PHYSICS
PART - IV
TOPIC: OPTICS & MODERN PHYSICS
EXERCISE # 01

801. A regular hexagonal lamina of side a made up of perfectly absorbing material is kept in a region where a parallel beam of light with intensity I having a large aperture falls on it. If the area normal of the hexagon makes an angle of 30° with the beam then the force experienced by the hexagon will be (c is the velocity of light)

(A) $\frac{5a^2I}{4c}$ (B) $\frac{9a^2I}{4c}$ (C) $\frac{a^2I}{c}$ (D) $\frac{6a^2I}{c}$

802. If an endoergic nuclear reaction is brought about by bombarding a stationary nucleus with a projectile then

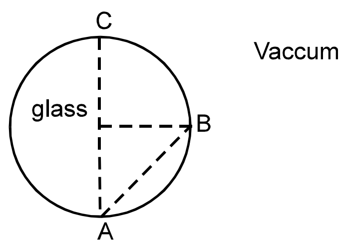
(A) Kinetic energy of the projectile must be equal to the magnitude of Q-value of the reaction

(B) Kinetic energy of the projectile must be less than the magnitude of the Q-value of the reaction

(C) The kinetic energy of the projectile must be more than the magnitude of Q-value of the reaction

(D) The momentum will not be conserved in such a nuclear reaction

803. It is found that all electromagnetic signals sent from A towards B reach point C inside the glass sphere, as shown. The speed of electromagnetic signals in glass can not be



(A) 1.0×10^8 m/s (B) 2.4×10^8 m/s (C) 2×10^7 m/s (D) 4×10^7 m/s

$\therefore$ only (B) is not possible.

804. The energy that should be added to an electron, to reduce its debroglie wavelength from 2×10^{-9} m to 0.5×10^{-9} m will be :

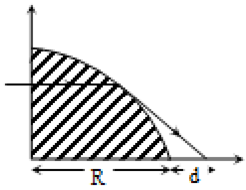
(A) 1.1 MeV (B) 0.56 MeV (C) 0.56 KeV (D) 5.6 eV

805. Hydrogen (H), deuterium (D), singly ionised helium $(He)^+$ and doubly ionised (Li^{++}) all have one electron round the nucleus. Consider n = 2 to n = 1 transition. The wavelength of emitted radiations are λ_1, λ_2, λ_3 and λ_4 respectively. Then approximately

(A) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$ (B) $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$

(C) $\lambda_1 = 2\lambda_2 = 2\sqrt{2}\lambda_3 = 3\sqrt{2}\lambda_4$ (D) $\lambda_1 = {}_2 = 2\lambda_3 = 3\lambda_4$

806. A uniform horizontal light beam is incident upon a prisms (quarter cylindrical shape) as shown in the figure. The radius of the prism is R and the cylinder material has a refractive index $2/\sqrt{3}$. A patch on the table for a distance d from the surface of the cylinder is unilluminated. Find the value of d in terms of R.



(A) R/2 (B)R (C) $\sqrt{3}$ R (D) 2R

807. In Young's double slit experiment the slits are 0.5 mm apart and interference is observed on a screen placed at a distance of 100 cm from the slits. It is found that the 9^{th} bright fringe is at a distance of 9.0 mm from the second dark fringe. Find the wavelength of light used in the experiment

(A) 8000 Å (B) 6000 Å (C) 4000 Å (D) 2000 Å

808. The following data are given for a crown glass prism ;
refractive index for violet light $n_v = 1.521$
refractive index for red light $n_r = 1.510$
refractive index for yellow light $n_y = 1.550$
Dispersive power of a parallel glass slab made of the same material is :

(A) 0.01 (B) 0.02 (C) 0.03 (D) 0

809. Three convex lens L_1, L_2, L_3 have the same radius of curvature but their r.i. are $\mu_1 = 1.2$, $\mu_2 = 1.4$, $\mu_3 = 1.6$. The ratio of their focal length $f_1 : f_2 : f_3$, when placed in air, is:

(A) 1 : 2 : 3 (B) 3 : 2 : 1 (C) 6 : 3 : 2 (D) 2 : 3 : 6

810. A fraction f_1 of a radioactive sample decays in one mean life, and a fraction f_2 decay in one half life

(A) $f_1 > f_2$

(B) $f_1 < f_2$

(C) $f_1 = f_2$

(D) may be A, B, C depending on the values of the man life and half life.

811. A photon of energy 12.1 eV corresponds to light of wave length λ_0. Due to an electron from n = 3 to n =1 in a hydrogen atom, light of wavelength λ is emitted. If we take in to account the recoil of the atom when the photon is emitted

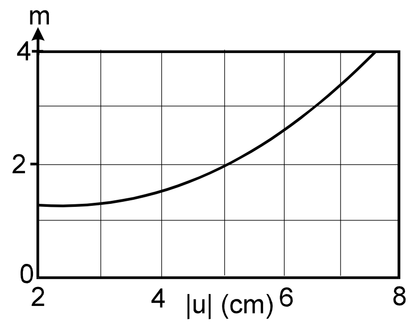
(A) $\lambda = \lambda_0$

(B) $\lambda < \lambda_0$

(C) $\lambda > \lambda_0$

(D) the data is not sufficient to reach a conclusion.

812. An object kept on the principal axis and infront of a spherical mirror, is moved along the axis itself. Its lateral magnification m is measured, and plotted versus object distance |u| for a range of u, as shown below :



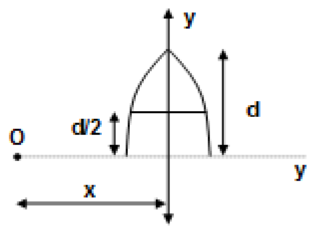
The magnification of the object when it is placed at a distance 20 cm in front of the mirror, is

(A) – 1 (B) 1 (C) 8 (D) 20

813. The refractive index of the material of the lens (see the figure) is given by

$\mu = \mu_0\left(1+\frac{y}{d}\right)$; for $0 \ll y \ll \frac{d}{2}$

$= \frac{3\mu_0}{2}$ for $\frac{d}{2} < y \leq d$, where μ_0 is a positive constant. The number images of a point object O formed by the lens is (assume $d \ll x$)

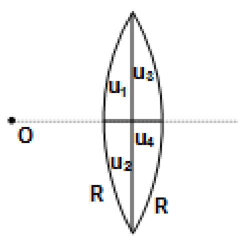


(A) 1 (B) 2 (C) 0 (D) ∞

814. The radioactive samples have decay constants λ_1 and λ_2 ($\lambda_1 > \lambda_2$). Let p_1 = probability that a particular nucleus in the first sample will decay and p_2 probability that a particular nucleus in the second sample will decay. Then

(A) $p_1 > p_2$ (B) $p_1 < p_2$ (C) $p_1 = p_2$ (D) $\frac{p_1}{p_2} = \frac{\lambda_1}{\lambda_2}$

815. A thin lens is made up of four different materials as shown. The number of images for a point object at O is (Given $\mu_1 + \mu_3 \neq \mu_2 + \mu_4$ and aperture is very small compared to the object distance.)



