Instruction: Choose the correct answer from the given alternatives and write your answer on the separate answer sheet provided (Time Given 2:30)

1. Which one of the following is true about Arrhenius concept of acid-base?
   A. An acid is a substance that dissociates in water to form hydroxide ions.
   B. An acid is a substance that dissociates in water to form hydrogen ions.
   C. An acid decreases the concentration of hydrogen ions in aqueous solutions.
   D. A base decreases the concentration of hydroxide ions in an aqueous solution.
2. Consider the acid-base reaction given below.

   $H_2O(l) + C_5NH_5(aq) \rightleftharpoons C_5NH_6^+(aq) + OH^-(aq)$

   Which one of the following is Brønsted-Lowry base in the reverse reaction?
   A. C_5NH_5 B. H_2O
   C. $C_5NH_6^+$ D. OH^-
3. Which one of the following species has amphiprotic behavior?
   A. $H_2PO_4^-$ B. CH_3COO^-
   C. HF D. NH_3
4. Which one of the following is **NOT TRUE** about self-ionization of water?
   A. A solution is basic, where $[H_3O^+] = [OH-]$.
   B. A solution is acidic, where $[H_3O^+] > [OH-]$.
   C. A solution is basic, where $[H_3O^+] > [OH-]$.
   D. A solution is acidic, where $[H_3O^+] < [OH-]$.
5. What is the pH of stomach acid, a solution of HCl, with a hydronium ion concentration of 1.2×10^{-3} M?
   A. 11.08 B. 2.92
   C. 4.08 D. 3.0
6. The pH of human blood sample during diagnostic test is found to be 7.3. What is the hydroxide concentration of blood sample?
   A. 2.0 M B. 0.1 M
   C. 5×10^{-6} M D. 2.8×10^{-6} M
7. Which one of the following is strongest acid?
   A. $HClO_4$ B. H_2O
   C. H_2CO_3 D. CH_3COOH
8. Which one of the following is TRUE about the relative strength of a base?
   A. Ionization of a base increases with its strength.
   B. Ionization of a base decreases with its strength.
   C. Weak bases dissociate completely in water.
   D. Strong bases dissociate partially in water

9. A shift in an ionic equilibrium caused by the addition of a solute that provides an ion that takes part in the equilibrium is known as _____.
   A. Common-ion effect B. Leveling effect
   C. Buffer D. Conjugation
10. A buffer solution is prepared by mixing 0.1 M acetic acid and 0.10 M sodium acetate at 25 ^{o}C. What is the pH of the buffer solution? (Given Ka = 1.8×10^{-5}).
   A. 9.26 B. 5.24
   C. 4.74 D. 0.99
11. A solution containing appreciable amounts of a weak conjugate acid-base pair is known as _____.
   A. Buffer solution B. Saturated solution
   C. Diluted solution D. Concentrated solution
12. Buffer solution is a mixture of _____.
   A. Weak base and strong acid
   B. Weak base and its conjugate acid
   C. Weak acid and strong acid
   D. Strong acid and its conjugate base
13. Grade 12 student has prepared a solution by adding acetic acid and sodium acetate to water. Which one of the following is NOT TRUE about the resulting solution?
   A. The presence of CH_3COO^- ions in the solution suppresses the ionization of CH_3COOH.
   B. The presence of CH_3COOH in the solution suppresses the hydrolysis of the CH_3COO^- ions.
   C. The solution has the ability to neutralize added acid due to the presence of CH_3COOH in the solution.
   D. The presence of CH_3COO^- ions in the solution enhances the ionization of CH_3COOH.
14. A common form of a chemical reaction where water is mostly used to break down chemical bonds that exists in a compound is known as _____.
   A. Hydrolysis B. Disproportionation
   C. Electrolysis D. Dissociation
15. Sodium hypochlorite (NaOCl, the active ingredient of almost all bleaches) was dissolved in a solution buffered of pH 6.20. If pKa of HOCl is 7.53, what is the ratio of $[OCl^-]/[HOCl]$ in the solution
   A. 6.2 B. 6.25
   C. 0.047 D. 7.6

16. Which one of the following can represent the net ionic reaction of sodium hydroxide and hydrochloric acid?
    A. $H^+(aq) + Cl^-(aq) \rightarrow HCl(g)$
    B. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
    C. $Na^+(aq) + OH^-(aq) \rightarrow NaOH(s)$
    D. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
17. Given below are K_a and K_b values of some four cations and one anion respectively. Which one of the following salt can result in a neutral solution?

