PGIMER BSc Nursing Chemistry

Sample Paper – 11

Duration: 23 Minutes **Maximum Marks: 25**

Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of the **PGIMER BSc Nursing** entrance exam.
- Each correct answer carries **+1 mark**. **0.25 mark** is deducted for every incorrect answer. Unattempted questions carry **0 marks**.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 and 12 (NCERT) Chemistry**.
- The exam is conducted as a computer-based test. Personal calculators, mobile phones, log tables, and other electronic gadgets are strictly prohibited.

Q1. The number of atoms present in 12 g of magnesium (Mg, molar mass $= 24$ g mol^{-1}, $N_A = 6.022 \times 10^{23}$ mol^{-1}) is:

(A) 6.022×10^{23}

(B) 1.204×10^{24}

(C) 1.505×10^{23}

(D) 3.011×10^{23}

Q2. The number of radial nodes and angular nodes, respectively, in a $3p$ orbital are:

(A) 2 and 0

(B) 0 and 1

(C) 1 and 1

(D) 1 and 2

Q3. Which statement about the acid–base nature of the oxides across period 3 is correct?

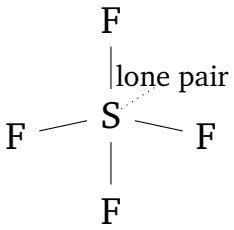
(A) Na_2O is basic, Al_2O_3 is amphoteric and Cl_2O_7 is acidic

(B) Na_2O is acidic, Al_2O_3 is basic and Cl_2O_7 is amphoteric

(C) all the oxides across period 3 are basic

(D) acidic character decreases steadily from Na_2O to Cl_2O_7

Q4. The molecular shape of sulphur tetrafluoride (SF_4), whose central atom carries four bond pairs and one lone pair as shown, is:



(A) square planar

(B) tetrahedral

(C) trigonal bipyramidal

(D) see-saw

Q5. The correct order of bond order among N_2, NO and CO is:

(A) $NO > N_2 > CO$

(B) $N_2 = CO > NO$

(C) $CO > N_2 > NO$

(D) $N_2 > CO > NO$

Q6. A reaction has $\Delta H < 0$ (exothermic) and $\Delta S > 0$ (entropy increases). Using $\Delta G = \Delta H - T\Delta S$, this reaction is spontaneous at:

(A) all temperatures

(B) only high temperatures

(C) only low temperatures

(D) no temperature

Q7. For a weak monobasic acid, $K_a = 1.0 \times 10^{-5}$ at a concentration of 0.1 M. Using Ostwald's dilution law ($K_a \approx C\alpha^2$), the degree of dissociation α is:

(A) 0.01

(B) 0.10

(C) 0.001

(D) 0.02

Q8. In the permanganate ion of potassium permanganate ($KMnO_4$), the oxidation state of manganese is:

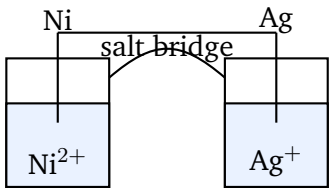
(A) $+2$

(B) $+4$

(C) $+7$

(D) $+6$

Q9. For the galvanic cell shown, $E^\circ_{Ag^+/Ag} = +0.80$ V and $E^\circ_{Ni^{2+}/Ni} = -0.25$ V. The standard cell potential E°_{cell} is:



(A) 0.55 V

(B) -1.05 V

(C) 1.05 V

(D) 0.80 V

Q10. When the concentration of reactant A is doubled, the rate of the reaction becomes four times its original value. The order of the reaction with respect to A is:

(A) 2

(B) 1

(C) 3

(D) 0

Q11. At the same temperature, which of the following solutions is isotonic with a 0.1 M glucose solution? (Assume glucose and urea are non-electrolytes and NaCl dissociates completely.)

