

# NEST Chemistry Sample Paper – 6

Duration: 45 Minutes

Maximum Marks: 60

## Instructions

- This paper contains **20 Multiple Choice Questions (single correct answer)**, modelled on the Chemistry section of **NEST 2026**.
- Each correct answer carries **+3 marks**. There is a deduction of **–1 mark** for each incorrect answer; **no marks** are deducted for an unattempted question.
- Every question has exactly **four options**, of which only **one** is correct. Choose carefully.
- Personal calculators, log tables, mobile phones, and other electronic gadgets are strictly prohibited in the examination hall.
- A simple on-screen (virtual) calculator is provided in the computer-based test interface and may be used; blank sheets for rough work are supplied at the exam centre.

**Q1.** The equivalent weight of phosphoric acid ( $H_3PO_4$ , molar mass = 98  $g\ mol^{-1}$ ) when it is completely neutralised to form the salt  $Na_3PO_4$  is

- (A) 98  $g\ equiv^{-1}$
- (B) 49  $g\ equiv^{-1}$
- (C) 32.7  $g\ equiv^{-1}$
- (D) 24.5  $g\ equiv^{-1}$

**Q2.** In the Bohr model of the hydrogen atom the radius of the  $n^{\text{th}}$  orbit is  $r_n = 0.529 n^2 \text{ \AA}$ . The radius of the third orbit ( $n = 3$ ) of the hydrogen atom is

- (A) 4.76  $\text{ \AA}$
- (B) 1.59  $\text{ \AA}$



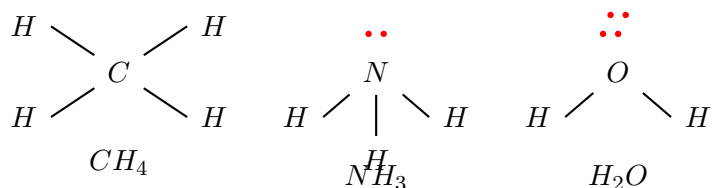
(C) 0.529 Å

(D) 2.12 Å

**Q3.** Consider the isoelectronic species  $O^{2-}$ ,  $F^{-}$ ,  $Na^{+}$  and  $Mg^{2+}$  (each has 10 electrons). The correct order of their ionic radii (largest first) is

(A)  $Mg^{2+} > Na^{+} > F^{-} > O^{2-}$ (B)  $Na^{+} > Mg^{2+} > O^{2-} > F^{-}$ (C)  $F^{-} > O^{2-} > Na^{+} > Mg^{2+}$ (D)  $O^{2-} > F^{-} > Na^{+} > Mg^{2+}$ 

**Q4.** The molecules  $CH_4$ ,  $NH_3$  and  $H_2O$  all have an  $sp^3$ -hybridised central atom, but their bond angles differ because of lone-pair repulsion, as suggested below.



The correct order of bond angle (largest first) is

(A)  $H_2O > NH_3 > CH_4$ (B)  $CH_4 > NH_3 > H_2O$ (C)  $NH_3 > CH_4 > H_2O$ (D)  $CH_4 > H_2O > NH_3$ 

**Q5.** When 250 mL of 1 M  $HCl$  is mixed with 250 mL of 1 M  $NaOH$  (both strong electrolytes), the standard enthalpy of neutralisation is  $-57.1$  kJ per mole of water formed. The heat released in this experiment is

(A) 57.1 kJ

(B) 28.55 kJ

(C) 14.275 kJ



(D) 114.2 kJ

**Q6.** A weak monobasic acid  $HA$  has an acid dissociation constant  $K_a = 1.0 \times 10^{-5}$ . For a  $0.1 M$  solution, the degree of dissociation  $\alpha$  (using Ostwald's dilution law  $\alpha \approx \sqrt{K_a/C}$ ) is

(A)  $1.0 \times 10^{-5}$

(B)  $1.0 \times 10^{-3}$

(C)  $1.0 \times 10^{-4}$

(D)  $1.0 \times 10^{-2}$

**Q7.** In acidic medium, the permanganate ion is reduced as  $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ . If the molar mass of  $KMnO_4$  is  $158 \text{ g mol}^{-1}$ , its equivalent weight in this reaction is

