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PREDICTED QUESTIONS AND ANSWERS- JAN 2023

CLASS: XII SUB: PHYSICS

SECTION A

1. Quantization of charge is
a) The electric charges can de add up like real numbers.
b) The charges are neither created nor destroyed
c) The electric charge is always an integral multiple of e.
d) The charge is positive or negative.

2. The quality factor is increases, if
a) R is low and L is large
b) R is large and L is low
c) R and L are large
d) R and L are low

3. The dipole moment vector P of an electric dipole is
a) qx2a, directed from -q to +q.
b) qxa, directed from -q to +q.
c) qx2a, directed from +q to -q.
d) 2qx2a, directed from -q to +q.

4. The electrostatic potential on the surface of a charged conducting sphere is 100V.Which of the following statement is true?

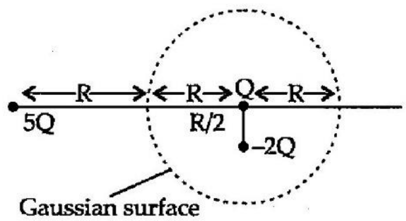
(a) At any point inside the sphere, the electrostatic potential is 100V and electric field intensity is zero.

(b) At any point inside the sphere, the electrostatic potential is 0V and electric field intensity is zero.

(c) At any point inside the sphere, the electrostatic potential is 0V and electric field intensity is 100V/m.

(d) At any point inside the sphere, the electrostatic potential is 100V and electric field intensity is 100V/m.

5. For the given arrangement of charges shown in figure and a Gaussian surface of radius R with charge Q at the centre of the surface, the total flux through the surface is



(a) Q/ε_0 (b) $-Q/\varepsilon_0$ (c) $-2Q/\varepsilon_0$ (d) $3Q/\varepsilon_0$

6. Out of two magnetic materials A and B, relative permeability is greater than unity for A and less than unity for B. Then the nature of A and B are

   (a) (ferromagnetic, paramagnetic)

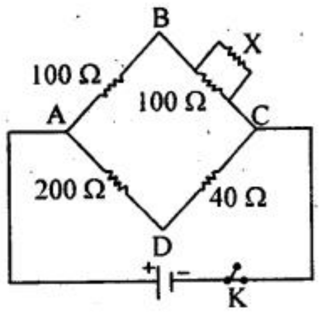
   (b) (ferromagnetic, diamagnetic)

   (c) (diamagnetic, paramagnetic)

   (d) (paramagnetic, ferromagnetic)

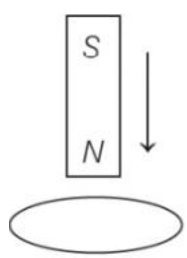
7. To convert a galvanometer into ammeter
   (a) Connect a high resistance in parallel
   (b) Connect a low resistance in parallel
   (c) Connect a high resistance in series
   (d) Connect a high resistance in series

8. The following figure represents a balanced Wheatstone bridge circuit. What is the value of X?



(a) 100Ω
(b) 60Ω
(c) 50Ω
(d) 25Ω

9. In a transformer the number of turns of the primary and secondary coils are 500 and 400 respectively. If 220 V is applied to the primary, then the ratio of currents primary and secondary coils is
a) 5:9
b) 5:4
c) 9:5
d) 4:5
10. The north pole of a magnet is falling on a metallic ring as shown in the figure. The direction of induced current, if looked from upside in the ring will be

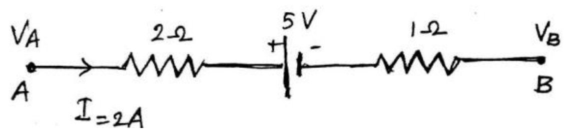


a) clockwise or anticlockwise depending on metal of the ring
b) no induced current
c) anticlockwise
d) clockwise
11. An equilateral prism is made up of material of refractive index √3. The angle of minimum deviation of light passing through the prism is
a) 45°
b) 30°

c) 60^o

d) 90^o

12. The potential difference (VA-VB) between the points A and B in the given figure is

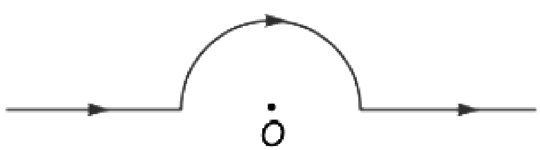


a) -11 V b) +11V c) -13V d) +13V

13. When a body is charged by conduction, its mass

a) remains same.
b) increases.
c) decreases.
d) increase or decrease

14. A straight wire carrying a current of 10A is bent into a semi-circular arc of radius 1cm as shown in the figure. What is the magnetic field B at O.



a) 10-4 T into the plane
b) 3.14 x 10-4 T into the plane
c) 10-4 T out of the plane
d) 3.14 x 10-4 T out of the plane

15. The angle of dip at the equator and at the poles respectively are:

a) 30^0 ,60^0 (b) 0^0 ,90^0 (c) 45^0 ,90^0 (d) 90^0 ,0^0

16. A positively charged particle is released from rest in a uniform electric field. The electric potential energy of the charge

a) remains a constant because the electric field is uniform.
b) increases because the charge moves along the electric field.
c) decreases because the charge moves along the electric field.
d) decreases because the charge moves opposite to the electric field.

16.An electron moves around the nucleus in a hydrogen atom of radius $2.1A^0$, with a velocity of 10^6 m/s. The magnetic moment associated with the electron is (charge of $e=1.6x10^{-19}$ C))

a) 8.16 x 10-^{25}Am2
b) 1.68 x 10-^{23}Am2
c) 3.36 x 10-^{23}Am2
d) 0.84 x10-^{25}Am2

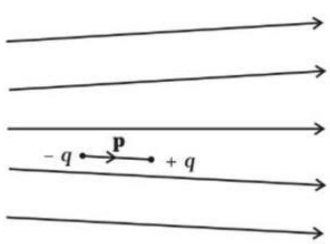
17.The shape of equipotential surfaces due to an isolated charge is

a) Concentric spherical shells and the distance between the shells increases with the decrease in electric field
b) Concentric spherical shells and the distance between the shells decreases with the decrease in electric field
c) Equi-spaced concentric spherical shells
d) Changes with the polarity of the charge.

18.Which of the following characteristics of electrons determines the current in a conductor?

a) Drift velocity alone
b) Thermal velocity alone
c) Both drift velocity and thermal velocity
d) Neither drift velocity nor thermal velocity

19.Figure shows electric field lines in which an electric dipole p is placed as shown. Which of the following statements is correct?



a) The dipole will not experience any force.
b) The dipole will experience a force towards right
c) The dipole will experience a force towards left
d) The dipole will experience a force upwards

20.Electric field at a point varies as r° for

a) Point charge
b) Dipole
c) Line charge
d) Infinite plane sheet of charge

21.A parallel plate capacitor is charged by connecting it to a battery. Which of the following will remain constant if the distance between the plates of the capacitor is increased in this situation?

a) Energy stored
b) Electric field
c) Potential difference
d) Capacitance.

