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Your JEE Guide

ISC Class XII · Chemistry Paper 1 (Theory)

Sample Question Paper 1 · Session 2026-27

Time allowed: 3 hours (plus 15 minutes reading time) **Maximum marks: 70**

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This is an original practice paper written to the CISCE 2027 specimen paper format; it is not issued by CISCE.

General instructions:

1. You are allowed an additional fifteen minutes for only reading the question paper. You must NOT start writing during the reading time.
2. The paper is divided into four sections and has twenty-one questions in all. Answer all questions.
3. Section A has fourteen subparts. Each subpart carries 1 mark.
4. While attempting Multiple Choice Questions in Section A, you are required to write only ONE option as the answer.
5. Section B has ten questions of 2 marks each. Section C has seven questions of 3 marks each. Section D has three questions of 5 marks each.
6. Internal choices have been provided in two questions each in Sections B, C and D.
7. The intended marks for questions are given in brackets [ ].
8. Balanced equations must be given wherever possible and diagrams where they are helpful. When solving numerical problems, all essential working must be shown.
9. Use: R = 1.987 cal K^{-1} mol^{-1} = 8.314 J K^{-1} mol^{-1} = 0.0821 dm^3 atm K^{-1} mol^{-1}; 1 L atm = 101.3 J; 1 faraday = 96500 C; Avogadro's number = 6.023×10^{23}.

Section A (14 marks)

1.	**(i)** *(A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:* [Sandmeyer, Gattermann, Kolbe's, independent, dependent, s^{-1}, mol L^{-1} s^{-1}, d^2sp^3, sp^3d^2, diamagnetic, paramagnetic, Tollens', Fehling's, iodoform, Lucas] Benzenediazonium chloride is converted to chlorobenzene by CuCl/HCl in the _____ reaction, and by copper powder and HCl in the _____ reaction.	1
	(ii) The half-life of a first-order reaction is _____ of the initial concentration, and the unit of its rate constant is _____.	1
	(iii) In $[Co(NH_3)_6]^{3+}$, cobalt uses _____ hybrid orbitals and the complex ion is _____.	1
	(iv) Aldehydes reduce _____ reagent to give a silver mirror, while acetone, which contains the $CH_3CO–$ group, gives a positive _____ test.	1

	(v) *(B) Select and write the correct alternative from the choices given below.* At the same temperature, which of the following 0.1 M aqueous solutions has the highest osmotic pressure? (a) urea (b) NaCl (c) $K_3[Fe(CN)_6]$ (d) $BaCl_2$	1
	(vi) The number of moles of electrons needed to reduce one mole of MnO_4^- to Mn^{2+} is: (a) 5 (b) 2 (c) 3 (d) 7	1
	(vii) For $2N_2O_5 \rightarrow 4NO_2 + O_2$, the rate of formation of O_2 is 1.5×10^{-4} mol L^{-1} s^{-1}. The rate of disappearance of N_2O_5 is: (a) 1.5×10^{-4} mol L^{-1} s^{-1} (b) 6.0×10^{-4} mol L^{-1} s^{-1} (c) 0.75×10^{-4} mol L^{-1} s^{-1} (d) 3.0×10^{-4} mol L^{-1} s^{-1}	1
	(viii) The correct order of basic strength in aqueous solution is: (a) $(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2 > NH_3$ (b) $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > NH_3$ (c) $C_2H_5NH_2 > (C_2H_5)_2NH > (C_2H_5)_3N > NH_3$ (d) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2NH > (C_2H_5)_3N$	1
	(ix) Which of the following is a non-reducing disaccharide? (a) glucose (b) lactose (c) maltose (d) sucrose	1
	(x) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** Most transition metal ions are coloured in aqueous solution. **Reason:** They have partly filled d orbitals, so d–d transitions can absorb visible light. (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion. (c) Assertion is true and Reason is false. (d) Both Assertion and Reason are false.	1

