Total No. of Questions : 6]

SEAT No. :

P2797

[Total No. of Pages : 3

[5530]-201

M.Sc. - I

PHYSICAL CHEMISTRY

CHP-210 : Fundamentals of Physical Chemistry - II

(2013 Pattern) (Semester - II) (5 Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) *Answers to the two sections should be written in separate answer books.*
2) *All questions are compulsory.*
3) *Figures to the right side indicates full marks.*
4) *Use of logarithmic table/calculator is allowed.*
5) *Neat diagrams must be drawn wherever necessary.*

Physico - Chemical Constants

1.	Avogadro Number	N	$= 6.022 \times 10^{23}$ mol^{-1}
2.	Boltzmann Constant	k	$= 1.38 \times 10^{-16}$ erg K^{-1} molecule^{-1}
			$= 1.38 \times 10^{-23}$ J K^{-1} molecule^{-1}
3.	Planck Constant	h	$= 6.626 \times 10^{-27}$ erg s
			$= 6.626 \times 10^{-34}$ J s
4.	Electronic Charge	e	$= 4.803 \times 10^{-10}$ esu
			$= 1.602 \times 10^{-19}$ C
5.	1 eV		$= 23.06$ k cal mol^{-1}
			$= 1.602 \times 10^{-12}$ erg
			$= 1.602 \times 10^{-19}$ J
			$= 8065.5$ cm^{-1}
6.	Gas Constant	R	$= 8.314 \times 10^{7}$ erg K^{-1} mol^{-1}
			$= 8.314$ J K^{-1} mol^{-1}
			$= 1.987$ cal K^{-1} mol^{-1}
7.	Faraday Constant	F	$= 96487$ C equiv^{-1}
8.	Speed of light	c	$= 2.997 \times 10^{10}$ cm s^{-1}
			$= 2.997 \times 10^{8}$ m s^{-1}
9.	1 cal		$= 4.184 \times 10^{7}$ erg
			$= 4.184$ J
10.	1 amu		$= 1.673 \times 10^{-27}$ kg
11.	Bohr magneton	β_e	$= -9.274 \times 10^{-24}$ J T^{-1}
12.	Nuclear magneton	β_n	$= 5.051 \times 10^{-27}$ J T^{-1}
13.	Mass of an electron	m_e	$= 9.11 \times 10^{-31}$ kg.

P.T.O.

SECTION - I

Q1) Attempt the following : **[10]**

a) Enlist the factors governing the intensity of spectral lines.

b) Define :

i) Hot bands.

ii) Fermi resonance.

c) Explain the principle of ESR.

d) State the rule of mutual exclusion.

e) Classify the following molecules on the basis of moment of inertia, CH_3F, C_2H_2, OSO_4, $CH_2 = CHCl$.

Q2) Attempt any two of the following : **[10]**

a) Discuss the pure rotational Raman spectra of Linear molecules.

b) What do you mean by non-rigid rotator? Discuss its spectrum.

c) Write a note on energy of a vibrating diatomic molecule. Give the expressions of oscillation frequency and vibrational energies in cm^{-1}. Define zero point energy.

d) State Franck-Condon principle and explain the intensity of vibrational electronic spectra.

Q3) Attempt any one of the following : **[5]**

a) The first rotational line of $^{12}C\ ^{16}O$ is observed at 3.84235 cm^{-1}, and that of $^{13}C\ ^{16}O$ is observed at 3.6737 cm^{-1}. Calculate the exact atomic weight of ^{13}C assuming that of oxygen to be 15.9949.

b) Calculate the population of first excited level of the ground state has 1000 molecules at 298K. Given $\Delta E = 4.005 \times 10^{-23}$ J $molecule^{-1}$.

SECTION - II

Q4) Attempt the following : **[10]**

a) What is dead time of G.M. counter?

b) Sketch the plane (111) in simple cubic cell.

c) State Fick's laws of diffusion.

d) What is the wavefunction of H_2 molecule in valence bond theory?

e) Give preparation of ^{22}Na and ^{35}S.

Q5) Attempt any two of the following : **[10]**

a) What is radiotracer technique? How it is used to determine surface area of precipitate?

b) Explain the Huckel theory of Cyclobutadiene.

c) Derive Bragg's equation for the interplaner distance in a crystal face. How is it used for the determination of a crystal structure?

d) Discuss zone diffusion technique to calculate diffusion coefficient.

Q6) Solve any one of the following : **[5]**

a) The element chromium exists as body centered cubic lattice. The unit cell edge is 2.88 $\mathring{A}$. The density of chromium is 7.2 gm cm^{-3}. How many atoms does 52 gram of chromium contain?

b) The half life period of ^{226}Ra is 1600 years. How many gram of it will be left undisintigrated from 1.0 gram of the isotope after 4750 years?

Total No. of Questions : 6]

SEAT No. :

P2761

[Total No. of Pages : 3

[5530]-21
M.Sc. - I
PHYSICAL CHEMISTRY
CH-210 : Physical Chemistry - II
(2008 Pattern) (Semester - II) (Old)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *Answers to the two sections should be written in separate answer books.*
2) *All questions are compulsory.*
3) *Figures to the right side indicates full marks.*
4) *Use of logarithmic table/calculator is allowed.*
5) *Neat diagrams must be drawn wherever necessary.*

Physico - Chemical Constants

1.	Avogadro Number	N	$= 6.022 \times 10^{23}$ mol^{-1}
2.	Boltzmann Constant	k	$= 1.38 \times 10^{-16}$ erg K^{-1} molecule^{-1}
			$= 1.38 \times 10^{-23}$ J K^{-1} molecule^{-1}
3.	Planck Constant	h	$= 6.626 \times 10^{-27}$ erg s
			$= 6.626 \times 10^{-34}$ J s
4.	Electronic Charge	e	$= 4.803 \times 10^{-10}$ esu
			$= 1.602 \times 10^{-19}$ C
5.	1 eV		$= 23.06$ k cal mol^{-1}
			$= 1.602 \times 10^{-12}$ erg
			$= 1.602 \times 10^{-19}$ J
			$= 8065.5$ cm^{-1}
6.	Gas Constant	R	$= 8.314 \times 10^{7}$ erg K^{-1} mol^{-1}
			$= 8.314$ J K^{-1} mol^{-1}
			$= 1.987$ cal K^{-1} mol^{-1}
7.	Faraday Constant	F	$= 96487$ C equiv^{-1}
8.	Speed of light	c	$= 2.997 \times 10^{10}$ cm s^{-1}
			$= 2.997 \times 10^{8}$ m s^{-1}
9.	1 cal		$= 4.184 \times 10^{7}$ erg
			$= 4.184$ J
10.	1 amu		$= 1.673 \times 10^{-27}$ kg
11.	Bohr magneton	β_e	$= -9.274 \times 10^{-24}$ J T^{-1}
12.	Nuclear magneton	β_n	$= 5.051 \times 10^{-27}$ J T^{-1}
13.	Mass of an electron	m_e	$= 9.11 \times 10^{-31}$ kg.

P.T.O.

SECTION - I

Q1) Answer any three of the following : **[15]**

a) Explain the hyperfine structure of ESR spectra.

b) Write a note on NMR spectroscopy principle.

c) Explain the advantages of FTIRS.

d) Write a note on Fortrat parabola.

e) Write an account of the quantum theory of Raman effect.

Q2) Answer any three of the following : **[15]**

a) Explain the factors governing intensity of spectral lines.

b) What are overtones, fundamental lines and hot bands?

c) Deduce the relation I - μr^2 for a rigid molecule.

d) Explain the effect of nuclear spin or spectral spacings.

e) State and explain the Franck-Condon principle.

Q3) Solve any two of the following : **[10]**

a) $^{1}H - ^{35}Cl$ is irradiated with 436 nm line. Estimate the wave number of the first two anti Stokes lines.

b) Evaluate the spectral width for a line representing a transition to an excited state having a lifetime of 100 ps.

c) If B for a molecule is 0.36 cm^{-1}, find J_{max} at 200ºC.

SECTION - II

Q4) Attempt any three of the following : **[15]**

a) Explain the terms G-value, electron absorption coefficient, spur and dead time.

b) Discuss the working of a scintillation counter. What is the role of pulse height analyzer in it?

c) What is hydrated electron? Give the different methods to obtain the hydrated electron.

d) Explain isotope separation method for plutonium.

e) What are the various modes of interaction of γ-rays with matter? Discuss any one of them in detail.

