

Code No.

L – 4029

**Entrance Examination for Admission to the P.G. Courses in the Teaching  
Departments, 2021**

**CSS**

**CHEMISTRY/RENEWABLE ENERGY**

**General Instructions**

- The Question Paper is having two Parts — Part 'A' Objective type (60%) & Part 'B' Descriptive type (40%).
- Objective type questions which carry 1 mark each are to be (✓) 'tick marked' in the response sheets against the appropriate answers provided.
- 8 questions are to be answered out of 12 questions carrying 5 marks each in Part 'B'.
- Negative marking** : 0.25 marks will be deducted for each wrong answer in Part 'A'.

**Time : 2 Hours**

**Max. Marks : 100**

To be filled in by the Candidate									
Register Number	in Figures								
	in words								

**PART – A**

(Objective Type)

Choose appropriate answer from the options in the questions. **One mark each.**

**(60 × 1 = 60 marks)**

- The bond order and the order of bond enthalpy for  $O_2$ ,  $O_2^-$  and  $O_2^{2-}$  is
 

a) 2,1.5,1; $O_2 > O_2^- > O_2^{2-}$	b) 1,1.5,2; $O_2 < O_2^- < O_2^{2-}$
c) 1,2,1.5; $O_2 < O_2^{2-} < O_2^-$	d) 1,2,3; $O_2 > O_2^- > O_2^{2-}$

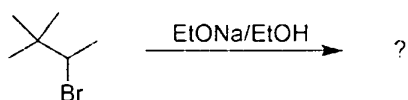
DO NOT WRITE HERE

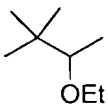


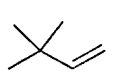
- 
2. The number of  $\alpha$  and  $\beta$  particles generated in the following radioactive decay process are,
- |                           |                           |
|---------------------------|---------------------------|
| a) $1\alpha$ and $1\beta$ | b) $2\beta$               |
| c) $1\alpha$ and $2\beta$ | d) $2\alpha$ and $2\beta$ |
3. Among the following which one is not an intermetallic compound
- |             |             |
|-------------|-------------|
| a) $MgZn_2$ | b) $Cu_3Au$ |
| c) $CuZn$   | d) $SnAs$   |



11. Which of the following is a disproportionation reaction
- $2\text{Cu}^+_{(\text{aq})} \rightarrow \text{Cu}^{2+}_{(\text{aq})} + \text{Cu}_{(\text{s})}$
  - $4\text{Fe}^{2+}_{(\text{aq})} + \text{O}_{2(\text{g})} + 4\text{H}^+_{(\text{aq})} \rightarrow 4\text{Fe}^{3+}_{(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})}$
  - $2\text{Sc}_{(\text{s})} + 6\text{H}^+_{(\text{aq})} \rightarrow 2\text{Sc}^{3+}_{(\text{aq})} + 3\text{H}_{2(\text{g})}$
  - $4\text{Co}^{3+}_{(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})} \rightarrow 4\text{Co}^{2+}_{(\text{aq})} + \text{O}_{2(\text{g})} + 4\text{H}^+_{(\text{aq})}$
12. The gas evolved when  $\text{PbO}_2$  is treated with Conc.  $\text{HNO}_3$ ?
- $\text{NO}_2$
  - $\text{O}_2$
  - $\text{N}_2$
  - $\text{N}_2\text{O}$
13. The metal ion that can give an EPR signal is
- $\text{Co}^+$
  - $\text{Cu}^+$
  - $\text{Ni}^{2+}$
  - $\text{Cu}^{2+}$
14. Example for a polydentate ligand is
- $\text{NO}_3^-$
  - $\text{NO}_2^-$
  - $\text{NCS}^-$
  - $\text{SCN}^-$
15. The octahedral crystal field splitting ( $\Delta_0$ ) of d-orbital energies of the following metal ions decreases in the order
- $\text{Co}^{2+} > \text{Co}^{3+} > \text{Rh}^{3+}$
  - $\text{Rh}^{3+} > \text{Co}^{3+} > \text{Co}^{2+}$
  - $\text{Rh}^{3+} > \text{Co}^{2+} > \text{Co}^{3+}$
  - $\text{Co}^{3+} > \text{Co}^{2+} > \text{Rh}^{3+}$
16. Identify the isoelectronic pairs
- $\text{NO}$  and  $\text{CO}$
  - $\text{BH}_3$  and  $\text{NH}_3$
  - $\text{BH}_3$  and  $\text{CH}_3^+$
  - $\text{O}_2$  and  $\text{N}_2$
17. The correct order of fundamental vibrational frequencies for the following diatomic molecules is
- ${}^1\text{H}^{35}\text{Cl} > {}^1\text{H}^{37}\text{Cl} > {}^2\text{D}^{35}\text{Cl}$
  - ${}^2\text{D}^{35}\text{Cl} > {}^1\text{H}^{37}\text{Cl} > {}^1\text{H}^{35}\text{Cl}$
  - ${}^1\text{H}^{37}\text{Cl} > {}^1\text{H}^{35}\text{Cl} > {}^2\text{D}^{35}\text{Cl}$
  - ${}^1\text{H}^{37}\text{Cl} > {}^2\text{D}^{35}\text{Cl} > {}^1\text{H}^{37}\text{Cl}$