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	(xi) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** o-Nitrophenol is more volatile than p-nitrophenol. **Reason:** o-Nitrophenol has intermolecular hydrogen bonding. (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion. (c) Assertion is true and Reason is false. (d) Both Assertion and Reason are false.	1
	(xii) *(C) Read the passage carefully and answer the questions that follow.* A lead storage battery, used in cars and inverters, has a lead anode and a grid of lead packed with lead dioxide as the cathode, dipped in about 38% sulphuric acid. On discharge, both electrodes are converted to lead sulphate. A fuel cell, in contrast, is supplied continuously with its reactants: in the hydrogen–oxygen fuel cell used in the Apollo space programme, hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous sodium hydroxide, and the water produced was used as drinking water by the astronauts. Electrochemical reactions can also be harmful: the rusting of iron is an electrochemical process in which iron acts as an anode, and it is commonly prevented by coating the iron with a more reactive metal such as zinc. Why does the density of the electrolyte in a lead storage battery fall as the battery discharges?	1
	(xiii) Write the overall cell reaction of the hydrogen–oxygen fuel cell.	1
	(xiv) Why does a coating of zinc keep protecting iron even after the coating is scratched?	1

Section B (20 marks)

2.	9.0 g of glucose ($C_6H_{12}O_6$, molar mass 180 g mol^{-1}) is dissolved in 250 g of water. Calculate the molality of the solution and its boiling point. (K_b for water = 0.52 K kg mol^{-1}; boiling point of water = 373.15 K)	2
3.	The conductivity of a 0.020 M solution of KCl at 298 K is 0.0025 S cm^{-1}. Calculate its molar conductivity. How does molar conductivity change with dilution? Give a reason.	2
4.	The half-life of a first-order reaction is 30 minutes. Calculate its rate constant and the time needed for 87.5% of the reaction to be completed. **OR** The rate law for A + B → products is rate = k[A][B]². (a) What is the overall order? (b) How does the rate change if [B] is doubled and [A] is halved?	2

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5.	Give reasons: (i) Zn, Cd and Hg are not regarded as transition elements. (ii) Cr^{2+} is a strong reducing agent whereas Mn^{3+} is a strong oxidising agent, although both are d^4 ions.	2
6.	Write the IUPAC names of: (i) $[Co(NH_3)_5(CO_3)]Cl$ (ii) $Na_2[Zn(OH)_4]$ **OR** Using crystal field theory, write the electronic configuration of a d^6 ion in an octahedral field when (a) $\Delta_0 > P$, (b) $\Delta_0 < P$. Give the number of unpaired electrons in each case.	2
7.	Give reasons: (i) Chlorobenzene is much less reactive than chloroethane towards nucleophilic substitution. (ii) The dipole moment of chlorobenzene is lower than that of cyclohexyl chloride.	2
8.	How will you convert: (i) phenol to benzoquinone, (ii) phenol to 2,4,6-tribromophenol? Write the chemical equations.	2
9.	Arrange HCHO, CH_3CHO and CH_3COCH_3 in increasing order of reactivity towards nucleophilic addition, and explain the order.	2
10.	How will you distinguish between methylamine and dimethylamine using Hinsberg's reagent? Write the equations.	2
11.	What happens when D-glucose is (i) heated for a long time with HI, (ii) treated with bromine water? Write what each reaction shows about the structure of glucose.	2

Section C (21 marks)