Q5) Attempt any three of the following : **[15]**

a) Explain in detail critical size of thermal reactor.

b) What is the breeder reactor? Explain with an example the principle of breeding.

c) Describe the use of radioisotope in the measurement of the thickness of a moving sheet.

d) Explain how the concentration of an element in a sample is determined by NAA? What are disadvantages of this technique?

e) Draw and explain a radiometric titration curve where in the reagent is labelled.

Q6) Solve any two of the following : **[10]**

a) The activity of a radioisotope fall to $1/12^{th}$ of its initial value in 12 hours. Find its half-life and average life.

b) Find the thickness of lead required to reduce the level of radiation from 10,000 cpm to 2,000 cpm. Given $\mu_{pb} = 0.57\ cm^{-1}$.

c) A 0.1 g gun metal alloy containing 90% Cu was irradiated for one day in a neutron flux $10^9\ ncm^{-2}S^{-1}$. Calculate the activity after a cooling period of 6 hrs.

[Given : At. weight of Cu = 63, $t_{1/2}$ for ^{64}Cu = 12.7 hrs, σ = 4.5 barn and r = 69.17%]

Total No. of Questions : 6]

SEAT No. :

P1161

[Total No. of Pages : 3

[5430]-2001

M.Sc. - I

PHYSICAL CHEMISTRY

CHP - 210 : Fundamentals of Physical Chemistry - II

(2014 Pattern) (Semester - II) (New 4 Credit)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of logarithmic tables/calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

1.	Avogadra Number	N	=	6.022×10^{23} mol^{-1}
2.	Boltzmann Constant	k	=	1.38×10^{-16} erg K^{-1} molecule^{-1}
			=	1.38×10^{-23} J K^{-1} molecule^{-1}
3.	Planck Constant	h	=	6.626×10^{-27} erg s
			=	6.626×10^{-34} J s
4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} Mol^{-1}
			=	8.314 J K^{-1} Mol^{-1}
			=	1.987 cal K^{-1} Mol^{-1}
7.	Fraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_c	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_c	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt the following: **[10]**

a) Write and explain the expression for the width of a spectral line.

b) Classify the following molecules based on moment of inertia.

i) Vinyl chloride

ii) C_6H_6

iii) H_2O

iv) BF_3

c) State the conditions for Raman activity.

d) State Born-oppenheimer approximation. Under what conditions it breaks down.

e) Write the expression for resolving power of FT-IR spectrophotometer.

Q2) Attempt any two of the following: **[10]**

a) Explain the rule of mutual exclusion and its converse.

b) Explain UPES with the help of a spectrum for CO molecule.

c) How many fundamental modes of vibrations are their for water molecule? Sketch and explain each vibrational mode.

d) Explain the applications of ESR spectroscopy.

Q3) Solve any one of the following: **[5]**

a) Calculate the fundamental frequency of DCI if the fundamental vibrational frequency of HCl is 2990 cm^{-1} assuming force constant to be the same.

b) The fundamental and first overtone transition of the NO molecule are at 1877.05 cm^{-1} and 3725.0 cm^{-1} respectively. Evaluate the equilibrium vibration frequency and the force constant of the molecule.

SECTION - II

Q4) Attempt the following : **[10]**

a) Explain the different types of radioactive decay process.

b) State Ficks laws of diffusion.

c) Define the terms radiation track, spurs, δ-ray and stopping power.

d) Give the preparation of ^{14}C and ^{3}H isotopes.

e) Define elementary separation factor. Write Fermis four factor formula. Give the meaning of each terms involved in it.

Q5) Attempt any two of the following : **[10]**

a) What are the modes of interaction of γ-rays with matter? Explain the photoelectric effect in detail.

b) What is diffusion phenomenon? Discuss zone-diffusion technique to determine diffusion coefficient.

c) Explain the principle and working of a breeder reactor.

d) Describe the principle, construction and working of G.M. counter.

Q6) Solve any one of the following : **[5]**

a) The half life period of ^{226}Ra is 1600 years. How many gram of it will be left undisintigrated from 1.0 gram of the isotope after 4750 years.

b) Calculate the thickness of Pb (Z = 82, A = 207.2) plate required to reduce the level of radiation from 0.1 Gy/min to 3.1 m Gy/hour.

[Given $e\mu$ = 0.211 b/electron, Density of pb = 11.35 g cm^{-3}]

Total No. of Questions :6]

SEAT No. :

P1117

[Total No. of Pages : 3

[5430]-21
M.Sc. I
CHEMISTRY
CH - 210 : Physical Chemistry - II
(2008 Pattern) (Semester - II) (Old)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Answers to the TWO sections should be written in SEPARATE answer books.***
2) ***ALL questions are COMPULSORY.***
3) ***Figures to the RIGHT SIDE indicate FULL marks.***
4) ***Use of logarithmic table/calculator is ALLOWED.***
5) ***Neat diagrams must be drawn WHEREVER necessary.***

Physico - Chemical Constants

1.	Avogadro Number	N	=	6.022×10^{23} mol^{-1}
2.	Boltzmann Constant	k	=	1.38×10^{-16} erg K^{-1} molecule^{-1}
			=	1.38×10^{-23} J K^{-1} molecule^{-1}
3.	Planck Constant	h	=	6.626×10^{-27} erg s
			=	6.626×10^{-34} J s
4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_e	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt any three of the following: **[15]**

a) Explain the factors affecting intensity of spectral lines.

b) Discuss the breakdown of Born-Oppenhiemer approximation.

c) Explain Raman Scattering on the basis of molecular polarizability.

d) Write a note on Pre-dissociation.

e) Give the classification of molecules on the basis of moment of inertia with suitable examples.

Q2) Attempt any three of the following: **[15]**

a) Give the principle of photo electron spectroscopy and discuss the UPES spectrum of carbon monoxide.

b) What is the criteria for a vibration on a molecule to be Raman active? Discuss Raman activity of CO_2 molecule.

c) Discuss the influence of rotation on the spectra of polyatomic linear molecules showing perpendicular vibrations.

d) What do you mean by non-rigid rotator? write the energy expression in cm^{-1} for the same and using equations of 'B' and 'D'. Show that $D=4B^3/\bar{w}^2$ compare the spectra of rigid and non rigid rotor.

e) What is Stark effect? Discuss its applications.

Q3) Solve any two of the following **[10]**

a) The spectrum of HCl shows a fundamental absorption at 2886 cm^{-1} and first overtone at 5668 cm^{-1}. Evaluate equilibrium vibrational frequency, the anharmonicity, zero point energy and force canstant.

b) The average spacing between successive rotational lines CO molecule is 3.6862cm^{-1}. Determine the trasitions which given the most intense spectral line at 308 K.

c) The first stokesline in the rotational Raman spectrum of $^{14}N^{15}N$ is observed at 11.5416 cm^{-1}. Calculate its 'B' value and bondlength. Comment on the intensity of spectrum.

SECTION - II

Q4) Attempt Any three of the following: **[15]**

a) How does the gamma rays interact with matter? Give an account of Photo-electric effect.

b) What is 'G' value? Explain radiolysis of Fricke solution.

c) Describe the application of radioisotopes in determining surface area of the precipitate.

d) Distinguish between secular and transient equilibria.

e) Explain the principle of a breeder reactor.

Q5) Attempt any three of the following: **[15]**

a) Describe isotope dilution and reverse isotope dilution analysis.

b) Explain the terms

i) tracks ii) Spurs

iii) δ-tracks and iv) Stopping power

c) How is ^{14}C obtained naturally and artificially?

d) Write a note on nuclear waste management.

e) Describe the working of a G.M. counter.

Q6) Solve any two of the following **[10]**

a) The half life period of a radio-isotope is 3.8 days. How much of it will remain after 28 days if 5 g of it is present initially?

b) A 0.1 g of a catalyst sample containing 65% Cu was irradiated for 24 h in a neutron flux of 10^9 $ncm^{-2}s^{-1}$. Calculate the activity due to ^{64}Cu after a cooling period of 6 hrs.

[Given : At. weight of Cu=63, $t_{1/2}$ of ^{64}Cu=12.7hrs, σ_{cu} = 4.5 b and isotopic abandance = 69.2%]

c) Determine linear absorption coefficient of ethanol using following data.

