SRMJEEE Chemistry Sample Paper – 10

Duration: 41 Minutes **Maximum Marks: 35**

Instructions

- This paper contains **35** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

Q1. An aqueous solution of urea (molar mass $= 60$ g mol^{-1}) is 10% by mass. The mole fraction of urea in the solution is approximately:

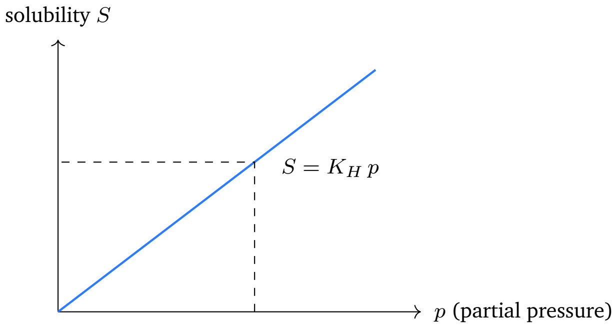
(A) 0.10

(B) 0.18

(C) 0.032

(D) 0.50

Q2. According to Henry's law, the solubility of a gas in a liquid is directly proportional to its partial pressure above the liquid, as shown. The slope of this line is governed by:



(A) the molar mass of the gas only

(B) the Henry's-law constant K_H (and temperature)

(C) the vapour pressure of the pure liquid

(D) the volume of the container

Q3. The vapour pressure of pure water at a given temperature is 100 mmHg. When 18 g of a non-volatile solute is dissolved in 90 g of water, the vapour pressure falls to 96 mmHg. The molar mass of the solute is closest to (take water $= 18$ g mol^{-1}):

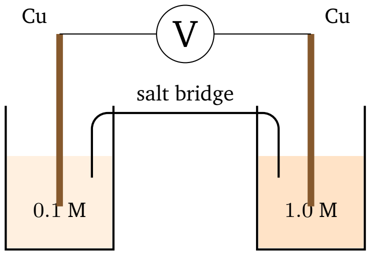
(A) 86 g mol^{-1}

(B) 180 g mol^{-1}

(C) 18 g mol^{-1}

(D) 44 g mol^{-1}

Q4. The concentration cell shown uses two copper electrodes dipping in Cu^{2+} solutions of unequal concentration (0.1 M and 1.0 M). For such a cell, the standard EMF E°_{cell} and the spontaneous direction of electron flow are:



(A) $E^\circ_{\text{cell}} = 1.10$ V; from dilute to concentrated

(B) $E^\circ_{\text{cell}} > 0$; the cell cannot work

(C) $E^\circ_{\text{cell}} = 0.34$ V; from concentrated to dilute

(D) $E^\circ_{\text{cell}} = 0$; electrons flow from the dilute to the concentrated electrode

Q5. As the temperature of an electrolytic (ionic) solution is raised, its electrical conductivity:

(A) increases, because ions move faster and viscosity falls

(B) decreases, as in a metallic conductor

(C) stays exactly constant

(D) first rises then falls to zero

Q6. In the electrolysis of *molten* sodium chloride, the products liberated at the cathode and the anode are, respectively:

(A) H_2 gas and Cl_2 gas

(B) Na metal and Cl_2 gas

(C) Na metal and O_2 gas

(D) H_2 gas and O_2 gas

Q7. For a reaction that is second order overall, the units of the rate constant k are:

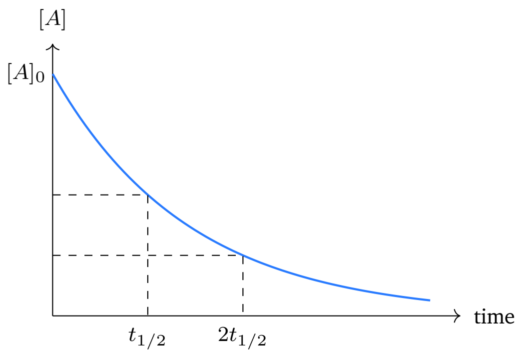
(A) s^{-1}

(B) $\text{mol L}^{-1}\ \text{s}^{-1}$

(C) $\text{L mol}^{-1}\ \text{s}^{-1}$

(D) $\text{L}^2\ \text{mol}^{-2}\ \text{s}^{-1}$

Q8. For a first-order reaction the concentration falls as shown, halving in each successive equal interval. This tells us that the half-life of a first-order reaction:



(A) doubles after each interval

(B) depends on the initial concentration

(C) decreases steadily with time

(D) is constant, independent of the starting concentration

Q9. A catalyst increases the rate of a reaction because it:

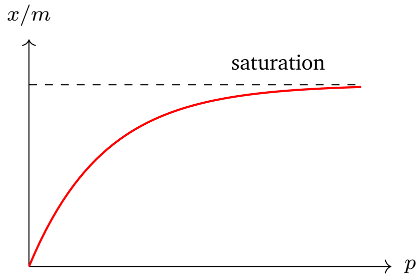
(A) provides an alternative path of lower activation energy

(B) raises the activation energy of the reaction

(C) shifts the position of equilibrium to the right

(D) increases the enthalpy change of the reaction

Q10. The adsorption of a gas on a solid is plotted against pressure at constant temperature, as shown. At *high* pressure the extent of adsorption x/m:



(A) keeps increasing linearly with pressure

(B) becomes almost constant, independent of pressure

(C) falls back to zero

(D) is exactly proportional to p^2

Q11. According to the Hardy–Schulze rule, the coagulating (flocculating) power of an ion for a given sol:

(A) decreases as the charge on the ion increases

(B) depends only on the size of the ion

(C) is the same for all ions

(D) increases as the charge on the (oppositely charged) ion increases

Q12. In a heterogeneously catalysed reaction, the catalyst speeds up the reaction by lowering the activation energy and, at the end of the reaction, it is:

(A) completely converted into product

(B) used up in equal amount to the reactant

(C) left chemically unchanged in mass and composition

(D) changed permanently into a new compound

Q13. Which of the following statements about the heavier non-metals of groups 15 and 16 is correct?