22.An electron enters uniform electric field maintained by parallel plates and of value 'E' Vm-1 with a velocity 'v' ms-1. The plates are separated by a distance 'd' metre. What is the acceleration of the electron in the field?

a) eE/d (b) $-eE/m$ (c) Ed/m (d) -Ed^2/m

23.A square of side L meters lies in the xy plane in a region where the magnetic field is given by B = Bo (2i + 3j+ 4k) T where Bo is a constant. The magnitude of the flux passing through the square is

a) $2BoL^2$ Wb b) $3BoL^2$ Wb c) $4BoL^2$ Wb d) $\sqrt{29}\ BoL^2$ Wb

24.The flux linked with a circuit is given by $\varphi = t^2 + 2$. The graph between time (x axis) and induced emf (y-axis) will be a

a) Straight line through the origin
b) Straight line with positive Intercept
c) Straight line with negative Intercept
d) Parabola not through the origin

25.In a pure capacitor connected to an a.c source the current

a) lags behind applied emf by angle $\pi/2$
b) leads the applied emf by angle π
c) leads the applied emf by angle $\pi/2$
d) is in phase with the emf

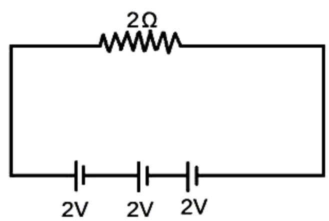
26.In a transformer the number of turns of the primary and secondary coils are 500 and 400 respectively. If 220 V is applied to the primary then the ratio of currents primary and secondary coils is

e) 5:9 (b) 5:4 (c) 9:5 (d) 4:5

27. Which of the following statement is correct about electric field lines?

a) Field lines start from negative charge and end at positive charge.
b) Electric field lines form closed loops.
c) Field lines are continuous curves without any breaks.
d) Field lines of a single positive charge is radially inward.

28. In the electric circuit shown, each cell has an emf of 2V and internal resistance 1Ω. The external resistance is 2Ω. The current in the circuit is



a) 3A b)1.2A c)0.4A d)2A

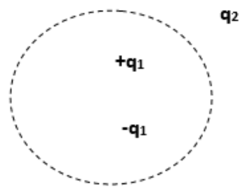
29. A point charge +q, is placed at a distance d from an isolated conducting plane. The field at a point P on the other side of the plane is

a) directed perpendicular to the plane and away from the plane.
b) directed perpendicular to the plane but towards the plane.
c) directed radially away from the point charge
d) directed radially towards the point charge.

30.A deuteron and an alpha particle with equal kinetic energies enter perpendicularly into a magnetic field. The respective radii of the circular path of deuteron to alpha particle is

a) 1:√2 b)1:1 c) √2:1 d)1:2

31.Consider the charge configuration and a spherical gaussian surface as shown in the figure. When calculating the field over the spherical surface , the electric field will be due to:



a) $q2$ b) only the positive charges c) all the charges d) $+q1$ and $-q1$

32.For a cell, the terminal potential difference is 3.6 V, when the circuit is open. If the potential difference reduces to 3V, when cell is connected to a resistance of 5Ω, the internal resistance of cell is

a) 1Ω b) 2Ω c) 4Ω d) 8Ω

33.A galvanometer has 20 divisions and a resistance of 60 ohm. A current of 4 x10-4A gives a deflection of one division. To convert this galvanometer into voltmeter having a range of 20 volt, it should be connected with a resistance of

a) 2440ohm in parallel to it.
b) 4940ohm in parallel to it.
c) 2440ohm in series to it.
d) 4940ohm in series to it.

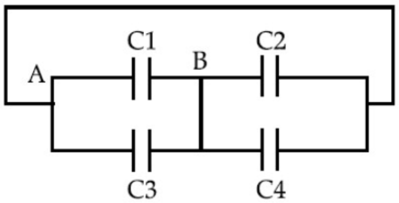
34.When a current drawn from a cell increase, the potential difference across the terminal of cell is

a) lowered b)more c)remain same d)infinite

35.The electric potential at a point on the equatorial line of an electric dipole is

a) directly proportional to the square of the distance.
b) indirectly proportional to the square of the distance.
c) directly proportional to the charge.
d) zero.

36. 4 capacitors, each of 2 μF, are connected as shown. What will be the equivalent capacitance across the points A and B ?



a) 0.5 μF b) 2 μF c) 8 μF d) 4 μF

37.Two long straight parallel conductors carrying a steady current Ia and Ib along the same direction are separated by a distance d. If a third conductor carrying a current Ic in the opposite direction is placed just in the middle of these conductors ,the resultant force acting per unit length on the third conductor is

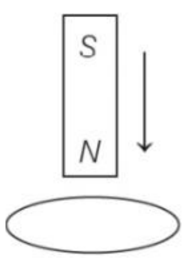
(a) $\frac{\mu_0(I_a-I_b)I_c}{\pi d}$ (b) $\frac{\mu_0(I_a-I_b)I_c}{2\pi d}$

(c) $\frac{\mu_0(I_a+I_b)I_c}{2\pi d}$ (d) $\frac{\mu_0(I_a+I_b)I_c}{\pi d}$

38.If emf induced in a coil is 2 V by changing the current in it from 8 A to 6A in 2×10^{-3} s , then the coefficient of self induction is

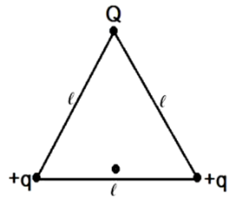
a) 2×10^{-3} H (b) 10^{-3}H (c) 0.5×10^{-3} H (d) 4×10^{-3}H

39.The north pole of a magnet is falling on a metallic ring as shown in the figure. The direction of induced current, if looked from upside in the ring will be



e) clockwise or anticlockwise depending on metal of the ring
f) non induced current
g) anticlockwise
h) clockwise

40. Three charges are placed at the vertex of an equilateral triangle of side las shown. For what value of Q the electrostatic potential energy of the system is zero.



a) q/2 b)-q c)-q/2 d)-2q

41. The weber /m2 is equal to

a) tesla b) henry c) watt d) dyne

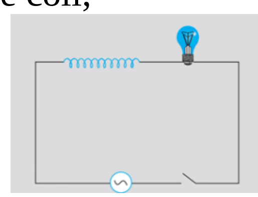
42. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system.

a) decreases by a factor of 2
b) remains the same
c) increases by a factor of 2
d) increases by a factor of 4

43. A 44 mH inductor is connected to 220 V ,50 Hz ac supply. Determine the rms value of the current in the circuit.

a) 16 A b) 12 A c) 13 A d) 14 A

44. Figure shows a light bulb connected to an inductor coil to an ac source.if an iron rod is inserted in to the coil,



a) Glow of bulb increases
b) Glow of bulb decreases
c) Does not affect the bulb
d) Bulb fuses

Given below are two statements labelled as Assertion (A) and Reason (R)

Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

45. Assertion(A): Two identical loops one of copper and another of aluminium are rotated with the same speed in the same magnetic field. The emf induced in both the loop will be the same.

