the cathode

(c) Cl_2 gas at the cathode

(d) Cl_2 and O_2 gases both at the anode

5. Brine solution on electrolysis will not give

(a) $NaOH$ (b) Cl_2

(c) H_2 (d) O_2

6. The passage of current liberates H_2 at cathode and Cl_2 at anode. The solution is

(a) Copper chloride in water (b) $NaCl$ in water

(c) H_2SO_4 (d) Water

7. Which of the following metal can be obtained by the electrolysis of the aqueous solution of their salts

(a) Cu (b) Na

(c) Mg (d) K

8. In electrolysis of aqueous copper sulphate, the gas at anode and cathode is

(a) O_2 and H_2 (b) SO_2 and H_2

(c) H_2 and O_2 (d) SO_3 and O_2 metal

9. In electroplating, the article to be electroplated serves as

(a) Cathode (b) Electrolyte

(c) Anode (d) Conductor

10. In electrolytic cell, cathode acts as an/a

(a) Oxidising agent (b) Reducing agent

(c) Either of the two (d) Neither (a) nor (b)

11. Which pair of electrolytes could not be distinguished by the products of electrolysis using inert electrodes

(a) $1\,M$ $CuSO_4$ solution, $1M$ $CuCl_2$ solution

(b) $1M$ KCl solution, $1M$ KI solution

(c) $1M$ $AgNO_3$ solution, $1M$ $Cu(NO_3)_2$ solution

(d) $1M$ KCl solution, $1M$ $NaCl$ solution

(e) $1M$ $CuBr_2$ solution, $1M$ $CuSO_4$ solution

12. In the electrolysis of which solution, OH^- ions are discharged in preference to Cl^- ions

(a) Dilute $NaCl$ (b) Very dilute $NaCl$

(c) Fused $NaCl$ (d) Solid $NaCl$

13. Which of the following liberate hydrogen on reaction with dilute H_2SO_4

(a) Fe (b) Cu

(c) Al (d) Hg

14. In the electrolytic refining of zinc, ...

(a) Graphite is at the anode

(b) The impure metal is at the cathode

(c) The metal ion gets reduced at the anode

(d) Acidified zinc sulphate is the electrolyte

15. For gold plating, the electrolyte used is

(a) $AuCl_3$ (b) $HAuCl_4$

(c) $K[Au(CN)_2]$ (d) None of these

2. Faraday's Law of Electrolysis

1. In an electroplating experiment m g of silver is deposited, when 4 amperes of current flows for 2 minutes. The amount (in gms) of silver deposited by 6 amperes of current flowing for 40 seconds will be

(a) $4m$ (b) $m/2$

(c) $m/4$ (d) $2m$

2. A current is passed through two cells connected in series. The first cell contains $X(NO_3)_{3(aq)}$ and the second cell contains $Y(NO_3)_{2(aq)}$. The relative atomic masses of X and Y are in the ratio $1:2$. What is the ratio of liberated mass of X to that of Y

(a) $3:2$ (b) $1:2$

(c) $1:3$ (d) $3:1$

(e) $2:1$

3. A current 2.0 A is passed for 5 hours through a molten metal salt deposits 22 g of metal (At. wt. $=177$). The oxidation state of the metal in the metal salt is

(a) + 1 (b) + 2

(c) + 3 (d) + 4

4. How many atoms of calcium will be deposited from a solution of $CaCl_2$ by a current of 25 milliamperes flowing for 60 seconds

(a) 4.68×10^{18} (b) 4.68×10^{15}

(c) 4.68×10^{12} (d) 4.68×10^{9}

5. The number of electrons passing per second through a cross-section of copper wire carrying 10^{-6} *amperes* of current per second is found to be

(a) 1.6×10^{-19} (b) 6×10^{-35}

(c) 6×10^{-16} (d) 6×10^{12}

6. The electrolytic cells, one containing acidified ferrous chloride and another acidified ferric chloride are connected in series. The ratio of iron deposited at cathodes in the two cells when electricity is passed through the cells will be

(a) 3 : 1 (b) 2 : 1

(c) 1 : 1 (d) 3 : 2

7. If the aqueous solutions of the following salts are electrolysed for 1 hour with 10 ampere current, which solution will deposit the maximum mass of the metal at the cathode. The atomic weights are, $Fe = 56$, $Zn = 65$, $Ag = 108$, $Hf = 178$ and $W = 184$

(a) $ZnSO_4$ (b) $FeCl_3$

(c) $HfCl_4$ (d) WCl_6

(e) $AgNO_3$

8. What current is to be passed for 0.25sec. for deposition of certain weight of metal which is equal to its electrochemical equivalent

(a) 4 A (b) 100 A

(c) 200 A (d) 2 A

9. In the electrolysis of acidulated water, it is desired to obtain 1.12 cc of hydrogen per second under S.T.P. condition. The current to be passed is

(a) 9.65 A (b) 19.3 A

(c) 0.965 A (d) 1.93 A

10. When same quantity of electricity is passed for half an hour, the amount of Cu and Cr deposited are respectively 0.375g and 0.30g. Ratio of electro chemical equivalent of Cu and Cr is

(a) 0.8 (b) 1.25

(c) 2.5 (d) 1.62

11. How many grams of cobalt metal will be deposited when a solution of cobalt (II) chloride is electrolyzed with a current of 10 amperes for 109 minutes

(1 Faraday $= 96,500C$; Atomic mass of $Co = 59u$)

(a) 4.0 (b) 20.0

(c) 40.0 (d) 0.66

12. How many Faradays are needed for reduction of 2.5 mole of $Cr_2O_7^{2-}$ into Cr^{3+}

(a) 15 (b) 12

(c) 6 (d) 3

13. On passing C ampere of current for time t sec through 1 litre of 2 (M) $CuSO_4$ solution (atomic weight of $Cu = 63.5$), the amount of m of Cu (in g) deposited on cathode will be

(a) $m = \dfrac{Ct}{(63.5 \times 96500)}$ (b) $m = \dfrac{Ct}{(31.25 \times 96500)}$

(c) $m = \dfrac{C \times 96500}{(31.25 \times t)}$ (d) $m = \dfrac{31.75 \times C \times t}{96500}$

14. In electrolysis of a fused salt, the weight of the deposit on an electrode will not depend on

(a) Temperature of the bath

(b) Current intensity

(c) Electrochemical equivalent of ions

(d) Time for electrolysis

15. A current being passed for two hour through a solution of an acid liberating 11.2 *litre* of oxygen at NTP at anode. What will be the amount of copper deposited at the cathode by the same current when passed through a solution of copper sulphate for the same time

(a) 16 g (b) 63 g

(c) 31.5 g (d) 8 g

16. When an electric current is passed through acidulated water 112 *mL* of hydrogen gas at N.T.P. collect at the cathode in 965 *seconds*. The current passed, in amperes is

(a) 1.0 (b) 0.5

(c) 0.1 (d) 2.0

17. Silver is removed electrically from 200 *mL* of a 0.1 *N* solution of $AgNO_3$ by a current of 0.1 *ampere*. How long will it take to remove half of the silver from the solution

(a) 16 *sec* (b) 9650 *sec*

(c) 100 *sec* (d) 10 *sec*

18. How many coulombs of electricity are required for the oxidation of one mol of water to dioxygen

(a) $1.93 \times 10^5 C$ (b) $9.65 \times 10^4 C$

(c) $19.3 \times 10^5 C$ (d) $1.93 \times 10^4 C$

19. $9.65 C$ of electric current is passed through fused anhydrous magnesium chloride. The magnesium metal thus, obtained is completely converted into a Grignard reagent. The number of moles of the Grignard reagent obtained is

(a) 5×10^{-4} (b) 1×10^{-4}

(c) 5×10^{-5} (d) 1×10^{-5}

20. On passing electric current through molten aluminium chloride, 11.2 *litre* of Cl_2 is liberated at NTP at anode. The quantity of aluminium deposited at cathode is (at. *wt*. of Al = 27)

(a) 9 *g* (b) 18 *g*

(c) 27 *g* (d) 36 *g*

21. A current of $10.0 A$ is passed through $1.0 L$ of $1.0 M\,HCl$ solution for 965 seconds, *pH* of the solution at the end of the experiment is

(a) 0 (b) 0.20

(c) 0.8 (d) None of the above

22. The number of coulombs required to reduce 12.3 *g* of nitrobenzene to aniline

(a) 115800 *C* (b) 5790 *C*

(c) 28950 *C* (d) 57900 *C*

23. A constant current (0.5*amp*) is passed for 1 hour through (i) aqueous $AgNO_3$, (ii) aqueous $CuSO_4$ and (iii) molten AlF_3, separately. The ratio of the mass of the metals deposited on the cathode is

[M_{Ag}, M_{Cu}, M_{Al} are molar masses of the respective metals]

(a) $M_{Ag} : 2M_{Cu} : 3M_{Al}$ (b) $M_{Ag} : M_{Cu} : M_{Al}$

(c) $6M_{Ag} : 3M_{Cu} : 2M_{Al}$ (d) $3M_{Ag} : 2M_{Cu} : M_{Al}$

3. Conductor and Conductance

1. Which of the statements about solutions of electrolytes is not correct

(a) Conductivity of solution depends upon size of ions

(b) Conductivity depends upon viscosity of solution

(c) Conductivity does not depend upon solvation of ions present in solution

(d) Conductivity of solution increases with temperature

2. The cell constant of a conductivity cell.......

(a) Changes with change of electrolyte

(b) Changes with change of concentration of electrolyte

(c) Changes with temperature of electrolyte

(d) Remains constant for a cell

3. Which solution will show highest resistance during the passage of current

(a) 0.05 N $NaCl$ (b) 2 N $NaCl$

(c) 0.1 N $NaCl$ (d) 1 N $NaCl$

4. It has been observed that gaseous hydrogen chloride is a very poor conductor of electricity but a solution of hydrogen chloride gas in water is a good conductor of electricity. This is due to the fact that

(a) Water is good conductor of electricity

(b) Hydrogen chloride gas in water solution ionizes

(c) A gas is non-conductor but a liquid conducts electricity

(d) Gas does not obey Ohm's law whereas solution does

5. Electrolytic conduction differs from metallic conduction in that in the case of electrolytic conduction

(a) The resistance increases with increasing temperature

(b) The resistance decreases with increasing temperature

(c) The flow of current does not generate heat

(d) The resistance is independent of the length of the conductor

6. The unit ohm^{-1} is used for

(a) Molar conductivity (b) Equivalent conductivity

(c) Specific conductivity (d) Conductance

7. When a solution of an electrolyte is heated, the conductance of the solution

(a) Increases because of the electrolyte conducts better

(b) Decreases because of the increased heat

(c) Decreases because of the dissociation of the electrolyte is suppressed

(d) Increases because the electrolyte is dissociated more

8. Molar conductance of electrolytic solution Λ_m is

(a) $\propto l$ (b) $\propto (1/A)$

(c) $\propto (1/C)$ (d) $\propto (\sqrt{C})$

9. The molar conductivity of a $0.5\,mol/dm^3$ solution of $AgNO_3$ with electrolytic conductivity of $5.76\times10^{-3}S\ cm^{-1}$ at $298\,K$ is

(a) $28.8\,S\,cm^2/mol$ (b) $2.88\,S\,cm^2/mol$

(c) $11.52\,S\,cm^2/mol$ (d) $0.086\,S\,cm^2/mol$

10. The electrolytic conductance is a direct measure of

(a) Resistance (b) Potential

(c) Concentration (d) Dissociation

11. The correct order of equivalent conductances at infinite dilution in water at room temperature for H^+, K^+, CH_3COO^- and HO^- ions is

(a) $HO^- > H^+ > K^+ > CH_3COO^-$

(b) $H^+ > HO^- > K^+ > CH_3COO^-$

(c) $H^+ > K^+ > HO^- > CH_3OO^-$

(d) $H^+ > K^+ > CH_3COO^- > HO^-$

12. Which of the following statement is incorrect with respect to metallic or electronic conductivity

(a) Metallic conductivity depends on the structure of metal and its characteristics

(b) Metallic conductivity depends on the number of electrons in the valence shell of atom of metal

(c) The electrical conductivity of metal increases with increase in temperature

(d) There is no change in the structure of metal during electrical conduction

13. The ionization constant of a weak acid is 1.6×10^{-5} and the molar conductivity at infinite dilution is $380\times10^{-4}\ Sm^2\,mol^{-1}$. If the cell constant is $0.01\,m^{-1}$ then conductance of $0.01\,M$ acid solution is

