1. Which one of the following statements regarding Henry's law not correct?

(1) The value of $K_H$ increases with function of the nature of the gas.
(2) Higher the value of $K_H$ at a given pressure, higher is the solubility of the gas in the liquids.
(3) The partial of the gas in vapour phase is proportional to the mole fraction of the gas in the solution.
(4) Different gases have different $K_H$ (Henry's law constant) values at the same temperature.

Ans. (2)
Sol. Liquid solution

$$P_{gas} = K_H \times X_{gas}$$

More is $K_H$ less is solubility, lesser solubility is at higher temperature. So more is temperature more is $K_H$.

2. The correct decreasing order for acid strength is:

(1) $\text{NO}_2\text{CH}_2\text{COOH} > \text{NCCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CICH}_2\text{COOH}$
(2) $\text{FCH}_2\text{COOH} > \text{NCCH}_2\text{COOH} > \text{NO}_2\text{CHCOOH} > \text{CICH}_2\text{COOH}$
(3) $\text{NO}_2\text{CH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CNCH}_2\text{COOH} > \text{CICH}_2\text{COOH}$
(4) $\text{CNCH}_2\text{COOH} > \text{O}_2\text{NCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CICH}_2\text{COOH}$

Ans. (1)
Sol. EWG increases acidic strength

$\text{NO}_2\text{CH}_2\text{COOH} > \text{NCCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CICH}_2\text{COOH}$

3. Two complexes [Cr(H$_2$O)$_6$]Cl$_3$ (A) and [Cr(NH$_3$)$_6$]Cl$_3$ (B) are violet and yellow coloured, respectively. The incorrect statement regarding them is:

(1) $\Delta_0$ value of (A) is less than that of (B).
(2) $\Delta_0$ value of (A) and (B) are calculated from the energies of violet and yellow light, respectively.
(3) Both absorb energies corresponding to their complementary colors.
(4) Both are paramagnetic with three unpaired electrons.

Ans. (2)
Sol. $\Delta_0$ order will be compared by spectro chemical series not by energies of violet & yellow light so $\Delta_0$ order is $[\text{Cr(H}_2\text{O)}_6]\text{Cl}_3 < [\text{Cr(NH}_3)_6]\text{Cl}_3$

4. Adsorption of a gas follows Freundlich adsorption isotherm. In the given plot, $x$ is the mass of the gas adsorbed on mass $m$ of the adsorbent at pressure $P$. $\frac{x}{m}$ is proportional to

$$\log \frac{x}{m} = \log K + \frac{1}{n} \log P$$

Ans. (4)
Sol. $\frac{x}{m} = K \times P^{\frac{1}{n}}$

$$\log \frac{x}{m} = \log K + \frac{1}{n} \log P$$

$\frac{1}{n} = \frac{2}{4} = \frac{1}{2} \Rightarrow n = 2$

So, $\frac{x}{m} = K \times P^{\frac{1}{2}}$
5. Correct statements among a to d regarding silicones are:
(a) They are polymers with hydrophobic character
(b) They are biocompatible.
(c) In general, they have high thermal stability and low dielectric strenght.
(d) Usually, they are resistant to oxidation and used as greases.
(1) (a), (b) and (c) only
(2) (a), and (b) only
(3) (a), (b), (c) and (d)
(4) (a), (b) and (d) only
Ans. (3)
Sol. These are properties and uses of silicones.

6. For emission line of atomic hydrogen from \(n_i = 8\) to \(n_f = \) the plot of wave number \(\nu\) against \(\left(\frac{1}{n^2}\right)\) will be (The Ry dberg constant, \(R_H\) is in wave number unit).
(1) Linear with slope - \(R_H\)
(2) Linear with intercept - \(R_H\)
(3) Non linear
(4) Linear with sslope \(R_H\)
Ans. (4)
Sol. 
\[
\frac{1}{\lambda} = \nu = R_H z^2 \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)
\]
\[
\nu = R_H \times \left(\frac{1}{n_i^2} - \frac{1}{8^2}\right)
\]
\[
\nu = R_H \times \frac{1}{8^2} \times \frac{R_H}{64}
\]
\[
m = R_H
\]
Linear with slope \(R_H\)

7. The major product the following reaction is:
(i) \(\text{Br}_2\)
(ii) \(\text{EtOH}\)
(1) \(\text{OEt} \quad \text{OEt}\)
(2) \(\text{OEt} \quad \text{OEt}\)
(3) \(\text{Br} \quad \text{OEt} \quad \text{Br}\)
(4) \(\text{OEt} \quad \text{Br}\)
Ans. (4)
Sol.

