NARAYANA EDUCATIONAL INSTITUTIONS

SUBJECT : ATOMIC STRUCTURE

1. Calculate the shortest wavelength in $H_2^{\oplus}$ spectrum of Lyman series when R_H=109,677 cm^{-1}.

A)911.7 A° B)912.7 A° C)91.7 A° D)921.7 A°

2. What is the maximum number of emission lines when the excited electron of a H atom in n=6 drops to the ground state?

A)36 B)6 C)15 D)10

3. The ionization energy of H atom is 13.6v. The ionization energy of Li^{2+} ion will be

A)54.4e V B)122.4e V C)13.6e V D)27.2e V

4. What transition in the hydrogen spectrum would have the same wavelength as the blamer transition n=4 to n=2 in the $He^{\oplus}$ spectrum

A) n=4 to n=2 B) n=3 to n=2 C) n=3 to n=1 D) n=2 to n=1

5. The ionization energy of H atom is 13.6e V. What will be the ionization energy of $He^{\oplus}$ ion

A)54.4ev B)52.4ev C)122.4ev D)54.1ev

6. The circumference of the first bohr orbit in H atom is 3.322×10^{-10} m. What is the velocity of the Electron of this orbit

A)3 B)4 C)9 D)12

7. Calculate the radius of the third orbit of a hydrogen atom; the radius of the first Bohr orbit of hydrogen

Atom is 0.53 $\overset{\circ}{A}$.

A)4.77 A^0 B)1.59 A^0 C)1.06 A^0 D)2.12 A^0

8. If an electron in H atom has an energy of -78.4 kcal mol^{-1} .The orbit in which the electron is present is.

A)1^{st} B)2^{nd} C)3^{rd} D)4^{th}

9. If the radius of the second Bohr orbit of hydrogen atom is r_2, the radius of the third Bohr orbit will be

A) $\frac{4}{9}r_2$ B)4r_2 C) $\frac{9}{4}r_2$ D)9r_2

10. If the radius of the Bohr orbit is r then the de Broglie wave length of the electron in the third orbit will be

A)2πr B) $\frac{2\pi r}{3}$ C) $\frac{3\pi r}{3}$ D)6πr

11. Choose the correct relations on the basis of bohr's theory

A) Velocity of electron $\alpha 1/n$

B)Frequency of revolution $\alpha 1/n^3$

C)Radius of orbit $\alpha n^2 Z$

D) Force on electron $\alpha 1/n^4$

A) (a) and (b) B) (a) and (c) C) (b) and (c) D) (a) and (d)

12. If the speed of electron in the first Bohr orbit of hydrogen atom is x, then the speed of the electron in the third Bohr orbit of hydrogen is

A) $\frac{x^2}{9}$ B) $\frac{x}{3}$ C)3x D)9x

13. The ratio of the difference between the first and second Bohr orbit energies to that between second and third Bohr orbit energies is

A) $\frac{1}{2}$ B) $\frac{1}{3}$ C) $\frac{27}{5}$ D) $\frac{5}{27}$

14. The λ of H_α line of the Balmer series is 6500 A. What is the λ of H_β line of the Balmer series

A)481.48 A° B)481.5 A° C)481 A° D)4814.8 A° 7

15. If the energy of electron in H atom is given by expression, $-1312/n^2$ KJ mol^{-1}, then the energy required to excite the electron from ground state to second orbit is

A)328 KJ B)656 KJ C)984 KJ D)1312 KJ

16. The ratio of the radii of the three Bohr orbit is

A) 1:1/2:1/3 B) 1:2:3 C) 1:4:9 D) 1:8:27

17. The wave number of the first line of Balmer series of hydrogen is 15200 cm^{-1}. The wave number of the

first Balmer line of Li^{2+} ion is

A)15200 cm^{-1} B)60800 cm^{-1} C)76000 cm^{-1} D)136800 cm^{-1}

18. The wave length of H_α line of Balmer series is X A^0. What is the X of H_β line of Balmer series

A) $X\frac{108}{80}A^0$ B) $X\frac{80}{108}A^0$ C) $\frac{1}{X}\frac{80}{108}A^0$ D) $\frac{1}{X}\frac{108}{80}A^0$