Anions	K_b	Cations	K_a
X^-	1.4×10^{-11}	C^+	5.6×10^{-10}
Y^-	2.0×10^{-5}		
Z^-	5.6×10^{-10}		
R^-	1.8×10^{-5}		

    A. CY B. CX
    C. CZ D. RC
18. What is the color of methyl red indicator on the exposure to acidic rain?
    A. Yellow B. Red
    C. Blue D. Colorless
19. The number of equivalents of solute per liter of a solution is known as ____.
    A. Molarity B. Molality
    C. Mole D. Normality
20. In the titration of a 50.0 mL sample of aqueous HCl, the end point was reached after the addition of 35.23 mL of 0.25 M NaOH titrant. What is the molarity of the HCl?
    A. 0.70 M B. 0.35 M
    C. 0.25 M D. 0.18 M
21. A process in which an atom increases its oxidation number by losing an electron is known as _____.
    A. Reduction B. Oxidation
    C. Redox D. Reaction
22. Which one of the following is oxidation number of Cl in $HClO_4$
    A. 0 B. -1
    C. +7 D. -8

23. Consider the reaction

$Cu(s) + HNO_3(aq) \rightarrow Cu(NO_3)_3(aq) + NO(g) + H_2O(l)$

Which of the following is the balanced form of this chemical equation?

A. $Cu(s) + HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + NO(g) + H_2O(l)$
B. $3Cu(s) + HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + NO(g) + H_2O(l)$
C. $Cu(s) + 2HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO(g) + H_2O(l)$
D. $3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 4H_2O(l)$

24. Which one of the following is reduced in the following reaction?

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

A. Zn B. H
C. O D. S

25. Which one of the following is an oxidizing agent in the reaction below?

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

A. $Cr_2O_7^{2-}$ B. Fe^{2+}
C. H^+ D. Cr^{3+}

26. Which of the following is true about metallic conductors?

A. There is flow of electrical energy and transfer of matter.
B. Electrical conduction through metals bring chemical transformations.
C. Free and mobile electrons of the metal are responsible for electrical conductance.
D. Conductivity of metal increases with increase in temperature.

27. Which one of the following is NOT TRUE about electrolytic conduction?

A. Passage of current through electrolytes is accompanied by chemical changes
B. The conductivity of electrolytes decrease with increase in temperature
C. There is actual transfer of matter
D. The conductivity of electrolytes increases with increase in temperature

28. Which one of the following element as an electrode can affect the preferential discharge of ions?

A. Platinum B. Graphite
C. Copper D. Gold

29. Which one of the following gas is liberated at the cathode if concentrated hydrochloric acid is electrolyzed?

A. H_2 B. Cl_2
C. O_2 D. H_2O

30. What is the residue remaining behind as a residue after the electrolysis of brine is over? ,

A. Na^+ and Cl^- B. H^+ and Cl^-
C. Na+ and OH^- D. H_2O

31. Which one of the following statement is TRUE about oxidation-reduction reactions?
    A. Oxidation can take place in the absence of reduction.
    B. The reduced reactant is electron provider.
    C. In the process of a redox reaction, the oxidation number of the oxidized species increases.
    D. Oxidizing agents bring about reduction on the other reactant.
32. Which one of the following electrochemical cells uses externally applied electrical energy to bring about redox reaction?
    A. Car battery B. Fuel cells
    C. Electrolytic cells D. Galvanic cells
33. Which one of the following redox reaction represents reduction half reaction in an electrolytic cell?
    A. $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$
    B. $Cr(s) \rightarrow Cr^{3+}(aq) + 3e^-$
    C. $Cr^{3+}(aq) \rightarrow Cr^{3+}(aq) + 3e^-$
    D. $Cr(s) + 3e^- \rightarrow Cr^{3+}(aq)$
34. The balanced cathode half reaction taking place during the electrolysis of brine is
    A. $2Cl^- \rightarrow Cl_2 + 2e^-$ B. $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
    C. $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$ D. $Na^+ + 1e^- \rightarrow Na$
35. What mass of gold will be deposited at cathode by passing a current of 50 A through aqueous solution of gold chloride ($AuCl_3$) for 30 minutes according to the following cathode half reaction?

    $Au^{3+}(aq) + 3e^- \rightarrow Au(s)$

    (Given: F = 96500 C, Atomic masses of Au = 197)
    A. 6.12 g B. 1.02 g
    C. 6.06 g D. 18.37 g

36. The half-cell reaction of the electrolysis of aqueous solution of copper (II) sulfate is given below.

    Cathode half Reaction: $Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$

    Anode half Reaction: $2OH^- \rightarrow O_2 + 2H_2O + 4e^-$

    During the electrolysis of copper (II) sulfate solution, 0.8 g of copper was produced at an inert platinum cathode electrode. What mass of oxygen gas was liberated?