[eμ=0.211 b/e^-, ρ= 0.713 g. cm^{-3}, Z of C=6, H=1, 0=8 and A of C=12, H=1 and O=16]

Total No. of Questions : 6]

SEAT No. :

P1926

[Total No. of Pages : 3

[5323]-2001
M.Sc. - I
PHYSICAL CHEMISTRY
CHP - 210 : Fundamentals of Physical Chemistry - II
(2013 Pattern) (Semester - II) (5 - Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of Logarithmic table / calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

1.	Avogadro Number	N	=	6.022×10^{23} mol^{-1}
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4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_e	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt the following: **[10]**

a) Explain signal to noise ratio.

b) Distinguish between prolate and oblate symmetric top with examples.

c) Define:

i) Zero point energy

ii) Hot bands

d) Why linear triatomic molecules shows only three vibrational modes instead of three.

e) Distinguish between Rayleigh scattering and Raman Scattering.

Q2) Attempt any two of the following: **[10]**

a) What is centrifugal distortion? Explain the effect of centrifugal distortion on the rotational energy levels of a diatomic molecule.

b) Discuss the break down of Born-Oppenhiemer approximation.

c) Explain the rule of mutual exclusion and its converse. Describe the various modes of vibration of CO_2 molecule.

d) State franck condon principle and write a brief note on dissociation energy and dissociation products.

Q3) Attempt any one of the following: **[5]**

a) What is the value of 'B' for $H^{37}Cl$ if the rotational constant of $H^{35}Cl$ is 10.5909 cm^{-1}?

b) The spectrum of HCl shows a fundamental absorption at 2886 cm^{-1}, and first overtone at 5668 cm^{-1}. Evaluate equilibrium vibrational frequency and force constant.

SECTION - II

Q4) Attempt the following: **[10]**

a) Sketch the plane (100) in simple cubic cell.

b) What is self and tracer diffusion?

c) Write any secular determinant for ethylene molecule.

d) Define the term 'Curie' and Becquerel (Bq).

e) Give preparation of ^{14}C and ^{137}I radioisotopes.

Q5) Attempt any two of the following: **[10]**

a) Discuss the principle of isotope dilution analysis. How it is used to determine the volume of blood in patient?

b) Discuss main assumptions of Huckel theory.

c) Describe how the x-rays are used to determine the Crystal Structure.

d) Explain different applications of Neutron activation analysis.

Q6) Solve any one of the following: **[5]**

a) Miller indices of the plane of a Crystal are 436. Calculate the intercept on Crystallographic axes.

b) An isotope loses $9/10^{th}$ of its activity in 23 hours. What is its half life and mean life.

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Total No. of Questions : 6]

SEAT No. :

P1846

[Total No. of Pages : 3

[5323]-21
M.Sc. - I
PHYSICAL CHEMISTRY
CH - 210 : Physical Chemistry - II
(2008 Pattern) (Semester - II) (Old)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of Logarithmic table / calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

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5.	1 eV		=	23.06 k cal mol^{-1}
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			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
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9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt any three of the following: **[15]**

a) What do you mean by beak broadening? Explain collision and Doppler broadening.

b) Distinguish between simple harmonic oscillator and anharmonic oscillator with respect to energy equation, section rule and energy curve.

c) Discuss the principles of fluorescence, phosphore scence and ESR.

d) What is Raman Scattering? Describe the quantum theory of Raman effect.

e) How many fundamental modes of vibrations are there for a linear and non-linear molecule made up of 'N' atoms? Depict the change in dipole proanced by each vibration of water molecule.

Q2) Attempt any three of the following: **[15]**

a) Discuss the different processes by which an electronically excreted molecule can lose energy.

b) State and explain the Franck-Condon principle. How can one explain the intensity of vibrational electronic spectra.

c) Derive the equation $I = \mu v^2$ for a rigid diatomic molecule and sketch the allowed rotational energy levels.

d) Explain the principle of NMR spectroscopy and give its application.

e) Discuss the Raman activity of vibrations with the help of polarizability ellipsoid and polarizability plots of CO_2 molecule.

Q3) Solve any two of the following: **[10]**

a) The fundamental vibration frequency of HCl is 2989 cm^{-1}. Find the force constant of HCl bond.

b) The average spacing between successive rotational lines of CO molecule is 3.8662 cm^{-1}. Determine the transitions which gives the most intense spectral line at 318K.

c) When 30.61 ev radiation is used to produce photo electron spectra of neon, photoelectrons of kinetic energy 1.5 eV have been emitted calculate the ionization energy of these electrons in R J mol^{-1}.

(Given : 1 eV = 9.635×10^4 J mol^{-1})

SECTION - II

Q4) Attempt any three of the following: **[15]**

a) Give an account of compton effect.

b) Explain the principle of neutron activation analysis. Give its applications.

c) Write a note on India's nuclear energy programme.

d) Derive Fermi's four factor formula for a nuclear reactor.

e) Explain scintillation counter.

Q5) Attempt any three of the following: **[15]**

a) Write a note on radiolysis of water.

b) Explain isotope dilution and reverse isotope dilution analysis.

c) What is diffusion? Explain zone diffusion technique.

d) How can radio-isotopes be employed to understand extent of wear and tear of machines?

e) Explain natural and artificial synthesis of ^{14}C.

Q6) Solve any two of the following: **[10]**

a) A radioactive sample decays to 40% of its original in 12.6 days calculate the radioactivity of 0.69 g of sample if the only isotope present in the sample is 32p.

b) One litre halide mixture was analyzed for its iodide content $2cm^3$ of labelled lodine having a specific activity 21 cps/cm^3 was added to this mixture. After proper mixing 2 cm^3 of pure iodide was separated which showed the activity of 400 counts for 10 minutes. Find the percentage of iodide in the mixture.

c) Fission energy due to single atom of 235 U is 200 MeV. Calculate the power released during the fission of 1 kg 235 U in 1 day.

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Total No. of Questions :6]

SEAT No. :

P1860

[Total No. of Pages : 3

[5223]-201
M.Sc. - I
PHYSICAL CHEMISTRY
CHP - 210 : Fundamentals of Physical Chemistry - II
(2013 Pattern) (5 Credit) (Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) *Answers to the TWO sections should be written in SEPARATE answer books.*
2) *ALL questions are COMPULSORY.*
3) *Figures to the RIGHT SIDE indicate FULL marks.*
4) *Use of logarithmic table/calculator is ALLOWED.*
5) *Neat diagrams must be drawn WHEREVER necessary.*

Physico - Chemical Constants

1.	Avogadro Number	N	=	6.022×10^{23} mol^{-1}
2.	Boltzmann Constant	k	=	1.38×10^{-16} erg K^{-1} molecule^{-1}
			=	1.38×10^{-23} J K^{-1} molecule^{-1}
3.	Planck Constant	h	=	6.626×10^{-27} erg s
			=	6.626×10^{-34} J s
4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_e	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt the following: **[10]**

a) Why H_2 molecule is microwave and IR inactive but is Raman active?

b) Explain the photoelectron spectrum of N_2O molecule.

c) Show the fluctuations in the dipole moment of carbondioxide during asymmetric stretching Vibrations.

d) Explain why the c = 0 stretching vibration of an aldehyde give rise to a strong absorption in the infra-red yet the absorption due to c = c vibration in an alkane is normally weak.

e) Give the principle of NMR spectroscopy.

Q2) Attempt any two of the following: **[10]**

a) Discuss different processes by which an electronically excited molecule can loose energy.

b) State the Born-Oppenheimer approximation. How do the interactions of rotations and vibrations affect the spectrum of diatomic molecule.

c) Sketch and explain the polarizability ellipsoids for Co_2 molecule. How they decide the Raman activity?

d) Explain Various advantages of Fourier transform spectroscopy.

Q3) Solve any one of the following **[5]**

a) If the $^1H^{35}Cl$ molecule is irradiated with 404.7 nm Hg line. Calculate the first two stokes as well as anti-stokes lines observed in the rotational Raman spectrum. The bond distance of $H^{35}Cl$ is 0.1275 nm.

b) Calculate the bond length of the HCl molecule. The frequency difference between successive spectral lines observed for its rotational spectra is 20.7 cm^{-1}.

SECTION - II

Q4) Attempt the following. **[10]**

a) Give natural and artificial preparation of ^{14}c.

b) Give Fick's laws of diffusion.

c) What are the Bravais lattices.

d) Write the secular determinant for ethylene molecule.

e) What are Miller indices.