Reason(R): The magnitude of induced emf is directly proportional to the rate of change of magnetic flux linked with a circuit.

a

46. Assertion (A): If two spherical conductors of different radii have the same surface charge densities, then their electric field intensities will be equal.

Reason (R): Surface charge density = Total charge /area

b

47. Assertion (A): Net magnetic field at a point in between two parallel current carrying conductors is zero, if current in both the conductors flows in the same direction.

Reason (R): At mid-point fields cancel out, if the currents are of same magnitude

a

48. Assertion (A): A unit charge moved along an equipotential surface having a potential of 4 volt. The work done is zero.

Reason (R):An equipotential surface is very smooth.

c

49.**Assertion:** if an electron and proton enter a perpendicular magnetic field with equal momentum, then path of electron is more curved than that of proton.
Reason: mass of the electron is greater than that of proton.
(d)

SECTION B

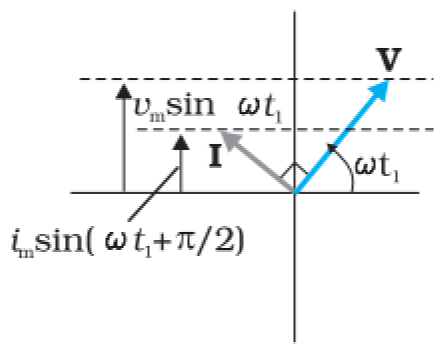
1) Two cells of emf ε_1 and ε_2 have their internal resistance r_1 and r_2 respectively. Deduce an expression for the equivalent emf and internal resistance of their series combination.
2) Two point charges 4Q and Q are separated by 1m in air. At what point from 4Q, on the line joining of charges, is the electric field intensity zero?

   3r=1

   r=1/3

   so, 1/3 m

3) Explain different types of magnetic properties of materials.
4) A biconvex lens has a focal length 2/3 times the radius of curvature of either surface. Calculate the refractive index of lens material. $n_{21}=7/4$
5) A device X is connected to an ac source $V=V_0 \sin \omega t$. The variation of voltage &current in phasor representation is as shown.



   (a)Identify the device 'X' and obtain expression for the current in the circuit. capacitor

   (b) Hence define a quantity for the circuit, which is analogous to the resistance. Xc=1/wc

6) Distinguish between a conductor, an insulator and a semiconductor on the basis of energy band diagrams.
7) Draw the circuit diagram for studying the VI characteristics of a pn junction diode in (i) forward bias and (ii) reverse bias.Draw and explain the typical VI characteristics of a silicon diode.

8) Obtain the expression for the maximum kinetic energy of the electrons emitted from a metal surface in terms of the frequency of the incident radiation and the threshold frequency. For a given K.E. which of the following has the smallest de–Broglie wavelength: electron, proton, alpha - particle? alpha

OR

An α-particle and a proton are accelerated from rest through the same potential difference V. Find the ratio of de–Broglie wavelength associated with them.1:sqrt8

9. In Geiger-Marsden scattering experiment, show the trajectory of α-particles in coulomb's field of a heavy nucleus and define impact parameter and scattering angle.

10. State de-Broglie hypothesis. A proton and α-particle are accelerated through same potential difference. Determine the ratio of their de-Broglie wavelength.

    Ans:$\lambda = h/\sqrt{2mqv}$ ➔ ma=4mp,qa=2qp ➔ $2/\sqrt{2}:1$

11. Obtain the binding energy (in MeV) of a nitrogen nucleus ${}_7N^{14}$, given ${}_7N^{14}$=14.00307 u

Ans: A nucleus of nitrogen 7N147N14 contains 7 protons and 7 neutrons. Hence, the mass defect of this nucleus, △m=7mH+7mn−m

Mass of a proton, mH=1.007825 umH=1.007825 u

mn=1.008665 umn=1.008665 u

∴△m=7×1.007825+×1.008665−14.00307∴△m=7×1.007825+×1.008665-14.00307

=7.054775+7.06055−14.00307=7.054775+7.06055-14.00307

=0.11236 u=0.11236 u

But 1 u=931.5(MeV)/c2But 1 u=931.5(MeV)/c2

∴△m=0.11236×931.5MeV/c2∴△m=0.11236×931.5MeV/c2

Hence, the binding energy of the nucleus is given as:

EbΔmc2EbΔmc2 Where,

c=c= Speed of light

∴Eb=0.11236×931.5(McVc2)×c2∴Eb=0.11236×931.5(McVc2)×c2

=104.66334 MeV=104.66334 MeV

Hence, the binding energy of a nitrogen nucleus is 104.66334 MeV.

12. Show that shortest wavelength lines in Lyman and Balmer series are in the ratio 1:4.

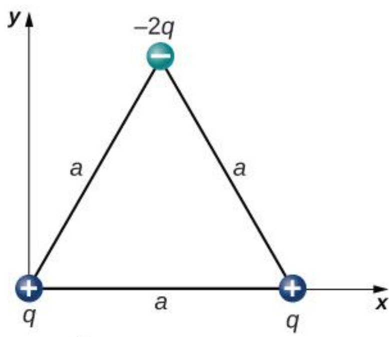
13. With the help of a suitable diagram, explain the formation of depletion region in a p-n junction. How does its width change when the junction is(i) forward biased, and (ii) reverse biased?

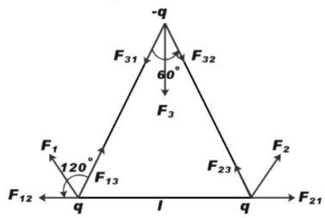
14. Draw the variation of stopping potential versus frequency of incident radiation for a photosensitive material. What does the slope of graph depict? Does the slope of the graph between stopping potential versus frequency of incident radiations for two different photosensitive materials different?

OR

Calculate the ratio of the frequencies of the radiation emitted due to the transition of the electron in a hydrogen atom from its (i) second permitted energy level to the first level and (ii) highest permitted energy level to the second permitted level.

15. consider three charges q, q, and -2q placed at the vertices of an equilateral triangle of each side ‘a’ as shown. what is the net force acting on charge -2q.