(a) $1.52\times10^{-5}S$ (b) $1.52\,S$

(c) $1.52\times10^{-3}S$ (d) $1.52\times10^{-4}\,S$

14. The order of equivalent conductances at infinite dilution of $LiCl$, $NaCl$ and KCl is

(a) $LiCl > NaCl > KCl$ (b) $KCl > NaCl > LiCl$

(c) $NaCl > KCl > LiCl$ (d) $LiCl > KCl > NaCl$

15. In infinite dilutions, the equivalent conductances of Ba^{2+} and Cl^- are 127 and 76 $ohm^{-1}cm^2\ eqvt^{-1}$. The equivalent conductivity of $BaCl_2$ at indefinite dilution is

(a) 101.5 (b) 139.5

(c) 203 (d) 279.5

16. If equivalent conductance of $1M$ benzoic acid is $12.8\,ohm^{-1}cm^2$ and if the limiting molar conductance of benzoate ion and H^+ ion are 42 and $288.42\,ohm^{-1}cm^2$ respectively. its degree of dissociation is

(a) 39% (b) 3.9%

(c) 0.35% (d) 0.039%

17. Equivalent conductivity at infinite dilution for sodium-potassium oxalate $(COO^-)_2Na^+K^+)$ will be [given, molar conductivities of oxalate, K^+ and Na^+ ions at infinite dilution are 148.2, 50.1, 73.5 $S\ cm^2 mol^{-1}$, respectively]

(a) $271.8\ S\ cm^2\ eq^{-1}$ (b) $67.95\ S\ cm^2\ eq^{-1}$

(c) $543.6\ S\ cm^2\ eq^{-1}$ (d) $135.9\ S\ cm^2\ eq^{-1}$

18. The value of the limiting molar conductivity (Λ°) for $NaCl, HCl$ and $NaOAc$ are $126.4, 425.9$ and $91.0\,S\,cm^2 mol^{-1}$, respectively. For $HOAc$, Λ° in $S\,cm^2\ mol^{-1}$ is

(a) 390.5 (b) 299.5

(c) 208.5 (d) 217.4

19. The most abundant transition metal in human body is

(a) Copper (b) Iron

(c) Zinc (d) Manganese

4. Cell Constant and Electrochemical Cells

1. The unit of cell constant is

(a) $ohm^{-1}\,cm^{-1}$ (b) $ohm\,cm$

(c) cm (d) cm^{-1}

2. For cell reaction, $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$, cell representation is

(a) $Zn \mid Zn^{2+} \| Cu^{2+} \mid Cu$ (b) $Cu \mid Cu^{2+} \| Zn^{2+} \mid Zn$

(c) $Cu \mid Zn^{2+} \| Zn \mid Cu^{2+}$ (d) $Cu^{2+} \mid Zn \| Zn^{2+} \mid Cu$

3. $\underset{(anode)}{Zn_{(s)} \mid Zn^{2+}{}_{(aq)}} \| \underset{(cathode)}{Cu^{2+}{}_{(aq)} \mid Cu_{(s)}}$ is

(a) Weston cell (b) Daniel cell

(c) Calomel cell (d) Faraday cell

(e) Standard cell

4. In galvanic cell, the salt bridge is used to

(a) Complete the circuit

(b) Reduce the electric resistance in the cell

(c) Separate cathode from anode

(d) Carry salts for the chemical reaction

5. The electrochemical cell stops working after sometimes because

(a) Electrode potential of both the electrodes becomes zero

(b) Electrode potential of both the electrodes becomes equal

(c) One of the electrodes is eaten away

(d) The cell reaction gets reversed

6. The acid used in lead storage battery is

(a) H_2SO_4 (b) H_3PO_4

(c) HCl (d) HNO_3

7. Which of the following is concentration cell

(a) $Cu_{(s)}/Cu^{2+}_{(aq.1M)}//Cu^{2+}_{(aq.1M)}/Cu_{(s)}$

(b) $Cu_{(s)}/Cu^{2+}_{(aq.0.5M)}//Cu^{2+}_{(aq.0.5M)}/Cu_{(s)}$

(c) $Zn_{(s)}/Zn^{2+}_{(aq.0.5M)}//Cu^{2+}_{(aq.1M)}/Cu_{(s)}$

(d) $^{\ominus}Pt/H_{2(g1bar)}/HCl_{(aq0.002M)}//HCl_{(aq.0.005M)}/H_{2(g.1bar)}/Pt^{\oplus}$

8. In H_2-O_2 fuel cell the reaction occurring at cathode is

(a) $H^+ + e^- \to \frac{1}{2}H_2$

(b) $2H_{2(g)} + O_{2(g)} \to 2H_2O_{(l)}$

(c) $H^+_{(aq)} + \bar{O}H_{(aq)} \to H_2O_{(l)}$

(d) $O_{2(g)} + 2H_2O_{(l)} + 4e^- \to 4\bar{O}H_{(aq)}$

9. Which of the following is incorrect in a galvanic cell

(a) Oxidation occurs at anode

(b) Reduction occurs at cathode

(c) The electrode at which electrons are gained is called cathode

(d) The electrode at which electrons are lost is called cathode

10. In dry cell, what acts as negative electrode

(a) Zinc (b) Graphite

(c) Ammonium chloride (d) Manganese dioxide

11. Which of the following statements is true for fuel cells

(a) They are more efficient

(b) They are free from pollution

(c) They run till reactants are active

(d) All of these

12. Which of the following statement is not correct about an inert electrode in a cell

(a) It does not participate in the cell reaction

(b) It provides surface either for oxidation or for reduction reaction

(c) It provides surface for conduction of electrons

(d) It provides surface for redox reaction

13. An electrochemical cell can behave like an electrolytic cell when......

(a) $E_{cell} = 0$ (b) $E_{cell} > E_{ext}$

(c) $E_{ext} > E_{cell}$ (d) $E_{cell} = E_{ext}$

14. Which of the following reaction cannot be a basis for electrochemical cell

(a) $H_2 + O_2 \longrightarrow H_2O$

(b) $AgNO_3 + Zn \longrightarrow Zn(NO_3)_2 + Ag$

(c) $AgNO_3 + NaCl \longrightarrow AgCl \downarrow + NaNO_3$

(d) $KMnO_4 + FeSO_4 + H_2SO_4 \longrightarrow K_2SO_4 + Fe_2(SO_4)_3 + MnSO_4 + H_2O$

15. The electrolyte used in Leclanche cell is

(a) Paste of KOH and ZnO

(b) 38% solution of H_2SO_4

(c) Moist paste of NH_4Cl and $ZnCl_2$

(d) Moist sodium hydroxide

(e) Moist potassium hydroxide

16. In a galvanic cell, the electrons flow from

(a) Anode to cathode through the solution

(b) Cathode to anode through the solution

(c) Anode to cathode through the external circuit

(d) Cathode to anode through the external circuit

17. If the half cell reaction $A + e^- \to A^-$ has a large negative reduction potential, it follows that

(a) A is readily reduced (b) A is readily oxidised

(c) A^- is readily reduced (d) A^- is readily oxidized

18. Which one of the following statement is true for a electrochemical cell

(a) H_2 is cathode and Cu is anode

(b) H_2 is anode and Cu is cathode

(c) Reduction occurs at H_2 electrode

(d) Oxidation occurs at Cu electrode

19. Which of the following statements about galvanic cell is incorrect

(a) Anode is positive

(b) Oxidation occurs at the electrode with lower reduction potential

(c) Cathode is positive

(d) Reduction occurs at cathode

20. Which of the following is not used to construct salt bridge

(a) CH_3COOK (b) KCl

(c) NH_4NO_3 (d) KNO_3

21. The electrode reaction that takes place at the anode of CH_4-O_2 fuel cell is

(a) $2O_2+8H^++8e^- \rightarrow 4H_2O$

(b) $CH_4+2H_2O \rightarrow CO_2+8H^++8e^-$

(c) $CH_4+2O_2 \rightarrow CO_2+2H_2O$

(d) $2H^++2e^- \rightarrow H_2$

22. In which cell, the free energy of a chemical reaction is directly converted into electricity

(a) Leclanche cell (b) Concentration cell

(c) Fuel cell (d) Lead storage battery

23. While charging the lead storage battery,_______

(a) $PbSO_4$ on cathode is oxidized to Pb

(b) $PbSO_4$ on anode is reduced to Pb

(c) $PbSO_4$ on anode is oxidized to PbO_2

(d) $PbSO_4$ on cathode is reduced to Pb

24. When lead storage battery is charged

(a) Lead dioxide dissolves

(b) Sulphuric acid is regenerated

(c) The lead electrode becomes coated with lead sulphate

(d) The amount of sulphuric acid decreases

25. Which colourless gas evolves, when NH_4Cl reacts with zinc in a dry cell battery

(a) NH_4 (b) N_2

(c) H_2 (d) Cl_2

26. Which of the following is used widely in the manufacture of lead storage battery

(a) Arsenic (b) Lithium

(c) Bismuth (d) Antimony

5. Electrode Potential, E$_{cell}$, Nernst Equation and ECS

1. Which cell will measure standard electrode potential of copper electrode

(a) $Pt(s)|H_2(g,0.1\,bar)|H^+(aq.,1M)||Cu^{2+}(aq,1M)|Cu$

(b) $Pt(s)|H_2(g,1\,bar)|H^+(aq.,1M)||Cu^{2+}(aq,2M)|Cu$

(c) $Pt(s)|H_2(g,1\,bar)|H^+(aq.,1M)||Cu^{2+}(aq,1M)|Cu$

(d) $Pt(s)|H_2(g,0.1\,bar)|H^+(aq,0.1M)||Cu^{2+}(aq,1M)|Cu$

2. The difference between the electrode potentials of two electrodes when no current is drawn through the cell is called.......

(a) Cell potential (b) Cell emf

(c) Potential difference (d) Cell voltage

3. Oxidation and reduction take place in a cell, then its electromotive force will be

(a) Positive (b) Negative

(c) Zero (d) Stable

4. Standard electrode potential of Ag^+/Ag and Cu^+/Cu is $+0.80V$ and $+0.34V$ respectively. These electrodes are joint together by salt bridge if

(a) Copper electrode work like cathode, then E^o_{cell} is $+0.45V$

(b) Silver electrode work like anode then E^o_{cell} is $-0.34V$

(c) Copper electrode work like anode then E^o_{cell} is $+0.46V$

(d) Silver electrode work like cathode then E^o_{cell} is $-0.34V$

(e) Silver electrode work like anode then E^o_{cell} will be $+1.14V$

5. Calculate standard free energy change for the reaction $\frac{1}{2}Cu(s)+\frac{1}{2}Cl_2(g) \quad \frac{1}{2}Cu^{2+}+Cl^-$ taking place at $25°C$ in a cell whose standard e.m.f. is 1.02 *volts*

(a) – 98430 J (b) 98430 J

(c) 96500 J (d) – 49215 J

6. What is E° for electrode represented by $Pt, O_2(1\,atm)/2H^+(\text{Im})$

(a) Unpredictable (b) Zero

(c) 0.018 V (d) 0.118 V

7. In a galvanic cell the following reaction takes place at $298^{\circ}K$

$$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

given that : $E^{\circ}(Cr_2O_7^{2-}, H^+, Cr^{3+}/Pt) = 1.33V$

$E^{\circ}(Fe^{3+}, Fe^{2+}/Pt) = 0.77V$. The standard $e.m.f.$ of the cell is

(a) $(1.33 + 0.77)V$ (b) $(1.33 - 0.77)V$

(c) $-(1.33 + 0.77)V$ (d) $(-1.33 + 0.77)V$

8. For the cell reaction, $2Ce^{4+} + Co \rightarrow 2Ce^{3+} + Co^{2+}$ E°_{cell} is $1.89V$ and $E^{o}_{Co/Co^{2+}} = +0.28$. If $E^{\circ}_{Ce^{4+}/Ce^{3+}}$

(a) – 1.64 V (b) + 1.64 V

(c) – 2.08 V (d) + 2.17 V

9. $Cr_2O_7^{2-} + I^- \rightarrow I_2 + Cr^{3+}$

$E^{o}_{cell} = 0.79\,V$; $E^{o}_{Cr_2O_7^{2-}} = 1.33\,V, E^{o}_{I_2}$ is

(a) –0.10 V (b) +0.18 V

(c) –0.54 V (d) 0.54 V

10. The standard electrode potential is measured by

(a) Electrometer (b) Voltmeter

(c) Pyrometer (d) Galvanometer

11. $Zn^{2+} \rightarrow Zn_{(s)}; E^{\circ} = -0.76V$

$Cu^{2+} \rightarrow Cu_{(s)}; E^{\circ} = -0.34V$

Which of the following is spontaneous

(a) $Zn^{2+} + Cu \rightarrow Zn + Cu^{2+}$ (b) $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$

