Bachelor of Engineering Examination, 2019
(1st Year, 1st Semester)
CHEMISTRY

Time: Three hours **Full Marks: 100**

[USE SEPARATE ANSWERSRIPTS FOR CHEMISTRY-I, CHEMISTRY-II and CHEMISTRY-III]

CHEMISTRY-I

CO 1

Answer any three questions of the following:

Q 1.

(a) State Bohr postulates for the H atom and derive the necessary energy expression of the electron in terms of Bohr concept. 2 + 3

(b) What would be the wavelength of the 3rd line in the Lyman series in the emission spectra of the H atom? [Given $R_\infty = 109677\ cm^{-1}$] 2

(c) Calculate the ionization energies of He^+ and Li^{2+}. 3

Q 2.

(a) Write a short explanatory note on the "Heisenberg Uncertainty Principle". 2

(b) Considering $\lambda = h/mv$, after de Broglie, derive Bohr's postulate of $mvr = nh/2\pi$ 3

(c) Two minute particles having masses 1×10^{-12} grams and 3×10^{-14} grams are running with velocities of 1×10^7 cm/sec and 5×10^9 cm/sec respectively. What would be the wavelengths associated with their motions? 3

(d) Mention limitations of Bohr's theory. 2

Q 3.

(a) Construct the Born-Haber cycle for the formation of NaCl. From the following data provided in kJ/mole calculate the lattice energy of NaCl.

$Na(s) \rightarrow Na(g)$: +109; $Na(g) \rightarrow Na^+(g)$: +494; $\frac{1}{2}Cl_2(g) \rightarrow Cl(g)$: +121;

$Cl(g) \rightarrow Cl^-(g)$: -347; heat of formation of NaCl(s): -414. **3 + 3**

(b) Predict the shapes of the following species (any two) using any theory of your choice

XeF_2, SF_4, I_3^-, BrF_3, XeF_4 **2 × 2 = 4**

Q 4.

(a) Arrange the following compounds in the increasing order of their melting points:

CaF_2, $CaCl_2$, $CaBr_2$, CaI_2 **2**

(b) What do you mean by a buffer solution? Give examples. Discuss mechanism of buffer action. What is buffer capacity? **2 + 1 + 3 + 2**

Q 5.

(a) What will be the pH of an aqueous solution of 1×10^{-3} M acetic acid? Given: pK_a of acetic acid = 4.74. **3**

(b) Define ionic product of water. Discuss the effect of temperature on it. **2 + 2**

(c) A solution containing 0.5 M acetic acid and 0.5 M sodium acetate has a pH of 4.74. What would be the pH of the solution upon the addition of 1mL of 0.01 M HCl to 1 L of the above solution. (K_a of acetic acid = 1.81×10^{-5}). **3**

CO2

Answer any two questions of the following:

Q 6.

(a) Write a short note on rusting of iron. 5

(b) What do you mean by nano-particles? Describe any method for the preparation of silver or gold nano particles. 2 + 3

Q 7.

(a) Derive $t_{½} = 0.693/\lambda$ where symbols have their usual meaning, for a single step radioactive disintegration process. 4

(b) What are the essential differences between a radioactive reaction and a purely chemical reaction? 3

(c) How does nuclear stability depend on the n/p ratio? 3

Q 8.

(a) Explain α and β decay with regard to a radioactive nuclei. 3

(b) If the half-life of Radon is 3.824 days, how long would it take for 60% of the sample to disintegrate? 3

(c) Name the experimental techniques by which a nano particle can be characterized. 2

(d) Show that corrosion is an electrochemical phenomenon. 2

Q 9.

(a) Write short notes on any two of the following $2 \times 3 = 6$

(i) Principle of radio-carbon dating (ii) Magic Number

(iii) π-meson theory (iv) Fission

(b) How can corrosion be prevented? Discuss in short. 3

(c) Mention one application of a nano particle. 1

CHEMISTRY - II

CO3

Answer Question No. 10 and any two from the rest:

Q 10.

What is the use of spectroscopy? State and explain the Lambert-Beer Law. Which of the following molecules give rotational spectra H_2, HCl, CH_4, CH_3Cl and O_2?

2+2+1

Q 11.

(a) What is electrochemical cell?

(b) Represent an electrochemical cell where the following chemical reaction takes place: Zn (s) + Cu^{2+} (aq) $\rightarrow$ Cu (s) + Zn^{2+} (aq).

(c) Why is a salt bridge used? 1+2+1

Q 12.

(a) On passing monochromatic light through a solution of 0.004 M in a cell of 10 mm thickness the intensity of the transmitted light was reduced by 50 %. Calculate the molar extinction coefficient with its unit.

(b) Why is potential measured by a potentiometer and not by a voltmeter?

2+2

Q 13.

(a) Write down a short note on fuel cell.

(b) How are battery's voltage output and current ratings determined?

2+2

CO4

Answer any three questions of the following

Q14.