(A) Sulphur shows catenation and exists in allotropes such as rhombic and monoclinic sulphur

(B) Phosphorus exists only as a single form with no allotropes

(C) Oxygen catenates far more strongly than sulphur

(D) Sulphur has no tendency to form S_8 rings

Q14. In bleaching powder, written as Ca(OCl)Cl, the two chlorine atoms are present in different oxidation states. These oxidation states are:

(A) $+1$ and $+1$

(B) $+1$ (in OCl^-) and -1 (as Cl^-)

(C) -1 and -1

(D) $+3$ and -1

Q15. Down group 14, the relative stability of the $+2$ oxidation state increases (Pb^{2+} is more stable than Pb^{4+}). This is explained by:

(A) increasing electronegativity down the group

(B) the lanthanide contraction

(C) a steady rise in catenation

(D) the inert-pair effect (reluctance of the ns^2 pair to bond)

Q16. The spin-only magnetic moments of Ti^{3+} $(3d^1)$ and Ni^{2+} $(3d^8)$ are, respectively (in BM):

(A) 2.84 and 1.73

(B) 1.73 and 1.73

(C) 1.73 and 2.84

(D) 5.92 and 2.84

Q17. Towards the right-hand end of the first transition series, the $+2$ oxidation state becomes increasingly stable (relative to higher states). The main reason is:

(A) the $3d$ orbitals become higher in energy than the $4s$

(B) the increasing effective nuclear charge makes removal of the $3d$ electrons progressively harder

(C) the atoms become larger across the period

(D) the $4s$ electrons are more tightly held than the $3d$

Q18. Transition metals readily form interstitial compounds (e.g. with H, C, N) and alloys mainly because:

(A) they have many vacant interstitial sites and similar metallic radii, letting small atoms occupy the lattice

(B) their atoms are all of very different sizes

(C) they are non-metallic in character

(D) they have completely filled d-orbitals

Q19. The IUPAC name of the complex $[Co(NH_3)_4Cl_2]Cl$ is:

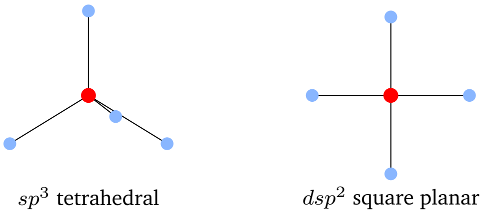
(A) dichlorotetraamminecobalt(III) chloride

(B) tetraamminedichlorocobalt(II) chloride

(C) tetraamminedichloridocobaltate(III) chloride

(D) tetraamminedichloridocobalt(III) chloride

Q20. For coordination number four, complexes may be tetrahedral (sp^3) or square planar (dsp^2). The two geometries are sketched below. The square-planar shape is associated with the hybridisation:



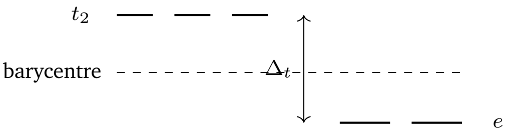
(A) dsp^2

(B) sp^3

(C) sp^3d^2

(D) sp

Q21. In a tetrahedral crystal field the d-orbitals split as shown, with the e set below the t_2 set. Compared with an octahedral field, the splitting Δ_t is:



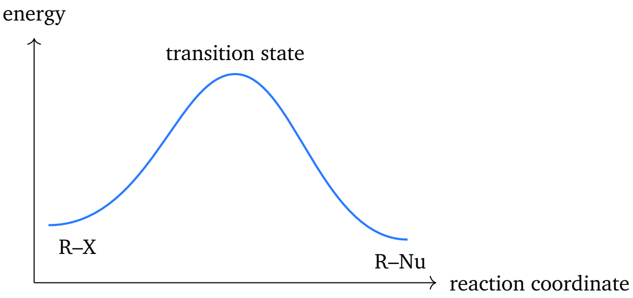
(A) larger than Δ_o, so low-spin is common

(B) equal to Δ_o

(C) smaller than Δ_o (about $\frac{4}{9}\Delta_o$), so tetrahedral complexes are normally high-spin

(D) always zero

Q22. The energy profile of an S_N2 reaction is a single hump, as shown. Using a *stronger* nucleophile (other factors equal) will:



(A) have no effect on the rate

(B) increase the rate, because the rate depends on the nucleophile concentration and strength

(C) change the reaction to S_N1

(D) decrease the rate of substitution

Q23. An alkyl halide R–X reacts differently with sodium and with magnesium. Which pairing of reagent and product is correct?