19. The shortest and longest wave number in $H_2^{\oplus}$ spectrum of Lyman series is (R= Rydberg constant)

A) $\frac{3}{4}R, R$ B) $\frac{1}{R}, \frac{4}{3}R$ C) $R, \frac{4}{3}R$ D) $R, \frac{3}{4}R$

20. The radius of the first Bohr orbit for $He^{\oplus}$ is

A)0.529 A^0 B)0.264 A^0 C)0.132 A^0 D)0.176 A^0

21. The ratio of the energy of a photon of 2000 A^0 wavelength radiation to that of 4000 A^0 radiation is

A)1/4 B)4 C)1/2 D)2

22. Energy of electron is given by $E = -2.178\times10^{-18}J\left[\frac{Z^2}{n^2}\right]$ Wavelength of light required to excite an electron in an hydrogen atom from level n=1 to n=2 will be:

($h = 6.62\times10^{-34}Js$ and $c = 3.0\times10^8 ms^{-1}$)

A) $2.816\times10^{-7}m$ B) $6.500\times10^{-7}m$ C) $8.500\times10^{-7}m$ D) $1.214\times10^{-7}m$

23. The angular momentum of an electron is 4s orbital, 3p orbital, and 4th orbit are

A) 0, $\frac{1}{\sqrt{2}}\frac{h}{\pi}, \frac{2h}{\pi}$ B) $\frac{1}{\sqrt{2}}\frac{h}{2}, \frac{2h}{\pi}, 0$ C) $0, \frac{\sqrt{2h}}{\pi}, \frac{4h}{\pi}$ D) $\frac{\sqrt{2h}}{\pi}, \frac{4h}{\pi}, 0$

24. Which combination of quantum numbers n,l,m and s for the electron in an atom does not provide a Permissible solution to the wave equation

A)3,2.-2,+ $\frac{1}{2}$ B)3,3,1,- $\frac{1}{2}$ C)3,2,1,+ $\frac{1}{2}$ D)3,1,1,- $\frac{1}{2}$

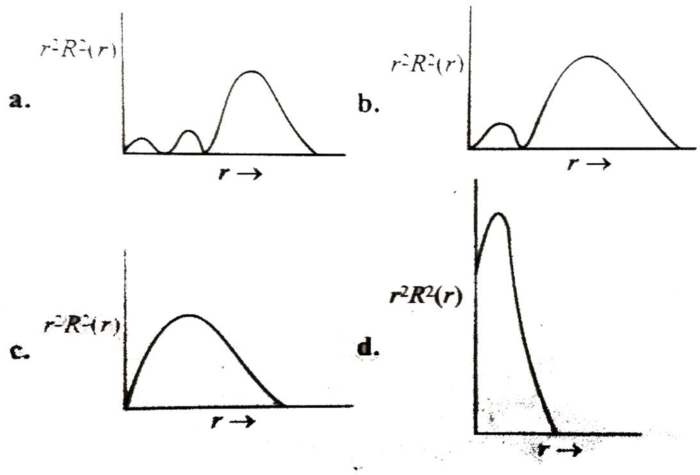
25. If the value of n + l = 7, then what should be the increasing order of energy of the possible sub-shell

A)75>6p>5d>4f B)75>5d>6p>4f C)6p>75>5d>4f D)75=9p=5d=4f

26. What is the orbital angular momentum of a d electron

A) $\sqrt{2}\frac{h}{2\pi}$ B) $\sqrt{2}\frac{h}{4\pi}$ C) $\sqrt{6}\frac{h}{2\pi}$ D) $\sqrt{6}\frac{h}{\pi}$

