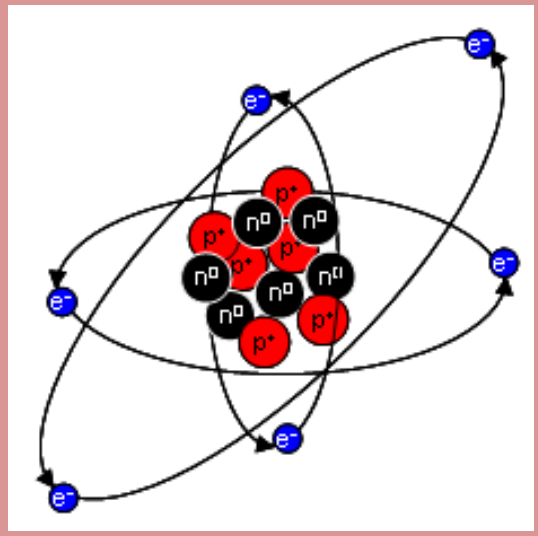
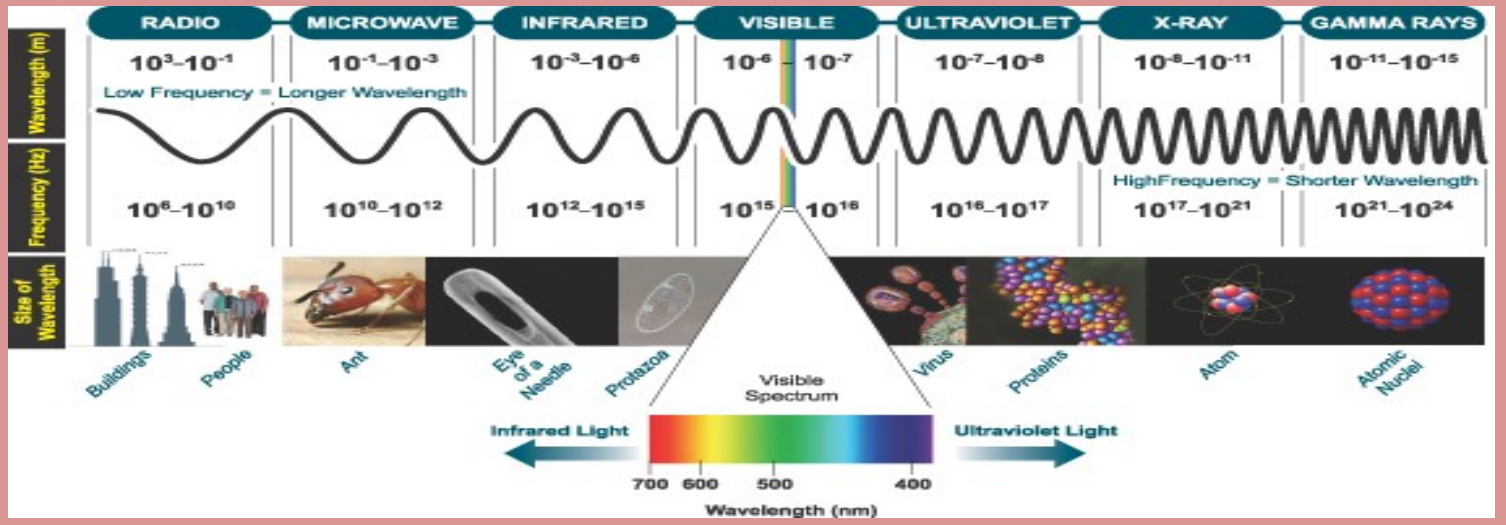
ATOMIC PHYSICS

1) Introduction
2) Photo electric effect
3) Dual nature of matter
4) Bohr's atom model
5) LASERS





