CHEMISTRY

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ELECTROMOTIVE FORCE

Examples

1. Derive expression to calculate emf (reduction) of the following half cells at $25^{\circ} C$

$H^{+} \mid \mid H_2(Pt)(1atm)$

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2. Derive expression to calculate emf (reduction) of the following half cells at $25^{\circ} C$

$Cl_2(g) \mid 2Cl^-(Pt)(1atm)$

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3. Derive expression to calculate emf (reduction) of the following half cells at $25^\circ C$

$Fe^{3+} \mid Fe^{2+}(Pt)$

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4. Derive expression to calculate emf (reduction) of the following half cells at $25^\circ C$

$AgCl(s), Cl^- \mid Ag$

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5. Derive expression to calculate emf (reduction) of the following half cells at $25^\circ C$

$Hg_2Cl_2(s), Cl^- \mid Hg$

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6. Derive expression to calculate emf (reduction) of the following half cells at $25^\circ C$

$Cu^{2+} \mid Cu(s)$

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7. Calculate the reduction potential for the following half cells at $25^\circ C$

$Mg \mid Mg^{2+}\left(1 \times 10^{-4} M\right), E^\circ_{Mg, Mg^{2+}} = +2.36V$

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8. Calculate the reduction potential for the following half cells at $25^\circ C$

$Cl_2 \mid Cl^-\left(2 \times 10^{-5} M\right), E^\circ_{Cl_2, Cl^-} = +1.36V$

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9. Calculate the reduction potential for the following half cells at $25^\circ C$

$Pt \mid Fe^{2+}(0.1M) - Fe^{3+}(0.01M), E^\circ_{Fe^{3+}, Fe^{2+}} = +0.77V$

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10. The standard electrode potential of Cu, Cu^{2+} is -0.34 volt. At what concentration of Cu^{2+} ions will this electrode potential be zero?

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11. Will Ag metal reduce Sn^{2+}?

$E^\circ_{Ag^+}, Ag = +0.8volt, E^\circ_{Sn^{2+}}, Sn = -0.14$ volt

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12. Construct galvanic cells from the following pairs of half cells and calculate their emf at $25^\circ C$

$Fe^{3+}(0.1M), Fe^{2+}(1M)(Pt) E_{Fe^{3+}, Fe^{2+}} = 0.77$volt

$AgCl(s), Cl^{-}{}^{(0.001M)} \mid Ag E^{\circ}_{AgCl, Cl^-} = 0.22$ volt

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13. Construct galvanic cells from the following pairs of half cells and calculate their emf at $25^\circ C$

$Cd^{2+} \mid Cd E^{\circ}_{Cd^{2+}, Cd} = 0.40$ volt (1M)

and $Hg_2Cl_2(s), Cl^- 0.1M \mid Hg E^{\circ}_{Hg_2Cl_2, Cl^-} = 0.28$ volt

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14. Construct galvanic cells from the following pairs of half cells and calculate their emf at $25^\circ C$

$Sn, SnCl_2(1M) E^{\circ}_{Sn^{2+}, Sn} = -0.14$ volt

and $Fe \mid FeSO_4(1M) E^{\circ}_{Fe^{2+}, Fe} = 0.44$ volt

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15. The standard reduction potential of $Cu^{2+} \mid Cu$ and $Ag^{+} \mid Ag$ electrodes are 0.337 and 0.799 volt respectively. Construct a galvanic cell using these electrodes so that its standard emf is positive. For what concentration of Ag^{+} will the emf of the cell at $25^{\circ} C$ be zero if the concentration of Cu^{2+} is 0.01M?

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16. Zinc granules are added in excess to 500mL of 1M nickel nitrate solution at $25^{\circ} C$ until the equilibrium is reached. If the standard reduction potentials of $Zn^{2+} \mid Zn$ and $Ni^{2+} \mid Ni$ are -0.75V and -0.24V respectively, find out the concentration of Ni^{2+} in solution at equilibrium.

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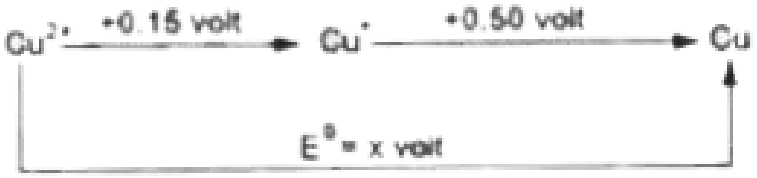
17. The reduction potential diagram (Latimer diagram) for Cu is acid solution



Calculate x. Does Cu^+ disproportionate in the solution?

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18. What is the standard electrode potential for the electrode, MnO_4^- / MnO_2 in an acid solution?

