1. In a hydrogen-oxygen fuel cell, combustion of hydrogen occurs to
(a) generate heat
(b) create a potential difference between the two electrodes
(c) produce high purity water
(d) remove adsorbed oxygen from the electrode surface.

Solution:
In a hydrogen-oxygen fuel cell, the combustion of hydrogen occurs because of the difference in potential between two electrodes.
Hence option (b) is the answer.

2. Conductivity (unit Siemen's S) is directly proportional to the 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
(a) $Sm\ mol^{-1}$
(b) $Sm^2\ mol^{-1}$
(c) $S^{-2}m^2\ mol^1$
(d) $S^2m^2\ mol^1$

Solution:
$S = Km^2 mol/\ m \times m^3$
$K = Sm^2\ mol^{-1}$
Hence option (b) is the answer.

3. Galvanization is applying a coating of
(a) Pb
(b) Cr
(c) Cu
(d) Zn

Solution:
Galvanization is a method of preventing rust by applying zinc coating. Zinc acts as a sacrificial metal.
Hence option (d) is the answer.

4. Identify the correct statement.
(a) Corrosion of iron can be minimized by forming contact with another metal with a higher reduction potential.
(b) Iron corrodes in oxygen-free water.
(c) Corrosion of iron can be minimized by forming an impermeable barrier at its surface.
(d) Iron corrodes more rapidly in saltwater because its electrochemical potential is higher.

Solution:
Corrosion of iron can be minimized by forming an impermeable barrier at its surface.
Hence option (c) is the answer.

5. A solution of $Ni(NO_3)_2$ is electrolysed between platinum electrodes using 0.1 Faraday electricity. How many moles of Ni will be deposited at the cathode?
(a) 0.10
(b) 0.15
(c) 0.20
(d) 0.05

Solution:
$Ni^{2+} + 2e^- \rightarrow Ni$
2 F deposits 1 mole of Ni.
So 0.1 F will deposit (0.1/2) moles of Ni.
(0.1/2) = 0.05 mole.
Hence option (d) is the answer.

6. EMF of a cell in terms of reduction potential of its left and right electrodes is
(a) $E = E_{left} - E_{right}$
(b) $E = E_{left} + E_{right}$
(c) $E = E_{right} - E_{left}$
(d) $E = -(E_{right} + E_{left})$

Solution:
E_{cell} = Reduction potential of the cathode - Reduction potential of the anode
$= E_{right} - E_{left}$
Hence option (c) is the answer.

7. For a cell reaction involving a two-electron change, the standard e.m.f. of the cell is found to be 0.295 V at 25°C. The equilibrium constant of the reaction at 25°C will be
(a) 1×10^{-10}
(b) 29.5×10^{-2}
(c) 10
(d) 1×10^{10}

Solution:
Given $E^0_{cell} = 0.295$ V
$E^0_{cell} = (0.0591/n) \log K_c$
n = 2
$0.295 = (0.0591/2)\log K_c$
$0.295 = 0.0295 \log K_c$
$\log K_c = 0.295/0.0295 = 10$

K_c = Antilog 10 = 10^{10}
Hence option (d) is the answer.

8. If ϕ denotes reduction potential, then which is true?
(a) E°cell = $\phi_{right} - \phi_{left}$
(b) E°cell = $\phi_{left} + \phi_{right}$
(c) E°cell = $\phi_{left} - \phi_{right}$
(d) E°cell = $-(\phi_{left} + \phi_{right})$

Solution:
E°cell = $\phi_{right} - \phi_{left}$
Hence option (a) is the answer.

9. The anodic half-cell of lead-acid battery is recharged using electricity of 0.05 Faraday. The amount of $PbSO_4$ electrolyzed in g during the process is [Molar mass of $PbSO_4$ = 303 g mol^{-1}]
(a) 15.2
(b) 11.4
(c) 7.6
(d) 22.8

Solution:
$PbSO_{4(s)} + 2OH^- \rightarrow PbO_2 + H_2SO_4 + 2e^-$
$PbSO_4 + 2e^- + 2H^+ \rightarrow Pb_{(s)} + H_2SO_4$
Total number of moles of $PbSO_4$ = 0.05/2 = 0.025
Mass of $PbSO_4$ = 0.025 × 303 = 7.575g
Hence option (c) is the answer.