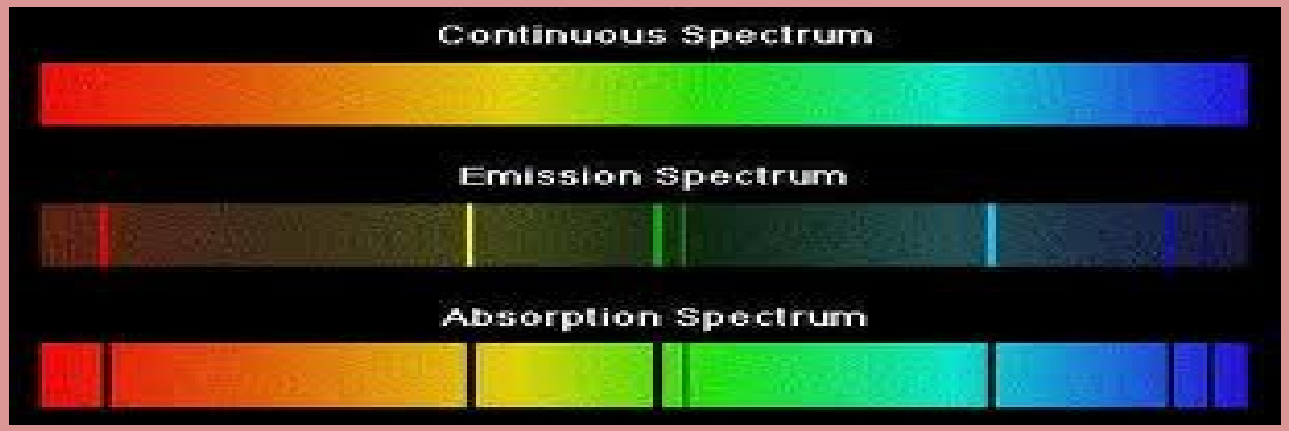
CONCEPTS

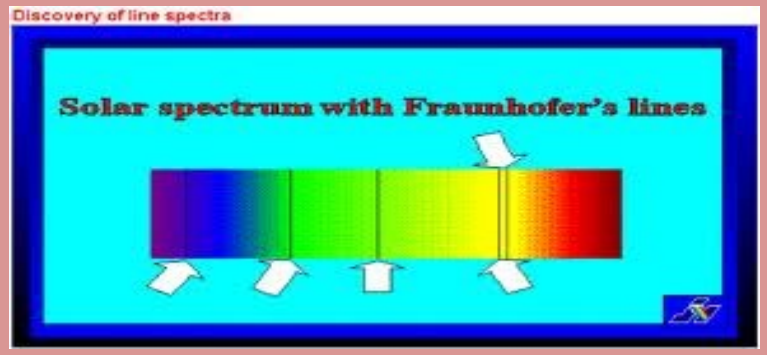
&

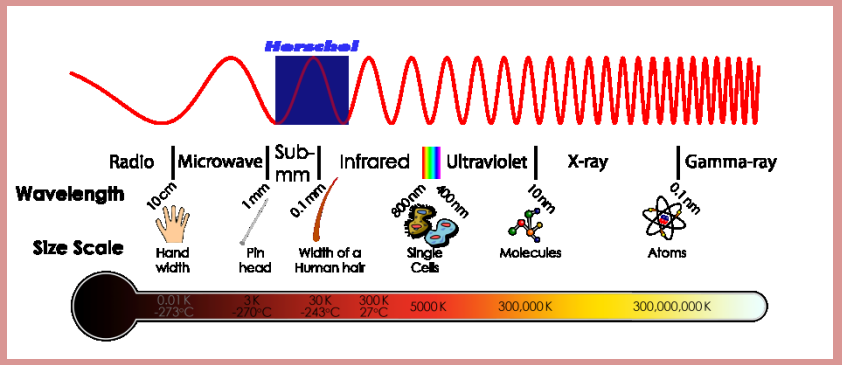
FORMULAE

1. Introduction

Types of electron emission, Dunnington's method, different types of spectra, Fraunhoffer spectrum, electromagnetic spectrum



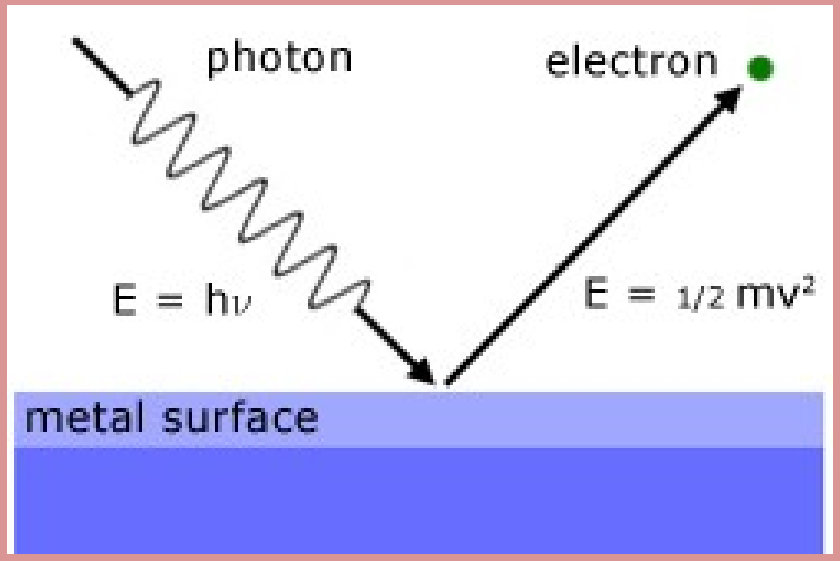




2. Photo-electric effect

$$h\vartheta = h\vartheta_0 + \frac{1}{2}mv^2$$

Photo cells – principle and applications



3. Dual Nature of Matter

de-Broglie wavelength

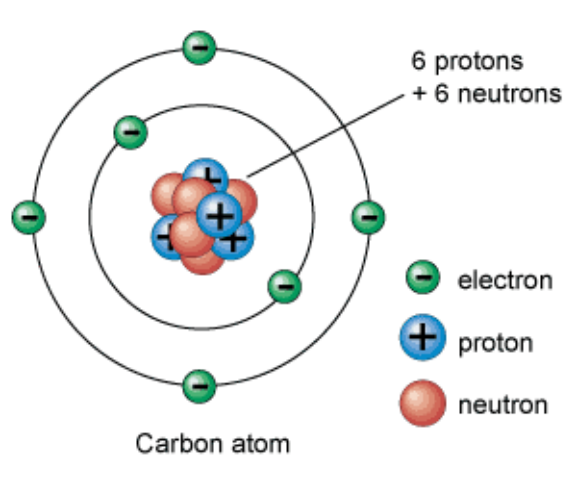
$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2meV}}$$