27. Which of the following radial distribution graphs corresponds to $l = 2$ for H atom for the least value of n for which $l = 2$ is allowed



28. The dissociation energy of H_2 is 430.53 KJ mol^{-1}. If H_2 is dissociated by illumination with radiation of Wavelength 253.7 nm, the fraction of the radiant energy Which will be converted into kinetic energy is given by

A)8.86% B)2.33% C)1.3% D)90%

29. In a photoelectric effect experiment, irradiation of a metal with light of frequency 5.2 $\times 10^{14}$ s^{-1} yields electrons with maximum kinetic energy 1.3×10^{-19} J. calculate the threshold frequency (v_0) for the metal

A) $3.24\times10^{15}s^{-1}$ B) $3.42\times10^{14}s^{-1}$ C) $3.24\times10^{14}s^{-1}$ D) $3.3\times10^{14}s^{-1}$

30. The threshold frequency v_0 for a metal is $7.0\times10^{14}s^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of frequency $v = 1.0\times10^{15}s^{-1}$

A) $1.97\times10^{-19}J$ B) $1.988\times10^{-19}J$ C) $1.988\times10^{-12}J$ D) $1.99\times10^{19}J$

31. Calculate and compare the energies of two radiations, one with a wavelength of 300 nm and the other with 600 nm

A) $E_1 = E_2$ B) $E_1 = 4E_2$ C) $E_2 = 2E_1$ D) $E_1 = 2E_2$

32. A 100-watt bulb emits monochromatic light of wavelength 400 nm. Calculate the number of photons emitted per second by the bulb

A) $20.12\times10^{20}S^{-1}$ B) $2.012\times10^{20}S^{-1}$ C) $2.012\times10^{19}S^{-1}$ D) $2.012\times10^{20}s^{-1}$

33. What is the ratio of the velocities of CH_4 and O_2 molecules so that they are associated with de Broglie waves of equal wavelength

A) $V_{CHY} = 2V_{0_2}$ B) $V_{CHY} = V_{0_2}$ C) $V_{CH2} = 4V_{0_2}$ D) $V_{CHY} = 3V_{0_2}$

34. A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 $\overset{\circ}{A}$. What is the uncertainty involved in the measurement of its velocity

A) $5.69\times10^{6}ms^{-1}$ B) $5.78\times10^{6}ms^{-1}$ C) $5.69\times10^{6}ms^{-1}$ D) $5.79\times10^{6}ms^{-1}$

35. Match the items in Column-I with those in column-II

Column-I	Column-II
A)Radius of electron in nth orbit	P)= $2.18\times10^{6}\times\frac{Z}{n}ms^{-1}$
B)Energy of electron in nth orbit	Q) $mvr=\frac{nh}{2\pi}$
C)velocity of electron in nth orbit	R) $=13.6ev\times\frac{Z^{2}}{n^{2}}$
D)Angular momentum in an orbit is	S) $=0.529\,\mathring{A}\times\frac{n^{2}}{Z}$

A) A-R, B-Q, C-P, D-S
B) A-Q, B-Q, C-R, D-P
C) A-S, B-P, C-R, D-S
D) A-S, B-R, C-P, D-Q

36. Match the items in column –I with those in columns –II

Column-I	Column-II
A)Radial probability is	P) $n-l-1$
B)Radial nodes	Q) $=l$
C)Angular nodes	R) $=l$
D)Total number of nodes	S) $=n-1$
E)nodal planes	T) $=4\pi r^{2}dr4^{2}$