$E^\circ_{MnO_4^-, Mn^{2+}} = 1.51V, E^\circ_{MnO_2, Mn^{2+}} = 1.23V$

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19. Two electrochemical cells are assembled in which the following reaction occur.

$V^2 + VO^2 + 2H^+ \rightarrow 2V^3 + H_2O, E^\circ_{cell} = 0.616V$

$V^3 + Ag^+ + H_2O \rightarrow VO^2 + 2H^+ + Ag(s), E^\circ_{cell} = 0.439V$

calculate E° for the half cell reaction

$V^{3+} + e \rightarrow V^{2+} \left(E^\circ_{Ag}, Ag = 0.799 \text{ volt }\right)$

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20. How much is the oxidising power of the $MnO_4^- (1M) \mid Mn^{2+}$ (1M) couple decreased if the H^+ concentration is decreased from 1M to $10^{-4}M$ at $25^\circ C$

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21. Consider the cell

$Zn\left|Zn^{2+}(aq)(1.0M)\right|\left|Cu^{2+}(aq)(1.0M)\right|Cu$

The standard reduction potentials are +0.35 V for

$2e + Cu^{2+}(aq) \rightarrow Cu \text{ and } -0.763Vf \text{ or } 2e + Zn^{2+}(aq) \rightarrow Zn$

Write down the cell reaction.

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22. Consider the cell

$$Zn\left|Zn^{2+}(aq)(1.0M)\right|\left|Cu^{2+}(aq)(1.0M)\right|Cu$$

The standard reduction potentials are +0.35 V for

$$2e + Cu^{2+}(aq) \rightarrow Cu \text{ and } -0.763Vf \text{ or } 2e + Zn^{2+}(aq) \rightarrow Zn$$

Calculate the emf of the cell.

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23. Consider the cell

$$Zn\left|Zn^{2+}(aq)(1.0M)\right|\left|Cu^{2+}(aq)(1.0M)\right|Cu$$

The standard reduction potentials are +0.35 V for

$$2e + Cu^{2+}(aq) \rightarrow Cu \text{ and } -0.763Vf \text{ or } 2e + Zn^{2+}(aq) \rightarrow Zn$$

Is the cell reaction spontaneous or not?

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24. The following galvanic cell

$Zn|Zn(NO_3)_2(aq)||Cu(NO_3)_2(aq)|Cu$

$Anode(100mL, 1M)(100mL, 1M)cathode$

was operated as an electrolysis cell as Cu as the anode and Zn as the cathode. A current of 0.48 ampere was passed for 10 hours and then the cell was allowed to function to galvanic cell.What would be the emf of the cell at $25^\circ C$ Assume that the only electrode reactions occurring were those involving

Cu/Cu^{2+} and Zn/Zn^{2+}

$\left(E^\circ_{Cu^{2+},Cu} = +0.34V, E^\circ_{Zn^{2+},Zn} = -0.76V\right)$

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25. For the reaction

$H_2(g) + 2AgCl(s) = 2Ag(s) + 2H^+(aq)(0.1M) + 2Cl^-(aq)(0.1M)(1atn$

$\Delta G^\circ = 42927$ joules at $25^\circ C$. Calculate the emf of the cell in which the given reaction takes place .

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26. The standard reduction potential at $25^\circ C$ of the reaction $2H_2O + 2e^- \leftrightarrow H_2 + 2OH^-$ is -0.8277 volt. Calculate the equilibrium constant for the reaction $2H_2O = H_3O^+ + OH^-$ at $25^\circ C$

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27. Distinguish clearly between the meanings of $E_{cell} = 0$ and $E^\circ_{cell} = 0$

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28. Calculate the number of coulombs delivered by a Daniel cell, initially containing 1 litre each of 1M Cu^{2+} and $1MZn^{2+}$ ion which is operated until its potential drops to 1V.

$E^\circ_{Cu^{2+},Cu} = 0.34V$, $E^\circ_{Zn^{2+},Zn} = -0.76V$

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29. Calculate the potential of a Daniel cell, initially containing 1 litre each of 1M Cu^{2+} and $1MZn^{2+}$ after a passage of 1×10^5 coulombs of charge . $E^{\circ}_{Cu^{2+},Cu} = +0.34V$, $E^{\circ}_{Zn^{2+},Zn} = -0.76V$

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30. The emf of a particular voltaic cell with the cell reaction $Hg_2^{2+} + H_2 \leftrightarrow 2Hg + 2H^+$ is 0.65V. Calculate the maximum electrical work of this cell when $0.5gH_2$ is consumed.