(A)  $31.6 \text{ g equiv}^{-1}$

(B)  $158 \text{ g equiv}^{-1}$

(C)  $52.7 \text{ g equiv}^{-1}$

(D)  $79 \text{ g equiv}^{-1}$

**Q8.** A fixed mass of an ideal gas occupies  $4.0 \text{ L}$  at a pressure of  $1.5 \text{ atm}$  and constant temperature. If the pressure is increased to  $3.0 \text{ atm}$  at the same temperature, the new volume (by Boyle's law) is

(A)  $8.0 \text{ L}$

(B)  $2.0 \text{ L}$

(C)  $6.0 \text{ L}$

(D)  $1.0 \text{ L}$

**Q9.** The solubility of a gas in water follows Henry's law,  $p = K_H x$ , where  $x$  is the mole fraction of the dissolved gas. For a gas with  $K_H = 1.0 \times 10^5 \text{ atm}$  at a given temperature, the mole fraction of the gas dissolved when its partial pressure is  $2.0 \text{ atm}$  is

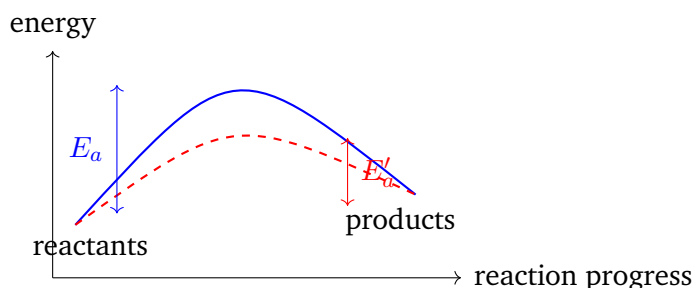


- (A)  $2.0 \times 10^{-3}$
- (B)  $5.0 \times 10^{-6}$
- (C)  $2.0 \times 10^{-5}$
- (D)  $5.0 \times 10^4$

**Q10.** Given the standard reduction potentials  $E^\circ(Zn^{2+}/Zn) = -0.76\text{ V}$ ,  $E^\circ(Fe^{2+}/Fe) = -0.44\text{ V}$ ,  $E^\circ(Cu^{2+}/Cu) = +0.34\text{ V}$  and  $E^\circ(Ag^+/Ag) = +0.80\text{ V}$ , which one of the following displacement reactions is feasible?

- (A) *Cu* displaces  $Zn^{2+}$  from solution
- (B) *Ag* displaces  $Cu^{2+}$  from solution
- (C) *Cu* displaces  $Fe^{2+}$  from solution
- (D) *Zn* displaces  $Cu^{2+}$  from solution

**Q11.** The energy profile below shows a reaction proceeding with and without a catalyst.



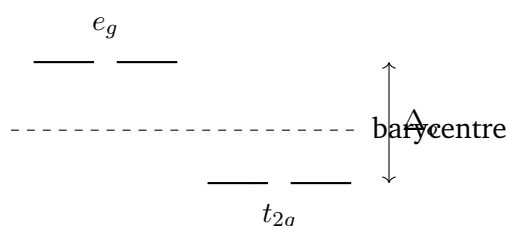
For this reaction, adding the catalyst

- (A) raises  $E_a$  and decreases the rate
- (B) lowers the enthalpy change  $\Delta H$  of the reaction
- (C) lowers  $E_a$  and increases the rate
- (D) changes the equilibrium constant in favour of products

**Q12.** The spin-only magnetic moment of an ion is  $\mu = \sqrt{n(n+2)}$  Bohr magnetons, where  $n$  is the number of unpaired electrons. For the  $Ni^{2+}$  ion (atomic number of *Ni* = 28), the value of  $\mu$  is

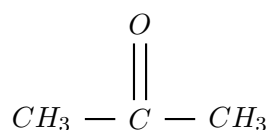
- (A) 1.73 BM  
 (B) 2.83 BM  
 (C) 3.87 BM  
 (D) 4.90 BM

