CET - II PUC: PHYSICS: ATOMIC PHYSICS -1

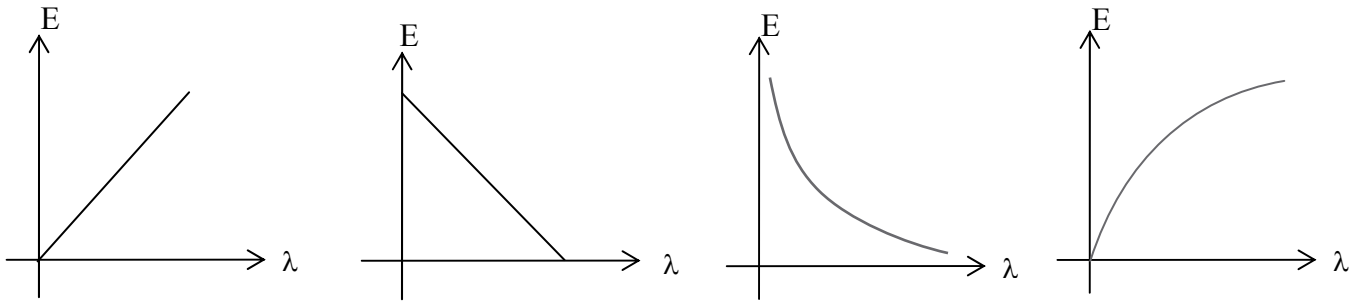
INTRODUCTION TO ATOMIC PHYSICS, PHOTOELECTRIC EFFECT DUAL NATURE OF MATTER, BOHR'S ATOM MODEL SCATTERING OF LIGHT and LASERS

QUESTIONS

1) Which of the following statements are correct?
   a) Electromagnetic waves can have wavelengths of several kilometres.
   b) High energy gamma rays travel at a higher speed than lower energy ones in free space.
   c) X-rays are transverse waves.
   d) An electromagnetic wave can penetrate matter.
   1) (a), (b) and (c) 2)(b), (c) and (d) 3) (a), (c) and (d) 4)(a), (b) and (d)

2) Given that the mass of neutron or proton is approximately 1840 times the mass of electron, then the ratio of specific charge of electron to that of α-particle is
   1) 1840 2)3680 3) $\frac{1}{1840}$ 4) $\frac{1}{3680}$

3) Of the following the graph which represents the variation of Energy (E) of the photon with the wavelength (λ) is



1) 2) 3) 4)

4) Match the following:

List – 1		List – 2	
a)	Burning candle	i)	Line absorption spectrum
b)	Sodium vapour lamp	ii)	Continuous emission spectrum
c)	Sun	iii)	Band emission spectrum
d)	Bunsen flame	iv)	Line emission spectrum

   1) a – iii, b – i, c – iv, d – ii 2) a – iv, b – ii, c – i, d –iii
   3) a – ii, b – iii, c – i, d – iv 4) a – ii, b – iv, c – i, d – iii

5) The kinetic energy of the photoelectron increases by 0.5 eV when the wavelength of incident light is changed from 500nm to another wavelength which is nearly
   1) 400 nm 2) 700 nm 3)1000 nm 4) 1250 nm

6) Light photons of energies 1 eV and 2.5 eV are successively incident on a metal surface of work function 0.5 eV, then the ratio maximum velocities of the emitted electrons will be
1) 1 : 5 2)1 : 4 3)1 : 3 4) 1 : 2

7) When UV light of wavelength 100 nm is incident on silver surface of work function 4.7eV, a negative potential of 7.7V is required to stop the photoelectrons from reaching the collector plate. The potential which is required to stop the photoelectrons when light of wavelength 200nm is incident on it will be
1) 1.5V 2) 3V 3)4.5V 4) 6V

8) When a monochromatic point source of light is at a distance of 1.50 m from a photoelectric cell, the cut-off voltage and the saturation current are respectively 2V and 20 μA. If the same source is placed 75cm away from the photoelectric cell, then
1) The stopping potential will be 2V and saturation current will be 80 μA
2) The stopping potential will be 4V andsaturation current will be 80 μA
3) The stopping potential will be 2V and saturation current will be 40 μA
4) The stopping potential will be 4V andsaturation current will be 40 μA

9) If E is the energy, de-Broglie wavelength is proportional to
1) E^{-1} for both photons and particles 2) E^{-1} for photons and $E^{-1/2}$ particles
3) $E^{-1/2}$ for both photons and particles 4) $E^{-1/2}$ for photons and E^{-1} for particles

