GAT B Chemistry

Sample Paper – 2

Duration: 23 Minutes **Maximum Marks: 15**

Instructions

- This paper contains **15** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of **GAT B** entrance.
- Each correct answer carries **+1 mark**. There is **a deduction of 0.5 marks for each incorrect answer**.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **NCERT Class 11 & 12 Chemistry — Physical, Organic, and Inorganic Chemistry.**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. The α-helix secondary structure of a protein is primarily stabilised by:

α-helix backbone (schematic)

(A) Disulfide bonds between cysteine residues at regular intervals

(B) Ionic interactions between oppositely charged amino acid side chains

(C) Intramolecular hydrogen bonds between the N–H of one peptide bond and the C=O of the peptide bond four residues away

(D) Hydrophobic interactions between non-polar side chains buried in the helix interior

Q2. The $5' \rightarrow 3'$ directionality of DNA synthesis refers to the fact that:

(A) New nucleotides are added exclusively to the free $3'$-OH end of the growing strand, so the chain elongates in the $5' \rightarrow 3'$ direction

(B) DNA polymerase reads the template in the 5′→3′ direction

(C) The new strand is synthesised from 3′ to 5′ relative to the template

(D) The phosphate backbone is charged 5′ to 3′ across the helix

Q3. In Michaelis-Menten enzyme kinetics, when the substrate concentration $[S]$ equals the Michaelis constant K_m, the initial reaction velocity v is:

(A) $V_{\max}$

(B) $2\,V_{\max}$

(C) Zero

(D) $V_{\max}/2$

Q4. The pH of a 0.10 M acetic acid solution ($K_a = 1.8 \times 10^{-5}$) is approximately:

(A) 2.37

(B) 2.87

(C) 4.74

(D) 3.37

Q5. When excess NaCl is dissolved in a saturated solution of AgCl ($K_{sp} = 1.6 \times 10^{-10}$), the solubility of AgCl:

(A) Increases due to formation of soluble complex ions

(B) Remains unchanged because K_{sp} is a thermodynamic constant at fixed temperature

(C) Decreases because the additional $\mathrm{Cl^-}$ ions shift the equilibrium $\mathrm{AgCl(s)} \rightleftharpoons \mathrm{Ag^+(aq) + Cl^-(aq)}$ to the left

(D) Increases because the ionic strength of the solution increases

Q6. Which of the following processes is accompanied by an INCREASE in entropy ($\Delta S > 0$)?

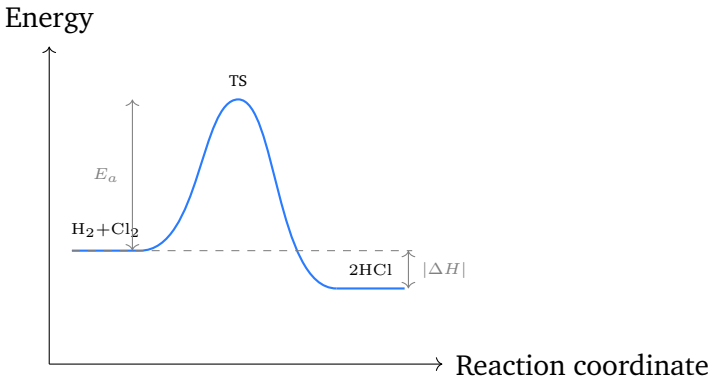
(A) Sublimation of dry ice: $\mathrm{CO_2(s) \rightarrow CO_2(g)}$

(B) Condensation of water vapour: $H_2O(g) \rightarrow H_2O(l)$

(C) Crystallisation of a solute from a supersaturated solution

(D) Dissolving a gas in a liquid: $CO_2(g) \rightarrow CO_2(aq)$

Q7. Using the bond enthalpies H–H $= 436\,\text{kJ mol}^{-1}$, Cl–Cl $= 242\,\text{kJ mol}^{-1}$, and H–Cl $= 431\,\text{kJ mol}^{-1}$, the enthalpy change for $H_2(g) + Cl_2(g) \rightarrow 2\,HCl(g)$ is:



