1. For the cell \( \text{Zn(s)} | \text{Zn}^{2+} (\text{aq}) \parallel \text{M}^{x+} (\text{aq}) | \text{M(s)} \), different half cells and their standard electrode potentials are given below:

<table>
<thead>
<tr>
<th>( M^{x+} (\text{aq})/M(s) )</th>
<th>( \text{Au}^{3+} (\text{aq})/\text{Au(s)} )</th>
<th>( \text{Ag}^{+} (\text{aq})/\text{Ag(s)} )</th>
<th>( \text{Fe}^{3+} (\text{aq})/\text{Fe(s)} )</th>
<th>( \text{Fe}^{2+} (\text{aq})/\text{Fe(s)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta G_{rxn}^{\circ} )</td>
<td>1.40</td>
<td>0.80</td>
<td>0.77</td>
<td>−0.44</td>
</tr>
</tbody>
</table>

If \( E_{\text{Zn}^{2+}/\text{Zn}}^{\circ} = −0.76 \text{V} \), which cathode will give a maximum value of \( E_{\text{cell}}^{\circ} \) per electron transferred?

(1) \( \text{Fe}^{3+}/\text{Fe}^{2+} \)  
(2) \( \text{Ag}^{+}/\text{Ag} \)  
(3) \( \text{Au}^{3+}/\text{Au} \)  
(4) \( \text{Fe}^{2+}/\text{Fe} \)

Ans. (2)

2. The correct match between items-I and II is:

<table>
<thead>
<tr>
<th>Item-I</th>
<th>Item-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Mixture)</td>
<td>(Separation method)</td>
</tr>
<tr>
<td>(A) ( \text{H}_2\text{O} : \text{Sugar} )</td>
<td>(P) Sublimation</td>
</tr>
<tr>
<td>(B) ( \text{H}_2\text{O} : \text{Aniline} )</td>
<td>(Q) Recrystallization</td>
</tr>
<tr>
<td>(C) ( \text{H}_2\text{O} : \text{Toluene} )</td>
<td>(R) Steam distillation</td>
</tr>
<tr>
<td>(S) Differential extraction</td>
<td></td>
</tr>
</tbody>
</table>

(1) A-Q, B-R, C-S  
(2) A-R, B-P, C-S  
(3) A-S, B-R, C-P  
(4) A-Q, B-R, C-P

Ans. (1)

Sol. (Mixture) (Separation method)

- \( \text{H}_2\text{O} : \text{Sugar} \Rightarrow \text{Recrystallization} \)
- \( \text{H}_2\text{O} : \text{Aniline} \Rightarrow \text{Steam distillation} \)
- \( \text{H}_2\text{O} : \text{Toluene} \Rightarrow \text{Differential extraction} \)

3. If a reaction follows the Arrhenius equation, the plot \( \ln k \) vs \( \frac{1}{(RT)} \) gives straight line with a gradient \( (−y) \) unit. The energy required to activate the reactant is:

(1) \( y \) unit  
(2) \( −y \) unit  
(3) \( yR \) unit  
(4) \( y/R \) unit

Ans. (1)

4. The concentration of dissolved oxygen (DO) in cold water can go up to:

(1) 10 ppm  
(2) 14 ppm  
(3) 16 ppm  
(4) 8 ppm

Ans. (1)

Sol. In cold water, dissolved oxygen (DO) can reach a concentration up to 10 ppm.

5. The major product of the following reaction is:

\[
\begin{align*}
\text{O} & \quad \text{OEt} \\
\text{CN} & \quad \text{(i) Ni/H}_2 \\
\text{C} & \quad \text{DIBAL–H} \\
\text{CHO} & \quad \rightarrow \\
\text{NH}_2 & \quad \text{(1)} \\
\text{NH} & \quad \text{(2)} \\
\text{OH} & \quad \text{(3)} \\
\text{NH}_2 & \quad \text{(4)}
\end{align*}
\]

Ans. (2)

Sol.

