Atomic Structure JEE Main PYQ - 1

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Atomic Structure

1. If the shortest wavelength in Lyman series of hydrogen atom is A, then the longest wavelength in Paschen series of He^+ is : **(+4, -1)**

[Online April 8, 2017]

a. $\frac{5A}{9}$

b. $\frac{9A}{5}$

c. $\frac{36A}{5}$

d. $\frac{36A}{7}$

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2. The electron in the hydrogen atom undergoes transition from higher orbitals to orbital of radius $211.6\,pm$. This transition is associated with **(+4, -1)**

[Online April 9, 2017]

a. Lyman series

b. Balmer series

c. Paschen series

d. Brackett series

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3. The de Broglie wavelength of an electron in the 4^{th} Bohr orbit is : **(+4, -1)**

[Jan. 09, 2020 (I)]

a. $6\pi a_0$

b. $2\pi a_0$

c. $8\pi a_0$

d. $4\pi a_0$

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4. The energy of an electron in first Bohr orbit of H - atom is $-13.6\,eV$. The energy value of electron in the excited state of Li^{2+} is : **(+4, -1)**

[Online April 9, 2014]

a. -27.2 eV

b. 30.6 eV

c. -30.6 eV

d. 27.2 eV

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5. Based on the equation : $\Delta E = -2.0 \times 10^{-18} J \left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$ the wavelength of the light that must be absorbed to excite hydrogen electron from level n=I to level n=2 will be : $(h = 6.625 \times 10^{-34}\, Js, C = 3 \times 10^{8}\, ms^{-1})$ **(+4, -1)**

[Online April 11, 2014]

a. $1.325 \times 10^{-7} m$

b. $1.325 \times 10^{-10} m$

c. $2.650 \times 10^{-7} m$

d. $5.300 \times 10^{-10} m$

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6. If m and e are the mass and charge of the revolving electron in the orbit of radius r for hydrogen atom, the total energy of the revolving electron will be : **(+4, -1)**

[Online April 12,2014]

a. $\frac{1}{2}\frac{e^2}{r}$

b. $-\frac{e^2}{r}$

c. $\frac{me^2}{r}$

d. $-\frac{1}{2}\frac{e^2}{r}$

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7. Excited hydrogen atom emits light in the ultraviolet region at $2.47 \times 10^{15}\, Hz$. With this frequency, the energy of a single photon is : $(h = 6.63 \times 10^{-34}\, Js)$ **(+4, -1)**

[Online April 12, 2014]

a. 8.041×10^{-40} J

b. 2.680×10^{-19} J

c. 1.640×10^{-18} J

d. 6.111×10^{-17} J

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8. The total number of orbitals associated with the principal quantum number 5 is : **(+4, -1)**

[Online April 9,2016]

a. 5

b. 10

c. 20

d. 25

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9. Which of the following is the energy of a possible excited state of hydrogen? **(+4, -1)**

a. $+13.6\,eV$ **[2015]**

b. $-6.8\,eV$

c. $-3.4\,eV$

d. $+6.8\,eV$

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10. Which of the following statements is false? **[Online April 16, 2018]** **(+4, -1)**

a. Photon has momentum as well as wavelength.

b. Splitting of spectral lines in electrical field is called Stark effect.

c. Rydberg constant has unit of energy.

d. Frequency of emitted radiation from a black body goes from a lower wavelength to higher wavelength as the temperature increases.

Answers

1. **Answer: d**

Explanation:

Shortest wavelength is corresponding to best ine
? n = 1 (Lyman series)
n = 8 (infinite)
$\frac{1}{A} = r \times (1)^2 \left\{\frac{1}{12} - \frac{1}{2}\right\} = R$
Longest wavelength = 1 Line
? = 3 n = 4
$\frac{1}{\lambda} = r \times (2)^2 \left\{\frac{1}{3^2} - \frac{1}{4^2}\right\} = \frac{r \times 7}{36}$
$\lambda = \frac{36A}{7}$

Concepts:

1. Structure of Atom:

Atomic Structure:

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Dalton's Atomic Theory

Dalton proposed that every matter is composed of atoms that are indivisible and indestructible.

