Chemistry

Higher level

Paper 1A

Practice paper

Topic: Redox Processes

Chemistry

Higher level

Paper 1A

Specimen paper

1 hour

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the best answer.
- A clean copy of the chemistry data booklet is required.
- The maximum mark for this paper is [30 marks].

Section A

1. What is the standard electrode potential, E^{θ}, of the standard hydrogen electrode?
   A. -1.00 V
   B. 0.00 V
   C. +1.00 V
   D. +298 V

2. Which combination of conditions defines standard electrode potentials?
   A. 298 K, 100 kPa, 1.0 mol dm^{-3}
   B. 273 K, 101 kPa, 1.0 mol dm^{-3}
   C. 298 K, 101 kPa, 0.1 mol dm^{-3}
   D. 0 K, 100 kPa, 1.0 mol dm^{-3}

3. In a functioning voltaic cell operating under standard conditions, which relates delta G^{θ} and $E^{\theta}_{c}ell$?
   A. delta $G^{\theta} > 0$ and $E^{\theta}_{c}ell > 0$
   B. delta $G^{\theta} < 0$ and $E^{\theta}_{c}ell > 0$
   C. delta $G^{\theta} < 0$ and $E^{\theta}_{c}ell < 0$
   D. delta $G^{\theta} > 0$ and $E^{\theta}_{c}ell < 0$

4. Which conditions are required for standard electrode potentials?
   I. 1.0 mol dm^{-3} concentration for aqueous ions
   II. 100 kPa pressure for gases
   III. Platinum electrodes in all half-cells
   A. I and II only
   B. I and III only
   C. II and III only
   D. I, II and III

5. Which species is preferentially discharged at the anode during the electrolysis of dilute aqueous sodium chloride using inert electrodes?
   A. Na^{+}
   B. Cl^{-}
   C. OH^{-}
   D. H^{+}

6. Which factors affect the amount of product discharged during electrolysis?
   A. Time and temperature
   B. Current, time, and charge of the ion
   C. Current and voltage only

D. Concentration of the electrolyte only

7. In the balancing of a redox reaction in basic medium, how are the H^+ ions neutralized?
A. By adding H_2O
B. By adding OH^- to both sides
C. By adding O_2
D. By subtracting H^+ from the products

8. Which statements apply to an electrolytic cell?
I. delta G > 0 for the overall chemical reaction
II. Electrical energy drives a non-spontaneous reaction
III. Oxidation occurs at the positive electrode
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

9. A voltaic cell consists of Ag^+/Ag (E^θ = +0.80 V) and Ni^{2+}/Ni (E^θ = -0.26 V). What is the standard cell potential?
A. +1.06 V
B. +0.54 V
C. -1.06 V
D. -0.54 V

10. In electroplating a copper spoon with silver, the spoon must be placed at the:
A. Anode, where reduction occurs
B. Cathode, where oxidation occurs
C. Cathode, where reduction occurs
D. Anode, where oxidation occurs

11. Which of the following is an expected product at the cathode during the electrolysis of aqueous copper(II) sulfate using inert electrodes?
A. Oxygen gas
B. Hydrogen gas
C. Copper metal
D. Sulfur dioxide

12. In comparing the electrolysis of molten NaCl vs dilute aqueous NaCl using inert electrodes:
I. Both produce chlorine gas at the anode.

II. Molten NaCl yields sodium metal at the cathode.
III. Aqueous NaCl yields hydrogen gas at the cathode.
A. I and II only
B. II and III only
C. I and III only
D. I, II and III

13. Which equation relates Gibbs free energy to cell potential?
A. delta $G^{\theta} = -nFE^{\theta}$
B. delta $G^{\theta} = nFE^{\theta}$
C. delta $G^{\theta} = -RT\ln(K)$
D. $E^{\theta} = nF(\text{delta } G^{\theta})$

14. What is the value of the Faraday constant?
A. 9.65×10^{3} C mol^{-1}
B. 9.65×10^{4} C mol^{-1}
C. 8.31 J K^{-1} mol^{-1}
D. 6.02×10^{23} mol^{-1}

15. If a current of 2.0 A flows for 10 minutes, what charge has passed?
A. 20 C
B. 120 C
C. 1200 C
D. 2400 C

16. Which relate to determining the mass of metal deposited during electroplating?
I. Current applied
II. Time of electroplating
III. The charge of the metal ion
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

17. Which metal is the strongest reducing agent according to its highly negative standard electrode potential?
A. Gold
B. Silver
C. Copper
D. Lithium

18. What occurs during the electrolysis of concentrated aqueous sodium chloride?
A. Hydrogen gas is formed at the anode.
B. Chlorine gas is formed at the anode.
C. Sodium metal is formed at the cathode.
D. Oxygen gas is formed at the anode.