18. Low spin Iron (III) centre is found in  
 a) deoxy form of haemoglobin      b) oxy form of haemoglobin  
 c) Haemocyanin      d) Carbonic anhydrase
19. The rodenticide action of  $Zn_3P_2$  is due to the formation of  
 a)  $Zn(OH)_2$       b)  $PH_3$   
 c)  $ZnCO_3$       d)  $P_4$
20. Which among the following is an indicator used in complexometric titrations  
 a) Methyl Orange      b) Phenolphthalein  
 c) Murexide      d) Methylene Blue
21. When a dry hydrogen halide (HX) was dissolved in an alcohol [ROH] the solution conducted electricity and an alkyl halide is formed. The order of reactivity for different ROH towards the given HX was  $3^\circ > 2^\circ > 1^\circ < CH_3$ . The reaction could be  
 a)  $S_N^1$       b)  $S_N^2$   
 c)  $S_NAr$       d)  $S_E^2$
22. In the following reaction choose the product that can be formed with a 2<sup>nd</sup> order rate constant.

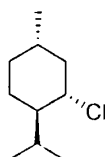
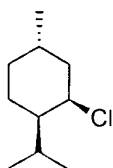


- a)       b) 
- c)       d) 
23. The correct order of solubility of following alcohols in water is,  
 a)  $CH_3OH > CH_3CH_2OH > CH_3(CH_2)_3OH < CH_3(CH_2)_7OH$   
 b)  $CH_3OH > CH_3CH_2OH > CH_3(CH_2)_3OH > CH_3(CH_2)_7OH$   
 c)  $CH_3CH_2OH > CH_3OH > CH_3(CH_2)_7OH > CH_3(CH_2)_3OH$   
 d)  $CH_3(CH_2)_7OH > CH_3(CH_2)_3OH > CH_3CH_2OH > CH_3OH$

24. The suitable reagent for the preparation of a *cis*-alkene from an alkyne is

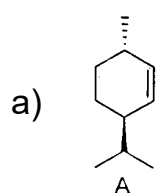
- a)  $\text{NH}_2\text{NH}_2 \cdot \text{H}_2\text{O}$                       b)  $\text{Na, Liq. NH}_3$   
 c)  $\text{H}_2$ , Lindlar's Catalyst                d)  $\text{NaBH}_4$

25. In the base catalysed elimination of HCl from neomenthyl chloride two products A and B are formed, whereas, menthyl chloride under the same conditions gave only one product.