(c) $Zn^{2+} + Cu^{2+} \rightarrow Zn + Cu$ (d) None of these

12. If the half cell reactions are given as

(i) $Fe^{2+}{}_{(aq)} + 2e \rightarrow Fe_{(s)}; E^{\circ} = -0.44V$

(ii) $2H^+{}_{(aq)} + \frac{1}{2}O_{2(g)} + 2e \rightarrow H_2O_{(l)}; E^{\circ} = +1.23V$

The E° for the reaction

$$Fe_{(s)} + 2H^+ + \frac{1}{2}O_{2(g)} \rightarrow Fe^{2+}{}_{(aq)} + H_2O_{(l)}$$

(a) +1.67V (b) –1.67V

(c) +0.79V (d) –0.79V

13. Normal aluminium electrode coupled with normal hydrogen electrode gives an e.m.f. of $1.66\,volts$. So the standard electrode potential of aluminium is

(a) – 1.66 V (b) + 1.66 V

(c) – 0.83 V (d) + 0.83 V

14. If an element A is placed in electrochemicals series above element B but below element C, then the order of oxidation power of elements

(a) A > B > C (b) C > B > A

(c) C > A > B (d) B > A > C

15. Which of the following statement is correct

(a) E_{cell} and $\Delta_r G$ of cell reaction both are extensive properties

(b) E_{cell} and $\Delta_r G$ of cell reaction both are intensive properties

(c) E_{cell} is an intensive property while $\Delta_r G$ of cell reaction is an extensive property

(d) E_{cell} is an extensive property while $\Delta_r G$ of cell reaction is an intensive property

16. Using the data given below find out the strongest reducing agent

$$E^{\ominus}_{Cr_2O_2^{2-}/Cr^{3+}} = 1.33V;\ E^{\ominus}_{Cl_2/Cl^-} = 1.36V$$

$$E^{\ominus}_{MnO_4^-/Mn^{2+}} = 1.51V;\ E^{\ominus}_{Cr^{3+}/Cr} = -0.74V$$

(a) Cl^- (b) Cr

(c) Cr^{3+} (d) Mn^{2+}

17. Using the data given in Q. 16 find out in which option the order of reducing power is correct

(a) $Cr^{3+} < Cl^- < Mn^{2+} < Cr$

(b) $Mn^{2+} < Cl^- < Cr^{3+} < Cr$

(c) $Cr^{3+} < Cl^- < Cr_2O_7^{2-} < MnO_4^-$

(d) $Mn^{2+} < Cr^{3+} < Cl^- < Cr$

18. Use the data given in Q. 16 and find out the most stable ion in its reduced form

(a) Cl^- (b) Cr^{3+}

(c) Cr (d) Mn^{2+}

19. Use the data of Q. 16 and find out the most stable oxidised species

(a) Cr^{3+} (b) MnO_4^-

(c) $Cr_2O_7^{2-}$ (d) Mn^{2+}

20. If hydrogen electrode dipped in 2 solution of $pH = 3$ and $pH = 6$ and salt bridge is connected; the e.m.f. of resulting cell is

(a) 0.177 V (b) 0.3 V

(c) 0.052 V (d) 0.104 V

21. E_1, E_2 and E_3 are the emf values of the three galvanic cells respectively.

(i) $Zn \mid Zn^{2+}_{1M} \| Cu^{2+}_{0.1M} \mid Cu$ (ii) $Zn \mid Zn^{2+}_{1M} \| Cu^{2+}_{1M} \mid Cu$

(iii) $Zn \mid Zn^{2+}_{0.1M} \| Cu^{2+}_{1M} \mid Cu$

Which one of the following is true

(a) $E_2 > E_3 > E_1$ (b) $E_3 > E_2 > E_1$

(c) $E_1 > E_2 > E_3$ (d) $E_1 > E_3 > E_2$

22. Which one of the following has a potential more than zero

(a) $Pt, \frac{1}{2}H_2\,(1\ atm) \mid HCl\ (1\ M)$

(b) $Pt, \frac{1}{2}H_2\,(1\ atm) \mid HCl\ (2\ M)$

(c) $Pt, \frac{1}{2}H_2\,(1\ atm) \mid HCl\ (0.1\ M)$

(d) $Pt, \frac{1}{2}H_2\,(1\ atm) \mid HCl\ (0.5\ M)$

23. The reference electrode is made from which of the following

(a) $ZnCl_2$ (b) $CuSO_4$

(c) Hg_2Cl_2 (d) $HgCl_2$

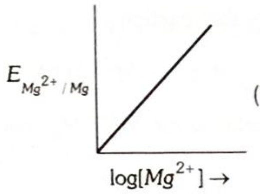
24. The standard electrode potential (E^o) for OCl^- / Cl^- and $Cl^- / \frac{1}{2}Cl_2$ respectively are $0.94\,V$ and $-1.36\,V$. The E^o value for $OCl^- / \frac{1}{2}Cl_2$ will be

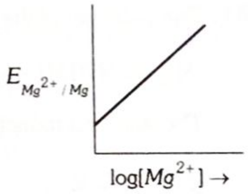
(a) $-0.42\,V$ (b) $-2.20\,V$

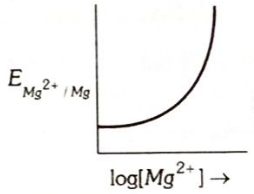
(c) $0.52\,V$ (d) $1.04\,V$

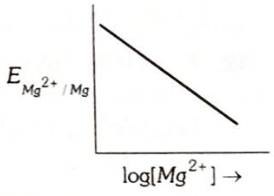
25. Electrode potential for Mg electrode varies according to the equation

$$E_{Mg^{2+}/Mg} = E^{\ominus}_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}.$$ The graph of $E_{Mg^{2+}/Mg}$ vs. $\log[Mg^{2+}]$ is

(a) 

(b) 

(c) 

(d) 

26. Mark the false statement

(a) A salt bridge is used to eliminate liquid junction potential

(b) The Gibbs free energy change, ΔG is related with electromotive force (E), as $\Delta G = -nFE$

(c) Nernst equation for single electrode potential is $E = E^o - \frac{RT}{nF}\ln a_{M^{n+}}$

(d) The efficiency of a hydrogen oxygen fuel cell is 23%

27. The standard cell potential of $Zn \mid Zn^{2+}{}_{(aq)} \| Cu^{2+}{}_{(aq)} \mid Cu$ cell is 1.10 V. The maximum work obtained by this cell will be

(a) 106.15 kJ (b) – 212.30 kJ

(c) – 318.45 kJ (d) – 424.60 kJ

28. Consider two half cells based on the reaction $Ag^+{}_{(aq)} + e \rightarrow Ag_{(s)}$. The left half cell contain Ag^+ ions at unit concentration, and the right half cell initially had the same concentration of Ag^+ ions, but just enough $NaCl_{(aq)}$ had been added to completely precipitate the $Ag^+{}_{(aq)}$ as $AgCl$. If the emf of the cell is $0.29\,V$, then $\log_{10} K_{sp}$ would have been

(a) 9.804 (b) –9.804

(c) –4.902 (d) 10.004

29. The hydrogen electrode is dipped in a solution of $pH = 3$ at $25^\circ C$. The potential of the cell would be (the value of $2.303RT/F$ is 0.059 V)

(a) 0.177 V (b) – 0.177 V

(c) 0.087 V (d) 0.059 V

30. The e.m.f. of the cell in which the following reaction $Zn_{(s)} + Ni^{2+}(a = 1.0) \rightleftharpoons Zn^{2+}(a = 10) + Ni_{(s)}$ occurs, is found to be $0.5105\,V$ at $298\,K$. The standard e.m.f. of the cell is

(a) 0.5400 V (b) 0.4810 V

(c) 0.5696 V (d) – 0.5105 V

31. The potential of the cell for the reaction

$$M_{(s)} + 2H^+(1M) \longrightarrow H_{2(g)}, (1\ atm) + M^{2+}\ (0.1M) \text{ is } 1.500\ V.$$

The standard reduction potential for $M^{2+}/M_{(s)}$ couple is

(a) 0.1470 V (b) –1.470 V

(c) 14.70 V (d) None of these

32. $E_{cell} = 0.78$ volt for the following cell.

$$Fe_{(s)} \mid \underset{(xM)}{Fe^{2+}{}_{(aq)}} \parallel \underset{(0.01M)}{Cu^{2+}{}_{(aq)}} \mid Cu_{(s)}$$

$$E^\circ_{Fe/Fe^{2+}{}_{(aq)}} = 0.44V, E^\circ_{Cu/Cu^{2+}{}_{(aq)}} = -0.34V$$

(a) x cannot be predicted (b) $x = 0.01M$

(c) $x > 0.01M$ (d) $x < 0.01M$

33. The potential of standard hydrogen electrode is zero. This implies that

(a) $\Delta G^\circ_f\ (H^+, aq) = 0$ (b) $\Delta H^\circ_f\ (H^+, aq) = 0$

(c) $\Delta G^\circ_f\ (H^+, aq) < 0$ (d) $\Delta G^\circ_f\ (H^+, aq) > 0$

34. The E° values of the following reduction reactions are given $Fe^{3+}{}_{(aq)} + e \rightarrow Fe^{2+}{}_{(aq)},\ E^\circ = 0.771V$

$$Fe^{2+}{}_{(aq)} + 2e \rightarrow Fe_{(s)},\ E^\circ = -0.447V$$

What will be the free energy change for the reaction

$$Fe_{(aq)}{}^{3+} + 3e^- \rightarrow Fe_{(s)} \qquad (1F = 96485\,C\,mol^{-1})$$

(a) $+18.51\,kJ\,mol^{-1}$ (b) $+11.87\,kJ\,mol^{-1}$

(c) $-8.10\,kJ\,mol^{-1}$ (d) $-10.41\,kJ\,mol^{-1}$

35. Consider the cell

$Pt \mid H_{2(g,\,1\,atm)} \mid H^+{}_{(aq,\,1M)} \mid\mid Fe^{3+}{}_{(aq)}, Fe^{2+}{}_{(aq)} \mid Pt_{(s)}$ Given that $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.771V$, the ratio of conc. of $Fe^{2+}{}_{(aq)}$ to $Fe^{3+}{}_{(aq)}$ is, when the cell potential is $0.830V$

(a) 0.101 (b) 0.924

(c) 0.120 (d) None of these

36. During spontaneous discharge of an electrochemical cell Gibb's free energy will

(a) Increase (b) Decrease

(c) Not change (d) Be infinity

37. The oxidation potential of a hydrogen electrode at $pH = 10$ and $pH_1 = 1$

(a) 0.059 V (b) 0.59 V

(c) 0.00 V (d) 0.51 V

38. Which of the following metal does not react with the solution of copper sulphate

(a) Mg (b) Fe

(c) Zn (d) Ag

39. The standard oxidation potential of zinc and silver in water at 298 K are

$$Zn_{(s)} \rightarrow Zn^{2+} + 2e^-; E = 0.76V$$

$$Ag_{(s)} \rightarrow Ag^{2+} + 2e^-; E = -0.80V$$

Which of the following reactions actually take place

(a) $Zn_{(s)} + 2Ag^+{}_{(aq)} \rightarrow Zn^{++}{}_{(aq)} + 2Ag_{(s)}$

(b) $Zn^{++}{}_{(aq)} + 2Ag_{(s)} \rightarrow 2Ag^+{}_{(aq)} + Zn_{(s)}$

(c) $Zn_{(s)} + Ag_{(s)} \rightarrow Zn^{++}{}_{(aq)} + Ag^+{}_{(aq)}$

(d) $Zn^{++}{}_{(aq)} + Ag^+{}_{(aq)} \rightarrow Zn_{(s)} + Ag_{(s)}$

40. $2H^+\,(aq) + 2e^- \rightarrow H_2\,(g)$. The standard electrode potential for the above reaction is (in volts)