10) The resolving power of an electron microscope at 10 kV is R. The potential increased to 90 kV. The new resolving power will be
1) R 2) 3R 3) R/3 4) 9R

11) For given kinetic energy which of the following has the smallest de-Broglie wavelength?
1) Electron 2)Proton 3)Neutron 4) alpha particle

12) The ionization energy of electron in the hydrogen 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
1) n = 2 to n =1 2)n = 3 to n = 1 3)n = 3 to n = 2 4) n = 4 to n =3

13) Hydrogen atom emits blue light when an electron jumps from n = 4 to n = 2 energy level. The colour of light emitted by the atom when the electron jumps from n = 15 to n = 2 energy level is
1) red 2) yellow 3) green 4) violet

14) Force acting on an electron in a Bohr orbit with principal quantum number n is proportional to
1) n 2)n^2 3) n^4 4) $1/n^4$

15) The kinetic energy of the orbiting electron in the hydrogen atom is E, then the potential energy and the total energy with proper sign are respectively
1) – E, 2E 2) – 2E, E 3) E, 2E 4) –2E, –E

16) The orbital radius of the electron in the hydrogen atom changes from r to 4r, then the energy of the orbital electron change from E to
1) E/4 2) E/2 3) 2E 4) 4E

17) When hydrogen atom is excited state, emits a photon of energy 12.1 eV when it makes a transition to a ground state, its orbital angular momentum changes by
1) 1.05×10^{-34}Js 2)2.11×10^{-34}Js 3) 3.16×10^{-34}Js 4)4.22×10^{-34}Js

18) How many times does the electron go around the first Bohr orbit in one second?

1) $\frac{4\pi^2 mr^2}{h}$ 2) $\frac{h}{4\pi^2 mr^2}$ 3) $\frac{h}{2\pi mr}$ 4) $\frac{2\pi mr}{h}$

19) Angular momentum of an electron in an orbit of H atom is proportional to

1) r 2) $\frac{1}{r}$ 3) $\sqrt{r}$ 4) $\frac{1}{\sqrt{r}}$

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

1)$\lambda_3 = \lambda_1 + \lambda_2$ 2) $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$ 3)$\lambda_1 + \lambda_2 + \lambda_3 = 0$ 4) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

21) If λ_1, λ and λ_2 are the wavelengths of stokes lines, incident light and anti-stokes lines respectively then

1) $\lambda_1 = \lambda = \lambda_2$ 2)$\lambda_1 < \lambda < \lambda_2$ 3)$\lambda_1 > \lambda > \lambda_2$ 4) $\lambda_1 < \lambda_2 < \lambda$

22) Check the incorrect statements on scattering of light.

1) Blue colour of sky is due to Rayleigh scattering

2) In Rayleigh scattering intensity of scattered light is proportional to $1/\lambda^4$

3) Clouds having droplets of water, which scatter all the wavelengths almost equal, so they are generally white.

4) The sun looks reddish at sunset and sunrise due to Tyndall scattering.

23) A composite beam of light containing wavelengths 440nm and 550nm is passed through a gas, in a given direction , the ratio of the intensity of scattered light of those wavelengths will be

1) 16 : 25 2) 25 : 16 3)256 : 625 4) 625 : 256

24) Consider the statements. A laser beam (a) is highly monochromatic (b) has angular divergence (c) is an electromagnetic wave (d) cannot be used in optical communication.

1) (a) (b) and (c) are correct 2) (a) (c) and (d) are correct

3) (a) and (c) are incorrect 4) (b) and (d) are incorrect

25) Which of the following statement is WRONG with respect to Ruby laser?

1)It is developed by T. Maiman. 2)The wavelength of light emitted by it is 694.3nm.

3) It is a continuous laser**.** 4) It is a three level laser.

26) The technique to measure large distances using lasers is known as

1) LIDAR 2) RADAR 3) SONAR 4) both (2) and (3)

27) Light of wavelength 300nm is incident on a surface of area 4 cm^2. If the intensity of light is 150mW/m^2, then rate at which photons strike the target (per second) is

1) 7×10^5 2)9×10^{13} 3)3×10^{10} 4) 6×10^{19}

28) An X–ray photon has a wavelength of 0.02 Å. Its momentum is

1) 3.3×10^{-22} kg m/s 2) 6.6×10^{-21} kg m/s

3) 6.6×10^{-24} kg m/s 4) 1.65×10^{22} kg m/s

29) Which one is the correct about the electromagnetic waves in free space?