Q5) Attempt any two of the following: **[10]**

a) How radio - tracer technique is used to assess the volume of blood in the patient.

b) Explain different applications of Neutron activation analysis.

c) Obtain the expression for normalization constant for H_2 molecule using molecular orbital theory.

d) Discuss main assumptions of Huckel theory.

Q6) Solve any one of the following **[5]**

a) The diffraction of crystal of sample with X-ray ($\lambda = 1.54\,A^{\circ}$) gives a first order reflection at 26.5°. Calculate the distance between the different planes.

b) Half - life of ^{226}Ra is 1500y. Calculate the activity corresponding to 2.5g of ^{226} Ra. Also determine the time required for ^{226}Ra to reduce to 3.5×10^4 dps if initial activity is 1 curie.

Total No. of Questions :6]

SEAT No. :

P1458

[Total No. of Pages : 3

[5223]-21
M.Sc.-I
PHYSICAL CHEMISTRY
CH - 210 :Physical Chemistry - II
(2008 Pattern) (Semester - II) (Old)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *Answers to the TWO sections should be written in SEPARATE answer books.*
2) *ALL questions are COMPULSORY.*
3) *Figures to the RIGHT SIDE indicate FULL marks.*
4) *Use of logarithmic table/calculator is ALLOWED.*
5) *Neat diagrams must be drawn WHEREVER necessary.*

Physico - Chemical Constants

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3.	Planck Constant	h	=	6.626×10^{-27} erg s
			=	6.626×10^{-34} J s
4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_e	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt any three of the following: **[15]**

a) Explain the applications of ESR spectroscopy.

b) What is centrifugal distortion? Explain the effect of centrifugal distortion on the rotational energy levels of a diatomic molecule.

c) How does isotopic substitution help in determing the CO and CS bond length in linear OCS molecule.

d) Discuss advantages of FTIR Spectroscopy.

e) Explain the factors which affects the width of Spectral line.

Q2) Attempt any three of the following: **[15]**

a) Explain the classical theory of Raman effect.

b) Discuss pure rotational Raman Spectra for linear diatomic molecule.

c) Explain the structure of nitrous oxide molecule in the light of XPES.

d) Write a note on Fartrant diagram.

e) Write the expression for Morse function and explain harmonic and anharmonic oscillators with respect to selection rule, zero point energy and energy equation.

Q3) Solve any two of the following: **[10]**

a) The fundamental vibrational frequency for HCl is 2886 cm^{-1}, and first overtone is 5668cm^{-1}. Calculate anharmonicity constant and equilibrium vibrational frequency.

b) Predict the position of rotational Raman spectral lines for $^{14}N_2$. [B = 1.99cm^{-1}, excitation frequency = 891 TH_2].

c) The energy change in a transition is 4.00×10^{-22}] $molecule^{-1}$. Calculate number of molecules in the excited state at 27°C, if there are 1000 molecules in the ground state.

SECTION - II

Q4) Attempt any three of the following: **[15]**

a) Explain the construction and working of Scintillator counter.

b) Give the different conversions of radiation absorption units.

c) Derive the rate equation for the decay constant of radioactive element. Explain its characteristic of the equation.

d) What is the breeder reactor? Explain the principle of breeding with an example.

e) How to assess the volume of blood in patient by using radiotracer technique.

Q5) Attempt any three of the following: **[15]**

a) Explain the terms G-value, electronic absorption coefficient, spur and δ – ray track.

b) Write a note on Lea Gray-Platzman and Samuel-Maggi model.

c) Explain the three phases in India's nuclear energy programme.

d) Discuss applications of Neutron activation analysis.

e) Enlist different modes of interaction of γ -radiation with matter. Explain one of them.

Q6) Solve any two of the following: **[10]**

a) The half life period of a radioisotope is 24.5m. How much of it would be left after 30m if its initial amount is 1.0gm?

b) 0.1 gm of a medicinal plant extract containing Mn was irradiated in a neutron flux of $10^{12} n.cm^{-2}s^{-1}$ for 5 minutes. The activity counted after 10h. of cooling period was 2500cpm with a HPGe detector with detection efficiency 20%. Determine the percentage of Mn in the extract.

[Given: σ =13.3b, $t_{½}$= 2.58h for ^{56}Mn, γ -ray abundance = 100%]

c) Assuming no loss of thermal or fast neutrons occurs, calculate the reproduction factor for a reactor for which the fast fission factor is 1.03, the number of fast neutrons generated per thermal neutron used up is 1.32, the resonance escape factor is 0.89 and the thermal utilisation factor is 0.87.

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Total No. of Questions : 6] **SEAT No. :**

P1378 **[Total No. of Pages : 3**

[5123]-201
M.Sc. - I (Semester - II)
PHYSICAL CHEMISTRY
CHP - 210 : Fundamentals of Physical Chemistry - II
(2013 Pattern) (5 Credit)

Time : 3 Hours] ***[Max. Marks : 50***

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table / calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

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			=	6.626×10^{-34} J s
4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_c	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt the following : **[10]**

a) Give the principle of ESR spectroscopy.

b) Pure rotational Raman Spectra of linear molecule exhibit first line at 6B cm^{-1} but remaining at 4B cm^{-1}. Explain.

c) How electronically excited molecule loses its energy by phosphorescence.

d) What is Fellget advantage in FTIR?

e) Explain any two factors which affect the width of spectral lines.

Q2) Attempt any two of the following : **[10]**

a) How does optics of IR spectroscopy differ from Raman spectroscopy? Discuss the merits and demerits of Raman spectroscopy.

b) Discuss rotational fine structure of electronic - vibration transition.

c) Explain photoelectron spectroscopy. Why is high vaccum needed for its study?

d) Explain classical theory of Raman effect.

Q3) Solve any one of the following : **[5]**

a) Find the value of rotational constant for the molecule $Br^{79}F^{19}$ if the most intense spectral line at 300k is for the transition J=17$\rightarrow$J==18.

b) The rotational constant for the V=0 state of the molecule is 10 cm^{-1} and V=1 state is 9.5 cm^{-1}. Estimate the rotational constant in the state V = 2.

SECTION - II

Q4) Attempt the following : **[10]**

a) Write any secular determinant for ethylene molecule.

b) Draw bonding and anti-bonding wave functions for H_2 molecule using valence bond theory.

c) What are Weiss indices?

d) Give preparation of ^{22}Na isotope.

e) Give the principle of isotope dilution technique.

Q5) Attempt <u>any two</u> of the following : **[10]**

a) Explain the Huckel theory of cyclobutadiene.

b) Discuss zone diffusion technique to calculate diffusion coefficient.

c) Explain the use of radio isotopes to determine the solubility of sparingly soluble salt.

d) Derive the expression for normalization constant for H_2 molecule using molecular orbital theory.

Q6) Solve <u>any one</u> of the following : **[5]**

a) Miller indices of the plane of a crystal are 436. Calculate the intercept on crystallographic axes.

b) The half - life period of a radio - element is 24.5 minutes. How much of it would be left after 30 minutes, if the initial amount of the radioelement is 1g.

Total No. of Questions : 6] **SEAT No. :**

P1341 **[Total No. of Pages : 3**

[5123]-21
M.Sc - I (Semester - II)
CH - 210 : PHYSICAL CHEMISTRY - II
(2008 Pattern)

Time : 3 Hours] ***[Max. Marks : 80***

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of logarithmic table/calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

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			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
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9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_e	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt any three of the following. **[15]**

a) Obtain the expression for moment of inertia for rigid diatomic molecule.

b) Explain the terms Resolving power and signal to noise ratio.

c) Explain the different factors affecting intensity of spectral transitions.

d) Distinguish between harmonic and anharmonic oscillator with respect to energy, selection rule and zero point energy.

e) Describe the P.Q.R. Branches of vibrational spectra of a diatomic molecule with a suitable example.

Q2) Attempt any two of the following. **[15]**

a) Explain the applications of Mösbauer spectroscopy.

b) Write a note on predissociation spectra.

c) Discuss Fortrant diagram.

d) Distinguish between Quantum and classical theory of Raman effect.

e) Sketch and explain the polarizability ellipsoids for CO_2 molecule.