(a) 0 (b) + 1

(c) – 1 (d) None of these

41. Li occupies higher position in the electrochemical series of metals as compared to Cu since

(a) The standard reduction potential of Li^+/Li is lower than that of Cu^{2+}/Cu

(b) The standard reduction potential of Cu^{2+}/Cu is lower than that of Li^+/Li

(c) The standard oxidation potential of Li/Li^+ is lower than that of Cu/Cu^{2+}

(d) Li is smaller in size as compared to Cu

42. Reduction potentials of A, B, C and D are $0.8V, 0.79V, 0.34V$ and $-2.37V$ respectively. Which element displaces all the other three elements

(a) B (b) A

(c) D (d) C

43. Will $Fe_{(s)}$ be oxidised to Fe^{2+} by the reaction with 1 M HCl (E° for Fe/Fe^{2+} = + 0.44 V)

(a) Yes (b) No

(c) May be (d) Can't say

44. What is wrongly stated about electrochemical series

(a) It is the representation of element in order of increasing or decreasing standard electrode reduction potential

(b) It does not compare the relative reactivity of metals

(c) It compares relative strengths of oxidising agents

(d) H_2 is centrally placed element

45. The tendencies of the electrodes made up of Cu, Zn and Ag to release electrons when dipped in their respective salt solutions decrease in the order

(a) $Zn > Ag > Cu$ (b) $Cu > Zn > Ag$

(c) $Zn > Cu > Ag$ (d) $Ag > Cu > Zn$

46. The standard reduction electrode potentials of the three electrodes P, Q and R are respectively $-1.76V$, $0.34\,V$ and $0.8V$. Then

(a) Metal Q will displace the cation of P from its aqueous solution and deposit the metal P

(b) Both metals Q and R will displace the cation of P from its aqueous solution and deposit the metal P

(c) Metal R will displace the cation of P from its aqueous solution and deposit the metal R

(d) Metal P will displace the cation of R from its aqueous solution and deposit the metal R

47. Standard reduction potential for Al^{3+}/Al, Fe^{2+}/Fe, Br/Br^- are -1.66 V, -0.45 V, 1.09 V. Order of their reducing capacity is

(a) Al>Fe>Br (b) Br>Fe>Al

(c) Al>Br>Fe (d) Fe>Al>Br

48. When $E^o_{Ag^+/Ag} = 0.8$ *volt* and $E^o_{Zn^{2+}/Zn} = -0.76$ *volt*, which of the following is correct

(a) Ag^+ can be reduced by H_2

(b) Ag can oxidise H_2 into H^+

(c) Zn^{2+} can be reduced by H_2

(d) Ag can reduce Zn^{2+} ion

49. Standard electrode potentials of Zn and Fe are known to be (i) $-0.76V$ and (ii) $-0.44\,V$ respectively. How does it explain that galvanization prevents rusting of iron while zinc slowly dissolves away

(a) Since (i) is less than (ii), zinc becomes the cathode and iron the anode

(b) Since (i) is less than (ii), zinc becomes the anode and iron the cathode

(c) Since (i) is more than (ii), zinc becomes the anode and iron the cathode

(d) Since (i) is more than (ii), zinc becomes the cathode and iron the anode

50. The oxide which is not reduced by hydrogen is

(a) Ag_2O (b) K_2O

(c) Fe_2O_3 (d) P_4O_{10}

51. Small quantities of solutions of compounds TX, TY and TZ are put into separate test tubes containing X, Y and Z solution. TX does not react with any of these. TY reacts with both X and Z. TZ reacts with X. The decreasing order of state of oxidation of the anions X^-, Y^-, Z^- is

(a) Y^-, Z^-, X^- (b) Z^-, X^-, Y^-

(c) Y^-, X^-, Z^- (d) X^-, Z^-, Y^-

52. The standard Gibbs free energy change (ΔG^o in kJ mol^{-1}), in a Daniel cell ($E^\circ_{cell} = 1.1V$), when 2 moles of $Zn(s)$ is oxidized at $298K$, is closest to

(a) -212.3 (b) -106.2

(c) -424.6 (d) -53.1

53. The order of reactivity of K, Mg, Au and Zn with water is

(a) $K > Zn > Mg > Au$ (b) $K > Mg > Zn > Au$

(c) $K > Au > Mg > Zn$ (d) $Au > Zn > K > Mg$

54. Which of the following metals will precipitate copper from copper sulphate solution

(a) Hg (b) Sn

(c) Au (d) Pt

55. Among Mg, Cu, Fe, Zn, the metal that does not produce hydrogen gas in reaction with hydrochloric acid is

(a) Cu (b) Zn

(c) Mg (d) Fe

56. The equilibrium constant of a 2 electron redox reaction at $298\,K$ is 3.8×10^{-3}. The cell potential E^o (in V) and the free energy change ΔG^o (in kJ mol^{-1}) for this equilibrium respectively, are

(a) -0.071, -13.8 (b) -0.071, 13.8

(c) 0.71, -13.8 (d) 0.071, -13.8

57. The reducing ability of the metals K, Au, Zn and Pb follows the order

(a) $K > Pb > Au > Zn$ (b) $Pb > K > Zn > Au$

(c) $Zn > Au > K > Pb$ (d) $K > Zn > Pb > Au$

58. Which of the following transformations can be carried out by using HI as a reducing agent, under acidic conditions

[Given $I_2(s) \rightarrow 2I^- \; E^0 = 0.54\,V$]

(I) $Cu^+ \rightarrow Cu(s) \; E^0 = 0.52\,V$

(II) $Cr^{3+} \rightarrow Cr^{2+} \; E^0 = -0.41\,V$

(III) $Fe^{3+} \rightarrow Fe^{2+} \; E^0 = 0.77\,V$

(IV) $Fe^{2+} \rightarrow Fe(s) \; E^0 = -0.44\,V$

(a) (I) and (III) (b) (II) and (IV)

(c) Only (III) (d) Only (II)

59. Among the following metals, the strongest reducing agent is

(a) Ni (b) Cu

(c) Zn (d) Fe

6. Corrosion

1. The metal that forms a self protecting film of oxide to prevent corrosion, is

(a) Cu (b) Al

(c) Na (d) Au

2. Corrosion is basically a

(a) Altered reaction in presence of H_2O

(b) Electrochemical phenomenon

(c) Interaction

(d) Union between light metal and heavy metal

3. On the basis of the electrochemical theory of aqueous corrosion, the reaction occurring at the cathode is

(a) $O_{2(g)} + 4H^+_{(aq)} + 4e^- \rightarrow 2H_2O_{(l)}$

(b) $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$

(c) $Fe^{2+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + e^-$

(d) $H_{2(g)} + 2OH^-_{(aq)} \rightarrow 2H_2O_{(l)} + 2e^-$

4. Aluminium is more reactive than Fe. But Al is less easily corroded than iron because

(a) Al is noble metal

(b) Iron forms both mono and divalent ions

(c) Oxygen forms a protective oxide layer

(d) Fe undergoes reaction easily with H_2O

5. Rusting of iron is catalysed by which of the following

(a) Fe (b) O_2

(c) Zn (d) H^+

6. Corrosion of iron is essentially an electrochemical phenomenon where the cell reactions are

(a) Fe is oxidised to Fe^{2+} and dissolved oxygen in water is reduced to $\overset{-}{OH}$

(b) Fe is oxidised to Fe^{3+} and H_2O is reduced to O_2^{2-}

(c) Fe is oxidised to Fe^{2+} and H_2O is reduced to O_2^-

(d) Fe is oxidised to Fe^{2+} and H_2O is reduced to O_2

7. IIT-JEE/ AIEEE

1. When the sample of copper with zinc impurity is to be purified by electrolysis, the appropriate electrodes are **[2002]**

	Cathode	**Anode**
(a)	Pure zinc	Pure copper
(b)	Impure sample	Pure copper
(c)	Impure zinc	Impure sample
(d)	Pure copper	Impure sample

2. In the electrolytic cell, flow of electrons is from **[2003]**

(a) Cathode to anode in solution

(b) Cathode to anode through external supply

(c) Cathode to anode through internal supply

(d) Anode to cathode through internal supply

3. A solution of sodium sulphate in water is electrolysed using inert electrodes. The products at the cathode and anode are respectively **[1987,96]**

(a) H_2, O_2 (b) O_2, H_2

(c) O_2, Na (d) O_2, SO_2

4. Several blocks of magnesium are fixed to the bottom of a ship to **[2003]**

(a) Keep away the sharks

(b) Make the ship lighter

(c) Prevent action of water and salt

(d) Prevent puncturing by under-sea rocks

5. Which one of the following metals could not be obtained on electrolysis of aqueous solution of its salts **[1990]**

(a) Ag (b) Mg

(c) Cu (d) Cr

6. During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are **[2005]**

(a) Sn and Ag (b) Pb and Zn

(c) Ag and Au (d) Fe and Ni

7. What weight of copper will be deposited by passing 2 Faradays of electricity through a cupric salt (Atomic weight of $Cu = 63.5$) **[2015]**

(a) 2.0 g (b) 3.175 g

(c) 63.5 g (d) 127.0 g

8. The electric charge for electrode decomposition of one gram equivalent of a substance is **[1984]**

(a) One ampere per second

(b) 96500 coulombs per second

(c) One ampere for one hour

(d) Charge on one mole of electrons

9. Electrolysis of dilute aqueous $NaCl$ solution was carried out by passing 10 milli ampere current . The time required to liberate 0.01 mol of H_2 gas at the cathode is (1 Faraday $=96500\ C\ mol^{-1}$) **[2008]**

(a) 9.65×10^4 sec (b) 19.3×10^4 sec

(c) 28.95×10^4 sec (d) 38.6×10^4 sec

10. Aluminium oxide may be electrolysed at 1000°C to furnish aluminium metal (At. Mass = 27 *amu*; 1 *Faraday* = 96,500 *Coulombs*). The cathode reaction is

$$Al^{3+} + 3e^- \rightarrow Al^0$$

To prepare $5.12 kg$ of aluminium metal by this method would require **[2005]**

(a) $5.49\times10^7 C$ of electricity

(b) $1.83\times10^7 C$ of electricity

(c) $5.49\times10^4 C$ of electricity

(d) $5.49\times10^1 C$ of electricity

11. How long (approximate) should water be electrolysed by passing through 100 amperes current so that the oxygen released can completely burn $27.66 g$ of diborane

(Atomic weight of $B = 10.8u$) **[2018]**

(a) 3.2 *hours* (b) 1.6 *hours*

(c) 6.4 *hours* (d) 0.8 *hours*

12. The highest electrical conductivity of the following aqueous solutions is of **[2005]**

(a) 0.1 M acetic acid (b) 0.1 M chloroacetic acid

(c) 0.1 M fluoroacetic acid (d) 0.1 M difluoroacetic acid

13. Resistance of $0.2\,M$ solution of an electrolyte is 50Ω. The specific conductance of the solution $1.4 Sm^{-1}$. The resistance of $0.5\,M$ solution of the same electrolyte is 280Ω. The molar conductivity of $0.5\,M$ solution of the electrolyte in $Sm^2\,mol^{-1}$ is **[2014]**

(a) 5×10^{-4} (b) 5×10^{-3}

(c) 5×10^{3} (d) 5×10^{2}

14. The equivalent conductance of $NaCl$ at concentration C and at infinite dilution are λ_C and λ_∞, respectively. The correct relationship between λ_C and λ_∞ is given as

(where the constant B is positive) **[2014]**

(a) $\lambda_C = \lambda_\infty + (B)C$ (b) $\lambda_C = \lambda_\infty - (B)C$

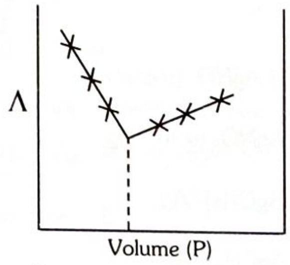
(c) $\lambda_C = \lambda_\infty - (B)\sqrt{C}$ (d) $\lambda_C = \lambda_\infty + (B)\sqrt{C}$

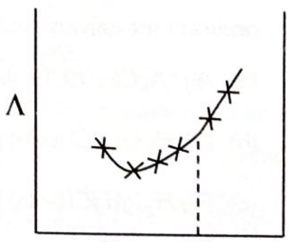
15. Resistance of a conductivity cell filled with a solution of an electrolyte of concentration 0.1M is 100 Ω. The conductivity of this solution is 1.29 Sm^{-1}. Resistance of the same cell when filled with 0.2 M of the same solution is 520 Ω. The molar conductivity of 0.2 M solution of the electrolyte will be **[2006]**