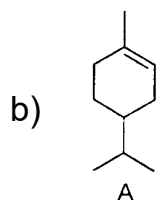
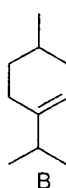


Neomenthyl chloride      Menthyl chloride

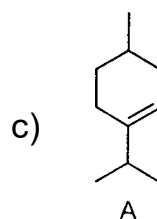
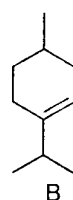
The products A and B are,



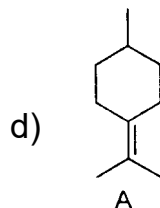
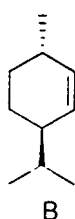
&



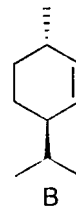
&



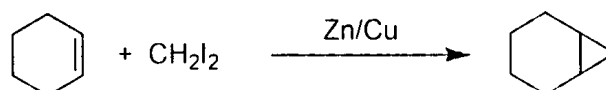
&



&

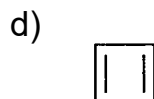
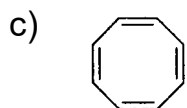
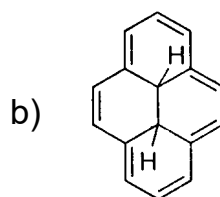
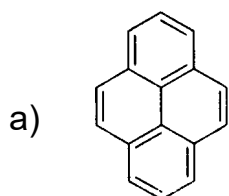


26. The reactive species involved in the following reaction is



- a) Carbene    b) Carbenoid  
 c) Carbanion                                        d) Carbocation

27. Choose the molecule that is non-aromatic



28. The number of signals/peaks in the  $^1\text{H}$ NMR spectrum of 1,3-dichloropropane is

a) One

b) Two

c) Three

d) Four

29. In Phenylacetylene the methine proton resonance at  $\delta$

a) 6.5 ppm

b) 1.7 ppm

c) 4.5 ppm

d) 9.0 ppm

30. The picrate of an aromatic hydrocarbon is

a) an ester

b) a salt

c) a charge - transfer complex

d) a coordination complex

31. A positive Hoffmann's isocyanide test can be obtained for

a)  $\text{CH}_3\text{CH}_2\text{OH}$

b)  $\text{CH}_3\text{CH}_2\text{NH}_2$

c)  $\text{CH}_3\text{NHCH}_3$

d)  $\text{CH}_3\text{OCH}_3$

32. The Tollen's test will not be positive for

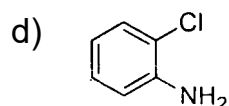
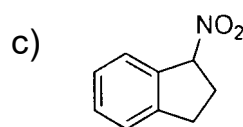
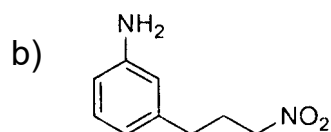
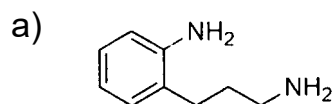
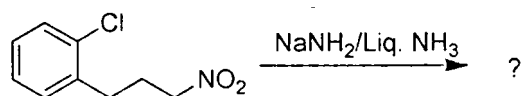
a) Glucose

b) Benzaldehyde

c) Phenylacetylene

d) Diphenylacetylene

33. The major product formed in the following reaction is



34. The complementary DNA sequence for 5'-G-A-A-T-T-C-3' is

a) 5'-C-T-T-A-AG-3'

b) 5'-C-U-U-A-A-G-3'

c) 3'-C-T-T-A-A-G-5'

d) 3'-G-A-A-T-T-C-5'