1) Electric and magnetic fields have a phase difference of $\pi/2$.

2) The speed of the wave is c = B/E.

3) Energy distribution of electric and magnetic fields are unequal.
4) Electromagnetic waves transport both energy and momentum.

30) The maximum velocity of photoelectrons emitted by a photo emitter is 7×10^5 m/s. If the specific charge of an electron is 1.75×10^{11} C/kg, stopping potential of the emitter is
1) 0.7 V 2) 1.4 V 3)2.8 V 4) 3.5 V

31) If the velocity of a particle is reduced to one-third then the percentage increase in its de-Broglie wavelength is
1) 50% 2) 100% 3) 200% 4) 300%

32) A proton and an α-particle are accelerated through the same p.d.. The ratio of their de-Broglie wavelengths is
1) 1 2) 2 3) $\sqrt{8}$ 4) $1/\sqrt{8}$

33) Energy required for the electron excitation in Li^{++} from first orbit to third orbit is
1) 12.1 eV 2)36.3 eV 3)108.8 eV 4) 122.4 eV

34) Pick out the wrong statement from the following:
1) As observed in spectrographs of high resolving power the H_α, H_β and H_γ lines are not single lines
2) According to Sommerfeld, the path of an electron around the nucleus is an ellipse
3) The speed of the electron moving in an elliptical orbit is a constant
4) The principal quantum number n takes integral values from 1 to ∞

35) Rayleigh scattering law is not applicable to
1) Water molecules 2)Gas molecules
3) Particles very small compared to wavelength of light 4) large dust particles

36) The material used in Ruby lasers is
1) Naturally occurring Ruby 2) Amorphous Al_2O_3
3) Crystalline Al_2O_3 doped with chromium 4) Chromium crystal doped withaluminium

37) Choose the WRONG statement out of the following.
1) X–rays are used in of study of crystal structure.
2) Like visible light, X–rays are diffracted at anobstacle.
3) X–rays can cause ionization of the atoms of a gases.
4) X–rays are deflected by electric and magnetic fields.

38) Which of the following is not correct regarding the photon?
1) $\nu = E/h$ 2) Momentum of photon = h/λ 3) Mass of photon = $h/c\lambda$ 4) $\lambda = \nu/c$

39) If photons of wavelength 60nm are incident on hydrogen, then the maximum kinetic energy of emitted electrons will be
1) 3 eV 2) 5 eV 3)7eV 4) 9 eV

40) The work function of a surface of a photosensitive material is 6.2eV. The wavelength of the incident radiation for which the stopping potential is 5V lies in the
1) Infra-red 2) Visible light 3)Ultraviolet light 4) X-ray

41) The kinetic energies of photoelectrons emitted from a metal are K_1 and K_2 when it is irradiated with lights of wavelength λ_1 and λ_2 respectively. The work function of the metal is
1) $\frac{K_1\lambda_1 - K_2\lambda_2}{\lambda_2 - \lambda_1}$ 2) $\frac{K_1\lambda_1 + K_2\lambda_2}{\lambda_2 + \lambda_1}$ 3) $\frac{K_1\lambda_2 - K_2\lambda_1}{\lambda_2 - \lambda_1}$ 4) $\frac{K_1\lambda_2 + K_2\lambda_1}{\lambda_2 + \lambda_1}$

42) In Sommerfeld's atomic model corresponding to principal quantum number n = 3, there will be
1) 3 circular orbits 2) 3 elliptical orbits
3)1 circular and 2 elliptical orbits 4) 2 circular and 1 elliptical orbits

43) Consider the spectral line resulting in the transition from n = 2 to n = 1, in atoms / ions given below. The highest frequency radiation is emitted by
1) Hydrogen atom 2)Deuterium atom 3)Singly ionized helium 4) Doubly ionized lithium

44) In which of the following systems will the radius of the first orbit (n = 1) be minimum?
1) Hydrogen atom 2)Deuterium atom 3)Singly ionized helium 4) Doubly ionized lithium

45) The wavelength of the matter waves is independent of
1) mass 2)velocity 3)momentum 4) charge

46) A photon of energy 9 eV is incident on a surface whose threshold frequency is 1.6×10^{15} Hz. The kinetic energy of the emitted electrons is
1) 2.37 eV 2)7.4 eV 3)9 eV 4) 10.6 eV

47) The momentum of a neutron of de-Broglie wavelength 0.1 nm is
1) 6.6×10^{-24} kg ms^{-1} 2)6.6×10^{-14} kg ms^{-1} 3)6.6×10^{-34} kg ms^{-1} 4) 6.6×10^{-4} kg ms^{-1}

Additional Questions:

INTRODUCTION TO ATOMIC PHYSICS

1) Infrared rays are used in long distance photography because
1) They travel with the velocity of light in vacuum.
2) They can be easily produced.
3) Due to their long wavelength, scattering is low.
4) Due to their small wavelength, scattering is high.

