

IIT-JEE-Chemistry-Screening-2000

SCREENING

Time : Three hours

Max. Marks : 100

1. For the electrochemical cell, $M|M^+||X^-|X$, $E^\circ(M^+|M) = 0.44V$ and $E^\circ(X|X^-) = 0.33V$. From this data one can deduce that:
(A) $M + X \rightarrow M^+ + X^-$ is the spontaneous reaction.
(B) $M^+ + X^- \rightarrow M + X$ is the spontaneous reaction.
(C) $E_{\text{cell}} = 0.77V$
(D) $E_{\text{cell}} = -0.7V$
2. The $\Delta_f H^\circ$ for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are -393.5 , -110.5 and $-241.8 \text{ kJ mol}^{-1}$ respectively. The standard enthalpy change (in kJ mol^{-1}) for the reaction $CO_2(g) + H_{2(g)} \rightarrow CO(g) + H_2O(g)$ is:
(A) 524.1
(B) 41.2
(C) -262.5
(D) -41.2
3. The number of P — O — P bonds in cyclic metaphosphoric acid is:
(A) zero
(B) two
(C) three
(D) four
4. The chemical processes in the production of steel from haematite ore involve:
(A) reduction
(B) oxidation
(C) reduction followed by oxidation
(D) oxidation followed by reduction
5. Which of the following has the highest nucleophilicity:
(A) F^-
(B) OH^-
(C) CH_3^-
(D) NH_2^-
6. The order of reactivities of the following alkyl halides for a SN_2 reaction is:
(A) $RF > RCl > RBr > RI$
(B) $RF > RBr > RCl > RI$
(C) $RCl > RBr > RF > RI$
(D) $RI > RBr > RCl > \text{therefore}$
7. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$. This represents its:
(A) excited state
(B) ground state
(C) cationic form
(D) anionic form

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8. The correct order of acidic strength is:

- (A) $\text{Cl}_2\text{O}_7 > \text{SO}_2 > \text{P}_2\text{O}_5$ (B) $\text{CO}_2 > \text{N}_2\text{O}_5 > \text{SO}_3$
(C) $\text{Na}_2\text{O} > \text{MgO} > \text{Al}_2\text{O}_3$ (D) $\text{K}_2\text{O} > \text{CaO} > \text{MgO}$

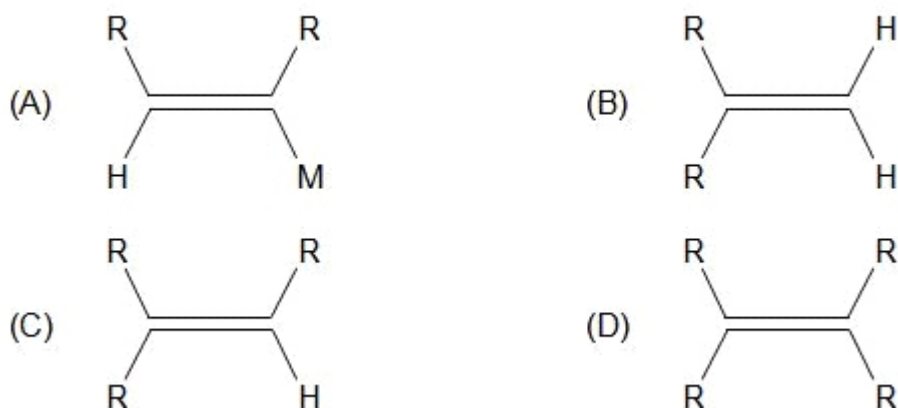
9. Which of the following, has the most acidic hydrogen:

- (A) 3-hexanone (B) 2, 4-hexanedione
(C) 2, 5-hexanedione (D) 2, 3-hexanedione

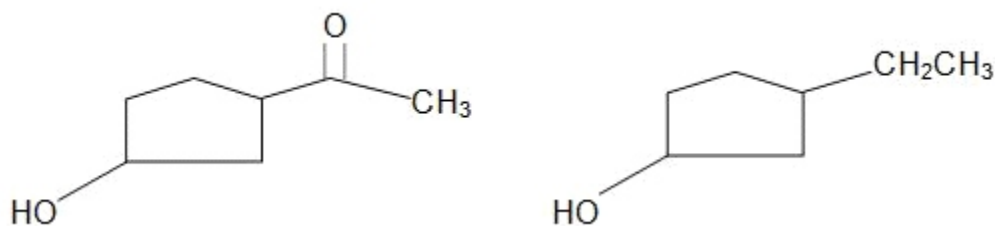
10. Benzoyl chloride is prepared from benzoic acid by:

- (A) $\text{Cl}_2, h\nu$ (B) SO_2Cl_2
(C) SOCl_2 (D) $\text{Cl}_2, \text{H}_2\text{O}$

11. Which one of the following alkenes will react fastest with H_2 under catalytic hydrogenation condition :



12. The appropriate reagent for the following transformation :



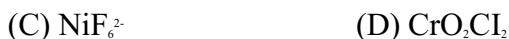
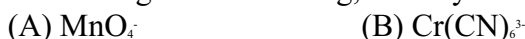
- (A) Zn(Hg), HCl (B) $\text{NH}_2\text{NH}_2, \text{OH}^-$
(C) H_2/Ni (D) NaBH_4

13. Electrolytic reduction of alumina to aluminium by Hall-Heroult process is carried out:

- (A) in the presence of NaCl .
(B) in the presence of fluorite.
(C) in the presence of cryolite which forms a melt with lower melting temperature.
(D) in the presence of cryolite which forms a melt with higher melting temperature.

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14. Amongst the following, identify the species with an atom in +6 oxidation state.



15. For the reversible reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) = 2\text{NH}_3(\text{g})$ at 500°C, the value of K_p is 1.44×10^{-5} when partial pressure is measured in atmospheres. The corresponding value of K_c with concentration in mol L^{-1} is:

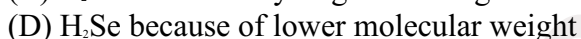
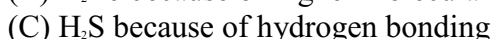
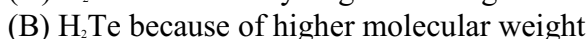
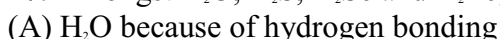
(A) $1.44 \times 10^{-5}/(0.082 \times 500)^2$ (B) $1.44 \times 10^{-5}/(8.314 \times 773)^2$

(C) $1.44 \times 10^{-5}/(0.082 \times 773)^2$ (D) $1.44 \times 10^{-5}/(0.082 \times 773)^2$

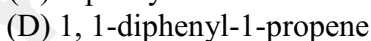
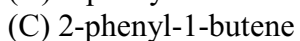
16. The hybridization of atomic orbitals of nitrogen in NO_2^+ , NO_3^- and NH_4^+ are:



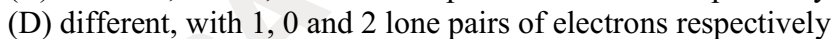
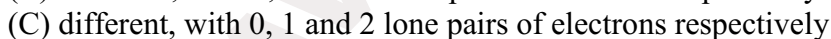
17. Amongst H_2O , H_2S , H_2Se and H_2Te , the one with the highest boiling point is:



18. Which of the following compounds will exhibit geometrical isomerism:



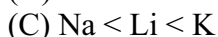
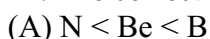
19. Molecular shapes of SF_4 , CF_4 and XeF_4 are:



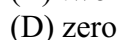
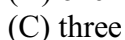
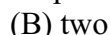
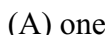
20. Among the following, the strongest base is:



21. The correct order of radii is:



22. The number of nodal planes in a p_x orbital is:



23. Ammonia can be dried by:

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- (C) CaO (D) anhydrous CaCl₂

24. The rms velocity of hydrogen is $\sqrt{7}$ times the rms velocity of nitrogen. If T is the temperature of the gas:

- (A) $T(\text{H}_2) = T(\text{N}_2)$ (B) $T(\text{H}_2) > T(\text{N}_2)$
(C) $T(\text{H}_2) < T(\text{N}_2)$ (D) $T(\text{H}_2) = \sqrt{7} T(\text{N}_2)$

25. Propyne and propene can be distinguished by:

- (A) conc. H₂SO₄ (B) Br₂ in CCl₄
(C) dil. KMnO₄ (D) AgNO₃ in ammonia

26. Which one of the following will most readily be dehydrated in acidic condition:



27. The compressibility of a gas is less than unity at STP. Therefore :

- (A) $V_m > 22.4$ litres (B) $V_m < 22.4$ litres
(C) $V_m = 22.4$ litres (D) $V_m = 44.8$ litres