(A) 0.1 M urea

(B) 0.2 M urea

(C) 0.05 M urea

(D) 0.1 M NaCl

Q12. For the complex $[Co(NH_3)_6]Cl_3$, shown below, the number of chloride ions precipitated immediately by excess silver nitrate (the ionisable chlorides) is:

$$\underset{\text{complex cation}}{[Co(NH_3)_6]^{3+}} \cdots \underset{\text{outside sphere}}{3\,Cl^-}$$

(A) 1

(B) 2

(C) 3

(D) 0

Q13. Which of the following statements about the bleaching action of sulphur dioxide (SO_2) and chlorine (Cl_2) is correct?

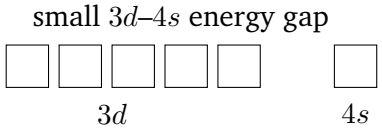
(A) SO_2 bleaches by reduction and its action is temporary, whereas Cl_2 bleaches by oxidation and is permanent

(B) both SO_2 and Cl_2 bleach only by oxidation

(C) SO_2 bleaches permanently by oxidation

(D) the bleaching action of Cl_2 is temporary and reversible

Q14. Transition metals commonly show variable oxidation states. As the orbital diagram below suggests, the main reason is:



(A) a large energy difference between the $4s$ and $3d$ orbitals

(B) a completely filled d subshell in every ion

(C) the small energy gap between the $(n-1)d$ and ns orbitals, so electrons from both can take part in bonding

(D) the presence of only s electrons in the valence shell

Q15. Considering ionisation enthalpy, the reducing character of the alkali metals in the gas phase, on moving down group 1 from Li to Cs:

(A) decreases down the group

(B) increases down the group

(C) remains unchanged down the group

(D) is zero for every alkali metal

Q16. Which of the following species acts as a nucleophile?

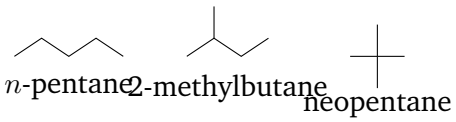
(A) CN^- (cyanide ion)

(B) BF_3

(C) NO_2^+ (nitronium ion)

(D) H^+

Q17. The three carbon skeletons drawn below correspond to the structural isomers of pentane (C_5H_{12}). The total number of structural isomers of C_5H_{12} is:



(A) 5

(B) 2

(C) 4

(D) 3

Q18. The correct order of reactivity (fastest first) towards the S_N1 mechanism among methyl, primary, secondary and tertiary alkyl halides is:

(A) primary $>$ secondary $>$ tertiary $>$ methyl

(B) methyl $>$ primary $>$ secondary $>$ tertiary

(C) secondary $>$ tertiary $>$ primary $>$ methyl

(D) tertiary $>$ secondary $>$ primary $>$ methyl

Q19. In Kolbe's reaction, sodium phenoxide is heated with carbon dioxide under pressure and the product is then acidified. The main organic product is:

(A) benzoic acid

(B) salicylic acid

(C) picric acid

(D) benzaldehyde

Q20. Which of the following compounds gives a positive Tollens' test (formation of a silver mirror)?

(A) acetone (CH_3COCH_3)

(B) ethanal (CH_3CHO)

(C) benzophenone ($C_6H_5COC_6H_5$)

(D) tert-butyl alcohol ($(CH_3)_3COH$)

Q21. For the chlorine-substituted butanoic acids, the correct order of acid strength (strongest first) is:

(A) butanoic acid $>$ 4-chlorobutanoic $>$ 3-chlorobutanoic $>$ 2-chlorobutanoic

(B) 4-chlorobutanoic $>$ 3-chlorobutanoic $>$ 2-chlorobutanoic $>$ butanoic acid

(C) all four acids have equal strength

(D) 2-chlorobutanoic $>$ 3-chlorobutanoic $>$ 4-chlorobutanoic $>$ butanoic acid

Q22. When acetamide (CH_3CONH_2) is treated with bromine and aqueous sodium hydroxide (Hofmann bromamide degradation), the product is:

(A) ethylamine ($CH_3CH_2NH_2$)

(B) methylamine (CH_3NH_2)

(C) acetic acid (CH_3COOH)

(D) ethanamide (unchanged)

Q23. Which of the following is an essential amino acid (one that the human body cannot synthesise and must obtain from the diet)?