G.P.Thomson's experiment -- diffraction

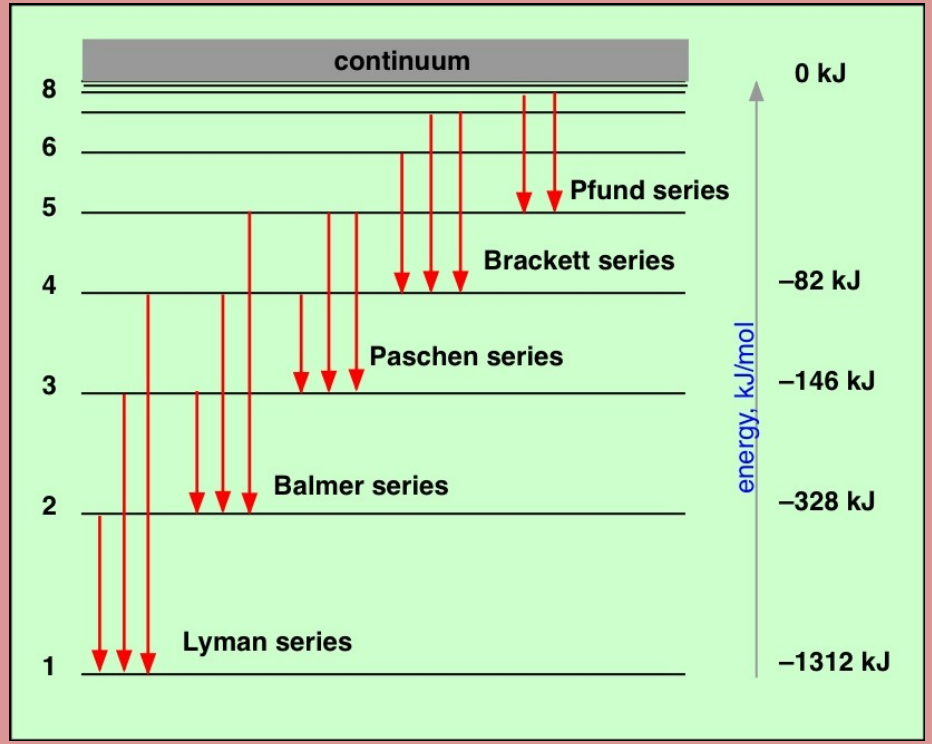
Principle of electron microscope; electron beam is used instead of optical beam