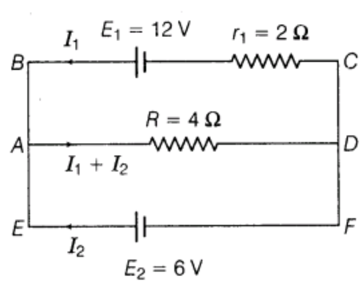


Ans:
√3k(2q2/a2)

16.Consider three charges q1,q2 and q3 placed at positions r1,r2 and r3 respectively.Obtain an expression for electrostatic potential energy of system of three charges. How PE modifies if the system is placed in an external field?

17. (a).What is terminal potential difference of a cell? Can its value be greater than the emf of a cell?
(b).Two cells of emf e1 and e2 are connected in series. Calculate the total emf and internal resistance of the combination.

18.Use Kirchhoff's rules for the following circuit to calculate the current through the arm AD of the given circuit



Ans:I1=3A,I2=-1.5A➔I1+I2=1.5A

19.Define wavefront of a travelling wave. Using Huygens principle, obtain the law of refraction at a plane interface when light passes from a denser to rarer medium.

20. Using lens maker's formula, derive the thin lens formula for a biconvex lens.
21. Define the terms (a) threshold frequency, and (b) stopping potential. How were these terms incorporated in Einstein's photoelectric equation?
22. A parallel beam of light of 500nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1m away. It is observed that the first minimum is at a distance of 2mm from the centre of the screen. Calculate the width of the slit.

Ans: $a=\lambda D/x=0.25mm$

23. An object is placed 30 cm in front of a plano-convex lens with its spherical surface of radius of curvature 20 cm. If the refractive index of the material of the lens is 1·5, find the position and nature of the image formed.

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

for plano convex lens $R_1 \rightarrow R$ and $R_2 \rightarrow \infty$

$$\frac{1}{f} = \frac{(\mu - 1)}{R} = \frac{1.5 - 1}{20}$$

$\therefore f=40$ cm

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{40} = \frac{1}{v} - \frac{1}{-30}$$

$$v = -12\ cm$$

Nature: virtual

24. The following table gives the values of work-function for a few photosensitive metals A,B and C:

Sl No.	Metal	Work function(eV)
1	A	2.14
2	B	1.62
3	C	4.85

If these metals are illuminated by radiation of wavelength 300nm, which of them will emit photo electrons? Justify with relevant calculations.

Ans:

$E=hc/\lambda$ =1237/300 =4.12 Ev

For emission, Energy should be greater than work function.

So A and B emit photo electrons.

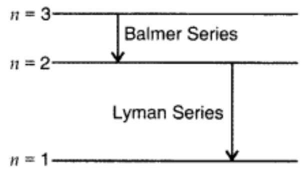
SECTION C

25. i) In hydrogen atom, an electron undergoes transition from 2nd excited state to the first excited state and then to the ground state. Identify the spectral series to which these transitions belong.

(ii) Find out the ratio of the wavelengths of the emitted radiations in the two cases.

(*i*) $n_f = 2, \quad n_i = 3$ *Balmer series*

$n_i = 2, \quad n_f = 1$ *Lyman series*



(*ii*) $\frac{1}{\lambda_B} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5}{36}R$

...where $\left[\begin{array}{l}\lambda_B \text{ is the wavelength for Balmer series.} \\ \lambda_L \text{ is the wavelength for Lyman series.}\end{array}\right.$

and $\frac{1}{\lambda_L} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = R\left[\frac{1}{1} - \frac{1}{4}\right] = \frac{3}{4}R$

$\therefore \frac{\lambda_B}{\lambda_L} = \frac{36}{5} \times \frac{3}{4} = \frac{27}{5}$

$\therefore$ ***Ratio*** $= \lambda_B : \lambda_L = 27 : 5$

26. (a)State two characteristic properties of nuclear force.

Ans: 1. Nuclear forces are strongest forces in nature: Magnitude of nuclear forces is 100 times that of electrostatic force and 10^{38} times the gravitational forces.

2. Nuclear forces are charge independent: Nuclear forces between a pair of protons, a pair of neutrons or a pair of neutron and proton act with same strength.

(b) Distinguish between nuclear fission and fusion. Show how in both these processes energy is released. Calculate the energy release in MeV in the deuterium-tritium fusion reaction :

$${}^2_1H + {}^3_1H \longrightarrow {}^4_2He + n$$

Using the data :

$m({}^2_1H) = 2.014102 \text{ u} \quad m({}^3_1H) = 3.016049 \ u$

$m({}^4_2He) = 4.002603 \text{ u} \quad m_n = 1.008665 \text{ u}$

$1u = 931.5 \text{ MeV}/c^2$

Ans: In the given problem, mass defect is

$\Delta m = 2.014102 + 3.016049 - 4.002603 - 1.008665$

$\Delta m = 0.018883$ u

Energy released, $\Delta E = \Delta mc^2$

$\Delta E = 0.018883 \times 931.5 = 17.589$ MeV

27. (a)Derive an expression for fringe width of interference fringes in Young's double slit experiment. Show that bright and dark fringes are having equal widths.

Ans: proof for β in YDSE,with diagram.

(b) What will be effect on the fringe width if entire YDSE set up is immersed in water?

Ans: Fringe width decreases to β/μ, where μ is refractive index of water.

28. (a)State two properties of photons. For a monochromatic radiation incident on a photosensitive surface, why do all photoelectrons not come out with the same energy? Give reason for your answer.

(b) Write Einsten's photoelectric equation. Write the two salient features observed in photoelectric effect which can be explained using this equation.

- Ans:(a) Two properties of photons :
  - photon is electrically neutral.
  - photon has an energy equal to hv
- For a monochromatic radiation incident on a photosensitive surface, all photoelectrons do not come out with the same energy, because in addition to the work done to free electrons from the surface, different (emitted) photoelectrons need different amount of work to be done on them to reach the surface.

(*i*) **Threshold frequency.** For $KE_{max} \geq 0$.

$\Rightarrow \nu \geq \nu_0$ ...(*i*)

i.e., the phenomenon of photoelectric effect takes place when incident frequency is greater or equal to a minimum frequency (threshold frequency) ν_0 fixed for given material.

(*ii*) **KE_{max} of photoelectron.** When incident frequency is greater than threshold frequency, then KE_{max} of photo electron is directly proportional to $(\nu - \nu_0)$ as

$$KE_{max} = h(\nu - \nu_0)$$

$$\Rightarrow KE_{max} \propto (\nu - \nu_0)$$

(*iii*) **Effect of intensity of incident light.** The number of photon incident per unit time per unit area increases with the increase of intensity of incident light. More number of photons facilitates ejection of more number of photoelectrons from metal surface leadint to further increase of photo current till its saturation value is reached.

(b)

29. (a) Which one of the following electromagnetic radiations has the least frequency: UV radiations, X-rays, Microwaves?

Ans: Microwaves

(b)Mention one use of each.

(c) How do you show that electromagnetic waves carry energy and momentum?