    (Atomic mass: Cu = 64, O = 16)
    A. 0.4 g B. 0.2 g
    C. 16 g D. 0.8 g.

37. When metals like iron undergo corrosion process, it is considered as an electrochemical cell. and the metal itself serves as:
    A. an oxidizing agent
    B. a reducing agent
    C. an electrolyte
    D. a cathode of the electrochemical cell

38. The reaction given below takes place in the lead storage cell or car battery.

$$Pb + PbO_2 + H_2SO_4 \underset{\text{Charging}}{\overset{\text{Discharge}}{\rightleftharpoons}} PbSO_4 + H_2O$$

    Which reactant undergoes reduction when the car battery on duty?
    A. $PbSO_4$
    B. PbO_2
    C. H_2SO_4
    D. Pb

39. Iron spoons are usually corroded and become useless through time when exposed to air and moisture. It requires protecting the spoon by covering it with less reactive metal. What will be the appropriate electrochemical cell arrangement for electroplating iron spoon with silver metal so as to make silver plated spoon?
    A. The iron spoon is kept at anode being immersed in iron (II) chloride solution.
    B. Silver metal has to be kept at cathode being immersed in silver nitrate solution.
    C. The iron spoon is kept at cathode being immersed in iron (II) chloride solution.
    D. Silver metal has to be kept at cathode being immersed in iron (II) chloride solution.

40. How long would take to deposit 5.2 g of silver metal on an iron spoon by passing 52 A of electric current through an electrolytic aqueous solution of $AgNO_3$?
    A. 178.70 s
    B. 44.68 s
    C. 268.06 s
    D. 89.35 s

41. Faraday's second law of electrolysis relates:
    A. molecular masses of different electrolytes.
    B. atomic weights of electrolytes.
    C. atomic numbers of cations and anions
    D. equivalent weights of cations and anions

42. The quantity of electricity required to liberate 0.01 gram equivalent of an element at an electrode is:
    A. 96,500 C
    B. 9,650 C
    C. 965 C
    D. 96.5 C

43. What is the weight of silver deposited from $AgNO_3$ solution by the same quantity of electricity that liberated 5.6 L of oxygen at STP?
(Atomic weight of Ag = 108, Molecular mass of O_2 = 32)
A. 5.4 g B. 108 g
C. 8 g D. 16 g

44. Calculate the number of moles of Mg produced when a current of 60 A is passed through a magnesium chloride solution ($MgCl_2$) for 4.00 h.
A. 0.45 mole B. 10.44 moles
C. 21.48 moles D. 0.95 mole

45. Consider that three different electrolytic cells containing aqueous solutions iron chloride ($FeCl_2$), aluminum chloride ($AlCl_3$) and chromium chloride ($CrCl_3$) were connected in series and the same amount of electric current was passed through the cells for the same time. After the electrolysis was completed, the mass of iron deposited at the cathode from the cell containing $FeCl_2$ solution was found to be 1.4 g. What were the masses of aluminum and chromium deposited from their respective electrolytes?
(Atomic mass: Fe = 56, Al =27, Cr = 52)
A. Al = 0.675 g, Cr = 1.30 g
B. Al = 0.225 g, Cr = 0.433 g
C. Al = 173.57 g, Cr = 322.93 g
D. Al = 0.45 g, Cr = 0.865 g

46. Which one of the following electrolytic system is suitable for the electro-synthesis of active metals?
A. Aqueous solution of salts B. Molten salts
C. Solid salts C. Mixture of molten salts

47. Which one of the following is not correct about the industrial production of aluminum using electrolysis?
A. Aluminum metal is produced from molten aluminum oxide (Al_2O_3).
B. Graphite electrode is used as an anode for the electrolytic cell.
C. 4 moles of aluminum is deposited at cathode for every 3 moles oxygen liberated at anode.
D. During the electrolysis of molten aluminum oxide, oxygen is liberated at the cathode of the electrolytic cell.