Resolving power is inversely proportional to the wavelength

4. Bohr's atom model



$$mvr = \frac{nh}{2\pi}$$



$$r = \frac{n^2 h^2 \in_0}{\pi m Z e^2} = 0.053nm$$

$$v = \frac{Ze^2}{2nh\varepsilon_0} = 2X10^6 ms^{-1}$$

$$T.E = \frac{mZ^2e^4}{8\varepsilon_0^2 n^2 h^2} = \frac{-13.6}{n^2} eV,$$

$$E_1 = -13.6eV, \qquad E_2 = -3.4eV, E_3 = -1.51eV$$

$$\bar{\vartheta} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right)$$

$$R = \frac{me^4}{8\varepsilon_0^2 h^3 c} = 1.097X10^7 m^{-1}$$

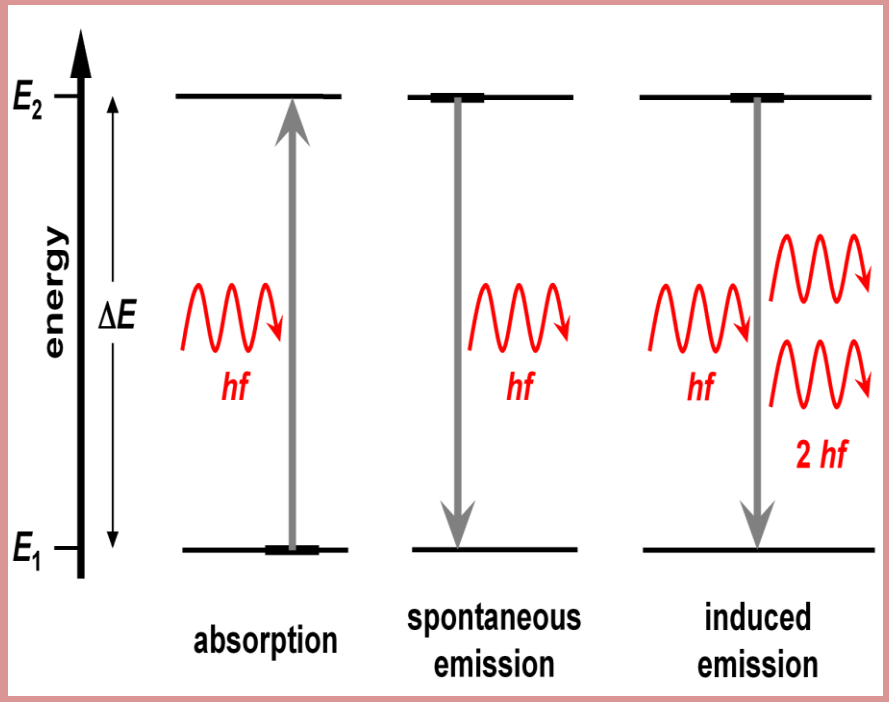
Series limit :- n_2=infinity

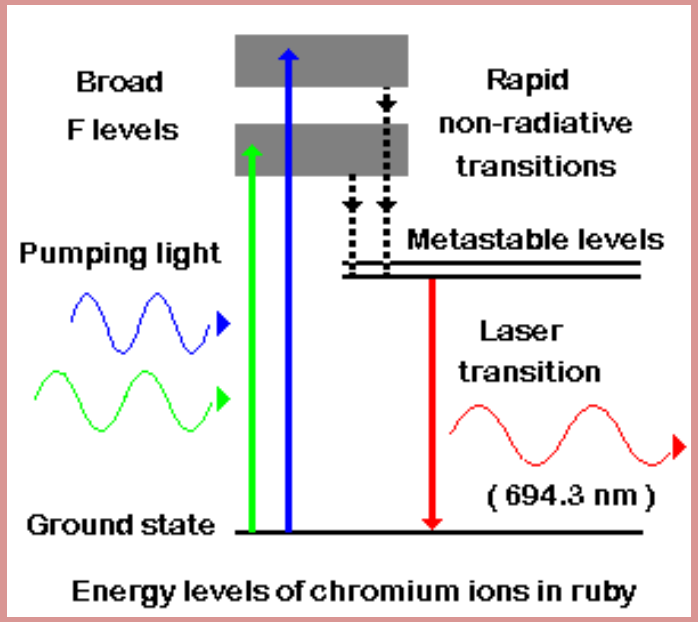
First line n_1=series value, n_2= n+1

If ionisation potential value given, corresponding energy in joule is series limit.

5. LASERS

Spontaneous emission and stimulated emission. Optical pumping, metastable state, population inversion





1. The dimensions of Planck's constant is

1) Force X displacement X time
2) Mass X velocity X time
3) Power X time
4) Force X time

$$E = h\vartheta$$

$$h = \frac{E}{\vartheta} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$$

$$Force X displacement\ X time$$

$$= MLT^{-2}\ X\ L\ XT$$

$$= ML^2T^{-1}$$

Ans (1)

2. Incandescent gases and vapors produces

1) Continuous emission spectrum
2) Continuous absorption spectrum
3) Line emission spectrum
4) Band emission spectrum

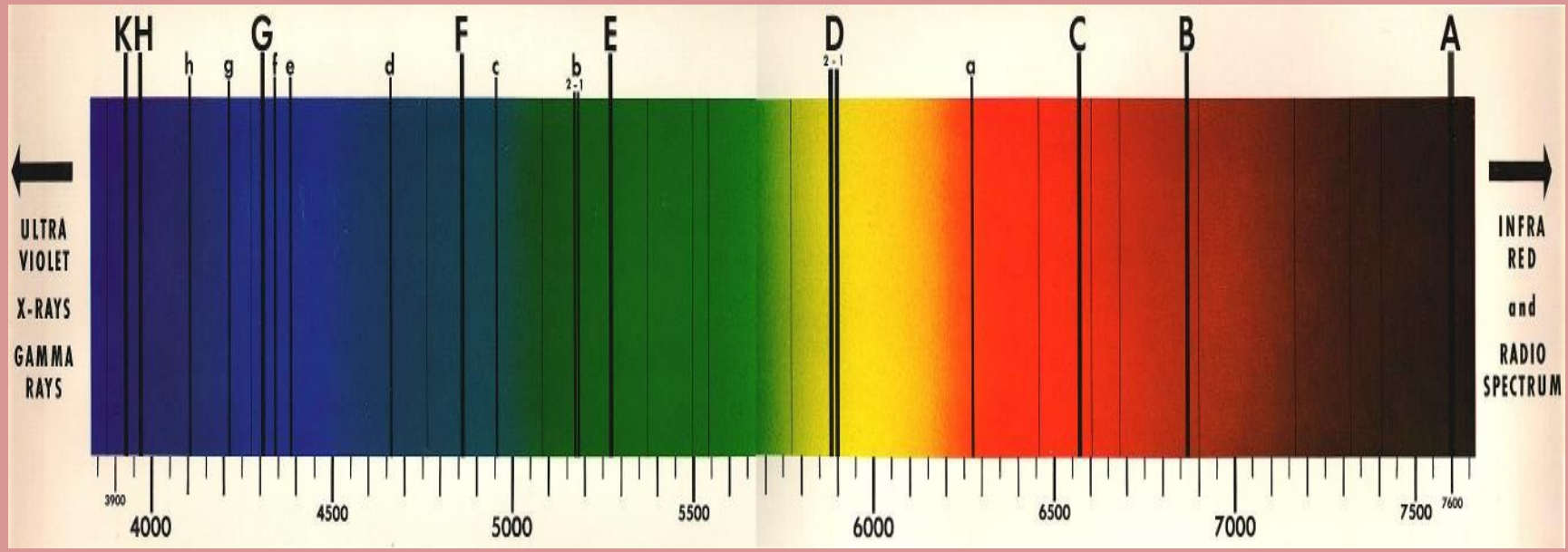
Incandescent solids and liquids give - continuous spectrum