12.	(a) 2.0 g of a non-volatile non-electrolyte dissolved in 40 g of benzene lowers its freezing point by 0.64 K. Find the molar mass of the solute. (K_f for benzene = 5.12 K kg mol^{-1}) *[2]* (b) Why is the vapour pressure of a solution of a non-volatile solute lower than that of the pure solvent? *[1]*	3
13.	For the cell Zn | Zn^{2+}(1 M) || Cu^{2+}(1 M) | Cu at 298 K, (a) calculate E°cell, (b) calculate ΔG° for the cell reaction, (c) name the anode. (E°(Zn^{2+}/Zn) = −0.76 V, E° (Cu^{2+}/Cu) = +0.34 V, F = 96500 C mol^{-1}) **OR** (a) A current of 2.0 A is passed for 965 s through aqueous $CuSO_4$. Calculate the mass of copper deposited at the cathode. (Cu = 63.5) *[2]* (b) State Faraday's second law of electrolysis. *[1]*	3
14.	The rate constant of a reaction is 0.05 s^{-1} at 400 K and 0.20 s^{-1} at 450 K. Calculate the activation energy. (R = 8.314 J K^{-1} mol^{-1})	3
15.	(i) Write the balanced ionic equation for the reaction of acidified potassium dichromate with iron(II) ions. (ii) What is lanthanoid contraction? Give one consequence. (iii) Why is Ce^{4+} a good oxidising agent?	3

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16.	$[NiCl_4]^{2-}$ is paramagnetic and tetrahedral, whereas $[Ni(CN)_4]^{2-}$ is diamagnetic and square planar. Explain using valence bond theory. **OR** (a) Draw the geometrical isomers of $[Pt(NH_3)_2Cl_2]$. *[2]* (b) Why does $[Co(en)_3]^{3+}$ show optical isomerism? *[1]*	3
17.	An aromatic compound A (C_7H_6O) forms a silver mirror with Tollens' reagent. With concentrated NaOH it gives sodium benzoate and an alcohol B. (a) Identify A and B. (b) Write the equation for the reaction with NaOH and name it. (c) Give one test to distinguish A from acetophenone.	3
18.	Write the chemical equations for the following conversions: (i) benzene to aniline, (ii) aniline to sulphanilic acid, (iii) ethanamine to ethanol.	3

Section D (15 marks)

19.	A compound A (C_3H_6O) gives a yellow precipitate with iodine and NaOH but does not reduce Tollens' reagent. (a) Identify A. *[1]* (b) What is formed when A reacts with HCN? *[1]* (c) What is formed when A reacts with CH_3MgBr followed by hydrolysis? *[1]* (d) Name the product of Clemmensen reduction of A. *[1]* (e) What is formed when A is treated with dilute NaOH? *[1]* **OR** (a) Write the equation for the Rosenmund reduction. *[1]* (b) Write the equation for the Etard reaction. *[1]* (c) Write the equation for the Hell–Volhard–Zelinsky reaction of ethanoic acid. *[1]* (d) Why do carboxylic acids not give the characteristic reactions of the carbonyl group? *[1]* (e) Arrange CH_3COOH, $ClCH_2COOH$ and FCH_2COOH in increasing order of acidity. *[1]*	5
20.	(a) 250 mL of an aqueous solution contains 2.0 g of a protein. Its osmotic pressure at 300 K is 4.0×10^{-3} atm. Calculate the molar mass of the protein. (R = 0.0821 L atm K^{-1} mol^{-1}) *[2]* (b) Liquids X and Y form an ideal solution. At a certain temperature the vapour pressures of pure X and pure Y are 120 kPa and 40 kPa. Calculate the total vapour pressure of a solution with mole fraction of X = 0.25, and the mole fraction of X in the vapour. *[2]* (c) Why does 0.1 M NaCl have a higher osmotic pressure than 0.1 M glucose at the same temperature? *[1]*	5

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21.	(a) The limiting molar conductivities of HCl, NaCl and CH_3COONa are 425.9, 126.4 and 91.0 S cm^2 mol^{-1}. Calculate Λ°_m for CH_3COOH. *[2]* (b) If the molar conductivity of an acetic acid solution is 39.05 S cm^2 mol^{-1}, find its degree of dissociation. *[1]* (c) Calculate the emf at 298 K of the cell Ni | Ni^{2+}(0.1 M) || Ag^+(0.01 M) | Ag. (E° (Ni^{2+}/Ni) = −0.25 V, E°(Ag^+/Ag) = +0.80 V) *[2]* **OR** (a) The rate constant of a first-order reaction is 2.0×10^{-3} s^{-1}. How long will it take for 8.0 g of the reactant to fall to 2.0 g? *[2]* (b) A first-order reaction is 20% complete in 10 minutes. How long will it take to be 75% complete? *[2]* (c) What is a pseudo first-order reaction? Give one example. *[1]*	5

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Answers and Marking Scheme

Marks for each step are shown in brackets. Any correct alternative method gets full credit.