**Q13.** For an octahedral complex the  $d$  orbitals split into a lower  $t_{2g}$  set and an upper  $e_g$  set, as shown. For  $[Fe(H_2O)_6]^{2+}$  ( $Fe^{2+}$  is  $3d^6$ ;  $H_2O$  is a weak-field ligand, high-spin), the number of unpaired electrons is



- (A) 4  
 (B) 0  
 (C) 2  
 (D) 6

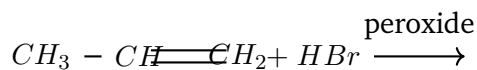
**Q14.** The functional group present in the compound shown below is



- (A) aldehyde  
 (B) carboxylic acid  
 (C) ketone  
 (D) alcohol

**Q15.** In the presence of organic peroxides, propene adds  $HBr$  by the anti-Markovnikov (peroxide / Kharasch) pathway:





The major product formed is

- (A) 2-bromopropane
- (B) propan-1-ol
- (C) 1,2-dibromopropane
- (D) 1-bromopropane

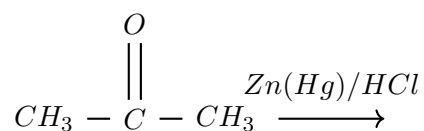
**Q16.** Consider the substrates  $CH_3Cl$  (i),  $CH_3CH_2Cl$  (ii),  $(CH_3)_2CHCl$  (iii) and  $(CH_3)_3CCl$  (iv). Which one reacts *fastest* by an  $S_N1$  mechanism (most stable carbocation)?

- (A) (i)  $CH_3Cl$
- (B) (iv)  $(CH_3)_3CCl$
- (C) (ii)  $CH_3CH_2Cl$
- (D) (iii)  $(CH_3)_2CHCl$

**Q17.** Ethanol ( $CH_3CH_2OH$ ) reacts with acetic acid ( $CH_3COOH$ ) in the presence of a few drops of concentrated  $H_2SO_4$  (Fischer esterification). The major organic product is

- (A) ethyl acetate ( $CH_3COOC_2H_5$ )
- (B) diethyl ether ( $C_2H_5OC_2H_5$ )
- (C) ethene ( $CH_2 = CH_2$ )
- (D) acetaldehyde ( $CH_3CHO$ )

**Q18.** Propanone (acetone) is treated with the Clemmensen reagent (amalgamated zinc and concentrated  $HCl$ ):



The organic product of this Clemmensen reduction is

- (A) propan-2-ol ( $CH_3CHOHCH_3$ )
- (B) propan-1-ol ( $CH_3CH_2CH_2OH$ )
- (C) propene ( $CH_3CH = CH_2$ )
- (D) propane ( $CH_3CH_2CH_3$ )

**Q19.** When ethylamine ( $CH_3CH_2NH_2$ , a primary aliphatic amine) is treated with nitrous acid ( $HNO_2$ , generated from  $NaNO_2$  and dilute  $HCl$ ) at low temperature, the diazonium salt formed is unstable and decomposes. The main observation is

- (A) formation of a stable, coloured diazonium salt
- (B) brisk effervescence of  $N_2$  gas with formation of an alcohol
- (C) precipitation of a yellow nitroso compound
- (D) no reaction at low temperature

**Q20.** When crystalline  $\alpha$ -D-glucose is dissolved in water, its specific rotation gradually changes until it reaches a constant value, due to interconversion of the  $\alpha$  and  $\beta$  cyclic forms through the open-chain aldehyde. This phenomenon is called

- (A) epimerisation
- (B) racemisation
- (C) mutarotation
- (D) inversion



## Detailed Solutions

Q1.

## Solution

**Concept — Equivalent weight of an acid:** The equivalent weight equals the molar mass divided by the basicity ( $n$ -factor), i.e. the number of replaceable  $H^+$  ions in the given reaction.

