Sanjay Ghodawat University, Kolhapur

2018-19

Established as State Private University under Govt. of Maharashtra. Act No XL, 2017

EXM/P/09/00

Year and Program: F.Y.M.Sc | **School: Science** | **Department: Physics**

Course Code: PHS 503 | **Course Title: Atomic & Molecular Physics** | **Semester – I**

Day and Date: Saturday Saturday 01/06/2019 | **Examination: End Semester Examination (ESE)** | **Time: 30 Mins** | **Max Marks: 20**

(A)

10·30 to 11·00 a.m.

Seat No.:	PRN No.:	Student Sign:
Invigilator Sign:	Examiner Sign:	Marks Obtained:

Instructions:
1) All Questions are compulsory.
2) Mark √ to the correct option. Do not circle.
3) More than one options marked will not be considered for assessment.
4) Rough calculations on paper are not allowed.
5) Use non-programmable calculator is allowed.

Q.1. A Select the correct alternative **Marks (16)**

		Marks	Bloom's Level	CO
1	The different values for the total orbital quantum number of a two electron system with $L_1=3$ and $L_2=2$ are a) 5 b) 5,1 c) 5,4,3,2,1 d) $\pm5,\pm4,\pm3,\pm2,\pm1$	1	L2	503.1
2	S value for the state $^2D_{3/2}$ is given by a) 0 b) 1/2 c) 1 d) 3/2	1	L2	503.1
3	Which of the following states exist? a) $2^2P_{3/2}$ b) $2^3P_{1/2}$ c) $2^2P_{5/2}$ d) $2^2P_{7/2}$	1	L2	503.1
4	Pauli exclusion principle state that a) Two electrons can have all the quantum numbers same b) Particles with integer and half integer spin cannot exist in the same state c) No two electrons can have all the quantum numbers same d) None of these	1	L1	503.1
5	One Bohr magneton is approximately a) 10^{23} J/T b) 10^{-24} J/T	1	L2	503.2

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c) 10^{10} J/T d) 10^{-10} J/T

6 If the magnetic field is continually increased there will come a time when coupling between S* and L* in case of LS coupling or between j_1* and j_2* in case of jj-coupling — 1 L1 503.2

a) Remains the same b) Increases

c) Broken down d) None of these

7 The interaction energy due to the coupling between j_1* and j_2* is given by — 1 L1 503.2

a) $\Gamma_{Strong} = A\, m_{j1}\, m_{j2}$ b) $\Gamma_{Strong} = A\, M_L\, M_S$

c) $\Gamma_{Strong} = A\, m_{j1}\, m_{j2} + A\, M_L\, M_S$ d) None of these

8 When splitting of the energy levels is due to weak magnetic field, then the effect is known as ..... effect. — 1 L1 503.2

a) Paschen-Back b) Weak field Stark

c) Strong field Stark d) Zeeman

9 Which one of the following molecules does not exhibit a rotational spectrum — 1 L2 503.3

a) H_2 b) CO

c) HCl d) HBr

10 The rotational energies of a diatomic molecule having rotational constant B Joule are — 1 L1 503.3

a) B,2B,3B,..... b) 0,2B,6B,12B,.....

c) B,4B,9B,..... d) 0,2B,4B,6B,.....

11 ..... is a microwave detector — 1 L1 503.3

a) Golay cell b) DTGS

c) Lead sulphate d) Crystal detector

12 The relation between rotational constant B and centrifugal distortion constant D is — 1 L1 503.3

a) $D = \frac{B^2}{\varpi}$ b) $B = \frac{D^2}{\varpi}$

c) $D = \frac{4B^3}{\varpi^2}$ d) $B = \frac{4D^3}{\varpi}$

13 Which of the following molecule will show the microwave spectra? — 1 L2 503.3

a) CH_2Cl_2 b) SF_6

c) H_2 d) CH_4

14 Consider the pure rotational spectrum of a diatomic rigid rotator. The separation between two consecutive lines ($\Delta\nu$) in the spectrum — 1 L2 503.3

a) Is directly proportional to the moment of inertia of the b) Is inversely proportional to the moment of inertia of the