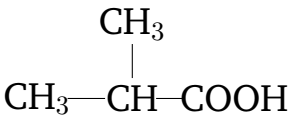
(A) glycine

(B) valine

(C) alanine

(D) glutamic acid

Q24. The IUPAC name of the branched carboxylic acid whose structure is shown below is:



(A) butanoic acid

(B) 2-methylbutanoic acid

(C) 2-methylpropanoic acid

(D) propanoic acid

Q25. Which of the following medicines is used as an antacid to control excess stomach acidity?

(A) chloroquine

(B) aspirin

(C) chloramphenicol

(D) ranitidine

Detailed Solutions

Q1.

Solution

Concept — Number of atoms from mass: First convert mass to moles using $n = \frac{m}{M}$, then multiply by Avogadro's number, since each mole contains N_A atoms.

Step 1 — Find the moles of magnesium:

$$n = \frac{m}{M} = \frac{12}{24} = 0.5 \text{ mol}.$$

Step 2 — Multiply by Avogadro's number:

$$\text{Number of atoms} = n \times N_A = 0.5 \times 6.022 \times 10^{23}.$$

Step 3 — Simplify:

$$\text{Number of atoms} = 3.011 \times 10^{23}.$$

Why other options are wrong:

- Option A (6.022×10^{23}): this is the count for a full 1 mol (24 g).
- Option B (1.204×10^{24}): corresponds to 2 mol (48 g).
- Option C (1.505×10^{23}): corresponds to 0.25 mol (6 g).

Final Answer: Number of atoms $= 3.011 \times 10^{23} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q1

Q2.

Solution

Concept — Nodes of an orbital: For an orbital with principal quantum number n and azimuthal quantum number l, the number of radial nodes $= n - l - 1$ and the number of angular nodes $= l$.

Step 1 — Identify n and l for a $3p$ orbital: For $3p$: $n = 3$ and $l = 1$.

Step 2 — Compute the radial nodes:

$$\text{Radial nodes} = n - l - 1 = 3 - 1 - 1 = 1.$$

Step 3 — Compute the angular nodes:

$$\text{Angular nodes} = l = 1.$$

Why other options are wrong:

- Option A (2 and 0): gives the total node count as radial and ignores the angular node of a p orbital.
- Option B (0 and 1): misses the single radial node.
- Option D (1 and 2): a p orbital has $l = 1$, so only one angular node, not two.

Final Answer: $3p$ has 1 radial node and 1 angular node $\Rightarrow$ C

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Oxides across a period: Across period 3 from left to right the character of the oxides changes from basic (metals) through amphoteric to acidic (non-metals), as metallic character falls.

Step 1 — Classify the sodium oxide: Na_2O is the oxide of a reactive metal, so it is basic.

Step 2 — Classify the aluminium oxide: Al_2O_3 reacts with both acids and bases, so it is amphoteric.

Step 3 — Classify the chlorine oxide: Cl_2O_7 is the oxide of a non-metal and dissolves to give an acid, so it is acidic.

Why other options are wrong:

- Option B: reverses the trend, wrongly calling Na_2O acidic.
- Option C: only the left-hand metal oxides are basic, not all of them.
- Option D: acidic character actually increases (not decreases) from Na_2O to Cl_2O_7.

Final Answer: Na_2O basic, Al_2O_3 amphoteric, Cl_2O_7 acidic $\Rightarrow$ A

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — VSEPR shape: The number of bond pairs plus lone pairs on the central atom fixes the electron geometry; lone pairs then distort the shape actually seen.