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31. Calculate the standard reduction potential for the reaction $H_2O + e \rightarrow \frac{1}{2}H_2 + OH^-$ using the Nernst equation and the fact that the standard reduction potential for the reaction $H^+ + e \rightarrow \frac{1}{2}H_2$ is by definition equal to 0.00V at $25^{\circ}C$

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32. Given the following E° values at $25^\circ C$ calcualte K_{sp} for silver bromide, AgBr.

$Ag^+(aq) + e = Ag(s), E_1^0 = 0.80V$

$AgBr(s) + e = Ag(s) + Br^-(aq), E_2^0 = 0.07V$

Also calculate ΔG° at $25^\circ C$ for the process

$AgBr(s) \leftrightarrow Ag^+(aq) + Br^-(aq)$

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33. Calculate the emf of the following cell at $25^\circ C$

$H_2(g)(1atm)/H^+(aq) \mid \mid OH^-(aq)/O_2(g)(1atm)$ from the following data:

$H_2 + \frac{1}{2}O_2 = H_2O, \Delta G^\circ = -226.8kJ/mole$

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34. Calculate the emf of the following cell at $25^\circ C$

$H_2(g)(1atm)/H^+(aq) \mid \mid OH^-(aq)/O_2(g)(1atm)$ from the

following data:

$H_2O = H^+ + OH^-, \Delta G^\circ = 76.2kJ/mole$

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35. Under standard conditions for all concentrations, the following reactions is spontaneous at $25^\circ C$

$O_2(g) + 4H^+(aq) + 4Br^-(aq) \rightarrow 2H_2O(l) + 2Br_2(l), E^\circ = 0.16V$

IF $\left[H^+\right]$ is adjusted by adding a buffer of 0.10 M NaOCN

and 0.10 M HOCN $\left(K_a = 3.5 \times 10^{-4}\right)$ what value will E_{cell} have and will the reaction be spontaneous at this $\left[H^+\right]$?

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36. The emf of a standard Cd- cell is 1.018V at $25^\circ C$. The temperature coefficient of the cell is $-5.0 \times 10^{-5} Vk^{-1}$. Calculate $\Delta G, \Delta H$ and ΔS for the cell reaction. Will the cell temperature change during operation?

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37. The standard potential of the following cell is 0.23 V at $15^\circ C$ and $0.21V$ at $35^\circ C$

$(Pt)H_2(g)|HCl(aq)|AgCl(s) \mid Ag(s)$

Write the cell reaction.

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38. The standard potential of the following cell is 0.23 V at $15^\circ C$ and $0.21V$ at $35^\circ C$

$(Pt)H_2(g)|HCl(aq)|AgCl(s) \mid Ag(s)$

Calculate ΔH° and ΔS° for the cell reaction by assuming that these quantities remain unchanged in the range 15° to $35^\circ C$

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39. The standard potential of the following cell is 0.23 V at $15^\circ C$ and $0.21V$ at $35^\circ C$

$(Pt)H_2(g)|HCl(aq)|AgCl(s) \mid Ag(s)$

Calculate the solubility of AgCl in water at $25^\circ C$ Given:

$E^\circ_{Ag^+, Ag} = 0.80V$ at $25^\circ C$

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40. A cell utilises the following reaction:

$2CO^{3+}(aq) + Zn(s) \rightarrow 2CO^{2+}(aq) + Zn^{2+}(aq)$

What is the effect on cell emf of each of the following changes?

Co(II) nitrate is dissociated in the cathode compartment.

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41. A cell utilises the following reaction:

$2CO^{3+}(aq) + Zn(s) \rightarrow 2CO^{2+}(aq) + Zn^{2+}(aq)$

What is the effect on cell emf of each of the following changes?

Co(III) nitrate is dissolved in the cathode compartment

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42. A cell utilises the following reaction:

$2CO^{3+}(aq) + Zn(s) \rightarrow 2CO^{2+}(aq) + Zn^{2+}(aq)$

What is the effect on cell emf of each of the following changes?

The size or area of Zn (s) electrode is doubled

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43. A cell utilises the following reaction:

$2CO^{3+}(aq) + Zn(s) \rightarrow 2CO^{2+}(aq) + Zn^{2+}(aq)$

What is the effect on cell emf of each of the following changes?

Additional water is added to the anode compartment

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44. A solution containing 4.5 mmol of $Cr_2O_7^{2-}$ and 15 mmol of Cr^{3+} shows a pH of 2.0. calculate the potential of the half reaction

$Cr_2O_7^{2-} \rightarrow Cr^{3+}, E^\circ = 1.33V$

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Problems

1. Calculate the reduction potentials for the following half cells:

$Ag \mid Ag^{+}\left(10^{-5}M\right), E^{\circ}_{Ag^{+},Ag} = 0.80V$

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2. Calculate the reduction potentials for the following half cells:

$Cu \mid Cu^{2+}(0.2M), E^{\circ}_{Cu^{2+},Cu} = 0.34V$

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3. Construct galvanic cells from the following pairs of half cells and calculate their emf.