(A) $+816\,\text{kJ mol}^{-1}$

(B) $-109\,\text{kJ mol}^{-1}$

(C) $+185\,\text{kJ mol}^{-1}$

(D) $-184\,\text{kJ mol}^{-1}$

Q8. The complex $[Fe(H_2O)_6]^{2+}$ has Fe^{2+} with a d^6 configuration. Since H_2O is a weak-field ligand, the complex is high-spin. The number of unpaired electrons in this complex is:

(A) 0

(B) 4

(C) 2

(D) 6

Q9. The complex $[Co(en)_2Cl_2]^+$, where en = ethylenediamine, exhibits isomerism arising from different spatial arrangements of the Cl^- ligands relative to each other. This type of isomerism is:

(A) Geometric isomerism (cis and trans forms)

(B) Ionisation isomerism

(C) Linkage isomerism

(D) Optical isomerism due to a chiral metal centre only

Q10. When acetaldehyde (CH_3CHO) undergoes an aldol condensation with dilute NaOH, the initial product *before* dehydration is:

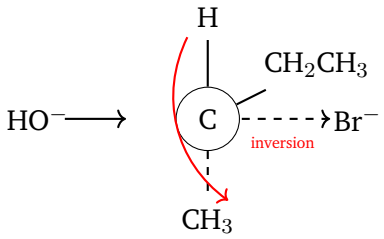
(A) $CH_3-CO-CH_2-CHO$

(B) $CH_3-CH=CH-CHO$ (crotonaldehyde)

(C) $CH_3-CH(OH)-CH_2-CHO$ (3-hydroxybutanal)

(D) $CH_3-CO-CO-CH_3$

Q11. When (S)-2-bromobutane undergoes an SN2 reaction with aqueous NaOH, the product is:



(A) A racemic mixture of (R)- and (S)-2-butanol

(B) (S)-2-butanol with retention of configuration

(C) An achiral (meso) compound

(D) (R)-2-butanol with complete inversion of configuration (Walden inversion)

Q12. During the electrolysis of dilute $H_2SO_4(aq)$, the product evolved at the ANODE is:

(A) SO_3 gas

(B) O_2 gas (from oxidation of water at the anode)

(C) H_2 gas

(D) Dissolved SO_4^{2-} being oxidised to $S_2O_8^{2-}$

Q13. According to the Arrhenius equation $k = Ae^{-E_a/RT}$, doubling the activation energy E_a while keeping temperature T constant will cause the rate constant k to:

(A) Decrease exponentially (k becomes much smaller)

(B) Increase linearly

(C) Remain unchanged

(D) Double

Q14. The violet colour of $[Ti(H_2O)_6]^{3+}$ arises from:

(A) Charge-transfer from the ligand to the metal (LMCT)

(B) s–p electronic transitions in the titanium atom

(C) A d–d transition in which the single d electron absorbs visible light and is promoted from the t_{2g} to the e_g level

(D) Fluorescence due to f-block electron configurations

Q15. Aspirin (acetylsalicylic acid) is classified as:

(A) An antacid

(B) An antimicrobial agent

(C) A tranquilizer (anxiolytic)

(D) An analgesic and antipyretic agent

Detailed Solutions

Q1.

Solution

Concept — Protein Secondary Structure: The α-helix is a regular, right-handed coiled conformation of a polypeptide chain maintained by intramolecular hydrogen bonds. Each N–H group of residue i donates an H-bond to the backbone C=O of residue $i+4$. This periodicity of one H-bond every four residues creates the helical geometry with approximately 3.6 residues per turn and a rise of 0.15 nm per residue.

Step 1 — Identifying the stabilising interaction: The H-bond forms between the backbone amide N–H (hydrogen bond donor) and the backbone carbonyl C=O (acceptor) four residues further along the same chain. These are *intramolecular* H-bonds involving the peptide backbone, not the side chains.

Why other options are wrong:

- Option A: Disulfide (S–S) bonds between cysteine residues stabilise *tertiary* (and quaternary) structure; they require two distant cysteine residues and are not part of the regular α-helix pattern.
- Option B: Ionic (salt-bridge) interactions between charged side chains contribute to *tertiary* structure stability, not to α-helix formation directly.
- Option D: Hydrophobic interactions among non-polar side chains are important for the folded *tertiary* structure (hydrophobic core); they are not the primary force maintaining α-helix geometry.

Final Answer: Intramolecular H-bonds (N–H$\cdots$O=C, residue i to $i+4$) $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q 1

Q2.

