Master Testing Agency
Practice papers, exam-standard · www.mastertestingagency.com

Principles Related to Practical Chemistry — JEE (Main) Pattern Topic Test

FREE SAMPLE TEST · CHEMISTRY · PATTERN OF JEE (MAIN)

DURATION	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
60 minutes	100	25 (20 + 5)	

GENERAL INSTRUCTIONS

1. This question paper has two sections, A and B. All 25 questions are compulsory.
2. Section A has TWENTY (20) multiple-choice questions. Each has FOUR options, (1), (2), (3) and (4), of which ONLY ONE is correct.
3. Section B has FIVE (05) questions whose answer is a numerical value. Enter the value rounded off to the nearest integer.
4. Marking scheme for both sections: +4 for a correct answer, −1 for an incorrect answer, 0 if the question is not attempted.
5. Use of a calculator, log tables or any other aid is not allowed.
6. The answer key and worked solutions are at the end of this booklet. Attempt the paper in 60 minutes before you look at them.

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Master Testing Agency is an independent test-prep publisher, not affiliated with, endorsed by or connected to the National Testing Agency (NTA), the IITs or any other exam-conducting body.

Topics covered: Preparation of inorganic compounds · Titrimetric analysis · Qualitative salt analysis · Tests for functional groups · Preparation of organic compounds · Physical chemistry experiments

SECTION A (Q1–20) · Multiple choice · +4 / 0 / −1

Each question has FOUR options. ONLY ONE of them is correct.

1. In the preparation of Mohr's salt, a few drops of dilute sulphuric acid are added while dissolving the mixture of ferrous sulphate and ammonium sulphate in water, in order to

(1) increase the solubility of ammonium sulphate

(2) act as a catalyst for crystallisation

(3) oxidise Fe^{2+} to Fe^{3+}

(4) prevent the hydrolysis of ferrous sulphate

2. The formula of potash alum is

(1) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$

(2) $KAl(SO_4)_2 \cdot 6H_2O$

(3) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 12H_2O$

(4) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

3. No separate indicator is used in the titration of oxalic acid with potassium permanganate because

(1) the reaction is too fast for an indicator

(2) $KMnO_4$ acts as a self-indicator: the first excess drop gives a permanent pink colour

(3) oxalic acid is coloured

(4) the Mn^{2+} ions formed are deep purple

4. The permanganate titrations of oxalic acid and of Mohr's salt are carried out in dilute H_2SO_4 and not in dilute HCl, because

(1) HCl is a weaker acid than H_2SO_4

(2) HCl forms a precipitate with Mn^{2+}

(3) $KMnO_4$ oxidises Cl^- to Cl_2, so part of the $KMnO_4$ is used up by the acid

(4) H_2SO_4 is a reducing agent that helps the reaction

5. In the titration of warm oxalic acid with $KMnO_4$, the first few drops are decolourised slowly, but later drops are decolourised almost at once. This is because

(1) the solution cools down

(2) the Mn^{2+} ions formed catalyse the reaction (autocatalysis)

(3) oxalic acid becomes more concentrated

(4) the pink colour of MnO_4^- fades in light

6. In the titration of 0.1 M ethanoic acid with 0.1 M NaOH, the most suitable indicator is

(1) methyl orange (pH range 3.1–4.4)

(2) phenolphthalein (pH range 8.3–10.0)

(3) either indicator equally

(4) neither, because no end point can be seen

7. Which of the following cations is precipitated as its sulphide when H_2S is passed through its solution acidified with dilute HCl?

(1) Zn^{2+}

(2) Ni^{2+}

(3) Cu^{2+}

(4) Ca^{2+}

8. A salt solution gives a white precipitate when H_2S is passed through it in the presence of NH_4Cl and NH_4OH (after groups I to III have been tested). The cation is

(1) Ni^{2+}

(2) Zn^{2+}

(3) Cu^{2+}

(4) Ba^{2+}

9. A blue solution of a salt gives, on adding ammonium hydroxide drop by drop, a pale blue precipitate that dissolves in excess to give a deep blue solution. The cation is

(1) Cu^{2+}

(2) Ni^{2+}

(3) Fe^{3+}

(4) Al^{3+}

10. Al^{3+} is confirmed by dissolving the white group III precipitate in dilute HCl, adding a few drops of blue litmus and then adding NH_4OH. The observation is