		rotator		rotator		
	c)	Depends on the angular momentum	d)	Is directly proportional to the square of the inter atomic separation		
15	Vibrational transitions exist in				1	L1	503.4
	a)	Infra-red	b)	Microwave		
	c)	Radio wave region	d)	None of these		
16	The selection rule of Stoke's line in the rotational Raman spectrum of a molecule				1	L1	503.4
	a)	$\Delta J = -2$	b)	$\Delta J = +2$		
	c)	$\Delta J = 0$	d)	$\Delta J = +1$		
17	The molecule which is IR inactive but Raman active is:				1	L2	503.4
	a)	HCl	b)	SO_2		
	c)	N_2	d)	Protein		
18	In case lines are obtained in infra-red and raman spectra, then the molecule should				1	L2	503.4
	a)	Be centrosymmetric	b)	Has no centre of symmetry		
	c)	Have high value of dipole moment	d)	Low value of dipole moment		
19	The energy required for various transitions follow the order				1	L2	503.4
	a)	$\sigma \rightarrow \sigma^* > n \rightarrow \sigma^* > \pi \rightarrow \pi^* > n \rightarrow \pi^*$	b)	$\sigma \rightarrow \sigma^* > \pi \rightarrow \pi^* > n \rightarrow \sigma^* > n \rightarrow \pi^*$		
	c)	$\pi \rightarrow \pi^* > n \rightarrow \pi^* > \sigma \rightarrow \sigma^* > n \rightarrow \sigma^*$	d)	$n \rightarrow \pi^* > \sigma \rightarrow \sigma^* > n \rightarrow \sigma^* > \pi \rightarrow \pi^*$		
20	In case of vibrational –rotational spectrum; the lines to the higher frequency side of are referred to as				1	L1	503.4
	a)	P-branch	b)	Q-branch		
	c)	R-branch	d)	O-branch		

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Day and Date: Saturday Saturday 01/06/2019 | **Examination:** End Semester Examination (ESE) (B) | **Time:** 2 Hrs 30 Mins | **Max Marks:** 80

11.00 am to 1.30 pm

Instructions:
1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Neat diagrams must be drawn wherever necessary.
4) Assume suitable data if necessary.
5) Use of logarithmic table and non-programmable calculator is allowed.

		Marks	Bloom's Level	CO
Q.2	**Answer the following questions. Marks (16)**			
a)	Explain *jj*-coupling scheme for the two valence electrons with the help of ideal vector model and obtain the expression for interaction energies with schematic representation for the ideal case of *jj*-coupling with *ps* configuration.	12	L5	503.1
b)	Explain Pauli Exclusion Principle.	4	L2	503.1
	OR			
b)	Describe intensity relations for two valence electron system	4	L2	503.1
Q.3	**Answer the following questions. Marks (16)**			
a)	Explain the Paschen-Back effect in detail with neat ideal vector model for LS coupling.	12	L3	503.2
b)	What is Zeeman effect? Describe the intensity rules for the Zeeman effect of two valence electron systems.	4	L2	503.2
	OR			
b)	Discuss strong field Stark effect	4	L2	503.2
Q.4	**Answer the following questions. Marks (24)**			
a)	Deduce the expression for rotational energy of a rigid rotator. Draw a schematic diagram illustrating transitions between energy levels and the spectrum of rigid rotator.	12	L4	503.3
b)	Explain principle & working of electron spin resonance spectroscopy in detail.	8	L3	503.3
	OR			
b)	Explain principle and working of nuclear magnetic resonance spectroscopy in detail.	8	L3	503.3
c)	What are the characteristics of symmetric tops and spherical tops type of molecules? Give examples of each type.	4	L2	503.3
	OR			

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c)	Explain the method of chemical analysis of material by using microwave spectroscopy.	4	L2	503.3

Q.5 Answer the following questions. **Marks (24)**

a)	Develop the expression for the combined rotational-vibrational energy and analytical expression for the combined rotational-vibrational spectrum by applying the selection rules for a diatomic molecule	12	L4	503.4
b)	Illustrate Franck-Condon principle.	8	L3	503.4
	OR			
b)	State and explain the anharmonic oscillator.	8	L3	503.4
c)	Describe stretching and bending vibrations.	4	L2	503.4
	OR			
c)	Explain the instrumentation and techniques used in infra-red spectroscopy.	4	L2	503.4

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