Q3) Solve any two of the following. **[10]**

a) The rotational constant for $^{79}Br\ ^{19}F$ is 0-35717 cm^{-1}. What is the value of J for which the most intense line will be seen at 300k?

b) The life time of an excited species is 100Ps. Estimate the separation between the spectral lines corresponding to the excitation transition.

c) The equilibrium vibration frequency of the iodine molecule is 215 cm^{-1} and the anharmonicity constant *xe* is 0.003. What is the intensity of the hot band for $\gamma = 1 \rightarrow \gamma = 2,$ relative to the fundamental $\gamma = 0 \rightarrow \gamma = 1,$ if the temperature is 300k.

SECTION - II

Q4) Attempt any three of the following. **[15]**

a) Discuss the four factor formula used in reactor technology.

b) Explain the terms half life, average life and δ - ray track

c) Explain isotope separation method for plutonium.

d) Write a note on compton scattering.

e) Describe principle, construction, working and limitations of G. M. Counter.

Q5) Attempt any three of the following. **[15]**

a) What are the different modes of interaction of gamma rays with matter?

b) How does the solubility of a sparingly soluble salt be determined using radio-isotopes. Explain with suitable example.

c) What is design parameter? Classify the reactors on the basis of fuel and moderator.

d) Give the preparation of ^{35}S and ^{22}Na isotopes.

e) Write a note on Fricke desimeter.

Q6) Solve any two of the following. **[10]**

a) It is known that 1gm of ^{226}Ra emits 11.6×10^{17} atoms of radon per year. Given the half-life period of Ra to be 1600y. Calculate the value of the Avogadro's constant.

b) Given the electron absorption coefficient to be 0.211 b/electron for 1 MeV, r - radiation. Calculate the molecular, mass and linear absorption coefficient for water [Given, ρ=1.0gm cm^{-3} for H_2O]

c) 0.1gm of Mn sample was irradiated in a Neutron flux of 10^7n. cm^{-2} s^{-1}, for 30 minutes. What will be its activity at the end of the irradiation.

Total No. of Questions : 6]

SEAT No. :

P2908

[Total No. of Pages : 3

[5023]-2001
M.Sc.
PHYSICAL CHEMISTRY
CHP-210 : Fundamentals of Physical Chemistry - II
(2014 Pattern)(Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of logarithmic table calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

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4.	Electronic Charge	e	=	4.803×10^{-10} esu
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			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt the following: **[10]**

a) What is Zero-point energy? What is its significance?

b) Define polarizability ellipsoid.

c) What are symmetric and asymmetric vibrations? Explain with an example.

d) What is a hot band?

e) What is the effect of breakdown of Born-Oppenheimer approximation on the nature of vibrational rotational spectrum?

Q2) Attempt any two of the following: **[10]**

a) What is Raman shift? Explain the occurrence of stokes and antistokes lines with respect to quantum theory.

b) Give the detailed classification of molecules based on moment of inertia with suitable examples.

c) Describe different processes by which an electronically excited molecule can lose energy.

d) Discuss the various factors affecting the band broadening of spectral transitions.

Q3) Attempt any one of the following: **[5]**

a) The rotational Raman spectrum of $CO_2(g)$ shows a series of lines separated by $3.16cm^{-1}$ in the S branch calculate the rotational constant and moment of inertia of CO_2.

b) The fundamental vibrational frequency of HCl is 2990 cm^{-1}. Find the position of first two lines in P and R branches of vibrational-rotational spectrum of HCl.
[bond length of HCl=127.4pm, H=1amu, Cl=35amu]

SECTION - II

Q4) Attempt the following: **[10]**

a) Define dose and dose rate.

b) What is design parameter? Give its significance.

c) Explain the use of radio isotopes to understand friction and wear out of moving machine parts.

d) Define elementary separation factor.

e) Explain gas diffusion to enrich ^{235}U.

Q5) Attempt any two of the following: **[10]**

a) Write a note on compton scattering.

b) How does zone diffusion technique be used to determine the diffusion coefficients of radio-isotopes. Explain with suitable diagram and boundry conditions.

c) Describe the working and mechanism of natural nuclear reactor.

Q6) Solve any one of the following: **[5]**

a) The electronic absorption coefficient is 0.211 $b/\bar{e}$ for 1meV γ-rays. Calculate μ_{linear}, μ_{mass} and μ_a for ethanol.

[Given: ρ for ethanol =0.789 g/cm^3]

b) 0.1 g of Mn sample was irradiated in a thermal neutron flux of $10^7 n.cm^{-2}s^{-1}$ for 1h. What will be the radioactivity induced at the end of irradiation?

[Given: γ=100%, σ=13.3 b, $t_{1/2}$=2.58h for 56 Mn]

Total No. of Questions : 6]

SEAT No :

P2867

[Total No. of Pages : 3

[5023]-201

M.Sc.

PHYSICAL CHEMISTRY

CHP-210 : Fundamentals of Physical Chemistry - II

(New) (Semester - II) (2013 Pattern)

Time : 3Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) *Answers to the two sections should be written in separate answer books.*
2) *All questions are COMPULSORY.*
3) *Figures to the right side indicate full marks.*
4) *Use of logarithmic tables/calculator is ALLOWED.*
5) *Neat diagrams must be drawn WHEREVER necessary.*

Physico - Chemical Constants

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			=	6.626×10^{-34} J s
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5.	1 eV		=	23.06 k cal mol^{-1}
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7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
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9.	1 cal		=	4.184×10^{7} erg
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION -I

Q1) Attempt the following : **[10]**

a) Explain stokes and anti-stokes lines.

b) State the rule of mutual exclusion.

c) State the condition for Raman activity.

d) State the expression for J_{max}.

e) Why is NMR principle used in MRI but called as MRI?

Q2) Attempt any two of the following: **[10]**

a) Write a note on predissociation spectra.

b) Find V_{max} for x=0.0174.

c) Explain the applications of esr spectra

d) Discuss fortrait diagram.

Q3) Solve any one of the following: **[5]**

a) The vibration frequency of the H-F molecule is $4138cm^{-1}$. Determine the force constant

[At.wts. H=1 F=19]

b) Determine the energy in $kJmol^{-1}$ for a wavenumber of $1mm^{-1}$

SECTION -II

Q4) Attempt the following: **[10]**

a) Give natural artificial preparation of ^{14}C isotope.

b) What are Weiss indices?

c) Write down secular determinant for butadine and obtain its polynomial equation.

d) Sketch the plane (111) in simple cubic cell.

e) Define tracer and electrolyte diffusion processes.

Q5) Attempt any two of the following : **[10]**

a) Discuss assumptions of H*ü* ckel molecular orbital theory.

b) Explain the principle of isotope dilution techinque. What are its applications.

c) What is radio tracer technique? How it is used to determine surface area of a precipitate.

d) Using Huckels molecular orbital theory obtain energy levels in cyclobutadiene.

Q6) Solve any one of the following : **[5]**

a) What weight of Cu sample should be taken in mg for its activation analysis with a neutron flux of 1×10^8 ncm^{-2} s^{-1}, if the irradiation period is 6hrs and the desired activity after a cooling period of 3hrs is 80,000 dpm.[Given t ½ for ^{64}Cu is 12.7 hrs, % abundance is 69.17% and 6 for the reaction is 4.5b]

b) An element (At mass 60) having face centred cubic structure has a density of 6.23g cm^{-3}, what is the edge length of the unit cell?

✡ ✡ ✡

Total No. of Questions :6]

SEAT No. :

P1990

[Total No. of Pages :3

[4923]-201

M.Sc.