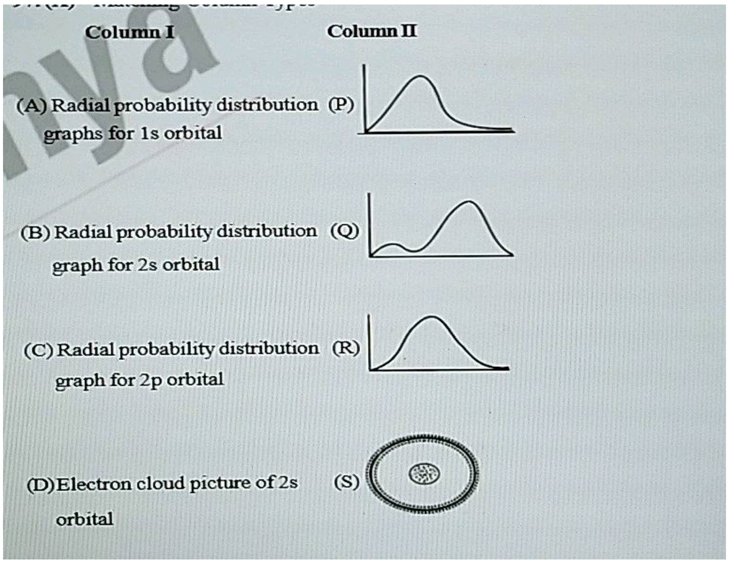
A) A-S, B-Q, C-P, D-R, E-T
B) A-T, B-P, C-Q, D-S, E-R
C) A-T, B-Q, C-P, D-S, E-R
D) A-R, B-S, C-P, D-Q, E-T

37. Match the items in column –I with those in columns –II

Column-I	Column-II
A) $n=2,l=1,m=-1$	P) $2p_x$ or $2p_y$
B) $n=4,l=2,m=0$	Q) $4dZ^{2}$
C) $n=3,l=1,m=\pm1$	R) $3p_x$ or $3p_y$
D) $n=4,l=0,m=0$	S) 4S
E) $n=3,l=2,m=\pm2$	T) $3d_{x}2_{-y}2$ or $3d_{xy}$

A) A-p, B-R, C-Q, D-S
B) A-R, B-P, C-S, D-Q
C) A-Q, B-P, C-S, D-R
D) A-P, B-Q, C-R, D-S

38. Match the items in column –I with those in columns –II



A) A-p, b-q, c-r, d-s
B) A-q, b-p, c-r, d-s
C) A-p, b-r, c-q, d-s
D) A-s, b-p, c-r, d-q

39. Match the items in column –I with those in columns –II

Column-I	Column-II
A) Orbit angular momentum	P) $\sqrt{n(n+2)}$
B) Orbital angular momentum	Q) $nh/2\pi$
C) Spin angular momentum	R) $\sqrt{s(s+1)}h$
D)Magnetic moment	S) $\sqrt{l(l+1)}h$
	T) $\sqrt{n(n+1)}h$

A) A-s, B-q, C-r, d-p
B) A-q, B-s, C-r, d-p
C) A-r, B-p, C-q, d-s
D) A-p, B-q, C-s, d-r

CHEMISTRY

1	**A**	2	**C**	3	**B**	4	**D**	5	**A**
6	**B**	7	**A**	8	**B**	9	**C**	10	**B**
11	**D**	12	**B**	13	**C**	14	**B**	15	**C**
16	**C**	17	**D**	18	**B**	19	**A**	20	**B**
21	**D**	22	**D**	23	**A**	24	**B**	25	**A**
26	**C**	27	**C**	28	**A**	29	**C**	30	**B**
31	**D**	32	**B**	33	**A**	34	**D**	35	**D**
36	**B**	37	**D**	38	**A**	39	**B**	40	

SOLUTIONS

CHEMISTRY:-

1 For Lyman series, $n_1 = 1$.

For the shortest Lyman series, the energy difference in two levels showing transition should be maximum (i.e., $n_2 = \infty$).