$\underset{1atm}{(Pt)}H_2 \left| HCl(1M) \right.$ and $\underset{1atm}{Pt}(Cl_2) \left| HCl(1M) \right.$

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4. Construct galvanic cells from the following pairs of half cells and calculate their emf.

$Cu\left|Cu^{2+}(1M)\right.$ and $\underset{(1M)}{C}\ l^{-}\left|\underset{(1atm)}{C}\ l_2Pt\right.$

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5. Can F^{-} be oxidised to F_2 by any substance listed in the electrochemical series?

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6. A Cu rod is dipped in 0.1M $CuSO_4$ solution. Calculate the potential of this half cell if $CuSO_4$ undergoes 90% dissociation at this dilution at $25^{\circ}C$. $E^{\circ}_{Cu,Cu^{2+}} = -0.34V$

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7. IF excess metallic iron is added to an $N - CuSO_4$ solution, calculate the approximate concentration of Cu^{2+} when equilibrium is established.

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8. Will Mg reduce $CuSO_4$?

$E^{\circ}_{Mg, Mg^{2+}} = +2.36V$ and $E^{\circ}_{Cu, Cu^{2+}} = 0.34V$

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9. Calculate emf of the following cells at $25^{\circ}C$ in which the following reactions are taking place, use E° values from table

$Mg + Cl_2(1atm) \leftrightarrow Mg^{2+}\left(10^{-2}M\right) + 2Cl^{-}\left(2 \times 10^{2}M\right)$

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10. Calculate emf of the following cells at $25^{\circ}C$ in which the following reactions are taking place, use E° values from table

$$Zn + Fe^{2+}\left(10^{-3}M\right) \leftrightarrow Zn^{2+}\left(10^{-4}M\right) + Fe$$

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11. E°_{cell} for $Zn(s) + Pb^{2+}(1M) \rightarrow Zn^{2+}(1M) + Pb(s)$ is 0.66 volt. E_{cell} for the reaction

$$Zn(s) + Pb^{2+}(0.1M) \rightarrow Zn^{2+}(0.1M) + Pb(s) \text{ is}$$

A. $+0.63$ volt

B. $+0.66$ volt

C. $+0.69$ volt

D. $+0.72$ volt

Answer:

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12. E_{cell}° for the reaction $Cu^{2+} + 2Cl^{-} \rightarrow Cu(s) + Cl_2(g)$ is -1.02 V. This reaction

A. can be made to produce electricity in a volataic cell

B. occurs whenever Cu^{2+} and Cl^{-} are brought together in an aqueous solution

C. can be made to occur in an electrolytic cell

D. can occur in an acidic solution but not in a basic solution

Answer:

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13. E_{cell}° for the reaction $Co(s) + Ni^{2+} \rightarrow Co^{2+} + Ni(s)$ is +0.03 volt. IF cobalt metal is added to an aqueous solution having $\left[Ni^{2+}\right] = 1M$,

A. the reaction will not proceed in the forward direction at all

B. the displacement of Ni^{2+} from solution by Co will go to completion

C. the displacement of Ni^{2+} from solution by Co will proceed to a considerable extent, but the reaction will stop before the Ni^{2+} is completely displaced

D. only the reverse reaction will occur

Answer:

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14. From the electrochemical series given in the text, determine the approximate value of E° for $X^{2+}(aq) + 2e \rightarrow X(s)$

The metal X dissolves in nitric acid but not in hydrochloric acid . It can displace Ag^{+} but not Cu^{2+}

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15. From the electrochemical series given in the text, determine the approximate value of E° for $X^{2+}(aq) + 2e \rightarrow X(s)$

The metal X dissolves in hydrochloric acid producing H_2 but does not replace either Zn^{2+} or Fe^{2+}.

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16. The standard reaction potential of a calomel half cell is 0.28V at $25^{\circ}C$. Calculate half cell potential when 0.1N KCl solution is used

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17. What is the potential of a cell containing two hydrogen electrodes, the negative one in contact with 10^{-8} molar H^{+} and the positive one in contact with 0.025 molar H^{+}?

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18. Copper can reduce zinc ions if the resultant copper ions can be kept at a sufficiently low concentration by the formation of an insoluble salt. What is the maximum concentration of Cu^{2+} in solution if this reaction is to occur, when Zn^{2+} is 1 molar?