(1) a red solution

(2) a blue precipitate floating in a colourless solution (blue 'lake')

(3) a yellow precipitate

(4) a black precipitate

11. In group III analysis, solid NH_4Cl is added before NH_4OH because

(1) NH_4Cl precipitates Al^{3+} and Fe^{3+} as chlorides

(2) NH_4Cl oxidises Fe^{2+} to Fe^{3+}

(3) NH_4^+ ions suppress the ionisation of NH_4OH, keeping $[OH^-]$ too low to precipitate the hydroxides of groups IV, V and Mg^{2+}

(4) NH_4Cl dissolves the group II sulphides

12. A solution of a salt gives a yellow precipitate with potassium iodide solution. The precipitate dissolves in hot water and reappears as shining golden spangles on cooling. The cation is

(1) Ba^{2+}

(2) Pb^{2+}

(3) Ag^+

(4) Zn^{2+}

13. The silver halide precipitates obtained in the tests for halide ions are shaken with dilute ammonia solution. The one that dissolves readily is

(1) AgI

(2) AgBr

(3) AgCl

(4) all three dissolve equally

14. A salt gives a colourless gas with the smell of rotten eggs when warmed with dilute H_2SO_4. The gas turns a filter paper soaked in lead acetate solution

(1) black

(2) blue

(3) yellow

(4) red

15. An aromatic compound gives brisk effervescence with aqueous $NaHCO_3$ and also a violet colour with neutral $FeCl_3$ solution. The compound is

(1) benzoic acid

(2) phenol

(3) salicylic acid

(4) benzaldehyde

16. A primary aromatic amine is identified by dissolving it in dilute HCl, adding cold $NaNO_2$ solution and then an alkaline solution of β-naphthol. The observation is

(1) a silver mirror

(2) an orange-red dye (precipitate)

(3) a violet colour

(4) an offensive smell

17. Acetanilide is prepared in the laboratory by

(1) heating aniline with acetic anhydride in the presence of glacial acetic acid

(2) nitrating aniline at 273 K

(3) heating benzene with acetamide and $AlCl_3$

(4) treating aniline with chloroform and alcoholic KOH

18. Which of the following forms a lyophobic sol, and is prepared by adding its salt solution drop by drop to boiling water?

(1) starch

(2) gum arabic

(3) egg albumin

(4) ferric hydroxide

19. In the study of the reaction between iodide ions and H_2O_2 at room temperature, a fixed small amount of sodium thiosulphate and some starch are added to the mixture. The blue colour appears suddenly after a time t because

(1) starch is oxidised only after time t

(2) thiosulphate reacts with H_2O_2 first

(3) the reaction does not start until time t

(4) the I_2 formed is converted back to I^- by thiosulphate until all the thiosulphate is used up, after which free I_2 gives the blue colour with starch

20. Statement I: In determining the enthalpy of solution of copper sulphate, the heat absorbed or released is found from the temperature change of a known mass of water in a calorimeter of known water equivalent.
Statement II: Anhydrous $CuSO_4$ and $CuSO_4 \cdot 5H_2O$ have the same enthalpy of solution, because both give the same ions in water.
In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are true

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are false

SECTION B (Q21–25) · Numerical value · +4 / 0 / −1

The answer to each question is a NUMERICAL VALUE. Enter it rounded off to the nearest integer.

---

21. To prepare 250 mL of a 0.050 M standard solution of Mohr's salt, $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$, the mass of the salt needed is x/10 g. The value of x is _____. (H = 1, N = 14, O = 16, S = 32, Fe = 56)

Answer: _____

22. 15.0 mL of 0.10 M oxalic acid is titrated with 0.025 M $KMnO_4$ in dilute H_2SO_4. The volume of $KMnO_4$ needed (in mL) is _____.

Answer: _____

23. 20.0 mL of 0.10 M Mohr's salt solution needs 18.0 mL of a $KMnO_4$ solution for complete oxidation in dilute H_2SO_4. The molarity of the $KMnO_4$ solution is $x \times 10^{-3}$ M. The value of x (to the nearest integer) is _____.