6. The correct statements among (a) to (d) regarding \( \text{H}_2 \) as a fuel are:

(a) It produces less pollutant than petrol  
(b) A cylinder of compressed dihydrogen weighs ~ 30 times more than a petrol tank producing the same amount of energy  
(c) Dihydrogen is stored in tanks of metal alloys like NaNi  
(d) On combustion, values of energy released per gram of liquid dihydrogen and LPG are 50 and 142 kJ, respectively

(1) b and d only  
(2) a, b and c only  
(3) b, c and d only  
(4) a and c only

Ans. (2)

Sol. Option (a), (b) & (c) are correct answer (NCERT THEORY BASED)
7. The major product of the following reaction is:

\[
\text{(1) } \text{HBr} \xrightarrow{(i) \text{ alc. KOH}} \text{(2) } \text{Cl} \xrightarrow{(ii) \text{ alc. KOH}} \text{(3) } \text{OH} \xrightarrow{(iii) \text{ alc. KOH}} \text{(4) } \text{OCl}
\]

Ans. (1)

Sol. (1) \( \text{HBr} \rightarrow \text{Br} \rightarrow \text{Br} \rightarrow \text{Cl} \rightarrow \text{Cl} \rightarrow \text{OH} \rightarrow \text{OCl} \)

8. The element that usually does not show variable oxidation states is:

(1) V (2) Ti (3) Sc (4) Cu

Ans. (3)

Sol. Usually Sc (Scandium) does not show variable oxidation states.

Most common oxidation states of:
(i) Sc : +3
(ii) V : +2, +3, +4, +5
(iii) Ti : +2, +3, +4
(iv) Cu : +1, +2

9. An organic compound is estimated through Dumas method and was found to evolve 6 moles of \( \text{CO}_2 \), 4 moles of \( \text{H}_2\text{O} \) and 1 mole of nitrogen gas. The formula of the compound is:

(1) \( \text{C}_{12}\text{H}_8\text{N}_2 \) (2) \( \text{C}_{12}\text{H}_8\text{N}_2 \)
(3) \( \text{C}_6\text{H}_8\text{N}_2 \) (4) \( \text{C}_6\text{H}_8\text{N}_2 \)

Ans. (4)

Sol. \( \text{[C}_6\text{H}_8\text{N}_2] \xrightarrow{\text{Dumas Method}} 6\text{CO}_2 + 4\text{H}_2\text{O} + \text{N}_2 \)

Hence, \( \text{C}_6\text{H}_8\text{N}_2 \)

10. The major product of the following reaction is:

\[
\text{(1) } \text{HBr} \xrightarrow{(i) \text{ alc. KOH}} \text{(2) } \text{Cl} \xrightarrow{(ii) \text{ alc. KOH}} \text{(3) } \text{OH} \xrightarrow{(iii) \text{ alc. KOH}} \text{(4) } \text{OCl}
\]

Ans. (2)

Sol. (1) \( \text{HBr} \rightarrow \text{Br} \rightarrow \text{Br} \rightarrow \text{Cl} \rightarrow \text{Cl} \rightarrow \text{OH} \rightarrow \text{OCl} \)

11. Among the following compound which one is found in RNA?

(1) \( \text{NH}_2\text{N} \)
(2) \( \text{NH}_2\text{N} \)
(3) \( \text{NH}_2\text{N} \)
(4) \( \text{NMe}\text{Me} \)

Ans. (3)

Sol. For the given structure 'uracil' is found in RNA.

\( \text{C}_6\text{H}_4\text{N}_2 \)
12. Which compound(s) out of the following is/are not aromatic?

\[ \begin{align*}
\text{(A)} & \quad \bigtriangleup \\
\text{(B)} & \quad \bigtriangledown \\
\text{(C)} & \quad \bigcirc \\
\text{(D)} & \quad \square
\end{align*} \]

(1) C and D  
(2) B, C and D  
(3) A and C  
(4) B

**Ans. (2)**

**Sol.** out of the given options only \( \bigtriangledown \) is aromatic.

Hence (B), (C) and (D) are not aromatic.

13. The correct match between Item(I) and Item(II) is:

<table>
<thead>
<tr>
<th>Item-I</th>
<th>Item-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Nortehindrone</td>
<td>(P) Anti-biotic</td>
</tr>
<tr>
<td>(B) Ofloxacin</td>
<td>(Q) Anti-fertility</td>
</tr>
<tr>
<td>(C) Equanil</td>
<td>(R) Hypertension</td>
</tr>
<tr>
<td>(S) Analgesics</td>
<td></td>
</tr>
</tbody>
</table>

(1) A-R, B-P, C-S  
(2) A-Q, B-P, C-R  
(3) A-R, B-P, C-R  
(4) A-Q, B-R, C-S

**Ans. (2)**

**Sol.** (A) Norethindrone – Antifertility  
(B) Ofloaxacin – Anti-Biotic  
(C) Equanil – Hypertension (traiquilizer)

14. Heat treatment of muscular pain involves radiation of wavelength of about 900 nm. Which spectral line of H-atom is suitable for this purpose?

\[ R_H = 1 \times 10^5 \text{ cm}^{-1}, \quad h = 6.6 \times 10^{-34} \text{ Js}, \quad c = 3 \times 10^8 \text{ ms}^{-1} \]