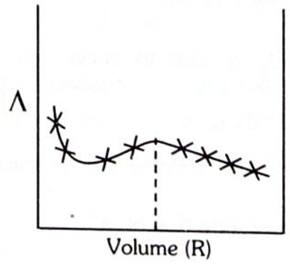
(a) $124\times10^{-4} Sm^2\,mol^{-1}$ (b) $1240\times10^{-4} Sm^2\,mol^{-1}$

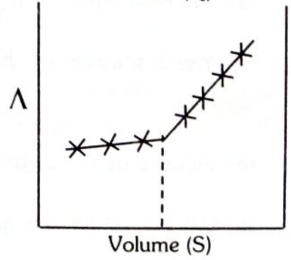
(c) $12.4\times10^{-4} Sm^2 mol^{-1}$ (d) $1.24\times10^{-4} Sm^2\,mol^{-1}$

16. $AgNO_{3\,(aq.)}$ was added to an aqueous KCl solution gradually and the conductivity of the solution was measured. The plot of conductance (∧) versus the volume of $AgNO_3$ is **[2011]**









(a) (P) (b) (Q)

(c) (R) (d) (S)

17. The molar conductivities $\wedge^{o}_{NaOAc}$ and $\wedge^{o}_{HCl}$ at infinite dilution in water at 25°C are 91.0 and 426.2 S cm^2/mol respectively. To calculate $\wedge^{o}_{HOAc}$, the additional value required is **[2006]**

(a) $\wedge^{o}_{H_2O}$ (b) $\wedge^{o}_{KCl}$

(c) $\wedge^{\circ}_{NaOH}$ (d) $\wedge^{o}_{NaCl}$

18. The limiting molar conductivities $\wedge$ for $NaCl$, KBr and KCl are 126, 152 and 150 $S\,cm^2mol^{-1}$ respectively. The $\wedge$ for $NaBr$ is **[2004]**

(a) $278\ S\,cm^2mol^{-1}$ (b) $176\ S\,cm^2mol^{-1}$

(c) $128\ S\,cm^2mol^{-1}$ (d) $302\ S\,cm^2mol^{-1}$

19.

Electrolyte :	KCl	KNO_3	HCl	$NaOAc$	$NaCl$
$\Lambda^{\infty}(Scm^2mol^{-1})$	149.9	145.0	426.2	91.0	126.5

Calculate Λ^{∞}_{HOAc} using appropriate molar conductances of the electrolytes listed above at infinite dilution in H_2O at 25°C **[2005]**

(a) 517.2 (b) 552.7

(c) 390.7 (d) 217.5

20. Conductivity (unit *Siemens*) is directly proportional to area of the vessel and the concentration of the solution in it and is inversely proportional to the length of the vessel then the unit of the constant of proportionality is **[2002]**

(a) $Sm\ mol^{-1}$ (b) $Sm^2\ mol^{-1}$

(c) $S^{-2}m^2\ mol$ (d) $S^2m^2\ mol^{-2}$

21. The reaction $\frac{1}{2}H_{2(g)} + AgCl_{(s)} \rightarrow H^{+}{}_{(aq)} + Cl^{-}{}_{(aq)} + Ag_{(s)}$

occurs in the galvanic cell **[1985]**

(a) $Ag / AgCl(s) KCl$ (soln) $||$ $AgNO_3$ (soln)$/ Ag$

(b) $Pt / H_2(g) HCl$ (soln) $||$ $AgNO_3$ (soln)$/ Ag$

(c) $Pt / H_2(g) HCl$ (soln) $||$ $AgCl(s) / Ag$

(d) $Pt / H_2(g) KCl$ (soln) $||$ $AgCl(s) / Ag$

22. Saturated solution of KNO_3 is used to make 'salt-bridge' because **[2002]**

(a) Velocity of K^+ is greater than that of NO_3^-

(b) Velocity of NO_3^- is greater than that of K^+

(c) Velocities of both K^+ and NO_3^- are nearly the same

(d) KNO_3 is highly soluble in water

23. In a hydrogen – oxygen fuel cell, combustion of hydrogen occurs to **[2004]**

(a) Produce high purity water

(b) Create potential difference between the two electrodes

(c) Generate heat

(d) Remove adsorbed oxygen from electrode surfaces

24. When a lead storage battery is discharged **[1987]**

(a) SO_2 is evolved

(b) Lead sulphate is consumed

(c) Lead is formed

(d) Sulphuric acid is consumed

25. The standard reduction potential for Fe^{2+} / Fe and Sn^{2+} / Sn electrodes are -0.44 and -0.14 volt respectively. For the given cell reaction $Fe^{2+} + Sn \rightarrow Fe + Sn^{2+}$, the standard EMF is **[1990]**

(a) $+ 0.30\ V$ (b) $- 0.58\ V$

(c) $+ 0.58\ V$ (d) $- 0.30\ V$

26. *EMF* of a cell in terms of reduction potential of its left and right electrodes is **[2002]**

(a) $E = E_{left} - E_{right}$ (b) $E = E_{left} + E_{right}$

(c) $E = E_{right} - E_{left}$ (d) $E = -(E_{right} + E_{left})$

27. Consider the following E^o values :

$E^o{}_{Fe^{3+} / Fe^{2+}} = +0.77\ V$

$E^o{}_{Sn^{2+} / Sn} = -0.14\ V$

Under standard conditions the potential for the reaction $Sn_{(s)} + 2Fe^{3+}{}_{(aq)} \rightarrow 2Fe^{2+}{}_{(sq)} + Sn^{2+}{}_{(aq)}$ is **[2004]**

(a) $0.91\ V$ (b) $1.40\ V$

(c) $1.68\ V$ (d) $0.63\ V$

28. Given : $E^0_{Cr^{3+}/Cr} = -0.74\,V;\ E^0_{MnO_4^-/Mn^{2+}} = 1.51\,V$

$E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\,V;\ E^0_{Cl/Cl^-} = 1.36\,V$

Based on the data given above, strongest oxidising agent will be **[2013]**

(a) Cl (b) Cr^{3+}

(c) Mn^{2+} (d) MnO_4^-

29. Which of the following reaction is possible at anode **[2002]**

(a) $2Cr^{3+} + 7H_2O \rightarrow Cr_2O_7{}^{2-} + 14H^+$

(b) $F_2 \rightarrow 2F^-$

(c) $\frac{1}{2}O_2 + 2H^+ \rightarrow H_2O$

(d) None of these

30. What will be the *emf* for the given cell $Pt \mid H_2(P_1) \mid H^+{}_{(aq)} \mid\mid H_2(P_2) \mid Pt$ **[2002]**

(a) $\frac{RT}{f}\ln\frac{P_1}{P_2}$

(b) $\frac{RT}{2f}\ln\frac{P_1}{P_2}$

(c) $\frac{RT}{f}\ln\frac{P_2}{P_1}$

(d) None of these

31. In a cell that utilises the reaction $Zn_{(s)} + 2H^+{}_{(aq)} \rightarrow Zn^{2+}{}_{(aq)} + H_{2(g)}$ addition of H_2SO_4 to cathode compartment, will **[2004]**

(a) Increase the E and shift equilibrium to the right

(b) Lower the E and shift equilibrium to the right

(c) Lower the E and shift equilibrium to the left

(d) Increase the E and shift equilibrium to the left

32. Given below are the half-cell reactions **[2014]**

$$Mn^{2+} + 2e^- \longrightarrow Mn;\ E^\circ = -1.18\,V$$

$$2(Mn^{3+} + e^- \longrightarrow Mn^{2+});\ E^\circ = +1.51\,V$$

The E° for $3Mn^{2+} \longrightarrow Mn + 2Mn^{3+}$ will be :

(a) $-2.69\,V$; the reaction will not occur

(b) $-2.69\,V$; the reaction will occur

(c) $-0.33\,V$; the reaction will not occur

(d) $-0.33\,V$; the reaction will occur

33. The standard reduction potentials for $Zn^{2+}/Zn, Ni^{2+}/Ni$ and Fe^{2+}/Fe are $-0.76, -0.23$ and $-0.44V$ respectively. The reaction $X + Y^{2+} \rightarrow X^{2+} + Y$ will be spontaneous when **[2012]**

(a) $X = Ni, Y = Fe$

(b) $X = Ni, Y = Zn$

(c) $X = Fe, Y = Zn$

(d) $X = Zn, Y = Ni$

34. The reduction potential of hydrogen half-cell will be negative if **[2011]**

(a) $P_{(H_2)} = 1\,atm$ and $[H^+] = 2.0M$

(b) $P_{(H_2)} = 1\,atm$ and $[H^+] = 1.0M$

(c) $P_{(H_2)} = 2\,atm$ and $[H^+] = 1.0M$

(d) $P_{(H_2)} = 2\,atm$ and $[H^+] = 2.0M$

35. Given

$$E^o_{Fe^{3+}/Fe} = -0.036V,\ E^o_{Fe^{2+}/Fe} = -0.439V$$

The value of standard electrode potential for the change, $Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}(aq)$ will be **[2009]**

(a) $-0.072V$

(b) $0.385V$

(c) $0.770V$

(d) $-0.270V$

36. For the electrochemical cell,

$M \mid M^+ \mid\mid X \mid X^-$, $E^o(M^+/M) = 0.44\ V$ and $E^o(X/X^-) = 0.33\ V$. From this data one can deduce that **[2000]**

(a) $M + X \rightarrow M^+ + X^-$ is the spontaneous reaction

(b) $M^+ + X^- \rightarrow M + X$ is the spontaneous reaction

(c) $E_{cell} = 0.77\ V$

(d) $E_{cell} = -0.77\ V$

37. Cu^+ ion is not stable in aqueous solution because of disproportionation reaction. E^o value for disproportionation of Cu^+ is

(Given $E^o_{Cu^{2+}/Cu^+} = 0.15$, $E^o_{Cu^{2+}/Cu} = 0.34V$) **[1995]**

(a) $-0.49\ V$

(b) $0.49\ V$

(c) $-0.38\ V$

(d) $0.38\ V$

38. Given $E^o_{Cr^{3+}/Cr} = -0.72V, E^o_{Fe^{2+}/Fe} = -0.42V$. The potential for the cell $Cr\left|Cr^{3+}(0.1M)\right|\left|Fe^{2+}(0.01M)\right|\ Fe$ is **[2008]**

(a) 0.339V

(b) – 0.339V

(c) – 0.26V

(d) 0.26V

39. For a spontaneous reaction the ΔG, equilibrium constant (K) and E^o_{Cell} will be respectively **[2005]**

(a) $-ve, > 1, +ve$

(b) $+ve, > 1, -ve$

(c) $-ve, < 1, -ve$

(d) $-ve, > 1, -ve$

40. The standard *e.m.f.* of a cell, involving one electron change is found to be $0.591\ V$ at $25°C$. The equilibrium constant of the reaction is ($F = 96{,}500\ C\ mol^{-1}$; $R = 8.314\ JK^{-1}mol^{-1}$) **[2004]**

(a) 1.0×10^{10}

(b) 1.0×10^{5}

(c) 1.0×10^{1}

(d) 1.0×10^{30}

41. The cell, $Zn\,|\,Zn^{2+}\,(1M)\,||\,Cu^{2+}\,(1M)\,|\,Cu\,(E^{o}_{cell}=1.10\,V)$, was allowed to be completely discharged at 298 K. The relative concentration of Zn^{2+} to Cu^{2+} $\left[\frac{[Zn^{2+}]}{[Cu^{2+}]}\right]$ is **[2007]**

(a) Antilog (24.08) (b) 37.3

(c) $10^{37.3}$ (d) 9.65×10^4

42. For the redox reaction

$$Zn_{(s)} + Cu^{2+}(0.1M) \rightarrow Zn^{2+}(1M) + Cu_{(s)}$$

taking place in a cell, E^{o}_{cell} is 1.10 *volt*. E_{cell} for the cell will be $\left(2.303\frac{RT}{F} = 0.0591\right)$ **[2003]**

(a) 2.14 *volt* (b) 1.80 *volt*

(c) 1.07 *volt* (d) 0.82 *volt*

43. The rusting of iron takes place as follows

$$2H^+ + 2e^- + 1/2O_2 \longrightarrow H_2O_{(l)}\ ;\ E^\circ = +1.23\ V$$

$$Fe^{2+} + 2e^- \longrightarrow Fe_{(s)}\ ;\ E^\circ = -0.44\ V$$

Calculate ΔG° for the net process **[2005]**

(a) $-322\ kJ\ mol^{-1}$ (b) $-161\ kJ\ mol^{-1}$

(c) $-152\ kJ\ mol^{-1}$ (d) $-76\ kJ\ mol^{-1}$

44. Consider the following cell reaction :

$$2Fe_{(s)} + O_{2(g)} + 4H^+_{(aq)} \longrightarrow 2Fe^{2+}_{(aq)} + 2H_2O_{(l)}$$

$$E^\circ = 1.67\,V$$

$At\,[Fe^{2+}] = 10^{-3}M, P_{(O_2)} = 0.1\,atm$ and $pH = 3$, the cell potential at 25°C is **[2011]**