28. The rate constant for the reaction, $2\text{N}_2\text{O}_5 \rightarrow 4\text{NO}_2 + \text{O}_2$ is $3.0 \times 10^{-5} \text{ s}^{-1}$. If the rate is $2.40 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$, then the concentration of N_2O_5 (in mol L^{-1}) is :

- (A) 1.4 (B) 1.2
(C) 0.04 (D) 0.8

29. At 100°C and 1 atm if the density of the liquid water is 1.0 g cm^{-3} and that of water vapour is 0.0006 g cm^{-3} , then the volume occupied by water molecules in 1 litre of steam at this temperature is:

- (A) 6 cm^3 (B) 60 cm^3
(C) 0.6 cm^3 (D) 0.06 cm^3

30. When two reactants, A and B are mixed to give products C and D, the reaction quotient, Q, at the initial stages of the reaction :

- (A) is zero (B) decreases with time
(C) is independent of time (D) increases with time

The questions below consist of an 'Assertion' in column I and the 'Reason' in column 2. Use of the following key to choose the appropriate answer.

- (A) If both assertion and reason are CORRECT, and reason is the CORRECT explanation

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of the assertion.

(B) If both assertion and reason are CORRECT, but reason is NOT the CORRECT explanation of the assertion.

(C) If assertion is CORRECT, but reason is INCORRECT.

(D) If assertion is INCORRECT, but reason is CORRECT.

	Assertion	Reason
31.	1-Butene on reaction with HBr in the presence of a peroxide produces 1-bromobutane	It involves the formation of primary radical.
32.	The first ionization energy of Be is greater than that of B.	2p orbital is lower in energy than 2s.
33.	The pressure of a fixed amount of an ideal gas is proportional to its temperature	Frequency of collisions and their impact both increase in proportion to the square root of temperature.
34.	Phenol is more reactive than benzene towards electrophilic substitution reaction	In the case of phenol, the intermediate carbocation is more resonance stabilized.
35.	The heat absorbed during the isothermal expansion of an ideal gas against vacuum is zero	The volume occupied by the molecules of an ideal gas is zero.

MAINS

Time : Two hours

Max. Marks : 100

General Instructions :

1. There are ten questions in this paper. Attempt all Questions.
2. Answer each question starting on a new page. The corresponding question number must be written in the left margin. Answer all the parts of a question at one place only.
3. Use only Arabic numerals (0, 1, 29) in answering the questions irrespective of the language in which your answer.
4. Use of logarithmic tables is not permitted.
5. Use of calculator is NOT PERMITTED.

1. (a) Write the chemical reactions associated with the 'brown ring test'.

(b) Draw the structures of $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{Ni}(\text{CO})_4]$. Write

the hybridization of atomic orbitals of the transition metal in each case.

(c) An aqueous blue coloured solution of a transition metal sulphate reacts with H_2S in

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acidic medium to give a black precipitate A, which is insoluble in warm aqueous solution of KOH. The blue solution on treatment with KI in weakly acidic medium, turns yellow and produces a white precipitate B. Identify the transition metal ion. Write the chemical reactions involved in the formation of A and B.

2. (a) Give an example of oxidation of one halide by another halogen. Explain the feasibility of the reaction.

(b) Write the MO electron distribution of O_2 . Specify its bond order and magnetic property.

(c) ${}_{92}^{238}\text{U}$ is radioactive and it emits α and β particles to form ${}_{82}^{206}\text{Pb}$. Calculate the number of α and β particles emitted in this conversion. An ore of ${}_{92}^{238}\text{U}$ is found to contain ${}_{92}^{238}\text{U}$ and ${}_{82}^{206}\text{Pb}$ in the weight ratio of 1 : 0.1. The half-life period of ${}_{92}^{238}\text{U}$ is 4.5×10^9 years. Calculate the age of the ore.