PHYSICAL CHEMISTRY

CHP -210: Fundamentals of Physical Chemistry-II

(2013-2014 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) *Answers to the TWO sections should be written in SEPARATE answer books.*
2) *ALL questions are COMPULSORY.*
3) *Figures to the RIGHT SIDE indicate FULL marks.*
4) *Use of logarithmic table/calculator is ALLOWED.*
5) *Neat diagrams must be drawn WHEREVER necessary.*

Physico-Chemical Constants

1.	Avogadro Number	N	$= 6.022 \times 10^{23} mol^{-1}$
2.	Boltzmann Constant	k	$= 1.38 \times 10^{-16}$ erg K^{-1} $molecule^{-1}$
			$= 1.38 \times 10^{-23}$ J K^{-1} $molecule^{-1}$
3.	Planck Constant	h	$= 6.626 \times 10^{-27}$ erg s
			$= 6.626 \times 10^{-34}$ J s
4.	Electronic Charge	e	$= 4.803 \times 10^{-10}$ esu
			$= 1.602 \times 10^{-19}$ C
5.	1 eV		$= 23.06$ k cal mol^{-1}
			$= 1.602 \times 10^{-12}$ erg
			$= 1.602 \times 10^{-19}$ J
			$= 8065.5$ cm^{-1}
6.	Gas Constant	R	$= 8.314 \times 10^{7}$ $ergK^{-1}$ mol^{-1}
			$= 8.314$ J K^{-1} mol^{-1}
			$= 1.987$ cal K^{-1} mol^{-1}
7.	Faraday Constant	F	$= 96487$ C $equiv^{-1}$
8.	Speed of light	c	$= 2.997 \times 10^{10}$ cm s^{-1}
			$= 2.997 \times 10^{8}$ m s^{-1}
9.	1 cal		$= 4.184 \times 10^{7}$ erg
			$= 4.184$ J
10.	1 amu		$= 1.673 \times 10^{-27}$ kg
11.	Bohr magneton	β_e	$= -9.274 \times 10^{-24}$ J T^{-1}
12.	Nuclear magneton	β_n	$= 5.051 \times 10^{-27}$ JT^{-1}
13.	Mass of an electron	m_e	$= 9.11 \times 10^{-31}$ kg

P.T.O.

SECTION - I

Q1) Attempt the following. **[10]**

a) H_2 does not show a pure rotational spectrum whereas HF does show. Explain why?

b) Why is collision broadening the most important factor in case of liquids than Doppler broadening?

c) What is a hot band? Why is it called so?

d) What is Franck condon principle?

e) What is the criterion for the molecule to be Raman active?

Q2) Attempt any two of the following. **[10]**

a) Explain the factors affecting the intensity of the spectral lines.

b) Explain the rule of mutual exclusion and its converse.

c) Explain the principle of NMR spectroscopy and give its applications.

d) How does isotopic substitution help in determining the CO and CS bond lengths in linear OCS molecule.

Q3) Solve any one of the following. **[5]**

a) The fundamental and first overtone transitions of $^{14}N\ ^{16}O$ are centered at 1876. 06 cm^{-1} and 3724.20 cm^{-1} respectively. Evaluate the equilibrium vibrational frequency and anharmonicity constant of the molecule.

b) The rotational constant for $^{79}Br\ ^{19}F$ molecule is 0.3517 cm^{-1}. What is the value of J for which most intense line will be seen?

SECTION - II

Q4) Attempt the following. **[10]**

a) Explain the boundry conditions for a diffusing species in one diamentional gel column.

b) Explain the preparation and one application of ^{22}Na.

c) State any two laws of crystallography.

d) What is the wavefunction of H_2 molecule in valence bond theory?

e) Write the secular determinant for ethylene molecule.

Q5) Attempt <u>any two</u> of the following. **[10]**

a) Derive the expression for normalization constant for H_2 molecule using molecular orbit theory.

b) Explain the huckel theory of cyclobutadiene.

c) Explain use of radioisotopes to determine the surface area of a powdered sample.

d) How radioisotopes are used to determine the diffusion coefficient of diffusing species?

Q6) Attempt <u>any one</u> of the following. **[5]**

a) Activity of 1 g of ^{226}Ra is found to be 3.7×10^{10} dps. Calculate its half life period.

b) An element crystallizes having cubical unit cell having one atom on each corner of the cube and two atoms on one of its diagonals. of volume and density are 24×10^{-24} cm^3 and 7.2 g/cm^3 respectively, calculate the number of atoms present in 200 g of the element.

Total No. of Questions : 6]

SEAT No. :

P1952

[Total No. of Pages : 4

[4923] - 21

M.Sc.

CH - 210 : PHYSICAL CHEMISTRY - II (Old)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Answers to the TWO sections should be written in SEPARATE answer books.***
2) ***All questions are COMPULSORY.***
3) ***Figures to the RIGHT SIDE indicate FULL marks.***
4) ***Use of logarithmic table/calculator is ALLOWED.***
5) ***Neat diagrams must be drawn WHEREVER necessary.***

Physico-Chemical Constants

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4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} ergK^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C $equiv^{-1}$
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
11.	Bohr magneton	β_e	=	-9.274×10^{-24} J T^{-1}
12.	Nuclear magneton	β_n	=	5.051×10^{-27} JT^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt any three of the following: **[15]**

a) What is the energy range of IR radiation? Write a note on signal to noise ratio.

b) Discuss advantages of FTIR spectroscopy.

c) Show that for a rigid diatomic rotator the moment of inertia $I = \mu r^2$, where μ is reduced mass and r is the bond length.

d) How does isotopic substitution reveal the exact isotopic mass and relative isotopic abundance in microwave studies?

e) Explain the applications of Mössbauer spectra.

Q2) Attempt any three of the following: **[15]**

a) Explain the classical theory of Raman effect.

b) Sketch and explain the polarizability ellipsoids for the various vibration modes of H_2O molecule, which of these are Raman active?

c) Write a note on Fortrat Parabola.

d) Explain the applications of ESR spectroscopy.

e) Explain the structure of nitrous oxide molecule in the light of XPES.

Q3) Solve any two of the following: **[10]**

a) Predict the position of rotational Raman spectral lines for $^{14}N_2$. [$B = 1.99 cm^{-1}$, excitation frequency = 891 THz].

b) The anharmonicity constant for a diatomic molecule is 0.0061. Evaluate the vibrational quantum number that would lead to dissociation of molecule.

c) The first rotational absorption of $^{12}C\ ^{16}O$ occurs at $3.84235cm^{-1}$, while that of $^{13}C\ ^{16}O$ occurs at $3.67337cm^{-1}$. Evaluate the exact atomic weight of ^{13}C [mass of oxygen = 15.9994].

SECTION - II

Q4) Attempt ANY THREE of the following: **[15]**

a) Explain the constraction and working of G.M. counter.

b) Discuss in detail, the mechanism of radiolysis of water.

c) Explain the different units for measuring absorption of radiations.

d) What are the various modes of interaction of γ- rays with matter? Discuss any one of them in detail.

e) Explain isotope separation method for plutonium.

Q5) Attempt ANY THREE of the following: **[15]**

a) What is the breeder reactor? Explain the principle of breeding with an example.

b) What is design parameter? Classify the reactors on the basis of fuel and moderator.

c) Explain in detail critical size of thermal reactor.

d) What is isotope dilution analysis (IDA)? Explain its principle. Give the applications of isotope dilution analysis.

e) Describe the use of radio isotope in the measurement of thickness of moving sheet.

Q6) Solve ANY TWO of the following: **[10]**

a) The half life period of 226Ra is 1600 years. How many gram of it will be left undisintegrated from 1.0 gm of the isotope after 4750 years.

b) Calculate the linear absorption coefficient of methanol.

(Given, $e\mu = 0.211$ barn/electron

density of methanol is 0.713 gm cm^{-3}.

Z of C = 6, H = 1, O = 8

A of C = 12, H = 1 , O = 16)

c) 0.1g of Mn sample was irradiated in a neutron flux of 10^7 n. $cm^{-2}s^{-1}$, for 30 minutes. What will be its activity at the end of the irradiation.

($\gamma = 100\%$, $\sigma = 13.3$ b, $t_{1/2}$ of $^{56}Mn = 2.58h$).

Total No. of Questions :6]

SEAT No. :

P2200

[Total No. of Pages :4

[4823]-2001

M.Sc.

PHYSICAL CHEMISTRY

CHP - 210: Fundamentals of Physical Chemistry - II

(New) (4 - Credits) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of logarithmic table / calculator is allowed.***
5) ***Neat diagrams must be drawn wherever necessary.***

Physico - Chemical Constants

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4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
			=	1.987 cal K^{-1} mol^{-1}
7.	Faraday Constant	F	=	96487 C equiv^{-1}
8.	Speed of light	c	=	2.997×10^{10} cm s^{-1}
			=	2.997×10^{8} m s^{-1}
9.	1 cal		=	4.184×10^{7} erg
			=	4.184 J
10.	1 amu		=	1.673×10^{-27} kg
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION -I

Q1) Attempt the following: **[10]**

a) Classify the following molecules on the basis of their moment of inertia,

i) BF_3,

ii) Vinyl chloride,

iii) CH_3F and

iv) HCl.

b) State the conditions for Raman activity.

c) State the factors determining the intensity of spectral lines.

d) State Born-Oppenheimer approximation. Under what conditions it breaks down.

e) Explain what is pre-dissociation spectra.