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19. A cell contains two hydrogen electrodes. The negative electrode is in contact with a solution of $10^{-6}M$ hydrogen ions. The emf of the cell is 0.118V at $25^{\circ}C$. Calculate the concentration of hydrogen ions at the positive electrode.

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20. The standard potentials, E° for the half reaction are as

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

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

The emf for the cell reaction $Fe^{3+} + Zn \rightarrow Zn^{2+} + Fe$ is

A. $-0.35V$

B. $+0.35V$

C. $+1.17V$

D. $-1.17V$

Answer:

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21. Given that

$Fe^{3+} + e \leftrightarrow Fe^{2+}, E^{\circ} = 0.77V$

$Fe^{2+} + 2e \leftrightarrow Fe, E^{\circ} = -0.44V$

What will be the E° value for the following half cell.

$Fe^{3+} + 3e \leftrightarrow Fe$

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22. From the following values of E° drawn from the emf series, calculate standard emf and the equilibrium constant for the reaction

$Hg^{2+} + Hg \leftrightarrow Hg_2^{2+}$

$E^{\circ}_{Hg_2^{2+}, Hg} = 0.788V$, $E^{\circ}_{Hg^{2+}, Hg_2^{2+}} = 0.92V$

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23. Will Fe (s) be oxidised to Fe^{2+} by reacting with 1M HCl?

$E^{\circ}_{Fe, Fe^{2+}} = +0.44V$

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24. A galvanic cell is composed of a standard Zn electrode and a chromium electrode immersed in a solution containing Cr^{3+} At what concentration of Cr^{3+} will the emf o the cell be zero?

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25. The standard electrode potential corresponding to the reduction $Cr^{3+} + e \rightarrow Cr^{2+}$ is $E^{\circ} = -0.407$ volt. IF excess $Fe(s)$ is added to a solution in which $\left[Cr^{3+}\right] = 1M$, what will be $\left[Fe^{2+}\right]$ when equilibrium is established at $25^{\circ} C$

$\left[Fe(s) + 2Cr^{3+} \leftrightarrow Fe^{2+} + 2Cr^{2+}\right]$

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26. The emf of a cell consisting of a copper and a lead electrode immersed in 1M solution of salts of these metals is 0.47V. Will the emf change if 0.001 solutions are taken?

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27. What is the potential of a hydrogen electrode at pH=10?

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28. We have an oxidation -reduction system:

$\left[Fe(CN)_6\right]^{3-} + e \leftrightarrow \left[Fe(CN)_6\right]^{4-}, E^\circ = +0.36V$

At what ratio of the concentrations of the oxidised and reduced forms will the potential of the system be 0.28V?

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29. Calculate the emf of the following cell at $25^\circ C$

$Fe|FeSO_4||CuSO_4|Cu$

(0.1 M) (0.01 M)

Given that E° (oxd.) of Fe and Cu are 0.44V and -0.34V respectively.

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30. Calculate the emf of the following cells, find their cells reactions using E° values from the table?

$Ag|Ag^+(0.01M)||Zn^{2+}(0.1M)|Zn$

In each case, is the reaction as written spontaneous or not?

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31. Calculate the emf of the following cells, find their cells reactions using E° values from the table?

$Pt\left|Fe^{2+}(1M), Fe^{3+}(0.1M)\right|\left|Cl^{-}(0.001M)\right|AgCl \mid Ag$

In each case, is the reaction as written spontaneous or not?

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32. Calculate the emf of the following cells, find their cells reactions using E° values from the table?

$Zn\left|ZnO_2^{2-}(0.1M), OH^{-}(1M)\right|HgO \mid Hg$

In each case, is the reaction as written spontaneous or not?

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33. Neglecting the liquid junction potential, calculate the emf of the following cell at $25^{\circ}C$

$H_2(1atm)|0.5MHCOOH||1MCH_3COOH|H_2(1atm)$

The dissociation constants of HCOOH and CH_3COOH are 1.77×10^{-4} and 1.8×10^{-8} respectively.

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34. The emf of the cell,

$(Pt)H_2 \mid H^+$ (c=unknown) $\mid \mid KCN$ soln. $|HgCl_2|Hg$ is 0.4783 V.

IF the electrode potential of the calomel chloride is +0.2420 volt (reduction), calculate pH of the solution.