**Step 1 — Find the basicity:** Forming  $Na_3PO_4$  replaces all three acidic hydrogens of  $H_3PO_4$ , so  $n = 3$ .

**Step 2 — Compute:** Equivalent weight =  $\frac{98}{3} = 32.7 \text{ g equiv}^{-1}$ .

**Why other options are wrong:**

- (A) 98 uses  $n = 1$  (only one  $H^+$  replaced).
- (B) 49 uses  $n = 2$  (giving  $Na_2HPO_4$ ).
- (D) 24.5 wrongly uses  $n = 4$ .

**Final Answer:**  $32.7 \text{ g equiv}^{-1} \Rightarrow$   C

**Answer: (C)** [Go Back to Q1](#)

Q2.

## Solution

**Concept — Bohr orbit radius:** For hydrogen the radius of the  $n^{\text{th}}$  orbit is  $r_n = 0.529 n^2 \text{ \AA}$ ; it grows as the square of the principal quantum number.

**Step 1 — Substitute  $n = 3$ :**  $r_3 = 0.529 \times 3^2 = 0.529 \times 9$ .

**Step 2 — Compute:**  $r_3 = 4.761 \approx 4.76 \text{ \AA}$ .

**Why other options are wrong:**

- (B)  $1.59 \text{ \AA}$  uses  $n$  linearly ( $0.529 \times 3$ ).
- (C)  $0.529 \text{ \AA}$  is the first orbit ( $n = 1$ ).
- (D)  $2.12 \text{ \AA}$  is the second orbit ( $0.529 \times 4$ ).

**Final Answer:**  $r_3 = 4.76 \text{ \AA} \Rightarrow$   A

**Answer: (A)** [Go Back to Q2](#)



Q3.

**Solution**

**Concept — Isoelectronic ionic radii:** For species with the same number of electrons, the radius decreases as the nuclear charge (atomic number) increases, because the electrons are pulled in more tightly.

**Step 1 — List nuclear charges:**  $O^{2-}$  ( $Z = 8$ ),  $F^-$  ( $Z = 9$ ),  $Na^+$  ( $Z = 11$ ),  $Mg^{2+}$  ( $Z = 12$ ), all with 10 electrons.

**Step 2 — Order:** Lower  $Z$  means larger size, so  $O^{2-} > F^- > Na^+ > Mg^{2+}$ .

**Why other options are wrong:**

- (A) is exactly reversed.
- (B) and (C) scramble the nuclear-charge order.

**Final Answer:**  $O^{2-} > F^- > Na^+ > Mg^{2+} \Rightarrow$  **D**

**Answer: (D)** [Go Back to Q3](#)

Q4.

**Solution**

**Concept — Lone-pair repulsion and bond angle:** For  $sp^3$  centres, lone pairs occupy more space than bond pairs and compress the bond angle. More lone pairs give a smaller angle.

**Step 1 — Count lone pairs:**  $CH_4$  has 0 lone pairs (angle  $109.5^\circ$ ),  $NH_3$  has 1 ( $107^\circ$ ),  $H_2O$  has 2 ( $104.5^\circ$ ).

**Step 2 — Order of bond angle:**  $CH_4 > NH_3 > H_2O$ .

**Why other options are wrong:**

- (A) reverses the order (puts the most lone-pair molecule highest).
- (C) and (D) misplace  $H_2O$  and  $NH_3$ .

**Final Answer:**  $CH_4 > NH_3 > H_2O \Rightarrow$  **B**

**Answer: (B)** [Go Back to Q4](#)



Q5.

**Solution**

**Concept — Enthalpy of neutralisation:** For a strong acid and a strong base, the heat released is  $-57.1$  kJ per mole of water formed. First find the moles of water produced.

**Step 1 — Moles of acid and base:**  $HCl = 0.250 \text{ L} \times 1 \text{ M} = 0.25 \text{ mol}$ ;  $NaOH = 0.250 \text{ L} \times 1 \text{ M} = 0.25 \text{ mol}$ . They react  $1 : 1$ , giving  $0.25 \text{ mol}$  of water.