2) An electromagnetic radiation has energy of 13.2keV. Then the radiation belongs to the region of
1) Infra-red 2) Visible light 3)Ultraviolet light 4) X-ray

3) Flash spectrum that occurs at a total solar eclipse is
1) Line absorption spectrum 2)Line emission spectrum
3)Band emission spectrum 4)Band absorption spectrum

4) Band spectrum is obtained whenever the incandescent vapour of the excited substance is in
1) Atomic state 2)Molecular state 3)Ionised state 4)Atomicor Molecular state

5) A radio transmitter radiates 0.1kW power at a wavelength 198.6 nm. The number of photons emitted per second by it is
1) 10^{10} 2)10^{20} 3)10^{30} 4)10^{40}

6) Consider the following statements about electromagnetic waves and choose the correct ones.
A) EM waves having wavelength 1000 times smaller than visible light waves are called X-rays.
B) Ultraviolet waves are used sterilization of water and surgical equipment's.

C) de-Broglie waves are electromagnetic in nature.

D) Electromagnetic wavesexhibit polarization while sound waves do not.

1) (A), (B) and (C) 2)(A), (B) and (D)3) (B), (C) and (D) 4)(A), (C) and (D)

7) The ratio of specific charge of the electron and nucleus of hydrogen atom is nearly
1) 1 2) 2 3) 4 4) 1836

8) Identify the correct arrangement of electromagnetic radiations in ascending order of frequency.

1)γ- rays, X- rays, Visible light, radio waves.

2) Ultraviolet rays, visible light, X-rays, Infra-red rays.

3) Radio waves, micro waves, visible light, UV rays.

4) Infra-red rays, UV rays, γ- rays, X- rays.

9) In determining specific charge of electrons by Dunnington, electrons are made to negotiate a circular path by
1) Electric field only 3) Both electric and magnetic fields in the same directions
2) Magnetic field only 4) Mutually perpendicular electric and magnetic fields

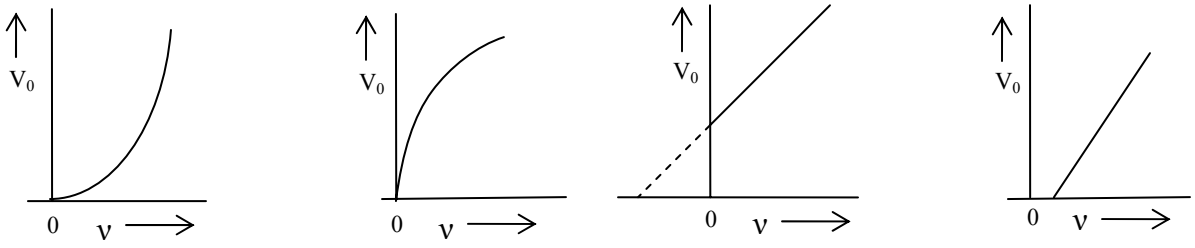
PHOTOELECTRIC EFFECT

1) Photons with energies twice and ten times the work function of a metal are incident successively on a metal. The ratio of the maximum energies of the photoelectrons emitted in the two cases is respectively
1) 1 : 5 2)5 : 1 3)1 : 3 4)1 : 9

2) Work function for copper is 4.4 eV. The potential difference that must be applied to stop the fastest electrons released when light of wavelength 100 nm is incident is
1) 4 V 2)8 V 3)16 V 4)20 V

3) On plotting frequency of incident radiation along X axis and stopping potential along Y axis, a straight line is obtained. Its slope is
1) h/e 2)e/h 3) h 4)1/h

4) For a photoelectric cell, the graph in Fig. showing the variation of the cut-off voltage V_0 with frequency (v) of incident light is



1) 2) 3) 4)

5) A photosensitive metal is incident with radiations of wavelength 400 nm and then with radiations of wavelength 800 nm. What will be the difference in the maximum energy of the photoelectrons
1) 0.5 eV 2)1 eV 3)1.5 eV 4) 2 eV

6) Monochromatic light of frequency ν_1 irradiates a photocell and the stopping potential is found to be V_1. What is the new stopping potential of the cell if it is irradiated by monochromatic light of frequency ν_2 ?