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35. Calculate the cell potential for the following galvanic cell:

The first electrode consists of $Fe^{3+} \mid Fe^{2+}$ complete in which $\left[Fe^{3+}\right] = 1M$ and $\left[Fe^{2+}\right] = [0.1M]$

The second electrode consists of $MnO_4(-) \mid Mn^{2+}$ couple in acidic solution in which

$\left[MnO_4^-\right] = 1 \times 10^{-2}M$, $\left[Mn^{2+}\right] = 1 \times 10^{-4}M$ and $\left[H^+\right] = 1 \times 10^{-3}M$

$\left[E^\circ_{Fe^{3+},Fe^{2+}} = 0.771V, E^\circ_{MnO_4^-,Mn^{2+}} = 1.51V\right)$

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36. Find the equilibrium constant at $25^\circ C$ for the reaction,

$Hg_2(NO_3)_2 + 2Fe(NO_3)_2 = 2Hg + 2Fe(NO_3)_3$

$E^\circ_{Hg_2^{2+},Hg} = 0.79$volt, $E^\circ_{Fe^{3+},Fe^{2+}} = 0.77$ volt

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37. Calculate the potential of a silver electrode in a saturated solution of $AgBr\left(K_{sp} = 6 \times 10^{-13}\right)$ containing, in addition, 0.1 mole per litre KBr.

$E^\circ_{Ag^+,Ag} = 0.80$ volt

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38. Calculate the potential of a cell in which hydrogen electrode is immersed in pure water, in a solution with a pH of 3.5 and in a solution with a pH of 10.7.

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39. A galvanic cell is constructed of two hydrogen electrodes, one immersed in a solution with H^+ at 1M and the other in 1M KOH. Calculate E_{cell}. If 1M KOH solution is replaced by $1MNH_3$, will E_{cell} be higher or lower than in 1M KOH?

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40. Using the electrochemical series table, explain why Cu (I) sulphate does not exist in aqueous solution

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41. For the cell

$(Pt)H_2(1atm) \mid H^+$ (pH unknown) $\|H^+6(pH=1)|H_2(1atm)$ The measured cell potential is 0.16volt at $25^\circ C$ calculate the unknown pH.

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42. Write the cell reaction and calculate the potential of the cell,

Cl_2 (p=0.9 atm) $|NaCl$ solution $|Cl_2$ (p=0.1 atm)

Will the cell reaction be spontaneous as written?

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43. The emf of a galvanic cell composed of two hydrogen electrodes is 272mV. What is the pH of the solution in which the anode is immersed if the cathode is in a solution with a pH of 3?

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44. Calculate the standard emf, standard free energy charge and equilibrium constant of a cell in which the following reaction takes place at $25^\circ C$

$$\frac{1}{2}Cu(s) + \frac{1}{2}Cl_2(g) = \frac{1}{2}Cu^{2+} + Cl^-$$

$E^\circ_{Cl_2, Cl^-} = +1.36$ volt, $E^\circ_{Cu^{2+}, Cu} = +0.34$ volt (1.02 volt $-98.43kJ$, 2×10^{17})

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45. What must be the pressure of the fluorine gas to produce a reduction material potential of 2.75V in a solution that contains 0.38 M F? $E^\circ_{F_2, F^-} = 2.87V$

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46. Show by calculation that $E^\circ = -1.662V$ for the reduction of Al^{3+} to $Al(s)$, regardless of whether the equation for the reaction is written

as

$$\frac{1}{3}Al^{3+} + e \rightarrow \frac{1}{3}Al(s), \Delta G^{\circ} = 160.4kJ/mole$$

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47. Show by calculation that $E^{\circ} = -1.662V$ for the reduction of Al^{3+} to $Al(s)$, regardless of whether the equation for the reaction is written as

$$Al^{3+} + 3e \rightarrow Al(s), \Delta G^{\circ} = 481.2kJ/mole$$

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48. If in a galvanic cell say, Daniel cell, an inert platinum is used instead of a salt bridge, wil the cell they still produce a potential.

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49. Does the physical size of a galvanic cell govern the potential that it will deliver? What does the size effect?

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50. Consider the electrochemical cell represented by

$Mg|Mg^{2+}||Fe^{3+} \mid Fe^{2+}$

If 150mA is to be drawn from this cell for a period of 20 minutes, what is the minimum mass for the magnesium electrode?

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Exercise

1. Is $1MH^+$ solution under hydrogen gas at 1 atm capable of oxidising Ag metal in the presence of $1MAg^+$

(a) yes

(b) No

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2. The potential of hydrogen electrode is $-118mV$. The concentration of H^+ in the solution is

A. 0.01M

B. 2M

C. $10^{-4}M$

D. 1M

Answer:

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3. E° for the half cell $Zn^{2+} \mid Zn$ is $-0.76V$ emf of the cell $Zn\left|Zn^{2+}(1M)\right|2H^+(1M) \mid H_2(1atm)$ is

A. $-0.76V$

B. $+0.76V$

C. $-0.38V$

D. $+0.38V$

Answer:

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

$Zn^{2+}(aq) + 2e = Zn(s), \ -0.762V$

$Cr^{3+}(aq) + 3e = Cr(s), \ -0.74V$

$2H^{+} + 2e = H_2(g), \ \pm 0.0V$

$Fe^{3+}(aq) + e = Fe^{2+}(aq), \ +0.77V$

What is the strongest reducing agent?