8. The alkaline earth metal nitrate that does not crystallise with water molecules, is:
(1) \(\text{Sr(NO}_3\text{)}_2\)
(2) \(\text{Mg(NO}_3\text{)}_2\)
(3) \(\text{Ca(NO}_3\text{)}_2\)
(4) \(\text{Ba(NO}_3\text{)}_2\)
Ans. (4)
Sol. Smaller in size of center atoms more water molecules will crystallize hence \(\text{Ba(NO}_3\text{)}_2\) is answer due to its largest size of ‘+ve’ ion.

9. Major product of the following reaction is:
\[
\begin{align*}
\text{Cl} & \quad \text{Cl} \quad \text{O} \quad \text{N} \quad \text{H} \\
\text{O} & \quad \text{Cl} \quad \text{Cl} \quad \text{NH}_3 \quad \text{NN} \\
\text{H} & \quad \text{O} \quad \text{Cl} \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\end{align*}
\]
(1) \(\text{EtN}\)
(2) Free radical polymerisation
(3) \(\text{NH}_2 \quad \text{O} \quad \text{Cl} \quad \text{NH}_2\)
(4) \(\text{NH}_2 \quad \text{O} \quad \text{Cl} \quad \text{NH}_2\)
Ans. (4)
10. The highest value of the calculated spin only magnetic moment (in BM) among all the transition metal complexes is:

(1) 5.92  (2) 3.87  (3) 6.93  (4) 4.90

Ans. (1)

Sol. \[ \mu = \sqrt{n(n+2)} \text{ B.M.} \]

- \( n \) = Number of unpaired electrons
- \( n \) = Maximum number of unpaired electron = 5

Ex: Mn\(^{2+}\) complex.

11. 20 mL of 0.1 M H\(_2\)SO\(_4\) solution is added to 30 mL of 0.2 M NH\(_4\)OH solution. The pH of the resultant mixture is: [pK\(_b\) of NH\(_4\)OH = 4.7].

(1) 9.4  (2) 5.0  (3) 9.0  (4) 5.2

Ans. (3)

Sol. 20 ml 0.1 M H\(_2\)SO\(_4\) \( \Rightarrow \eta_{H^+} = 4 \)

30 ml 0.2 M NH\(_4\)OH \( \Rightarrow \eta_{NH_4OH} = 6 \)

\[ \text{NH}_4\text{OH} + \text{H}^+ \rightleftharpoons \text{NH}_4^+ + \text{H}_2\text{O} \]

\[ \Rightarrow 6 \quad 4 \quad 0 \quad 0 \]

\[ \Rightarrow 2 \quad 0 \quad 4 \quad 4 \]

Solution is basic buffer

\[ \text{pOH} = \text{pK}_b + \log \frac{\text{NH}_4^+}{\text{NH}_4\text{OH}} \]

\[ = 4.7 + \log 2 \]

\[ = 4.7 + 0.3 = 5 \]

\[ \text{pH} = 14 - 5 = 9 \]

12. 0.5 moles of gas A and \( x \) moles of gas B exert a pressure of 200 Pa in a container of volume 10 m\(^3\) at 1000 K. Given \( R \) is the gas constant in J K\(^{-1}\) mol\(^{-1}\) m, \( x \) is:

(1) \( \frac{2R}{4+12} \)  (2) \( \frac{2R}{4-R} \)  (3) \( \frac{4-R}{2R} \)  (4) \( \frac{4+R}{2R} \)

Ans. (3)

Sol. \[ n_e = (0.5 + x) \]

\[ \text{PV} = n \times R \times T \]

\[ 200 \times 10 = (0.5 + x) \times R \times 1000 \]

\[ 2 = (0.5 + x) R \]

\[ 2 = \frac{1}{R} + x \]

\[ \frac{4}{R} - 1 = 2x \]

\[ \frac{4-R}{2R} = x \]

13. Consider the reversible isothermal expansion of an ideal gas in a closed system at two different temperatures \( T_1 \) and \( T_2 \) (\( T_1 < T_2 \)). The correct graphical depiction of the dependence of work done (\( w \)) on the final volume (\( V \)) is:

(1) \[ \text{Graph 1} \]

(2) \[ \text{Graph 2} \]

(3) \[ \text{Graph 3} \]

(4) \[ \text{Graph 4} \]

Ans. (2)
Sol. \[ w = -nRT \ln \frac{V_b}{V_i} \]

\[ w = -nRT \ln \frac{V_b}{V_i} \]

\[ |w| = nRT \ln \frac{V_b}{V_i} \]

\[ |w| = nRT (\ln V_b - \ln V_i) \]

\[ |w| = nRT \ln V_b - nRT \ln V_i \]

\[ Y = m x - C \]

So, slope of curve 2 is more than curve 1 and intercept of curve 2 is more negative than curve 1.

