

# Structure of Atom — NEET Chemistry PYQ (2005-2021)

Class 11 Chemistry · 34 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

**1. A particular station of All India Radio, New Delhi, broadcasts on a frequency of 1,368 kHz (kilohertz). The wavelength of the electromagnetic radiation emitted by the transmitter is : [speed of light,  $c = 3.0 \times 10^8 \text{ ms}^{-1}$ ]**

- (A) 219.3 m
- (B) 219.2 m
- (C) 2192 m
- (D) 21.92 cm

NEET 2020 · Q124

**2. The number of protons, neutrons and electrons in  $^{175}_{71}\text{Lu}$ , respectively, are :**

- (A) 71, 104 and 71
- (B) 104, 71 and 71
- (C) 71, 71 and 104
- (D) 175, 104 and 71

NEET 2019 · Q49

**3. 4d, 5p, 5f and 6p orbitals are arranged in the order of decreasing energy. The correct option is:**

- (A)  $5f > 6p > 5p > 4d$
- (B)  $6p > 5f > 5p > 4d$
- (C)  $6p > 5f > 4d > 5p$
- (D)  $5f > 6p > 4d > 5p$

NEET 2019 · Q87

**4. Which of the following series of transitions in the spectrum of hydrogen atom falls in visible region?**

- (A) Lyman series
- (B) Balmer series
- (C) Paschen series
- (D) Brackett series

NEET 2018 · Q90

**5. Which one is a wrong statement?**

- (A) The electronic configuration of N atom is  $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$  shown in boxes as  $[\uparrow \downarrow] [\uparrow \downarrow] [\uparrow] [\uparrow] [\downarrow]$
- (B) An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers.
- (C) Total orbital angular momentum of electron in 's' orbital is equal to zero.
- (D) The value of  $m$  for  $d_{z^2}$  is zero.

NEET 2017 · Q10

**6. Which one is the wrong statement?**

- (A) de-Broglie's wavelength is given by  $\lambda = h/mv$ , where  $m$  = mass of the particle,  $v$  = group velocity of the particle.
- (B) The uncertainty principle is  $\Delta E \times \Delta t \geq h/4\pi$
- (C) Half filled and fully filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement.
- (D) The energy of 2s orbital is less than the energy of 2p orbital in case of Hydrogen like atoms.

NEET 2017 (Gujarati paper) · Q27

**7. The total number of orbitals present for principle quantum number,  $n = 4$  is:**

- (A) 12
- (B) 15
- (C) 16
- (D) 30

**8. Which of the following pairs of d-orbitals will have electron density along the axes?**

- (A)  $d_{z^2}$ ,  $d_{xz}$
- (B)  $d_{xz}$ ,  $d_{yz}$
- (C)  $d_{z^2}$ ,  $d_{x^2-y^2}$
- (D)  $d_{xy}$ ,  $d_{x^2-y^2}$

**9. Two electrons occupying the same orbital are distinguished by:**

- (A) Principal quantum number
- (B) Magnetic quantum number
- (C) Azimuthal quantum number
- (D) Spin quantum number

**10. The angular momentum of electron in 'd' orbital is equal to:**

- (A)  $0 \hbar$
- (B)  $\sqrt{6} \hbar$
- (C)  $\sqrt{2} \hbar$
- (D)  $2\sqrt{3} \hbar$

**11. The number of d-electrons in  $\text{Fe}^{2+}$  ( $Z = 26$ ) is not equal to the number of electrons in which one of the following?**

- (A) p-electrons in Ne ( $Z = 10$ )
- (B) s-electrons in Mg ( $Z = 12$ )
- (C) p-electrons in Cl ( $Z = 17$ )
- (D) d-electrons in Fe ( $Z = 26$ )

**12. Calculate the energy in joule corresponding to light of wavelength 45 nm: (Planck's constant  $h = 6.63 \times 10^{-34}$  Js; speed of light  $c = 3 \times 10^8 \text{ ms}^{-1}$ )**