Using the expression

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

We get

$$\frac{1}{\lambda} = 109677\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)\text{cm}^{-1} = 109677\text{cm}^{-1}$$

Or $\lambda = 911.7 \times 10^{-8} cm = 911.7 \times 10^{-10} m = 911.7 \mathring{A}$

2. The number of liens produced when an electron from then nth shell drops to the ground state is $\frac{n(n-1)}{2}$ So the required number of emission lines is $\frac{6(6-1)}{2} = 15$

3. E_1 for $Li^{2+} = E_1$ for $H \times Z^2$

$= 13.6 \times 9 = 122.4 \text{e V}$

4. $\bar{v} = \frac{1}{\lambda} = \left(\frac{1}{2^2} - \frac{1}{4^2}\right)RZ^2 = \frac{3}{4}R$

In H spectrum for the same $\bar{v}$ or λ as Z=1, n=1, $n_2 = 2$

5. Ionizations energy of H atom =13.6V

Ionizations energy of $He^{\oplus}$ =IE for $H \times Z^2$

=13.6 $\times$4=54.4e V

Ionization energy for Li^{2+} =IE for H $\times Z^2$

=13.6 $\times 9 = 122.4$ e V

6. According to Bohr's model,

$mvr = \frac{nh}{2\pi}$; Given n=1 and 2 π (circumference)

=3.322×10^{-10} m

$$v = \frac{nh}{2\pi mr} = \frac{1 \times (6.626 \times 10^{-36} J\, s}{(9.1 \times 10^{-31} kg) \times 3.322 \times 10^{-10} m}$$
$$= 2.19 \times 10^{6}\, m\, s^{-1}$$

7. We know that

$r_n = n^2 r_0 = (3)^2 \times 0.53 = 4.77\, \overset{\circ}{A}$

8. $E_n = \frac{-13.6}{n^2}$ e V

When n=2 $E_2 = \frac{-13.6}{4} = -3.4$ e V

Hence, (a) is the correct answer.

9. $r = \frac{n^2 h^2}{4\pi^2 m Z e^2}$

$\therefore \frac{r_2}{r_3} = \frac{2^2}{3^2}$

$\therefore r_3 = \frac{9}{4} r_2$

10. Bohr radius=r

Bohr velocity, $V = \frac{nh}{2\pi mr}$

de-Broglie wavelength, $\lambda = \frac{h}{mV}$

$\therefore$ For third orbit, n=3

$$\therefore \lambda = \frac{h}{\frac{m \times 3h}{2\pi mr}} = \frac{2\pi r}{3}$$

11. (a) and (d)

12. velocity, $V \alpha \frac{Z}{n}$

If velocity of electron in first orbit =x

Then velocity in 3rd orbit= $\frac{x}{3}$

13. $\Delta E = -2.18 \times 10^{-18} \left(\frac{1}{n_1^{\ 2}} - \frac{1}{n_2^{\ 2}} \right) \text{J } atom^{-1}$

$\therefore \Delta E_{2\to 1} = -2.18 \times 10^{-18} \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$

$= -2.18 \times 10^{-18} \left(\frac{3}{4} \right)$

$\therefore \Delta E_{3\to 2} = -2.18 \times 10^{-18} \left(\frac{5}{36} \right)$

$\therefore \frac{\Delta E_{2\to 1}}{\Delta E_{3\to 2}} = \frac{3}{4} \times \frac{36}{5} = \frac{27}{5}$

Hence answer is (c)

14. For H_α line of the Balmer series, $n_1 = 2\,, n_2 = 3$

For H_β line of the Balmer series, $n_1 = 2\,, n_2 = 4$

$\therefore \frac{1}{\lambda_{H\alpha}} = R_H \left[\frac{1}{2^2} - \frac{1}{3^2} \right]$

and $\frac{1}{\alpha_{H\alpha}} = R_H \left[\frac{1}{2^2} - \frac{1}{4^2} \right]$

By equations (i) and (ii), we get

$\therefore \frac{\lambda_\beta}{\lambda_\alpha} = \frac{\frac{1}{4} - \frac{1}{9}}{\frac{1}{4} - \frac{1}{16}}$