14. The major product of following reaction is :

\[ R – C \equiv N \xrightarrow{\text{(1) AlH(–Bu)}_3} \text{(2) H}_2\text{O} \rightarrow ? \]

(1) RCHO  
(2) RCOOH  
(3) RCH\_2NH\_2  
(4) RCONH\_2

Ans. (1)

Sol. \[ \text{R–C≡N} \xrightarrow{\text{AlH(–Bu)}_3} \text{R–CH≡N} \xrightarrow{\text{H}_2\text{O}} \text{R–CH=O} \]

15. In general, the properties that decrease and increase down a group in the periodic table, respectively, are:

(1) electronegativity and electron gain enthalpy.  
(2) electron negativity and atomic radius.  
(3) atomic radius and electronegativity.  
(4) electron gain enthalpy and electronegativity.

Ans. (2)

Sol. Electronegativity decreases as we go down the group and atomic radius increases as we go down the group.

16. A solution of sodium sulfate contains 92 g of Na\(^+\) ions per kilogram of water. The molality of Na\(^+\) ions in that solution in mol kg\(^{-1}\) is:

(1) 16  
(2) 8  
(3) 4  
(4) 12

Ans. (4)

Sol. \[ n_{Na^+} = \frac{92}{23} = 4 \]

So molality = 4

17. A water sample has ppm level concentration of the following metals: Fe= 0.2; Mn = 5.0; Cu = 3.0; Zn = 5.0. The metal that makes the water sample unsuitable drinking is:

(1) Zn  
(2) Fe  
(3) Mn  
(4) Cu

Ans. (3)

Sol. (i) Zn = 0.2  
(ii) Fe = 0.2  
(iii) Mn = 5.0  
(iv) Cu = 3.0

18. The increasing order of pKa of the following amino acids in aqueous solution is:

\[ \text{Gly Asp Lys Arg} \]

(1) Asp < Gly < Arg < Lys  
(2) Arg < Lys < Gly < Asp  
(3) Gly < Asp < Arg < Lys  
(4) Asp < Gly < Lys < Arg

Ans. (4)

Sol. Order of acidic strength :

\[ \text{HOOC–CH}–\text{CH–COOH} > \text{NH}–\text{CH}–\text{COOH} > \text{NH}_2 \]

Aspartic acid  
Glycine  
(NH\_2)

\[ \text{H}_2\text{N–C–NH–CH}–\text{CH}–\text{CH–CH}–\text{CH}–\text{C–OH} \]

Arginine

So, pK\(_a\) \[ \text{Asp} < \text{Gly} < \text{Arg} < \text{Lys} \]

19. According to molecular orbital theory, which of the following is true with respect to Li\(^+\) and Li\(^-\)?

(1) Both are unstable  
(2) Li\(^+\) is unstable and Li\(^-\) is stable  
(3) Li\(^+\) is stable and Li\(^-\) is unstable  
(4) Both are stable

Ans. (4)

Sol. Both Li\(^+\) and Li\(^-\) has 0.5 bond order and hence both are stable.
20. The following results were obtained during kinetic studies of the reaction:

\[ 2A + B \rightarrow \text{Products} \]

<table>
<thead>
<tr>
<th>Experiment</th>
<th>[A] (in mol L(^{-1}))</th>
<th>[B] (in mol L(^{-1}))</th>
<th>Initial Rate of reaction (in mol L(^{-1}) min(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I)</td>
<td>0.10</td>
<td>0.20</td>
<td>(6.93 \times 10^{-3})</td>
</tr>
<tr>
<td>(II)</td>
<td>0.10</td>
<td>0.25</td>
<td>(6.93 \times 10^{-3})</td>
</tr>
<tr>
<td>(III)</td>
<td>0.20</td>
<td>0.30</td>
<td>(1.386 \times 10^{-2})</td>
</tr>
</tbody>
</table>

The time (in minutes) required to consume half of A is:

(1) 10 (2) 5 (3) 100 (4) 1

**Ans. (2)**

**Sol.**

\[
6.93 \times 10^{-3} = K \times (0.1)^x (0.2)^y
\]

\[
6.93 \times 10^{-3} = K \times (0.1)^x (0.25)^y
\]