30. Define the term, “refractive index” of a medium. Verify Snell’s law of refraction when a plane wavefront is propagating from a denser to a rarer medium. Also give the condition for TIR.

31. Draw a ray diagram to show the working of a compound microscope. Explain briefly its working.Write an expression for the total magnification when the final image is formed at the near point..

OR

(a) Draw a labelled ray diagram of a reflecting telescope. Mention its two advantages over the refracting telescope.

(b) You are given two converging lenses of focal lengths 1.25 cm and 5 cm to design a compound microscope. If it is desired to have a magnification of 30, find out the separation between the objective and the eyepiece when the final image is formed at infinity.

Ans:

Given: $f_1 = 1.25$ cm, $f_2 = 5$ cm,
$m = 30$, $D = 25$ cm

We know that $m = \frac{L}{f_1} \times \frac{D}{f_2}$

or $L = \frac{m(f_1 \times f_2)}{D} = \frac{30 \times 1.25 \times 5}{25}$

$= \mathbf{7.5\ cm}$

32. What is the difference in the construction of an astronomical telescope and a compound microscope? The focal lengths of the objective and eyepiece of a compound microscope are 1·25 cm and 5·0 cm, respectively. Find the position of the object relative to the objective in order to obtain an angular magnification of 30 when the final image is formed at the near point.

Ans: Aperture of telescope objective lens is large whereas aperture of microscope objective is small fo >fe in telescope/ fo<fe in microscope

$$m = m_o \times m_e$$

$$m_e = 1 + \frac{D}{f_e} = 1 + \frac{25}{5} = 6$$

$$\therefore m_o = \frac{30}{6} = -5$$

$$m_o = \frac{v}{u} = -5$$

$$v = -5u$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{1.25} = \frac{1}{5u_o} + \frac{1}{u_0} \qquad ; u = -u_0$$

$$u_0 = \frac{6}{5} \times 1.25 = 1.5\text{cm}$$

ternatively, $m_o = \frac{v}{u} = \frac{f_o}{f_o + u_o}$

$$-5 = \frac{1.25}{1.25 + u_o}$$

$$-7.5 = 5u_o$$

$u_o = -1.5\text{cm}$ (for last ½ mark)]

33. Two coherent light waves of intensity .004 W/m2 each super-impose and produce interference pattern on a screen.If the path difference between the waves at a point is λ/6.Find

(i)Phase difference between the waves.

(ii)Resultant intensity at the point.

(iii)Resultant intensity interms of the intensity at the maximum.

(a) Phase difference $\emptyset = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \frac{\pi}{3}$

(b) $I_1 = I_2 + I_3 + 2\sqrt{I_3 I_2} \cos \emptyset$

$$= I + I + 2\,I \times \frac{1}{2} = 3\,I$$

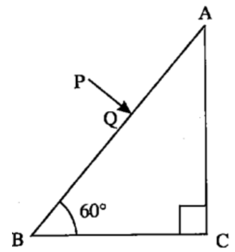
$$= 15 \times 10^{-2}\, Wm^{-2}$$

(c) $I_{max} = 4I$

$$I_1 = \frac{3I}{4I} \times 4I = \frac{3}{4} I_{max}$$

34. Draw the ray diagram showing refraction of ray of light through a glass prism. Derive the expression for the refractive index μ of the material of prism in terms of the angle of prism A and angle of minimum deviation δ_m

35. A ray PQ incident normally on the refracting face AB is refracted in the prism of refractive index 1.5. Complete the path of the ray through the orism.Justify your answer with necessary calculations.



$$n = \frac{1}{\sin C}$$

n = Refractive index

C = Critical angle.

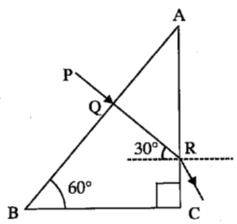
$\sin C = 1/n = 1/1.5 = 0.667$

$\sin C = \sin 41° 49'$

$C = 41° 49'$

$C > 30°$

Angle on face AC. which as greater than incident



36. Sketch the graph showing variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B having threshold frequencies $v_A > v_B$.

(i)in which case is the stopping potential more and why?

(ii)Does the slope of the graph depend on the nature of the material used? Explain.

37. Explain total internal reflection with a neat diagram. Give the conditions for TIR to occur. Hence define critical angle using mathematical expression.

39) (a)Derive an expression for force per unit length between two long straight current carrying conductors.

(b)Two long parallel straight conductors are place 12cm apart in air. They carry equal currents of 3A each. With a diagram, find the magnitude and direction of magnetic field at a point midway between them when the currents in them flow in opposite directions.

B=uoI/2πr➔B1+B2➔ 2uoI/2πr =2x10^{-5} T

40) (a) Define capacitance of a capacitor. Obtain expression for the capacitance of a parallel plate capacitor in vacuum.

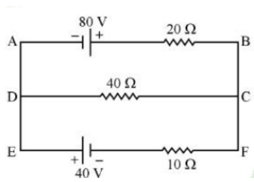
(b) A slab of material of dielectric constant K has the same area as the plates of parallel plate capacitor but has a thickness of 3d/4.Find the ratio of the capacitance with dielectric to the capacitance without dielectric.

$C/C_o=4K/K+3$

41) Apply Kirchhoff's rule to the given network and find the current flowing through arms AB and CD.

Loop equations:$I_1-2I_3=4$, and $I_1+5I_3=4$

$I_1=4A$&$I_3=0A$

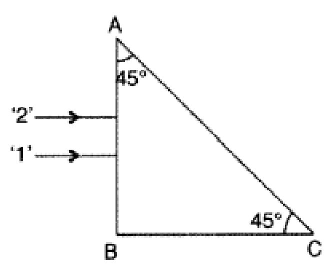


42) (a)Describe, with the help of a suitable diagram, the working principle of a device which is used to increase low ac voltage into a high ac voltage. Obtain the relation between input and output voltages in terms of the number of turns of primary and secondary windings and the currents in the input and output circuits. Transformer

(b) Given the input current 15 A and the input voltage of 100 V for a step-up transformer having 90% efficiency, find the output power and the voltage in the secondary if the output current is 3 A. $V_s=500V,P_s=1350W$

43) Two monochromatic rays of light are incident normally on the face AB of an isosceles right-angled prism ABC. The refractive indices of the glass prism for the two rays '1' and '2' are respectively 1.3 and 1.5. Trace the path of these rays after entering through the prism. Ray 1-n=1.3,1/sini=1/sin45=1.414➔n <1/sini➔Refraction(no TIR)

Ray 2-n=1.5,1/sini=1/sin45=1.414➔n >1/sini➔ TIR)



44) (a)What is inductance? Obtain an expression for the self-inductance of a long solenoid? $L=u_on^2lA$

(b)Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V induced, give an estimate of the self-inductance of the circuit. $E=LdI/dt=4H$

45. State Bohr's second postulate of quantization. Calculate the shortest and longest wavelength of the Bracket series and state to which part of the electromagnetic spectrum this series belongs.

