10.SPECTRA

SOLUTIONS

TEACHING TASK

1. The characteristic line spectrum of sodium vapor shows a bright yellow doublet because:

A) Sodium atoms have paired electrons B) Of transitions between 3p $\rightarrow$ 3s orbitals
C) Sodium reflects yellow light best D) It's a transition metal property

Answer:B

Solution:The yellow doublet in sodium's spectrum (589.0 nm and 589.6 nm) arises from transitions between the 3p and 3s orbitals

2.When analyzing starlight, dark Fraunhofer lines appear because:

A) The star's atmosphere absorbs specific wavelengths
B) Cosmic dust scatters light randomly
C) The telescope lens filters certain colors
D) Light pollution affects observations

Answer:A

Solution:Fraunhofer lines are dark absorption lines caused by elements in the star's outer atmosphere absorbing specific wavelengths of the continuous spectrum emitted from the hotter interior.

3.The Balmer series in hydrogen corresponds to:

A) All possible electron transitions B) Transitions ending at n=2
C) Only ionization events D) Molecular vibration modes

Answer:B

Solution:The Balmer series includes all transitions where electrons fall to the n=2 level in hydrogen, producing visible light.

4. Neon signs glow with characteristic colors because:

A) Noble gases reflect city lights B) Electron transitions release quantized energy
C) The glass tubing filters white light D) Electrical current heats the gas uniformly

Answer:B

Solution:Neon signs glow due to electrons in neon atoms being excited by electricity and then falling back to lower energy levels, emitting characteristic colored light.

5.Which element would show the most complex emission spectrum?

A) Hydrogen (1 electron) B) Helium (2 electrons)
C) Carbon (6 electrons) D) Iron (26 electrons)

Answer:D

Solution:More electrons mean more possible transitions between energy levels, so iron (with 26 electrons) would show the most complex emission spectrum.

6.In a mercury vapor lamp, the intense line at 253.7nm corresponds to:

A) A forbidden transition between singlet states

B) The $6^1P_1 \rightarrow 6^1S_0$ transition

C) Molecular vibration bands

D) Thermal blackbody radiation

Answer:B

Solution:The 253.7 nm line in mercury vapor lamps comes from this specific transition between excited and ground states in mercury atoms.

7.The Rydberg formula ($1/\lambda = R(1/n_1^2 - 1/n_2^2)$) fails to predict:

A) Hydrogen spectral lines

B) Multi-electron atom spectra precisely

C) Only infrared transitions

D) Molecular band spectra

Answer:B

Solution:The Rydberg formula works perfectly for hydrogen but becomes increasingly inaccurate for multi-electron atoms due to electron-electron interactions and shielding effects.

8. The Zeeman effect demonstrates that spectral lines:

A) Can split in magnetic fields

B) Always appear in triplets

C) Are unaffected by external fields

D) Shift uniformly to red wavelengths

Answer:A

Solution:The Zeeman effect shows how spectral lines split into multiple components when atoms are placed in a magnetic field, due to interaction of the magnetic field with atomic magnetic moments.

9.For a hydrogen-like Li^{2+} ion, the $n=4 \rightarrow n=2$ transition energy is:

A) Equal to hydrogen's transition

B) 9 times hydrogen's transition

C) 1/9 of hydrogen's transition

D) Unpredictable due to shielding

Answer:B

Solution:For hydrogen-like ions: $E \alpha Z^2$. Li^{2+} has Z=3 $\rightarrow 3^2 = 9$ times hydrogen's transition energy

10. The anomalous intensity of certain spectral lines in complex atoms occurs due to:

A) Selection rules for allowed transitions **B) Random measurement errors**

C) Temperature fluctuations **D) Impurities in samples**

Answer:A

Solution:Some transitions are more probable than others due to quantum mechanical selection rules, causing certain lines to appear more intense.

11.In X-ray spectra, K α lines result from:

A) Valence electron transitions

B) Inner shell 2p $\rightarrow$ 1s transitions

C) Nuclear energy level changes

D) Bremsstrahlung radiation only

Answer:B

Solution:Kα lines in X-ray spectra result from electrons falling from the L shell (n=2) to fill a vacancy in the K shell (n=1).