$\therefore \lambda_\beta = \lambda_\alpha \times \left[\frac{80}{108} \right] = 6500 \times \frac{80}{108} = 4814.8 \ \mathring{A}$

15. $\frac{-1321}{4} - \left(\frac{1312}{1} \right) = 984 KJ$

16. $r = \frac{n^2 a_0}{z}$, (when $n = 1, Z = 1$

$r_1 = a_0$

$r_2 = 4a_0$ (when $n = 2, Z = 1$)

$r_3 = 9a_0$ (when $n = 3, Z = 1$)

Hence, ratio is 1:4:9

17. $\bar{v}_{H_{2\oplus}} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 15200 cm^{-1}$

$\bar{v}_{Li^{2+}} RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 3^2 \times 15200$

$= 136800 cm^{-1}$

18. H_α line of Balmer series means first line of blamer series

$n_1 = 2\, n_2 = 3$

$\bar{v} = \frac{1}{\lambda_\alpha} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}$

$\therefore \lambda_\alpha = \frac{36}{5R} = X$

H_β line of Balmer series means, second line of Balmer series, $n_1 = 2, n_2 = 4$

$\bar{v} = \frac{1}{\lambda_\beta} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3R}{16}$

$\therefore \lambda_\beta = \frac{16}{3R} = X$

When $\frac{36}{3R} = X$

Then $\frac{16}{3R} = \frac{X \times 5R \times 16}{36 \times 3R} = \frac{80X}{108} A^0$

19. Shortest $\bar{v}$ means shortest E and vice versa.

When, $n = 1, n_2 = 2$

$\bar{v} = \left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3}{4}R$

Longest $\bar{v}$ means longest E

When $n_1 = 1, n_2 = \infty$

$$\bar{v} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = R$$

20. r_1 for $He^{\oplus} = \dfrac{0.529 \times 1^2}{2} = 0.264 A^0$

21. $E = \dfrac{hc}{\lambda} = 2.178 \times 10^{-18} \times Z^2 \left[\dfrac{1}{1^2} - \dfrac{1}{2^2}\right]$

$\lambda = 1.214 \times 10^{-7} m$

24. 3,3,1-1/2 in the combination n = 3, l = 3, m = 1, s = -1/2 since l cannot have a value equal to n.

25. Given that $n + l = 7$

Hence $7 + 0 = 7s$

$6 + 1 = 6p$

$5 + 2 = 5d$

$4 + 3 = 4f$

Thus the order of energy is $4f < 5d < 6p < 7s$

26. Orbital angular momentum = $\sqrt{l(l+1)}\dfrac{h}{2\pi}$

For d electron , $l = 2$

$\therefore$ Orbital, angular momentum

$$= \sqrt{2(2+1)}\frac{h}{2\pi} = \sqrt{6}\frac{h}{2\pi}$$

27. Option (c) represents the distribution of $l = 2$ for H atom

Two nodes: $(n - l - 1) = 2,\ (n - 2 - 1) = 2$

$\therefore n = 5$ (high value of n)

One node: $(n - 2 - 1) = 1, n = 4$

Zero node: $(n - 2 - 1) = 0, n = 3$ (minimum value of n which $l = 2$ is allowed)

Graph does not correspond to any radial distribution curve

28. $\dfrac{hc}{\lambda} = \dfrac{430.53 \times 10^3}{6.023 \times 10^{23}} + \text{KE}$

$$KE=\frac{6.626\times10^{-34}\times3\times10^{8}}{253.7\times10^{-9}}$$

$$=\frac{430.53\times10^{3}}{6.023\times10^{23}}=6.9\times10^{-20}$$

$$\therefore \text{Fraction } =\frac{6.9\times10^{-20}}{7.83\times10^{-19}}=0.088=8.86$$