(1) Paschen, 5 \( \rightarrow \) 3  
(2) Paschen, \( \infty \) \( \rightarrow \) 3  
(3) Lyman, \( \infty \) \( \rightarrow \) 1  
(4) Balmer, \( \infty \) \( \rightarrow \) 2

**Ans. (2)**

15. Consider the reaction,

\[ \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \]

The equilibrium constant of the above reaction is \( K_p \). If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by

\[ \frac{1}{4} \left( \frac{3^3}{1} \frac{K_p^3}{P^2} \right) \]

(1) \( \frac{3^3}{4} \frac{K_p^3}{P^2} \)  
(2) \( \frac{3^3}{16} \frac{K_p^3}{P^2} \)  
(3) \( \frac{1}{16} \frac{K_p^3}{P^2} \)  
(4) \( \frac{1}{4} \frac{K_p^3}{P^2} \)

**Ans. (2)**

16. Match the ores(Column A) with the metals (column B):

<table>
<thead>
<tr>
<th>Column-A</th>
<th>Column-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ores</td>
<td>Metals</td>
</tr>
<tr>
<td>(I) Siderite</td>
<td>(a) Zinc</td>
</tr>
<tr>
<td>(II) Kaolinite</td>
<td>(b) Copper</td>
</tr>
<tr>
<td>(III) Malachite</td>
<td>(c) Iron</td>
</tr>
<tr>
<td>(IV) Calamine</td>
<td>(d) Aluminium</td>
</tr>
</tbody>
</table>

(1) I-b ; II-c ; III-d ; IV-a  
(2) I-c ; II-d ; III-a ; IV-b  
(3) I-c ; II-d ; III-b ; IV-a  
(4) I-a ; II-b ; III-c ; IV-d

**Ans. (3)**

**Sol.** Siderite : FeCO\(_3\)  
Kaolinite : Al\(_2\)(OH)\(_4\)Si\(_2\)O\(_5\)  
Malachite : Cu(OH)\(_2\).CuCO\(_3\)  
Calamine : ZnCO\(_3\)

17. The correct order of the atomic radii of C, Cs, Al and S is:

(1) S < C < Al < Cs  
(2) S < C < Cs < Al  
(3) C < S < Cs < Al  
(4) C < S < Al < Cs

**Ans. (4)**

**Sol.**

In a period, atomic radius decreases from left to right.  
In a group, atomic radius increases from top to bottom.

Atomic radii order : C < S < Al < Cs  
Atomic radius of C : 170 pm  
Atomic radius of S : 180 pm  
Atomic radius of Al : 184 pm  
Atomic radius of Cs : 300 pm
18. Match the metals (Column I) with the coordination compound(s) / enzyme(s) (Column II)

<table>
<thead>
<tr>
<th>Metals</th>
<th>Coordination compound(s) / Enzyme(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Co</td>
<td>(i) Wilkinson catalyst</td>
</tr>
<tr>
<td>(B) Zn</td>
<td>(ii) Chlorophyll</td>
</tr>
<tr>
<td>(C) Rh</td>
<td>(iii) Vitamin B₁₂</td>
</tr>
<tr>
<td>(D) Mg</td>
<td>(iv) Carbonic anhydrase</td>
</tr>
</tbody>
</table>

(1) A-ii ; B-civ ; C-iii ; D-iii
(2) A-iii ; B-civ ; C-i ; D-ii
(3) A-civ ; B-iii ; C-i ; D-ii
(4) A-i ; B-ii ; C-iii ; D-iv

**Ans. (2)**

**Sol.**
(i) Wilkinson catalyst : RhCl(PPH₃)₃
(ii) Chlorophyll : C₅₅H₇₂O₅N₄Mg
(iii) Vitamin B₁₂ (also known as cyanocobalamin) contain cobalt.
(iv) Carbonic anhydrase contains a zinc ion.