**Step 2 — Heat released:**  $0.25 \times 57.1 = 14.275 \text{ kJ}$ .

**Why other options are wrong:**

- (A)  $57.1 \text{ kJ}$  assumes  $1 \text{ mole}$  of water.
- (B)  $28.55 \text{ kJ}$  assumes  $0.5 \text{ mole}$ .
- (D)  $114.2 \text{ kJ}$  assumes  $2 \text{ moles}$ .

**Final Answer:**  $14.275 \text{ kJ} \Rightarrow \boxed{\text{C}}$

**Answer: (C)** [Go Back to Q5](#)

Q6.

**Solution**

**Concept — Ostwald's dilution law:** For a weak monobasic acid,  $K_a = \frac{C\alpha^2}{1 - \alpha}$ .  
When  $\alpha \ll 1$ , this simplifies to  $\alpha \approx \sqrt{K_a/C}$ .

**Step 1 — Substitute:**  $\alpha = \sqrt{\frac{1.0 \times 10^{-5}}{0.1}} = \sqrt{1.0 \times 10^{-4}}$ .

**Step 2 — Compute:**  $\alpha = 1.0 \times 10^{-2}$ .

**Why other options are wrong:**

- (A)  $10^{-5}$  is  $K_a$  itself, not  $\alpha$ .
- (B)  $10^{-3}$  uses  $C = 10 \text{ M}$ .
- (C)  $10^{-4}$  forgets to take the square root.

**Final Answer:**  $\alpha = 1.0 \times 10^{-2} \Rightarrow \boxed{\text{D}}$

**Answer: (D)** [Go Back to Q6](#)



Q7.

**Solution**

**Concept — Equivalent weight in redox:** The equivalent weight equals the molar mass divided by the  $n$ -factor, where  $n$  is the number of electrons gained or lost per formula unit.

**Step 1 — Find  $n$ -factor:** In  $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ , manganese goes from +7 to +2, a gain of 5 electrons, so  $n = 5$ .

**Step 2 — Compute:** Equivalent weight =  $\frac{158}{5} = 31.6 \text{ g equiv}^{-1}$ .

**Why other options are wrong:**

- (B) 158 uses  $n = 1$ .
- (C) 52.7 uses  $n = 3$  (neutral-medium reduction to  $MnO_2$ ).
- (D) 79 uses  $n = 2$ .

**Final Answer:**  $31.6 \text{ g equiv}^{-1} \Rightarrow \boxed{\text{A}}$

**Answer: (A)** [Go Back to Q7](#)

Q8.

**Solution**

**Concept — Boyle's law:** At constant temperature and fixed mass,  $P_1V_1 = P_2V_2$ , so pressure and volume are inversely proportional.

**Step 1 — Substitute:**  $P_1 = 1.5 \text{ atm}$ ,  $V_1 = 4.0 \text{ L}$ ,  $P_2 = 3.0 \text{ atm}$ .

$$V_2 = \frac{P_1V_1}{P_2} = \frac{1.5 \times 4.0}{3.0}$$

**Step 2 — Compute:**  $V_2 = \frac{6.0}{3.0} = 2.0 \text{ L}$ .

**Why other options are wrong:**

- (A) 8.0 L assumes volume rises with pressure.
- (C) 6.0 L is the product  $P_1V_1$ , not  $V_2$ .
- (D) 1.0 L uses the wrong pressure ratio.

**Final Answer:**  $V_2 = 2.0 \text{ L} \Rightarrow \boxed{\text{B}}$

**Answer: (B)** [Go Back to Q8](#)



Q9.

**Solution**

**Concept — Henry's law:** The partial pressure of a gas above a solution is proportional to its mole fraction in the solution,  $p = K_H x$ , so  $x = p/K_H$ .

**Step 1 — Substitute:**  $p = 2.0$  atm,  $K_H = 1.0 \times 10^5$  atm.

$$x = \frac{2.0}{1.0 \times 10^5}.$$

**Step 2 — Compute:**  $x = 2.0 \times 10^{-5}$ .

**Why other options are wrong:**

- (A)  $2.0 \times 10^{-3}$  uses  $K_H = 10^3$ .
- (B)  $5.0 \times 10^{-6}$  inverts the ratio incorrectly.
- (D)  $5.0 \times 10^4$  computes  $K_H/p$ , not  $p/K_H$ .