Step 1 — Count electron domains around sulphur in SF_4: Four S–F bond pairs plus one lone pair give five electron domains.

Step 2 — Assign the electron geometry: Five domains give a trigonal bipyramidal arrangement, and the lone pair occupies an equatorial position (least repulsion).

Step 3 — Identify the molecular shape: With one equatorial position taken by the lone pair, the four fluorine atoms describe a see-saw shape, as shown.

Why other options are wrong:

- Option A (square planar): needs two lone pairs, as in XeF_4.
- Option B (tetrahedral): would need four bond pairs and no lone pair.
- Option C (trigonal bipyramidal): describes the electron geometry, not the actual molecular shape with the lone pair present.

Final Answer: SF_4 has a see-saw shape $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Bond order: Bond order $= \frac{1}{2}(N_b - N_a)$; molecules with more valence electrons in bonding orbitals have higher bond order.

Step 1 — Bond order of N_2: N_2 has 10 valence electrons; bond order $= \frac{1}{2}(8-2) = 3$.

Step 2 — Bond order of CO: CO is isoelectronic with N_2 (10 valence electrons); bond order $= 3$.

Step 3 — Bond order of NO: NO has one extra electron (11 valence electrons) in an antibonding orbital; bond order $= \frac{1}{2}(8-3) = 2.5$.

Step 4 — Arrange: $N_2 = CO = 3 > NO = 2.5$.

Why other options are wrong:

- Option A: places NO highest, but it has the lowest bond order.
- Option C: CO is not greater than N_2; they are equal.
- Option D: N_2 and CO are equal, so $N_2 >$ CO is incorrect.

Final Answer: $N_2 = CO > NO \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Gibbs energy and spontaneity: A process is spontaneous when $\Delta G < 0$, where $\Delta G = \Delta H - T\Delta S$.

Step 1 — Insert the signs given: ΔH is negative and ΔS is positive.

Step 2 — Analyse the $-T\Delta S$ term: Since $\Delta S > 0$, the term $-T\Delta S$ is negative at every temperature $T > 0$.

Step 3 — Combine the terms: A negative ΔH plus a negative $-T\Delta S$ makes ΔG negative for all temperatures, so the reaction is always spontaneous.

Why other options are wrong:

- Option B (only high temperatures): needed only when $\Delta H > 0$ and $\Delta S > 0$.
- Option C (only low temperatures): needed only when $\Delta H < 0$ and $\Delta S < 0$.
- Option D (no temperature): applies when $\Delta H > 0$ and $\Delta S < 0$, the opposite case.

Final Answer: The reaction is spontaneous at all temperatures $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Ostwald's dilution law: For a weak electrolyte, $K_a = \dfrac{C\alpha^2}{1-\alpha} \approx C\alpha^2$ when α is small, so $\alpha = \sqrt{\dfrac{K_a}{C}}$.

Step 1 — List the data: $K_a = 1.0 \times 10^{-5}$ and $C = 0.1$ M.

Step 2 — Substitute into the formula:

$$\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{1.0 \times 10^{-5}}{0.1}}.$$

Step 3 — Simplify inside the root:

$$\alpha = \sqrt{1.0 \times 10^{-4}} = 1.0 \times 10^{-2} = 0.01.$$

Why other options are wrong:

- Option B (0.10): would need $K_a = 10^{-3}$ at this concentration.
- Option C (0.001): too small; that would need $K_a = 10^{-7}$.
- Option D (0.02): does not satisfy $C\alpha^2 = K_a$ for the given data.

Final Answer: Degree of dissociation $\alpha = 0.01 \Rightarrow$ A

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Oxidation number: The sum of oxidation numbers of all atoms in a neutral compound is zero; here K is $+1$ and each O is -2.

Step 1 — Assign the known values in $KMnO_4$: K $= +1$; four oxygen atoms each -2 give -8.