19. A 10 mg effervescent tablet containing sodium bicarbonate and oxalic acid releases 0.25 ml of CO₂ at T = 298.15 K and p = 1 bar. If molar volume of CO₂ is 25.0 L under such condition, what is the percentage of sodium bicarbonate in each tablet? [Molar mass of NaHCO₃ = 84 g mol⁻¹]

(1) 16.8  (2) 8.4  (3) 0.84  (4) 33.6

**Ans. (1)**

20. The major product of the following reaction is:

- **OH**
- **SO₂H**
- **Br** (excess)

**Ans. (1)**

**Sol.**

\[
\text{Br}_{(\text{excess})} + \text{Br}_2 \rightarrow \text{Br}_3
\]

Due to Ipso attack

21. Two blocks of the same metal having same mass and at temperature \(T_1\) and \(T_2\), respectively, are brought in contact with each other and allowed to attain thermal equilibrium at constant pressure. The change in entropy, \(\Delta S\), for this process is:

\[
\begin{align*}
\text{(1)} & \quad 2C_p \ln \left( \frac{T_1 + T_2}{4T_1T_2} \right) \\
\text{(2)} & \quad 2C_p \ln \left[ \frac{(T_1 + T_2)^{\frac{1}{2}}}{T_1T_2} \right] \\
\text{(3)} & \quad C_p \ln \left[ \frac{(T_1 + T_2)^{\frac{1}{2}}}{4T_1T_2} \right] \\
\text{(4)} & \quad 2C_p \ln \left[ \frac{T_1 + T_2}{2T_1T_2} \right]
\end{align*}
\]

**Ans. (3)**
22. The chloride that CANNOT get hydrolysed is:
   (1) SiCl$_4$  
   (2) SnCl$_4$  
   (3) PbCl$_4$  
   (4) CCl$_4$
   Ans. (4)
   Sol. CCl$_4$ cannot get hydrolyzed due to the absence of vacant orbital at carbon atom.

23. For the chemical reaction $X \rightleftharpoons Y$, the standard reaction Gibbs energy depends on temperature T (in K) as:
   $$\Delta G^o \text{ (in kJ mol}^{-1}\text{)} = 120 - \frac{3}{8}T$$
   The major component of the reaction mixture at T is:
   (1) X if T = 315 K
   (2) X if T = 350 K
   (3) Y if T = 300 K
   (4) Y if T = 280 K
   Ans. (1)

24. The freezing point of a diluted milk sample is found to be –0.2°C, while it should have been –0.5°C for pure milk. How much water has been added to pure milk to make the diluted sample?
   (1) 2 cups of water to 3 cups of pure milk
   (2) 1 cup of water to 3 cups of pure milk
   (3) 3 cups of water to 2 cups of pure milk
   (4) 1 cup of water to 2 cups of pure milk
   Ans. (3)

25. A solid having density of $9 \times 10^3$ kg m$^{-3}$ forms face centred cubic crystals of edge length 200$\sqrt{2}$ pm. What is the molar mass of the solid?
   (Avogadro constant $\approx 6 \times 10^{23}$ mol$^{-1}$, $\pi \approx 3$)
   (1) 0.0216 kg mol$^{-1}$
   (2) 0.0305 kg mol$^{-1}$
   (3) 0.4320 kg mol$^{-1}$
   (4) 0.0432 kg mol$^{-1}$
   Ans. (2)

26. The polymer obtained from the following reactions is:
   HOOC$\cdots$NH$_2$\(\xrightarrow{(i) \text{NaNO}_2/\text{H}_2\text{O}^+}\)\(\xrightarrow{(ii) \text{Polymerisation}}\)
   (1) [O|\(\text{C-(CH}_2)_n\text{-N\}}\]
   (2) [O|\(\text{O-(CH}_2)_n\text{-C}\]
   (3) [HNC(CH$_2$)$_n$\text{-C-N\}}]
   (4) [O|\(\text{OC(CH}_2)_n\text{O}\]
   Ans. (2)
   Sol. \(\text{HOOC-NH}_2\text{NaNO}_2\text{HO}_3\text{Polymerisation}\)\(\text{HOOC-OH}\text{Polymerisation}\)

27. An example of solid sol is:
   (1) Butter  
   (2) Gem stones  
   (3) Paint  
   (4) Hair cream
   Ans. (2)

28. Peroxyacetyl nitrate (PAN), an eye irritant is produced by:
   (1) Acid rain  
   (2) Photochemical smog  
   (3) Classical smog  
   (4) Organic waste
   Ans. (2)
   Sol. Photochemical smog produce chemicals such as formaldehyde, acrolein and peroxyacetyl nitrate (PAN).

29. NaH is an example of:
   (1) Electron-rich hydride  
   (2) Molecular hydride  
   (3) Saline hydride  
   (4) Metallic hydride
   Ans. (3)
   Sol. NaH is an example of ionic hydride which is also known as saline hydride.

30. The amphoteric hydroxide is:
   (1) Ca(OH)$_2$  
   (2) Be(OH)$_2$  
   (3) Sr(OH)$_2$  
   (4) Mg(OH)$_2$
   Ans. (2)
   Sol. Be(OH)$_2$ is amphoteric in nature while rest all alkaline earth metal hydroxide are basic in nature.