Section A (14 marks)

Question 1

(i) Sandmeyer; Gattermann.

(ii) independent; s^{-1}.

(iii) d^2sp^3; diamagnetic.

(iv) Tollens'; iodoform.

(v) **(c)** $K_3[Fe(CN)_6]$. *Working:* π = iCRT; $K_3[Fe(CN)_6]$ gives four ions ($3K^+ + [Fe(CN)_6]^{3-}$), the largest i.

(vi) **(a)** 5. *Working:* Mn changes from +7 to +2.

(vii) **(d)** 3.0×10^{-4} mol L^{-1} s^{-1}. *Working:* $-\frac{1}{2}\frac{d[N_2O_5]}{dt} = \frac{d[O_2]}{dt}$, so the rate of disappearance is twice 1.5×10^{-4}.

(viii) **(b)** $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > NH_3$. *Working:* In water the order depends on the inductive effect, solvation of the cation and steric hindrance together; for ethyl amines it is 2° > 3° > 1° > NH_3.

(ix) **(d)** sucrose. *Working:* In sucrose the reducing groups of glucose (C1) and fructose (C2) are both used in the glycosidic bond.

(x) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. *Working:* The colour seen is the complement of the light absorbed in the d–d transition.

(xi) **(c)** Assertion is true and Reason is false. *Working:* o-Nitrophenol has intramolecular hydrogen bonding, so its molecules are not associated and it is steam volatile; p-nitrophenol is associated by intermolecular hydrogen bonds.

(xii) Sulphuric acid is used up ($Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$) and water is formed, so the acid becomes more dilute.

(xiii) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$.

(xiv) Zinc has a more negative reduction potential than iron, so zinc is oxidised in preference and acts as a sacrificial anode.

Section B (20 marks)

2. Moles of glucose = 9.0/180 = 0.050; molality = 0.050/0.250 = 0.20 mol kg^{-1} (1). $\Delta T_b = 0.52 \times 0.20 = 0.104$ K, so the boiling point is 373.254 K (1).

3. $\Lambda_m = \frac{\kappa \times 1000}{c} = \frac{0.0025 \times 1000}{0.020} = 125$ S cm^2 mol^{-1} (1). It increases on dilution, because the volume containing one mole of electrolyte increases (and, for weak electrolytes, ionisation increases) (1).

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4. $k = \frac{0.693}{30} = 0.0231$ min^{-1} (1). 87.5% completion leaves 1/8 = (1/2)^3, i.e. three half-lives = 90 minutes (1).

OR (a) 1 + 2 = 3 (1). (b) New rate = k(½[A])(2[B])^2 = 2k[A][B]^2: the rate doubles (1).

5. (i) They have completely filled d orbitals (d^{10}) in the ground state and in their common oxidation state +2 (1). (ii) $Cr^{2+} \rightarrow Cr^{3+}$ gives the stable d^3 (half-filled t_2g) configuration, while $Mn^{3+} \rightarrow Mn^{2+}$ gives the stable half-filled d^5 configuration (1).

6. (i) Pentaamminecarbonatocobalt(III) chloride (1). (ii) Sodium tetrahydroxidozincate(II) (1).

OR (a) $t_2g^6\ e_g^0$, no unpaired electrons (low spin) (1). (b) $t_2g^4\ e_g^2$, four unpaired electrons (high spin) (1).