1) $V_1 + \frac{h}{e}(\nu_2 - \nu_1)$ 2) $V_1 - \frac{h}{e}(\nu_2 - \nu_1)$ 3) $V_1 + \frac{h}{e}(\nu_1 + \nu_2)$ 4) $V_1 - \frac{h}{e}(\nu_1 + \nu_2)$

7) When radiation of wavelengthλ is incident on a metallic surface, the stopping potential is 4.8V. If the same surface is illuminated with radiation of double the wavelength, then the stopping potential becomes 1.6 V. Then the threshold wavelength for the surface is

1) 2λ 2) 4λ 3)6λ 4) 8λ

DUAL NATURE OF MATTER

1) If the kinetic energy of a particle is reduced to one-fourth then the percentage increase in the de-Broglie wavelength is

1) 41% 2)100% 3)144% 4) 200%

2) If E_1, E_2 and E_3 are the respective kinetic energies of an electron, an alpha particle and a proton each having the same de-Broglie wavelength then

1) $E_1 > E_3 > E_2$ 2)$E_2 > E_3 > E_1$ 3)$E_1 > E_2 > E_3$ 4)$E_1 = E_2 = E_3$

3) Wavelength of a γ- ray photon whose energy is half the rest mass energy of an electron is

1) 5×10^{-12} m 2)5×10^{-8} m 3)7×10^{-12} m 4)7×10^{-2} m

4) A marble of mass 30g is moving with a speed of 180 kmph. The de-Broglie wavelength associated with is nearly

1) 10 m 2)10^{-10} m 3)4×10^{-34} Å 4)4×10^{-24} Å

5) Choose the only correct statement out of the following.

1) only a charged particle in motion is accompanied by matter waves
2) only subatomic particles in motion are accompanied by matter waves
3) any particle in motion, whether charged or uncharged, is accompanied by matter waves
4) no particle, whether at rest or in motion, is ever accompanied by matter waves

6) The de-Broglie wavelength associated with an electron when it is accelerated through a p.d. of 40 kV is

1) 0.614 pm 2)6.14 pm 3)61.4 Å 4) 0.0614 pm

7) The de-Broglie wavelength of a particle moving with velocity 10^8 m/s is equal to the wavelength of a photon. The ratio of kinetic energy of the particle to the energy of the photon is

1) 1/8 2) 1/6 3)¼ 4) ½

8) Electrons used in an electron microscope are accelerated by a voltage of 25kV. If the voltage is increased to 100kV then the de-Broglie wavelength associated with the electrons would

1) increases to 2 times 2) increases to 4 times3)decreases by 2 times4)decreases by 4 times

9) Electrons behave like waves in G.P. Thomson experiment because they

1) Ionize the gas 2) Are affected by electric field

3) Are deflected by magnetic field 4) Diffracted by a crystal

10) Wave nature of matter is revealed by

1) Photoelectric effect 2) Raman effect 3) Electron diffraction 4) Compton effect

11) The de-Broglie wavelength of electron is 0.5nm, the retarding potential to stop it is

1) 2V 2) 3V 3)4V 4) 6V

12) The momentum of electron having de-Broglie wavelength100Å is

1) 6.6×10^{-32}g cm/s 2) 6.6×10^{-25}g cm/s 3)6.6×10^{-21}g cm/s 4) 6.6×10^{-29}g cm/s

13) Electron microscope works on the principle of

1) Particle nature of electron 2) Wave nature of electron

3) Wave nature of light 4) Quantum nature of light

BOHR'S ATOM MODEL

1) The ratio of kinetic energy of the n = 2 state electron for the hydrogen atom to that of He^+ ion is

1) 1 2) 2 3)½ 4) ¼

2) An electron in a hydrogen atom has moved from n =1 to n = 5 orbit, then

1) Both potential energy and kinetic energyof the system increases.

2)Both potential energy and kinetic energy of the system decreases.

3)Potential energy of the system decreases and kinetic energy of the system increases.

4) Potential energy of the system increases and kinetic energy of the system decreases.