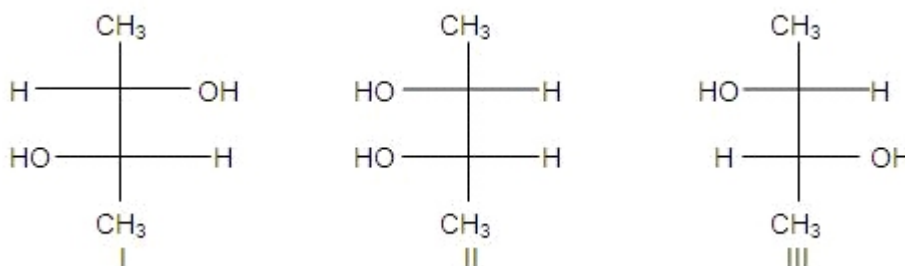
3. (a) (i) Give an example of oxidation of one halide by another halogen. Explain the feasibility of the reaction.

(ii) Write the balanced chemical equation for developing photographic films.

(b) Write the chemical reactions associated with the 'borax bead test' of cobalt (II) oxide.

(c) Draw the molecular structures of XeF_2 , XeF_4 and XeO_2F_2 , indicating the location of lone pair(s) of electrons.

4. (a) Identify the pairs of enantiomers and diastereomers from the following compounds I, II and III.



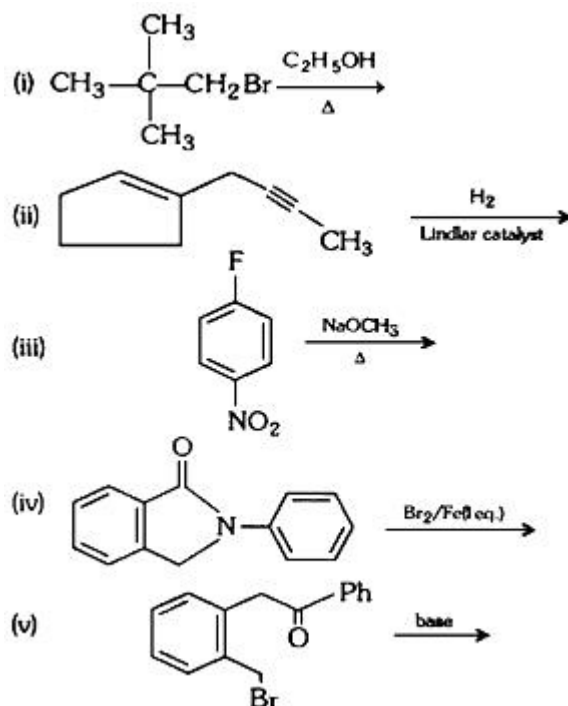
(b) Give reasons for the following :

(i) tert-Butylbenzene does not give benzoic acid on treatment with acidic KMnO_4 .

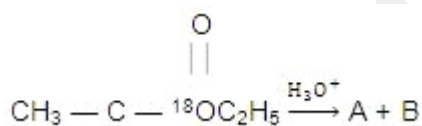
(ii) $\text{CH}_2 = \text{CH}^-$ is more basic than $\text{HC} \equiv \text{C}^-$.

(iii) Normally, benzene gives electrophilic substitution reaction rather than electrophilic addition reaction although it has double bonds.

(c) What would be the major product in each of the following reactions?



5. (a) Write the structures of the products A and B.



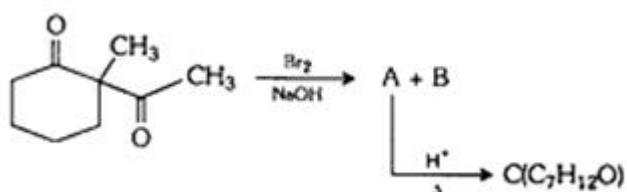
(b) How would you bring about the following conversion (in 3 steps)?

Aniline \rightarrow Benzylamine

(c) An organic compound A, $\text{C}_6\text{H}_{10}\text{O}$, on reaction with CH_3MgBr followed by acid treatment gives compound B. The compound B on ozonolysis gives compound C, which in presence of a base gives 1-acetyl cyclopentene D. The compound B on reaction with HBr gives compound E. Write the structures of A, B, C and E. Show how D is formed from C.

6. (a) Write the structures of alkaline at $\text{pH} = 2$ and $\text{pH} = 10$.

(b) Identify A, B and C, and give their structures.



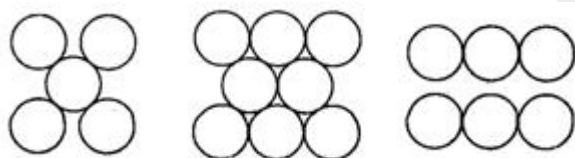
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(c) An organic compound A, $C_8H_4O_3$, in dry benzene in the presence of anhydrous $AlCl_3$ gives compound B. The compound B on treatment with PCl_5 , followed by reaction with $H_2/Pb(BaSO_4)$ gives compound C, which on reaction with hydrazine gives a cyclised compound D ($C_{14}H_{10}N_2$). Identify A, B, C and D. Explain the formation of D from C.