48. Which one of the following is correct about refining of impure metals using electrolysis?
    A. The impure metal be refined is kept at anode.
    B. Purest form of the same metal as the impure metal is kept at cathode
    C. Aqueous solution of a salt different from the one to be purified is used as an electrolyte.
    D. The impure metal is transferred from anode to cathode after being oxidized at anode and then reduced at the cathode.
49. Which one of the following statement is correct about the comparative properties of voltaic cells and electrolytic cells?
    A. A Voltaic cell coverts chemical energy into electrical energy while electrolytic cells store electrical energy in the form of chemical energy.
    B. Processes in the voltaic cells are endothermic whereas processes in electrolytic cells exothermic.
    C. A voltaic cell uses the electrical energy from an external source to force a reaction to occur whereas an electrolytic cell uses the energy that is released from the redox reaction to generate electricity
    D. Reactions in both voltaic and electrolytic cells are spontaneous redox reactions.
50. Which one of the following statements is not true about voltaic cells and electrolytic cells?.
    A. In voltaic cells, anode is the negative electrode whereas in electrolytic cells cathode is the negative electrode.
    B. In voltaic cells, electrons flow from anode to cathode through the external circuit whereas in electrolytic cells, electrons flow from cathode to anode through external circuit.
    C. Voltaic cells operate for spontaneous reaction whereas electrolytic cells use electrical energy to drive a non-spontaneous reaction
    D. In voltaic cells, reduction takes place at the negative anode electrode while in electrolytic cells, reduction takes place at the positive anode electrode.

51. Which one of the following is not the major function salt bridge in voltaic cells?
    A. Salt bridge is used to maintain electrical neutrality inside the circuit between the two half cells of the voltaic cell.
    B. Salt bridge serves as electrical connection between the two half cells of the voltaic cell.
    C. Salt bridge makes the two half cells of the voltaic cell a closed circuit.
    D. It serves as cathode and anode electrode of the voltaic cell.

52. A voltaic cell was constructed from aluminum electrode immersed in 1.0 M aqueous solution of aluminum chloride solution and nickel electrode immersed in 1.0 M aqueous solution of nickel chloride. The redox reaction of the cells given as follows.

    Oxidation half reaction: $Al(s) \rightarrow Al^{3+}(aq) + 3e^-$

    Reduction half reaction: $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

    Which one of the following cell notation is the correct for the above voltaic cell?
    A. $Al^{3+}(aq, 1.0M) \mid Al(s) \mid\mid Ni(s) \mid Ni^{2+}(aq, 1.0M)$
    B. $Al(s) \mid Al^{3+}(aq, 1.0M) \mid\mid Ni^{2+}(aq, 1.0M) \mid Ni(s)$
    C. $Ni^{2+}(aq, 1.0M) \mid Ni(s) \mid\mid Al(s) \mid Al^{3+}(aq, 1.0M)$
    D. $Ni(s) \mid Ni^{2+}(aq, 1.0M) \mid\mid Al^{3+}(aq, 1.0M) \mid Al(s)$

53. Identify the wrong statement about electrode potential and cell potential in voltaic cells.
    A. Cell potential is the sum of the electrical potentials of two electrodes.
    B. Electrode potential of a single electrode can be measured alone.
    C. Electrode potential of an electrode is measured relative to another electrode taken as a standard.
    D. Electrode potential of an unknown electrode is measured relative to the electrode potential of standard hydrogen electrode.

Answer question 54 – 57 based on the information given below.

A voltaic cell was constructed from aluminum electrode immersed in 1.0 M aqueous solution of aluminum chloride ($AlCl_3$) and zinc electrode immersed in 1.0 M aqueous solution of zinc chloride ($ZnCl_2$) at 25 ^oC and the two half-cells were connected with the salt bridge composed of potassium nitrate (KNO_3). The standard reduction electrode potentials of Al^{3+}/Al is –1.66 V and Zn^{2+}/Zn is –0.76 V.

54. What is the standard cell potential of the voltaic cell?
    A. +0.90 V B. –0.90 V
    C. –2.42 V D. +2.42 V

55. The correct assignment of anode and cathode with their corresponding signs of the electrodes in the cell diagram of the galvanic cell.
    A. Aluminum anode (+ve) and Zinc cathode (–ve)
    B. Aluminum cathode (–ve) and Zinc Anode (+ve)
    C. Aluminum anode (–ve) and Zinc cathode (+ve)
    D. Aluminum cathode (+ve) and Zinc anode (–ve)
56. The correct direction of electron in the voltaic cell given is:
    A. From zinc electrode–through salt-bridge-to-aluminum electrode
    B. From zinc electrode -to-aluminum electrode
    C. From aluminum electrode–through salt bridge-to-zinc electrode
    D. From aluminum electrode-to-Zinc electrode
57. In the voltaic cell given above, as the electrochemical reaction is proceeding, the incorrect electrochemical processes taking place in the cell is:
    A. the migration of negative NO^{3-} ions from the salt bridge towards the aluminum electrode of the cell.
    B. the migration of negative NO^{3-} ions from the salt bridge towards the zinc electrode of the cell.
    C. aluminum metal dissolves to form Al^{3+} ions and enter into the solution $AlCl_3$ solution.
    D. Zn^{3+} ions are reduced into Zn atoms and deposited on to the zinc electrode.
58. What is the electromotive force (EMF) of the following voltaic cell at 25 ^{o}C?