(a) What is the difference between crystalline solid and amorphous solid? Give one example of each type.

(b) Arrange simple cubic, body centred cubic, face centred cubic lattice in decreasing order of the fraction of the unoccupied space. **2+1+1**

Q 15.

(a) If the Miller indices of a plane be 120, what are its Weiss indices?

(b) $a \neq b \neq c$, $\alpha = \gamma = 90°$, $\beta \neq 90°$. Identify the crystal system.

(c) For which plane Weiss indices and Miller indices are the same?

2 +1+1

Q 16.

(a) Describe the classification of unit cells.

(b) In body centred cubic unit cell how many lattice points are there? Describe with diagram.

2+2

Q 17.

Silver crystalizes in fcc unit cell. Each side of the unit cell is 400 pm. Calculate the radius of the silver atom.

4

CHEMISTRY - III

CO5

Q18.

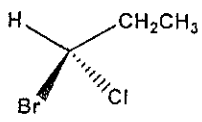
Define electrophile or nucleophile . 1

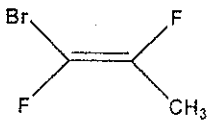
Q19. Answer **any four** questions of the following: 3 x 4

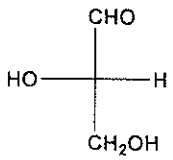
(a) Write the mechanism of nitration of benzene. Draw the corresponding energy profile diagram.

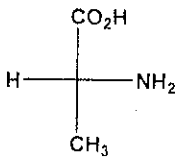
(b) Write stereospecific reaction with suitable example. Why is it so called?

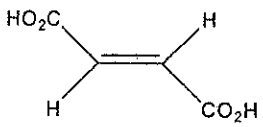
(c) Write *R/S* or *E/Z* (as applicable) of **any three** of the following compounds

i) 

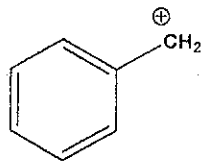
ii) 

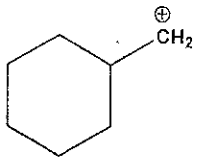
iii) 

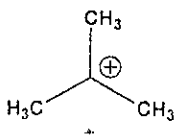
iv) 

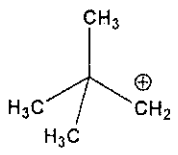
v) 

(d) Comment on the relative stability of the following pairs of ionic species with proper reason (**any two**).

i) 

and 

ii) 

and 

iii) 

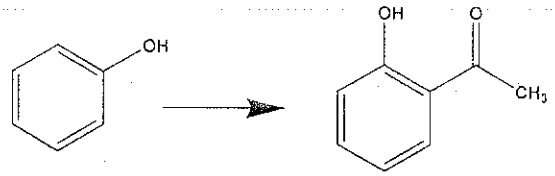
and 

(e) Accomplish the following conversions (**any two**) (No mechanism required).

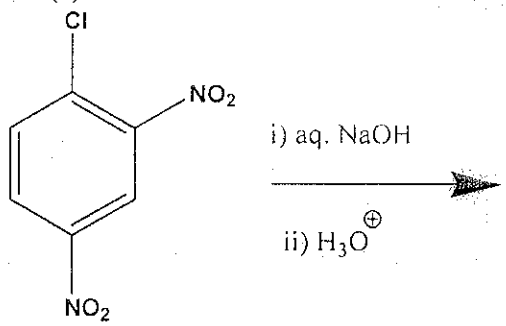
i) 

ii) 

iii) PhCHO ⟶ $PhCH{=}CHCO_2Et$

iii) 

(f) Predict the product(s) with mechanism of the following reactions (**any two**).

i) 

ii) **PhCHO** $\xrightarrow{\text{aq. NaOH}}$

iii) **CH_3CO_2Et** $\xrightarrow[\text{ii) } H_3O^{\oplus}]{\text{i) NaOEt/ EtOH}}$

CO6

Q 20. Answer **any four** questions of the following: 3 x 4

(a) What is peptide linkage of protein? Draw the possible structure of dipeptides formed by the following α-amino acids.

CH_3CHNH_2COOH and NH_2CH_2COOH

(b) Write any one method for determination of the N-Terminal amino acid of the following tripeptide [A].

$H_2N\text{-}CH(R^1)\text{-}C(=O)NH\text{-}CH(R^2)\text{-}C(=O)NH\text{-}CH(R^3)\text{-}COOH$ (A)

(c) Outline the industrial synthesis of phenol from benzene by cumene hydroperoxide method.

(d) What is osazone reaction? Why do D-glucose and D-mannose give same osazone?

(e) Write the steps involved in detection of the aldehyde group of D-glucose (Use RCHO as the structure)

(f) What is meant by saponification of lipids? Discuss with suitable example.

(g) Write short notes on **any two**:

i) Rancidity of fat; ii) Mutarotation; iii) Iodine number of fat.