Solution

Concept — DNA Replication Directionality: DNA polymerases catalyse the nucleophilic attack of the 3′-OH of the terminal nucleotide on the 5′-α-phosphate of the incoming deoxyribonucleoside triphosphate (dNTP). This forms a new 3′-5′ phosphodiester bond and releases pyrophosphate. Because the new nucleotide is always attached to the *3′-OH*, the chain can only grow in the 5′$\rightarrow$3′ direction.

Step 1 — Chain elongation: Each new dNTP is added to the free 3′-OH of the growing strand. The strand therefore grows from its 5′ end toward its 3′ end. The

newly formed strand is antiparallel to the template.

Step 2 — Template reading: The template strand is read in the 3′→5′ direction (antiparallel to the growing strand). This is a *consequence* of the directionality, not its definition.

Why other options are wrong:

- Option B: The template is read 3′→5′ (not 5′→3′). This is the direction of template scanning, not the direction of new strand synthesis.
- Option C: This reverses the truth; the *new* strand is synthesised 5′→3′, so relative to the template the template runs 3′→5′.
- Option D: The phosphate backbone charge is uniform and is not the basis for directional synthesis.

Final Answer: New nucleotides added to 3′-OH; chain elongates 5′→3′ $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q 2

Q3.

Solution

Concept — Michaelis-Menten Equation: The rate of an enzyme-catalysed reaction is described by:

$$v = \frac{V_{\max}[S]}{K_m + [S]}$$

where $V_{\max}$ is the limiting velocity at saturating substrate and K_m is the Michaelis constant. Operationally, K_m is the substrate concentration at which the enzyme operates at exactly half its maximum velocity.

Step 1 — Substitute $[S] = K_m$:

$$v = \frac{V_{\max} \cdot K_m}{K_m + K_m} = \frac{V_{\max} \cdot K_m}{2K_m} = \frac{V_{\max}}{2}$$

This result is, in fact, the *definition* of K_m: the substrate concentration at which $v = V_{\max}/2$.

Why other options are wrong:

- Option A ($V_{\max}$): Achieved only when $[S] \gg K_m$ (enzyme active sites are fully saturated).
- Option B ($2V_{\max}$): Impossible; the Michaelis-Menten model has $V_{\max}$ as its asymptotic upper bound.

- Option C (Zero): $v = 0$ only when $[S] = 0$ (no substrate present).

Final Answer: $v = V_{\max}/2$ when $[S] = K_m \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q 3

Q4.

Solution

Concept — pH of a Weak Acid: For a weak acid HA of concentration C and acid dissociation constant K_a, the equilibrium is $\mathrm{HA} \rightleftharpoons \mathrm{H^+} + \mathrm{A^-}$. When the degree of dissociation $\alpha \ll 1$:

$$[\mathrm{H^+}] = \sqrt{K_a \cdot C}$$

Step 1 — Calculate $[\mathrm{H^+}]$:

$$[\mathrm{H^+}] = \sqrt{1.8 \times 10^{-5} \times 0.10} = \sqrt{1.8 \times 10^{-6}} = 1.342 \times 10^{-3}\ \mathrm{M}$$

Check: $\alpha = 1.342 \times 10^{-3}/0.10 = 1.34\% \ll 1$. Approximation valid.

Step 2 — Calculate pH:

$$\mathrm{pH} = -\log(1.342 \times 10^{-3}) = 3 - \log(1.342) = 3 - 0.128 = 2.87$$

Alternatively, using the formula $\mathrm{pH} = \frac{1}{2}(pK_a - \log C)$:

$$pK_a = -\log(1.8 \times 10^{-5}) = 4.74, \quad \mathrm{pH} = \tfrac{1}{2}(4.74 - \log 0.10) = \tfrac{1}{2}(4.74 + 1.00) = 2.87$$

Why other options are wrong:

- Option A (2.37): Corresponds to $[\mathrm{H^+}] \approx 4.3 \times 10^{-3}$ M, which requires a much larger K_a or concentration.
- Option C (4.74): This is pK_a of acetic acid — the pH at the half-equivalence point of a titration, not of the pure 0.10 M acid.
- Option D (3.37): Arithmetic error, likely from incorrectly combining the values.

Final Answer: $\mathrm{pH} \approx 2.87 \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q 4

Q5.