12. For a hypothetical element with electron configuration [Xe]$4f^{14}5d^{10}6s^{2}6p^{3}$, the most complex spectra would arise from:

A) 6p $\rightarrow$ 6s transitions

B) 5d $\rightarrow$ 6p transitions

C) 4f $\rightarrow$ 5d transitions

D) All of the above simultaneously

Answer:D

Solution:With so many valence electrons in different orbitals (4f, 5d, 6s, 6p), all these types of transitions could occur, creating a very complex spectrum.

13. The hyperfine structure in spectral lines reveals:

A) Nuclear spin effects **B) Relativistic corrections**

C) Quantum electrodynamics effects **D) All of the above**

Answer:A

Solution:The hyperfine structure in spectral lines reveals A) Nuclear spin effects. This splitting arises from the interaction between the magnetic dipole moment of the nucleus and the magnetic moment associated with the electron's spin and orbital angular momentum.

14. In a Stark effect experiment, spectral line splitting indicates:

A) Presence of electric fields

B) Magnetic dipole moments

C) Molecular rotation

D) Isotopic variations

Answer:A

Solution:The Stark effect is the splitting of spectral lines in the presence of an electric field, analogous to the Zeeman effect for magnetic fields.

15.The Lamb shift observed in hydrogen's fine structure demonstrates:

A) Vacuum polarization effects

B) Instrumental error

C) Classical wave behavior

D) Molecular contamination

Answer:A

Solution:The Lamb shift demonstrates small energy differences caused by quantum electrodynamic effects like vacuum fluctuations and electron-photon interactions.

MULTIPLE CORRECT ANSWER TYPE

16. Which of the following statements are correct?

A) The emission spectrum of helium contains more spectral lines than hydrogen due to electron-electron repulsion.

B) In a helium ion (He^+), the spectrum resembles the hydrogen spectrum but with shifted wavelengths.

C) Singlet and triplet states in helium arise due to different electron spin configurations.

D) All spectral lines of helium fall in the visible region.

Answer:A,B,C

Solution:

A)Helium has two electrons, leading to more complex interactions (electron-electron repulsion, spin-orbit coupling) and thus more spectral lines than hydrogen (which has only one electron).

B) He^+ is a hydrogen-like ion with one electron, so its spectrum follows the Rydberg formula but with a nuclear charge Z=2, causing wavelengths to be 4 times shorter than hydrogen's for the same transition.

C)Singlet state (S=0): Electrons have opposite spins (↑↓).

Triplet state (S=1): Electrons have parallel spins (↑↑).

These configurations lead to different energy levels and spectral lines

D)Correction: Helium emits lines in UV, visible, and IR regions (e.g., 58.4 nm in UV, 1083 nm in IR)

17. Which of the following statements are correct about [Fe XIV] (iron ion with 13 electrons)?

A) Its green coronal line at 530.3 nm is a "forbidden transition" under normal lab conditions.

B) The spectrum of highly ionized iron (Fe XIV) resembles hydrogen due to a single valence electron.

C) Forbidden lines in astrophysical spectra indicate low-density environments (e.g., nebulae).

D) The 530.3 nm line results from a $3s^2 3p^5 \rightarrow 3s^2 3p^4 3d$ transition.

Answer:A,C

Solution:

A (True): The 530.3 nm green coronal line of [Fe XIV] is a forbidden transition under normal lab/terrestrial densities — it's observable in the low-density solar corona because the metastable level can radiatively decay before being collisionally de-excited.

B (False): Although Fe XIV is highly ionized, it is not hydrogen-like (it still has many electrons — Fe XIV has 13 electrons remaining), so its spectrum does not generally resemble hydrogen's simple pattern.

C (True): Forbidden lines in astrophysical spectra are signatures of low-density environments (nebulae, coronae) where collisional de-excitation is rare, allowing slow forbidden decays to occur.