7. (i) Resonance gives the C–Cl bond in chlorobenzene partial double-bond character, and the carbon is sp^2 hybridised, so the bond is stronger and harder to break (1). (ii) The sp^2 carbon of chlorobenzene is more electronegative than the sp^3 carbon of cyclohexyl chloride, and resonance also opposes the C–Cl polarity, so the dipole moment is lower (1).

8. (i) Oxidation with sodium dichromate and sulphuric acid: $C_6H_5OH \rightarrow (Na_2Cr_2O_7/H_2SO_4)$ O=C_6H_4=O, p-benzoquinone (1). (ii) $C_6H_5OH + 3Br_2(aq) \rightarrow 2,4,6\text{-}Br_3C_6H_2OH$ (white precipitate) + 3HBr (1).

9. $CH_3COCH_3 < CH_3CHO < HCHO$ (1). Alkyl groups release electrons, making the carbonyl carbon less positive, and they also hinder the approach of the nucleophile; HCHO has no alkyl group and acetone has two (1).

10. $CH_3NH_2 + C_6H_5SO_2Cl \rightarrow C_6H_5SO_2NHCH_3$, which has an acidic N–H and dissolves in aqueous KOH (1). $(CH_3)_2NH + C_6H_5SO_2Cl \rightarrow C_6H_5SO_2N(CH_3)_2$, which has no H on nitrogen and is insoluble in alkali (1).

11. (i) It forms n-hexane, showing that the six carbon atoms are in a straight chain (1). (ii) It is oxidised to gluconic acid, showing the presence of an aldehyde group (1).

Section C (21 marks)

12. (a) \(M = \frac{K_f\times w\times1000}{\Delta T_f\times W} = \frac{5.12\times2.0\times1000}{0.64\times40}\) (1) = 400 g mol^{-1} (1). (b) Solute particles occupy part of the surface, so fewer solvent molecules can escape into the vapour (1).

13. (a) E°cell = 0.34 – (–0.76) = 1.10 V (1). (b) ΔG° = –nFE° = –2 × 96500 × 1.10 = –212300 J mol^{-1} = –212.3 kJ mol^{-1} (1). (c) The zinc electrode, where oxidation occurs (1).

OR (a) Q = 2.0 × 965 = 1930 C = 0.020 F (1). $Cu^{2+} + 2e^- \rightarrow Cu$, so 0.010 mol Cu = 0.635 g (1). (b) When the same charge passes through different electrolytes, the masses deposited are proportional to their equivalent masses (1).

14. $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{T_2-T_1}{T_1T_2}\right)$ (1). $\log 4 = 0.602 = \frac{E_a}{2.303\times8.314} \times \frac{50}{400\times450}$ (1). $E_a = 0.602 \times 19.15 \times 3600 \approx 4.15 \times 10^4$ J mol^{-1} = 41.5 kJ mol^{-1} (1).

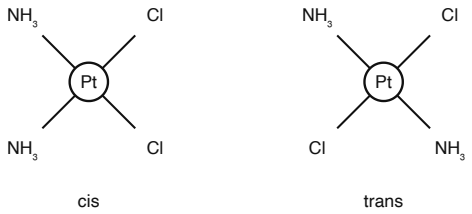
15. (i) $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$ (1). (ii) The steady decrease in atomic and ionic radii from La to Lu, due to poor shielding by 4f electrons; as a result Zr and Hf have almost

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equal radii and very similar properties (1). (iii) The most stable oxidation state of cerium is +3, so Ce^{4+} readily gains an electron (1).

16. Ni^{2+} is $3d^8$ (½). Cl^- is a weak ligand: the two unpaired 3d electrons remain, and 4s and 4p orbitals give sp^3 hybridisation: tetrahedral and paramagnetic (1). CN^- is a strong ligand: it pairs the 3d electrons, freeing one 3d orbital for dsp^2 hybridisation: square planar, no unpaired electrons, diamagnetic (1½).