(a) 1.47 V (b) 1.77 V

(c) 1.87 V (d) 1.57 V

45. Which substance eliminates bromine from KBr solution **[1981]**

(a) I_2 (b) Cl_2

(c) HI (d) SO_2

46. Given the data at 25°C,

$$Ag + I^- \rightarrow AgI + e^- \quad E^\circ = 0.152V$$

$$Ag \rightarrow Ag^+ + e^- \quad E^\circ = -0.800V$$

What is the value of log K_{sp} for AgI $(2.303RT/F = 0.059\,V)$ **[2006]**

(a) −8.12 (b) +8.612

(c) −37.83 (d) −16.13

47. The $E^{o}_{M^{3+}/M^{2+}}$ values for Cr, Mn, Fe and Co are −0.41, +1.57, +0.77 and +1.97 V respectively. For which one of these metals the change in oxidation state from +2 to +3 is easiest **[2004]**

(a) Fe (b) Mn

(c) Cr (d) Co

48. A gas X at 1 atm is bubbled through a solution containing a mixture of $1M\,Y^-$ and $1M\,Z^-$ at $25°C$. If the reduction potential of $Z > Y > X$, then **[1999]**

(a) Y will oxidize X and not Z

(b) Y will oxidize Z and not X

(c) Y will oxidize both X and Z

(d) Y will reduce both X and Z

49. The standard reduction potentials at 298 K for the following half reactions are given against each

$$Zn^{2+}_{(aq.)} + 2e \rightleftharpoons Zn_{(s)}\ ; \quad -0.762$$

$$Cr^{3+}_{(aq)} + 3e \rightleftharpoons Cr_{(s)}\ ; \quad -0.740$$

$$2H^+_{(aq)} + 2e \rightleftharpoons H_{2(g)}\ ; \quad 0.00$$

$$Fe^{3+}_{(aq)} + e \rightleftharpoons Fe^{2+}_{(aq)}\ ; \quad 0.770$$

Which is the strongest reducing agent **[1981]**

(a) $Zn(s)$ (b) $Cr(s)$

(c) $H_2(g)$ (d) $Fe^{2+}(aq)$

50. A solution containing one mole per litre of each $Cu(NO_3)_2$, $AgNO_3$, $Hg_2(NO_3)_2$ and $Mg(NO_3)_2$, is being electrolysed by using inert electrodes. The values of standard electrode potentials in volts (reduction potentials) are $Ag/Ag^+ = +0.80$, $2Hg/Hg_2^{2+} = +0.79$, $Cu/Cu^{2+} = +0.34$, $Mg/Mg^{2+} = -2.37$ with increasing voltage, the sequence of deposition of metals on the cathode will be **[1984]**

(a) Ag, Hg, Cu, Mg (b) Mg, Cu, Hg, Ag

(c) Ag, Hg, Cu (d) Cu, Hg, Ag

51. A standard hydrogen electrode has zero electrode potential because **[1997]**

(a) Hydrogen is easier to oxidise

(b) This electrode potential is assumed to be zero

(c) Hydrogen atom has only one electron

(d) Hydrogen is the lightest element

52. The correct order of $E^{o}_{M^{2+}/M}$ values with negative sign for the four successive elements Cr, Mn, Fe and Co is **[2010]**

(a) Cr > Mn > Fe > Co (b) Mn > Cr > Fe > Co

(c) Cr > Fe > Mn > Co (d) Fe > Mn > Cr > Co

53. Given

$E^o_{Cl_2/Cl^-} = 1.36\,V, E^o_{Cr^{3+}/Cr} = -0.74\,V$

$E^o_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\,V, E^o_{MnO_4^-/Mn^{2+}} = 1.51\,V$

Among the following, the strongest reducing agent is **[2017]**

(a) Mn^{2+} (b) Cr^{3+}

(c) Cl^- (d) Cr

8. NEET/ AIPMT/ CBSE-PMT

1. On electrolysing a solution of dilute H_2SO_4 between platinum electrodes, the gas evolved at the anode is **[1992]**

(a) SO_2 (b) SO_3

(c) O_2 (d) H_2

2. Sodium is made by the electrolysis of a molten mixture of about 40% $NaCl$ and 60% $CaCl_2$ because **[1995]**

(a) $CaCl_2$ helps in conduction of electricity

(b) This mixture has a lower melting point than $NaCl$

(c) Ca^{++} can displace Na from $NaCl$

(d) Ca^{++} can reduce $NaCl$ to Na

3. 5 amperes is passed through a solution of zinc sulphate for 40 minutes. Find the amount of zinc deposited at the cathode **[1996]**

(a) 40.65 g (b) 4.065 g

(c) 0.4065 g (d) 65.04 g

4. Al_2O_3 is reduced by electrolysis at low potential and high currents. If 4.0×10^4 amperes of current is passed through molten Al_2O_3 for 6 hours, what mass of aluminium is produced (Assume 100% current efficiency, At. mass of $Al = 27\ g\ mol^{-1}$) **[2009]**

(a) $9.0\times10^3\ g$ (b) $8.1\times10^4\ g$

(c) $2.4\times10^5\ g$ (d) $1.3\times10^4\ g$

5. During electrolysis of aqueous $NaOH, 4\,g$ of O_2 gas is liberated at NTP at anode, H_2 gas liberated at cathode is **[1998]**

(a) 2.8 L (b) 5.6 L

(c) 11.2 L (d) 22.4 L

6. During the electrolysis of molten sodium chloride, the time required to produce 0.10 mol of chlorine gas using a current of 3 amperes is **[2016]**

(a) 330 min (b) 55 min

(c) 110 min (d) 220 min

7. The mass of carbon anode consumed (giving only carbondioxide) in the production of 270kg of aluminium metal from bauxite by the Hall process is **[2005]**

(a) 180kg (b) 270kg

(c) 540kg (d) 90kg

8. 4.5g of aluminium (at mass 27amu) is deposited at cathode from Al^{3+} solution by a certain quantity of electric charge. The volume of hydrogen produced at STP from H^+ ions in solution by the same quantity of electric charge will be **[2005]**

(a) 22.4 L (b) 44.8 L

(c) 5.6 L (d) 11.2 L

9. The equivalent conductance of $\frac{M}{32}$ solution of a weak monobasic acid is 8.0 $mho\ cm^2$ and at infinite dilution is 400 $mho\ cm^2$. The dissociation constant of this acid is **[2009]**

(a) 1.25×10^{-5} (b) 1.25×10^{-6}

(c) 6.25×10^{-4} (d) 1.25×10^{-4}

10. At $25°C$ molar conductance of 0.1 molar aqueous solution of ammonium hydroxide is $9.54\,ohm^{-1}\,cm^2\,mol^{-1}$ and at infinite dilution its molar conductance is $238\,ohm^{-1}\,cm^2\,mol^{-1}$. The degree of ionization of ammonium hydroxide at the same concentration and temperature is **[2013]**

(a) 40.800% (b) 2.080%

(c) 20.800% (d) 4.008%

11. Aqueous solution of which of the following compounds is the best conductor of electric current **[2015]**

(a) Acetic acid, $C_2H_4O_2$ (b) Hydrochloric acid, HCl

(c) Ammonia, NH_3 (d) Fructose, $C_6H_{12}O_6$

12. An increase in equivalent conductance of a strong electrolyte with dilution is mainly due to **[2010]**

(a) Increase in number of ions

(b) Increase in ionic mobility of ions

(c) 100% ionisation of electrolyte at normal dilution

(d) Increase in both i.e. number of ions and ionic mobility of ions

13. The resistance of 0.01N $NaCl$ solution at $25°C$ is 200 Ω. Cell constant of conductivity cell is 1 cm^{-1}. The equivalent conductance is **[1999]**

(a) $5\times10^2\Omega^{-1}cm^2eq^{-1}$ (b) $6\times10^3\Omega^{-1}cm^2eq^{-1}$

(c) $7\times10^4\Omega^{-1}cm^2eq^{-1}$ (d) $8\times10^5\Omega^{-1}cm^2eq^{-1}$

14. If one end of a piece of a metal is heated, the other end becomes hot after some time. This is due to **[1995]**

(a) Energised electrons moving to the other part of the metal

(b) Resistance of the metal

(c) Mobility of atoms in the metal

(d) Minor perturbation in the energy of atoms

15. Limiting molar conductivity of $NH_4OH(i.e.\overset{0}{\Lambda}_{m(NH_4OH)})$ is equal to **[2012]**

(a) $\overset{0}{\Lambda}_{m(NH_4Cl)} + \overset{0}{\Lambda}_{m(NaCl)} - \overset{0}{\Lambda}_{m(NaOH)}$

(b) $\overset{0}{\Lambda}_{m(NaOH)} + \overset{0}{\Lambda}_{m(NaCl)} - \overset{0}{\Lambda}_{m(NH_4Cl)}$

(c) $\overset{0}{\Lambda}_{m(NH_4OH)} + \overset{0}{\Lambda}_{m(NH_4Cl)} - \overset{0}{\Lambda}_{m(HCl)}$

(d) $\overset{0}{\Lambda}_{m(NH_4Cl)} + \overset{0}{\Lambda}_{m(NaOH)} - \overset{0}{\Lambda}_{m(NaCl)}$

16. The molar conductances of $NaCl, HCl$ and CH_3COONa at infinite dilution are 126.45, 426.16 and $91\,ohm^{-1}\,cm^2\,mol^{-1}$ respectively. The molar conductance of CH_3COOH at infinite dilution is **[1997; 2012]**

(a) $201.28\,ohm^{-1}\,cm^2\,mol^{-1}$

(b) $390.71\,ohm^{-1}cm^2\,mol^{-1}$

(c) $698.28\,ohm^{-1}\,cm^2\,mol^{-1}$

(d) $540.48\,ohm^{-1}cm^2\,mol^{-1}$

17. Kohlrausch's law states that at **[2008]**

(a) Infinite dilution, each ion makes definite contribution to conductance of an electrolyte whatever be the nature of the other ion of the electrolyte

(b) Infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte

(c) Finite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte

(d) Infinite dilution each ion makes definite contribution to equivalent conductance of an electrolyte depending on the nature of the other ion of the electrolyte

18. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$. Given that $\Lambda^0_{Al^{3+}}$ and $\Lambda^0_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions **[2010]**

(a) $2\Lambda^0_{Al^{3+}} + 3\Lambda^0_{SO_4^{2-}}$

(b) $\Lambda^0_{Al^{3+}} + \Lambda^0_{SO_4^{2-}}$

(c) $(\Lambda^0_{Al^{3+}} + \Lambda^0_{SO_4^{2-}}) \times 6$

(d) $\frac{1^{\Lambda^\circ}}{3} Al^{3+} + \frac{1^{\Lambda^\circ}}{2} SO_4^{2-}$

19. A hypothetical electrochemical cell is shown below

⊕ ⊖

$A \mid A^+ (xM) \mid\mid B^+ (yM) \mid B$

The emf measured is + 0.20 V. The cell reaction is **[2006]**

(a) The cell reaction cannot be predicted

(b) $A + B^+ \rightarrow A^+ + B$

(c) $A^+ + B \rightarrow A + B^+$

(d) $A^+ + e^- \rightarrow A; B^+ + e^- \rightarrow B$

20. A device that converts energy of combustion of fuels like hydrogen and methane, directly into electrical energy is know as **[2015]**

(a) Electrolytic cell

(b) Dynamo

(c) $Ni - Cd$ cell

(d) Fuel cell

21. The efficiency of a fuel cell is given by **[2007]**

(a) $\frac{\Delta H}{\Delta G}$

(b) $\frac{\Delta G}{\Delta S}$

(c) $\frac{\Delta G}{\Delta H}$

(d) $\frac{\Delta S}{\Delta G}$

22. Electrode potential of Zn^{2+}/Zn is $-0.76\,V$ and that of Cu^{2+}/Cu is $+0.34V$. The EMF of the cell constructed between these two electrodes is **[2001]**

