DPP - Daily Practice Problems

Name : ____________________ **Date :** __________

Start Time : __________ **End Time :** __________

PHYSICS 55

SYLLABUS : Atoms

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

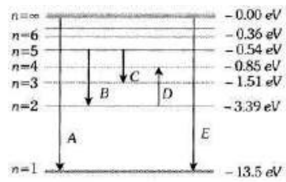
DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 In nature there may not be an element for which the principal quantum number $n > 4$, then the total possible number of elements will be
(a) 60 (b) 32 (c) 4 (d) 64

Q.2 In the following atoms and molecule for the transition from $n = 2$ to $n = 1$, the spectral line of minimum wavelength will be produced by
(a) Hydrogen atom (b) Deuterium atom
(c) Uni-ionized helium (d) Di-ionized lithium

Q.3 The Lyman series of hydrogen sperctum lies in the region
(a) Infrared (b) Visible
(c) Ultraviolet (d) X - rays

Q.4 The energy levels of the hydrogen spectrum is shown in figure. There are some transitions. A,B,C,D and E. Transition A, B and C respectively represent

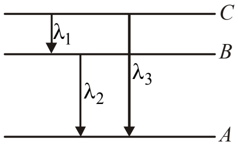


(a) First spectral line of Lyman series, third spectral line of Balmer series and the second spectral line of Paschen series.
(b) Ionization potential of hydrogen, second spectral line of Balmer series and third spectral line of Paschen series
(c) Series limit of Lyman series, third spectral line of Balmer series and second spectral line of Paschen series
(d) Series limit of Lyman series, second spectral line of Balmer series and third spectral line of Paschen series

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ

Space for Rough Work

Q.5 Energy levels A, B, C of a certain atom corresponding to increasing values of *energy i.e.* $E_A < E_B < E_C$. If $\lambda_1, \lambda_2, \lambda_3$ are the wavelengths of radiations corresponding to the transitions C to B, B to A and C to A respectively, which of the following statements is correct?



(a) $\lambda_3 = \lambda_1 + \lambda_2$ (b) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$

(c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (d) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Q.6 If m is mass of electron, v its velocity, r the radius of stationary circular orbit around a nucleus with charge Ze, then from Bohr's first postulate, the kinetic energy $K = \frac{1}{2}mv^2$ of the electron in $C.G.S.$ system is equal to

(a) $\frac{1}{2}\frac{Ze^2}{r}$ (b) $\frac{1}{2}\frac{Ze^2}{r^2}$ (c) $\frac{Ze^2}{r}$ (d) $\frac{Ze}{r^2}$

Q.7 When a hydrogen atom is raised from the ground state to an excited state

(a) P. E. increases and K. E. decreases
(b) P. E. decreases and K. E. increases
(c) Both kinetic energy and potential energy increase
(d) Both K. E. and P. E. decrease

Q.8 The value of the kinetic energy divided by the total energy of an electron in a Bohr orbit is

(a) – 1 (b) 2
(c) 0.5 (d) None of these

Q.9 The ratio of the frequencies of the long wavelength limits of Lyman and Balmer series of hydrogen spectrum is

(a) 27 : 5 (b) 5 : 27
(c) 4 : 1 (d) 1 : 4

Q.10 Ratio of the wavelengths of first line of Lyman series and first line of Balmer series is

(a) 1 : 3 (b) 27 : 5 (c) 5 : 27 (d) 4 : 9

Q.11 According to Bohr's theory the moment of momentum of an electron revolving in second orbit of hydrogen atom will be

(a) $2\pi h$ (b) πh (c) $\frac{\pi}{h}$ (d) $\frac{h}{\pi}$

Q.12 In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass, e is the charge on the electron and ε_0 is the vacuum permittivity, the speed of the electron is

(a) 0 (b) $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$

(c) $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$ (d) $\frac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

Q.13 Which of the following transitions in hydrogen atoms emit photons of highest frequency?