29. We know that

$$hv=hv_0+KE$$

$$\text{Or } v_0=v-\frac{KE}{h}$$

$$\text{KE}=1.3\times10^{-19}\text{ J; } v=5.2\times10^{14}s^{-1};$$

$$h=6.626\times10^{-34}\text{ J s}$$

$\therefore$ Threshold frequency

$$v_0=5.2\times10^{14}s^{-1}-\frac{1.3\times10^{19}J}{6.626\times10^{-34}J\,s}$$

$$=5.2\times10^{14}s^{-1}-1.96\times10^{14}s^{-1}$$

$$=3.24\times10^{14}s^{-1}$$

30. According to Einstein's equation

$$\text{Kinetic energy }=\frac{1}{2}meV^2$$

$$=h(v-v_0)$$

$$=\left(6.626\times10^{-34}Js\right)\times$$

$$(1.0\times10^{15}s^{-1}-7.0\times10^{14}s^{-1})$$

$$=(6.626\times10^{-34}Js)\times$$

$$(10\times10^{14}Js^{-1}-7.0\times10^{14}s^{-1})$$

$$=(6.626\times10^{-34}Js)\times$$

$$(3.0\times10^{14}s^{-1})$$

$$=1.988\times10^{-19}J$$

31. Energy of radiation $(E)=hv=\frac{hc}{\lambda}$

$$\therefore E_1 = \frac{hc}{\lambda_1} = \frac{6.626 \times 10^{-34} Js \times 3 \times 10^8 m\, s^{-1}}{300 \times 10^{-9} m}$$

$$= 6.626 \times 10^{-19} J$$

and $E_2 = \dfrac{hc}{\lambda_2} = \dfrac{6.626 \times 10^{-34} Js \times 3 \times 10^8 m\, s^{-1}}{600 \times 10^{-9} m}$

$$= 3.313 \times 10^{-19} \text{ J}$$

The ratio of E_1 and E_2 is

$$\frac{E_1}{E_2} = \frac{6.626 \times 10^{-19} J}{3.313 \times 10^{-19} J} = 2$$

$$\therefore E_1 = 2E_2$$

32. Power of the bulb = 100 watt

$= 100\, Js^{-1}$

Energy of one photon:

$$E = hv = hc / \lambda$$

$$= \frac{6.626 \times 10^{-34} Js \times 3 \times 10^8 ms^{-1}}{400 \times 10^{-9} m}$$

$$= 4.969 \times 10^{-19} \text{ J}$$

Number of photon emitted

$$= \frac{100 Js^{-1}}{4.969 \times 10^{-19} J} = 2.012 \times 10^{20} s^{-1}$$

33. From the de Broglie relationship

$$\lambda = \frac{h}{mv}$$

For $CH_4, \lambda_{CH_4} = \dfrac{h}{m_{CH_4} \times v_{CH_4}}$

For $O_2, \lambda_{o_2} = \dfrac{h}{m_{o_2} \times v_{o_2}}$

Wavelength of CH_4 and O_2 is equal, hence

$$\frac{h}{m_{CH_4} \times v_{CH_4}} = \frac{h}{m_{o_2} \times v_{o_2}}$$

$$\Rightarrow \frac{v_{CH_4}}{v_{o_2}} = \frac{m_{o_2}}{m_{CH_4}} = \frac{32}{16} = 2$$

$$\therefore v_{CH_4} = 2v_{o_2}$$

The velocity of CH_4 molecule is two times the velocity of O_2 molecule

34. $$\Delta x \times \Delta p = \frac{h}{4\pi}$$

Or $\Delta x \times m\Delta v = \frac{h}{4\pi}$

$$\Delta v = \frac{h}{4\pi \times \Delta x \times m}$$

$$\frac{6.626 \times 10^{-34} Js}{4 \times 3.14 \times 1 \times 10^{-10} m \times 9.11 \times 10^{-31} Kg}$$

$$= 0.579 \times 10^{7} ms^{-1}$$

$$= 5.79 \times 10^{6} ms^{-1}$$

35. Formula based

36. Formula based

37. Formula based

38. Formula based

39. Formula based