(a) 1.10 V

(b) 0.42 V

(c) – 1.1V

(d) – 0.42 V

23. E^o for the cell $Zn \mid Zn^{2+}{}_{(aq)} \mid\mid Cu^{2+}{}_{(aq)} \mid Cu$ is $1.10V$ at 25^oC, the equilibrium constant for the reaction $Zn + Cu^{2+}(aq) \rightleftharpoons Cu + Zn^{2+}{}_{(aq)}$ is of the order of **[1997]**

(a) 10^{-28}

(b) 10^{-37}

(c) 10^{+18}

(d) 10^{+17}

24. Standard electrode potential for Sn^{4+}/Sn^{2+} couple is $+0.15V$ and that for the Cr^{3+}/Cr couple is $-0.74V$. These two couples in their standard state are connected to make a cell. The cell potential will be **[2011]**

(a) + 1.83 V

(b) +1.19 V

(c) +0.89 V

(d) +0.18V

25. An electrochemical cell is set up as follows

$Pt(H_2, 1\,atm)/0.1\,M\,HCl$ || 0.1 M acetic acid /($H_2, 1\,atm$) Pt E.M.F. of this cell will not be zero because **[1995]**

(a) The pH of 0.1 $M\,HCl$ and 0.1 M acetic acid is not the same

(b) Acids used in two compartments are different

(c) E.M.F. of a cell depends on the molarities of acids used

(d) The temperature is constant

26. Consider the following relations for emf of a electrochemical cell

(1) emf of cell = (Oxidation potential of anode)– (Reduction potential of cathode)

(2) emf of cell = (Oxidation potential of anode)+ (Reduction potential of cathode)

(3) emf of cell = (Reduction potential of anode)+ (Reduction potential of cathode)

(4) emf of cell = (Oxidation potential of anode)– (Oxidation potential of cathode)

Which of the above relations are correct **[2010]**

(a) (3) and (1) (b) (1) and (2)

(c) (3) and (4) (d) (2) and (4)

27. A button cell used in watches function as following $Zn(s) + Ag_2O(s) + H_2O(l) \rightleftharpoons 2Ag(s) + Zn^{2+}(aq) + 2OH^-(aq)$ If half cell potentials are

$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s);$ $E° = -0.76V$

$Ag_2O(s) + H_2O(l) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq);$ $E° = 0.34V$

The cell potential will be **[2013]**

(a) 1.34 V (b) 1.10 V

(c) 0.42 V (d) 0.84 V

28. Given :

(i) $Cu^{2+} + 2e^- \rightarrow Cu, \ E° = 0.337\ V$

(ii) $Cu^{2+} + e^- \rightarrow Cu^+, \ E° = 0.153\ V$

Electrode potential, $E°$ for the reaction, $Cu^+ + e^- \rightarrow Cu$, will be **[2009]**

(a) 0.52 V (b) 0.90 V

(c) 0.30 V (d) 0.38 V

29. Which of the following condition will increase the voltage of the cell, represented by the equation $Cu_{(s)} + 2Ag^+{}_{(aq)} \rightarrow Cu^{2+}{}_{(aq)} + 2Ag_{(s)}$ **[2001]**

(a) Increase in the concentration of Ag^+ ion

(b) Increase in the concentration of Cu^{2+} ion

(c) Increase in the dimension of silver electrode

(d) Increase in the dimension of copper electrode

30. The cell reaction of a cell is

$$Mg_{(s)} + Cu^{2+}(aq) \rightarrow Cu_{(s)} + Mg^{2+}(aq)$$

If the standard reduction potentials of Mg and Cu are -2.37 and $+0.34\,V$ respectively. The *emf* of the cell is **[2002]**

(a) 2.03 V (b) – 2.03 V

(c) + 2.71 V (d) – 2.71 V

31. The electrode potentials for $Cu^{2+}_{(aq)} + e^- \rightarrow Cu^+_{(aq)}$ and $Cu^+_{(aq)} + e^- \rightarrow Cu_{(s)}$ are +0.15V and +0.50V respectively. The value of $E^o_{Cu^{2+}/Cu}$ will be **[2011]**

(a) 0.150V (b) 0.500V

(c) 0.325V (d) 0.650V

32. If $E^o_{Fe^{2+}/Fe} = -0.441V$ and $E^o_{Fe^{3+}/Fe^{2+}} = 0.771V$, the standard EMF of the reaction $Fe + 2Fe^{3+} \rightarrow 3Fe^{2+}$ will be **[2006]**

(a) 1.212 V (b) 0.111 V

(c) 0.330 V (d) 1.653 V

33. Standard free energies of formation (in *kJ/mol*) at 298 *K* are – 237.2, – 394.4 and – 8.2 for $H_2O(l)$, $CO_2(g)$ and pentane (g), respectively. The value of E^o_{cell} for the pentane-oxygen fuel cell is **[2008]**

(a) 1.0968 V (b) 0.0968 V

(c) 1.968 V (d) 2.0968 V

34. For the cell reaction

$$Cu^{2+}(C_{1aq}) + Zn_{(s)} = Zn^{2+}(C_{2\,aq}) + Cu_{(s)}$$

of an electrochemical cell, the change in free energy at a given temperature is a function of **[1998]**

(a) ln (C_1) (b) ln (C_2)

(c) ln $(C_1 + C_2)$ (d) ln (C_2 / C_1)

35. If the E^o_{cell} for a given reaction has a negative value, then which of the following gives the correct relationships for the values of ΔG^o and K_{eq} **[2011]**

(a) $\Delta G^o > 0; K_{eq} < 1$ (b) $\Delta G^o > 0; K_{eq} > 1$

(c) $\Delta G^o < 0; K_{eq} > 1$ (d) $\Delta G^o < 0; K_{eq} < 1$

36. For the reduction of silver ions with copper metal, the standard cell potential was found to be $+0.46\ V$ at $25°C$. The value of standard Gibbs energy, $\Delta G°$ will be $(F = 96500\,C\,mol^{-1})$ **[2010]**

(a) $-98.0\,kJ$ (b) $-89.0\,kJ$

(c) $-89.0\,J$ (d) $-44.5\,kJ$

37. The Gibb's energy for the decomposition of Al_2O_3 at $500°$ C is as follows

$$\frac{2}{3}Al_2O_3 \rightarrow \frac{4}{3}Al + O_2, \Delta_r G = +966 kJ\,mol^{-1}$$

The potential difference needed for electrolytic reduction of Al_2O_3 at $500°C$ is at least **[2012]**

(a) 5.0 V (b) 4.5 V

(c) 3.0 V (d) 2.5 V

38. A hydrogen gas electrode is made by dipping platinum wire in a solution of HCl of $pH = 10$ and by passing hydrogen gas around the platinum wire at one *atm* pressure. The oxidation potential of electrode would be **[2013]**

(a) 1.81 V (b) 0.059 V

(c) 0.59 V (d) 0.118 V

39. The pressure of H_2 required to make the potential of H_2-electrode zero in pure water at 298 K is **[2016]**

(a) 10^{-14} *atm* (b) 10^{-12} *atm*

(c) 10^{-10} *atm* (d) 10^{-4} *atm*

40. The *e.m.f.* of the cell $Zn\,|\,Zn^{2+}(0.01M)\,||\,Fe^{2+}(0.001M)\,|\,Fe$ at 298 K is 0.2905 then the value of equilibrium for the cell reaction is **[2004]**

(a) $e^{\frac{0.32}{0.0295}}$ (b) $10^{\frac{0.32}{0.0295}}$

(c) $10^{\frac{0.26}{0.0295}}$ (d) $10^{\frac{0.32}{0.0591}}$

41. Standard reduction potentials at $25°C$ of $Li^+\,|\,Li, Ba^{2+}\,|Ba, Na^+\,|Na$ and $Mg^{2+}\,|\,Mg$ are $-3.05, -2.90, -2.71$ and -2.37 *volt* respectively. Which one of the following is the strongest oxidising agent **[1994]**

(a) Na^+ (b) Li^+

(c) Ba^{2+} (d) Mg^{2+}

42. Which of the following displaces Br_2 from an aqueous solution containing bromide ion **[1994]**

(a) Cl_2 (b) Cl^-

(c) I_2 (d) I_3^-

43. Standard reduction electrode potentials of three metals *A*, *B* and *C* are respectively + 0.5*V*, − 3.0*V* and − 1.2 *V*. The reducing powers of these metals are **[2011]**

(a) $B > C > A$ (b) $A > B > C$

(c) $C > B > A$ (d) $A > C > B$

44. Standard reduction potentials of the half reactions are given below

$F_2(g) + 2e^- \rightarrow 2F^-(aq);\quad E^o = +2.85V$

$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq);\quad E^o = +1.36V$

$Br_2(l) + 2e^- \rightarrow 2Br^-(aq);\quad E^o = +1.06V$

$I_2(s) + 2e^- \rightarrow 2I^-(aq);\quad E^o = +0.53V$

The strongest oxidising and reducing agents respectively are **[2012]**

(a) F_2 and I^- (b) Br_2 and Cl^-

(c) Cl_2 and Br^- (d) Cl_2 and I_2.

45. Four successive members of the first series of the transition metals are listed below. For which one of them the standard potential $(E^0_{M^{2+}/M})$ value has a positive sign **[2012]**

(a) $Co(Z = 27)$ (b) $Ni(Z = 28)$

(c) $Cu(Z = 29)$ (d) $Fe(Z = 26)$

46. On the basis of the following E° values, the strongest oxidizing agent is

$[Fe(CN)_6]^{4-} \rightarrow [Fe(CN)_6]^{3-} + e^{-1}; E° = -0.35V$

$Fe^{2+} \rightarrow Fe^{3+} + e^-;\ E° = -0.77V$ **[2008]**

(a) Fe^{3+} (b) $[Fe(CN)_6]^{3-}$

(c) $[Fe(CN)_6]^4$ (d) Fe^{2+}

47. A solution contains Fe^{2+}, Fe^{3+} and I^- ions. This solution was treated with iodine at $35°C$. E^o for Fe^{3+}/Fe^{2+} is $+0.77\,V$ and E^o for $I_2/2I^- = 0.536V$. The favourable redox reaction is **[2011]**

(a) I^- will be oxidised to I_2

(b) Fe^{2+} will be oxidised to Fe^{3+}

(c) I_2 will be reduced to I^-

(d) There will be no redox reaction

48. In the electrochemical cell :

$Zn\,|\,ZnSO_4(0.01\,M)\,||\,CuSO_4(1.0\,M)Cu$, the *emf* of this Daniel cell is E_1. When the concentration of $ZnSO_4$ is changed to $1.0\,M$ and that of $CuSO_4$ changed to $0.01\,M$, the emf changes to E_2. From the followings which one is the relationship between E_1 and E_2? (Given $\frac{RT}{F} = 0.059$)

[2017]

(a) $E_1 = E_2$

(b) $E_1 < E_2$

(c) $E_1 > E_2$

(d) $E_2 = 0 \neq E_1$

49. Zinc can be coated on iron to produce galvanized iron but the reverse is not possible. It is because **[2016]**

(a) Zinc has higher negative electrode potential than iron

(b) Zinc is lighter than iron

(c) Zinc has lower melting point than iron

(d) Zinc has lower negative electrode potential than iron

9. AIIMS

1. Electrolysis of molten anhydrous calcium chloride produces **[2000]**

(a) Calcium

(b) Phosphorus

(c) Sulphur

(d) Sodium

2. The products formed when an aqueous solution of *NaBr* is electrolysed in a cell having inert electrodes are **[2006]**

(a) *Na* and Br_2

(b) *Na* and O_2

(c) H_2, Br_2 and *NaOH*

(d) H_2 and O_2

3. A certain current liberated 0.504 *g* of hydrogen in 2 hours. How many grams of copper can be liberated by the same current flowing for the same time in a copper sulphate solution **[1998]**

(a) 12.7 *g*

(b) 15.9 *g*

(c) 31.8 *g*

(d) 63.5 *g*

4. On passing one faraday of electricity through the electrolytic cells containing Ag^+, Ni^{+2} and Cr^{+3} ions solution, the deposited $Ag\,(At.\,wt. = 108)$, $Ni\,(At.wt. = 59)$ and $Cr\,(At.wt. = 52)$ is **[1982]**

Ag	***Ni***	***Cr***
(a) 108 g.	29.5 g.	17.3 g.
(b) 108 g.	59.0 g.	52.0 g.
(c) 108.0 g.	108.0 g.	108.0 g.
(d) 108 g.	117.5 g.	166.0 g.