- (A)  $6.67 \times 10^{11}$
- (B)  $4.42 \times 10^{-15}$
- (C)  $4.42 \times 10^{-18}$
- (D)  $6.67 \times 10^{15}$

**13.  $\text{Be}^{2+}$  is isoelectronic with which of the following ions?**

- (A)  $\text{Li}^+$
- (B)  $\text{Na}^+$
- (C)  $\text{Mg}^{2+}$
- (D)  $\text{H}^+$

**14. What is the maximum number of orbitals that can be identified with the following quantum numbers?  $n = 3$ ,  $l = 1$ ,  $m_l = 0$**

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

NEET 2013

**15. The value of Planck's constant is  $6.63 \times 10^{-34}$  J s. The speed of light is  $3 \times 10^{17}$  nm s<sup>-1</sup>. Which value is closest to the wavelength in nanometre of a quantum of light with frequency of  $6 \times 10^{15}$  s<sup>-1</sup>?**

- (A) 10
- (B) 25
- (C) 50
- (D) 75

NEET 2013

**16. What is the maximum number of electrons that can be associated with the following set of quantum numbers?  $n = 3$ ,  $l = 1$  and  $m = -1$ .**

- (A) 10
- (B) 6
- (C) 4
- (D) 2

NEET 2013

**17. Based on equation  $E = -2.178 \times 10^{-18}$  J ( $Z^2/n^2$ ), certain conclusions are written. Which of them is not correct?**

- (A) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus
- (B) Larger the value of  $n$ , the larger is the orbit radius
- (C) Equation can be used to calculate the change in energy when the electron changes orbit
- (D) For  $n = 1$ , the electron has a more negative energy than it does for  $n = 6$  which means that the electron is more loosely bound in the smallest allowed orbit

AIPMT 2012 Mains

**18. The orbital angular momentum of a p-electron is given as :**

- (A)  $h/(\sqrt{2} \pi)$
- (B)  $\sqrt{3} h/(2\pi)$
- (C)  $\sqrt{(3/2)} h/\pi$
- (D)  $\sqrt{6} h/(2\pi)$

AIPMT 2012 Prelims

**19. Maximum number of electrons in a subshell with  $l = 3$  and  $n = 4$  is:**

- (A) 12
- (B) 14
- (C) 16
- (D) 10

AIPMT 2012 Prelims

**20. The correct set of four quantum numbers for the valence electron of rubidium atom ( $Z = 37$ ) is**

- (A) 5, 1, 0, +1/2
- (B) 5, 1, 1, +1/2
- (C) 6, 0, 0, +1/2
- (D) 5, 0, 0, +1/2

AIPMT 2011 Mains

**21. According to the Bohr Theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon?**

- (A)  $n = 6$  to  $n = 5$
- (B)  $n = 5$  to  $n = 3$
- (C)  $n = 6$  to  $n = 1$
- (D)  $n = 5$  to  $n = 4$

AIPMT 2011 Prelims

**22. The total number of atomic orbitals in fourth energy level of an atom is**

- (A) 4
- (B) 8
- (C) 16
- (D) 32

AIPMT 2011 Prelims

**23. The energies  $E_1$  and  $E_2$  of two radiations are 25 eV and 50 eV respectively. The relation between their wavelengths i.e.  $\lambda_1$  and  $\lambda_2$  will be**

- (A)  $\lambda_1 = (1/2)\lambda_2$
- (B)  $\lambda_1 = \lambda_2$
- (C)  $\lambda_1 = 2\lambda_2$
- (D)  $\lambda_1 = 4\lambda_2$

AIPMT 2011 Prelims

**24. If  $n = 6$ , the correct sequence of filling of electrons will be**

- (A)  $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$
- (B)  $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$
- (C)  $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$
- (D)  $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$

AIPMT 2010 Mains · Q100

**25. A 0.66 kg ball is moving with a speed of 100 m/s. The associated wavelength will be ( $h = 6.6 \times 10^{-34} \text{ J s}$ )**

- (A)  $6.6 \times 10^{-32} \text{ m}$
- (B)  $6.6 \times 10^{-34} \text{ m}$
- (C)  $1.0 \times 10^{-35} \text{ m}$
- (D)  $1.0 \times 10^{-32} \text{ m}$