(a) $n = 1$ to $n = 2$ (b) $n = 2$ to $n = 6$
(c) $n = 6$ to $n = 2$ (d) $n = 2$ to $n = 1$

Q.14 As per Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom $(Z = 3)$ is

(a) 1.51 (b) 13.6
(c) 40.8 (d) 122.4

Q.15 The third line of Balmer series of an ion equivalent to hydrogen atom has wavelength of 108.5 nm. The ground state energy of an electron of this ion will be

(a) 3.4 eV (b) 13.6 eV
(c) 54.4 eV (d) 122.4 eV

Q.16 The wavelength of radiation emitted is λ_0 when an electron jumps from the third to the second orbit of hydrogen atom. For the electron jump from the fourth to the second orbit of the hydrogen atom, the wavelength of radiation emitted will be

(a) $\frac{16}{25}\lambda_0$ (b) $\frac{20}{27}\lambda_0$ (c) $\frac{27}{20}\lambda_0$ (d) $\frac{25}{16}\lambda_0$

RESPONSE GRID					
	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ
	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ			

Space for Rough Work

Q.17 The energy of electron in the n^{th} orbit of hydrogen atom is expressed as $E_n = \frac{-13.6}{n^2} eV$. The shortest and longest wavelength of Lyman series will be

(a) 910 Å, 1213 Å (b) 5463 Å, 7858 Å
(c) 1315 Å, 1530 Å (d) None of these

Q.18 Consider a hydrogen like atom whose energy in n^{th} exicited state is given by $E_n = -\frac{13.6Z^2}{n^2}$ when this excited atom makes a transition from excited state to ground state, most energetic photons have energy $E_{max} = 52.224\, eV$ and least energetic photons have energy $E_{min} = 1.224\, eV$. The atomic number of atom is

(a) 2 (b) 5
(c) 4 (d) None of these

Q.19 In the Bohr model of the hydrogen atom, let R, v and E represent the radius of the orbit, the speed of electron and the total energy of the electron respectively. Which of the following quantity is proportional to the quantum number n

(a) R/E (b) E/v
(c) RE (d) vR

Q.20 An α – particle of 5 MeV energy strikes with a nucleus of uranium at stationary at an scattering angle of 180°. The nearest distance upto which α – particle reaches the nucleus will be closest to

(a) 1 Å (b) 10^{-10}cm
(c) 10^{-12}cm (d) 10^{-15}cm

Q.21 In a hypothetical Bohr hydrogen, the mass of the electron is doubled. The energy E_0 and the radius r_0 of the first orbit will be (a_0 is the Bohr radius)

(a) $E_0 = -27.2 eV; r_0 = a_0/2$
(b) $E_0 = -27.2 eV; r_0 = a_0$
(c) $E_0 = -13.6 eV; r_0 = a_0/2$
(d) $E_0 = -13.6 eV; r_0 = a_0$

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 The electron in a hydrogen atom makes a transition $n_1 \to n_2$, where n_1 and n_2 are the principal quantum numbers of two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. Then

(1) $n_1 = 4$ (2) $n_2 = 2$ (3) $n_2 = 5$ (4) $n_1 = 5$

Q.23 A free hydrogen atom in ground state is at rest. A neutron of kinetic energy K collides with the hydrogen atom. After collision hydrogen atom emits two photons in succession one of which has energy 2.55eV. Assume that the hydrogen atom and neutron has same mass.

(1) Minimum value of K is 25.5 eV
(2) Minimum value of K is 12.75 eV
(3) The other photon has energy 10.2eV
(4) The upper energy level is of excitation energy 12.5 eV

Q.24 Which of the series of hydrogen spectrum are not in the visible region?

(1) Lyman series (2) Paschen series
(3) Bracket series (4) Balmer series

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

A gas of identical hydrogen like atoms has some atoms in ground state and some atoms in a particular excited state and there are no atoms in any other energy level. The atoms of the gas make transition to a higher energy state by absorbing monochromatic light of wavelength 304Å. Subsequently, the atoms emit radiation of only six different photon energies. Some of emitted photons have wavelength 304 Å, some have wavelength more and some have less than 304Å (Take hc = 12420 eV–Å)

Q.25 Find the principal quantum number of the initially excited state.

(a) 1 (b) 2 (c) 3 (d) 4

RESPONSE GRID					
	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ
	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	

Space for Rough Work

Q.26 Identify the gas (Z = ?)

(a) 1 (b) 2 (c) 3 (d) 4

Q.27 Find the maximum and minimum energies of emitted photons (in eV)

(a) 20.4, 10.6 (b) 10.4, 3.6

(c) 40.8, 10.6 (d) None of these

DIRECTIONS (Q.28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.28 **Statement-1 :** Bohr postulated that the electrons in stationary orbits around the nucleus do not radiate energy.

Statement-2 : According to classical physics all moving electrons radiate energy.

Q.29 **Statement-1 :** The force of repulsion between atomic nucleus and α-particle varies with distance according to inverse square law.

Statement-2 : Rutherford did α-particle scattering experiment.

Q.30 **Statement-1 :** Hydrogen atom consists of only one electron but its emission spectrum has many lines.