Bohr's quantization condition of angular momentum: According to Bohr, electron can revolve in certain discrete orbits called stationary orbits. The total angular momentum (L) of the revolving electron is integral multiple of h / 2π . Now, we have that the angular momentum is L = mvr, where m is mass of electron, v is velocity in circular orbit, and R is radius of circular orbit. Therefore, L = mvr = nh/2π where n = 1, 2, 3, … is the positive integer and the above condition is Bohr's quantization condition of angular momentum. When an electron jumps from on outer stationary orbit to an inner stationary orbit, the difference in the energy is of electron in two orbits is radiated in form of spectral line. Brackett series is obtained when an electron jumps to fourth orbit (n1 = 4) from any outer orbit (n2 = 5, 6, 7, …) of hydrogen atom.

The-shortest-wavelength

$$\frac{1}{\lambda} = R\left[\frac{1}{4^2} - \frac{1}{\infty^2}\right] = R\left(\frac{1}{4^2} - 0\right)$$

$$\frac{1}{\lambda} = R \times \frac{1}{16} = \frac{1.097 \times 10^7}{16}$$

$$\Rightarrow \lambda = \frac{16}{1.097 \times 10^7} = 14.585 \times 10^{-7}$$

The shortest wavelength of the Brackett series is 1458.5 nm. This wavelength belongs to infrared range of electromagnetic spectrum.

The longest wavelength is:

n1=4,n2=5

1/λ =Rx9/400 ➔λ=400/9xR➔405.1nm

It lies in UV region.

46. Draw a labelled diagram of a full wave rectifier circuit. State its working principle. Show the input-output waveforms.

47. A neutron is absorbed by *Li* nucleus by the subsequent emission of alpha. The corresponding nuclear reaction is given. Calculate the energy released in the given nuclear reaction using data given below:

$${}^{6}_{3}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{3}_{1}H$$

${}^{6}_{3}Li$ = 6.015126u, ${}^{1}_{0}n$ = 1.008665 u,

${}^{4}_{2}He$ = 4.002604u, ${}^{3}_{1}H$ = 3.016049u, 1 u =931.5 MeV/C^2

Ans:

$^{6}_{3}Li + ^{1}_{0}n \rightarrow ^{4}_{2}He + ^{3}_{1}H$

$\Delta M = \left\{m\left(^{6}_{3}Li\right) + m(^{1}_{0}n)\right\} - \left\{m\left(^{4}_{2}He\right) + m(^{3}_{1}H)\right\}$=7.023791 u-7.018653 u =0.005138 u

Energy released=0.005138 u x 931.5 MeV=4.786 MeV

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48. In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where the path difference is λ, is K units. Find out the intensity of light at a point where the path difference is 2λ / 3.

For monochromatic light intensity.

$I' = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos\phi$

Phase difference is given by

$\phi = 2\pi/\lambda$ x path difference

$\phi = 2\pi \times \lambda / \lambda$

$= 2\pi$

So, the new intensity can be obtained as: $\Rightarrow I' = 4I_1$

given $I' = K$, $I_1 = K/4$, path difference$=\lambda/3$

phase difference is $2\pi \times 1/3$

Hence, $I = I_1 + I_2 + 2I_1I_2 \cos 2\pi/3$

$\Rightarrow I = I_1 = K/4$

49. In an experiment on photo electric emission, following observations were made;(i) wave length of incident light = 1.98 x 10^{-7}m(ii) stopping potential = 2.5 V. Find (a) kinetic energy of photo electrons with maximum speed(b) work function & (c) threshold frequency

(a) Kmax = 2.5eV (b) work function = E=ϕo+KEmax➔hc/λ –Kemax➔(1237/198)eV - 2.5Ev= 3.76eV

(c) threshold frequency = ϕo=hνo➔νo=3.76x1.6x10-19/6.6x10-34= 9.1x 1014Hz

50. Identify the part of the electromagnetic spectrum which is (i) Suitable for radar systems used in aircraft navigation. Microwaves (0.1m-1mm or 10^{9}-10^{11}Hz))(ii) Produced in nuclear reactions gamma rays(<10^{-3}nm or 10^{18}-10^{23} Hz)) (iii) Produced by bombarding a metal target by high Speed? X-ray(1nm-10^{-3}nm or 10^{17}-10^{20}Hz)

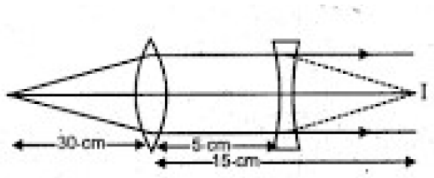
51. State Huygens's principle. For reflection of a plane wavefront at a plane reflecting surface, construct the corresponding Reflected wavefront. Using this diagram, prove that angle of incidence is equal to the angle of reflection

52. Draw the ray diagram for the refraction of light through a glass prism. Obtain the relation for the angle of deviation in terms of angle of incidence, angle of emergence and angle of prism. Hence derive the relation for the refractive index of the glass prism in terms of angle of prism and angle of minimum deviation.

OR

(a)A convex lens of focal length 10 cm is placed coaxially 5 cm away from a concave lens of focal length 10 cm. If an object is placed 30 cm in front of the convex lens, find the position of the final image formed by the combined system.

(b) A biconvex lens has a focal length 2/3 times the radius of curvature of either surface. Calculate the refractive index of lens material.



for convex lens, u_1=-30cm, f_1=+10cm,V_1=?

$\frac{1}{V_1} - \frac{1}{U_1} = \frac{1}{f_1} \Rightarrow \frac{1}{V_1} - \frac{1}{-30} = \frac{1}{10}$

$\Rightarrow v_1$=15cm

Image formed by convex lens 1 will act as an virtual object

for concave lens 2.

for concave lens, u_2=+10 cm, f_2=-10cm,V_2=?

$\frac{1}{V_2} - \frac{1}{U_2} = \frac{1}{f_2} \Rightarrow \frac{1}{V_2} - \frac{1}{10} = \frac{1}{-10} \Rightarrow$ v_2= infinity

Here f =+$\frac{2}{3}R$, R_1=+R and

R_2= -R

From lens maker's formula

$\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{3}{2R} = (n_{21} - 1)\left(\frac{1}{R} - \frac{1}{-R}\right)$

$\frac{3}{2R} = (n_{21} - 1)\left(\frac{2}{R}\right) \Rightarrow n_{21} = 1.75$

53. Use de-Broglie's hypothesis to write the relation for the nth radius of Bohr orbit in terms of Bohr's quantization condition of orbital angular momentum.