**Final Answer:**  $x = 2.0 \times 10^{-5} \Rightarrow$  C

Answer: (C) [Go Back to Q9](#)

Q10.

**Solution**

**Concept — Feasibility of displacement:** A metal displaces a metal ion from solution if it is a stronger reducing agent, i.e. it has a more negative reduction potential than the ion being displaced ( $E_{\text{cell}}^{\circ} > 0$ ).

**Step 1 — Check each pair:**  $Zn$  ( $-0.76$  V) is more negative than  $Cu^{2+}/Cu$  ( $+0.34$  V), so  $Zn$  readily reduces  $Cu^{2+}$ . The cell EMF =  $0.34 - (-0.76) = +1.10$  V  $> 0$ , so the reaction is feasible.

**Step 2 — Conclusion:**  $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$  is feasible.

**Why other options are wrong:**

- (A)  $Cu$  ( $+0.34$ ) cannot displace  $Zn^{2+}$  ( $-0.76$ );  $E_{\text{cell}}^{\circ} < 0$ .
- (B)  $Ag$  ( $+0.80$ ) cannot displace the less noble  $Cu^{2+}$  ( $+0.34$ ).
- (C)  $Cu$  ( $+0.34$ ) cannot displace  $Fe^{2+}$  ( $-0.44$ ).

**Final Answer:**  $Zn$  displaces  $Cu^{2+} \Rightarrow$  D

Answer: (D) [Go Back to Q10](#)



Q11.

**Solution**

**Concept — Action of a catalyst:** A catalyst provides an alternative reaction path with a lower activation energy  $E_a$ . The energy profile shows the catalysed path (dashed) with a smaller hump than the uncatalysed path (solid).

**Step 1 — Effect on  $E_a$ :** The catalyst lowers  $E_a$ , so in  $k = Ae^{-E_a/RT}$  a larger fraction of molecules can cross the barrier, raising the rate.

**Step 2 — What stays unchanged:** The catalyst does not change  $\Delta H$  (reactant and product levels are the same on both paths) nor the equilibrium constant; it only speeds up attainment of equilibrium.

**Why other options are wrong:**

- (A) A catalyst lowers, not raises,  $E_a$ .
- (B)  $\Delta H$  depends only on reactants and products, not on the path.
- (D) A catalyst speeds both forward and reverse rates equally, so  $K$  is unchanged.

**Final Answer:** Lowers  $E_a$  and increases the rate  $\Rightarrow$  **C**

**Answer: (C)** [Go Back to Q11](#)

Q12.

**Solution**

**Concept — Spin-only magnetic moment:** Find the  $d$ -electron count of the ion, count the unpaired electrons  $n$ , then evaluate  $\mu = \sqrt{n(n+2)}$  BM.

**Step 1 — Configuration of  $Ni^{2+}$ :**  $Ni$  ( $Z = 28$ ) is  $[Ar]3d^84s^2$ ;  $Ni^{2+}$  loses the two  $4s$  electrons to give  $[Ar]3d^8$ .

**Step 2 — Unpaired electrons:**  $3d^8$  has two unpaired electrons, so  $n = 2$ .

**Step 3 — Compute:**  $\mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83$  BM.

**Why other options are wrong:**

- (A) 1.73 BM is  $n = 1$ .
- (C) 3.87 BM is  $n = 3$ .
- (D) 4.90 BM is  $n = 4$ .

**Final Answer:**  $\mu = 2.83$  BM  $\Rightarrow$  **B**



Answer: (B) [Go Back to Q12](#)

Q13.

### Solution

**Concept — Crystal field theory (high spin):** With a weak-field ligand,  $\Delta_o$  is small, so electrons fill all five  $d$  orbitals singly before pairing (Hund's rule), maximising unpaired electrons.