Q2) Attempt any two of the following: **[10]**

a) Explain the applications of ESR spectroscopy.

b) Explain UPES with the help of a spectrum for CO molecule.

c) Obtain an expressions for stokes and anti-stokes frequencies for pure rotational Raman spectra for linear molecule.

d) Sketch and explain the different stretching vibrational frequencies for H_2O and CO_2 molecules.

Q3) Solve any one of the following: **[5]**

a) The bond length of H_2 molecule is 0.07417nm, predict the spacing of lines in the pure rotational Raman spectrum.

b) Calculate the force constant for $^{1}H\ ^{35}Cl$. Given, $\bar{w}_e = 2990\ cm^{-1}$.

SECTION -II

Q4) Attempt the following: **[10]**

a) Draw a graph showing effect of applied voltage on current pulse height for detection and measurement of radioactivity.

b) Define the term-

i) Tracks and

ii) Spurs.

c) Write a short note on excess reactivity.

d) Explain the principle underlying radiometric titrations.

e) Define elementry seperation factor.

Q5) Attempt any two of the following: **[10]**

a) Write a note on compton scattering.

b) Explain isotope dilution analysis and reverse isotope dilution analysis.

c) Obtain critical size of a cubical nuclear reactor.

d) How does molecular distillation used for 6Li seperation?

Q6) Solve <u>any one</u> of the following: **[5]**

a) Calculate the thickness of Zn (Z = 30, A = 64) plate required to reduce the level of radiation from 1.2 Gy / min to 1.2 m Gy / hr.

(Given $e\mu$ = 0.211 b/electron, Density of Zn = 7.1 g cm^{-3})

b) The half life period of a radio isotope is 24.5m. How much of it would be left after 30 minutes if its initial amount is 1.09.

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Total No. of Questions : 6]

SEAT No. :

P2121

[Total No. of Pages : 4

[4823]-21

M.Sc.

PHYSICAL CHEMISTRY

CH-210 : Physical Chemistry-II

(2008 Pattern) (Semester-II) (Old)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *Answer to the two sections should be written in separate answer books.*
2) *All questions are compulsory.*
3) *Figures to the right side indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*
5) *Neat diagrams must be drawn wherever necessary.*

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4.	Electronic Charge	e	=	4.803×10^{-10} esu
			=	1.602×10^{-19} C
5.	1 eV		=	23.06 k cal mol^{-1}
			=	1.602×10^{-12} erg
			=	1.602×10^{-19} J
			=	8065.5 cm^{-1}
6.	Gas Constant	R	=	8.314×10^{7} erg K^{-1} mol^{-1}
			=	8.314 J K^{-1} mol^{-1}
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7.	Faraday Constant	F	=	96487 C equiv^{-1}
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} J T^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION-I

Q1) Attempt Any Three of the following: **[15]**

a) Discuss Fourier transform spectroscopy.

b) Explain how microwave spectra can be used to determine the isotopic abundance of elements. Give the expression for the centrifugal distortion constant and explain the terms therein.

c) Give an account of the isotopic effect on vibrational spectra.

d) Describe the vibrational spectra of polyatomic molecule with suitable example.

e) Explain the applications of ESR spectroscopy.

Q2) Attempt Any Three of the following: **[15]**

a) With a suitable example, explain the rule of mutual exclusion.

b) Explain the quantum theory of Raman effect.

c) What is dissociation energy? Illustrate dissociation by excitation into stable upper state and continuous state.

d) Write a note on predissociation spectra.

e) Write a note on fluorescence and phosphorescence.

Q3) Solve Any Two of the following: **[10]**

a) The rotational spectrum of ^{79}Br-^{19}F shows a series of equidistant lines spaced at 0.7070 cm^{-1} apart. Evaluate the bond length of the molecule.

b) If $H^{35}Cl$ is irradiated with 435.8 mm Hg lines, calculate the Raman line in nm, if the fundamental vibrational frequency of $H^{35}Cl$ 8.667×10^{13} s^{-1}.

c) The upper electronic state dissociates into ground state atom and excited state atom. The excitation energy is 15875 cm^{-1}. The dissociation energy of the ground state is 491.5 kJ mol^{-1}. Find the position where absorption spectrum becomes a continuum.

SECTION-II

Q4) Attempt Any Three of the following: **[15]**

a) Explain in detail the quenching mechanism in G.M. counter. What do you mean by dead time of G.M. counter?

b) Which are the different modes of interaction of gamma radiation with matter? Discuss the prominent mode of interaction with matter.

c) Define the term-separation factor. Explain the electromagnetic method for separation of isotopes.

d) What is hydrated electron? Explain various methods of obtaining the hydrated electron.

e) Discuss, how the primary radiolytic products of water are formed in radiolysis? Describe in brief Lea-Gray-Platzmann model.

Q5) Attempt Any Three of the following: **[15]**

a) Discuss the fast breeder test reactor (FBTR) at Kalpakkam.

b) Explain in detail, nuclear waste management.

c) Describe the use of radiotracer in the determination of friction & wear out of machine.

d) Explain different applications of neutron activation analysis.

e) Discuss the radio analytical method to determine surface area of a powder.

Q6) Solve Any Two of the following: **[10]**

a) ^{90}Sr isotope emits β-rays with half life 28.1 years. If 1 μg of ^{90}Sr was absorbed by a newborn child, how much of it will remain at the age of 18 years in the body.

b) Find the molecular and mass absorption coefficient of propanol

(At wt - H = 1, C = 12, O = 16)

Given, e^{μ} = 0.211 barn / electron.

c) A 150 mg of sample containing manganese shows an activity of 500 dps when irradiated in a neutron flux of 1.5×10^8 n cm^{-2} s^{-1} for 10 hours. Find the percentage of manganese in the given sample.

(Given, γ = 100%, σ = 13.3 b, t $\frac{1}{2}$ of ^{56}Mn = 2.58 h).

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Total No. of Questions : 6]

SEAT No. :

P2979

[Total No. of Pages :6

[4723] - 2001

M.Sc.

PHYSICAL CHEMISTRY

CHP- 210 : Physical Chemistry - II

(Semester - II) (2013 Pattern)

Time : 3Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***All questions are compulsory.***
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13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

P.T.O.

SECTION - I

Q1) Attempt the following: **[10]**

a) Write and explain the expression for the width of a spectral line.

b) What is the significance of force constant. Give its unit.

c) State the rule of the converse of mutual exclusion principle.

d) Write the expression for resolving power of FT-IR spectrophotometer.

e) Give the conditions for fluorescence.

Q2) Attempt any two of the following: **[10]**

a) Explain the applications of Mössbauer spectroscopy.

b) Write the expression for Morse function and explain the following for Harmonic and Anharmonic Oscillators: Selection rule, zero point energy and energy equation.

c) Compare the classical and quantum theories of the Raman effect.

d) Write a note on Fortrat diagram.

Q3) Solve any one of the following: **[5]**

a) The energy change in a transition is 4.00×10^{-22} J molecule^{-1}. Calculate number of molecules in the excited state at 27ºC, if there are 1000 molecules in the ground state.

b) The fundamental vibrational frequency for HCl is 2886cm^{-1}, and first overtone is 5668cm^{-1}. Calculate anharmonicity constant and equilibrium vibrational frequency.

SECTION - II

Q4) Attempt the following: **[10]**

a) Draw a graph showing the effect of applied voltage on current pulse height for detection and measurement of radioactivity.

b) Define the terms:

i) tracks and

ii) spurs.

c) Write a short note on excess reactivity.

d) Explain the principle underlying radiometric titrations.

e) Define elementary separation factor.

Q5) Attempt <u>any two</u> of the following: **[10]**

a) Write a note on compton scattering.

b) Explain isotope dilution and reverse isotope dilution analysis.

c) Obtain critical size of a cubical nuclear reactor.

d) How does molecular separation method be used for ^{6}Li separation?

Q6) Solve <u>any one</u> of the following: **[5]**

a) Calculate the thickness of Zn = (Z = 30, A = 64) plate required to reduce the level of radiation from 1.2 Gy/m to 1.2 m Gy/h.

