

Atoms — NEET Physics PYQ (2005-2020)

Class 12 Physics · 25 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2020 · Q136

1. For which one of the following, Bohr model is not valid ?

- (A) Hydrogen atom
- (B) Singly ionised helium atom (He^+)
- (C) Deuteron atom
- (D) Singly ionised neon atom (Ne^+)

NEET 2019 · Q27

2. The total energy of an electron in an atom in an orbit is -3.4 eV. Its kinetic and potential energies are, respectively:

- (A) -3.4 eV, -3.4 eV
- (B) -3.4 eV, -6.8 eV
- (C) 3.4 eV, -6.8 eV
- (D) 3.4 eV, 3.4 eV

NEET 2018 · Q11

3. The ratio of kinetic energy to the total energy of an electron in a Bohr orbit of the hydrogen atom, is

- (A) $2 : -1$
- (B) $1 : -1$
- (C) $1 : 1$
- (D) $1 : -2$

NEET 2017 · Q143

4. The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is:

- (A) 2
- (B) 1
- (C) 4
- (D) 0.5

NEET 2017 (Gujarati paper) · Q172

5. If the longest wavelength in the ultraviolet region of hydrogen spectrum is λ_0 then the shortest wavelength in its infrared region is:

- (A) $(20/3)\lambda_0$
- (B) $(36/5)\lambda_0$
- (C) $(27/4)\lambda_0$
- (D) $(46/7)\lambda_0$

NEET 2016 Phase 2 · Q41

6. If an electron in a hydrogen atom jumps from the 3rd orbit to the 2nd orbit, it emits a photon of wavelength λ . When it jumps from the 4th orbit to the 3rd orbit, the corresponding wavelength of the photon will be

- (A) $16\lambda/25$
- (B) $9\lambda/16$
- (C) $20\lambda/7$
- (D) $20\lambda/13$

NEET 2016 Phase 1 · Q23

7. When an α -particle of mass 'm' moving with velocity 'v' bombards on a heavy nucleus of charge 'Ze', its distance of closest approach from the nucleus depends on m as:

- (A) $1/m$
- (B) $1/\sqrt{m}$
- (C) $1/m^2$
- (D) m

NEET 2016 Phase 1 · Q38

8. Given the value of Rydberg constant is 10^7 m^{-1} , the wave number of the last line of the Balmer series in hydrogen spectrum will be:

- (A) $0.025 \times 10^4 \text{ m}^{-1}$
- (B) $0.5 \times 10^7 \text{ m}^{-1}$
- (C) $0.25 \times 10^7 \text{ m}^{-1}$
- (D) $2.5 \times 10^7 \text{ m}^{-1}$

AIPMT 2015

9. Consider 3rd orbit of He^+ (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given $K = 9 \times 10^9$ constant, $Z = 2$ and h (Planck's Constant) = $6.6 \times 10^{-34} \text{ J s}$]

- (A) $3.0 \times 10^8 \text{ m/s}$
- (B) $2.92 \times 10^6 \text{ m/s}$
- (C) $1.46 \times 10^6 \text{ m/s}$
- (D) $0.73 \times 10^6 \text{ m/s}$

AIPMT 2014

10. Hydrogen atom in ground state is excited by a monochromatic radiation of $\lambda = 975 \text{ \AA}$. Number of spectral lines in the resulting spectrum emitted will be:

- (A) 2
- (B) 6
- (C) 10
- (D) 3

NEET 2013

11. Ratio of longest wavelengths corresponding to Lyman and Balmer series in hydrogen spectrum is

- (A) $5/27$
- (B) $3/23$
- (C) $7/29$
- (D) $9/31$

AIPMT 2012 Mains

12. The transition from the state $n = 3$ to $n = 1$ in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from :

- (A) $2 \rightarrow 1$
- (B) $3 \rightarrow 2$
- (C) $4 \rightarrow 2$
- (D) $4 \rightarrow 3$

AIPMT 2012 Prelims

13. An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be (m is the mass of the electron, R the Rydberg constant and h Planck's constant)

- (A) $24m/(25hR)$
- (B) $24hR/(25m)$
- (C) $25hR/(24m)$
- (D) $25m/(24hR)$

AIPMT 2012 Prelims

14. Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelengths $\lambda_1 : \lambda_2$ emitted in the two cases is