35. The amino acid with 'R' configuration is

a) L-leucine

b) L-alanine

c) L-valine

d) L-cysteine

36. 100% racemic diads are found in

a) Atactic polymers

b) Syndiotactic polymers

c) Isotactic polymers

d) Elastic polymers





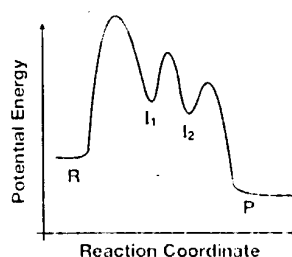
41. A gas at constant temperature occupies a volume of 0.2 L at a pressure of 0.64 atm. The same gas was subjected to a pressure change to 0.80 atm. Calculate the resulting volume of the gas.  
a) 0.20L                      b) 0.32L                      c) 0.08L                      d) 0.16L
42. Choose an appropriate vessel from the given set for an isothermal process involving a gas.  
a) Glass cylinder                      b) A bamboo cylinder  
c) Thermos Flask                      d) Copper vessel
43. Choose the exothermic process from the following  
a) Combustion of LPG  
b) Splitting of water into hydrogen and oxygen  
c) Dehydrogenation of ethane to ethane  
d) Conversion of graphite to Diamond
44. Which among the following can give the lowest freezing point for its 0.1M aqueous solution?  
a)  $K_2SO_4$                       b) NaCl                      c) Urea                      d) Glucose
45. Which among the Following is an intensive property?  
a) Mass                      b) Volume                      c) Enthalpy                      d) Pressure
46. Refrigeration technology uses,  
a) Faraday Effect                      b) Joule - Thomson Effect  
c) Gibbs - Thomson Effect                      d) Jahn - Teller Effect
47. A regular solution is one with  
a)  $H^E = 0$                       b)  $H^E = S^E$                       c)  $S^E \neq 0$                       d)  $H^E \neq 0$
48. For a linear molecule having N atoms, the number of independent vibrational modes is  
a)  $3N-6$                       b)  $3N-5$                       c)  $3N$                       d)  $3N+6$
49. Choose the right statement  
a) A bonding  $\sigma$  orbital has even parity  
b) A bonding  $\sigma$  orbital has odd parity  
c) An antibonding  $\sigma$  orbital has even parity  
d) A bonding  $\pi$  orbital has even parity

50. In the ESR spectrum a hyperfine interaction between an electron and a spin  $\frac{1}{2}$  nucleus can give,
- one line
  - two lines of equal intensity
  - three lines with intensity ratios 1:2:1
  - four lines with intensity ratios 1:2:2:1

51.  $t_{1/2}$  for a second order conversion of A to p is,

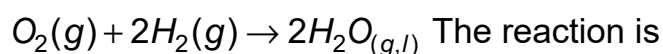
- a)  $\frac{[A]_0}{2k}$       b)  $\frac{\ln 2}{k}$       c)  $\frac{\ln k}{[A]_0}$       d)  $\frac{1}{k[A]_0}$

52. From the given reaction coordinate diagram identify the rate determining step



- a)  $R \rightarrow I_1$       b)  $I \rightarrow I_2$   
 c)  $I_2 \rightarrow P$       d)  $I_2 \rightarrow I_1$

53. The following reaction describes burning of hydrogen gas in air



- Not spontaneous as there are less number of molecules after the reaction ( $\Delta S < 0$ )
- Spontaneous as there are less number of molecules after the reaction ( $\Delta S > 0$ )
- Spontaneous as there is a 'pop' sound during the reaction and  $\Delta S_{\text{surr}} \gg 0$
- Non spontaneous and  $\Delta S_{\text{tot}} = 0$



ANSWER SHEET — PART — A

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

21	A	B	C	D	E
22	A	B	C	D	E
23	A	B	C	D	E
24	A	B	C	D	E
25	A	B	C	D	E
26	A	B	C	D	E
27	A	B	C	D	E
28	A	B	C	D	E
29	A	B	C	D	E
30	A	B	C	D	E
31	A	B	C	D	E
32	A	B	C	D	E
33	A	B	C	D	E
34	A	B	C	D	E
35	A	B	C	D	E
36	A	B	C	D	E
37	A	B	C	D	E
38	A	B	C	D	E
39	A	B	C	D	E
40	A	B	C	D	E