(A) Na (dry ether) gives a Grignard reagent

(B) Mg (dry ether) gives a higher alkane R–R

(C) Na gives an alkene by elimination

(D) Na (dry ether, Wurtz) gives R–R, while Mg (dry ether) gives the Grignard reagent R–MgX

Q24. Unlike alkenes, haloarenes (e.g. chlorobenzene) undergo electrophilic *substitution* rather than addition. The reason addition is disfavoured is that:

(A) the ring has no π-electrons

(B) addition would give a more stable product

(C) addition would destroy the aromatic stability of the benzene ring

(D) the C–Cl bond is too weak

Q25. On oxidation with acidified $K_2Cr_2O_7$, a primary, a secondary and a tertiary alcohol behave differently. The correct set of products is:

(A) $1^\circ \rightarrow$ carboxylic acid; $2^\circ \rightarrow$ ketone; $3^\circ \rightarrow$ resistant (no easy oxidation)

(B) $1^\circ \rightarrow$ ketone; $2^\circ \rightarrow$ acid; $3^\circ \rightarrow$ aldehyde

(C) all three give the same carboxylic acid

(D) $3^\circ \rightarrow$ aldehyde; $2^\circ \rightarrow$ acid; $1^\circ \rightarrow$ ketone

Q26. Arrange the following in order of *decreasing* acidic strength: p-nitrophenol, phenol, p-cresol (p-methylphenol).

(A) phenol $>$ p-nitrophenol $>$ p-cresol

(B) p-nitrophenol $>$ phenol $>$ p-cresol

(C) p-cresol $>$ phenol $>$ p-nitrophenol

(D) p-nitrophenol $>$ p-cresol $>$ phenol

Q27. When anisole (methyl phenyl ether, C_6H_5–O–CH_3) is heated with excess HI, the products formed are:

(A) iodobenzene and methanol

(B) benzene and methyl iodide

(C) phenol and methanol

(D) phenol and methyl iodide (CH_3I)

Q28. The correct order of reactivity towards nucleophilic addition is:

(A) $CH_3COCH_3 > CH_3CHO > HCHO$

(B) $CH_3CHO > HCHO > CH_3COCH_3$

(C) $HCHO > CH_3CHO > CH_3COCH_3$

(D) $HCHO > CH_3COCH_3 > CH_3CHO$

Q29. Which one of the following compounds gives a *positive* iodoform test (yellow CHI_3 on warming with I_2/NaOH)?

(A) acetone, CH_3COCH_3

(B) benzaldehyde, C_6H_5CHO

(C) formaldehyde, HCHO

(D) diethyl ketone, $CH_3CH_2COCH_2CH_3$

Q30. In the vapour phase or in a non-polar solvent such as benzene, carboxylic acids often exist as:

(A) single (monomeric) molecules only

(B) hydrogen-bonded dimers, giving an apparent molar mass about double the formula value

(C) fully ionised carboxylate ions

(D) long covalent polymer chains

Q31. A given amine, on warming with chloroform and alcoholic KOH, produces a foul-smelling isocyanide. This carbylamine reaction confirms that the amine is:

(A) a tertiary amine

(B) a quaternary ammonium salt

(C) a secondary amine

(D) a primary amine

Q32. Azo dyes formed in a diazo-coupling reaction are intensely coloured. Their colour is due to the chromophore:

(A) $-C{\equiv}N$ (nitrile)

(B) $-NH_2$ (amino)

(C) $-N{=}N-$ (azo linkage)

(D) –OH (hydroxyl)

Q33. Stable diazonium salts ($Ar\text{–}N_2^+X^-$) at low temperature are obtained on treatment with nitrous acid only from:

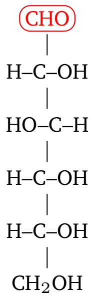
(A) primary aromatic amines (e.g. aniline)

(B) secondary amines

(C) tertiary amines

(D) aliphatic primary amines, which give stable salts at room temperature

Q34. The portion of glucose responsible for its behaviour as a *reducing* sugar (giving a positive Tollens' / Fehling's test) is highlighted below. That functional group is:



$$\begin{array}{c} \boxed{\mathrm{CHO}} \\ | \\ \mathrm{H\text{–}C\text{–}OH} \\ | \\ \mathrm{HO\text{–}C\text{–}H} \\ | \\ \mathrm{H\text{–}C\text{–}OH} \\ | \\ \mathrm{H\text{–}C\text{–}OH} \\ | \\ \mathrm{CH_2OH} \end{array}$$

(A) a tertiary alcohol group

(B) the free –CHO (aldehyde) group at C-1

(C) the terminal $-CH_2OH$ group

(D) a carboxylic acid group

Q35. Which of the following correctly matches a vitamin with the disease caused by its deficiency?

(A) Vitamin A — scurvy

(B) Vitamin D — night blindness

(C) Vitamin B_1 — rickets

(D) Vitamin C — scurvy

Detailed Solutions

Q1.

Solution

Concept — Mass percent to mole fraction: take a convenient 100 g of solution; the mole fraction of a component is its moles divided by the total moles.

Step 1 — Take 100 g of solution: 10% urea means 10 g urea and 90 g water.

Step 2 — Convert to moles: urea $= \frac{10}{60} = 0.167$ mol; water $= \frac{90}{18} = 5.0$ mol.

Step 3 — Mole fraction:

$$x_{\text{urea}} = \frac{0.167}{0.167 + 5.0} = \frac{0.167}{5.167} \approx 0.032.$$

Why other options are wrong:

- (A) 0.10 is the mass fraction, not the mole fraction.
- (B),(D) do not follow from the correct mole counts.

Final Answer: $x_{\text{urea}} \approx 0.032 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Henry's law: the solubility (mole fraction) of a gas in a liquid is directly proportional to the partial pressure of that gas above the liquid: $S = K_H\, p$ (equivalently $p = K_H\, x$).