Ans:2πrn=nh/mvn➔rn=n2h2 εo/mπe2

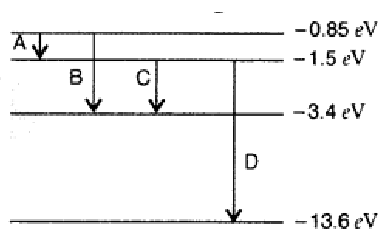
8.a) Using the Bohr's model calculate the speed of the electron in a hydrogen atom in the *n* = 1, 2, and 3 levels. b) Calculate the orbital period in each of these levels.

Ans:speed➔v=c/n α=v1=2.19x106m/s,v2=1.095x106m/s,v3=.

73x106m/s

T1=1.52x10-16s,T2=1.216X10-15s,T3=4.1x10-15s

54.The energy level diagram of an element is given. Identify, by doing necessary calculations, which transition corresponds to the emission of a spectral line of wavelength 102 nm



Ans:E=12.1eV➔D

55. a) Give one point of difference between nuclear fission and nuclear fusion.

b) Suppose we consider fission of a ${}_{26}Fe^{56}$ into two equal fragments of ${}_{13}Al^{28}$ nucleus. Is the fission energetically possible? Justify your answer by working out Q value of the process. Given (m) ${}_{26}Fe^{56}$ = 55.93494 u and (m) ${}_{13}Al^{28}$ = 27.98191u

ans:

Q=[m(.26Fe56)−2m(.13Al28)]×931.5MeV=[55.93494−2×27.9819]×931.5MeVQ=[m(.26Fe56)-2m(.13Al28)]×931.5MeV=[55.93494-2×27.9819]×931.5MeV

Q=−0.02886×931.5MeV=−26.88MeVQ=-0.02886×931.5MeV=-26.88MeV, which is negative.

The fission is not possible energetically.

56. a) What is pn junction diode? Explain the terms ‘depletion layer’ and ‘potential barrier’ in a p-n junction diode. How are the (a) width of depletion layer, and (b) value of potential barrier affected when the p-n junction is forward biased?

b) With the help of a labeled circuit diagram, explain full wave rectification using junction diode. Draw input and output wave forms?

57. a) State basic postulates of Bohr’s theory.

b) Using Bohr’s postulates, derive the expression for total energy and radius of orbit of the electron in the stationary states of the hydrogen atom.

58. a) What is meant by nuclear fission and nuclear chain reaction? Draw a labelled diagram of nuclear reactor.

b) Explain nuclear fusion reaction with an example.

59. What are extrinsic semiconductors? What are different types? Explain them in detail with relevant diagrams. Distinguish their features using energy band diagrams

SECTION D

60) (a) Draw a ray diagram for the formation of image in a compound microscope. Write the expression for its magnifying power.

(b)A compound microscope has an objective of focal length 1cm and an eye piece of focal length 2.5cm. An object has to be placed at a distance of 1.2cm away from the objective for normal adjustment. Find the angular magnification?

Lens formula, vo=6, magnification M=mome=D/fe x vo/uo =50

OR

(a)Trace the rays of light showing the formation of an image due to a point object placed on the axis of a convex spherical surface separating the two media of refractive indices n1 and n2. Establish the relation between the object and image distance in terms of refractive index of the medium and the radius of curvature of the curved spherical surface.

(b) The image obtained with a convex lens is erect and its length is four times the length of the object. If the focal length of the lens is 20 cm, calculate the object and image distances. u=15cm,v=60cm

61) (a)State Gauss's law in electrostatics. Use Gauss' law to derive the expression for electric field E due to a straight uniformly charged infinite line of charge density λ C/m.

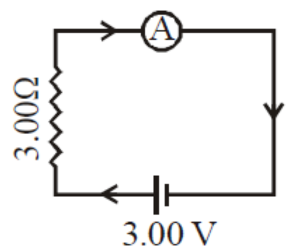
(b)Draw a graph to show the variation of E with perpendicular distance r from the line charge.

(c)Find the work done in bringing a charge q from perpendicular distance r_1 to r_2(r_2> r_1)

OR

(a) Obtain the expression for the deflecting torque acting on the current carrying rectangular coil of a galvanometer in a uniform magnetic field.Why is radial magnetic field employed in MCG?

(b) In the given circuit,the current is to be measured.what is the value of the current if the ammeter shown (a)is a galvanometer with a resistance R_G=60Ω (b)galvanometer described in (a)is converted to an ammeter by a shunt resistance r_s=0.02 Ω



Ans:

Let G be the resistance of ammeter (i.e. galvanometer). Then current in the circuit,

$$I = \frac{\varepsilon}{R+G} = \frac{3 \cdot 00}{3 \cdot 00 + 60 \cdot 00} = 0 \cdot 048A.$$

(ii) When the ammeter (i.e., galvanometer) is shunted with resistance S, its effective resistance,

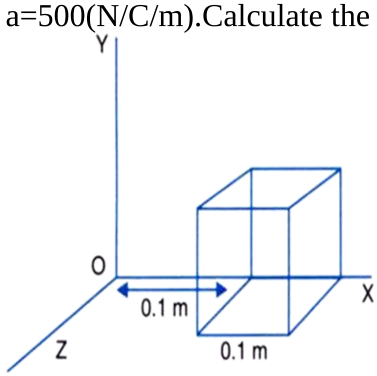
$$R_p = \frac{GS}{G+S} = \frac{60 \times 0 \cdot 02}{60 + 0 \cdot 02} \approx 0 \cdot 02\Omega$$

Current in the circuit,

$$I = \frac{\varepsilon}{R+R_p} = \frac{3 \cdot 00}{3 \cdot 00 + \ \cdot 02} \approx 0 \cdot 99A.$$

61.(a)What is Gauss's theorem for electrostatics? Apply this theorem to find E due to an infinitely long straight uniformly charged wire.

(b) The electric field components due to a charge inside the cube of side 0.1m are Ex=ax, where a=500(N/C/m).Calculate the flux through the cube and charge inside it.



$X = a$ is

$\therefore \quad E_L = \alpha\, a$

$\phi_L = \vec{E}_L \cdot \Delta\vec{S} = \alpha\, aa^2 \cos 180°$

$= -\alpha\, a^3 \qquad\qquad [\because E = \alpha\, x]$

and electric field at the right face, $x = a + a = 2a$ is

$\therefore \quad E_R = \alpha\,(2a)$

$\phi_R = \vec{E}_R \cdot \Delta\vec{S} = \alpha\,(2a)\, a^2 \cos 0^0$

$= 2\,\alpha\, a^3$

$\therefore$Net flux through the cube $= \phi_L + \phi_R$

$= -\alpha\, a^3 + 2\alpha\, a^3$

$= \alpha\, a^3 = 500 \times (0.1)^3 = 0.5\ \text{Nm}^2\ \text{C}^{-1}$

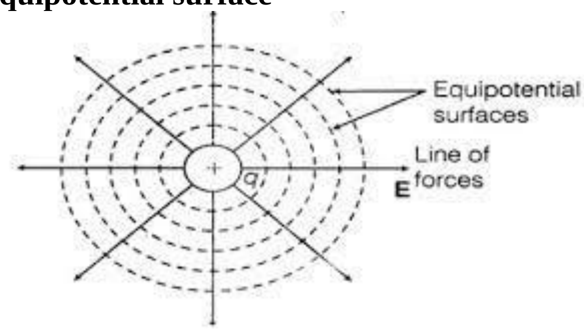
Ans with a=800
Total flux=0.8Nm^2/C,charge=7.08x10^-12C

SECTION E

1.Case Study:

Read the following paragraph and answer the questions.