Solution

Concept — Common Ion Effect: When a soluble salt sharing an ion with a sparingly soluble electrolyte is added to the saturated solution, the solubility of the sparingly soluble salt decreases. This follows directly from Le Chatelier's principle applied to the dissolution equilibrium.

Step 1 — Dissolution equilibrium:

$$\mathrm{AgCl(s)} \rightleftharpoons \mathrm{Ag^+(aq)} + \mathrm{Cl^-(aq)}, \quad K_{sp} = [\mathrm{Ag^+}][\mathrm{Cl^-}] = 1.6 \times 10^{-10}$$

Step 2 — Effect of added NaCl: NaCl is fully soluble and provides a large quantity of $\mathrm{Cl^-}$ ions. To maintain the constant K_{sp} at fixed temperature, $[\mathrm{Ag^+}]$ must decrease. This means less AgCl can remain dissolved; the solubility ($\mathrm{mol\,L^{-1}}$) of AgCl decreases.

Why other options are wrong:

- Option A: Complex ion formation ($[\mathrm{AgCl_2}]^-$) is possible only at very high $[\mathrm{Cl^-}]$ (concentrated NaCl); under normal conditions the dominant effect is solubility suppression.
- Option B: K_{sp} is constant, but this constrains the *product* $[\mathrm{Ag^+}][\mathrm{Cl^-}]$, not each ion independently. Adding $\mathrm{Cl^-}$ forces $[\mathrm{Ag^+}]$ to fall, reducing solubility.
- Option D: The ionic strength effect (activity coefficient correction) is a minor secondary effect and is overshadowed by the large common-ion suppression.

Final Answer: Common ion $\mathrm{Cl^-}$ shifts equilibrium left; solubility of AgCl decreases $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q 5

Q6.

Solution

Concept — Entropy and Phase Transitions: Entropy (S) is a measure of disorder or the number of accessible microstates. Phase changes from more ordered to less ordered states (solid $\rightarrow$ liquid $\rightarrow$ gas) increase entropy. The solid$\rightarrow$gas change (sublimation) produces by far the largest increase because gaseous molecules have vastly greater translational, rotational, and vibrational freedom.

Step 1 — Analyse each process:

- **Option A — Sublimation** $\mathrm{CO_2(s) \rightarrow CO_2(g)}$: Solid (highly ordered) converts to gas (highly disordered). $\Delta S \gg 0$. **Correct.**
- **Option B — Condensation** $\mathrm{H_2O(g) \rightarrow H_2O(l)}$: Gas to liquid; disorder decreases significantly. $\Delta S < 0$.
- **Option C — Crystallisation**: Solute transitions from dissolved (disordered) to crystalline (ordered) state. $\Delta S < 0$.
- **Option D — Gas dissolving** $\mathrm{CO_2(g) \rightarrow CO_2(aq)}$: Gaseous molecules are constrained in solution; translational freedom decreases. $\Delta S < 0$.

Final Answer: Sublimation of $\mathrm{CO_2(s)}$ gives $\Delta S > 0 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q 6

Q7.

Solution

Concept — Bond Enthalpy Calculation: The enthalpy of a gas-phase reaction can be estimated using average bond enthalpies:

$$\Delta H_{\text{rxn}} = \sum_{\text{broken}} D(\text{bonds}) - \sum_{\text{formed}} D(\text{bonds})$$

Bond breaking is endothermic; bond formation is exothermic.

Step 1 — Identify bonds broken (reactants):

$$\mathrm{H_2(g) + Cl_2(g)}: \quad 1 \times D(\mathrm{H{-}H}) + 1 \times D(\mathrm{Cl{-}Cl}) = 436 + 242 = 678\ \mathrm{kJ\,mol^{-1}}$$

Step 2 — Identify bonds formed (products):

$$\mathrm{2\,HCl(g)}: \quad 2 \times D(\mathrm{H{-}Cl}) = 2 \times 431 = 862\ \mathrm{kJ\,mol^{-1}}$$

Step 3 — Calculate ΔH:

$$\Delta H = 678 - 862 = -184\ \mathrm{kJ\,mol^{-1}}$$

The negative sign confirms the reaction is exothermic, consistent with the energy diagram (products lie below reactants).