Step 1 — Read the graph: a straight line through the origin means $S \propto p$. The proportionality constant is the Henry's-law constant K_H, which is fixed for a given gas–solvent pair at a given temperature.

Step 2 — Temperature dependence: since gas solubility falls as temperature rises, the slope (and hence K_H) depends on temperature.

Why other options are wrong:

- (A) molar mass alone does not set the slope.
- (C),(D) the pure-liquid vapour pressure and container volume are irrelevant to Henry's law.

Final Answer: the Henry's-law constant K_H (and temperature) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Relative lowering of vapour pressure: for a dilute solution of a non-volatile solute,

$$\frac{P^\circ - P_s}{P^\circ} = x_{\text{solute}} \approx \frac{n_{\text{solute}}}{n_{\text{solvent}}} = \frac{w_B/M_B}{w_A/M_A}.$$

Step 1 — Relative lowering: $\dfrac{100-96}{100} = \dfrac{4}{100} = 0.04.$

Step 2 — Moles of water: $n_A = \dfrac{90}{18} = 5$ mol.

Step 3 — Solve for M_B:

$$0.04 = \frac{18/M_B}{5} \Rightarrow \frac{18}{M_B} = 0.20 \Rightarrow M_B = \frac{18}{0.20} = 90.$$

Allowing for the dilute approximation, the value is closest to 86–90 g mol^{-1}.

Why other options are wrong:

- (B) 180 doubles the moles of solvent wrongly; (C) 18 ignores the relative lowering.
- (D) 44 has no basis in the data.

Final Answer: $M_B \approx 86$ g mol^{-1} $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Concentration cell: both electrodes and both electrolytes are chemically identical, differing only in concentration. Because the two standard electrode potentials are equal, $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 0$.

Step 1 — Standard EMF: identical electrodes $\Rightarrow E^\circ_{\text{cell}} = 0$. The cell still works because of the concentration difference (the Nernst term).

Step 2 — Direction of flow: to reduce the difference, the dilute half-cell (0.1 M) is oxidised ($\text{Cu} \to \text{Cu}^{2+}$, its concentration rises) and acts as the anode, while Cu^{2+} is reduced at the concentrated half-cell. Hence electrons flow externally from the dilute to the concentrated electrode.

Why other options are wrong:

- (A),(C) non-zero E° values are impossible with identical electrodes.
- (B) $E^\circ = 0$ does not stop the cell — the concentration term drives it.

Final Answer: $E^\circ_{\text{cell}} = 0$; electrons flow dilute $\to$ concentrated $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Conductivity of electrolytic solutions vs temperature: conduction in an ionic solution is by movement of ions, unlike metals where electrons carry the current.

Step 1 — Effect of heating: raising the temperature lowers the viscosity of the solvent, increases ionic mobility, and (for weak electrolytes) increases the degree of dissociation. All of these raise conductivity.

Step 2 — Contrast with metals: in metallic conductors, conductivity *falls* on heating because lattice vibrations scatter the electrons — the opposite trend.

Why other options are wrong:

- (B) that is the metallic, not the electrolytic, behaviour.
- (C),(D) conductivity is neither constant nor does it drop to zero on heating.

Final Answer: conductivity increases on heating $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Electrolysis of molten NaCl: in the molten salt the only ions present are $\mathrm{Na^+}$ and $\mathrm{Cl^-}$ (no water), so there is no competition from $\mathrm{H^+/OH^-}$.

Step 1 — Cathode (reduction): $\mathrm{Na^+} + e^- \to \mathrm{Na}$, depositing sodium metal.

Step 2 — Anode (oxidation): $2\mathrm{Cl^-} \to \mathrm{Cl_2} + 2e^-$, liberating chlorine gas. (This is the Down's process for making sodium.)

Why other options are wrong:

- (A),(D) $\mathrm{H_2/O_2}$ would form only in *aqueous* electrolysis (brine), where water is present.
- (C) $\mathrm{O_2}$ is not released; there is no oxygen source in molten NaCl.

Final Answer: Na at cathode, $\mathrm{Cl_2}$ at anode $\Rightarrow \boxed{\mathrm{B}}$

$\boxed{\text{Answer: (B)}}$ **Go Back to Q6**

Q7.

Solution

Concept — Units of the rate constant: for an n-th order reaction, rate $= k[\,\mathrm{conc}\,]^n$, so k has units $(\mathrm{mol\ L^{-1}})^{1-n}\ \mathrm{s^{-1}}$.

Step 1 — Put $n = 2$: units of $k = (\mathrm{mol\ L^{-1}})^{1-2}\ \mathrm{s^{-1}} = (\mathrm{mol\ L^{-1}})^{-1}\mathrm{s^{-1}}$.

Step 2 — Simplify: $(\mathrm{mol\ L^{-1}})^{-1} = \mathrm{L\ mol^{-1}}$, so k is in $L\ mol^{-1}\ s^{-1}$.

Why other options are wrong:

- (A) $\mathrm{s^{-1}}$ is for first order; (B) $\mathrm{mol\ L^{-1}\ s^{-1}}$ is for zero order.
- (D) $\mathrm{L^2\ mol^{-2}\ s^{-1}}$ corresponds to third order.

Final Answer: $\mathrm{L\ mol^{-1}\ s^{-1}} \Rightarrow \boxed{\mathrm{C}}$

$\boxed{\text{Answer: (C)}}$ **Go Back to Q7**

Q8.

Solution

Concept — Half-life of a first-order reaction: $t_{1/2} = \dfrac{0.693}{k}$. Since k is a constant and the formula contains no concentration term, $t_{1/2}$ does not depend on how much reactant is present.