Step 2 — Form the balance equation: Let Mn be x:

$$(+1) + x + (-8) = 0.$$

Step 3 — Solve for x:

$$x - 7 = 0 \Rightarrow x = +7.$$

Why other options are wrong:

- Option A ($+2$): the state of Mn in MnO.
- Option B ($+4$): the state in MnO_2.
- Option D ($+6$): the state in the manganate ion MnO_4^{2-}.

Final Answer: Oxidation state of Mn $= +7 \Rightarrow$ C

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — Standard cell potential: $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$; the electrode with the higher reduction potential is the cathode.

Step 1 — Identify cathode and anode: Silver has the higher reduction potential ($+0.80$ V), so it is the cathode; nickel (-0.25 V) is the anode.

Step 2 — Substitute the values:

$$E^\circ_{\text{cell}} = E^\circ_{\text{Ag}^+/\text{Ag}} - E^\circ_{\text{Ni}^{2+}/\text{Ni}} = (+0.80) - (-0.25).$$

Step 3 — Simplify:

$$E^\circ_{\text{cell}} = 0.80 + 0.25 = 1.05 \text{ V}.$$

Why other options are wrong:

- Option A (0.55 V): subtracts the magnitudes instead of accounting for the sign of the anode.
- Option B (-1.05 V): reverses cathode and anode, giving a negative value.
- Option D (0.80 V): uses only the silver value.

Final Answer: $E^\circ_{\text{cell}} = 1.05$ V $\Rightarrow$ C

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Order from rate data: For Rate $= k[\text{A}]^n$, if the concentration is multiplied by a factor f, the rate is multiplied by f^n; comparing the factors gives n.

Step 1 — Write the ratio of rates: Doubling A ($f = 2$) makes the rate 4 times, so

$$2^n = 4.$$

Step 2 — Express 4 as a power of 2:

$$2^n = 2^2.$$

Step 3 — Equate the exponents:

$$n = 2.$$

Why other options are wrong:

- Option B (1): first order would only double the rate, not quadruple it.
- Option C (3): third order would make the rate 8 times.
- Option D (0): zero order means the rate is unaffected by concentration.

Final Answer: Order with respect to A $= 2 \Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Isotonic solutions: Two solutions are isotonic when they exert the same osmotic pressure, which requires the same total concentration of solute particles (iC) at the same temperature.

Step 1 — Find the particle concentration of the reference: Glucose is a non-electrolyte ($i = 1$), so 0.1 M glucose gives 0.1 M of particles.

Step 2 — Match the particle concentration: Urea is also a non-electrolyte, so 0.1 M urea gives 0.1 M particles, the same as the glucose solution.

Step 3 — Check the electrolyte option: 0.1 M NaCl dissociates into two ions ($i = 2$), giving 0.2 M particles, so it is hypertonic (not isotonic).

Why other options are wrong:

- Option B (0.2 M urea): gives 0.2 M particles, twice the reference.
- Option C (0.05 M urea): gives only 0.05 M particles, half the reference.
- Option D (0.1 M NaCl): dissociates to give 0.2 M particles, so it is not isotonic.

Final Answer: 0.1 M urea is isotonic with 0.1 M glucose $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Werner's theory: The secondary valency (ligands inside the square brackets) is not ionisable, while the primary valency (ions written outside the brackets) is ionisable and can be precipitated by silver nitrate.

Step 1 — Separate the coordination sphere: In $[Co(NH_3)_6]Cl_3$, the six NH_3 are inside the sphere and the three Cl^- are outside.

Step 2 — Identify the ionisable ions: Only the three chloride ions outside the coordination sphere are free in solution and ionisable.

Step 3 — React with silver nitrate: All three free Cl^- are precipitated as AgCl, so three chloride ions are precipitated.

Why other options are wrong:

- Option A (1) and Option B (2): would apply if one or two chlorides were coordinated inside the sphere, which they are not here.
- Option D (0): would mean all chlorides are coordinated, contradicting the formula.