Incandescent vapours and gases give line emission spectrum = atomic spectrum

Ans (3)

3. Solar spectrum is a

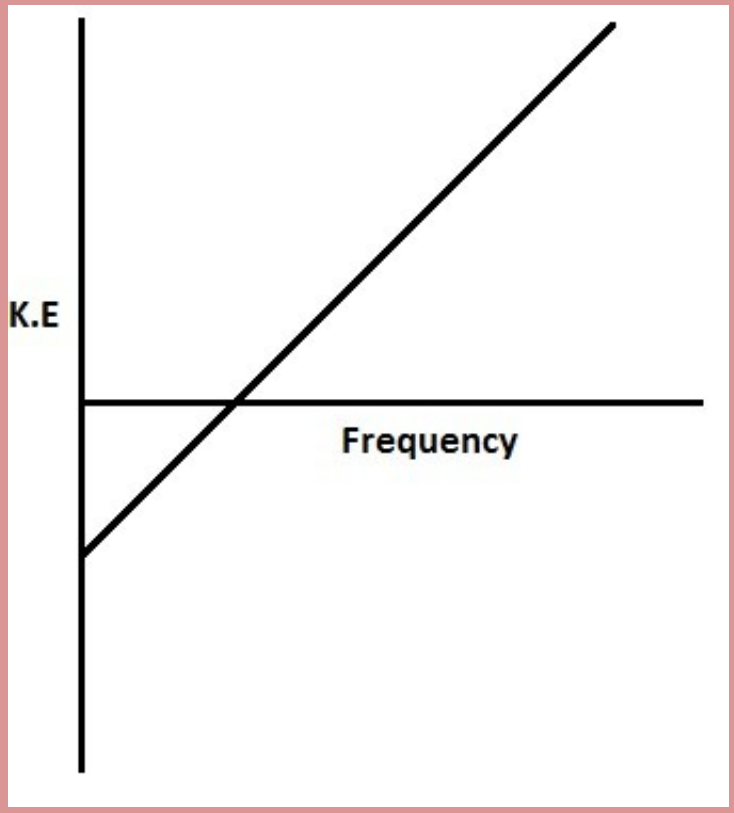
1) Line emission spectrum
2) Line absorption spectrum
3) Band emission spectrum
4) Band absorption spectrum


KH
G
F
E
D
C
B
A
h
g
f
e
d
c
b
2-1
2-1
a
ULTRA
VIOLET
X-RAYS
GAMMA
RAYS
INFRA
RED
and
RADIO
SPECTRUM
3900
4000
4500
5000
5500
6000
6500
7000
7500
7600

Ans (2)

4. In an experiment of photo electric effect, a graph of kinetic energy of the photo electron verses frequency of incident radiation is plotted. The slope of the curve and the Y-intercept respectively gives

1) Work function and Planck's constant
2) Planck's constant and work function
3) Planck's constant and stopping potential
4) Stopping potential and work function



$$slope = \frac{y}{x} = \frac{\max k.E}{frequency} = h$$

y-intercept gives work function

Ans (2)

5. The number of photons emitted per second by a 4.5 mW source operating at 662.5 nm is

1) 3×10^{16}
2) 1.5×10^{16}
3) 13.5×10^{16}
4) 1.5×10^{14}

$$E = nh\vartheta = \frac{nhc}{\lambda}$$

$$n = \frac{E\lambda}{hc} = \frac{4.5X10^{-3}X662.5X10^{-9}}{6.625X10^{-34}X3X10^{8}}$$

$$= 1.5X10^{16}$$

Ans (2)

6.A metal has a threshold wavelength λ_0 Light of wavelength λ is incident on this metal. Photo electric effect will take place only if

1) $\lambda \geq \lambda_0$
2) $\lambda \leq \lambda_0$
3) $\lambda < \lambda_0$
4) $\lambda > \lambda_0$

$\lambda < \lambda_0$

Ans (3)

7. The threshold wavelength of a metal is 560 nm. Photo electrons are emitted when this material is illuminated with a radiation from