Step 1 — Read the graph: the curve falls from $[A]_0$ to $[A]_0/2$ in one interval $t_{1/2}$, then from $[A]_0/2$ to $[A]_0/4$ in the *same* interval. Each successive half-life is equal.

Step 2 — Conclusion: the half-life is constant and independent of the initial concentration — a hallmark of first-order kinetics.

Why other options are wrong:

- (A),(C) the interval neither doubles nor shrinks with time.
- (B) only zero- and second-order half-lives depend on $[A]_0$.

Final Answer: $t_{1/2}$ is constant, independent of $[A]_0 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Action of a catalyst: a catalyst opens an alternative reaction pathway with a *lower* activation energy. More molecules can then cross the smaller barrier, so the rate rises.

Step 1 — Energy profile: the catalysed path has a lower-energy transition state; the reactant and product energies (and so ΔH) are unchanged.

Step 2 — Equilibrium: the catalyst speeds the forward and reverse reactions equally, so it does *not* shift the equilibrium position — only the rate of reaching it.

Why other options are wrong:

- (B) it lowers, not raises, E_a.
- (C) the equilibrium position is unaffected; (D) ΔH is unchanged.

Final Answer: provides a path of lower activation energy $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Adsorption isotherm at high pressure: adsorption occurs on a finite surface with a limited number of sites. As pressure rises, the sites fill up.

Step 1 — Read the graph: at low pressure x/m rises with p; at high pressure the curve flattens to a plateau (saturation), where almost all sites are occupied.

Step 2 — Conclusion: once saturated, x/m becomes essentially constant and independent of further increase in pressure ($1/n \to 0$ in the Freundlich form).

Why other options are wrong:

- (A) the rise is only at low pressure, not indefinitely linear.
- (C),(D) adsorption does not fall to zero, nor go as p^2.

Final Answer: becomes almost constant (saturation) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Hardy–Schulze rule: coagulation of a sol is caused by ions of charge *opposite* to that of the sol particles. The greater the charge (valency) of the effective ion, the greater its coagulating power.

Step 1 — Trend with charge: for a negative sol, the order of coagulating power is $\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^{+}$ — power rises with the charge.

Step 2 — Statement: therefore the coagulating power increases as the charge on the oppositely charged ion increases.

Why other options are wrong:

- (A) it increases, not decreases, with charge.
- (B),(C) charge (valency), not merely size, is the dominant factor; it is not the same for all ions.

Final Answer: power increases with the charge on the ion $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Nature of a catalyst: a catalyst takes part in the reaction (e.g. by forming surface intermediates) but is regenerated, so it is recovered chemically unchanged at the end.

Step 1 — Mechanism: on the catalyst surface, reactant molecules are adsorbed and activated, the reaction proceeds over a lower barrier, and the products desorb, freeing the surface.

Step 2 — Conclusion: since the catalyst is restored, its mass and composition are unchanged once the reaction is over.

Why other options are wrong:

- (A),(B) a catalyst is not consumed or converted to product.
- (D) it is not permanently changed into a new compound.

Final Answer: left chemically unchanged $\Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q12

Q13.

Solution

Concept — Catenation and allotropy in groups 15 and 16: catenation is the self-linking of like atoms into chains/rings; allotropy is the existence of an element in more than one physical form.

Step 1 — Sulphur: sulphur catenates strongly (S_8 puckered rings) and shows allotropy — rhombic (yellow) and monoclinic sulphur. Phosphorus too has allotropes (white, red, black).

Step 2 — Oxygen vs sulphur: oxygen catenates much *less* than sulphur because of strong lone-pair repulsion in the small O atom.

Why other options are wrong:

- (B) phosphorus does have several allotropes.
- (C) oxygen catenates less, not more, than sulphur; (D) sulphur readily forms S_8 rings.

Final Answer: sulphur shows catenation and allotropy $\Rightarrow \boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q13

Q14.

Solution

Concept — Oxidation states in bleaching powder: Ca(OCl)Cl contains chlorine in two environments — one bonded to oxygen in the hypochlorite group (OCl^-) and one present as a chloride ion (Cl^-).

Step 1 — Chlorine in OCl^-: with O $= -2$ and an overall charge of -1, $x + (-2) = -1 \Rightarrow x = +1$.

Step 2 — The other chlorine: the second Cl is a simple chloride ion, oxidation state -1.

Step 3 — Conclusion: the two chlorines are $+1$ and -1 (this is why bleaching powder is a mixed salt and acts as an oxidiser).

Why other options are wrong:

- (A),(C) both chlorines cannot be in the same state here.
- (D) $+3$ would be in a chlorite, not in bleaching powder.

Final Answer: $+1$ and $-1 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Inert-pair effect: down a p-block group, the ns^2 electron pair becomes increasingly reluctant to take part in bonding, so the lower oxidation state (group number -2) grows more stable.

Step 1 — Group 14 example: for Pb the $6s^2$ pair is poorly shielded and tightly held, so Pb^{2+} (retaining the pair) is more stable than Pb^{4+}; for the lighter Sn, the $+4$ state is the more stable.

Step 2 — Conclusion: the rising stability of the $+2$ state down the group is the inert-pair effect.

Why other options are wrong:

- (A) electronegativity decreases down the group; that is not the cause.
- (B),(C) the lanthanide contraction and catenation do not explain this oxidation-state trend.

Final Answer: the inert-pair effect $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Spin-only magnetic moment: $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons.