10. Calculate the standard cell potential (in V) of the cell in which the following reaction takes place.
$Fe^{2+}{}_{(aq)} + Ag^+{}_{(aq)} \rightarrow Fe^{3+}{}_{(aq)} + Ag_{(s)}$
Given that $E^\circ_{Ag+/Ag}$ = x V; $E^\circ_{Fe2+/Fe}$ = y V; $E^\circ_{Fe3+/Fe}$ = z V
(a) x – z
(b) x – y
(c) x + 2y – 3z
(d) x + y – z

Solution:
$Fe^{2+}{}_{(aq)} + Ag^+{}_{(aq)} \rightarrow Fe^{3+}{}_{(aq)} + Ag_{(s)}$
$Fe^{2+} + 2e^- \rightarrow Fe$
$E^\circ_{Fe2+/Fe}$ = y V
$\Delta G^\circ_1 = -2Fy$ .....(i)
$Fe^{3+} + 3e^- \rightarrow Fe$
$E^\circ_{Fe3+/Fe}$ = z V
$\Delta G^\circ_2 = -3Fz$ ...(ii)

$Ag^+ + e^- \rightarrow Ag$
$E° = +x$ V
$\Delta G°_3 = -Fx$ ...(iii)
Adding equations (i) and (iii) and subtracting (ii) from it, we get
$Fe^{2+}_{(aq)} + Ag^+_{(aq)} \rightarrow Ag_{(s)} + Fe^{3+}_{(aq)}$
$\Delta G = \Delta G°_1 + \Delta G°_3 - \Delta G°_2$
$-FE°cell = -2Fy - Fx - (-3Fz)$
$-E°cell = -2y - x + 3z$
$E°cell = x + 2y - 3z$
Hence option (c) is the answer.

11. The standard Gibbs energy for the given cell reaction in kJ mol^{-1} at 298 K is
$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$, E ° = 2 V at 298 K (Faraday's constant, F = 96000 C mol^{-1}) (a) –192
(b) 192
(c) –384
(d) 384

Solution:
Given $E^0 = 2$
F = 96000
n = 2
$\Delta G° = -nFE° = -2 \times 96000 \times 2$
= –384000 J/mol
= –384 kJ/mol
Hence option (c) is the answer.

12. Consider the statements S1 and S2:
S1: Conductivity always increases with decrease in the concentration of electrolyte.
S2: Molar conductivity always increases with decrease in the concentration of electrolyte. The correct option among the following is
(a) both S1 and S2 are wrong
(b) both S1 and S2 are correct
(c) S1 is wrong and S2 is correct
(d) S1 is correct and S2 is wrong.

Solution:
Conductivity increases with an increase in concentration.
Molar Conductivity increases with decrease in concentration.
Hence option (c) is the answer.

13. If the standard electrode potential for a cell is 2 V at 300 K, the equilibrium constant (K) for the reaction,
Zn(s) + Cu2+ (aq) Zn2+ (aq) + Cu(s)

at 300 K is approximately (R = 8 J K^{-1} mol^{-1}, F = 96500 C mol^{-1})
(a) e^{-80}
(b) e^{160}
(c) e^{-160}
(d) e^{320}

Solution:
Given T = 300 K
ΔG° = - nFE°cell
= -2 × 96000 × 2
= -384000 C V mol^{-1}
ΔG° = – RT ln K
-384000 = -8 ×300 ln K
ln K = 384000/2400 = 160
So K = e^{160}
Hence option (b) is the answer.

14. When during electrolysis of a solution of $AgN0_3$ 9650 coulombs of charge pass through the electroplating bath, the mass of silver deposited on the cathode will be
(a) 10.8 g
(b) 21.6 g
(c) 108 g
(d) 1.08 g

Solution:
No. of moles of Ag = 9650/96500 = 0.1
Mass of Ag deposited = 0.1× 108 = 10.8
Hence option (a) is the answer.

15. The correct order of $E^0_{M2+/M}$ values with negative sign for the four successive elements Cr, Mn, Fe and Co is
(a) Mn > Cr > Fe > Co
(b) Cr > Fe > Mn> Co
(c) Fe > Mn > Cr > Co
(d) Cr > Mn > Fe > Co

Solution:
The negative values for standard electrode potential decrease except for Mn because of the stable d^5 configuration, across the first transition series.
Mn > Cr > Fe > Co
Hence option (a) is the answer.