19. A cell with an $E^{\theta}_{c}ell$ of 0.00 V implies:
A. The reaction is spontaneous.
B. The reaction is at equilibrium.
C. The cell is short-circuited.
D. The cell has an infinite resistance.

20. For a spontaneous electrochemical reaction:
I. The total cell potential ($E^{\theta}_{c}ell$) is positive.
II. The Gibbs free energy change (delta G^{θ}) is negative.
III. The equilibrium constant (K) is greater than 1.
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

21. Which describes the electron flow in an electrolytic cell?
A. From anode to cathode via the external circuit
B. From cathode to anode via the external circuit
C. Through the electrolyte from anode to cathode
D. Through the electrolyte from cathode to anode

22. When copper is electro-refined, what forms at the anode?
A. Pure copper is deposited.
B. Impure copper undergoes oxidation to Cu^{2+}.
C. Oxygen gas is evolved.
D. Hydrogen gas is evolved.

23. What is the oxidation state of Mn in the permanganate ion, MnO_4^-?
A. +2
B. +4
C. +6
D. +7

24. During the electrolysis of concentrated NaCl(aq) (brine), which products are formed?
I. Hydrogen gas
II. Chlorine gas
III. Sodium hydroxide solution
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

25. Which is an appropriate salt bridge electrolyte?
A. $BaSO_4$
B. AgCl
C. KNO_3
D. $PbBr_2$

26. The standard electrode potential for a half cell is defined relative to the SHE. What is the material of the SHE electrode?
A. Copper
B. Zinc
C. Platinum
D. Graphite

27. During the rusting of iron, what is the initially formed solid product?
A. Fe_2O_3
B. $Fe(OH)_2$
C. $Fe(OH)_3$
D. Fe_3O_4

28. Which factors influence the selective discharge of ions in an aqueous solution?
I. The position of the ion in the standard electrode potential series
II. The concentration of the electrolyte
III. the nature of the electrode
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

29. If E^θ for the reaction $X + Y^{2+} \rightarrow X^{2+} + Y$ is positive, what can be deduced about the reverse reaction?
A. It has a positive delta G^θ and is non-spontaneous.
B. It has a negative delta G^θ and is spontaneous.

C. It has a positive delta G^{θ} and is spontaneous.
D. It has a negative delta G^{θ} and is non-spontaneous.

What is the oxidation state of Chromium in the dichromate ion, $Cr_2O_7^{2-}$?
A. +3
B. +6
C. +7
D. +12

Which statement defines oxidation?
A. Gain of electrons
B. Loss of electrons
C. Decrease in oxidation state
D. Addition of hydrogen

32. Which changes occur when balancing redox half-equations in basic solution instead of acidic?
I. H^+ ions are neutralized by adding OH^- to both sides.
II. Water is added to balance oxygen.
III. The number of transferred electrons changes.
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

In a voltaic cell, where does reduction take place?
A. At the anode, which is positive.
B. At the anode, which is negative.
C. At the cathode, which is positive.
D. At the cathode, which is negative.

Which species acts as the oxidizing agent in the reaction: $Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$?
A. Cu(s)
B. $Ag^+(aq)$
C. $Cu^{2+}(aq)$
D. Ag(s)

What is the primary function of a salt bridge in a voltaic cell?
A. To provide a pathway for electrons to flow

B. To maintain electrical neutrality by allowing ions to migrate
C. To act as an electrode
D. To stop the reaction from proceeding too quickly

Which variables must be designated for standard electrode potential conditions?
I. Temperature of 298 K
II. Solutions at 1.0 mol dm^{-3}
III. Gases at 100 kPa pressure
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

During the electrolysis of molten sodium chloride, what is produced at the negative electrode (cathode)?
A. Sodium metal
B. Chlorine gas
C. Hydrogen gas
D. Oxygen gas

A standard hydrogen electrode (SHE) is assigned an electrode potential of exactly what value?
A. 1.00 V
B. 0.00 V
C. -1.00 V
D. 2.98 V

Which of the following indicate a spontaneous reaction?
I. A positive standard cell potential
II. A negative Gibbs free energy change
III. The oxidation of a highly unreactive metal like gold
A. I and II only
B. I and III only
C. II and III only
D. I, II and III