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

SECTION : (B) - More Than One Correct Options

816. It is desired to produce an achromatic combination of thin lenses having an effective focal length f in air. The two lenses to be used for the combination must have their dispersive powers ω_1 and ω_2 and focal lengths for yellow light as f_1 and f_2 respectively then:(An achromatic combination means that the combination must have same focal length for all the colours)

(A) $f_1 = \left(1 - \frac{\omega_1}{\omega_2}\right)f$ (B) $f_2 = \left(1 - \frac{\omega_2}{\omega_1}\right)f$ (C) $f_1 = \left(1 + \frac{\omega_2}{\omega_1}\right)f$ (D) $f_2 = \left(1 + \frac{\omega_1}{\omega_2}\right)f$

817. Which of the following statements are true about X-rays?

(A) They are deflected by electric field and magnetic field.

(B) They ionise the gas through which they pass.

(C) They exhibit polarization under special conditions.

(D) They travel with a speed of light.

818. When a hydrogen atom is excited from ground state to first excited state.

(A) its kinetic energy increases by 102 eV
(B) its kinetic energy decreases by 10.2 eV.
(C) its potential energy increases by 20.4 eV.
(D) its angular momentum increases by 1.05×10^{-34} J–s

819. A virtual image larger than the object can be formed by a

(A) Convex mirror (B) Concave mirror (C) Convex lens (D) concave lens

820. Mark the correct statement(s)

(A) To observe interference, two sources of slightly difference frequencies are required.

(B) To observe interference, two coherent sources of same frequency must be placed some distance apart from each other.

(C) To observe interference, two coherent sources must have same frequency and same amplitude.

(D) none of these

821. The penetrating power of X-rays increases with the

(A) increase in its frequency
(B) decreases in its frequency
(C) increase in its wavelength
(D) decreases in its wavelength

822. When an electron moving at a high speed strikes a metal surface, which of the following are possible?

(A) The entire energy of the electron may be converted into an x-ray photon.

(B) Any fraction of the energy of the electron may get converted to heat

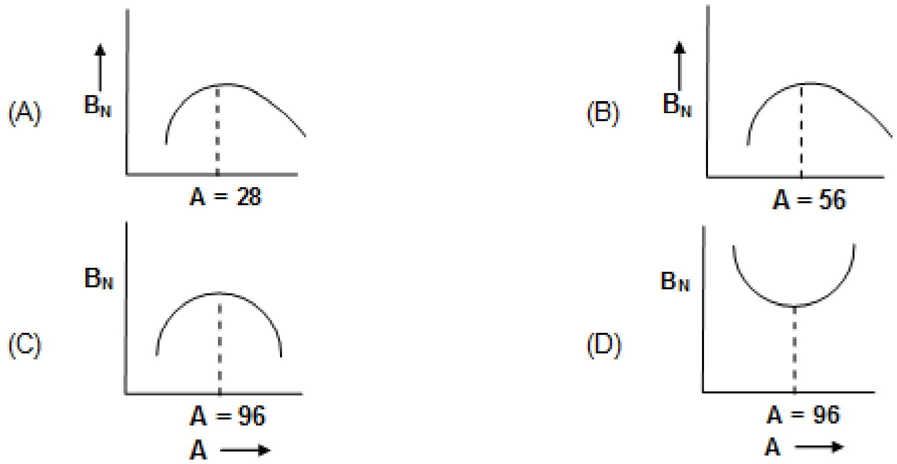
(C) The entire energy of the electron may get converted to heat

(D) The electron may undergo an elastic collision with the target metal

823. Let λ_{α}, λ_{β} and λ_{α}- denote the wavelength of x-rays of the k_{α}, k_{β} and L_{α} lines in the characteristic x-ray spectrum for a metal.

(A) $\lambda_{\alpha}^{'} > \lambda_{\beta} > \lambda_{\gamma}$ (B) $\lambda_{\alpha}^{'} > \lambda_{\alpha} > \lambda_{\gamma}$ (C) $\frac{1}{\lambda_{\alpha}} + \frac{1}{\lambda_{\beta}} = \frac{1}{\lambda_{\alpha}^{'}}$ (D) $\frac{1}{\lambda_{\beta}} + \frac{1}{\lambda_{\alpha}} = \frac{1}{\lambda_{\alpha}^{'}}$

824. The dependence of binding energy per nucleon, B_N, on the mass number A, is represented by



825. The electric field at a point in vacuum associated with light wave is given by $E = E_0 \sin \omega_1 t \sin \omega_2 t$. If this light is used in ejecting photoelectrons from a metal of work function ϕ, the maximum kinetic energy of the photoelectrons is

(A) $\frac{h\omega_1}{2\pi} - \phi$

(B) $\frac{h\omega_2}{2\pi} - \phi$

(C) $\frac{h(\omega_1 + \omega_2)}{2\pi} - \phi$

(D) not predictable as magnitudes of ω_1 and ω_2 are not known.

826. White light is used to illuminate the two slits in young double slit experiment. The separation between the slits is b and the screen is at a distance d (>>b) from the slits. Certain wavelengths are missing. Some of the missing wavelengths are.

(A) $\lambda = b^2/d$ (B) $\lambda = 2b^2/d$ (C) $\lambda = b^2/3d$ (D) $\lambda = 2b^2/d$

827. An electron with kinetic energy varying from 5 eV to 50 eV is incident on a hydrogen atom in its ground state. The collision

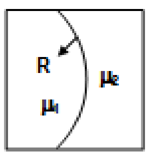
(A) May be elastic

(B) may be partially elastic

(C) must be completely inelastic

(D) from zero to 13.6 eV be elastic and more than 27.2 eV be inelastic

828. A plane glass plate behaves as a lens when made as shown in figure.



(A) For $\mu_1 = \mu_2$, it will behave as a glass slab

(B) For $\mu_1 > \mu_2$, it will behave as a divergent lens.

(C) For $\mu_1 < \mu_2$, it will behave as a convergent lens.