So \(y = 0\)

and \(1.386 \times 10^{-2} = K \times (0.2)^x (0.30)^y\)

\[
\frac{1}{2} = \left(\frac{1}{2}\right)^x \Rightarrow x = 1
\]

So \(r = K \times (0.1) \times (0.2)^y\)

\[
6.93 \times 10^{-3} = K \times 0.1 \times (0.2)^0
\]

\[K = 6.93 \times 10^{-2}\]

\[
t_{1/2} = \frac{0.693}{2K} = \frac{0.693 \times 10^{-1} \times 2}{10} = 5
\]

21. The major product of the following reaction is:

\[
\begin{align*}
\text{(1) KOH (aqueous)} & \quad \text{Br} \\
\text{(2) CrO}_3/H^+ & \quad \text{O} \\
\text{(3) H}_2\text{SO}_4/\Delta & \quad \text{OH}
\end{align*}
\]

**Ans. (2)**

22. During AES Br is o/p directing and major product will be formed on less hindrance p position:

23. The major product of the following reaction is:

\[
\text{(1) KOH (aqueous)} & \quad \text{Br} \\
\text{(2) CrO}_3/H^+ & \quad \text{O} \\
\text{(3) H}_2\text{SO}_4/\Delta & \quad \text{OH}
\]

**Ans. (2)**

24. The anodic half-cell of lead-acid battery is recharged using electricity of 0.05 Faraday. The amount of PbSO\(_4\) electrolyzed in g during the process is:

\[
\text{(Molar mass of PbSO}_4 = 303} \ g \text{ mol}^{-1})
\]

(1) 22.8 (2) 15.2 (3) 7.6 (4) 11.4

**Ans. (2)**
25. The one that is extensively used as a piezoelectric material is:
(1) Quartz
(2) Amorphous silica
(3) Mica
(4) Tridymite
Ans. (1)
Sol. Quartz (Information)

26. Aluminium is usually found in +3 oxidation stage. In contrast, thallium exists in +1 and +3 oxidation states. This is due to:
(1) lanthanoid contraction
(2) lattice effect
(3) diagonal relationship
(4) inert pair effect
Ans. (4)
Sol. Inert pair effect is prominent character of p-block element.

27. The correct match between Item -I and Item- II is:

<table>
<thead>
<tr>
<th>Item – I (drug)</th>
<th>Item – II (test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Chloroxylenol</td>
<td>(P) Carbylamine Test</td>
</tr>
<tr>
<td>(B) Norethindrone</td>
<td>(Q) Sodium Hydrogen carbonate Test</td>
</tr>
<tr>
<td>(C) Sulphapyridine</td>
<td>(R) Ferric chloride test</td>
</tr>
<tr>
<td>(D) Penicillin</td>
<td>(S) Bayer’s test</td>
</tr>
</tbody>
</table>

(1) A→Q ; B→P ; C→S ; D→R
(2) A→R ; B→P ; C→S ; D→Q
(3) A→R ; B→S ; C→P ; D→Q
(4) A→Q ; B→S ; C→P ; D→R
Ans. (3)

28. The ore that contains both iron and copper is:
(1) malachite
(2) dolomite
(3) azurite
(4) copper pyrites
Ans. (4)
Sol. Copper pyrites : CuFeS₂
Malachite : Cu(OH)₂ . CuCO₃
Azurite Cu(OH)₂ . 2CuCO₃
Dolomite CaCO₃ . MgCO₃
29. The compounds A and B in the following reaction are, respectively:

\[ \text{HCHO} + \text{HCl} \rightarrow \text{A} \quad \text{AgCN} \rightarrow \text{B} \]

(1) A = Benzyl alcohol, B = Benzyl isocyanide
(2) A = Benzyl alcohol, B = Benzyl cyanide
(3) A = Benzyl chloride, B = Benzyl cyanide
(4) A = Benzyl chloride, B = Benzyl isocyanide

Ans. (4)

Sol. 

\[ \text{HCHO} \quad \text{HCl} \rightarrow \text{CH}_2\text{Cl} \quad \text{AgCN (covalent)} \rightarrow \text{CH}_2\text{N}==\text{C} \]

30. The isotopes of hydrogen are:

(1) Tritium and protium only
(2) Deuterium and tritium only
(3) Protium and deuterium only
(4) Protium, deuterium and tritium

Ans. (4)

Sol. Isotopes of hydrogen is:

Protium Deuterium Tritium