Answer: _____

24. 100 mL of 1.0 M HCl and 100 mL of 1.0 M NaOH, both at the same temperature, are mixed in a calorimeter, and the temperature rises by 6.8 K. Taking the density of the solution as 1.0 g/mL, its specific heat as 4.18 J g^{-1} K^{-1} and neglecting the heat taken by the calorimeter, the magnitude of the enthalpy of neutralisation (in kJ/mol, to the nearest integer) is _____.

Answer: _____

25. The number of the following cations whose precipitate in its own group test is coloured (not white) is _____.
Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Zn^{2+}, Ni^{2+}, Ca^{2+}, Ba^{2+}, Mg^{2+}

Answer: _____

END OF THE QUESTION PAPER

ANSWER KEY

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
(4)	(1)	(2)	(3)	(2)	(2)	(3)	(2)	(1)	(2)

Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
(3)	(2)	(3)	(1)	(3)	(2)	(1)	(4)	(4)	(2)

Q21	Q22	Q23	Q24	Q25
49	24	22	57	3

WORKED SOLUTIONS

Q1. Answer (4). Fe^{2+} salts are hydrolysed in water ($Fe^{2+} + 2H_2O \rightleftharpoons Fe(OH)_2 + 2H^+$), which makes the solution turbid. Extra H^+ shifts this back. The solution is also not heated for long, because Fe^{2+} would be oxidised by air to Fe^{3+}.

Q2. Answer (1). Potash alum is a double salt, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ (equivalently $KAl(SO_4)_2 \cdot 12H_2O$). The last option is Mohr's salt.

Q3. Answer (2). MnO_4^- is intensely purple and Mn^{2+} almost colourless. While any oxalate is left, each drop is decolourised; one drop in excess at the end point gives a light pink colour that persists.

Q4. Answer (3). $2MnO_4^- + 10Cl^- + 16H^+ \rightarrow 2Mn^{2+} + 5Cl_2 + 8H_2O$: in HCl some permanganate oxidises the chloride ions, so the titre would be too high. Nitric acid is also avoided because it is itself an oxidising agent.

Q5. Answer (2). The product Mn^{2+} catalyses the reaction between MnO_4^- and $C_2O_4^{2-}$. At the start there is almost no Mn^{2+}, so the reaction is slow; as Mn^{2+} builds up it speeds up. Warming to 333–343 K helps the slow start.

Q6. Answer (2). At the equivalence point the solution is 0.05 M sodium ethanoate, which is alkaline by hydrolysis: pH = 7 + ½(pKa + log c) = 7 + ½(4.74 − 1.30) = 8.7. This falls in the range of phenolphthalein; methyl orange would change colour long before the equivalence point.

Q7. Answer (3). In acid solution the H^+ ions suppress the ionisation of H_2S (common ion effect), so the S^{2-} concentration is very low and only sulphides with very small Ksp, such as CuS (group II), precipitate. ZnS and NiS need the higher S^{2-} concentration of ammoniacal solution (group IV); calcium sulphide is not precipitated at all.

Q8. Answer (2). Group IV cations (Zn^{2+}, Ni^{2+}, Co^{2+}, Mn^{2+}) are precipitated as sulphides by H_2S in ammoniacal solution. ZnS is white; NiS is black. Cu^{2+} would already have come down in group II, and Ba^{2+} belongs to group V.

Q9. Answer (1). $Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2$ (pale blue); in excess ammonia it forms the deep blue complex $[Cu(NH_3)_4]^{2+}$. Ni^{2+} salts are green, Fe^{3+} gives reddish-brown $Fe(OH)_3$ and Al^{3+} a white gelatinous precipitate.

Q10. Answer (2). $Al(OH)_3$ is re-precipitated by NH_4OH and adsorbs the blue dye of litmus on its surface, so a blue precipitate (the 'lake') floats in a colourless liquid.

Q11. Answer (3). Common ion effect: NH_4^+ from the fully ionised NH_4Cl pushes $NH_4OH \rightleftharpoons NH_4^+ + OH^-$ to the left. The low $[OH^-]$ still exceeds the very small Ksp of $Fe(OH)_3$ and $Al(OH)_3$, but not that of $Zn(OH)_2$, $Ni(OH)_2$ or $Mg(OH)_2$. (Fe^{2+} is first oxidised to Fe^{3+} by conc. HNO_3, not by NH_4Cl.)