Why other options are wrong:

- Option A ($+816$): Sum of bonds broken only, forgetting to subtract bond formation energy.

- Option B (-109): Likely used only one H–Cl bond formed ($678 - 431 = 247$; sign error).
- Option C ($+185$): Reversed sign and/or incorrect arithmetic.

Final Answer: $\Delta H = 678 - 862 = -184\,\text{kJ mol}^{-1} \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q 7

Q8.

Solution

Concept — Crystal Field Theory, High-Spin d^6: In an octahedral field the five d orbitals split into the lower-energy t_{2g} set (three orbitals) and higher-energy e_g set (two orbitals), separated by Δ_o. A *weak-field* ligand gives small $\Delta_o < P$ (pairing energy), so electrons spread out to maximise unpaired spins (high-spin).

Step 1 — Configuration of Fe^{2+}: Iron(II) has electronic configuration [Ar] $3d^6$.

Step 2 — High-spin filling for d^6 octahedral: Fill t_{2g} and e_g by Hund's rule first, then pair:

$$t_{2g}: \uparrow\downarrow \quad \uparrow \quad \uparrow \qquad e_g: \uparrow \quad \uparrow$$

The 6 electrons occupy: 1 paired orbital in t_{2g} (2 electrons) and 4 singly-occupied orbitals ($t_{2g} \times 2$ and $e_g \times 2$). Unpaired electron count $= 4$.

Why other options are wrong:

- Option A (0 unpaired): This is the *low-spin* d^6 arrangement ($t_{2g}^6 e_g^0$), occurring with strong-field ligands such as CN^- or CO.
- Option C (2 unpaired): Not consistent with any standard high- or low-spin d^6 filling.
- Option D (6 unpaired): Impossible; with only 5 d orbitals and 6 electrons, at least one pair must form.

Final Answer: High-spin d^6 gives 4 unpaired electrons $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q 8

Q9.

Solution

Concept — Geometric Isomerism in Octahedral Complexes: Geometric (cis-trans) isomerism arises when the same set of ligands can be arranged in different spatial configurations relative to each other around the metal centre. In octahedral complexes of the type $[\mathrm{M(AA)_2X_2}]^n$ (AA = bidentate ligand, X = monodentate), the two X ligands can be either adjacent (cis, 90° apart) or opposite (trans, 180° apart).

Step 1 — Identify the isomers of $[\mathrm{Co(en)_2Cl_2}]^+$:

- *cis* isomer: Both $\mathrm{Cl^-}$ on the same side; two en ligands span the remaining equatorial and axial positions. The cis isomer is also optically active (chiral).
- *trans* isomer: Both $\mathrm{Cl^-}$ on opposite axial (or equivalent) positions; achiral.

The interconversion between these two is **geometric isomerism**.

Why other options are wrong:

- Option B (Ionisation isomerism): Would require exchange of $\mathrm{Cl^-}$ between the coordination sphere and outer sphere (e.g. $\mathrm{[Co(en)_2Cl_2]Cl}$ vs. $\mathrm{[Co(en)_2Cl]Cl_2}$). That is not the case here.
- Option C (Linkage isomerism): Requires ambidentate ligands (e.g. $\mathrm{SCN^-}$, $\mathrm{NO_2^-}$). Neither en nor $\mathrm{Cl^-}$ is ambidentate.
- Option D: Although the cis isomer *is* optically active, the isomerism *between* the cis and trans forms is defined as geometric isomerism, not optical isomerism.

Final Answer: Cis–trans geometric isomerism $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q 9

Q10.

Solution

Concept — Aldol Condensation (Addition Step): Under basic conditions, a weak base (dilute NaOH) abstracts an α-hydrogen to form an enolate ion. This nucleophilic enolate adds to the carbonyl carbon of a second aldehyde molecule to give a β-hydroxy carbonyl compound (the *aldol* product). Heating further causes dehydration to give an α,β-unsaturated carbonyl compound (the *condensation* product).

Step 1 — Enolate formation:

$$CH_3CHO \xrightarrow{OH^-} [^-CH_2CHO] + H_2O$$

Step 2 — Nucleophilic addition (aldol step):

$$[^-CH_2CHO] + CH_3CHO \longrightarrow CH_3CH(O^-)CH_2CHO \xrightarrow{H_2O} CH_3CH(OH)CH_2CHO$$

This is **3-hydroxybutanal** (also called β-hydroxybutyraldehyde).