AIPMT 2009 Prelims · Q161

**26. The energy absorbed by each molecule ( $A_2$ ) of a substance is  $4.4 \times 10^{-19} \text{ J}$  and bond energy per molecule is  $4.0 \times 10^{-19} \text{ J}$ . The kinetic energy of the molecule per atom will be:**

- (A)  $2.2 \times 10^{-19} \text{ J}$
- (B)  $2.0 \times 10^{-19} \text{ J}$
- (C)  $4.0 \times 10^{-20} \text{ J}$
- (D)  $2.0 \times 10^{-20} \text{ J}$

AIPMT 2009 Prelims · Q168

**27. Maximum number of electrons in a subshell of an atom is determined by the following:**

- (A)  $2l + 1$
- (B)  $4l - 2$
- (C)  $2n^2$
- (D)  $4l + 2$

AIPMT 2009 Prelims · Q173

**28. Which of the following is not a permissible arrangement of electrons in an atom?**

- (A)  $n = 5, l = 3, m = 0, s = +1/2$
- (B)  $n = 3, l = 2, m = -3, s = -1/2$
- (C)  $n = 3, l = 2, m = -2, s = -1/2$
- (D)  $n = 4, l = 0, m = 0, s = -1/2$

**29. If uncertainty in position and momentum are equal, then uncertainty in velocity is**

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

**30. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to  $1 \times 10^{-18} \text{ g cm s}^{-1}$ . The uncertainty in electron velocity is, (mass of an electron is  $9 \times 10^{-28} \text{ g}$ )**

- (A)  $1 \times 10^{11} \text{ cm s}^{-1}$
- (B)  $1 \times 10^9 \text{ cm s}^{-1}$
- (C)  $1 \times 10^6 \text{ cm s}^{-1}$
- (D)  $1 \times 10^5 \text{ cm s}^{-1}$

**31. Consider the following sets of quantum numbers (n, l, m, s):**

- (i) 3, 0, 0, +1/2
- (ii) 2, 2, 1, +1/2
- (iii) 4, 3, -2, -1/2
- (iv) 1, 0, -1, -1/2
- (v) 3, 2, 3, +1/2

**Which of the following sets of quantum number is not possible?**

- (A) (i), (ii), (iii) and (iv)
- (B) (ii), (iv) and (v)
- (C) (i) and (iii)
- (D) (ii), (iii) and (iv)

**32. Given : The mass of electron is  $9.11 \times 10^{-31} \text{ kg}$ , Planck constant is  $6.626 \times 10^{-34} \text{ Js}$ , the uncertainty involved in the measurement of velocity within a distance of  $0.1 \text{ \AA}$  is :**

- (A)  $5.79 \times 10^6 \text{ m s}^{-1}$
- (B)  $5.79 \times 10^7 \text{ m s}^{-1}$
- (C)  $5.79 \times 10^8 \text{ m s}^{-1}$
- (D)  $5.79 \times 10^9 \text{ m s}^{-1}$

**33. The orientation of an atomic orbital is governed by :**

- (A) azimuthal quantum number
- (B) spin quantum number
- (C) magnetic quantum number
- (D) principal quantum number

**34. The energy of second Bohr orbit of the hydrogen atom is  $-328 \text{ kJ mol}^{-1}$  ; hence the energy of fourth Bohr orbit would be :**

- (A)  $-41 \text{ kJ mol}^{-1}$
- (B)  $-1224 \text{ kJ mol}^{-1}$
- (C)  $-284 \text{ kJ mol}^{-1}$
- (D)  $-82 \text{ kJ mol}^{-1}$

## Answer key and explanations

### 1. Answer: (A) 219.3 m

$\lambda = c/\nu = (3.0 \times 10^8)/(1368 \times 10^3) = 219.30 \text{ m}$ . 2192 m results from a decimal slip; the value 219.2 m is a rounding error.