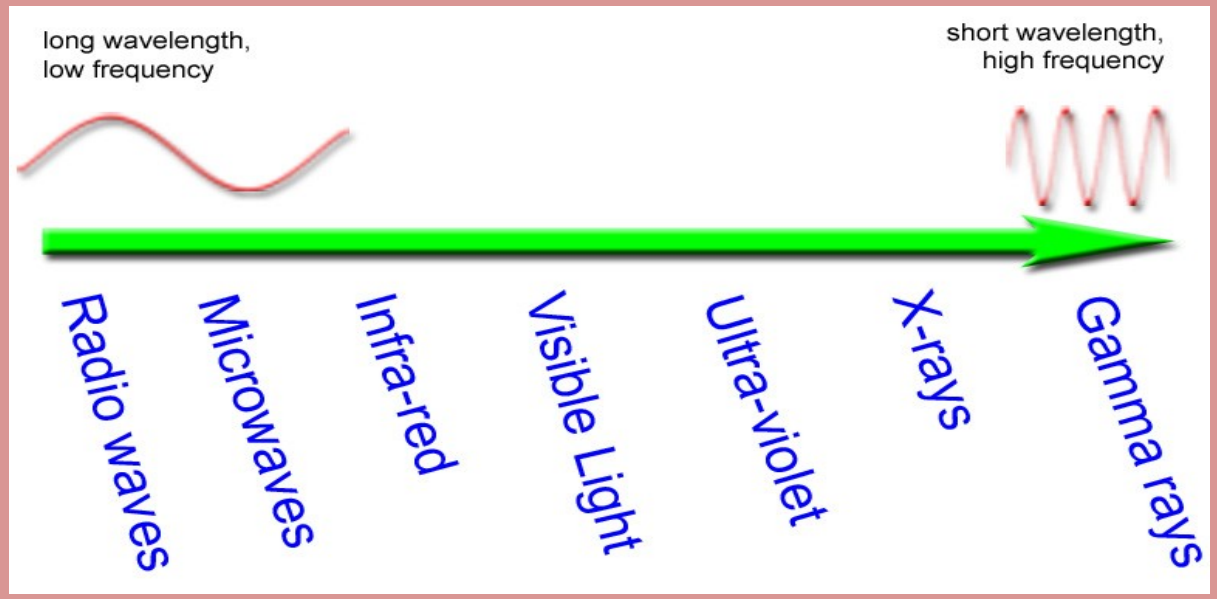
1) 1W infrared source
2) 5W infrared source
3) 50 W infrared source
4) 50W u-v source

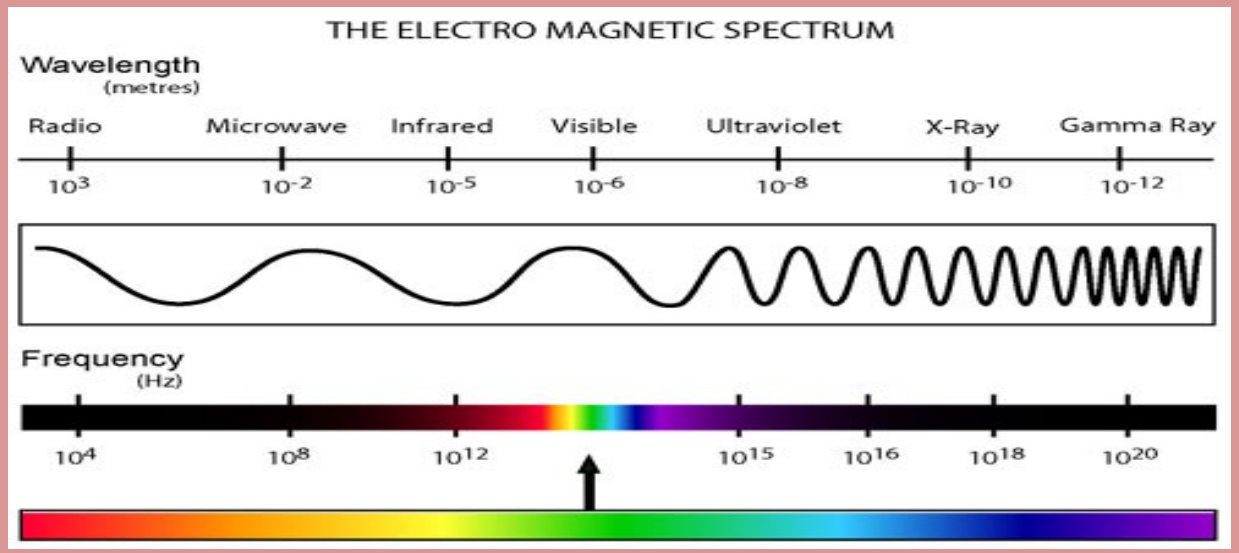
given threshold wavelength = 560 nm
it is in visible range –
I-R radiation wavelength is greater
than it, so
50W u-v source produces PEE

Ans (4)

8. As per decreasing order of the frequency which of the following is correct?

1)U-V, visible, I.R, microwave
2)I.R, microwave, visible, U-V
3)microwave, I.R, visible, U-V
4)U-V, visible, microwave, I.R


long wavelength,
low frequency
short wavelength,
high frequency
Radio waves
Microwaves
Infra-red
Visible Light
Ultra-violet
X-rays
Gamma rays


THE ELECTRO MAGNETIC SPECTRUM
Wavelength
(metres)
Radio
Microwave
Infrared
Visible
Ultraviolet
X-Ray
Gamma Ray
10^3
10^-2
10^-5
10^-6
10^-8
10^-10
10^-12
Frequency
(Hz)
10^4
10^8
10^12
10^15
10^16
10^18
10^20