(D) for any value of μ_1 and μ_2 it behave as a lens

829. Photoelectric effect supports quantum nature of light because

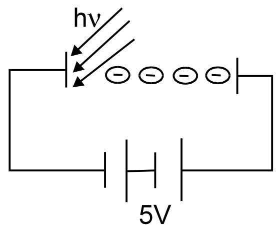
(A) there is a minimum frequency of light below which no photoelectrons are emitted

(B) the maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity

(C) even when the metal surface is faintly illuminated, the photoelectrons leave the surface immediately.

(D) electric charge of photoelectrons is quantised.

830. Photons of energy 5 eV are incident on cathode. Electrons reaching the anode have kinetic energies varying from 6eV to 8eV.



(A) Work function of the metal is 2 eV

(B) Work function of the metal is 3 eV

(C) Current in the circuit is equal to saturation value.

(D) Current in the circuit is less than saturation value.

831. Pick out the correct statement(s) :

(A) A moving electron in isolation cannot spontaneously change into an x-ray photon in free space.

(B) The optical spectrums in the visible region are not sensitive probe of nuclear charge as these involve transitions of outermost electrons for which effective inner charge is almost independent of the atomic number.

(C) In moseley's equation $\sqrt{\nu} = a(z-b)$, constant a has dimension of frequency equal to $\frac{1}{2}$.

(D) X-rays can produce photoelectric effect.

832. A sample of hydrogen atom gas contains 100 atoms. All the atoms are excited to the same n^{th} excited state. The total energy released by all the atoms is $\frac{4800}{49}$ Rch (where Rch = 13.6 eV), as they come to the ground state through various types of transitions.

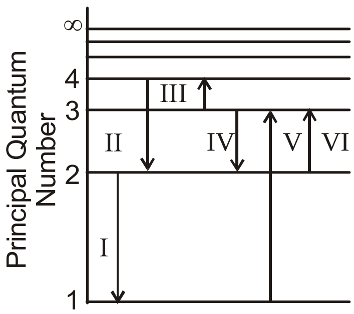
(A) Maximum energy of the emitted photon is $\frac{48}{49}$ Rch

(B) Initially atoms are in 6th excited state.

(C) Initially atoms are in 7th excited state.

(D) Maximum total number of photons that can be emitted by this sample is 100.

833. The figure above shows an energy level diagram for the hydrogen atom. Several transitions are marked as I, II, III, _______ . The diagram is only indicative and not to scale.



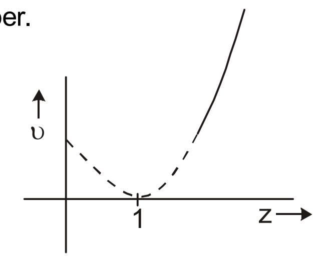
(A) The transition in which a Balmer series photon absorbed is VI.

(B) The wavelength of the radiation involved in transition II is 486 nm.

(C) IV transition will occur when a hydrogen atom is irradiated with radiation of wavelength 103nm.

(D) IV transition will emit the longest wavelength line in the visible portion of the hydrogen spectrum.

834. Figure shows the variation of frequency of a characteristic x-ray and atomic number.

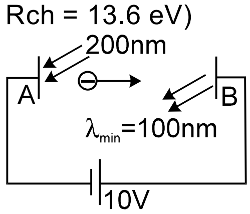


(A) The characteristic x-ray is K_α
(B) The characteristic x-ray is K_β
(C) The energy of photon emitted when this x-ray is emitted by a metal having z = 101 is 204 keV.
(D) The energy of photon emitted when this x-ray is emitted by a metal having z = 101 is 102 keV.

835. A single electron orbits a stationary nucleus of charge + Ze where Z is a constant and e is the magnitude of electronic charge. It releases 47.22 eV energy if it comes from the third orbit to second orbit. [Use ionization energy of hydrogen atom = 13.6 eV]
(A) The value of the Z is 5.
(B) The wavelength of electromagnetic radiation required to remove the electron from first orbit to infinity, is nearly 3653 pm.
(C) The radius of the first orbit is 10.6 pm.
(D) The angular momentum of the electron in first orbit is 1.05×10^{-34} J-s.

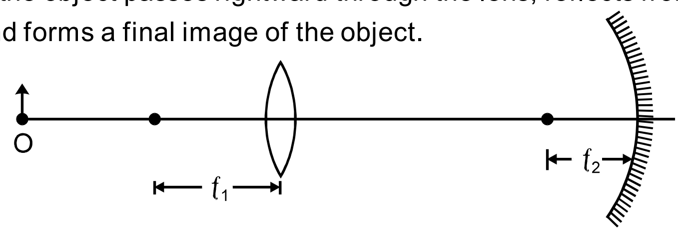
836. Two electrons starting from rest are accelerated by equal potential difference.
(A) they will have same kinetic energy
(B) they will have same linear momentum
(C) they will have same de Broglie wave length
(D) they will produce x-rays of same minimum wave length when they strike different targets.

837. In the figure shown electromagnetic radiations of wavelength 200nm are incident on the metallic plate A. The photo electrons are accelerated by a potential difference 10V. These electrons strike another metal plate B from which electromagnetic radiations are emitted. The minimum wavelength of the emitted photons is 100nm. (use hc = 12400 eVÅ, use Rch = 13.6 eV)



(A) Energy of incident photons is 6.2 eV.
(B) Maximum kinetic energy of ejected electrons from plate A is 2.4 eV
(C) Maximum kinetic energy of electrons striking plate B is 2.4 eV
(D) Work function of the metal A is 4.8 eV

838. An object is placed in front of a converging lens at a distance equal to twice the focal length f_1 of the lens. On the other side of the lens is a concave mirror of focal length f_2 separated from the lens by a distance $2(f_1 + f_2)$. Light from the object passes rightward through the lens, reflects from the mirror, passes leftward through the lens, and forms a final image of the object.



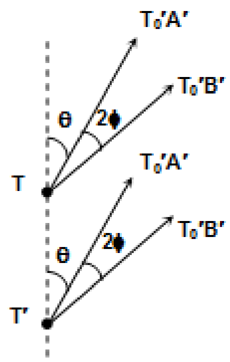
(A) The distance between the lens and the final image is equal to $2f_1$.
(B) The distance between the lens and the final image is equal to $2(f_1 + f_2)$.
(C) The final image is real, inverted and of same size as that of the object.
(D) The final image is real, erect and of same size as that of the object.

SECTION : (C) -Passage Type Questions

PASSAGE 01:

A radio transmitter consists of two vertical transmitting aerials T and T′ separated by distance d. It has been constructed so that citizens of city A can receive radio programmes but those at city B are unable to do so. Both aerials transmit radio signals of equal amplitude of S; T′ is leading T in phase by δ. The cities A and B are at a considerable distance from the transmitter.