Final Answer: Three chloride ions are precipitated $\Rightarrow$ C

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Mechanism of bleaching: SO_2 removes colour by reduction (adding hydrogen), a change that reverses in air, whereas Cl_2 removes colour by oxidation, destroying the coloured matter permanently.

Step 1 — Bleaching by SO_2: In the presence of moisture, SO_2 acts as a reducing agent; the reduced (colourless) product is slowly re-oxidised by air, so the bleaching is temporary.

Step 2 — Bleaching by Cl_2: Moist Cl_2 produces nascent oxygen that oxidises the dye irreversibly, so the bleaching is permanent.

Step 3 — Select the correct statement: The statement matching both facts is option A.

Why other options are wrong:

- Option B: SO_2 bleaches by reduction, not oxidation.
- Option C: SO_2 bleaching is temporary, not permanent.
- Option D: Cl_2 bleaching is permanent, not reversible.

Final Answer: SO_2 bleaches temporarily by reduction, Cl_2 permanently by oxidation $\Rightarrow$ A

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Variable oxidation states: In transition metals the $(n-1)d$ and ns orbitals lie very close in energy, so electrons from both sets can be removed in successive steps, giving several oxidation states.

Step 1 — Compare the orbital energies: For a first-row transition metal the $3d$ and $4s$ levels are almost equal in energy, as the diagram shows.

Step 2 — Explain the multiple states: Because the energy gap is small, the metal can lose the $4s$ electrons and a varying number of $3d$ electrons, producing oxidation states that differ by one unit.

Step 3 — Select the correct reason: This matches option C.

Why other options are wrong:

- Option A: the gap is small, not large; a large gap would fix a single oxidation state.
- Option B: a filled d subshell would give a single stable state, the opposite of variable states.
- Option D: transition metals use both s and d electrons, not s electrons alone.

Final Answer: The small $(n-1)d$–ns energy gap causes variable oxidation states $\Rightarrow$ C

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Reducing character in the gas phase: A metal is a stronger reducing agent when it loses its electron more easily, i.e. when its ionisation enthalpy is lower.

Step 1 — Trend in ionisation enthalpy: Down group 1 the atomic size increases and the outermost electron is more loosely held, so the ionisation enthalpy decreases from Li to Cs.

Step 2 — Link to reducing character: A lower ionisation enthalpy means the electron is lost more readily, so the gas-phase reducing character increases down the group.

Step 3 — Conclude: Reducing character increases from Li to Cs in the gas phase.

Why other options are wrong:

- Option A (decreases): contradicts the falling ionisation enthalpy down the group.
- Option C (unchanged): ignores the clear increase in atomic size and fall in ionisation enthalpy.
- Option D (zero for all): alkali metals are among the strongest reducing agents, not inert.

Final Answer: Gas-phase reducing character increases down group 1 $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Nucleophiles and electrophiles: A nucleophile is electron-rich (has a lone pair or negative charge) and seeks a positive centre; an electrophile is electron-deficient and seeks electrons.

Step 1 — Examine the cyanide ion: CN^- carries a negative charge and a lone pair on carbon, making it electron-rich.

Step 2 — Classify it: An electron-rich species that donates its lone pair to a positive centre is a nucleophile, so CN^- is a nucleophile.

Why other options are wrong:

- Option B (BF_3): boron has an incomplete octet, so it is electron-deficient, an

electrophile.

- Option C (NO_2^+): positively charged and electron-deficient, an electrophile.
- Option D (H^+): a bare proton with no electrons, a classic electrophile.

Final Answer: CN^- is a nucleophile $\Rightarrow$ A

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Structural isomers: Structural isomers have the same molecular formula but different connectivity of atoms; for alkanes these arise from different branching of the carbon skeleton.

Step 1 — Draw the straight chain: The unbranched isomer is n-pentane, a five-carbon chain.