D (False): The 530.3 nm line is not due to a $3s^2 3p^5 \rightarrow 3s^2 3p^4 3d$ transition (that notation implies many more p electrons). The green line is a fine-structure (forbidden) transition within the $3s^2 3p$ ground-configuration levels of Fe XIV (a $2P \rightarrow 2P$ fine-structure transition)

STATEMENT TYPE

A) Both STATEMENT-I and STATEMENT-II are true and STATEMENT-II is the correct explanation of STATEMENT-I

B) Both STATEMENT-I and STATEMENT-II are true and STATEMENT-II is not the correct explanation of STATEMENT-I

C) STATEMENT-I is true and STATEMENT-II is false

D) STATEMENT-I is false and STATEMENT-II is true

18. STATEMENT–I: The emission spectrum of He^+ and Li^{2+} are different.

STATEMENT–II: The energy levels of hydrogen-like species depend on the atomic number (Z).

Answer:A

Solution: For hydrogen-like ions $.E_n = -13.6eV \times \frac{Z^2}{n^2}$. He^+ (Z=2) and Li^{+2} (Z=3) have different Z, so their energy levels (and therefore emission wavelengths) differ — Statement II both true and explains Statement I.

COMPREHENSION TYPE

When an electric discharge is passed through a gas at low pressure light is emitted. If this light is resolved by a spectroscope, it is found that some isolated bright coloured lines are obtained on a photographic plate separated from each other by dark spaces. This spectrum is called line spectrum. Each line in the spectrum corresponds to a particular wavelength. Each element gives its own characteristic spectrum.

Line spectrum is characteristic spectrum of Atoms and Band spectrum is the characteristic spectrum of Molecules.

Band spectrum consists of the radiation in the form of a band and when passed through prism, it gives spectral lines as a continuous band.

19.What is a line spectrum?

A) A spectrum formed by the overlapping of multiple wavelengths forming a band

B) A continuous spread of colors without any gaps

C) A set of bright, isolated lines each corresponding to a specific wavelength

D) A spectrum seen only in solids under high temperature

Answer:C

Solution:A line spectrum consists of discrete bright lines separated by dark spaces, each line corresponding to a specific wavelength.

It is produced by excited atoms (e.g., gas discharge tubes) when electrons transition between quantized energy levels.

20.Which of the following statements is true?

A) Band spectrum is the characteristic of atoms.

B) Line spectrum is observed only in liquids.

C) Band spectrum appears continuous due to overlapping radiation from molecules.

D) Line spectrum and band spectrum are identical in all substances.

Answer:C

Solution:Band spectra are produced by molecules (not atoms).

They appear as continuous bands because of numerous closely spaced rotational/ vibrational energy levels overlapping.

INTEGER TYPE

21.A gaseous mixture contains three species:

Doubly-ionized Beryllium (Be^{2+}) ions in the 3rd excited state (n=4)

Calculate the total number of spectral lines in the visible region (400–700 nm) when all electrons transition to the ground state.

Answer:0

Solution:Work (hydrogenic Rydberg formula)

$$\frac{1}{\lambda} = RZ^2[\frac{1}{n_1^2} - \frac{1}{n_2^2}], R = 1.097373 \times 10^7 m^{-1}$$

Initial/excited level: n_2 =4. Possible downward transitions among levels 4,3,2,1 give these wavelengths (in nm) for Z=4:

$4 \rightarrow 3$: 117.16nm

$4 \rightarrow 2$: 30.38nm

$4 \rightarrow 1$: 6.08 nm

$3 \rightarrow 2$: 41.01 nm

$3 \rightarrow 1$: 6.41 nm

$2 \rightarrow 1$: 7.59 nm

All of these lie well outside the visible window (400–700 nm) — they are in the extreme UV / soft X-ray region

MATRIX MATCHING TYPE

22.Number of Spectral Lines | **Possible Electronic Transitions (in Hydrogen Atom)**

Number of Spectral Lines	Possible Electronic Transitions (in Hydrogen Atom)
A) 3 spectral lines	**1) From n = 4 to n = 1**
B) 6 spectral lines	**2) From n = 4 to n = 2**
C) 1 spectral line	**3) From n = 3 to n = 2**
D) 10 spectral lines	**4) From n = 5 to n = 1**