41	A	B	C	D	E
42	A	B	C	D	E
43	A	B	C	D	E
44	A	B	C	D	E
45	A	B	C	D	E
46	A	B	C	D	E
47	A	B	C	D	E
48	A	B	C	D	E
49	A	B	C	D	E
50	A	B	C	D	E
51	A	B	C	D	E
52	A	B	C	D	E
53	A	B	C	D	E
54	A	B	C	D	E
55	A	B	C	D	E
56	A	B	C	D	E
57	A	B	C	D	E
58	A	B	C	D	E
59	A	B	C	D	E
60	A	B	C	D	E



## CHEMISTRY/RENEWABLE ENERGY

### PART – B

(Descriptive Type)

Answer **any eight** questions.

**(8 × 5 = 40 Marks)**

- Write a note on reactivity of Lanthanides.
  - Explain why separation of lanthanides difficult.
- Explain HSAB principle.
  - Comment on the acidity of  $VO$ ,  $V_2O_3$ ,  $V_2O_5$ .
- Draw all possible geometrical isomers for  $[Co(H_2O)_2(ox)BrCl]$  where  $ox = ^- OOC - COO^-$ .
  - Discuss about optical isomerism in coordination compounds using suitable examples.
- Give the structure and describe function of haemoglobin.
  - Explain sodium potassium pump
- Explain the mechanism
  - Wagner – Meerwein rearrangement and
  - Reimer-Tiemann reaction using suitable examples .

6. Malonic acid (A,  $C_3H_4O_3$ ), a dibasic acid on reaction with B ( $CH_4N_2O$ ) in the presence of  $POCl_3$  formed a cyclic compound C ( $C_4H_4N_2O_3$ ). C readily condensed with benzaldehyde giving D, which on  $CrO_3$  oxidation gave compound of E ( $C_4H_2N_2O_4$ ) a starting material for the preparation of an important Dye and indicator Murexide. Compound B has two amino groups but failed to give the test for amines and C is a strong acid with  $pK_a = 4.01$ . Identify compounds, B, C, D and E. Suggest a reason for the strong acid nature of compound C.
7. An unknown compound with molecular formula  $C_4H_{10}O$  was analysed by FTIR and  $^1H$ NMR. FTIR spectra gave a broad peak in the range  $3500-3200\text{ cm}^{-1}$  and peaks of medium and strong intensities at  $2850\text{ cm}^{-1}$  and  $1320\text{ cm}^{-1}$ .  $^1H$  NMR spectra showed peaks with  $\delta$  values at 0.95 ppm (doublet, 6H), 1.75 ppm (nonet, 1H), 2.4 ppm (triplet, 1H) and 3.4 ppm (doublet of doublet, 2H). Identify the structure of the compound.
8. (a) How will you distinguish between pentan-2-one and pentan-3-one by mass spectroscopy?
- (b) Give one synthetic application each for Organolithium and lithium organocuprate reagents.
9. A flask containing 6.4 g of methane gas is kept at a temperature of  $0^\circ\text{C}$ . Calculate the pressure exerted by the gas using ideal gas equation and Van der Waals equation. Van der Waals constants  $a$  and  $b$  for methane are  $2.3026\text{ dm}^6\text{ bar mol}^{-2}$  and  $0.043067\text{ dm}^3\text{ mol}^{-1}$  respectively. The experimentally observed pressure is 3.11 bar. Explain why there are variations between the calculated and experimental values.
10. Carbonic acid is expected to be a diprotic acid with two  $K_a$  values ( $4.3 \times 10^{-7}$  and  $5.6 \times 10^{-11}$ ). But in practice it is classified as a monoprotic acid. Explain why?
11. Define Partition Function. Derive an expression for the partition function for a rigid rotor taking HCl as an example.
12. Discuss about Lindemann-Hinshelwood mechanism.

