[Give e^{μ} = 0.211 b/electron, density of Zn = 7.1 gcm^{-3}]

b) The half life period of a radioisotope is 24.5m. How much of it would be left after 30m if its initial amount is 1.0g?

Total No. of Questions : 6]

SEAT No. :

P2979

[4723] - 2001
M.Sc.
PHYSICAL CHEMISTRY
CHP- 210 : Physical Chemistry - II
(2013 Pattern) (Semester - II)

Time : 3Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answers to the TWO sections should be written in SEPARATE answer books.***
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12.	Nuclear magneton	β_n	=	5.051×10^{-27} JT^{-1}
13.	Mass of an electron	m_e	=	9.11×10^{-31} kg

SECTION - I

Q1) Attempt the following: **[10]**

a) Explain the activity of the following molecules with respect to IR and microwave spectrum.

H_2, HCl, CO_2, CH_4 and CH_3Cl

b) What are symmetric and asymmetric vibrations? Explain with the example of H_2O molecule.

c) What is zero point energy? Give its significance.

d) Why is the selection rule for pure rotational Raman spectrum is $\Delta J = \pm 2$ instead of $\Delta J = \pm 1$ for pure rotational spectroscopy?

e) What is the effect of isotopic substitution on microwave spectra of linear diatomic molecule?

Q2) Attempt any two of the following: **[10]**

a) What is the effect of breakdown of Born-Oppenheimer approximation on P and R branches of the IR spectrum of a diatomic molecule?

b) What is Raman scattering? Describe the quantum theory of Raman effect.

c) Explain predissociation spectra using a suitable diagram.

d) What is stark effect? Discuss its applications.

Q3) Solve any one of the following: **[5]**

a) The first line in the rotational spectrum of $^{12}C\ ^{16}O$ molecule is $3.84235 cm^{-1}$. Find out the bond length of the molecule.

b) The fundamental vibrational frequency of $^{1}H\ ^{35}Cl$ molecule is 86.63×10^{12} Hz. Calculate the zero-point energy and force constant of HCl.

SECTION - II

Q4) Attempt the following: **[10]**

a) Write the nuclear reactions involving natural and artificial synthesis of 3H.

b) Explain the principle of isotope dilution analysis.

c) Draw a crystallographic plane that cuts the crystallographic axes at 1a, 2b, 3c.

d) Write the Bragg equation. Why X-rays are utilized to elucidate crystal structure?

e) Draw bonding and antibonding wavefunctions for H_2 molecule using valence bond theory.

Q5) Attempt <u>any two</u> of the following: **[10]**

a) Explain the assumptions in Huckel theory.

b) 'Radioisotopes can be used to determine diffusion coefficients of the diffusing species? Explain.

c) Derive the expression for bonding and antibonding wavefunctions of H_2 molecule using molecular orbit theory.

d) Write a note on

i) Isotope dilution analysis

ii) Reverse isotope dilution analysis

Q6) Solve <u>any one</u> of the following: **[5]**

a) An element with mass number 96 and density 10.3 g cm^{-3} crystallizes with cubical unit cell with edge length 0.314nm. Predict the Bravais lattice of the cube.

b) Activity of 1g Ra - 226 is found to be 1Ci. How much of it will remain after four half lives?

Total No. of Questions : 6]

SEAT No. :

P2940

[Total No. of Pages : 3

[4723]-201
M.Sc.
PHYSICAL CHEMISTRY
CH-210 : Physical Chemistry-II
(2008 Pattern) (Old) (Semester-II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *Answers to the two sections should be written in separate answer books.*
2) *All questions are compulsory.*
3) *Figures to the right side indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*
5) *Neat diagrams must be drawn wherever necessary.*

Physico - Chemical Constants

1.	Avogadro Number	N	$= 6.022 \times 10^{23}$ mol^{-1}
2.	Boltzmann Constant	k	$= 1.38 \times 10^{-16}$ erg K^{-1} molecule^{-1}
			$= 1.38 \times 10^{-23}$ J K^{-1} molecule^{-1}
3.	Planck Constant	h	$= 6.626 \times 10^{-27}$ erg s
			$= 6.626 \times 10^{-34}$ J s
4.	Electronic Charge	e	$= 4.803 \times 10^{-10}$ esu
			$= 1.602 \times 10^{-19}$ C
5.	1 eV		$= 23.06$ k cal mol^{-1}
			$= 1.602 \times 10^{-12}$ erg
			$= 1.602 \times 10^{-19}$ J
			$= 8065.5$ cm^{-1}
6.	Gas Constant	R	$= 8.314 \times 10^{7}$ ergK^{-1} mol^{-1}
			$= 8.314$ J K^{-1} mol^{-1}
			$= 1.987$ cal K^{-1} mol^{-1}
7.	Faraday Constant	F	$= 96487$ C equiv^{-1}
8.	Speed of light	c	$= 2.997 \times 10^{10}$ cm s^{-1}
			$= 2.997 \times 10^{8}$ m s^{-1}
9.	1 cal		$= 4.184 \times 10^{7}$ erg
			$= 4.184$ J
10.	1 amu		$= 1.673 \times 10^{-27}$ kg
11.	Bohr magneton	β_e	$= -9.274 \times 10^{-24}$ J T^{-1}
12.	Nuclear magneton	β_n	$= 5.051 \times 10^{-27}$ J T^{-1}
13.	Mass of an electron	m_e	$= 9.11 \times 10^{-31}$ kg

P.T.O.

SECTION-I

Q1) Attempt Any Three of the following: **[15]**

a) Explain the factors influencing the width and intensity of spectral lines.

b) Discuss the general rules governing the number of lines observed in the ESR spectrum.

c) What is centrifugal distortion? Explain the effect of centrifugal distortion on the rotational energy levels of a diatomic molecule.

d) Discuss the principle of IR spectroscopy in the molecular structure elucidation.

e) What is the significance of zero point energy? Obtain an expression for zero point energy of an anharmonic oscillator.

Q2) Attempt Any Three of the following: **[15]**

a) Write a note on Birge sponer extrapolation.

b) Sketch and explain the Fortrat diagram.

c) Explain the quantum theory of Raman effect.

d) Discuss the theory of pure rotational Raman spectra of linear molecule. Sketch the energy levels and the spectrum arising from transition between them.

e) What is Franck-condon principle? How is dissociation energy of a diatomic molecule determined from vibrational coarse structure in its electronic spectrum?

Q3) Solve Any Two of the following: **[10]**

a) Calculate the force constant for HCl molecule, as it shows absorption band at 2890 cm^{-1} [Given At. wt: Cl = 35.5, H = 1.008]

b) If $H^{36}Cl$ is irradiated with 435.8mm Hg lines, calculate the Raman line in nm, if the fundamental vibrational frequency of $H^{35}Cl$ is $8.667 \times 10^{13} S^{-1}$.

c) For a certain molecule, B = 200 m^{-1}. Estimate the relative population of the molecule in the first excited state to that in the ground state at 300°C.

SECTION-II

Q4) Attempt Any Three of the following: **[15]**

a) Describe the different types of radioactive decay processes. Give one example of each.

b) Give an account of nuclear waste management.

c) Explain seperation of isotopes by the gaseous diffusion method.

d) Discuss the four factor formula used in reactor technology.

e) Give the classification of nuclear reactor.

Q5) Attempt Any Three of the following: **[15]**

a) Enlist the different modes of interaction of gamma radiation with matter. Describe in detail any one of them.

b) Discuss the method of preparation of ^{14}C and ^{35}S isotopes.

c) What is principle of Frike dosimeter? Explain the mechanism of radiolysis of Frike solution.

d) Explain the principle of neutron activation analysis. Write the expression of induced activity.

e) What are the different units for the measurement of radiation energy? How are they related with each other?

Q6) Solve Any Two of the following: **[10]**

a) Calculate the number of atoms of uranium that must fission per second to generate 20 MW power.

Given-energy released per uranium fission is 200 MeV.

b) 0.1 mg of ^{239}Pu produces 1.4×10^7 dpm. Calculate the half life and average life of ^{239}Pu.

c) Calculate the mass, molecular and linear absorption coefficient of

i) Cyclohexane and

ii) Toluene.

Given - $e\mu = 0.211$ barn / electron.

densities of cyclohexane and toluene are 0.779 and 0.885 9 cm^{-3} respectively.

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