7. (a) The average concentration of SO_2 in the atmosphere over a city on a certain day is 10 ppm, when the average temperature is 298 K. Given that the solubility of SO_2 in water at 298 K is $1.3653 \text{ moles litre}^{-1}$ and pK_a of H_2SO_3 is 1.92, estimate the pH of rain on that day.

(b) Calculate the pressure exerted by one mole of CO_2 gas at 273 K if the Van der Waals constant $a = 3.592 \text{ dm}^6 \text{ atm mol}^{-2}$. Assume that the volume occupied by CO_2 molecules is negligible.

(c) The figures given below show the location of atoms in three crystallographic planes in a FCC lattice. Draw the unit cell for the corresponding structures and identify these planes in your diagram.



8. (a) A hydrogenation reaction is carried out at 500 K. If the same reaction is carried out in the presence of a catalyst at the same rate, the temperature required is 400 K. Calculate the activation energy of the reaction if the catalyst lowers the activation barrier by 20 kJ mol^{-1} .

(b) Copper sulphate solution (250 mL) was electrolysed using a platinum anode and a copper cathode. A constant current of 2 mA was passed for 16 minutes. It was found that after electrolysis the absorbance of the solution was reduced to 50% of its original value. Calculate the concentration of copper sulphate in the solution to begin with.

(c) Calculate the energy required to excite one litre of hydrogen gas at 1 atm and 298 K to the first excited state of atomic hydrogen. The energy for the dissociation of $H-H$ bond is 436 kJ mol^{-1} .

9. (a) A sample of argon gas at 1 atm pressure and 27°C expands reversibly and adiabatically from 1.25 dm^3 to 2.50 dm^3 . Calculate the enthalpy change in this process. $C_{V,m}$ for argon is $12.49 \text{ J K}^{-1} \text{ mol}^{-1}$.

(b) To 500 cm^3 of water, $3.0 \times 10^{-3} \text{ kg}$ of acetic acid is added. If 23% of acetic acid is dissociated, what will be the depression in freezing point? K_f and density of water are $1.86 \text{ K kg mol}^{-1}$ and 0.997 g cm^{-3} , respectively.

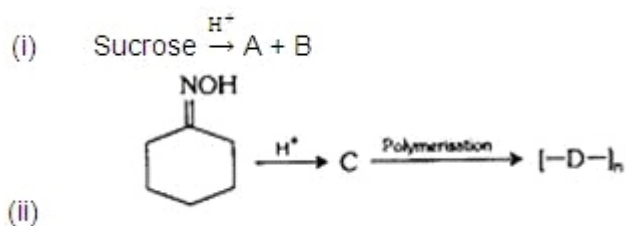
(c) Show that the reaction $CO(g) + (1/2)O_2(g) \rightarrow CO_2(g)$ at 300 K, is spontaneous and

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exothermic, when the standard entropy change is $-0.094 \text{ kJ mol}^{-1} \text{ K}^{-1}$. The standard Gibbs free energies of formation for CO_2 and CO are -394.4 and $-137.2 \text{ kJ mol}^{-1}$, respectively.

10. (a) Give reasons(s) why elemental nitrogen exists as a diatomic molecular whereas elemental phosphorus is a tetraatomic molecule.

(b) Give the structures of the products in each of the following reaction.

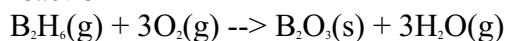


(c) The following electrochemical cell has been set up.

$\text{Pt}(1)|\text{Fe}^{3+}, \text{Fe}^{2+} (a = 1)|\text{Ce}^{4+}, \text{Ce}^{3+} (a = 1)|\text{Pt}(2)$

$\text{EO}(\text{Fe}^{3+}, \text{Fe}^{2+}) = 0.77 \text{ V}$ and $\text{EO}(\text{Ce}^{4+}, \text{Ce}^{3+}) = 1.61 \text{ V}$.

(d) Diborane is a potential rocket fuel which undergoes combustion according to the reaction



From the following data, calculate the enthalpy change for the combustion of diborane.