A)2 1 3 4 **B)3 2 1 4**

C)2 4 3 1 **D)3 1 2 4**

Answer:A

Solution:

Number of spectral lines= $\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$

1) From n = 4 to n = 1

$\frac{(4-1)(4-1+1)}{2} = 6$

2) From n = 4 to n = 2

$\frac{(4-2)(4-2+1)}{2} = 3$

3) From n = 3 to n = 2

$\frac{(3-2)(3-2+1)}{2} = 1$

4) From n = 5 to n = 1

$\frac{(5-1)(5-1+1)}{2} = 10$

A) 3 spectral lines	2) From n = 4 to n = 2
B) 6 spectral lines	1) From n = 4 to n = 1
C) 1 spectral line	3) From n = 3 to n = 2
D) 10 spectral lines	4) From n = 5 to n = 1

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1.The characteristic bright yellow lines in a sodium vapor lamp's spectrum are produced due to:

A) Thermal excitation of sodium metal

B) Electron transitions between 3p and 3s orbitals

C) Vibration of sodium diatomic molecules

D) Nuclear reactions in sodium atoms

Answer:B

Solution:The bright yellow doublet (589.0 nm and 589.6 nm) arises from transitions between the 3p $\rightarrow$ 3s orbitals in sodium atoms.

2.Neon signs glow with distinct colored lines because:

A) The glass tube filters white light

B) Excited neon atoms emit specific wavelengths

C) Electrical current produces continuous spectrum

D) Neon reflects surrounding light

Answer:B

Solution:Neon signs glow due to electron transitions in neon atoms (e.g., red-orange light at 640 nm).

3.In the hydrogen emission spectrum, the Lyman series appears in the UV region because:

A) These transitions involve the n=1 energy level

B) Hydrogen atoms absorb all visible light

C) The spectrometer cannot detect visible lines

D) They represent molecular vibrations

Answer:A

Solution:The Lyman series corresponds to transitions ending at n=1, which emit high-energy UV photons.

4.The spectrum of molecular nitrogen (N_2) shows bands instead of sharp lines because:

A) Molecules have vibrational and rotational energy levels

B) Nitrogen atoms have variable nuclear charge

C) The spectrometer resolution is poor

D) All diatomic molecules show continuous spectra

Answer:A

Solution:Band spectra arise from closely spaced rotational/vibrational transitions in molecules (not atoms).

5.The anomalous Zeeman effect observed in some elements' spectra indicates:

A) The presence of electron spin B) Inaccurate spectrometer calibration

C) Molecular contamination in samples D) Thermal broadening of spectral lines

Answer:A

Solution:The anomalous Zeeman effect (uneven line splitting) occurs due to spin-orbit coupling of electrons.

JEE MAIN LEVEL QUESTIONS

1.For hydrogen-like species, the ratio of wavelengths for transitions n=2 $\rightarrow$ 1 in He^+ and Li^{2+} is:

A) 1:2 B) 2:1 C) 4:9 D) 9:4

Answer:D

Solution:

$$\frac{1}{\lambda} = RZ^2[\frac{1}{n_1^2} - \frac{1}{n_2^2}]$$

For the same transition $(n = 2 \rightarrow n = 1)$:

$$He^+(Z = 2) : \lambda_{He} = \frac{1}{4}$$

$$Li^{+2}(Z = 3) : \lambda_{Li} = \frac{1}{9}$$

$$\frac{\lambda_{He}}{\lambda_{Li}} = \frac{9}{4}$$

2.In the Lyman series, the shortest wavelength corresponds to:

A) n=2$\rightarrow$1

B) n=8$\rightarrow$1

C) n=3$\rightarrow$1

D) n=4$\rightarrow$1

Answer:B

Solution:

In the Lyman series (transitions to n=1) shortest λ = highest-energy transition; among choices the largest initial n (here 8) gives the shortest wavelength

3.The Balmer series of hydrogen lies in the:

A) UV region B) Visible region C) IR region D) X-ray region

Answer:B

Solution:The Balmer series (transitions ending at n=2) includes wavelengths like 656 nm (red), 486 nm (blue-green), and 434 nm (violet), all in the visible spectrum.