OR (a) cis and trans isomers (1 each):



(b) The complex has no plane or centre of symmetry, so it exists as two non-superimposable mirror images (1).

17. (a) A is benzaldehyde, C_6H_5CHO; B is benzyl alcohol, $C_6H_5CH_2OH$ (1). (b) $2C_6H_5CHO + NaOH(conc.) \rightarrow C_6H_5CH_2OH + C_6H_5COONa$; Cannizzaro reaction (1). (c) Tollens' test: benzaldehyde gives a silver mirror, acetophenone does not (or acetophenone gives the iodoform test) (1).

18. (i) $C_6H_6 + HNO_3 \rightarrow$ (conc. H_2SO_4) $C_6H_5NO_2 + H_2O$; $C_6H_5NO_2 + 6[H] \rightarrow$ (Sn/HCl) $C_6H_5NH_2 + 2H_2O$ (1). (ii) $C_6H_5NH_2 + H_2SO_4(conc.) \rightarrow$ anilinium hydrogensulphate, which on heating at 453–473 K gives sulphanilic acid, p-$H_2N–C_6H_4–SO_3H$ (1). (iii) $C_2H_5NH_2 + HNO_2 \rightarrow C_2H_5OH + N_2 + H_2O$ (1).

Section D (15 marks)

19. (a) Propanone (acetone), CH_3COCH_3 (1). (b) Acetone cyanohydrin, $(CH_3)_2C(OH)CN$ (1). (c) 2-Methylpropan-2-ol, $(CH_3)_3COH$ (1). (d) Propane (1). (e) An aldol, 4-hydroxy-4-methylpentan-2-one (1).

OR (a) $C_6H_5COCl + H_2 \rightarrow$ (Pd/$BaSO_4$) $C_6H_5CHO + HCl$ (1). (b) $C_6H_5CH_3 + CrO_2Cl_2$ (in CS_2) $\rightarrow$ chromium complex $\rightarrow$ (H_3O^+) C_6H_5CHO (1). (c) $CH_3COOH + Cl_2 \rightarrow$ (red P) $ClCH_2COOH + HCl$ (1). (d) Resonance with the –OH oxygen lowers the electrophilic character of the carbonyl carbon (1). (e) $CH_3COOH < ClCH_2COOH < FCH_2COOH$ (1).

20. (a) $M = \frac{wRT}{\pi V} = \frac{2.0\times0.0821\times300}{4.0\times10^{-3}\times0.250}$ (1) ≈ 4.93 × 10^4 g mol^{-1} (1). (b) P = 0.25 × 120 + 0.75 × 40 = 60 kPa (1); y_X = 30/60 = 0.50 (1). (c) NaCl dissociates into two ions (i ≈ 2), so it has nearly twice as many solute particles (1).

21. (a) $\Lambda°(CH_3COOH) = \Lambda°(CH_3COONa) + \Lambda°(HCl) – \Lambda°(NaCl)$ (1) = 91.0 + 425.9 – 126.4 = 390.5 S cm^2 mol^{-1} (1). (b) α = 39.05/390.5 = 0.10 (1). (c) $Ni + 2Ag^+ \rightarrow Ni^{2+} + 2Ag$; E° = 0.80 – (–0.25) = 1.05 V. $E = 1.05 - \frac{0.059}{2}\log\frac{0.1}{(0.01)^2} = 1.05 - 0.0295\times3$ (1) ≈ 0.96 V (1).

OR (a) 8.0 g to 2.0 g is two half-lives (1); $t_{½}$ = 0.693/(2.0 × 10^{-3}) = 346.5 s, so t = 693 s (1). (b) $k = \frac{2.303}{10}\log\frac{100}{80} = 0.0223$ min^{-1} (1); $t = \frac{2.303}{0.0223}\log4 \approx 62$ min (1). (c) A reaction of higher order that

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behaves as first order because one reactant is in large excess, e.g. acid hydrolysis of ethyl acetate in excess water (1).

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