3) In case of hydrogen atom the ratio of energy difference between second orbit and third orbit to the energy difference between the first orbit and the second orbit is

1) 9/4 2)4/9 3)5/27 4) 27/5

4) The minimum required to strip off energy of 10 times ionized sodium atom (Z = 11) of its last electron is

1) 13.6eV 2)13.6× 11eV 3) 13.6×11^2eV 4)(13.6/11) eV

5) The de-Broglie wavelength of the electron in the first excited state of the hydrogen atom is nearly

1) 0.53Å 2)1.67 Å 3)3.33 Å 4) 6.66 Å

6) The transition of the electron from n = 4 to n =3 in a hydrogen like atom results in UV radiation. Infra-red radiation will be obtained in the transition

1) n = 2 to n =1 2)n = 3 to n =2 3)n = 4 to n =2 4) n = 5 to n =4

7) The ionization potential of hydrogen atom is 13.6 V. Hydrogen atoms in the ground state are excited by electromagnetic radiation of energy 12.75eV. How many spectral lines will be emitted by the hydrogen atom?
1) 1 2) 2 3)3 4) 6

8) Fine structure of spectral lines is accounted in Sommerfield atom model by considering
1) Elliptical orbits around the nucleus 2) Spin of electron
3)Relativistic change in mass of electron in elliptical orbits 4) Space quantisation of orbits

9) The area of the electron orbit for the ground state of H-atom is A. The area when it is in the first excited state is
1) 2A 2)4A 3)8A 4) 16A

10) The ionization potential of hydrogen atom is 13.6V. The energy needed to be supplied to ionize hydrogen atom in the first excited state.
1) 13.6 eV 2)3.4 eV 3)6.8 eV 4) 27.2 eV

11) An electron jumps from first excited state to ground state of hydrogen atom, then the percentage change in speed of electron
1) 25% 2) 50% 3) 100% 4) 200%

12) An electron jumps from the 4^{th} orbit to 2^{nd} orbit of hydrogen atom.Giventhe Rydberg's constant $R = 10^5 cm^{-1}$, the frequency (in Hz) of emitted radiation will be

1) $\frac{3}{16}\times 10^5$ 2) $\frac{3}{16}\times 10^{15}$ 3) $\frac{9}{16}\times 10^{15}$ 4) $\frac{3}{4}\times 10^{15}$

SCATTERING OF LIGHT

1) Raman effect is explained on the basis of
1) Corpuscular theory of light 2) Wavetheory of light
3) Electromagnetic theory of light 4) Quantum theory of light.

2) Pick out the incorrect statement from the following
1) Stokes lines have wavelengths greater than that of the incident light
2) Stokes lines are more intense than the anti-stokes lines
3) The intensity of stokes lines is found to depend on temperature
4) Stokes and anti-stokes lines are polarized.

3) The blue colour of the sky is due to the fact that
1) Red light is absorbed 2) Blue light is preferentially absorbed
3) Blue light is preferentially scattered 4) Blue is the natural colour of the sky

4) In a given direction, the intensities of scattered light substance for two beams of light are in the ratio 81: 16. The ratio of frequency of the first beam to the frequency of the second beam is
1) 3:2 2) 2:3 3) 9:4 4)4:9

LASERS

1) Average life time of metastable state is
   1) 10^{-3}s 2)10^{-8}s 3)10^{-14}s 4) 10^{-20}s
2) The output of Ruby Laser is pulsed because
   1)Ruby rod gets heated. 2) Stimulated emission is delayed.
   3) Optical pumping cannot be continuous.
   4) Stimulated emission occurs faster than population inversion.
3) The red colour of Ruby laser light is due to electron transition between energy levels of
   1) Aluminium 2)Oxygen 3) Chromium 4) All of these
4) The most relevant property involved in the cutting of metals by a laser beam is
   1) Monochromaticity 2) Coherence 3)Directionality 4) Sharp focus
5) If r_a = rate of absorption, r_b = rate of spontaneous emission and r_c = rate of stimulated emission, then for Laser action the condition to be satisfied is
   1) $r_b > r_a$ 2)$r_c > r_a$ 3)$r_c > r_b$ 4) both (2) and (3)
6) Photonics is concerned with
   1) Lasers 2) Fibre optics 3) Optical computing 4) All these
7) In Ruby laser stimulated emission is due to transition from
   1) One excited state to lower excited state 2) metastable state to a certain lower state
   3) metastable to an excited state 4) metastable state to ground state only
8) Ruby laser belongs to the class of
   1) Solid state lasers 2) Gas lasers 3) Liquid lasers 4) Semiconductor diode laser