4.Sodium's yellow doublet (589.0 nm and 589.6 nm) arises due to:

A) Spin-orbit coupling B) Nuclear spin

C) Isotopic difference D) Molecular vibration

Answer:A

Solution:The doublet arises due to spin-orbit interaction, splitting the 3p state into two levels ($3p^3/2$ and $3p^1/2$).

5.An element emitting a line spectrum must be in:

A) Solid state B) Gaseous state C) Plasma state D) Any state

Answer:B

Solution:Line spectra are produced by isolated atoms/molecules in the gas phase, where quantized transitions occur without interference.

6.For a hydrogen atom, if an electron transitions from n=4 to n=2, the emitted photon's energy (in eV) is:

A) 0.85 B) 2.55 C) 3.40 D) 13.6

Answer:B
Solution:

$$E = 13.6[\frac{1}{2^2} - \frac{1}{4^2}] = 13.6(\frac{3}{16}) = 2.55eV$$

7.In the Paschen series, the longest wavelength occurs for:
A) n=4 $\rightarrow$ 3
B) n=5 $\rightarrow$ 3
C) n=8 $\rightarrow$ 3
D) n=6 $\rightarrow$ 3
Answer:A
Solution:The Paschen series (n $\geq$ 4 $\rightarrow$ n=3) has its longest wavelength (lowest energy) for the smallest transition (n=4 $\rightarrow$ n=3).

8.The spectrum of molecular nitrogen (N_2) shows bands because of:
A) Electronic + vibrational transitions
B) Pure rotational transitions
C) Nuclear transitions
D) Spin-flip transitions
Answer:A
Solution:Bands arise from combined electronic, vibrational, and rotational transitions in molecules.

9.Heavy hydrogen (Deuterium) spectral lines are slightly shifted compared to normal hydrogen due to:
A) Different nuclear charge **B) Reduced mass effect**
C) Additional neutrons **D) Larger orbital size**
Answer:B
Solution:Deuterium (heavy hydrogen) has a neutron, changing the reduced mass of the electron-nucleus system and slightly shifting energy levels.

10.The Zeeman effect splits spectral lines due to:
A) Electric fields
B) Magnetic fields
C) Temperature gradients
D) Pressure changes
Answer:B
Solution:The Zeeman effect splits spectral lines due to interaction of electron magnetic moments with an external magnetic field.

11.The 21-cm line in astrophysics arises from:
A) Hydrogen hyperfine transition
B) Carbon monoxide rotation

C) Oxygen electronic transition
D) Nitrogen vibration
Answer:A
Solution:The 21-cm line results from hyperfine splitting due to spin-flip transitions in neutral hydrogen's ground state.

12.For a multi-electron atom, the 3d$\rightarrow$2p transition is:
A) Allowed **B) Forbidden**
C) Only occurs in magnetic fields **D) Possible only in solids**
Answer:A

Solution:3d$\rightarrow$2p has $\Delta l = -1$ (allowed electric-dipole transition), so it is allowed

13.X-ray Kα lines are produced by transitions:

A) n=2$\rightarrow$1
B) n=3$\rightarrow$1
C) Valence electron jumps
D) Nuclear excitations
Answer:A
Solution:Kα lines are produced by 2p $\rightarrow$ 1s transitions (inner-shell electrons).

14.The Rydberg constant for Li^{2+} is:
A) Same as for hydrogen
B) 3 times hydrogen's value
C) 9 times hydrogen's value
D) 1/9 of hydrogen's value
Answer:C

Solution:
The Rydberg constant scales with Z^2. For Li^{2+} (Z=3),

$R_{Li\,2+} = 9R_{H+}$

15.Stark effect is the splitting of spectral lines due to:
A) Electric fields
B) Magnetic fields
C) Gravitational fields
D) Temperature gradient
Answer:A
Solution:The Stark effect splits spectral lines due to external electric fields perturbing energy levels.