Step 1 — Ti^{3+} ($3d^1$): $n = 1 \Rightarrow \mu = \sqrt{1 \times 3} = \sqrt{3} = 1.73$ BM.

Step 2 — Ni^{2+} ($3d^8$): two unpaired electrons, $n = 2 \Rightarrow \mu = \sqrt{2 \times 4} = \sqrt{8} = 2.84$ BM.

Step 3 — Pair the values: $Ti^{3+} = 1.73$ BM, $Ni^{2+} = 2.84$ BM.

Why other options are wrong:

- (A) reverses the two ions; (B) wrongly gives both as 1.73.
- (D) 5.92 corresponds to five unpaired electrons (e.g. Mn^{2+}), not these ions.

Final Answer: 1.73 and 2.84 BM $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept — Stability of the $+2$ state across the 3d series: moving left to right, the effective nuclear charge rises and the $3d$ orbitals are pulled lower in energy and held more tightly.

Step 1 — Effect on oxidation: after the $4s$ electrons are removed (giving the $+2$ ion), removing further $3d$ electrons becomes progressively more difficult, so higher oxidation states get harder to reach.

Step 2 — Conclusion: hence towards the right (Fe, Co, Ni, Cu) the $+2$ state is increasingly favoured.

Why other options are wrong:

- (A) the $3d$ orbitals fall, not rise, relative to $4s$ across the period.
- (C) atomic size decreases across the series; (D) it is the $3d$, not the $4s$, electrons whose tighter binding raises $+2$ stability.

Final Answer: rising Z_{eff} makes $3d$ removal harder $\Rightarrow \boxed{\text{B}}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q17

Q18.

Solution

Concept — Interstitial compounds and alloys: transition-metal lattices have voids (interstices) between the metal atoms; small non-metal atoms (H, C, N, B) can slip into these gaps.

Step 1 — Interstitial compounds: the small atoms occupy interstitial sites without much distorting the lattice, giving hard, high-melting non-stoichiometric solids (e.g. steel, TiC).

Step 2 — Alloys: because transition metals have similar atomic radii and metallic bonding, one metal can replace another in the lattice, forming substitutional alloys readily.

Why other options are wrong:

- (B) similar (not very different) sizes favour alloy formation.
- (C) transition metals are strongly metallic; (D) they have *partly* filled d-orbitals.

Final Answer: vacant interstitial sites and similar radii $\Rightarrow \boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q18

Q19.

Solution

Concept — Naming a complex with two ligand types: in the complex cation, ligands are named in *alphabetical* order (ignoring multiplying prefixes), then the metal with its oxidation state in Roman numerals; the counter-ion (chloride) is named last.

Step 1 — Alphabetical order: "ammine" (a) comes before "chlorido" (c) $\Rightarrow$ tetraammine then dichlorido.

Step 2 — Oxidation state of Co: the complex ion is $[Co(NH_3)_4Cl_2]^+$. With NH_3 neutral and two Cl^-: $x + 0 + 2(-1) = +1 \Rightarrow x = +3$. The cation is not anionic, so no "-ate".

Step 3 — Full name: tetraamminedichloridocobalt(III) chloride.

Why other options are wrong:

- (A) ligands are out of alphabetical order.
- (B) oxidation state is III, not II; (C) "-ate" is only for anionic complexes.

Final Answer: tetraamminedichloridocobalt(III) chloride $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Hybridisation and shape for coordination number 4: four-coordinate complexes adopt either a tetrahedral geometry (sp^3 hybridisation) or a square-planar geometry (dsp^2 hybridisation).

Step 1 — Tetrahedral: uses one s and three p orbitals (sp^3); bond angles $\approx 109.5^\circ$ (e.g. $[\text{NiCl}_4]^{2-}$).

Step 2 — Square planar: uses one $(n-1)d$, the ns and two np orbitals (dsp^2); the four ligands lie at 90° in a plane (e.g. $[\text{Ni(CN)}_4]^{2-}$, $[\text{PtCl}_4]^{2-}$).

Step 3 — Match the figure: the planar diagram corresponds to dsp^2.

Why other options are wrong:

- (B) sp^3 is tetrahedral, not square planar.
- (C) sp^3d^2 is octahedral (CN 6); (D) sp is linear (CN 2).

Final Answer: square planar $= dsp^2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Tetrahedral crystal-field splitting: in a tetrahedral field none of the d-orbitals points directly at the ligands, so the splitting is smaller and the ordering is inverted relative to octahedral (e below t_2).

Step 1 — Size of Δ_t: for the same metal and ligands, $\Delta_t = \frac{4}{9}\Delta_o$, i.e. roughly 0.44 times the octahedral splitting.

Step 2 — Consequence: because Δ_t is so small (always less than the pairing energy), electrons prefer to remain unpaired — tetrahedral complexes are essentially always *high-spin*; low-spin tetrahedral complexes are not observed.

Why other options are wrong:

- (A) Δ_t is smaller, not larger, than Δ_o.
- (B) they are not equal; (D) Δ_t is small but not zero.

Final Answer: $\Delta_t < \Delta_o$, so high-spin $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ Go Back to Q21

Q22.

Solution

Concept — S$_N$2 kinetics: the bimolecular substitution is concerted (a single transition state, one energy hump). Its rate law is rate $= k[\text{R–X}][\text{Nu}]$, so it is first order in the nucleophile.

Step 1 — Role of the nucleophile: because the nucleophile is involved in the rate-determining (and only) step, a stronger, more reactive nucleophile lowers the barrier and speeds up the reaction.