**Step 1 —  $d$ -count of  $Fe^{2+}$ :**  $Fe^{2+}$  is  $3d^6$ .

**Step 2 — High-spin filling:** Distribute six electrons over  $t_{2g}$  and  $e_g$ :  $t_{2g}^4 e_g^2$ . Five orbitals get one electron each, then one orbital is doubly occupied, leaving 4 unpaired electrons.

**Why other options are wrong:**

- (B) 0 is the low-spin ( $t_{2g}^6$ ) case for a strong-field ligand.
- (C) 2 corresponds to low-spin  $d^6$  counted incorrectly.
- (D) 6 exceeds the maximum possible for  $d^6$ .

**Final Answer:** 4 unpaired electrons  $\Rightarrow$

Answer: (A) [Go Back to Q13](#)

Q14.

### Solution

**Concept — Identifying functional groups:** A carbonyl group ( $C = O$ ) flanked by two carbon atoms (alkyl groups) is a *ketone*; if the carbonyl carbon also bears an H it is an aldehyde, and if it bears  $-OH$  it is a carboxylic acid.

**Step 1 — Read the structure:** The structure is  $CH_3 - CO - CH_3$  (acetone): a central carbon doubly bonded to oxygen and singly bonded to two  $CH_3$  groups.

**Step 2 — Classify:** The  $C = O$  carbon is bonded to two carbons (no H, no  $OH$ ), so the functional group is a ketone.

**Why other options are wrong:**

- (A) An aldehyde requires an H on the carbonyl carbon ( $-CHO$ ).
- (B) A carboxylic acid needs an  $-OH$  on the carbonyl carbon ( $-COOH$ ).
- (D) An alcohol has  $-OH$  on a saturated carbon and no  $C = O$ .

**Final Answer:** Ketone  $\Rightarrow$



Answer: (C) [Go Back to Q14](#)

Q15.

### Solution

**Concept — Anti-Markovnikov (peroxide) addition:** In the presence of peroxides,  $HBr$  adds to an alkene by a free-radical mechanism. The bromine atom adds to the carbon bearing more hydrogens, opposite to Markovnikov's rule (the peroxide or Kharasch effect, only for  $HBr$ ).

**Step 1 — Radical addition:** The  $Br$  radical adds to the terminal  $=CH_2$  carbon, generating the more stable secondary carbon radical  $CH_3 - \dot{C}H - CH_2Br$ .

**Step 2 — Abstraction:** This radical abstracts H from  $HBr$ , giving  $CH_3 - CH_2 - CH_2Br$ , i.e. 1-bromopropane.

**Why other options are wrong:**

- (A) 2-bromopropane is the Markovnikov product (no peroxide).
- (B) propan-1-ol needs water, not  $HBr$ .
- (C) 1,2-dibromopropane requires  $Br_2$ .

**Final Answer:** 1-bromopropane  $\Rightarrow$

Answer: (D) [Go Back to Q15](#)

Q16.

### Solution

**Concept —  $S_N1$  reactivity and carbocation stability:**  $S_N1$  rate depends on the stability of the carbocation intermediate. More alkyl groups stabilise the positive charge (hyperconjugation + inductive effect), so tertiary > secondary > primary > methyl.

**Step 1 — Rank the cations:**  $(CH_3)_3C^+$  (tertiary) is the most stable, so  $(CH_3)_3CCl$  ionises fastest.

**Step 2 — Conclusion:** The fastest  $S_N1$  substrate is (iv)  $(CH_3)_3CCl$ .

**Why other options are wrong:**

- (A)  $CH_3Cl$  would give an unstable methyl cation; slowest by  $S_N1$ .
- (C)  $CH_3CH_2Cl$  gives a primary cation; very slow.
- (D)  $(CH_3)_2CHCl$  (secondary) is faster than primary but slower than tertiary.



**Final Answer:**  $(CH_3)_3CCl \Rightarrow$  B

**Answer:** (B) [Go Back to Q16](#)

**Q17.**

### Solution

**Concept — Fischer esterification:** A carboxylic acid and an alcohol react under acid catalysis ( $H_2SO_4$ ) to give an ester and water. The  $-OH$  of the acid is replaced by the  $-OR$  of the alcohol.

