

**Adama Science and Technology University**

**School of Applied Natural Science**

**Department of Applied Chemistry**

**Physical Chemistry II (Chemical Kinetics and Electrochemistry)**

1. A direct proof of existence of ions in electrolytic solution is its:
  - A) resistance to conductivity
  - B) conducting ability
  - C) dissolution in a given solvent
  - D) specific crystal structure
- 2) In metallic conduction the charge carriers (cause for conduction) are:
  - A) electrons
  - B) cations and anions
  - C) electrons and cations
  - D) electrons and anions
- 3) In electrolytic conduction the charge carriers (cause for conduction) are:
  - A) electrons
  - B) ions
  - C) electrons and cations
  - D) electrons and anions
- 4) The driving force for current to flow from one end to the other end during conduction is
  - A) Resistance difference of the two ends
  - B) Thickness difference of the two ends
  - C) Area difference of the two ends
  - D) Potential difference of the two ends
- 5) Which of the following does not conduct electricity?
  - A) Solid NaCl
  - B) Molten NaCl
  - C) Solution of sulphuric acid
  - D) Solution of glucose
- 6) Conductance of a volume of solution containing one mole of a dissolved substance when placed between two parallel electrodes which are at a unit distance apart and large enough to contain between them the whole solution is:
  - A) Specific conductivity
  - B) Equivalent conductivity
  - C) Molar conductivity
  - D) Electrolytic conductivity

- 7) If the molar conductivity of 0.05 M of  $\text{Mg}^{2+}$  is  $194.2 \text{ S cm}^2 \text{ mol}^{-1}$  at  $25^\circ\text{C}$ , what is its equivalent conductivity?
- A)  $194.2 \text{ S cm}^2 \text{ eq}^{-1}$
  - B)  $48.55 \text{ S cm}^2 \text{ eq}^{-1}$
  - C)  $388.4 \text{ S cm}^2 \text{ eq}^{-1}$
  - D)  $97.1 \text{ S cm}^2 \text{ eq}^{-1}$
- 8) Which of the following is NOT true?
- A) Molar conductivity of strong electrolytes decreases with increase in concentration
  - B) Molar conductivity of weak electrolytes decreases with increase in concentration
  - C) The molar conductivity of weak electrolytes increases more than strong electrolyte up on dilution
  - D) The molar conductivity of strong electrolytes increase more than weak electrolyte up on dilution
- 9) Degree of dissociation of electrolyte increases as concentration decreases. This is
- A) Ostwald dilution law
  - B) Arrhenius dilution law
  - C) Debye-Huckel-Onsagar dilution law
  - D) Kohlrausch's law of dilution
- 10) Each ion in solution is surrounded by an ionic atmosphere consisting of other ions whose net average charge is opposite to that of the central ion. This is
- A) Ostwald law
  - B) Arrhenius law
  - C) Debye-Huckel-Onsagar law
  - D) Kohlrausch's law of dilution
- 11) The equivalent conductivity of an electrolyte at infinite dilution is equal to the sum of the conductances of the anions and cations. This is
- A) Ostwald law
  - B) Arrhenius law
  - C) Debye-Huckel-Onsagar law
  - D) Kohlrausch's law
- 12) If molar conductivity at infinite dilution for hydrochloric acid at  $25^\circ\text{C}$  and that of  $\text{H}^+$  are  $426.14 \text{ S cm}^2 \text{ mol}^{-1}$  and  $349.82 \text{ S cm}^2 \text{ mol}^{-1}$ , respectively, what are the transport numbers of  $\text{H}^+$  and  $\text{Cl}^-$ , respectively?
- A) 0.8209, 0.1791
  - B) 0.1791, 0.8209
  - C) 0.3582, 0.6418
  - D) 0.6418, 0.3582