Step 2 — Read the profile: the single transition state confirms a one-step mechanism whose rate is sensitive to nucleophile strength and concentration.

Why other options are wrong:

- (A),(D) a stronger nucleophile raises, not lowers or leaves unchanged, the S$_N$2 rate.
- (C) nucleophile strength does not convert the mechanism to S$_N$1 (which is nucleophile-independent).

Final Answer: a stronger nucleophile increases the rate $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ Go Back to Q22

Q23.

Solution

Concept — Wurtz vs Grignard: the same alkyl halide gives different products with sodium and with magnesium in dry ether.

Step 1 — Wurtz reaction (Na): $2\text{R–X} + 2\text{Na} \rightarrow \text{R–R} + 2\text{NaX}$, coupling two alkyl groups into a symmetrical higher alkane.

Step 2 — Grignard formation (Mg): $\text{R–X} + \text{Mg} \xrightarrow{\text{dry ether}} \text{R–Mg–X}$, an alkyl magnesium halide (Grignard reagent).

Step 3 — Conclusion: Na (Wurtz) $\rightarrow$ R–R; Mg $\rightarrow$ R–MgX. Option (D) states both correctly.

Why other options are wrong:

- (A),(B) swap the two reagents.
- (C) Na does not give an alkene; that is elimination with alcoholic KOH.

Final Answer: Na $\rightarrow$ R–R; Mg $\rightarrow$ R–MgX $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Substitution vs addition in arenes: the benzene ring possesses a delocalised aromatic π-system that gives it extra (resonance) stability.

Step 1 — Why not addition: an addition reaction would saturate one ring double bond and *destroy* the aromatic sextet, losing the resonance stabilisation — energetically unfavourable.

Step 2 — Why substitution: electrophilic substitution replaces a ring hydrogen while the aromatic system is regenerated, so the ring keeps its stability. Hence haloarenes react mainly by substitution.

Why other options are wrong:

- (A) the ring is rich in π-electrons.
- (B) addition products are less stable here; (D) the C–Cl bond strength is not the reason addition is avoided.

Final Answer: addition would destroy aromatic stability $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Oxidation of alcohols: the product depends on the number of C–H bonds on the carbinol carbon.

Step 1 — Primary alcohol: R–CH_2OH is oxidised first to an aldehyde and, with the strong oxidant, on to a carboxylic acid (R–COOH).

Step 2 — Secondary alcohol: R_2CH–OH gives a ketone ($R_2C{=}O$), which resists further oxidation.

Step 3 — Tertiary alcohol: R_3C–OH has no H on the carbinol carbon, so it is not oxidised under mild conditions (only drastic conditions cleave C–C bonds).

Why other options are wrong:

- (B),(D) wrongly interchange the products of the three classes.
- (C) the three alcohols do not all give the same product.

Final Answer: $1^\circ \rightarrow$ acid, $2^\circ \rightarrow$ ketone, 3° resistant $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Acidity of substituted phenols: electron-*withdrawing* groups (like –NO_2) stabilise the phenoxide ion and increase acidity, whereas electron-*donating* groups (–CH_3, –OCH_3) destabilise it and decrease acidity.

Step 1 — p-nitrophenol: the –NO_2 group withdraws electron density (especially by resonance at the para position), strongly stabilising the anion $\Rightarrow$ most acidic.

Step 2 — p-cresol: the –CH_3 group is electron-donating ($+I$/hyperconjugation), so it is *less* acidic than phenol itself.

Step 3 — Order: p-nitrophenol $>$ phenol $>$ p-cresol.

Why other options are wrong:

- (A),(D) misplace p-nitrophenol or p-cresol.
- (C) reverses the trend entirely.

Final Answer: p-nitrophenol $>$ phenol $>$ p-cresol $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Cleavage of ethers with HI: an alkyl aryl ether is cleaved by hot HI at the alkyl–oxygen bond, because attack at the aryl carbon is hindered by the partial double-bond character of the O–aryl bond.

Step 1 — Site of cleavage: for anisole the C(aryl)–O bond is strong, so I^- attacks the methyl carbon, breaking the CH_3–O bond.

Step 2 — Products: this gives phenol (C_6H_5OH) and methyl iodide (CH_3I), not iodobenzene and methanol.

Why other options are wrong:

- (A) iodobenzene would need cleavage at the aryl carbon, which does not occur.
- (B),(C) benzene/methanol are not the products of this cleavage.

Final Answer: phenol and $CH_3I \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Reactivity towards nucleophilic addition: reactivity falls as the carbonyl carbon becomes more shielded and less electrophilic. Alkyl groups add steric bulk and donate electron density ($+I$), both reducing reactivity.

Step 1 — Compare: HCHO has two H atoms (no alkyl group), CH_3CHO has one alkyl group, and CH_3COCH_3 has two. More alkyl groups ⇒ more hindrance and more electron donation.

Step 2 — Order: HCHO $>$ CH_3CHO $>$ CH_3COCH_3.

Why other options are wrong:

- (A) reverses the trend; (B),(D) misorder formaldehyde or acetone.

Final Answer: HCHO $>$ CH_3CHO $>$ $CH_3COCH_3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept — Iodoform test: a positive iodoform test (yellow CHI_3) is given by compounds containing a CH_3CO- group (a methyl ketone) or a $CH_3CH(OH)-$ group that can be oxidised to it (and by acetaldehyde/ethanol).