ADVANCED LEVEL QUESTIONS

MULTIPLE CORRECT ANSWER TYPE

16.Which of the following statements are correct?

A) Helium's emission spectrum shows both singlet and triplet systems due to spin-spin interactions

B) The 1s2p $\rightarrow$ 1s² transition in helium produces a spectral line at 58.4 nm (UV)

C) He^+ ions exhibit a spectrum identical to hydrogen but with halved wavelengths

D) All helium spectral lines fall within the visible range

Answer:A,B

Solution:A)Helium has two electrons, leading to singlet (anti-parallel spins, total spin S=0) and triplet (parallel spins, S=1) states.

These systems arise from spin-spin coupling and have different energies.

B)This transition emits a UV photon at 58.4 nm (resonance line), corresponding to an electron falling from the 2p to the 1s orbital.

17.Which statements about iron (Fe) are correct?

A) The Kα line in iron's X-ray spectrum results from 2p$\rightarrow$1s transitions

B) Fe XIV (13 electrons lost) produces a hydrogen-like spectrum

C) The 6.4 keV fluorescent line from iron is used to study black hole accretion disks

D) Iron's complex visible spectrum arises solely from 3d$\rightarrow$4s transitions

Answer:A,C

Solution:

A (True). K-α (Kα) X-ray lines arise from an electron falling from the n=2 (L) shell to fill a vacancy in the n=1 (K) shell (i.e., a 2 $\rightarrow$ 1 transition). That is the Ka mechanism.

B (False). Fe XIV (Fe^{13+}) is highly ionized but still has many electrons (it is not hydrogen-like), so its spectrum does not exhibit the simple hydrogen pattern.

C (True). The ~6.4 keV Fe Kα fluorescent line (from near-neutral iron) is widely used in X-ray astronomy to study accretion-disk physics and black-hole environments.

D (False). Iron’s visible complexity is not solely from 3d–4s transitions — many configurations and transitions (including 3d–3p, 4s–4p, and others, plus fine structure and configuration mixing) contribute to its rich spectrum

STATEMENT TYPE

A) Both STATEMENT-I and STATEMENT-II are true and STATEMENT-II is the correct explanation of STATEMENT-I

B) Both STATEMENT-I and STATEMENT-II are true and STATEMENT-II is not the correct explanation of STATEMENT-I

C) STATEMENT-I is true and STATEMENT-II is false

D) STATEMENT-I is false and STATEMENT-II is true

18.STATEMENT–I: The emission spectrum of helium is more complex than that of hydrogen.

STATEMENT–II: Helium has only one electron like hydrogen and hence gives similar spectrum.

Answer:C

Solution:

Helium's emission spectrum is more complex than hydrogen's because helium has two electrons (leading to singlet/triplet systems and electron–electron interactions).

Statement-II is incorrect — helium does not have only one electron, so it does not give a spectrum similar to

COMPREHENSION TYPE

COMPREHENSION-I

When the electrons are getting de-excited from higher orbit to lower orbit it releases energy in the form of Radiation, when these radiations are passed through the spectroscope shows spectral lines, the number of spectral lines observed during an electron transition can be calculated using the formula

Number of spectral lines obtained $= \dfrac{n(n+1)}{2}$.

19.When an electron transitions from a higher orbit to a lower orbit, energy is released in the form of:

A) Sound waves B) Radiation C) Mass D) Heat only

Answer:B

Solution:When the electrons are getting de-excited from higher orbit to lower orbit it releases energy in the form of Radiation

20.The number of spectral lines observed during an electron transition from a higher energy level n_2 to a lower level n_1 can be calculated by the formula:

$A)\dfrac{n_2(n_2-1)}{2}$

$B) n_2 - n_1$

$C) n^2{}_2 - n_1{}^2$

$D)\frac{n(n-1)}{2}$ **is the principal quantum number of the excited state**

Answer:A

Solution:

The number of spectral lines observed when an electron transitions from a higher energy level n_2 to a lower level n_1 is given by the formula:

Number of spectral lines= $\frac{(n_2-n_1)(n_2-n_1+1)}{2}$

However, if the electron cascades through all possible intermediate levels (i.e., transitions from n_2 down to n_1=1), the formula simplifies to:

$$\frac{(n_2-1)(n_2-1+1)}{2}=\frac{(n_2)(n_2-1)}{2}$$

INTEGER TYPE

21.In a hydrogen atom, an electron transitions from the 6th excited state (n=7) to the 3rd state (n=3). The maximum number of distinct spectral lines observed is ______.