A. $Zn(s)$

B. $Cr(s)$

C. $H_2(g)$

D. $Fe^{3+}(aq)$

Answer:

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5. The standard reduction potentials E° for the half reactions are as

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

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

the emf of the cell reaction,

$Fe^{2+} + Zn = Zn^{2+} + Fe$ is

A. $-0.35V$

B. $+0.35V$

C. $+1.17V$

D. $-1.17V$

Answer:

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6. From the following E° values of half cells,

$(i) A + e \rightarrow A^-, E^\circ = -0.24V$

(ii) $B^- + e \rightarrow B^{2-}, E^\circ = +1.25V$

$(iii) C^- + 2e \rightarrow C^{3-}, E^\circ = -1.25V$

$(iv) D + 2e \rightarrow D^{2-}, E^\circ = +0.68V$

What combination of two half cells would result in a cell with the largest potential?

A. (ii) and (iii)

B. (ii) and (iv)

C. (i) and (iii)

D. (i) and (iv)

Answer:

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7. From the following E° values of half cells

$(i) A \rightarrow A^+ + e, E^\circ = +1.2V$

(ii) $B^- \rightarrow B + e, E^\circ = -2.1V$

$(iii) C \rightarrow C^{2+} + 2e, E^\circ = 0.38V$

(iv) $D^{-2} \rightarrow D^- + e, E^\circ = -0.59V$

What combination of two half cells would result in a cell with the largest potential?

A. (i) and (iv)

B. (ii) and (iii)

C. (iii) and (iv)

D. (i) and (ii)

Answer:

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8. From the following E° values of half cells

$(i) A^{3-} \rightarrow A^{2-} + e, E^{\circ} = 1.5V$

(ii) $B^{+} + e \rightarrow B, E^{\circ} = 0.5V$

(iii) $C^{2+} + e \rightarrow C^{+}, E^{\circ} = +0.5V$

$(iv) D \rightarrow D^{2+} + 2e, E^{\circ} = -1.5V$

What combination of two half cells would result in a cell with the largest potential

A. (i) and (iii)

B. (i) and (ii)

C. (ii) and (iv)

D. (iii) and (iv)

Answer:

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9. IF the following half cells have the E° values as

$Fe^{3+} + e \rightarrow Fe^{2+}, E^\circ = 0.77V$ and $Fe^{2+} + 2e \rightarrow Fe, E^\circ = -0.44V$

the E° of the cell half cell $Fe^{3+} + 3e \rightarrow Fe$ will be

A. 0.33V

B. 1.21V

C. $-0.04V$

D. $0.605V$

Answer:

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10. E° (red.) values of the half cells Mg^{2+}/Mg and Cl_2/Cl^- are respectively $-2.36V$ and $+1.36V$. The E° values of the cell $Mg|Mg^{2+}||Cl_2 \mid Cl^-$ is

A. 3.72V

B. 1V

C. 0.18V

D. 2.64V

Answer:

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11. For the cell reaction $Zn(s) + Mg^{2+}(1M) = Zn^{2+}(1M) + Mg$, the emf has been found to be 1.60V E° of the cell is

A. $-1.60V$

B. $1.60V$

C. $0.0V$

D. $0.16V$

Answer:

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12. E° for $F_2 + 2e = 2F^-$ is 2.8V, E° for $\frac{1}{2}F_2 + e = F^-$ is

A. 2.8V

B. 1.4V

C. $-2.8V$

D. $-1.4V$

Answer:

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13. ΔG° of the cell reaction $AgCl(s) + \frac{1}{2}H_2(g) = Ag(s) + H^+ + Cl^-$ is $-21.52kJ$. ΔG° of $2AgCl(s) + H_2(g) = 2Ag(s) + 2H^+ + 2Cl^-$ is

A. $-21.52kJ$

B. $-10.76kJ$

C. $-43.04kJ$

D. $43.0kJ$

Answer:

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14. The value of equilibrium constant for the feasible cell reaction is

A. < 1

B. 0

C. $= 1$

D. > 1

Answer:

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15. E° for the reaction $Fe + Zn^{2+} = Zn + Fe^{2+}$ is -0.35 V. The given cell reaction is

A. feasible

B. not feasible

C. in equilibrium

D. none of these

Answer:

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16. A galvanic cell is composed of two hydrogen electrodes, one of which is a standard one. In which of the following solutions should the other electrode be immersed to get maximum emf?