Statement-2 : Only Lyman series is found in the absorption spectrum of hydrogen atom whereas in the emission spectrum, all the series are found.

RESPONSE GRID					
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 55 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	30	Qualifying Score	50
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

55

1. **(a)** For $n = 1$, maximum number of states $= 2n^2 = 2$ and for $n = 2, 3, 4$ maximum number of states would be 8, 18, 32 respectively, Hence number of possible elements $= 2 + 8 + 18 + 32 = 60$

2. **(d)** $\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

For di-ionised lithium the value of Z is maximum

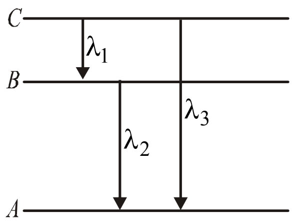
3. **(c)** Lyman series lies in the UV region.

4. **(c)** Transition A ($n = \infty$ to 1): Series limit of Lyman series

Transition B ($n = 5$ to $n = 2$) Third spectral line of Balmer series

Transition C ($n = 5$ to $n = 3$) : Second spectral line of Paschen series

5. **(b)** Let the energy in A, B and C state be E_A, E_B and E_C then from the figure



$$(E_C - E_B) + (E_B - E_A) = (E_C - E_A)$$

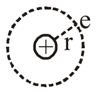
or $\frac{hc}{\lambda_1} + \frac{hc}{\lambda_2} = \frac{hc}{\lambda_3}$

$$\Rightarrow \lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

6. **(a)** In the revolution of electron, coulomb force provides the necessary centripetal force

$$\Rightarrow \frac{Ze^2}{r^2} = \frac{mv^2}{r} \Rightarrow mv^2 = \frac{Ze^2}{r}$$

$$\therefore \text{K.E.} = \frac{1}{2}mv^2 = \frac{Ze^2}{2r}$$



7. **(a)** P.E. $\propto -\frac{1}{r}$ and K.E. $\propto \frac{1}{r}$

As r increases so K.E. decreases but P.E. increases.

8. **(a)** K.E. $= -$(T.E.)

9. **(a)** For Lyman series

$$v_{Lyman} = \frac{c}{\lambda_{\max}} = Rc\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right] = \frac{3RC}{4}$$

For Balmer series

$$v_{Balmer} = \frac{c}{\lambda_{\max}} = Rc\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = \frac{5RC}{36}$$

$$\therefore \frac{v_{Lyman}}{v_{Balmer}} = \frac{27}{5}$$

10 **(c)** $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For first line of Lymen series $n_1 = 1$ and $n_2 = 2$

For first line of Balmer series $n_2 = 2$ and $n_2 = 3$

So, $\frac{\lambda_{Lymen}}{\lambda_{Balmer}} = \frac{5}{27}$

11. **(d)** Angular momentum $L = n\left(\frac{h}{2\pi}\right)$

For this case $n = 2$, hence $L = 2 \times \frac{h}{2\pi} = \frac{h}{\pi}$

12. **(c)** $\frac{mv^2}{a_0} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0^2} \Rightarrow v = \frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$

13. **(d)** We have to find the frequency of emitted photons. For emission of photons the transition must take place from a higher energy level to a lower energy level which are given only in options (c) and (d).
Frequency is given by

$$h\nu = -13.6\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

For transition from $n = 6$ to $n = 2$,

$$\nu_1 = \frac{-13.6}{h}\left(\frac{1}{6^2} - \frac{1}{2^2}\right) = \frac{2}{9} \times \left(\frac{13.6}{h}\right)$$

For transition from n = 2 to n = 1,

$$\nu_2 = \frac{-13.6}{h}\left(\frac{1}{2^2} - \frac{1}{1^2}\right) = \frac{3}{4} \times \left(\frac{13.6}{h}\right).$$

$$\therefore \nu_2 > \nu_1$$

14. **(d)** $E = -Z^2 \times 13.6\, eV = -9 \times 13.6\, eV = -122.4\, eV$

So ionisation energy $= +122.4\, eV$

15. **(c)** For third line of Balmer series $n_1 = 2, n_2 = 5$

$$\therefore \frac{1}{\lambda} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \text{ gives } Z^2 = \frac{n_1^2 n_2^2}{(n_2^2 - n_1^2)\lambda R}$$

On putting values Z = 2

$$\text{From } E = -\frac{13.6Z^2}{n^2} = \frac{-13.6(2)^2}{(1)^2} = -54.4\, eV$$