- 13) The ratio of molar conductivity to molar conductivity at infinite dilution of an electrolyte is
- A) Degree of dissociation
  - B) Equilibrium constant
  - C) Molar concentration
  - D) Transport number
- 14) Which of the following affects molar conductivity of electrolytes?
- A) Temperature
  - B) Pressure
  - C) Concentration
  - D) All
- 15) Increase in one of the following increase molar conductivity of most electrolytes
- A) Temperature
  - B) Pressure
  - C) Concentration
  - D) All
- 16) Which of the following is true?
- A) Activity of an ion is usually less than its actual concentration
  - B) At infinite dilution activity of an ion is equal to its concentration
  - C) Activity coefficient is usually less than unity
  - D) Activity coefficient of an ion is the ratio of concentration to its activity
- 17) If equivalent conductance of NaCl, HCl and  $\text{C}_2\text{H}_5\text{COONa}$  at infinite dilution are 126.45, 426.16 and  $91 \text{ ohm}^{-1} \text{ cm}^2$ , respectively, what is the equivalent conductance of  $\text{C}_2\text{H}_5\text{COOH}$
- A)  $390.71 \text{ ohm}^{-1} \text{ cm}^2$
  - B)  $461.61 \text{ ohm}^{-1} \text{ cm}^2$
  - C)  $643.61 \text{ ohm}^{-1} \text{ cm}^2$
  - D)  $195.355 \text{ ohm}^{-1} \text{ cm}^2$
- 18) Which of the following is in increasing order of molar ionic conductivities?
- A)  $\text{Li}^+ > \text{Na}^+ > \text{K}^+ > \text{Rb}^+$
  - B)  $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+$
  - C)  $\text{Rb}^+ < \text{K}^+ < \text{Na}^+ < \text{Li}^+$
  - D) None
- 19) During electrolytic conduction, the fraction of the total current carried by each ion is
- A) Degree of dissociation
  - B) Equilibrium constant
  - C) Molar concentration
  - D) Transport number
- 20) Which of the following is NOT application of electrolytic cell?
- A) Electrolysis of water
  - B) Extracting of metals from their ores
  - C) Electroplating
  - D) Electro-refining of metals
  - E) None

- 21) What is the condition for an electrochemical cell to behave like an electrolytic cell?
- $E_{\text{ext}} > E_{\text{cell}}$
  - $E_{\text{ext}} < E_{\text{cell}}$
  - $E_{\text{ext}} = E_{\text{cell}}$
  - None
- 22) Which of the following is NOT correct?
- Electrolytic cell converts electrical energy into chemical energy
  - Galvanic cell converts chemical energy into electrical energy
  - Electrolytic cell converts chemical energy into electrical energy
  - Galvanic cell undergoes spontaneous reactions
- 23) Which of the following is NOT correct about electrochemical cell?
- Reduction take place at cathode electrode for both electrolytic and galvanic cells
  - Oxidation takes place at anode electrode for both electrolytic and galvanic cells
  - The flow of electrons is from anode to cathode for both electrolytic and galvanic cells
  - Anode is negative electrode in galvanic cell
  - Anode is negative electrode in electrolytic cell
- 24) The cell representation for the cell reaction:  $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$  is?
- $\text{Zn} | \text{Zn}^{2+} || \text{Cu}^{2+} | \text{Cu}$
  - $\text{Cu} | \text{Cu}^{2+} || \text{Zn}^{2+} | \text{Zn}$
  - $\text{Zn} | \text{Cu}^{2+} || \text{Zn}^{2+} | \text{Cu}$
  - $\text{Cu} | \text{Zn}^{2+} || \text{Cu}^{2+} | \text{Zn}$
- 25) Which of the following is not a characteristic feature of a salt bridge?
- It provides contact between the two halves of an electrochemical cell
  - It completes the inner circuit
  - It reduces liquid junction potential
  - It does not maintain electrical neutrality of the electrolytic solutions of the half-cells
- 26) Which of the following is not a type of electrochemical cell?
- Voltaic cell
  - Photovoltaic cell
  - Electrolytic cell
  - Fuel Cell
- 27) Which of the following conditions are satisfied when the cell reaction in the electrochemical cell is spontaneous?
- $\Delta G^\circ > 0$
  - $E^\circ_{\text{cell}} > 0$
  - $E^\circ_{\text{cell}} = 0$
  - $\Delta G^\circ = 0$
- 28) Which of the following is an expression at equilibrium for electrochemical cell?
- $nFE^\circ_{\text{cell}} = RT \ln K$
  - $-nFE^\circ_{\text{cell}} = RT \ln K$
  - $\Delta G = \Delta G^\circ + RT \ln K$
  - $-\Delta G = \Delta G^\circ + RT \ln K$