The angle between T′T and the direction of A is θ, as indicated in the diagram. This angle can be varied by changing the direction of TT′. The angle between the directions of cities A and B is 2ϕ as indicated in the diagram. All angles are expressed in radians.



839. What is the path difference between transmitters T and T′ and city A

(A) d sin θ (B) d cos θ (C) d sin$(\theta + \phi)$ (D) d cos $(\theta + \phi)$

840. The radio signals reaching city A interfere constructively with Nth order interference. Choose the correct relation between the known physical quantities for this occurrence.

(A) $d\cos\theta = N\lambda$ (B) $d\cos\theta - \frac{\lambda\delta}{2\pi} = N\lambda$ (C) $d\cos\theta + \frac{\lambda\delta}{2\pi} = N\lambda$ (D) $\frac{\lambda\delta}{2\pi} = N\lambda$

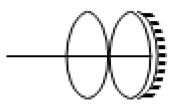
841. Choose the correct relation between the known physical quantities for destructive interference of the radio signals reaching city B, so that no signal is detected at B.

(A) $d\cos\theta - \frac{\lambda\delta}{2\pi} = \left(M + \frac{1}{2}\right)\lambda$ (B) $d\cos(\theta + 2\phi)\ \frac{\lambda\delta}{2\pi} = \left(M + \frac{1}{2}\right)\lambda$

(C) $d\cos\theta + \frac{\lambda\delta}{2\pi} = \left(M + \frac{1}{2}\right)\lambda$ (D) $d\cos(\theta + 2\phi) + \frac{\lambda\delta}{2\pi} = \left(M + \frac{1}{2}\right)\lambda$

PASSAGE 02:

Two convex lenses, each of focal length 40 cm, and a concave mirror of focal length 10 cm are kept as shown. An object is placed at 10 cm from the combination. Assume the lenses to be thin. Then answer the following



842. For a image to be formed, the total number of refractions occurring through the combination is

(A) 4 (B) 9 (C) 1 (D) 8

843. The radius of curvature of the combination is

(A) 10 cm (B) 5 cm (C) 90 cm (D) none of the above

844. The image distance from the combination is

(A) 5 cm (B) 10 cm (C) 20 cm (D) 40 cm

PASSAGE 03:

Number of radioactive nuclei in a sample reduces exponentially with time. The decay rate of a sample is also called its 'activity'. It can be shown that activity of a sample also decreases with time in an exponential manner. SI unit of activity is Becquerel (Bq) and 1 Bq = 1 decay/sec.

Activity of a radioactive sample was measured over a period of 10 hours beginning at t = 0. Results of these observations are given below.

Time(hour)	Decays/minute
1	5000
2	4205
4	2974
6	2103
8	1487
10	1051

845. Half life of the given sample is

(A) 6 hour (B) 4 hour (C) 1.5 hour (D) 7.5 hour

846. Activity of the sample at t = 16 hour will be nearly.

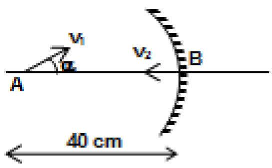
(A) 11.4 Bq (B) 8.6 Bq (C) 6.2 Bq (D) 3.4 Bq

847. Number of radioactive nuclei in the sample at t = 0 is of the order

(A) 1.54×10^8 (B) 2.72×10^4 (C) 1.72×10^5 (D) 2.06×10^6

PASSAGE 04:

A point object of mass m is placed at a distance 40 cm from a concave mirror of mass m and focal length f = 10 cm. At the given instant, object and mirror velocities V_1 and V_2 are as shown in the figure.



848. At the instant shown, what is the speed of the image if V_1 = 6 cm/s, V_2 = 0 and α = 90°?

(A) 2 cm/s (B) 6 cm/s (C) 9 cm/s (D) 18 cm/s

849. If v_1 = 6 cm/s, v_2 = 12 cm/s, α = 0°, the speed of the image when the object comes back to point A after an elastic collision with the mirror is

(A) 6 cm/s (B) 12 cm/s (C) 18 cm/s (D) 24 cm/s

850. The magnitude of average velocity of the image during the journey after collision described in the previous problem is:

(A) 1 cm/s (B) 2 cm/s (C) 3 cm/s (D) 4 cm/s

PASSAGE 05:

The radionuclide ^{56}Mn is being produced in a cyclotron at a constant rate P by bombarding a maganese target with deutrons. ^{56}Mn has a half life of 2.5 h and the target contains large number of only the stable maganese isotope ^{55}Mn. The reaction that produces ^{56}Mn is :

$$^{55}Mn + d \rightarrow {}^{56}Mn + p$$

After being bombarded for a long time, the activity of the target due to ^{56}Mn becomes constant equal to $13.86 \times 10^{10}\ s^{-1}$. (Use ln2 = 0.693; Avogadro No = 6×10^{23}; atomic weight ^{56}Mn = 56 gm/mole)

851. At what constant rate P, ^{56}Mn nuclei are being produced in the cyclotron during the bombardment?

(A) 2×10^{11} nuclei/s (B) 13.86×10^{10} nuclei/s (C) 9.6×10^{10} nuclei/s (D) 6.93×10^{10} nuclei/s

852. After a long time, number of ^{56}Mn nuclei present in the target, is equal to

(A) 5×10^{11} (B) 20×10^{11} (C) 1.2×10^{14} (D) 1.8×10^{15}

853. After a long time bombardment, number of ^{56}Mn nuclei present in the target depends upon

(a) the number of ^{56}Mn nuclei present at the start of the process.

(b) half life of the ^{56}Mn

(c) the constant rate of production P.

(A) All (a), (b) and (c) are correct (B) only (a) and (b) are correct

(C) only (b) and (c) are correct (D) only (a) and (c) are correct

PASSAGE 06:

If energy in the ground state is taken as zero then the energy levels of the tungsten atom with an electron knocked out are as follows :

Shell containing vacancy	K	L	M
Energy in keV	69.5	11.3	2.3

854. The minimum value of the accelerating potential that can result in the production of the characteristic K_β and K_α lines of tungsten, is

(A) 69.5 kV (B) 67.2 kV (C) 58.2 kV (D) 2.3 kV

855. For this same accelerating potential, what is the value of minimum wavelength as observed in the continuous X-rays ?