Ans (1)

9. An electron is accelerated through a potential difference of V volt, the corresponding de-Broglie wavelength is λ. If the same electron is accelerated through a potential of 3V, then its de-Broglie wavelength is

1) 3λ

2) $\sqrt{3}\,\lambda$

3) $\frac{\lambda}{\sqrt{3}}$

4) $\frac{\lambda}{3}$

$$\lambda_1 = \frac{h}{\sqrt{2meV}} = \frac{h}{\sqrt{2me3V}} = \frac{\lambda}{\sqrt{3}}$$

Ans (3)

10. The value of Bohr radius is

1) 5.3 nm

2) 0.053 nm

3) 53 nm

4) 13.6 nm

0.053nm

Ans (2)

11. The series limit of Balmer series of hydrogen atom is 364.5 nm. The wavelength of first member of this series is

1) 656.1 nm
2) 486.0 nm
3) 121.5 nm
4) 729.0 nm

Balmer series $n_1 = 2$ $n_2 = 3,4,5,....$

Given, series limit = 364.5 nm

$$\bar{\vartheta} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right) = R\left(\frac{1}{4} - \frac{1}{\infty}\right) = \frac{1}{\lambda}$$

$$R = \frac{4}{\lambda}$$

Wavelength of the first member

$$\frac{1}{\lambda} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right) = \frac{4}{\lambda} X \left(\frac{1}{4} - \frac{1}{9}\right)$$

$$= \frac{4}{364.5X10^{-9}} X \frac{5}{36}$$

$$\lambda = 656.1nm$$

Ans (1)

12. The value of first excitation energy of hydrogen atom is

1) 10.2 eV

2) 13.6 eV

3) -13.6 eV

4) -3.4 eV

excitation energy is the energy required to excite an electron from lower energy state to higher energy state

first excitation energy = $E_2 - E_1$

$= -3.4 - (-3.6)$

$= 10.2\text{eV}$

Ans (1)

13. A photon of wavelength 662.5 nm has a certain momentum. To have the same momentum the velocity associated with an electron of mass ‘m’ is

1) $\frac{3X10^{-19}}{m}$

2) $mX10^{-27}$

3) $3mX10^{-19}$

4) $\frac{10^{-27}}{m}$

given wavelength = 662.5nm

momentum $p = \frac{h}{\lambda} = \frac{6.625X10^{-34}}{662.5X10^{-9}} = 10^{-27}$

$p = mv$

$v = \frac{p}{m} = \frac{10^{-27}}{m}$

Ans (4)

14. The work function of a photo sensitive metal is 3.31 eV. The threshold frequency is

1) 8×10^{10} Hz

2) 5×10^{36} Hz

3) 8×10^{14} Hz

4) 6×10^{10} Hz

given work function = 3.31eV

$$\vartheta_0 = \frac{3.31eV}{h} = \frac{3.31X1.6X10^{-19}}{6.62X10^{-34}} = 0.8X10^{15}$$

Ans (3)

15. When a photon stimulates the emission of another photon, the two photons have

1)same energy but different phase and wavelength
2)same energy, phase & wavelength
3)same phase but different energy & wavelength
4)energy, phase and wavelength all are different

same energy, phase and wavelength

Ans (2)

16. An atom has jumped from higher energy state to lower energy state on its own. This process is called

1)stimulated emission
2)stimulated absorption
3)spontaneous emission
4)spontaneous absorption

spontaneous emission

Ans (3)

17. The speed of an electron in the orbit of hydrogen atom in its ground state is

1) $\frac{c}{137}$

2) $\frac{3c}{2}$

3) $\frac{c}{2}$

4) $\frac{c}{10}$

we have

velocity in the first orbit

$= 2 \text{ X } 10^{6} \text{ ms}^{-1}$

Speed of light $= 3 \text{ X } 10^{8} \text{ ms}^{-1}$

Therefore C/137

Ans (1)

18. A photon of frequency 'ν' has a momentum associated with it. If 'c' is the speed of photon the momentum is

1) $\frac{h\nu}{c^2}$

2) $\frac{h\nu}{c}$

3) $\frac{\nu}{c}$

4) $h\nu c$

momentum = p = mc $E=mc^2$

$$p = \frac{E}{c} = \frac{h\vartheta}{c}$$

Ans (2)

19. Of the following transitions in hydrogen atom the one which gives the absorption line of higher frequency is

1) n=3 to n=8
2) n=2 to n=1
3) n=8 to n=3
4) n=1 to n=2

To get absorption line transition should be from lower energy level to higher energy level

Here we have two options, 1→2 and 3→8

To get higher frequency line the transition should be from 1→2

Ans (4)

20. The de-Broglie wavelength of a particle of mass $6.625X10^{-30}$kg travelling with a speed of 10^5 ms^{-1} is

1)10 nm

2)1 nm

3)100 nm

4)0.1 nm

given mass $m = 6.625 \times 10^{-30}$ Kg

$v = 10^{5}\ ms^{-1}$

$$\lambda = \frac{h}{mv} = \frac{6.625\ X10^{-34}}{6.625\ X\ 10^{-30}\ X\ 10^{5}} = 10^{-9}m$$

Ans (2)

21. Stimulated emission means

1) An atom jumps to higher energy state by the absorption of photon

2) An atom from higher energy state comes to lower energy state on its own

3) An atom from metastable state comes to lower energy state when a photon of suitable energy incident on it.