Q12. Answer (2). $Pb^{2+} + 2I^- \rightarrow PbI_2$, yellow. Lead iodide is much more soluble in hot water than in cold, so it recrystallises as golden spangles. (AgI is also yellow, but it does not dissolve in hot water; Ag^+ is not among the cations of the syllabus list.)

Q13. Answer (3). AgCl (white, Ksp 1.8×10^{-10}) dissolves readily in dilute NH_3 as $[Ag(NH_3)_2]^+$. AgBr (pale yellow, Ksp 5×10^{-13}) is only sparingly soluble, and AgI (yellow, Ksp 8×10^{-17}) is insoluble.

Q14. Answer (1). Sulphide: $S^{2-} + 2H^+ \rightarrow H_2S$. With lead acetate, H_2S gives black lead sulphide: $(CH_3COO)_2Pb + H_2S \rightarrow PbS + 2CH_3COOH$.

Q15. Answer (3). Effervescence (CO_2) with $NaHCO_3$ shows a –COOH group; a violet colour with neutral $FeCl_3$ shows a phenolic –OH. Salicylic acid (2-hydroxybenzoic acid) has both. Benzoic acid shows only the first, phenol only the second, and benzaldehyde neither.

Q16. Answer (2). The amine is diazotised in the cold, and the diazonium salt couples with β-naphthol in alkali to give an orange-red azo dye. This azo-dye test is given only by primary aromatic amines.

Q17. Answer (1). Acetylation: $C_6H_5NH_2 + (CH_3CO)_2O \rightarrow C_6H_5NHCOCH_3 + CH_3COOH$. The crude acetanilide is poured into cold water and recrystallised from hot water. Aniline with $CHCl_3$/KOH gives an isocyanide (carbylamine test).

Q18. Answer (4). $FeCl_3 + 3H_2O \rightarrow Fe(OH)_3$ (sol) + 3HCl: hydrolysis in boiling water gives a red-brown lyophobic sol, which must be prepared by a special method and is easily coagulated. Starch, gum and egg albumin form lyophilic sols simply by warming with water.

Q19. Answer (4). $H_2O_2 + 2I^- + 2H^+ \rightarrow I_2 + 2H_2O$, and at once $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$. Only when the thiosulphate is used up does I_2 remain and colour the starch blue. Since the same amount of I_2 has formed each time, the rate is proportional to 1/t.

Q20. Answer (2). I is true: q = (mass of water + water equivalent) × c × ΔT. II is false: anhydrous $CuSO_4$ releases about 66 kJ/mol on dissolving (its ions are hydrated as it dissolves), while the pentahydrate, already hydrated, absorbs about 12 kJ/mol.

Q21. Answer 49. Molar mass = 56 + 96 + 36 + 96 + 108 = 392 g/mol. Moles needed = 0.050 × 0.250 = 0.0125 mol; mass = 0.0125 × 392 = 4.9 g = 49/10. x = 49.

Q22. Answer 24. $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$ (Mn gains 5 e^-; each $C_2O_4^{2-}$ loses 2 e^-). Oxalic acid = 1.5×10^{-3} mol, so $KMnO_4 = (2/5) \times 1.5 \times 10^{-3} = 6.0 \times 10^{-4}$ mol; volume = $6.0 \times 10^{-4}/0.025 = 0.024$ L = 24 mL.

Q23. Answer 22. $MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$. $Fe^{2+} = 2.0 \times 10^{-3}$ mol, so $MnO_4^- = 4.0 \times 10^{-4}$ mol, and its molarity = $4.0 \times 10^{-4}/0.0180 = 0.0222$ M = 22.2×10^{-3} M. x = 22.

Q24. Answer 57. q = 200 g × 4.18 × 6.8 = 5685 J for 0.10 mol of water formed. ΔH = −5685/0.10 J/mol = −56.8 kJ/mol; magnitude 57.

Q25. Answer 3. Group precipitates: $PbCl_2$ white, CuS black, $Al(OH)_3$ white, $Fe(OH)_3$ reddish brown, ZnS white, NiS black, $CaCO_3$ and $BaCO_3$ white, $MgNH_4PO_4$ white. Coloured: Cu^{2+}, Fe^{3+} and Ni^{2+}: 3.

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Every answer in this paper was checked independently by computer: titrations and calorimetry from balanced equations and q = mcΔT, the indicator from the pH at the equivalence point, and the salt analysis and functional group tests from separate tables of groups, reagents and precipitate colours.