Answer:10

Solution:

$$\frac{(n_2-n_1)(n_2-n_1+1)}{2}$$

$$\frac{(7-3)(7-3+1)}{2}=10$$

22.In a He^+ ion, an electron de-excites from n=5 to n=2 via all possible intermediate paths. The number of spectral lines emitted is ______.

Answer:6

Solution:

$$\frac{(n_2-n_1)(n_2-n_1+1)}{2}$$

$$\frac{(5-2)(5-2+1)}{2}=6$$

23.For a diatomic molecule (e.g., N_2), if an electronic transition produces 3 vibrational bands and each band has 5 rotational lines, the total number of spectral lines observed is ______.

Answer:15

Solution:

Total lines=vibrational bands x rotational lines =3 x 5 =15

24.In an iron (Fe) atom, if an electron fills a K-shell vacancy from the L-shell ($n=2\rightarrow 1$), followed by an M-shell ($n=3\rightarrow 2$) transition, the total number of distinct X-ray emission lines ($K\alpha$ + $L\alpha$) is ______.

Answer:2

Solution:

$K\alpha$ line: 2p $\rightarrow$ 1s (L-shell to K-shell).

$L\alpha$ line: 3d $\rightarrow$ 2p (M-shell to L-shell).

Total distinct lines: 2 (one K-series and one L-series line).

25.A hydrogen gas cloud in space emits 21 spectral lines in the Balmer series (visible region). The highest initial energy level (n) involved is ______.

Answer:8

Solution:

$$\frac{(n_2-n_1)(n_2-n_1+1)}{2}=21$$

$$\frac{(n_2-2)(n_2-2+1)}{2}=21$$

$$(n_2-2)(n_2-1)=42$$

$$(n_2^2-n_2-2n_2+2)=42$$

$$n_2^2-3n_2-40=0$$

$$n_2^2-8n_2+5n_2-40=0$$

$$n_2(n_2-8)-5(n_2-8)=0$$

$$n_2=8$$

MATRIX MATCHING TYPE

26. List – I **List – II**

List – I	List – II
I) Continuous Spectrum	**a) Emission from hot solids or liquids**
II) Molecular Spectrum	**b) Closely spaced lines forming bands**
III) Atomic Emission Spectrum	**c) Discrete lines due to electron transitions**
IV) Absorption Spectrum	**d) Dark lines over bright background**

A) I-a, II-b, III-c, IV-d **B) I-b, II-a, III-d, IV-c**

C) I-d, II-b, III-a, IV-c **D) I-c, II-d, III-b, IV-a**

Answer:A

Solution:

I) Continuous Spectrum	a) Emission from hot solids or liquids
II) Molecular Spectrum	b) Closely spaced lines forming bands
III) Atomic Emission Spectrum	c) Discrete lines due to electron transitions
IV) Absorption Spectrum	d) Dark lines over bright background

KEY

				TEACHING TASK					
1	2	3	4	5	6	7	8	9	10
B	A	B	B	D	B	B	A	B	A
11	12	13	14	15	16	17	18	19	20
B	D	A	A	A	A,B,C	A,C	A	C	C
21	22								
0	A								
				LEARNERS TASK					
			CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)						
1	2	3	4	5					
B	B	A	A	A					
			JEE MAIN LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
D	B	B	A	B	B	A	A	B	B
11	12	13	14	15					
A	A	A	C	A					
			ADVANCED LEVEL QUESTIONS						
16	17	18	19	20	21	22	23	24	25
A,B	A,C	C	B	A	10	6	15	2	8
26									
4									