Step 1 — Examine the choices: acetone, CH_3COCH_3, has the CH_3CO- group $\Rightarrow$ positive iodoform test.

Step 2 — Identify a methyl ketone: acetone is the simplest methyl ketone, so it forms iodoform on warming with I_2/NaOH.

Why other options are wrong:

- (B) benzaldehyde and (C) formaldehyde have no CH_3CO- group.
- (D) diethyl ketone has no methyl group attached to the carbonyl, so it fails the test.

Final Answer: acetone (a methyl ketone) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Dimerisation of carboxylic acids: the –COOH group has both an H-bond donor (O–H) and acceptor (C=O), letting two molecules link through a pair of hydrogen bonds.

Step 1 — Cyclic dimer: in the vapour phase or in non-polar solvents (benzene), carboxylic acids form a cyclic dimer held by two $O\text{–}H\cdots O$ hydrogen bonds.

Step 2 — Consequence: the measured (apparent) molar mass comes out about *twice* the simple formula mass because the species in solution is effectively the dimer.

Why other options are wrong:

- (A) monomers dominate only in very dilute or strongly H-bonding solvents.
- (C) ionisation needs water/base, not a non-polar medium; (D) they do not form covalent polymers.

Final Answer: hydrogen-bonded dimers ⇒ $\boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Carbylamine (isocyanide) test: only *primary* amines react with chloroform and alcoholic KOH on warming to give carbylamines (isocyanides), which have a very offensive smell.

Step 1 — Reaction: $\text{R–NH}_2\text{+ CHCl}_3 + \text{3KOH} \rightarrow \text{R–NC} + \text{3KCl} + \text{3H}_2\text{O}$.

Step 2 — Conclusion: formation of the foul-smelling isocyanide confirms that the amine is primary; secondary, tertiary and quaternary amines give no such smell.

Why other options are wrong:

- (A),(C) tertiary and secondary amines do not respond to the test.
- (B) a quaternary ammonium salt has no N–H and cannot react.

Final Answer: a primary amine ⇒ $\boxed{\text{D}}$

Answer: (D) Go Back to Q31

Q32.

Solution

Concept — Chromophore of azo dyes: a chromophore is the unsaturated group whose delocalised electrons absorb visible light and give a compound its colour.

Step 1 — The azo linkage: in a diazo-coupling reaction the two aromatic rings become joined by a –N=N– (azo) group, which extends the conjugation across the whole molecule.

Step 2 — Origin of colour: this extended conjugation through the –N=N– chromophore lets the dye absorb visible light, producing the bright colours of azo dyes.

Why other options are wrong:

- (A) –C≡N is not the azo-dye chromophore.
- (B),(D) –NH_2 and –OH are auxochromes (they intensify colour) but are not the chromophore itself.

Final Answer: the –N=N– azo linkage ⇒ $\boxed{\text{C}}$

Answer: (C) Go Back to Q32

Q33.

Solution

Concept — Diazotisation: treatment with nitrous acid ($NaNO_2$/HCl, 0–5 °C) converts a primary *aromatic* amine into a relatively stable arenediazonium salt, Ar–$N_2^+X^-$.

Step 1 — Aromatic vs aliphatic: the aryl diazonium ion is stabilised by delocalisation into the ring, so it survives at low temperature. Aliphatic diazonium salts are very unstable and decompose at once (evolving N_2), so they cannot be isolated.

Step 2 — Secondary/tertiary amines: these do not form diazonium salts (secondary amines give N-nitrosamines instead).

Why other options are wrong:

- (B),(C) secondary and tertiary amines do not give diazonium salts.
- (D) aliphatic diazonium salts are unstable, not stable at room temperature.

Final Answer: primary aromatic amines $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Reducing sugars: a sugar is reducing if it contains a free aldehyde (or α-hydroxy ketone) group that can be oxidised, reducing Tollens' or Fehling's reagent.

Step 1 — Identify the group: in the open-chain Fischer projection of glucose, C-1 carries a free –CHO (aldehyde) group, highlighted at the top of the chain.

Step 2 — Why it reduces: this aldehyde group is oxidised to –COOH while it reduces Ag^+ (Tollens') to silver mirror or Cu^{2+} (Fehling's) to red Cu_2O. Hence glucose is a reducing sugar.

Why other options are wrong:

- (A),(C) the secondary –OH and terminal –CH_2OH groups are not oxidised under these conditions.

- (D) glucose has no free –COOH group; that would be the oxidation product, not the cause.

Final Answer: the free –CHO group at C-1 $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Vitamins and deficiency diseases: each vitamin has a specific physiological role, and its deficiency causes a characteristic disease.

Step 1 — Check vitamin C: a deficiency of vitamin C (ascorbic acid) causes *scurvy* (bleeding gums, poor wound healing) — a correct match.

Step 2 — Correct the others: vitamin A deficiency $\to$ night blindness/xerophthalmia; vitamin D deficiency $\to$ rickets; vitamin B_1 (thiamine) deficiency $\to$ beri-beri.

Why other options are wrong:

- (A) scurvy is from vitamin C, not A.
- (B) night blindness is from vitamin A, not D; (C) rickets is from vitamin D, not B_1.

Final Answer: Vitamin C — scurvy $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q35

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	B	3	A	4	D	5	A
6	B	7	C	8	D	9	A	10	B
11	D	12	C	13	A	14	B	15	D
16	C	17	B	18	A	19	D	20	A
21	C	22	B	23	D	24	C	25	A
26	B	27	D	28	C	29	A	30	B
31	D	32	C	33	A	34	B	35	D