Why other options are wrong:

- Option A: $CH_3{-}CO{-}CH_2{-}CHO$ has an extra ketone group, which would require oxidation of the α-carbon; not produced by simple aldol condensation of acetaldehyde.
- Option B: Crotonaldehyde ($CH_3CH{=}CHCHO$) is the *dehydrated* (condensation) product, formed in a second step upon heating. The question asks for the initial (pre-dehydration) product.
- Option D: $CH_3{-}CO{-}CO{-}CH_3$ (diacetyl) is an α-diketone; not an aldol product.

Final Answer: Initial aldol product is 3-hydroxybutanal $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q 10

Q11.

Solution

Concept — SN2 Mechanism and Walden Inversion: The bimolecular nucleophilic substitution (SN2) proceeds in a single concerted step. The nucleophile approaches the electrophilic carbon from the side *diametrically opposite* (180°) to the leaving group. As the new bond forms and the leaving group departs, the three remaining substituents undergo complete inversion — an *umbrella* inversion analogous to a wind-blown umbrella reversing. This gives **100% inversion of configuration** (Walden inversion) at the stereogenic centre.

Step 1 — Configuration of starting material: (S)-2-Bromobutane has the S configuration at C-2, with substituents CH_3, CH_2CH_3, H, and Br.

Step 2 — Inversion of configuration: OH^- attacks from the back face (anti to Br). The configuration inverts: S $\rightarrow$ R. Product is **(R)-2-butanol**.

Why other options are wrong:

- Option A (racemic mixture): Racemisation is characteristic of SN1 reactions, which proceed via a planar carbocation intermediate. SN2 has no such intermediate and gives only the inverted product.
- Option B (retention): Retention would require a double inversion (e.g. via neighbouring group participation), which does not occur here.
- Option C (meso): 2-Butanol has only R and S enantiomers; no meso form exists because C-2 is the only stereocentre.

Final Answer: (R)-2-butanol; complete Walden inversion $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q 11

Q12.

Solution

Concept — Electrolysis: Electrode Reactions: In electrolysis, oxidation occurs at the anode and reduction at the cathode. In an aqueous solution, both water molecules and dissolved ions can undergo electrode reactions. The process with the lower discharge potential (smaller overpotential) is preferred.

Step 1 — Cathode (reduction): H^+ ions are preferentially reduced:

$$2H^+(aq) + 2e^- \longrightarrow H_2(g) \quad (E^\circ = 0.00\ V)$$

Step 2 — Anode (oxidation) in dilute H_2SO_4: In dilute acid, the concentration of SO_4^{2-} is relatively low. The standard reduction potential of $S_2O_8^{2-}/SO_4^{2-}$ is $+2.01\,V$ (very high overpotential needed). Water is much more easily oxidised:

$$2H_2O(l) \longrightarrow O_2(g) + 4H^+(aq) + 4e^- \quad (E^\circ = +1.23\ V)$$

Hence O_2 gas is the anode product.

Why other options are wrong:

- Option A (SO_3): SO_3 is not produced electrochemically from dilute $H_2SO_4(aq)$.
- Option C (H_2): H_2 is evolved at the *cathode*, not the anode.
- Option D ($S_2O_8^{2-}$): Peroxodisulfate is only formed at the anode in *concentrated* H_2SO_4 at high current density; in dilute solution, water oxidation is preferred.

Final Answer: O_2 gas evolved at the anode $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q 12

Q13.

Solution

Concept — Arrhenius Equation: The rate constant k depends on activation energy E_a and temperature T as:

$$k = A\, e^{-E_a/RT}$$

where A is the pre-exponential (frequency) factor and R is the gas constant. The exponential relationship means that k is extremely sensitive to changes in E_a.

Step 1 — Effect of doubling E_a: Let the new activation energy be $E_a' = 2E_a$. At the same T:

$$k' = A\, e^{-2E_a/RT} = \left(A\, e^{-E_a/RT}\right) \cdot e^{-E_a/RT} = k \cdot e^{-E_a/RT}$$

Since $E_a > 0$ and $RT > 0$, we have $e^{-E_a/RT} \in (0, 1)$, so $k' < k$. The decrease is *exponential*.