Step 2 — Draw the singly branched isomer: Moving one carbon to a branch on a four-carbon chain gives 2-methylbutane (isopentane).

Step 3 — Draw the doubly branched isomer: Placing two methyl groups on a central carbon gives 2,2-dimethylpropane (neopentane).

Step 4 — Count: There are exactly three distinct skeletons, so C_5H_{12} has three structural isomers.

Why other options are wrong:

- Option A (5) and Option C (4): overcount; no further distinct carbon skeletons exist for C_5H_{12}.
- Option B (2): misses one of the three isomers.

Final Answer: C_5H_{12} has 3 structural isomers $\Rightarrow$ D

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — S_N1 reactivity: The rate-determining step of S_N1 forms a carbocation, so the halide that gives the most stable carbocation reacts fastest; carbocation stability is tertiary $>$ secondary $>$ primary $>$ methyl.

Step 1 — Rank carbocation stability: Alkyl groups release electron density and stabilise the positive charge, so a tertiary carbocation is the most stable and a methyl cation the least.

Step 2 — Translate to reaction rate: Because a more stable carbocation forms more easily, the S_N1 rate follows the same order as carbocation stability.

Step 3 — Write the order: Tertiary $>$ secondary $>$ primary $>$ methyl.

Why other options are wrong:

- Option A: puts primary ahead of tertiary, reversing the stability order.
- Option B: puts methyl first, but the methyl cation is the least stable.
- Option C: places secondary above tertiary, which is incorrect.

Final Answer: S_N1 order is tertiary $>$ secondary $>$ primary $>$ methyl $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept — Kolbe's reaction: Sodium phenoxide reacts with carbon dioxide under pressure; the ring is carboxylated at the ortho position, and acidification gives 2-hydroxybenzoic acid (salicylic acid).

Step 1 — Form the phenoxide: Phenol is first converted to sodium phenoxide, which has an electron-rich ring.

Step 2 — Carboxylation with CO_2: The ortho carbon attacks CO_2 under pressure to give sodium salicylate.

Step 3 — Acidify: Acidification of sodium salicylate gives salicylic acid (2-hydroxybenzoic acid).

Why other options are wrong:

- Option A (benzoic acid): lacks the ortho hydroxyl group that comes from phenol.

- Option C (picric acid): the product of nitration, not carboxylation.
- Option D (benzaldehyde): a formylation product (Reimer–Tiemann uses $CHCl_3$), not Kolbe's reaction.

Final Answer: Kolbe's reaction gives salicylic acid $\Rightarrow$ B

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Tollens' test: Tollens' reagent (ammoniacal silver nitrate) is reduced by aldehydes to metallic silver, forming a silver mirror; ketones do not respond.

Step 1 — Pick the compound with an aldehyde group: Ethanal (CH_3CHO) contains the $-CHO$ group.

Step 2 — Predict the reaction: The aldehyde reduces Ag^+ in the reagent to metallic silver, depositing a silver mirror on the tube.

Why other options are wrong:

- Option A (acetone): a ketone, which does not reduce Tollens' reagent.
- Option C (benzophenone): a diaryl ketone, also negative.
- Option D (tert-butyl alcohol): an alcohol with no carbonyl group, so no silver mirror.

Final Answer: Ethanal gives a positive Tollens' test $\Rightarrow$ B

Answer: (B) Go Back to Q20

Q21.

Solution

Concept — Inductive effect and distance: An electron-withdrawing chlorine stabilises the carboxylate anion and raises acidity; the effect is strongest when the chlorine is closest to the $-COOH$ group and falls off with distance.

Step 1 — Compare the positions of chlorine: In 2-chlorobutanoic acid the Cl is on the carbon next to $-COOH$; in the 3- and 4-chloro acids it is progressively farther away; butanoic acid has no Cl.

Step 2 — Apply the distance rule: The nearer the chlorine, the stronger the electron withdrawal, so acidity decreases as the chlorine moves away: 2-chloro >

3-chloro > 4-chloro.