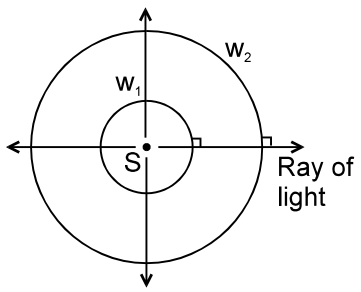
(A) 18.5 pm (B) 17.8 pm (C) 14.6 pm (D) 10.8 pm

856. The wavelength of the characterstic K_β X-rays will be

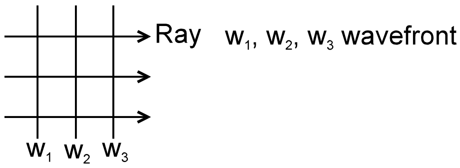
(A) 21.3 pm (B) 20.8 pm (C) 18.5 pm (D) 16.2 pm

PASSAGE 07:

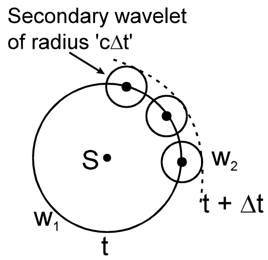
Huygen was the first scientist who proposed the idea of wave theory of light. He said that the light propagates in form of wavefronts. A wavefront is an imaginary surface at every point of which waves are in the same phase. For example the wavefronts for a point source of light is collection of concentric spheres which have centre at the origin. w_1 is a wavefront. w_2 is another wavefront.



The radius of the wavefront at time 't' is 'ct' in this case where 'c' is the speed of light. The direction of propagation of light is perpendicular to the surface of the wavefront. The wavefronts are plane wavefronts in case of a parallel beam of light.

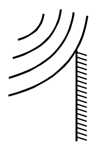


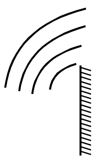
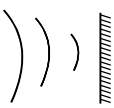
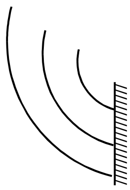
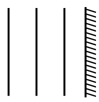
Huygen also said that every point of the wavefront acts as the source of secondary wavelets. The tangent drawn to all secondary wavelets at a time is the new wavefront at that time. The wavelets are to be considered only in the forward direction (i.e. the direction of propagation of light) and not in the reverse direction. If a wavefront w_1 at time t is given, then to draw the wavefront at time t + Δt take some points on the wavefront w_1 and draw spheres of radius 'cΔt'. They are called secondary wavelets.



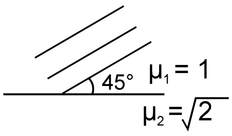
Draw a surface w_2 which is tangential to all these secondary wavelets. w_2 is the wavefront at time 't + Δt'.
Huygen proved the laws of reflection and laws of refraction using concept of wavefronts.

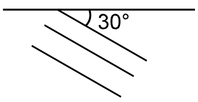
857. Spherical wave fronts shown in figure, strike a plane mirror. Reflected wave fronts will be as shown in

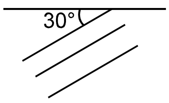


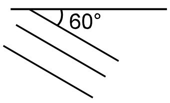
(A)  (B)  (C)  (D) 

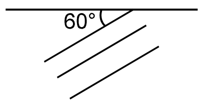
858. Wavefronts incident on an interface between the media are shown in the figure. The refracted wavefronts will be as shown in



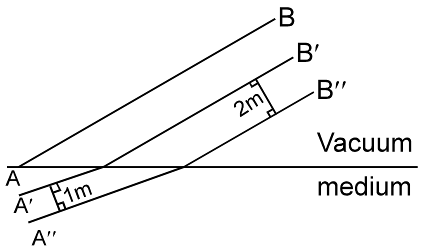
(A) 

(B) 

(C) 

(D) 

859. Certain plane wavefronts are shown in figure. The refractive index of medium is



(A) 2 (B) 4 (C) 1.5 (D) Cannot be determined

PASSAGE 08:

A glass prism with a refracting angle of 60^0 has a refractive index 1.52 for red and 1.6 for violet light. A parallel beam of white light is incident on one face at an angle of incidence, which gives minimum deviation for red light. Find :

[**Use:** sin (50º) = 0.760; sin (31.6º) = 0.520 ; sin (28.4º) = 0.475; sin (56º) = 0.832 ; π = 22/7]

860. The angle of incidence at the prism is :

(A) 30º (B) 40º (C) 50º (D) 60º

861. The angular width of the spectrum is :

(A) 6º (B) 4.8º (C) 9.6º (D) 12º

SECTION : (D) - Matrix Match

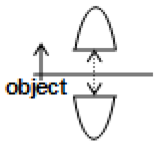
862. Match the Column – I with Column – II.

	Column I		**Column II**
(A)	k_α photon of aluminium	(1)	Will be most energetic among the four.
(B)	k_β photon of aluminium	(2)	Will be least energetic among the four.
(C)	k_α photon from sodium	(3)	Will be more energetic than the k_α photon of Lithium.
(D)	k_α photon from Beryllium	(4)	Will be less energetic than k_α photon of magnesium.

863. Match the atom given in list I with their ionization energy given in list II

	List I		**List II**
(A)	Lithium atom	(i)	54.4 eV
(B)	Helium atom	(ii)	13.6 eV
(C)	Beryllium atom	(iii)	122 eV
(D)	Hydrogen atom	(iv)	217.6 eV

864. When a convex lens is broken into half along the optical axis and symmetrically separated as shown. Then, considering initial and final situation, match the following



	List – I		**List – II**
(A)	Object size	(i)	increases
(B)	Image size	(ii)	decreases
(C)	Intensity	(iii)	remains the same
(D)	Image position	(iv)	insufficient data

865. For photoelectric effect, when the values given in list I are increased individually then match them with the correct option(s) in list II

	List – I		**List – II**
(A)	Frequency of incident light	(i)	Stopping potential increases
(B)	Intensity of incident light	(ii)	Stopping potential decreases
(C)	Work function	(iii)	No of photoelectrons emitted increases.
(D)	Frequency and intensity of incident light	(iv)	No of photoelectrons emitted decreases.

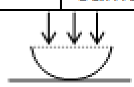
866.

	List – I		**List – II**
(A)	Radioactive nuclei	(i)	Quantization comes into picture
(B)	Bohr H-atom	(ii)	may emit electromagnetic waves
(C)	Photoelectric effect	(iii)	Existence of cut-off wavelength
(D)	X-ray generation	(iv)	Reverse process of photoelectric effect

867. What is the shape of the wavefront in each of the following cases

	List – I		List – II
(A)	Light diverging from a point source	(i)	plane
(B)	Light diverging from a line source	(ii)	spherical
(C)	Light emerging out of a convex lens when a point source is placed at it focus.	(iii)	cylindrical
(D)	Light reflected by concave mirror when point source is placed at it focus	(iv)	conical

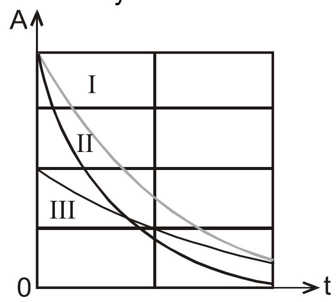
868.