- 29) Which of the following shows thermodynamic expression of electrochemical cell at equilibrium?
- $nFE_{\text{cell}}^{\circ} = RT \ln K$
  - $\Delta G = \Delta G^{\circ} + RT \ln K$
  - $\Delta G^{\circ} = -nFE_{\text{cell}}^{\circ}$
  - $\Delta G = -nFE_{\text{cell}}$
- 30) Which of the following factors does not affect the electrode potential of an electrode?
- Nature of the electrode
  - Temperature of the solution
  - Concentration of the solution
  - Size of the electrode
- 31) Which of the following statements is Not correct
- Applying infinitesimally greater potential than cell potential can reverse process in reversible cell
  - For reversible cell the cell potential and opposing potential are infinitesimally different from each other
  - For irreversible cell thermodynamic properties of the cell reaction can be determined
  - For reversible cell thermodynamic properties of cell reaction can be determined
- 32) Measure of tendency of a metallic electrode to lose or gain electrons, when it is in contact with a solution of its own salt is
- Single electrode potential
  - Cell potential
  - Electromotive force
  - Liquid junction potential
- 33) The difference of potential which causes flow of current from one electrode of higher potential to the other electrode of lower potential is
- Single electrode potential
  - Cell potential
  - Electromotive force
  - Liquid junction potential
- 34) Which of the following is NOT correct?
- The cell potential of spontaneous cell reaction is negative
  - The Gibbs free energy of spontaneous cell reaction is negative
  - The Gibbs free energy of cell reaction at equilibrium is zero
  - The cell potential of cell reaction at equilibrium is zero
- 35) Which of the following is NOT correct about cell reaction:  $\text{Fe(s)} + \text{Cl}_2(\text{g}) \rightarrow \text{Fe}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq})$ ?
- The reduction half reaction is  $\text{Cl}_2(\text{g}) + 2\text{e}^{-} \rightarrow 2\text{Cl}^{-}(\text{aq})$
  - The oxidation half reaction is  $\text{Fe(s)} + 2\text{e}^{-} \rightarrow \text{Fe}^{2+}$
  - $E_{\text{cell}}^{\circ} = E_{\text{Fe}^{2+}/\text{Fe}}^{\circ} - E_{\text{Cl}_2/\text{Cl}^{-}}^{\circ}$
  - $\text{Fe} \mid \text{FeCl}_2(\text{aq}) \parallel \text{KCl}(\text{aq}) \mid \text{Cl}_2(\text{g}) \mid \text{Pt}$