The following are the postulates of his theory:

- Every matter is made up of atoms.
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- Specific elements have only one type of atoms in them.
- Each atom has its own constant mass that varies from element to element.
- Atoms undergo rearrangement during a chemical reaction.
- Atoms can neither be created nor be destroyed but can be transformed from one form to another.

Cons of Dalton's Atomic Theory

- The theory was unable to explain the existence of isotopes.
- Nothing about the structure of atom was appropriately explained.
- Later, the scientists discovered particles inside the atom that proved, the atoms are divisible.

Subatomic Particles

1. Protons - are positively charged subatomic particles.
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Several atomic structures of an element can exist, which differ in the total number of nucleons.These variants of elements having a different nucleon number (also known as the mass number) are called isotopes of the element. Therefore, the isotopes of an element have the same number of protons but differ in the number of neutrons. For example, there exist three known naturally occurring isotopes of hydrogen, namely, protium, deuterium, and tritium.

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2. Answer: b

Explanation:

$R = 211.6\,pm = 2.11?$
$R = 0.529 \times \frac{n^2}{Z} = 2.11\,?$
$n^2 = 4$
$\Rightarrow n = 2$

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3. **Answer: c**

Explanation:

$2\pi r = n\lambda$
$for\, n = 1, r = a_0$
$n = 4, r = 16a_0$
$So,\, 2\pi \times 16a_0 = 4 \times \lambda$
$\lambda = 8\pi a_0$

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4. **Answer: c**

Explanation:

Energy of e^- in the excited state of Li^{+2}

$E = -13.6\frac{Z^2}{n^2}$

$= -13.6 \times \frac{(3)^2}{(2)^2} eV$

$= -\frac{9}{4} \times 13.6\, eV$

$= -30.6\, eN$

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5. Answer: a

Explanation:

$\frac{1}{\lambda} = \frac{2\times10^{-18}}{hc}\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right]$

$\Rightarrow \quad \frac{1}{\lambda} = \frac{2\times10^{-18}}{6.625\times10^{-34}\times3\times10^{8}} \times \frac{3}{4}$

$\Rightarrow \quad \lambda = \frac{2\times6.625\times10^{-34}\times10^{8}}{10^{-18}}$

$= 13.25 \times 10^{-8}$

$= 13.25 \times 10^{-7}\, m$

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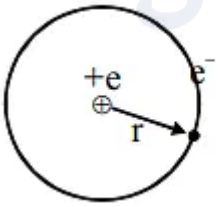
6. **Answer: d**

Explanation:



$= PE + KE \quad \left\{\because \frac{mv^2}{r} = \frac{ke^2}{r^2}\right.$
$= -\frac{ke^2}{r} + \frac{1}{2}mv^2 \quad \left.\therefore \frac{1}{2}mv^2 = \frac{1}{2}\frac{ke^2}{r}\right\}$
$= -\frac{ke^2}{r} + \frac{1}{2}\frac{ke^2}{r}$
$= -\frac{1}{2}\frac{ke^2}{r}$
$= -\frac{1e^2}{2r}$ [In CGS system $K = 1$]

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7. **Answer: c**

Explanation:

$$E = hv$$
$$= 6.63 \times 10^{-4} \times 2.47 \times 10^{15}$$
$$= 1.640 \times 10^{-18}\, J$$

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8. **Answer: d**

Explanation:

Number of orbitals in a shell $= n^2 = (5)^2 = 25$

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9. Answer: c

Explanation:

$-\frac{13.6z^2}{n^2}$

$\Rightarrow$ for hydrogen ; $z = 1$

$-\frac{13.6}{n^2}$

Possible is $-13.6, -3.4, -1.5$ etc.

So, the correct option is (C): $-3.4\,eV$

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10. **Answer: d**

Explanation:

A body which can emit or absorb radiation of all frequencies is known as blackbody and the radiation emitted by it is known as blackbody radiation.
At a given temperature, the spectral emissive power, of light emitted by a blackbody depends on the wavelength emitted. At a given temperature, the intensity of radiation emitted increases with increase of wavelength, reaches a maximum value and then decreases with further increase in wavelength.
With increase in the temperature of the blackbody, the wavelength corresponding to the most intense radiation decreases.

So, the correct option is (D).

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