	List – I		List – II
(A)	In young's double slit experiment with monochromatic light	(i)	The shape of interference fringes observed is circular
(B)	In young's double P in hole experiment with monochromatic light	(ii)	The shape of interference fringes observed is straight line
(C)	The phenomena is carried out with a thin film formed by placing a plane convex lens on the top of a flat glass plate with monochromatic light as shown in the figure	(iii)	The shape of interference fringes observed is Hyperbolic
		(iv)	Fringe width for all dark fringes are same
(D)	The phenomena of interference is carried out with Lloyd's mirror arrangement as shown in the figure.		

869. Match the following

	List I		List II
(A)	For a concave mirror, when an object is placed between pole and focus, the image is	(i)	Virtual
(B)	For a convex mirror, when an object is placed between pole and infinity, the image is	(ii)	Enlarged
(C)	For a concave mirror, when an object is placed between the centre of curvature and focus, the image is	(iii)	Erect
(D)	For a convex mirror, when an object is placed at infinity, the image is	(iv)	Formed between pole and focus

870. Figure shows activities A of three different radioactive material's samples (labelled as I, II and III) versus time. Using the given information, correctly match the requisite parameter in the left column with the options given in right column. Consider only their natural decay as the cause of rate of change of no. of parent nuclei



(a)	Disintegration constant has maximum value for the material of sample ...	(P)	I
(b)	Half life is maximum for the material of the sample	(Q)	II
(c)	Initially if samples of all three materials have same number of atoms then number of parent atoms will be maximum after their respective two half-lives in the sample...	(R)	III
(d)	Suppose all the materials decay by emitting α-particles of same energy and initially all three samples contain same amount (in gm) of the materials. Till the end of time span equal to their respective half lives, maximum energy is radiated by the sample	(S)	anyone out of these, as it is not possible to compare.

871.

	COLUMN - I		**COLUMN - II**
(a)	A convex lens in a denser medium will behave like a	(P)	converging lens
(b)	A concave lens in a rarer medium will behave like a	(Q)	diverging lens
(c)	A planoconvex lens silvered on its curved surface and placed in air will behave like a	(R)	concave mirror
(d)	A planoconcave lens silvered on its plane surface and placed in air will behave like a	(S)	convex mirror

872. Match the entries in column I with appropriate entries in column II

h – Planck constant K – Boltzmann constant
λ – Wavelength R – Resistance
C – Capacitance F – Force
V – Potential L – Inductance

	Column I		**Column II**
(A)	$\frac{hK}{\lambda}$	(p)	$\frac{\text{(watt) (metre)}}{\text{kelvin}}$
(B)	$\frac{K\lambda}{RC}$	(q)	$\frac{\text{(ampere) (kelvin)}}{\text{(joule)}^2}$
(C)	$\frac{F}{RC}$	(r)	$\frac{\text{(joule)(second)(newton)}}{\text{(kelvin)}}$
(D)	$\frac{VC}{hK}$	(s)	$\frac{\text{newton}}{\text{second}}$
		(t)	$\frac{\text{(ohm)(joule) (metre)}}{\text{(henry)(kelvin)}}$

873. A real object is being seen by optical component listing in column A and nature of image of this object is listing in column B:

Column A		Column B Nature of image	
(a)	Convex lens.	(p)	Real.
(b)	Convex mirror.	(q)	Virtual.
(c)	Concave lens.	(r)	Erect.
(d)	Concave mirror.	(s)	Inverted.

874.

	Column- I		Column-II
(a)	X-rays	(p)	Davisson and Germer experiment
(b)	Atomic number determination	(q)	Crystal structure determination
(c)	Duality of matter	(r)	Moseley's law
(d)	Duality of radiation	(s)	Bragg's law
		(t)	None

875.

	Column-I		Column-II
(a)	Wave character of radiation	(p)	Photoelectric effect
(b)	Photon character of radiation	(q)	Compton effect
(c)	Interaction of a photon with an electron, such that photon energy is equal to or slightly greater than the binding energy of electron, is more likely to result in	(r)	Diffraction
(d)	Interaction of a photon with an electron, such that photon energy is much greater than the binding energy of electron, is more likely to result in	(s)	Interference

876. In regard to motion of an electron in the atom and using Bohr's theory of atom, match Column - I with Column - II:

	Column - I		Column -II
(a)	Total energy of electron is	(p)	Directly proportional to n
(b)	Angular momentum of electron	(q)	Negative
(c)	Potential energy of electron is	(r)	Directly proportional to $\frac{1}{n}$
(d)	Linear momentum of electron is	(s)	Directly proportional to $-\frac{1}{n^2}$

(here n is the principal quantum number of the shell)

877.

	Column A		Column B
(a)	Characteristic x-rays	(p)	Photons liberated due to reduction in energy of accelerated electrons colliding with the atoms of target material.
(b)	Continuous x-rays	(q)	Accelerated electron creating a vacancy by knocking out inner electron of an atom of the target material and an electron from higher energy level occupying the vacancy and thus producing photons.
(c)	Minimum wavelength of x-rays	(r)	Depends on voltage applied between filament and target material.
(d)	Minimum wavelength of characteristic x-rays	(s)	Depends on target material

878. In hydrogen like atoms, match the following:

Table-1		**Table - 2**	
(a)	v_n	(p)	Proportional to n^2
(b)	r_n	(q)	Proportional to n
(c)	L_n	(r)	Proportional to n^{-2}
(d)	E_n	(s)	Proportional to n^{-1}

879. An unstable nucleus decays by various decay processes. Match each of the decay process in Column I with the relevant statement in Column II.

	Column I		***Column II***
(a)	γ – decay	(P)	accompanied by the emission of a neutrino
(b)	β^- – decay	(Q)	without change of number of nucleons
(c)	β^+ – decay	(R)	followed by X-ray emission
(d)	K – capture	(S)	resulting nuclei has lower energy configuration

880. An object located between the focus and the pole of a concave mirror moves towards the pole with a constant velocity along its principal axis. Consider the image formed by paraxial rays. Let θ_0 and θ_I represent the magnitudes (absolute values) of the angles subtended by the object and its image at the pole of the mirror respectively; and let m be defined as $\frac{\theta_I}{\theta_0}$. Use the New Cartesan Sign Convention.