- (A) 20/7
- (B) 7/5
- (C) 27/20
- (D) 27/5

AIPMT 2011 Mains

15. An electron in the hydrogen atom jumps from excited state n to the ground state. The wavelength so emitted illuminates a photosensitive material having work function 2.75 eV. If the stopping potential of the photoelectron is 10 V, then the value of n is

- (A) 5
- (B) 2
- (C) 3
- (D) 4

AIPMT 2011 Prelims

16. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is

- (A) 2
- (B) 3
- (C) 4
- (D) 1

AIPMT 2010 Prelims · Q43

17. The energy of a hydrogen atom in the ground state is -13.6 eV. The energy of a He^+ ion in the first excited state will be

- (A) -6.8 eV
- (B) -13.6 eV
- (C) -27.2 eV
- (D) -54.4 eV

AIPMT 2010 Prelims · Q45

18. A alpha nucleus of energy $(1/2)mv^2$ bombards a heavy nuclear target of charge Ze . Then the distance of closest approach for the alpha nucleus will be proportional to

- (A) $1/v^4$
- (B) $1/(Ze)$
- (C) v^2
- (D) $1/m$

19. In a Rutherford scattering experiment when a projectile of charge z_1 and mass M_1 approaches a target nucleus of charge z_2 and mass M_2 , the distance of closest approach is r_0 . The energy of the projectile is:

- (A) directly proportional to $z_1 z_2$
- (B) inversely proportional to z_1
- (C) directly proportional to mass M_1
- (D) directly proportional to $M_1 \times M_2$

20. The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths. Maximum wavelength of emitted radiation corresponds to the transition between:

- (A) $n = 3$ to $n = 1$ states
- (B) $n = 2$ to $n = 1$ states
- (C) $n = 4$ to $n = 3$ states
- (D) $n = 3$ to $n = 2$ states

21. The ground state energy of hydrogen atom is -13.6 eV. When its electron is in the first excited state, its excitation energy is

- (A) 0
- (B) 3.4 eV
- (C) 6.8 eV
- (D) 10.2 eV

22. The total energy of electron in the ground state of hydrogen atom is -13.6 eV. The kinetic energy of an electron in the first excited state is

- (A) 6.8 eV
- (B) 13.6 eV
- (C) 1.7 eV
- (D) 3.4 eV

23. Ionization potential of hydrogen atom is 13.6 eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. According to Bohr's theory, the spectral lines emitted by hydrogen will be :

- (A) two
- (B) three
- (C) four
- (D) one

24. Energy levels A, B and C of a certain atom correspond to increasing values of energy i.e., $E_A < E_B < E_C$. If λ_1 , λ_2 and λ_3 are wavelengths of radiations corresponding to transitions C to B, B to A and C to A respectively, which of the following relations is correct ?

- (A) $\lambda_3 = \lambda_1 + \lambda_2$
- (B) $\lambda_3 = \lambda_1 \lambda_2 / (\lambda_1 + \lambda_2)$
- (C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$
- (D) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

25. The total energy of an electron in the first excited state of hydrogen is about -3.4 eV. Its kinetic energy in this state is :

- (A) -3.4 eV
- (B) -1.7 eV
- (C) 1.7 eV
- (D) 3.4 eV

Answer key and explanations

1. Answer: (D) Singly ionised neon atom (Ne^+)

Bohr's model applies only to one-electron (hydrogen-like) systems. Hydrogen, deuterium and He^+ each have a single electron, but Ne^+ still has 9 electrons, so electron-electron interactions make the model invalid.

2. Answer: (C) 3.4 eV, -6.8 eV

In the Bohr model $K = -E$ and $U = 2E$. With $E = -3.4$ eV, $K = +3.4$ eV and $U = -6.8$ eV. Kinetic energy can never be negative, which rules out the choices with negative KE.

3. Answer: (B) $1 : -1$

In a Bohr orbit, $K = ke^2/2r$ and the total energy $E = -ke^2/2r$, so $E = -K$ and $K : E = 1 : -1$. The ratio $1 : -2$ is kinetic to potential energy, not to total energy.

4. Answer: (C) 4

The last (series limit) line has $n_1 \rightarrow \infty$. Balmer: $1/\lambda = R(1/4)$, so $\lambda = 4/R$; Lyman: $1/\lambda = R(1/1)$, so $\lambda = 1/R$. Their ratio is 4. Taking the ratio the other way round gives 0.25, not an option.