5. What is the amount of chlorine evolved when 2 amperes of current is passed for 30 minutes in an aqueous solution of *NaCl* **[1999]**

(a) 66 *g*

(b) 1.32 *g*

(c) 33 *g*

(d) 99 *g*

6. The number of electrons required to deposit 1*gm* atom of aluminium (at. wt. = 27) from a solution of aluminium chloride will be (where *N* is Avogadro's number) **[1992]**

(a) 1 *N*

(b) 2 *N*

(c) 3 *N*

(d) 4 *N*

7. Charge required to liberate 11.5 *g* sodium is **[1992]**

(a) 0.5 *F*

(b) 0.1 *F*

(c) 1.5 *F*

(d) 96500 *coulombs*

8. The mass of copper deposited from a solution of $CuSO_4$ by passage of 5 *A* current for 965 second is

(*Mol. wt.* of Copper = 63.5) **[2001]**

(a) 15.875 *g*

(b) 1.5875 *g*

(c) 4825 *g*

(d) 96500 *g*

9. The current in a given wire is 1.8 *A*. The number of coulombs that flow in 1.36 minutes will be **[2001]**

(a) 100 *C*

(b) 147 *C*

(c) 247 *C*

(d) 347 *C*

10. A current of 96.5 *A* is passed for 18 min between nickel electrodes in 500 *mL* solution of 2*M* $Ni(NO_3)_2$. The molarity of solution after electrolysis would be **[2007]**

(a) 0.46 *M*

(b) 0.92 *M*

(c) 0.625 *M*

(d) 1.25 *M*

11. Which of the following shows electrical conduction **[1999]**

(a) Potassium

(b) Graphite

(c) Diamond

(d) Sodium

12. Which of the following statements is not applicable to electrolytic conductors **[1991]**

(a) New products show up at the electrodes

(b) Ions are responsible for carrying the current

(c) Show a positive temperature coefficient for conductance

(d) A single stream of electrons flows from cathode to anode

13. Which of the following reaction is used to make a fuel cell **[2003]**

(a) $Cd_{(s)} + 2Ni(OH)_{3(s)} \rightarrow CdO_{(s)} + 2Ni(OH) + H_2O_{(l)}$

(b) $Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)} \rightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$

(c) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

(d) $2Fe_{(s)} + O_{2(g)} + 4H^+_{(aq)} \rightarrow 2Fe^{2+}_{(aq)} + 2H_2O_{(l)}$

14. In the reaction

$$Cu_{(s)} + 2Ag^{+}{}_{(aq)} \rightarrow Cu^{2+}{}_{(aq)} + 2Ag_{(s)}$$

The reduction half-cell reaction is **[1997]**

(a) $Cu + 2e^{-} \rightarrow Cu^{2-}$ (b) $Cu - 2e^{-} \rightarrow Cu^{2+}$

(c) $Ag^{+} + e^{-} \rightarrow Ag$ (d) $Ag - e^{-} \rightarrow Ag^{+}$

15. When electric current is passed through a cell having an electrolyte, the positive ions move towards the cathode and the negative ions towards the anode. If the cathode is pulled out of the solution **[1980]**

(a) The positive and negative ions will move towards the anode

(b) The positive ions will start moving towards the anode, the negative ions will stop moving

(c) The negative ions will continue to move towards the anode and the positive ions will stop moving

(d) The positive and negative ions will start moving randomly

16. Which of the substances *Na*, *Hg*, *S*, *Pt* and graphite can be used as electrodes in electrolytic cells having aqueous solutions **[1982]**

(a) *Na*, *Pt* and graphite (b) *Na* and *Hg*

(c) *Pt* and graphite only (d) *Na* and *S* only

17. Which of the following statement is true for the electrochemical Daniel cell **[2004]**

(a) Electrons flow from copper electrode to zinc electrode

(b) Current flows from zinc electrode to copper electrode

(c) Cations move toward copper electrode which is cathode

(d) Cations move toward zinc electrode

18. During charging of lead storage battery, the reaction occurring at the cathode is **[2005]**

(a) $Pb^{2+} + 2e \rightarrow Pb$

(b) $Pb \rightarrow Pb^{2+} + 2e$

(c) $PbSO_4 + 2H_2O \rightarrow PbO_2 + 4H^{+} + SO_4^{2-} + 2e^{-}$

(d) $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

19. The *emf* of a galvanic cell, with electrode potentials of silver = +0.80V and that of copper = + 0.34 V, is **[1999]**

(a) – 1.1 V (b) + 1.1 V

(c) + 0.46 V (d) + 0.76 V

20. The standard reduction potential E° for the half reactions are as

$$Zn = Zn^{2+} + 2e^{-};\ E^{\circ} = +0.76\,V$$

$$Fe = Fe^{2+} + 2e^{-};\ E^{\circ} = +0.41\,V$$

The EMF for cell reaction $Fe^{2+} + Zn \rightarrow Zn^{2+} + Fe$ is **[2000, 15]**

(a) $-0.35\,V$ (b) $+0.35\,V$

(c) $+1.17\,V$ (d) $-1.17\,V$

21. What is the potential of a half-cell consisting of zinc electrode in $0.01m$ $ZnSO_4$ solution at $25^{\circ}C$ $(E^{\circ} = 0.763\,V)$ **[2000]**

(a) 0.8221 V (b) 8.221 V

(c) 0.5282 V (d) 9.232 V

22. For a cell reaction involving a two-electron change, the standard *emf* of the cell is found to be 0.295 V at $25^{\circ}C$. The equilibrium constant of the reaction at $25^{\circ}C$ will be **[2007]**

(a) 1×10^{-10} (b) 1×10^{-10}

(c) 10 (d) 1×10^{10}

23. The *emf* of a Daniel cell at 298K is E_1 $Zn \mid \underset{(0.01\,M)}{ZnSO_4} \mid\mid \underset{(1.0\,M)}{CuSO_4} \mid Cu$ when the concentration of $ZnSO_4$ is 1.0 *M* and that of $CuSO_4$ is 0.01 *M*, the *emf* changed to E_2. What is the relationship between E_1 and E_2 **[2008]**

(a) $E_2 = 0 \neq E_1$ (b) $E_1 > E_2$

(c) $E_1 < E_2$ (d) $E_1 = E_2$

24. Which of the following is a highly corrosive salt **[2015]**

(a) $FeCl_2$ (b) $PbCl_2$

(c) Hg_2Cl_2 (d) $HgCl_2$

10. Assertion and Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : Zn metal is formed when a Cu plate is dipped in $ZnSO_4$ solution.

Reason : Cu being placed above Zn in electrochemical series.

2. Assertion : Electrical conductivity of copper increases with increase in temperature.

Reason : The electrical conductivity of metals is due to the motion of electrons.

3. Assertion : When acidified zinc sulphate solution is electrolysed between zinc electrodes, it is zinc that is deposited at the cathode and hydrogen evolution does not take place.

Reason : The electrode potential of zinc is more negative than hydrogen but the overvoltage for the hydrogen evolution on zinc is quite large.

4. Assertion : Galvanised iron does not rust.

Reason : Zinc has a more negative electrode potential than iron. **[AIIMS 2005]**

5. Assertion : For the Daniel cell $Zn|Zn^{2+}||Cu^{2+}|Cu$ with $E_{cell} = 1.1V$, the application of opposite potential greater than $1.1\ V$ results into flow of electron from cathode to anode.

Reason : Zn is deposited at anode and Cu is dissolved at cathode. **[AIIMS 2006]**

6. Assertion : The cell potential of mercury cell is $1.35V$, which remains constant.

Reason : In mercury cell, the electrolyte is a paste of KOH and ZnO. **[AIIMS 2008]**

7. Assertion : According to Kohlrausch's law the molar conductivity of a strong electrolyte at infinite dilution is sum of molar conductivities of its ions.

Reason : The current carried by cation and anion is always equal. **[AIIMS 2007]**

8. Assertion : In the electrolysis of aqueous $NaCl$, Na is preferentially discharged at mercury cathode forming sodium amalgam.

Reason : It is due to the fact that hydrogen has a high over voltage at mercury cathode.

[AIIMS 2007]

19. Electrochemistry – Answers Keys

1. Electrolytes and Electrolysis

1	c	**2**	d	**3**	c	**4**	b	**5**	d
6	b	**7**	a	**8**	a	**9**	a	**10**	b
11	d	**12**	b	**13**	ac	**14**	d	**15**	c

2. Faraday's Law of Electrolysis

1	b	**2**	c	**3**	c	**4**	a	**5**	d
6	d	**7**	e	**8**	a	**9**	a	**10**	b
11	b	**12**	a	**13**	d	**14**	a	**15**	c
16	a	**17**	b	**18**	a	**19**	c	**20**	a
21	d	**22**	d	**23**	c				

3. Conductor and Conductance

1	c	**2**	d	**3**	b	**4**	b	**5**	b
6	d	**7**	d	**8**	c	**9**	c	**10**	d
11	b	**12**	c	**13**	c	**14**	b	**15**	c
16	b	**17**	d	**18**	a	**19**	b		

4. Cell Constant and Electrochemical Cells

1	d	**2**	a	**3**	b	**4**	a	**5**	b
6	a	**7**	d	**8**	d	**9**	d	**10**	a
11	d	**12**	d	**13**	c	**14**	d	**15**	c
16	c	**17**	d	**18**	b	**19**	a	**20**	a
21	b	**22**	c	**23**	b	**24**	b	**25**	c
26	d								

5. Electrode Potential, Ecell, Nernst Equation and ECS

1	c	**2**	b	**3**	a	**4**	c	**5**	a
6	b	**7**	b	**8**	b	**9**	d	**10**	b
11	b	**12**	a	**13**	a	**14**	d	**15**	c
16	b	**17**	b	**18**	d	**19**	a	**20**	a
21	b	**22**	b	**23**	c	**24**	c	**25**	b
26	d	**27**	b	**28**	c	**29**	b	**30**	a
31	b	**32**	b	**33**	a	**34**	b	**35**	a
36	b	**37**	b	**38**	d	**39**	a	**40**	a
41	a	**42**	c	**43**	a	**44**	b	**45**	c
46	d	**47**	a	**48**	a	**49**	b	**50**	b
51	a	**52**	c	**53**	b	**54**	b	**55**	a
56	b	**57**	d	**58**	c	**59**	c		

6. Corrosion

1	b	**2**	b	**3**	a	**4**	c	**5**	d
6	a								

7. IIT-JEE/ AIEEE

1	d	**2**	c	**3**	a	**4**	c	**5**	b
6	c	**7**	c	**8**	d	**9**	b	**10**	a
11	a	**12**	d	**13**	a	**14**	c	**15**	c
16	d	**17**	d	**18**	c	**19**	c	**20**	b
21	c	**22**	c	**23**	b	**24**	d	**25**	d
26	c	**27**	a	**28**	d	**29**	a	**30**	b
31	a	**32**	a	**33**	d	**34**	c	**35**	c
36	b	**37**	d	**38**	d	**39**	a	**40**	a
41	c	**42**	c	**43**	a	**44**	d	**45**	d
46	b	**47**	c	**48**	a	**49**	a	**50**	c
51	b	**52**	b	**53**	d				

8. NEET/ AIPMT/ CBSE-PMT

1	c	**2**	b	**3**	b	**4**	b	**5**	b

6	c	**7**	d	**8**	c	**9**	a	**10**	d
11	b	**12**	b	**13**	a	**14**	a	**15**	d
16	b	**17**	b	**18**	b	**19**	b	**20**	d
21	c	**22**	a	**23**	b	**24**	c	**25**	a
26	d	**27**	b	**28**	a	**29**	a	**30**	c
31	c	**32**	a	**33**	a	**34**	d	**35**	a
36	b	**37**	d	**38**	c	**39**	a	**40**	b
41	d	**42**	a	**43**	a	**44**	a	**45**	c
46	a	**47**	a	**48**	c	**49**	a		

9. AIIMS

1	a	**2**	c	**3**	b	**4**	a	**5**	b
6	c	**7**	a	**8**	b	**9**	b	**10**	b
11	b	**12**	d	**13**	c	**14**	c	**15**	d
16	c	**17**	c	**18**	c	**19**	c	**20**	b
21	a	**22**	d	**23**	b	**24**	d		

10. Assertion & Reason

1	d	**2**	e	**3**	a	**4**	a	**5**	a
6	b	**7**	c	**8**	a				