    $$Ni(s)\,|\,Ni^{2+}(1.0M)\,||\,Sn^{2+}(1.0\times10^{-4}\ M)\,|\,Sn(s)$$

    Given that the standard reduction electrode potentials of $Ni(s)\,|\,Ni^{2+}$ = –0.25 and $Sn^{2+}\,|\,Sn(s)$ = –0.14
    A. –0.01 V B. 0.23 V
    C. 0.13 V D. 0.14 V
59. Dry cells that is commonly used in torch batteries, remote control etc. are the applications of voltaic cells in our daily life. Which one of the following is the composition of dry cells?
    A. Zinc metal which is used both as anode and container
    B. Paste of manganese dioxide which serves as cathode of the cell.
    C. Graphite electrode at the center of the dry cell.
    D. Sodium chloride as an electrolytic media.

60. Identify the correct order of manufacturing materials in industry.
    A. Raw materials identification, finishing, processing and using for the desired purpose.
    B. Finishing, processing, raw materials identification and using for the desired purpose.
    C. Raw materials identification, processing, Finishing and using for the desired purpose.
    D. Raw materials identification, processing, for the desired purpose and using Finishing.
61. A well-organized set up facility established mainly for the production of useful materials and goods in large scale though the application of physical and chemical processes is:
    A. chemical industry
    B. petrochemical industry
    C. construction industry
    D. electrochemistry
62. Which of the following statement is not part of the major activity of industrial chemistry?
    A. Study materials to gain knowledge.
    B. Processing and transforming of raw materials into more useful products using chemical reactions.
    B. Isolation of naturally occurring substances for use as raw materials.
    D. Treating of waste products to protect the environment from pollution.
63. Part or environment of the earth that serves as a source of majority of elements and compounds is:
    A. atmosphere
    B. hydrosphere
    C. lithosphere
    D. biosphere
64. Which one of the following is a non-renewable resource?
    A. Forests and crops
    B. Animals and plants
    C. Solar Energy and hydropower
    D. Minerals and petroleum
65. Which one of the following is NOT the major function of chemical industry?
    A. Reacting organic compounds, inorganic materials and organic and inorganic materials to obtain materials useful for the society.
    B. Separating and purifying plant and animal products with or without using chemical reactions.
    C. Production of specialty chemicals.
    D. Distribution of material and goods produced on the market.

66. Which one of the following is TRUE about ammonia?
    A. Ammonia is gas at room temperature.
    B. Ammonia is Lewis acid and forms acidic solution when dissolved in water.
    C. Ammonia has a sweet smell.
    D. Ammonia is a liquid at room temperature.
67. One of the following is NOT TRUE the commercial use of ammonia?
    A. Ammonia is used in the manufacturing of nitrogen fertilizers.
    B. Ammonia is in the production of trinitrotoluene and gunpowder.
    C. Ammonia is used in the production of sulfuric acid.
    D. Ammonia is raw material in Ostwald process.
68. Which one of the following industrial processes is used for the production of ammonia?
    A. Contact process
    B. Solvay Process
    C. Ostwald process
    D. Haber process
69. Ammonia is manufacture in industry according to the following reaction:
    $N_2 + 3H_2 \rightarrow 2NH_3$
    Which one of the following is TRUE about currently used sources of the reactants?
    A. Both nitrogen and hydrogen are obtained directly from air.
    B. Both nitrogen and hydrogen are obtained as petroleum products.
    C. Nitrogen is obtained from thermal decomposition of nitrates while hydrogen is from the electrolytic decomposition of water.
    D. Nitrogen is obtained from fractional distillation of liquid air while hydrogen is from methane from natural gas.
70. Which one of the following procedure and observation are NOT TRUE in the laboratory preparation process of ammonia?
    A. Ammonia gas is prepared in the laboratory by heating the mixture of NH_4Cl (solid ammonium chloride and $Ca(OH)_2$ (solid calcium hydroxide) in a dry test tube.
    B. Ammonia gas is produced from the reaction of NH_4Cl and $Ca(OH)_2$ is collected in an inverted dry test tube by a downward displacement of air.
    C. When water is added to the test tube containing ammonia and tested by dipping a blue litmus paper, the color of the blue litmus paper changed to red.
    D. When ammonia gas produced from the reaction of NH_4Cl and $Ca(OH)_2$ is collected in a test tube containing concentrated hydrochloric acid, a white fume (smoke) is observed due to the formation of ammonium chloride.