5. Answer: (C) $(27/4)\lambda_0$

The longest Lyman (UV) line is $n = 2 \rightarrow 1$: $1/\lambda_0 = R(1 - 1/4) = 3R/4$. The shortest infrared wavelength is the Paschen series limit, $\infty \rightarrow 3$: $1/\lambda = R/9$, so $\lambda = 9/R = 9 \times (3\lambda_0/4) = 27\lambda_0/4$. $36/5 \lambda_0$ is the longest Balmer line ($3 \rightarrow 2$), which is in the visible region.

6. Answer: (C) $20\lambda/7$

$1/\lambda \propto (1/2^2 - 1/3^2) = 5/36$ and $1/\lambda' \propto (1/3^2 - 1/4^2) = 7/144$. So $\lambda'/\lambda = (5/36)/(7/144) = 20/7$, giving $\lambda' = 20\lambda/7$. The $4 \rightarrow 3$ photon has less energy, so its wavelength must be longer than λ , which rules out the fractions smaller than 1.

7. Answer: (A) $1/m$

At closest approach all kinetic energy becomes potential energy: $\frac{1}{2}mv^2 = k(\text{Ze})(2e)/r_0$, so $r_0 = 4kZe^2/(mv^2)$. With v fixed, $r_0 \propto 1/m$: a heavier particle carries more kinetic energy and gets closer. A $1/\sqrt{m}$ or $1/m^2$ dependence does not follow from this energy balance.

8. Answer: (C) $0.25 \times 10^7 \text{ m}^{-1}$

The last (series-limit) line of Balmer corresponds to $n = \infty \rightarrow 2$: wave number $= R(1/2^2 - 0) = 10^7/4 = 0.25 \times 10^7 \text{ m}^{-1}$. The first Balmer line would use $1/4 - 1/9$ instead.

9. Answer: (C) $1.46 \times 10^6 \text{ m/s}$

Bohr speed $v = 2\pi kZe^2/(nh) = 2\pi \times 9 \times 10^9 \times 2 \times (1.6 \times 10^{-19})^2/(3 \times 6.6 \times 10^{-34}) \approx 1.46 \times 10^6 \text{ m/s}$ (equivalently $2.19 \times 10^6 \times Z/n$). $2.92 \times 10^6 \text{ m/s}$ would be the $n = 1.5$ value, i.e. a mistake in n .

10. Answer: (B) 6

Photon energy $= 12400/975 \approx 12.7$ eV, which matches $E_4 - E_1 = 13.6(1 - 1/16) = 12.75$ eV, so the atom reaches $n = 4$. Lines emitted $= n(n - 1)/2 = 6$.

11. Answer: (A) $5/27$

Longest wavelengths: Lyman ($2 \rightarrow 1$): $1/\lambda = R(1 - 1/4) = 3R/4$, $\lambda = 4/(3R)$. Balmer ($3 \rightarrow 2$): $1/\lambda = R(1/4 - 1/9) = 5R/36$, $\lambda = 36/(5R)$. Ratio $= (4/3)/(36/5) = 20/108 = 5/27$.

12. Answer: (D) $4 \rightarrow 3$

Infrared needs a much smaller energy gap than the ultraviolet $3 \rightarrow 1$ line. The energy factors $(1/n_1^2 - 1/n_2^2)$ are $3/4$ for $2 \rightarrow 1$, $5/36$ for $3 \rightarrow 2$, $3/16$ for $4 \rightarrow 2$ and only $7/144$ for $4 \rightarrow 3$, so $4 \rightarrow 3$ (Paschen-type) is the infrared one; $3 \rightarrow 2$ and $4 \rightarrow 2$ are visible for hydrogen.

13. Answer: (B) $24hR/(25m)$

The photon energy for $n = 5 \rightarrow 1$ is $E = hcR(1 - 1/25) = (24/25)hcR$. Its momentum $p = E/c = (24/25)hR$, and the atom recoils with equal momentum, so $v = p/m = 24hR/(25m)$. The inverted forms have wrong dimensions for velocity.