4) An atom absorbs energy from the neighboring atom and goes to metastable state.

An atom from metastable state comes to lower energy state when a photon of suitable energy incident on it

Ans (3)

22. The value of e/m determined by Dunnington is

1) $1.75X10^{11}$ Ckg^{-1}

2) $1.75X10^{19}$ Ckg^{-1}

3) $1.75X10^{11}$ kg C^{-1}

4) $1.75X10^{15}$ kgC^{-1}

$$\frac{e}{m} = \frac{1.6\ X\ 10^{-19}}{9.1\ X\ 10^{-31}} = 10^{11}$$

Ans (1)

23. When ultra-voilet light is incident on a photocell, the stopping potential required is v, and kinetic energy of photoelectrons is k.If the same photo cell is illuminated by X-rays then

1)both v & K decreases
2)v increases but k decreases
3)v decreases but k increases
4)both v & K increases

frequency of X-rays is greater than u-v rays and hence energy.
stopping potential and kinetic energy depends on frequency of incident radiation. Hence both v & k increases

Ans (4)

24. In a laser tube all the photons

1) have same wavelength

2) have same energy

3) move in same direction

4) move with same speed

all of them are photons, so they move with same speed

Ans (4)

25. An electron revolves $1.6X10^{15}$ times per second in a circular orbit. The current in the loop is

1) $2.56X10^{-5}$ A

2) $25.6X10^{-5}$A

3) $1.6X10^{-5}$A

4) 2.56mA

$$I = \frac{dq}{dt} = \frac{1.6\ X\ 10^{-19}}{1/1.6\ X\ 10^{15}}$$

$$= 1.6\ X\ 1.6\ X\ 10^{-4} = 2.56\ X\ 10^{-4}$$

Ans (2)

26. An electron jumps from n=4 to n=2 state of hydrogen atom. If Rydberg constant is 10^7 the frequency in Hz is

1) $\frac{3}{16}X10^{15}$

2) $\frac{3}{16}X10^{7}$

3) $\frac{9}{16}X10^{15}$

4) $\frac{9}{16}X10^{7}$

$$\bar{\vartheta} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right)$$

$$= 10^7\left(\frac{1}{4} - \frac{1}{16}\right) = 10^7 X \frac{3}{16} = \frac{1}{\lambda}$$

$$\vartheta = \frac{c}{\lambda} = 10^7 X \frac{3}{16}\ X3\ X\ 10^8 = \frac{9}{16} X 10^{15}$$

Ans (3)

27. When a monochromatic point source of light is at a distance of 0.2 m from a photocell, the cut-off voltage is 0.6V. If the same source is placed 0.6m away from the photocell the stopping potential is

1)0.2V 2)0.6V 3)0.1V 4)0.3V

stopping potential depends on the frequency of the incident radiation not on the intensity of the incident radiation

Ans (2)

28. A composite light is used in an experiment of photo electric effect. The stopping potential

1)depends on the mean wavelength

2)depends on the longest wavelength

3)does not depend on the wavelength

4)depends on the shortest wavelength

shortest wavelength

Ans (4)

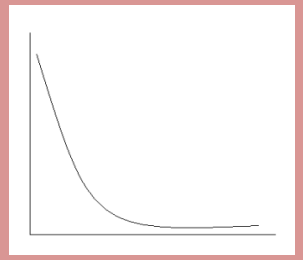
29. In ruby laser highly directional property of laser is obtained using

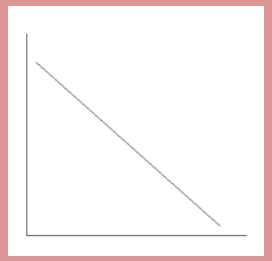
1)xenon flash lamp
2)the reflecting mirrors on either side
3)external battery
4)a specific composition of lasing material

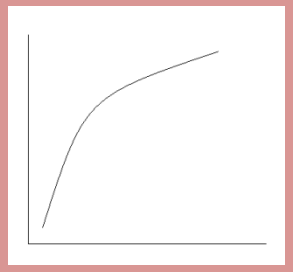
the reflecting mirrors on either side

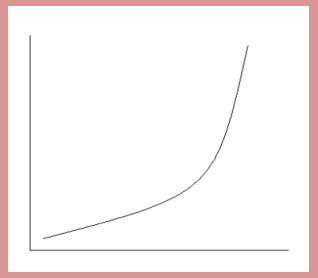
Ans (2)

30. Which of the following curves represent the speed of the electron in hydrogen atom as a function of principal quantum number?

1) 

2) 

3) 

4) 

Speed = velocity is inversely proportional to n

Ans (1)

Velocity decreases with increase in n but not linear