**2. Answer: (A) 71, 104 and 71**

Atomic number 71 gives 71 protons and, for the neutral atom, 71 electrons; neutrons =  $175 - 71 = 104$ . Using the mass number 175 as the proton count is the common slip.

**3. Answer: (A)  $5f > 6p > 5p > 4d$**

$(n + l)$  values:  $5f = 8$ ,  $6p = 7$ ,  $5p = 6$ ,  $4d = 6$ ; for equal  $n + l$  the higher  $n$  is higher in energy, so  $5p > 4d$ . Order:  $5f > 6p > 5p > 4d$ . Putting  $4d$  above  $5p$  ignores the tie-break on  $n$ .

**4. Answer: (B) Balmer series**

Balmer lines (transitions ending at  $n = 2$ ) lie in the visible region. Lyman lines (ending at  $n = 1$ ) are ultraviolet; Paschen and Brackett are infrared.

**5. Answer: (A) The electronic configuration of N atom is  $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$  shown in boxes as  $[\uparrow\downarrow] [\uparrow\downarrow] [\uparrow][\uparrow][\downarrow]$**

By Hund's rule, the three unpaired  $2p$  electrons of nitrogen must have parallel spins; the box diagram with one  $2p$  electron spin-down is wrong. An  $s$  electron has  $l = 0$  so zero orbital angular momentum, and  $d_{z^2}$  corresponds to  $m = 0$ .

**6. Answer: (D) The energy of  $2s$  orbital is less than the energy of  $2p$  orbital in case of Hydrogen like atoms.**

In hydrogen-like (one-electron) species the energy depends only on  $n$ , so  $2s$  and  $2p$  are degenerate; the  $2s$ -below- $2p$  order holds only for multi-electron atoms. The other statements are correct:  $\lambda = h/mv$ ,  $\Delta E \cdot \Delta t \geq h/4\pi$ , and half/fully filled subshells are extra stable.

**7. Answer: (C) 16**

The number of orbitals in a shell is  $n^2$ , so  $n = 4$  has 16 orbitals (one  $4s$ , three  $4p$ , five  $4d$ , seven  $4f$ ). 32 would be the number of electrons,  $2n^2$ .

**8. Answer: (C)  $d_{z^2}$ ,  $d_{x^2-y^2}$**

The lobes of  $d_{x^2-y^2}$  lie along the  $x$  and  $y$  axes and the main lobes of  $d_{z^2}$  lie along the  $z$  axis.  $d_{xy}$ ,  $d_{yz}$  and  $d_{xz}$  have their lobes between the axes, so any pair containing them is wrong.

**9. Answer: (D) Spin quantum number**

Electrons in the same orbital share  $n$ ,  $l$  and  $m$ ; by the Pauli exclusion principle they must differ in spin quantum number ( $+\frac{1}{2}$  and  $-\frac{1}{2}$ ). The other three quantum numbers define the orbital itself and are therefore identical.

**10. Answer: (B)  $\sqrt{6} \hbar$**

Orbital angular momentum =  $\sqrt{l(l+1)} \hbar$ . For a  $d$  orbital  $l = 2$ , giving  $\sqrt{6} \hbar$ .  $\sqrt{2} \hbar$  is the value for a  $p$  orbital.

**11. Answer: (C) p-electrons in Cl ( $Z = 17$ )**

$Fe^{2+}$  is  $[Ar]3d^6$ , so it has 6  $d$ -electrons. Ne has 6  $p$ -electrons, Mg has 6  $s$ -electrons and Fe has 6  $d$ -electrons, but Cl ( $1s^2 2s^2 2p^6 3s^2 3p^5$ ) has 11  $p$ -electrons.

**12. Answer: (C)  $4.42 \times 10^{-18}$**

$E = hc/\lambda = (6.63 \times 10^{-34} \times 3 \times 10^8)/(45 \times 10^{-9}) = 4.42 \times 10^{-18} \text{ J}$ .

**13. Answer: (A)  $Li^+$**

$Be^{2+}$  has  $4 - 2 = 2$  electrons, the same as  $Li^+$  ( $3 - 1 = 2$ ).  $Na^+$  and  $Mg^{2+}$  have 10 electrons and  $H^+$  has none.