Step 3 — Place the parent acid: Butanoic acid, with no electron-withdrawing group, is the weakest of the four.

Why other options are wrong:

- Option A: reverses the order, making the parent acid strongest.
- Option B: places the 4-chloro acid ahead of the 2-chloro acid, opposite to the distance rule.
- Option C: the acids are not equal; the position of chlorine changes the strength.

Final Answer: 2-chloro > 3-chloro > 4-chloro > butanoic acid $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Hofmann bromamide degradation: A primary amide treated with bromine and alkali loses the carbonyl carbon as carbonate and gives a primary amine with one fewer carbon atom.

Step 1 — Identify the amide: Acetamide is CH_3CONH_2, a two-carbon amide.

Step 2 — Apply the one-carbon loss: The carbonyl carbon is removed, so the two-carbon amide gives a one-carbon amine.

Step 3 — Name the product: The one-carbon primary amine is methylamine, CH_3NH_2.

Why other options are wrong:

- Option A (ethylamine): keeps two carbons, ignoring the loss of the carbonyl carbon.
- Option C (acetic acid): hydrolysis product, not the Hofmann degradation product.
- Option D (ethanamide unchanged): the amide does react, so it is not recovered unchanged.

Final Answer: Acetamide gives methylamine $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Essential amino acids: Essential amino acids cannot be made in the body and must come from the diet; non-essential ones can be synthesised internally.

Step 1 — Recall the essential list: Valine, leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and histidine are essential.

Step 2 — Match the options: Among the choices, valine appears on the essential list.

Why other options are wrong:

- Option A (glycine): synthesised by the body, so non-essential.
- Option C (alanine): non-essential, made from pyruvate.
- Option D (glutamic acid): non-essential, made in the body.

Final Answer: Valine is an essential amino acid $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — IUPAC naming of carboxylic acids: The longest chain that includes the $-\text{COOH}$ carbon is the parent; the $-\text{COOH}$ carbon is always C-1, and branches are named as prefixes with their locants.

Step 1 — Find the parent chain: The chain containing $-\text{COOH}$ is $\text{COOH} - \text{CH} - \text{CH}_3$, i.e. three carbons: a propanoic acid parent.

Step 2 — Number the chain: The $-\text{COOH}$ carbon is C-1, the central CH is C-2, and its terminal CH_3 is C-3.

Step 3 — Locate the branch: The extra CH_3 hangs from C-2, giving a 2-methyl substituent, so the name is 2-methylpropanoic acid.

Why other options are wrong:

- Option A (butanoic acid): would require an unbranched four-carbon chain.
- Option B (2-methylbutanoic acid): implies a four-carbon parent, but the parent here has only three carbons.
- Option D (propanoic acid): ignores the methyl branch on C-2.

Final Answer: The compound is 2-methylpropanoic acid $\Rightarrow$ C

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Antacids: Antacids neutralise or reduce excess acid in the stomach; H_2-receptor blockers such as ranitidine lower the secretion of hydrochloric acid.

Step 1 — Recall the action needed: An antacid must counter excess stomach acidity, either by neutralising the acid or by cutting its production.

Step 2 — Identify the correct drug: Ranitidine blocks the histamine H_2 receptors of the stomach, reducing acid secretion, so it is used as an antacid.

Why other options are wrong:

- Option A (chloroquine): an antimalarial drug.
- Option B (aspirin): an analgesic and antipyretic, and actually acidic itself.
- Option C (chloramphenicol): a broad-spectrum antibiotic.

Final Answer: Ranitidine is used as an antacid $\Rightarrow$ D

Answer: (D) Go Back to Q25

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	2	C	3	A	4	D	5	B
6	A	7	A	8	C	9	C	10	A
11	A	12	C	13	A	14	C	15	B
16	A	17	D	18	D	19	B	20	B
21	D	22	B	23	B	24	C	25	D