16. **(b)** $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow \frac{1}{\lambda_{3\to 2}} = R\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = \frac{5R}{36}$

and $\frac{1}{\lambda_{4\to 2}} = R\left[\frac{1}{(2)^2} - \frac{1}{(4)^2}\right] = \frac{3R}{16}$

$$\therefore \frac{\lambda_{4\to 2}}{\lambda_{3\to 2}} = \frac{20}{27} \Rightarrow \lambda_{4\to 2} = \frac{20}{27}\lambda_0$$

17. **(a)** $\frac{1}{\lambda_{max}} = R\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right] \Rightarrow \lambda_{max} = \frac{4}{3R} \approx 1213 Å$

and $\frac{1}{\lambda_{min}} = R\left[\frac{1}{(1)^2} - \frac{1}{\infty}\right] \Rightarrow \lambda_{min} = \frac{1}{R} \approx 910 Å$

18. **(a)** Maximum energy is liberated for transition $E_n \to 1$ and minimum energy for $E_n \to E_{n-1}$

Hence $\frac{E_1}{n^2} - E_1 = 52.224\, eV$ .....(i)

and $\frac{E_1}{n^2} - \frac{E_1}{(n-1)^2} = 1.224\, eV$ ......(ii)

Solving equations (i) and (ii) we get

$E_1 = -54.4\, eV$ and $n = 5$

Now $E_1 = -\frac{13.6Z^2}{1^2} = -54.4\, eV$. Hence $Z = 2$

19. **(d)** Radius $R = \frac{\varepsilon_0 n^2 h^2}{\pi n Z e^2}$

Velocity $v = \frac{Ze^2}{2\varepsilon_0 nh}$ and energy $E = -\frac{mZ^2e^4}{8\varepsilon_0^2 n^2 h^2}$

Now, it is clear from above expressions $R.v \propto n$

20. **(c)** At closest distance of approach

Kinetic energy = Potential energy

$$\Rightarrow 5\times 10^6 \times 1.6 \times 10^{-19} = \frac{1}{4\pi\varepsilon_0} \times \frac{(Ze)(2e)}{r}$$

For uranium Z = 92, so $r = 5.3 \times 10^{-12}\, cm$

21. **(a)** Here radius of electron orbit $r \propto 1/m$ and energy $E \propto m$, where m is the mass of the electron.

Hence energy of hypothetical atom

$E_0 = 2 \times (-13.6\, eV) = -27.2\, eV$ and radius $r_0 = \frac{a_0}{2}$

22. **(a)** Time period, $T_n = \frac{2\pi r_n}{v_n}$ (in n^{th} state)

i.e. $T_n \propto \frac{r_n}{v_n}$ But $r_n \propto n^2$ and $v_n \propto \frac{1}{n}$

Therefore, $T_n \propto n^3$.

Given $T_{n_1} = 8T_{n_1}$, Hence $n_1 = 2n_2$. $\Rightarrow n_1$ is even

23. **(d)** $2.55\text{eV} = E_4 - E_2$.

Therefore other photon will have energy

$= E_2 - E_1 = 10.2$ eV.

Energy given to H-atom excitation $= E_2 - E_1 = 12.75$ eV.

Consider perfectly inelastic collision for other answer.

24. **(a)** Balmer series lies in the visible region.

25. **(b),** **26.** **(d),** **27.** **(a)**

Since 6 different types of photons are emitted implies ${}^4C_2$

i.e. highest excitation state is n = 4

Since emission energies are equal, lesser and greater so initial state

$$e = \frac{12420}{\lambda} = 13.6Z^2\left[\frac{1}{4} - \frac{1}{16}\right]$$

$\Rightarrow Z^2 = 16 \Rightarrow Z = 4$

$$E_{4\to 1} = 13.6\,(16)\left|\frac{1}{1} - \frac{1}{16}\right| = 20.4\text{eV}$$

$$E_{4\to 3} = 13.6\,(16)\left|\frac{1}{9} - \frac{1}{16}\right| = 10.6\text{ eV}$$

28. **(b)** Bohr postulated that electrons in stationary orbits around the nucleus do not radiate.

This is the one of Bohr's postulate. According to this the moving electrons radiate only when they go from one orbit to the next lower orbit.

29. **(b)** Rutherford confirmed the repulsive force on α-particle due to nucleus varies with distance according to inverse square law and that the positive charges are concentrated at the centre and not distributed throughout the atom.

30. **(b)** When the atom gets appropriate energy from outside, then this electron rises to some higher energy level. Now it can return either directly to the lower energy level or come to the lowest energy level after passing through other lower energy lends, hence all possible transitions take place in the source and many lines are seen in the spectrum.