**14. Answer: (D) 1**

$n = 3$  and  $l = 1$  specify the  $3p$  subshell, and  $m_l = 0$  picks out exactly one of its three orbitals. Three would be the answer if  $m_l$  were not given.

**15. Answer: (C) 50**

$\lambda = c/\nu = (3 \times 10^{17} \text{ nm s}^{-1})/(6 \times 10^{15} \text{ s}^{-1}) = 50 \text{ nm}$ . Planck's constant is not needed to find the wavelength.

**16. Answer: (D) 2**

$n = 3$ ,  $l = 1$ ,  $m = -1$  specifies one particular  $3p$  orbital. One orbital holds at most two electrons with opposite spins. 6 is the capacity of the whole  $3p$  subshell.

**17. Answer: (D) For  $n = 1$ , the electron has a more negative energy than it does for  $n = 6$  which means that the electron is more loosely bound in the smallest allowed orbit**

For  $n = 1$  the energy is the most negative, which means the electron is most tightly bound in the smallest orbit, not more loosely bound, so that conclusion is wrong. The other statements correctly describe the negative sign, the growth of radius with  $n$  and use of the equation for energy changes.

**18. Answer: (A)  $h/(\sqrt{2} \pi)$** 

Orbital angular momentum =  $\sqrt{l(l+1)} \cdot h/2\pi$ . For a p-electron  $l = 1$ , giving  $\sqrt{2} \cdot h/2\pi = h/(\sqrt{2} \pi)$ .  $\sqrt{6} \cdot h/2\pi$  would be for a d-electron ( $l = 2$ ).

**19. Answer: (B) 14**

$l = 3$  is an f subshell, with  $2l + 1 = 7$  orbitals, each holding 2 electrons: 14 electrons. The value  $n = 4$  only fixes the shell (4f) and does not change the subshell capacity; 10 is the capacity of a d subshell ( $l = 2$ ).

**20. Answer: (D) 5, 0, 0,  $+1/2$** 

Rb ( $Z = 37$ ) is  $[\text{Kr}] 5s^1$ , so the valence electron has  $n = 5$ ,  $l = 0$  (s),  $m = 0$  and  $s = +1/2$ . Sets with  $l = 1$  describe a 5p electron, and  $n = 6$  is the wrong shell.

**21. Answer: (A)  $n = 6$  to  $n = 5$** 

$\Delta E \propto (1/n_1^2 - 1/n_2^2)$ : for  $6 \rightarrow 5$  it is  $1/25 - 1/36 = 0.0122$ , for  $5 \rightarrow 4$  it is  $1/16 - 1/25 = 0.0225$ , and the others are larger. So the  $6 \rightarrow 5$  transition gives the least energetic photon.

**22. Answer: (C) 16**

The number of orbitals in shell  $n$  is  $n^2$ . For  $n = 4$  (4s, 4p, 4d, 4f:  $1 + 3 + 5 + 7$ ) this is 16 orbitals. 32 is the maximum number of electrons ( $2n^2$ ), not orbitals.

**23. Answer: (C)  $\lambda_1 = 2\lambda_2$** 

$E = hc/\lambda$ , so  $\lambda \propto 1/E$ .  $E_2$  is twice  $E_1$ , so  $\lambda_2 = \lambda_1/2$ , i.e.  $\lambda_1 = 2\lambda_2$ . The higher-energy radiation has the shorter wavelength, so  $\lambda_1 = \lambda_2/2$  is the reverse.

**24. Answer: (B)  $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$** 

For  $n = 6$  the Aufbau order is  $6s \rightarrow 4f \rightarrow 5d \rightarrow 6p$  (as in Cs, Ba, La/Ce onwards, Hf, then Tl), i.e.  $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$ . Filling np before the inner d and f orbitals is the trap.

**25. Answer: (C)  $1.0 \times 10^{-35} \text{ m}$** 

$\lambda = h/(mv) = 6.6 \times 10^{-34}/(0.66 \times 100) = 6.6 \times 10^{-34}/66 = 1.0 \times 10^{-35} \text{ m}$ .  $6.6 \times 10^{-34} \text{ m}$  comes from forgetting to divide by the momentum.