**Step 1 — Identify the ester:**  $CH_3COOH + C_2H_5OH \xrightarrow{H_2SO_4} CH_3COOC_2H_5 + H_2O$ .

**Step 2 — Name the product:**  $CH_3COOC_2H_5$  is ethyl acetate (ethyl ethanoate).

**Why other options are wrong:**

- (B) Diethyl ether forms from two alcohol molecules ( $2C_2H_5OH$ ), not with an acid.
- (C) Ethene results from dehydration of ethanol at high temperature, not esterification.
- (D) Acetaldehyde forms by oxidation of ethanol, not by reaction with acetic acid.

**Final Answer:** Ethyl acetate  $\Rightarrow$  A

**Answer:** (A) [Go Back to Q17](#)

**Q18.**

### Solution

**Concept — Clemmensen reduction:** Treatment of an aldehyde or ketone with amalgamated zinc and concentrated  $HCl$  reduces the carbonyl group ( $C=O$ ) all the way to a  $CH_2$  group, i.e. it converts  $>C=O$  into  $>CH_2$ .

**Step 1 — Apply to acetone:**  $CH_3-CO-CH_3 \xrightarrow{Zn(Hg)/HCl} CH_3-CH_2-CH_3$ .  
The carbonyl becomes a methylene group.

**Step 2 — Identify the product:** The product is propane.

**Why other options are wrong:**

- (A) Propan-2-ol would result from mild reduction (e.g.  $NaBH_4$ ), which stops at the alcohol, not Clemmensen.



- (B) Propan-1-ol has the wrong carbon skeleton.
- (C) Propene would need dehydration, not reduction.

**Final Answer:** Propane ( $CH_3CH_2CH_3$ )  $\Rightarrow$  **D**

**Answer: (D)** [Go Back to Q18](#)

Q19.

### Solution

**Concept — Primary aliphatic amine with  $HNO_2$ :** Primary aliphatic amines react with nitrous acid to give unstable aliphatic diazonium salts that decompose immediately, releasing  $N_2$  gas and forming the corresponding alcohol (along with other products).

**Step 1 — Reaction:**  $CH_3CH_2NH_2 + HNO_2 \rightarrow CH_3CH_2OH + N_2 \uparrow + H_2O$ .

**Step 2 — Observation:** Brisk effervescence of nitrogen gas is seen, and an alcohol is formed. (Aliphatic diazonium salts are too unstable to isolate, unlike aromatic ones.)

**Why other options are wrong:**

- (A) Stable, coloured diazonium salts form only with aromatic primary amines at low temperature.
- (C) A yellow nitroso compound is typical of secondary amines, not primary.
- (D) The reaction does occur readily even at low temperature.

**Final Answer:** Effervescence of  $N_2$  with formation of an alcohol  $\Rightarrow$  **B**

**Answer: (B)** [Go Back to Q19](#)

Q20.

### Solution

**Concept — Mutarotation:** The two cyclic anomers of a sugar ( $\alpha$  and  $\beta$ ) differ in configuration at the anomeric carbon. In solution they interconvert through the open-chain form, and the optical rotation drifts to an equilibrium value.

**Step 1 — What happens to glucose:** Pure  $\alpha$ -D-glucose ( $[\alpha]_D = +111^\circ$ ) slowly equilibrates with  $\beta$ -D-glucose ( $[\alpha]_D = +19^\circ$ ) until the rotation settles at about  $+52.7^\circ$ .

**Step 2 — Name the phenomenon:** This spontaneous change in specific rotation



due to anomer interconversion is called mutarotation.

**Why other options are wrong:**

- (A) Epimerisation is a change at a chiral centre other than the anomeric carbon.
- (B) Racemisation produces a 50 : 50 mix of enantiomers (here the forms are diastereomers, not enantiomers).
- (D) Inversion refers to the hydrolysis of sucrose, a different process.

**Final Answer:** Mutarotation  $\Rightarrow$

[Go Back to Q20](#)



## Answer Key

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