Step 2 — Numerical illustration: For $E_a = 50\,\text{kJ mol}^{-1}$ at $T = 300\,\text{K}$:

$$e^{-E_a/RT} = e^{-50000/(8.314\times 300)} \approx e^{-20.1} \approx 1.8 \times 10^{-9}$$

Doubling E_a reduces k by a factor of $\sim 10^9$ — a dramatic, non-linear decrease.

Why other options are wrong:

- Option B (increases linearly): The function $e^{-E_a/RT}$ decreases as E_a increases; there is no mechanism by which k could increase when E_a increases.
- Option C (unchanged): k depends exponentially on E_a; any change in E_a changes k.
- Option D (doubles): Doubling k would require $e^{-2E_a/RT} = 2e^{-E_a/RT}$, i.e. $e^{-E_a/RT} = 2$, which is impossible ($e^{-\text{positive}} < 1$).

Final Answer: k decreases exponentially $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q 13

Q14.

Solution

Concept — d–d Transitions and Colour: Transition metal ions with partially filled d orbitals absorb visible light when an electron is promoted between crystal-field-split d levels. The observed colour is the complement of the absorbed wavelength. This type of transition, involving only d orbitals of the metal, is called a d–d *transition*.

Step 1 — Electronic configuration of Ti^{3+}: Titanium has atomic number 22; Ti^{3+} has lost 3 electrons to give configuration [Ar] $3d^1$.

Step 2 — Crystal field splitting: In the octahedral complex $[Ti(H_2O)_6]^{3+}$, the single d electron occupies the lower t_{2g} level. It absorbs visible light (green-yellow, $\sim$500 nm) and is promoted to the higher e_g level. The transmitted colour is the complement: *violet*.

Why other options are wrong:

- Option A (LMCT): Ligand-to-metal charge-transfer bands are typically very intense and occur in the UV region. LMCT is important in complexes with easily oxidised ligands (e.g. halides) and metals in high oxidation states. H_2O is a poor reducing ligand; LMCT is not responsible for the colour of $[Ti(H_2O)_6]^{3+}$.
- Option B (s–p transitions): These transitions occur at UV energies ($>$ 200 nm) and are not responsible for visible colour.
- Option D (f-block configurations): Titanium is a d-block (4th period) element. Ti^{3+} has no f electrons; f–f transitions are characteristic of lanthanides and actinides.

Final Answer: d–d transition ($t_{2g} \rightarrow e_g$) produces violet colour $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q 14

Q15.

Solution

Concept — Classification of Common Drugs: Aspirin (acetylsalicylic acid, $CH_3CO\text{-}O\text{-}C_6H_4\text{-}COOH$) is a non-steroidal anti-inflammatory drug (NSAID). Its mechanism of action involves irreversible inhibition of cyclooxygenase (COX-1 and COX-2) enzymes, which catalyse the conversion of arachidonic acid to prostaglandins and thromboxanes.

Step 1 — Pharmacological classification:

- **Analgesic**: Reduces pain perception by inhibiting prostaglandin synthesis at peripheral and central sites.
- **Antipyretic**: Lowers body temperature (fever) by inhibiting prostaglandin-mediated resetting of the hypothalamic thermostat.
- **Anti-inflammatory**: Reduces inflammation at higher doses.
- **Antiplatelet**: Irreversibly inhibits thromboxane A_2 synthesis in platelets (used in low-dose cardioprotective therapy).

Why other options are wrong:

- Option A (Antacid): Antacids neutralise gastric acid (e.g. $NaHCO_3$, $Al(OH)_3$). Aspirin is an acidic drug ($pK_a \approx 3.5$) and can in fact *irritate* the gastric mucosa.
- Option B (Antimicrobial): Aspirin has no clinically relevant antibacterial or antifungal activity. Antimicrobials include antibiotics (penicillins, tetracyclines) and antifungals (fluconazole).
- Option C (Tranquilizer/Anxiolytic): Tranquilizers are CNS depressants that reduce anxiety (e.g. benzodiazepines, barbiturates). Aspirin does not act on CNS receptors in this manner.

Final Answer: Aspirin is an analgesic and antipyretic $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q 15

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	A	3	D	4	B	5	C
6	A	7	D	8	B	9	A	10	C
11	D	12	B	13	A	14	C	15	D