	Column A		**Column B**
(a)	Velocity of image	(p)	Positive.
(b)	Acceleration of image	(q)	Negative.
(c)	$\frac{d\theta_0}{dt}$, i.e., the rate at which θ_0 changes with time	(r)	Zero.
(d)	$\frac{dm}{dt}$	(s)	Changes from positive to negative.

881.

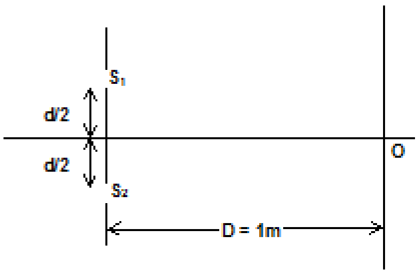
	Column A		**Column B**
(a)	Excited atom of small atomic number with a vacancy in M – shell	(p)	β–rays.
(b)	Excited atom of large atomic number with a vacancy in K – shell	(q)	Infra–red rays.
(c)	Electron – positron annihilation	(r)	X–rays.
(d)	Unstable nuclei	(s)	γ–rays.

SECTION : (E) - Integer Type

882. A man is looking down a 9 m deep tank filled with a transparent liquid of refractive index $\sqrt{3}$. The line of sight of the man makes an angle of 30° with the horizontal. What is the apparent depth of the tank as seen by the man?

883. A point source of power $P = \dfrac{8hc}{\lambda \ln 1.5}$ is kept on the axis (perpendicular to the plane of the disc and passing through the centre of disc) at a distance $a = \sqrt{2}R$ from the centre of the disc. λ is the wavelength of light emitted by the source, R = radius of disc, h = plank's constant and c = speed of light in vacuum. Assuming that each photon striking the plate ejects one electron, find the number of electrons emitted per unit time from the plate.

884. In a double slit experiment the separation between the slits is 1mm. Light rays fall normally on the plane of the slits and the interference pattern is observed on a screen placed at a distance of 1m from the plane of the slits. The arrangement is shown in the figure. When one of the slits is covered by a transparent strip of thickness 4μm, the central maximum is formed at a distance of 2mm from the point O. When the entire apparatus (one of the slits remaining covered) is immersed in a liquid, the distance between the central maximum and the point O is reduced to 0.5mm. The refractive index of the liquid is of the form $\dfrac{X}{Y}$. Then the value of X + Y is:



885. In an hydrogen atom, the energy released during transition from 4th to 2nd level is E. Now, light of the same energy E is incident on a metal surface of work function 0.56×10^{-19}J. The maximum KE (in eV) of the emitted electrons is X/10. Find the value of X(Take Ionization energy of hydrogen atom = 13.6 eV)

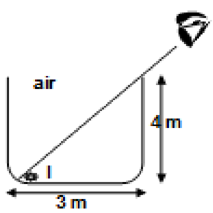
886. In the reaction ${}_1H^1 + {}_1H^3 \rightarrow {}_1H^2 + {}_1H^2$ protons ${}_1H^1$ with kinetic energy 8.03 MeV are incident on ${}_1H^3$ at rest. What is the total kinetic energy of products (both ${}_1H^2$) emitted along the direction of the incident proton in MeV

Give $m({}_1H^1) = 1.007825$ u $m({}_1H^3) = 3.016049$ u

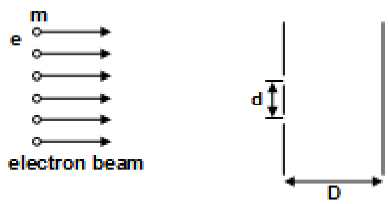
1u = 931.5 meV/C^2

$m({}_1H^2) = 2.014102$ u

887. An insect inside a beaker is just observable from a eye as shown from outside. At t=0 insect starts moving towards 'B' in straight line with constant velocity 0.5 m/s. If simultaneously a liquid of refractive index μ is gently filled inside the beaker with uniform rate $\dfrac{dy}{dt}$ so that insect is just observed always to the eye till t=4 sec. find refractive index of liquid is $\dfrac{X\sqrt{17}}{Y}$. Assume insect survives always inside the liquid. Find X + Y.



888. An electron beam is accelerated through a potential difference V and allowed to fall on the slits of a YDSE set up. Calculate the fringe width in mm. Given $V = \frac{50\ D^2h^2}{med^4}$, where h = Planck constant, m = mass of an electron, e = charge on an electron and d = 10 mm.



889. A double convex lens forms a real image of an object on a screen which is fixed. Now the lens is given a constant velocity v = $1 ms^{-1}$ along its axis and away from the screen. For the purpose of forming the image always on the screen, the object is also required to be given an appropriate velocity. Find the velocity in ms^{-1} of the object at the instant its size is double the size of the image towards the screen.

890. A thin rod of length (f/3) is placed along the principle axis of a concave mirror of focal length 'f' such that its image which is real and elongated, just touches the d. The linear magnification is X/Y. The value of X+Y is:

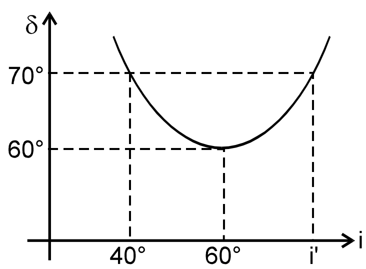
891. A monochromatic of wavelength 400 nm falls on the metal plate of a photoelectric arrangement. The work function of the metal is 2.5 eV. The maximum magnitude of the linear momentum of emitted photoelectron is 4.2×10^{-n} m/sec, then the value of n is ....

892. A neutron beam, in which each neutron has same kinetic energy, is passed through a sample of hydrogen like gas (but not hydrogen) in ground state. Due to collision of neutrons with the ions of the gas, ions are excited and then they emit photons. Six spectral lines are obtained in which one of the lines is of wavelength (6200/51) nm. What is the minimum possible value of kinetic energy of the neutrons for this to be possible. The mass of neutron and proton can be assumed to be nearly same. Find the answer in the form $X \times 10^{-2}$ eV and fill value of X.