14. Answer: (A) 20/7

Third excited state $n = 4 \rightarrow$ second excited $n = 3$: $1/\lambda_1 = R(1/9 - 1/16) = 7R/144$. Second excited $n = 3 \rightarrow$ first excited $n = 2$: $1/\lambda_2 = R(1/4 - 1/9) = 5R/36 = 20R/144$. Ratio $\lambda_1/\lambda_2 = 20/7$. Taking excited state numbers as n values directly gives a wrong ratio.

15. Answer: (D) 4

Photon energy = work function + $eV_0 = 2.75 + 10 = 12.75$ eV. For hydrogen, $13.6(1 - 1/n^2) = 12.75$ gives $1/n^2 = 0.0625$, so $n = 4$. The $n = 3 \rightarrow 1$ transition gives only 12.09 eV, too little.

16. Answer: (A) 2

Lyman first line: $1/\lambda = R(1 - 1/4) = 3R/4$. Balmer second line ($n = 4 \rightarrow 2$) for the ion: $1/\lambda = Z^2R(1/4 - 1/16) = 3Z^2R/16$. Equating gives $Z^2 = 4$, $Z = 2$ (He^+). Using $n = 3 \rightarrow 2$ as the second Balmer line gives a non-integer Z .

17. Answer: (B) -13.6 eV

$E_n = -13.6 Z^2/n^2$ eV. For He^+ , $Z = 2$ and first excited state $n = 2$: $E = -13.6 \times 4/4 = -13.6$ eV. -54.4 eV is the He^+ ground state.

18. Answer: (D) 1/m

At closest approach all kinetic energy becomes potential energy: $\frac{1}{2}mv^2 = (1/4\pi\epsilon_0)(Ze)(2e)/r_0$, so $r_0 = 4Ze^2/(4\pi\epsilon_0mv^2)$. Thus $r_0 \propto 1/m$, $\propto Ze$ and $\propto 1/v^2$, so $1/v^4$ and v^2 are wrong powers and $1/(Ze)$ has the wrong dependence.

19. Answer: (A) directly proportional to z_1z_2

At the distance of closest approach all kinetic energy becomes electrostatic potential energy: $E = kz_1z_2e^2/r_0$. So, for a given r_0 , the energy is directly proportional to z_1z_2 and does not depend on the masses.

20. Answer: (C) $n = 4$ to $n = 3$ states

Number of lines from level $n = n(n - 1)/2 = 6$, so $n = 4$. The longest wavelength needs the smallest energy gap, which is between $n = 4$ and $n = 3$. The $3 \rightarrow 1$ or $2 \rightarrow 1$ lines have larger gaps and shorter wavelengths.

21. Answer: (D) 10.2 eV

The first excited state is $n = 2$ with energy $-13.6/4 = -3.4$ eV. Excitation energy = $-3.4 - (-13.6) = 10.2$ eV. 3.4 eV is the energy needed to ionise from $n = 2$, not the excitation energy from the ground state.

22. Answer: (D) 3.4 eV

$E_n = -13.6/n^2$ eV, so in the first excited state ($n = 2$) $E = -3.4$ eV. For a Bohr orbit kinetic energy = $-E = 3.4$ eV. 13.6 eV is the ground-state value.

23. Answer: (B) three

After absorbing 12.1 eV the electron's energy is $-13.6 + 12.1 = -1.51$ eV, which is the $n = 3$ level ($-13.6/9$). From $n = 3$ the possible downward transitions are $3 \rightarrow 2$, $3 \rightarrow 1$ and $2 \rightarrow 1$, i.e. $n(n - 1)/2 = 3$ lines. Counting only the direct jump to the ground state would give one line.

24. Answer: (B) $\lambda_3 = \lambda_1\lambda_2/(\lambda_1 + \lambda_2)$

Photon energies add: $hc/\lambda_3 = hc/\lambda_1 + hc/\lambda_2$, so $1/\lambda_3 = 1/\lambda_1 + 1/\lambda_2$ and $\lambda_3 = \lambda_1\lambda_2/(\lambda_1 + \lambda_2)$. Adding the wavelengths directly is wrong because energy, not wavelength, is additive.

25. Answer: (D) 3.4 eV

In a Bohr orbit $KE = -E_{\text{total}}$, so $KE = +3.4$ eV. Kinetic energy can never be negative, which rules out -3.4 eV and -1.7 eV.

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