A. $0.1MHCl$

B. $0.1MCH_3COOH$

C. $0.1MH_3PO_4$

D. $0.1MH_2SO_4$

Answer:

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17. $\frac{1}{2}H_2(g) + AgCl(s) = H^+(aq) + Cl^-(aq) + Ag(s)$ occurs in the galvanic cell:

A. $Ag / AgCl(s)|KCl(sol)||AgNO_3(sol)|Ag$

B. $Pt / H_2(g)|HCl(sol)||AgNO_3(sol)|Ag$

C. $Pt / H_2(g)|HCl(sol)||AgNO_3(s)|Ag$

D. $Pt / H_2(g)|KCl(sol)||AgNO_3(s)|Ag$

Answer:

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18. For the cell $Tl|Tl^{+}(0.001M)||Cu^{2+}(0.1M)|Cu.\ E_{cell}$ at $25^{\circ}C$ is 0.83V which can be increased

A. by increasing $\left[Cu^{2+}\right]$

B. by increasing $\left[Tl^{+}\right]$

C. by decreasing $\left[Cu^{2+}\right]$

D. by decreasing $\left[Tl^{+}\right]$

Answer:

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19. $(i)E^{\circ}\left(Cu^{2+}, Cu\right) = 0.34V$

(ii) $E^{\circ}\left(Cu^{+}, Cu\right) = +0.52V$

$(iii)E^{\circ}\left[O_2(g) + H^{+} + 4e \rightarrow 4OH^{-}\right] = +1.23V$

$(iv)E^{\circ}\left[O_2(g) + 2H_2O + 4e \rightarrow 4OH^{-}\right] = +0.40V$

(v) $E^{\circ}\left(Cr^{3+}, Cr\right) = -0.74V$

$(vi)E^{\circ}\left(Cr^{2+}, Cr\right) = +0.91V$

Match E° of the redox pair is List I with the values given in List II and select the correct answer using the code given below the lists.

	List I		List II
P	$E^{\circ}(Fe^{3+}, Fe)$	1	– 0.18 V
Q	$E^{\circ}(4H_2O \rightleftharpoons 4H^{+} + 4OH^{-})$	2	– 0.4 V
R	$E^{\circ}(Cu^{2+}, Cu \rightarrow 2Cu^{+})$	3	– 0.04 V
S	$E^{\circ}(Cr^{3+}, Cr^{2+})$	4	– 0.83 V

A. P Q R S

4 1 2 3

B. P Q R S

2 3 4 1

C. P Q R S

1 2 3 4

D. P Q R S

3 4 1 2

Answer:

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20. Given below the half cell reactions

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

$2\left(Mn^{3+} + e \rightarrow Mn^{2+}\right), E^{\circ} = +1.51V$

The E° for , $3Mn^{2+} \rightarrow Mn + 2Mn^{3+}$ will be

A. $-2.69V$ the reaction will not occur

B. $-2.69V$ the reaction will occur

C. $-0.33V$ the reaction will not occur

D. $-0.33V$ the reaction will occur

Answer:

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21. In a galvanic cell, the salt bridge

A. does not participate chemically in the reaction

B. stops the diffusion of ions from one electrode to other

C. is necessary for the occurrence of the cell reaction

D. ensures mixing of two electrolytic solutions

Answer:

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22. Galvanisation is applying a coating of

A. Cr

B. Cu

C. Zn

D. Pb

Answer:

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23. For the following electrochemical cell at 298 K

$$Pt(s)|H_2(g)(1bar)|H^+(aq)1M \parallel \left|M^{4+}(aq), M^{2+}(aq)\right|Pt(s)$$

$E_{cell} = 0.092V$ when $\frac{[M^{2+}]}{[M^{4+}]} = 10^x$

Given: $E^\circ_{M^{4+}, M^{2+}} = 0.151V$, $2.303\frac{RT}{F} = 0.059$

The value of x is

A. -2

B. -1

C. 1

D. 2

Answer:

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24. Given: $E^\circ_{Cl_2, Cl^-} = 1.36V$, $E^\circ_{Cr^{3+}, Cr} = -0.74V$

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

Among the following the strongest reducing agent is

A. Cr

B. Mn^{2+}

C. Cr^{3+}

D. Cl^{-}

Answer:

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25. For the following cell

$Zn(s)|ZnSO_4(aq)||CuSO_4(aq)|Cu(s)$

When $\left[Zn^{2+}\right]$ is ten times of $\left[Cu^{2+}\right]$ the expression ΔG (in $Jmol^{-1}$) is

A. 2.303 RT +1.1F

B. 1.1F

C. 2.303RT -2.2F

D. 2.2F

Answer:

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