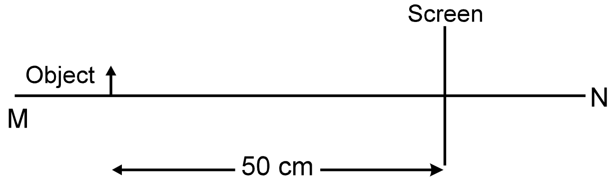
893. A beam of light has power of 144 W equally distributed among three wavelengths of 410 nm, 496 nm and 620 nm. The beam is incident at an angle of incidence of 60° on an area of 1 cm^2 of a clean sodium surface, having a work function of 2.3 eV. Assuming that there is no loss of light by reflection and that each energetically capable photon ejects a photoelectron, find the saturation photocurrent in μA (micro ampere).

894. An extended object of size 2 mm is placed on the principal axis of a converging lens of focal length 10 cm.It is found that when the object is placed perpendicular to the principal axis the image formed is 4 mm in size.The size of image when it is placed along the principal axis is _____________ mm.

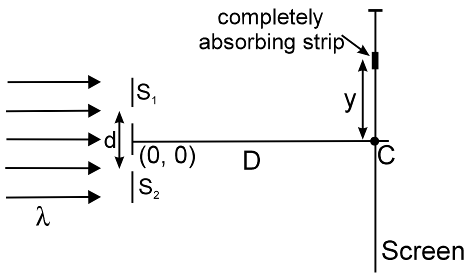
895. The curve of angle of incidence versus angle of deviation shown below has been plotted using a prism. Find the value of refractive index (in multiple of 10^{-2}) of the prism used.



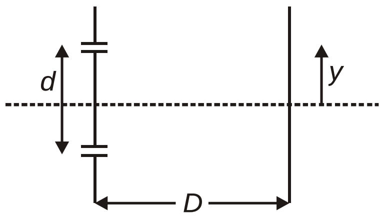
896. An object is placed 50 cm from a screen, as shown. A converging lens is moved such that line MN is its principal axis. Sharp images are formed on the screen in two positions of lens separated by 10 cm. Find the focal length of the lens in cm.



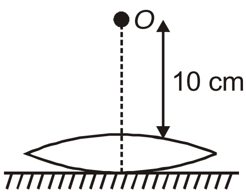
897. Figure shows two, identical narrow slits S_1 and S_2. A very small completely absorbing strip is placed at distance 'y' from the point C. 'C' is the point on the screen equidistant from S_1 and S_2. Assume $\lambda << d << D$ where λ, d and D have usual meaning. When S_2 is covered the force due to light acting on strip is 'f' and when both slits are opened the force acting on strip is 2f. Find the minimum positive 'y' (<< D) coordinate (in μm) of the strip if $\frac{\lambda D}{d}$ = 0.1 cm .



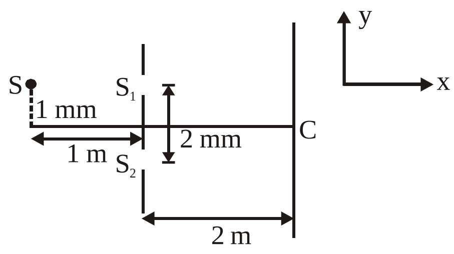
898. In YDSE if incident light consists of two wavelengths λ_1 = 4000 Å and λ_2 = 5600 Å and is parallel to line *SO*. The minimum distance *y* upon screen, measured from point *O*, will be where the bright fringe due to two wavelengths coincide is $\frac{n\lambda_1 D}{d}$. Find *n*.



899. An object is placed at a distance of 10 cm from convex lens $\left(\mu = \frac{3}{2}\right)$ which is placed on plane mirror as shown in figure. In this situation, image is formed on the object itself. Now the space between lens and mirror is filled with water $\left(\mu = \frac{4}{3}\right)$. Find, by how much distance (in cm) object must be moved so, that image again coincides with the object itself?



900. In a Young's double slit experiment set up, source S of wavelength 6000Å illuminates wo slits S_1 and S_2 which act two coherent sources. The source S oscillates about its shown position according to the equation $y = 1 + \cos \pi t$ where y is in millimeters and t in seconds At t = 2 second, the position of central maxima is x mm below C.Find the value of x.



901. In the above question,at t = 1 second, a slab of thickness 2×10^{-3} mm and refractive index 1.5 is placed in just front of S_1. The central maxima is formed at ymm aboce C.Find the value of y.

AnswerKey

Qs.	Ans.	Qs.	Ans.	Qs.	Ans.
801	B	851	B	901	1
802	C	852	D		
803	B	853	C		
804	D	854	A		
805	A	855	B		
806	B	856	C		
807	B	857	C		
808	B	858	B		
809	C	859	A		
810	A	860	C		
811	C	861	A		
812	A	862	A-(3),B-(1,3),C-(3,4),D-(2,3,4)		
813	D	863	A-(3),B-(1),C-(4),D-(2)		
814	C	864	A-(3),B-(1),C-(2),D-(3)		
815	B	865	A-(1),B-(3),C-(2),D-(1,3)		
816	AB	866	A-(2),B-(1,2,3),C-(1,3),D-(3,4)		
817	BCD	867	A-(2),B-(3),C-(1),D-(1)		
818	BCD	868	A-(2,4),B-(3,4),C-(1),D-(2,4)		
819	BC	869	A-(1,2,3),B-(1,3,4),C-(2),D-(1,3)		
820	B	870	A-(Q),B-(R),C-(R),D-(S)		
821	AD	871	A-(Q),B-(Q),C-(R),D-(S)		
822	BC	872	A-(R),B-(P,T),C-(S),D-(Q)		
823	BD	873	A-(P,Q,R,S),B-(Q,R),C-(Q,R),D-(P,Q,R,S)		
824	B	874	A-(Q,R,S),B-(R),C-(P),D-(T)		
825	C	875	A-(R,S),B-(P,Q),C-(P),D-(Q)		
826	AC	876	A-(Q,S),B-(P),C-(Q,S),D-(R)		
827	ABD	877	A-(Q),B-(P),C-(R),D-(S)		
828	ABC	878	A-(S),B-(P),C-(Q),D-(R)		
829	ABCD	879	A-(Q,S),B-(Q,S),C-(P,Q,S),D-(P,Q,R,S)		
830	AD	880	A-(Q),B-(P),C-(P),D-(R)		
831	ABCD	881	A-(Q),B-(R),C-(S),D-(PS)		
832	AB	882	1		
833	ABD	883	2		
834	AD	884	7		
835	ABCD	885	22		
836	ACD	886	4		
837	AB	887	8		
838	AC	888	1		
839	B	889	3		
840	B	890	5		
841	B	891	25		
842	D	892	6375		
843	D	893	1760		
844	B	894	8		
845	B	895	173		
846	C	896	12		
847	D	897	250		
848	A	898	7		
849	D	899	5		
850	B	900	4		