Equipotential surface



The surface which is the locus of all points which are at the same potential is known as the equipotential surface. No work is required to move a charge from one point to another on the equipotential surface. In other words, any surface with the same electric potential at every point is termed as an equipotential surface. If a point charge is moved from point VA to VB, in an equipotential surface, then the work done in moving the charge is given by W = q (VA –VB).

i. A charged particle (q =1.4 mC) moves a distance of 0.4 m along an equipotential surface of 10 V, Calculate the work done by the field during this motion.(1M) 0
ii. For any charge configuration, equipotential surface through a point is normal to the electric field at that point. Justify.(1M)
iii. Draw equipotential surfaces for(a) a dipole (b)uniform electric field. (2M)

2.Case Study:

Electromagnetic Spectrum

The systematic sequential distribution of electromagnetic waves in ascending or descending order of frequency or wavelength is known as electromagnetic spectrum. The range varies from 10^{-12} m, to 10^{4} m, i.e. from γ-rays to radio waves. The electromagnetic waves include visible light rays, X-rays, gamma rays, radio waves, microwaves, UV rays and infrared waves.

i. Arrange the electromagnetic waves in the decreasing order of frequency with their frequency range.gamma,x-ray,uv…..radio
ii. How infrared waves are produced? Give their uses. hot bodies,remote,lamp

iii. An electromagnetic wave has electric field amplitude E_o=120N/C and frequency ν=50MHz.Determine B_o, ω, k and λ. B_o=40x10^{-8} T , ω=314x10^6rad/s, k=1.04 rad/m and λ=6m

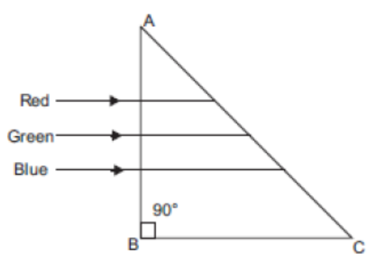
3.TOTAL INTERNAL REFLECTION

When light travels from an optically denser medium to a rarer medium at the interface, it is partly reflected back into the same medium and partly refracted to the second medium. This reflection is called the internal reflection.When a ray of light enters from a denser medium to a rarer medium, it bends away from the normal. If the angle of incidence is greater than critical angle then the incident ray is totally reflected.

(A)For a ray of light travelling from a denser medium of refractive index $n1$ to a rarer medium of refractive index $n2$. The correct relation is

(i) n_{21} =sin i_c (ii)n_{21} =1/sin i_c (iii)n_{12} =sini_c (iv) n_{21} = i_c

(B)In the figure given below, light rays of blue, green, red wavelengths are incident on an isosceles right angled prism. The refractive index of the prism for red, green, blue light are 1.39, 1.424, 1.476 respectively. The ray of light which will be transmitted through the face AC.



Red➔sin ic=1/1.39=0.719

Green➔sin ic=1/1.424=0.702

Blue➔sin ic=1/1.476=0.677

sin i=sin 45=0.707

for transmission, sin i <sin ic➔0.707<0.719➔red

(i) Green (ii) Red (iii) Blue (iv) None of these

(C) Velocity of light in glass is 2 x 10^8m/s and in air is 3 x 10^8 m/s. Value of critical angle is

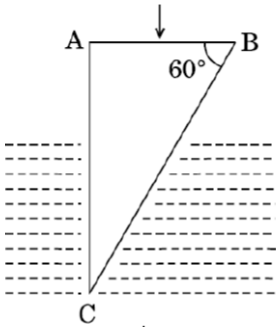
(i) $\sin^{-1}$(0.67) (ii) $\sin^{-1}$(0.71) (iii) $\sin^{-1}$(0.77) (iv) $\sin^{-1}$(0.50)

(D)Which among the following is not an application of TIR?

(i)optical fibers (ii)Prism (iii)mirage (iv)microscopes

(E) A ray of light incident normally on the face AB of a right angled glass prism of refractive index 1.5. The prism is partly immersed in a liquid of unknown refractive index.

Find the value of refractive index of the liquid so that the ray grazes along the face BC after refraction through the prism.



(i)1.5 (ii)1.29 (ii)0.75 (iv)1.66

Here the critical angle for interface BC is also 60^0 so from

$\sin i_c = n_r / n_d$ we have $n_l = n_d \times \sin i_c = 1.5 \times \sqrt{3}/2 = 1.299$

4.**Lens maker's formula** is the relation between the focal length of a lens to the refractive index of its material and the radii of curvature of its two surfaces. Lens maker formula is used to construct a lens with the specified focal length. A lens has two curved surfaces, but these are not exactly the same. If we know the refractive index and the radius of the curvature of both the surface, then we can determine the focal length of the lens by using the given lens maker's formula:

$$\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

(A)A converging lens has a focal length of power +5D in air. It is made of a material of refractive index 1,6. It is immersed in a liquid of refractive index 1.3. Its new focal length in liquid will be (i)65cm (ii)45 cm (iii)52cm (iv) 72cm

(B)A diverging lens of refractive index 1.5 and of focal length 15 cm in air has the same radii of curvature for both sides. If it is immersed in a liquid of refractive index 1.7, the focal length of the lens in the liquid will be (i)63.75 cm (ii)-63.75cm (iii) 55 cm (iv)-55cm

(C)Focal length of a plano-convex lens is 0.3 m and the refractive index of the material of the lens is 1.5. The radius of curvature of the convex surface of a plano-convex lens will be

(i) 15cm (ii)30 cm (iii)20cm (iv) 25cm

(D)The radii of curvature of the faces of a double convex lens are 10 cm and 15 cm. If focal length of the lens is 12 cm, then the refractive index of the material of the lens is

(i)1.33 (ii)1.414 (iii)1.5 (iv) 2

(E)A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. The new nature of the lens will be

(i) diverging (ii) converging (iii) behave as a plane glass slab (iv) can’t say

(Ans: (A)-(iii),(B)-(ii),(C)-(i),(D)-(iii),(E)-(ii))