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

<table>
<thead>
<tr>
<th>( M^{x+}(aq/MM) )</th>
<th>( \text{Au}^{3+}(aq)/\text{Au}(s) )</th>
<th>( \text{Ag}^{+}(aq)/\text{Ag}(s) )</th>
<th>( \text{Fe}^{3+}(aq)/\text{Fe}^{2+}(aq) )</th>
<th>( \text{Fe}^{2+}(aq)/\text{Fe}(s) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E_{\text{M}^{x+}/\text{M}^{x-}}^0 )</td>
<td>1.40</td>
<td>0.80</td>
<td>0.77</td>
<td>−0.44</td>
</tr>
</tbody>
</table>

If \( E_{\text{Zn}^{2+/\text{Zn}}}^0 = −0.76 \text{V} \), which cathode will give a maximum value of \( E_{\text{cell}}^0 \) 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 (Mixture)</th>
<th>Item-II (Separation method)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) ( \text{H}_2\text{O} ) : Sugar</td>
<td>(P) Sublimation</td>
</tr>
<tr>
<td>(B) ( \text{H}_2\text{O} ) : Aniline</td>
<td>(Q) Recrystallization</td>
</tr>
<tr>
<td>(C) ( \text{H}_2\text{O} ) : 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)

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)

5. The major product of the following reaction is:

\[
\text{OEt} \quad \text{CN} \quad \xrightarrow{(1) \text{Ni/H}_2} \quad \text{OEt} \quad \text{CN} \quad \xrightarrow{(i) \text{DIBAL-H}}
\]

(1) \( \text{HO} \quad \text{CHO} \)
(2) \( \text{NH} \)
(3) \( \text{NH} \)
(4) \( \text{OH} \quad \text{NH}^+ \quad \text{NH}_2 \)

Ans. (2)

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

(a) It produces less pollutants 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 \( \text{NaNi}_5 \)
(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)
7. The major product of the following reaction is:

\[ \text{Cl} \xrightarrow{(i) \text{HBr}} \xrightarrow{(ii) \text{aq. KOH}} \]

\( \text{(1) } \text{OH} \quad \text{(2) } \text{Cl} \)
\( \text{(3) } \text{Cl} \quad \text{(4) } \text{OH} \)

Ans. (1)

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

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

Ans. (3)

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

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

Ans. (4)

10. The major product of the following reaction is:

\[ \text{COCH}_3 \xrightarrow{(i) \text{KmnO}_4/\text{KOH}} \xrightarrow{(ii) \text{H}_2\text{SO}_4} \]

\( \text{(1) } \text{COCH}_3 \quad \text{(2) } \text{COOH} \)
\( \text{(3) } \text{HOOC} \quad \text{(4) } \text{COCH}_3 \)

Ans. (2)

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

\( \text{(1) } \text{NH}_2 \quad \text{(2) } \text{NH}_3 \)
\( \text{(3) } \text{H} \quad \text{(4) } \text{Me} \)

Ans. (3)

12. Which compound(s) out of the following is/are not aromatic?

\( \text{(A) } \text{C} \quad \text{(B) } \text{C} \quad \text{(C) } \text{C} \quad \text{(D) } \text{C} \)

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

Ans. (2)

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>


Ans. (2)

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 → 3  (2) Paschen, ∞ → 3  (3) Lyman, ∞ → 1  (4) Balmer, ∞ → 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 (Assume that \( P_{\text{NH}_3} << P_{\text{total}} \) at equilibrium)

\[
\frac{1}{3} K_p^\frac{1}{2} P^2
\]

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

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><strong>Ores</strong></td>
<td><strong>Metals</strong></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-a ; II-d ; III-b ; IV-a

Ans. (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)

18. Match the metals (Column I) with the coordination compound(s) / enzyme(s) (Column II)

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metals</strong></td>
<td><strong>Coordination compound(s) / Enzyme(s)</strong></td>
</tr>
<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-i ; C-iv ; D-iii
(2) A-iii ; B-iv ; C-i ; D-ii
(3) A-iv ; B-iii ; C-i ; D-ii
(4) A-i ; B-ii ; C-iii ; D-iv

Ans. (2)

19. A 10 mg effervescent tablet containing sodium bicarbonate and oxalic acid releases 0.25 ml of CO\(_2\) at \( T = 298.15 \) K and \( p = 1 \) bar. If molar volume of CO\(_2\) is 25.0 L under such condition, what is the percentage of sodium bicarbonate in each tablet? [Molar mass of NaHCO\(_3\) = 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:

\[
\begin{array}{c}
\text{OH} \\
\text{SO}_2\text{H} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{OH} \\
\text{SO}_2\text{H} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{OH} \\
\end{array} \rightarrow \begin{array}{c}
\text{Br}_2\text{(excess)} \\
\end{array}
\]

(1) (2) (3) (4)

Ans. (3)

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:

(1) \( 2C_p \ln \left( \frac{T_1 + T_2}{4T_1 T_2} \right) \)
(2) \( 2C_p \ln \left( \frac{(T_1 + T_2)^2}{T_1 T_2} \right) \)
(3) \( C_p \ln \left( \frac{(T_1 + T_2)^2}{4T_1 T_2} \right) \)
(4) \( 2C_p \ln \left( \frac{T_1 + T_2}{2T_1 T_2} \right) \)

Ans. (3)
22. The chloride that CANNOT get hydrolysed is:

(1) SiCl$_4$  
(2) SnCl$_4$  
(3) PbCl$_4$  
(4) CCl$_4$

Ans. (4)

23. For the chemical reaction $X \xrightarrow{\text{reaction}} Y$, the standard reaction Gibbs energy depends on temperature $T$ (in K) as:

$$\Delta G^\circ \text{ (in kJ mol}^{-1}\text{)} = 120 - \frac{3T}{8}$$

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 $-0.2^\circ$C, while it should have been $-0.5^\circ$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:

$$\text{HOOC} \xrightarrow{(i) \text{ NaNO}_2/\text{H}_2\text{O}^+} \text{NH}_2 \xrightarrow{(ii) \text{Polymerisation}}$$

(1) $-\text{C}-(\text{CH}_3)\text{-N} -$  
(2) $-\text{O}-(\text{CH}_3)\text{-C} -$  
(3) $-\text{HNC(}\text{CH}_3\text{)}\text{-C-N} -$  
(4) $-\text{OC(}\text{CH}_3\text{)}\text{O} -$  

Ans. (2)

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)

29. NaH is an example of:

(1) Electron-rich hydride  
(2) Molecular hydride  
(3) Saline hydride  
(4) Metallic hydride

Ans. (3)

30. The amphoteric hydroxide is:

(1) Ca(OH)$_2$  
(2) Be(OH)$_2$  
(3) Sr(OH)$_2$  
(4) Mg(OH)$_2$

Ans. (2)