- 36) If an electrochemical cell is constructed from half-reactions:  $\text{Mg}^{2+} (1 \text{ M}) + 2\text{e}^- \rightarrow \text{Mg} (\text{s})$  (-2.37 V) and  $\text{Zn}^{2+} (1 \text{ M}) + 2\text{e}^- \rightarrow \text{Zn} (\text{s})$  (-0.763 V), which of the following is correct?
- A) The cell reaction is  $\text{Mg}^{2+} + \text{Zn} (\text{s}) \rightarrow \text{Mg} (\text{s}) + \text{Zn}^{2+}$
  - B) The cell reaction is  $\text{Mg} (\text{s}) + \text{Zn}^{2+} \rightarrow \text{Mg}^{2+} + \text{Zn} (\text{s})$
  - C)  $E_{\text{cell}}$  is -1.607 V
  - D)  $E_{\text{cell}}$  is -3.133 V
- 37) If a zinc rod is placed in 0.1M  $\text{ZnSO}_4$  solution at 2980 K, what is the potential of the electrode?  $E^0_{\text{Zn}^{2+}/\text{Zn}} = -0.76\text{V}$ .
- A) -0.76 V
  - B) +0.76 V
  - C) -0.79 V
  - D) +0.79 V
- 38) The number of electrons (n) involved in cell reaction  $\text{Fe} | \text{Fe}^{2+} // \text{Fe}^{3+} | \text{Fe}$  is
- A) 6
  - B) 3
  - C) 2
  - D) 1
- 39) Estimate the equilibrium constant for the system indicated at 25°C for the cell reaction:
- $$3\text{Mg}^{2+} + 2\text{Al} \leftrightarrow 3\text{Mg} + 2\text{Al}^{3+}$$
- A)  $\sim 10^{69}$
  - B)  $\sim 10^{23}$
  - C)  $\sim 10^{-24}$
  - D)  $\sim 10^{-36}$
  - E)  $\sim 10^{-72}$
- 40) What is  $\Delta G^\circ$  for the following balanced cell reaction if  $E^\circ_{\text{cell}} = +2.431 \text{ V}$ ?
- $$\text{Al} (\text{s}) + \text{Fe}^{3+} (\text{aq}) \rightarrow \text{Al}^{3+} (\text{aq}) + \text{Fe} (\text{s}) \quad E^\circ = +2.431 \text{ V}$$
- A) -704 kJ/mol
  - B) +704 kJ/mol
  - C) -235 kJ/mol
  - D) -469 kJ/mol
- 41) What is  $E^\circ$  for the following balanced reaction if  $K = 4.38 \times 10^{10}$ ?
- $$\text{Zn} (\text{s}) + \text{Fe}^{2+} (\text{aq}) \rightarrow \text{Zn}^{2+} (\text{aq}) + \text{Fe} (\text{s})$$
- A) -0.578 V
  - B) +0.866 V
  - C) -0.315 V
  - D) +0.315 V
- 42) The value of  $E^\circ_{\text{cell}}$  for the following reaction is 1.260 V. What is the value of  $E_{\text{cell}}$  given the concentrations as shown?
- $$2\text{Al} (\text{s}) + 3\text{Cd}^{2+} (\text{aq}, 0.1 \text{ M}) \rightarrow 3\text{Cd} (\text{s}) + 2\text{Al}^{3+} (\text{aq}, 0.6 \text{ M}) \quad E^\circ_{\text{cell}} = 1.260 \text{ V}$$
- A) 1.235 V
  - B) 1.285 V
  - C) 1.150 V
  - D) 1.370 V

- 43) Potential that occurs when two solutions of electrolytes of different concentrations are in contact with each other is
- A) Standard potential
  - B) Liquid junction potential
  - C) Electromotive force
  - D) Electrode potential
- 44) Which of the following is NOT true about electrochemical notation/diagram?
- A) Anode half is written first and the cathode half is written later
  - B) The halves are separated by using two vertical parallel lines in between
  - C) This double vertical line indicates the salt bridge of the galvanic cell
  - D) None
- 45) Type of electrochemical cells that convert the chemical energy of fuel into electricity
- A) Fuel cell
  - B) Primary cell/non-rechargeable cell
  - C) Secondary cell/rechargeable cell
  - D) Voltaic cell

The molar conductivity of 0.05 M solution of  $\text{MgCl}_2$  is  $194.2 \text{ S cm}^2 \text{ mol}^{-1}$  at  $25^\circ\text{C}$ . A cell with electrodes that are  $1.50 \text{ cm}^2$  in surface area and  $0.50 \text{ cm}$  apart is filled with 0.05 M  $\text{MgCl}_2$  solution. How much current will flow when the potential difference between the two electrodes is 5.0 V?