**26. Answer: (D)  $2.0 \times 10^{-20} \text{ J}$** 

Energy left after breaking the bond =  $4.4 \times 10^{-19} - 4.0 \times 10^{-19} = 0.4 \times 10^{-19} \text{ J}$  per molecule. It is shared by the two atoms:  $2.0 \times 10^{-20} \text{ J}$  per atom.  $4.0 \times 10^{-20} \text{ J}$  forgets to divide between the two atoms.

**27. Answer: (D)  $4l + 2$** 

A subshell with quantum number  $l$  has  $(2l + 1)$  orbitals, each holding 2 electrons, so the maximum is  $2(2l + 1) = 4l + 2$ .  $2l + 1$  counts orbitals, not electrons, and  $2n^2$  is for a whole shell.

**28. Answer: (B)  $n = 3$ ,  $l = 2$ ,  $m = -3$ ,  $s = -1/2$** 

For  $l = 2$  the magnetic quantum number can only take values from  $-2$  to  $+2$ , so  $m = -3$  is not allowed. The other sets obey all the rules ( $l < n$ ,  $|m| \leq l$ ,  $s = \pm 1/2$ ).

**29. Answer: (B)  $(1/2m)\sqrt{(h/\pi)}$** 

$\Delta x \cdot \Delta p = h/4\pi$  with  $\Delta x = \Delta p$  gives  $\Delta p^2 = h/4\pi$ , so  $\Delta p = (1/2)\sqrt{(h/\pi)}$ . Then  $\Delta v = \Delta p/m = (1/2m)\sqrt{(h/\pi)}$ . The forms without  $m$  are momenta, not velocities.

**30. Answer: (B)  $1 \times 10^9 \text{ cm s}^{-1}$** 

$\Delta v = \Delta p/m = (1 \times 10^{-18} \text{ g cm s}^{-1})/(9 \times 10^{-28} \text{ g}) \approx 1.1 \times 10^9 \text{ cm s}^{-1}$ . Both quantities are already in CGS units, so no conversion is needed, and converting only one of them gives the wrong power of ten.

**31. Answer: (B) (ii), (iv) and (v)**

(ii) is impossible because  $l$  must be less than  $n$  ( $l = 2$  with  $n = 2$ ), (iv) because  $m$  must lie between  $-l$  and  $+l$  ( $m = -1$  with  $l = 0$ ) and (v) because  $m = 3$  exceeds  $l = 2$ . (i) and (iii) are valid, so the impossible sets are (ii), (iv) and (v).

**32. Answer: (A)  $5.79 \times 10^6 \text{ m s}^{-1}$** 

Heisenberg:  $\Delta x \cdot \Delta v \geq h/4\pi$ , so  $\Delta v = 6.626 \times 10^{-34}/(4 \times 3.1416 \times 9.11 \times 10^{-31} \times 1 \times 10^{-11}) = 6.626 \times 10^{-34}/1.145 \times 10^{-40} \approx 5.79 \times 10^6 \text{ m s}^{-1}$ . Remember  $0.1 \text{ \AA} = 10^{-11} \text{ m}$ ; using  $10^{-10} \text{ m}$  would change the power of ten.

**33. Answer: (C) magnetic quantum number**

The magnetic quantum number  $m_l$  fixes the orientation of an orbital in space, e.g. the three p orbitals along x, y and z. The azimuthal quantum number fixes the shape, the principal quantum number the size and energy, and the spin quantum number refers to the electron, not the orbital.

**34. Answer: (D)  $-82 \text{ kJ mol}^{-1}$** 

$E_n \propto 1/n^2$ , so  $E_4 = E_2 \times (2/4)^2 = -328/4 = -82 \text{ kJ mol}^{-1}$ . Dividing by 8 ( $-41 \text{ kJ mol}^{-1}$ ) wrongly uses  $E_n \propto 1/n^3$ .

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