SECTION 'A'

01. An electric dipole is at stable equilibrium in a uniform external electric field when the angle between $\vec{p} and \vec{E}$.

A) 90^0 B) 180^0 C) 0^0 D) 270^0

02. In an ac circuit at resonance the power factor is

A) 1 B) 0 C) 0.5 D) 1.414

03. Which one of the following instrument has least resistance?

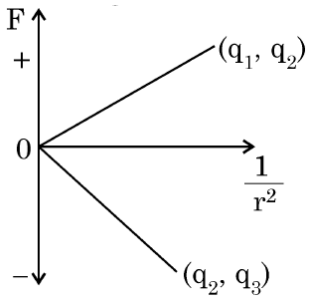
A) Ammeter of range 0-1 amp

B) Voltmeter of range 0-1 volt

C) Ammeter of range 0-10 amp

D) Voltmeter of range 0-10 volt

04.



The Coulomb force versus $\frac{1}{r^2}$ graphs for two pair of charges $(q_1 and\ q_2)$ and $(q_2 and\ q_3)$ are shown. The charge q_2 is positive and has least magnitude then, magnitude of chares related as:

A) $q_1 > q_2 > q_3$ B) $q_1 > q_3 > q_2$

C) $q_3 > q_2 > q_1$ D) $q_3 > q_1 > q_2$

05. The minimum distance between an object and its real image formed by a convex lens of focal length 'f' is :

A) f B) 6f C) 2f D) 4f

06. When a plane wave front is refracted by a convex lens of focal length 'f' , the refracted wave front is a

A) Spherical wave front with radius f

C) Spherical wave front with radius f/2

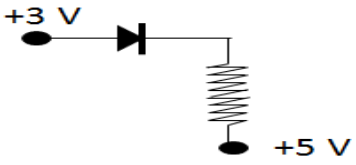
B) Spherical wave front with radius 2f

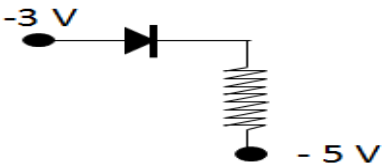
D) Spherical wave front with radius 4f

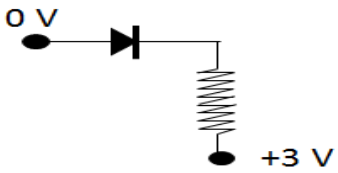
07. The ratio of nuclear radii of two nuclei of mass number 27 and 64 is

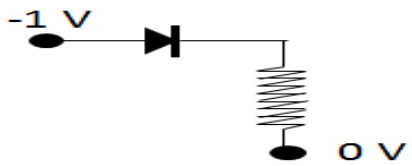
A) $\frac{9}{289}$ B) $\frac{27}{64}$ C) $\frac{3}{4}$ D) $\sqrt{\frac{3}{17}}$

08. Which one of the following diodes is conducting

A) 

B) 

C) 

D) 

09. Approximate energy released in a complete fusion of uranium 235 is:

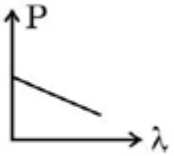
A) 200 MeV B) 400 MeV C) 200 KeV D) 100 MeV

10. Which of the following graphs represents the variation of momentum of a particle with the de-Broglie wavelength associated with it

A) 

B) 

C) 

D) 

11. A convex lens of focal length 30cm is in contact with a concave lens of focal length 20cm? Then this act as a

A) Converging lens of focal length 60 cm

B) Diverging lens of focal length 60 cm

C) Converging lens of focal length 12 cm

D) Diverging lens of focal length 12 cm

12. At the centre of the dipole

A) Electric field = 0 and potential = 0

B) Electric field≠ 0 and potential = 0

C) Electric field ≠ 0 and potential ≠ 0

D) Electric field = 0 and potential ≠ 0

Assertion and Reason type questions

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

13. **Assertion (A)** Magnetic field lines form closed loops.
Reason (R) Source of magnetism is electric current.

14. **Assertion (A)** Electric potential energy is negative
Reason (R) Work is done in the direction of the electric field

15. **Assertion (A)** Isotones have identical chemical behavior.
Reason (R) They have same electronic structure.

16. **Assertion (A)** Gamma rays have very high penetrative power.
Reason (R) The speed of gamma rays in free space is $3 \times 10^8\ m/s$

SECTION 'B'

17. A short bar magnet of magnetic moment m = 0.32 JT^{-1} is placed in a uniform magnetic field of 0.15 T. If the bar is free to rotate in the plane of the field, which orientation would correspond to its (a) stable, and (b) unstable equilibrium? What is the potential energy of the magnet in each case?

18. A charge of 6 μC is given to a hollow metallic sphere of radius 0.2 m. Find the potential at (i) the surface and (ii) the centre of the sphere.

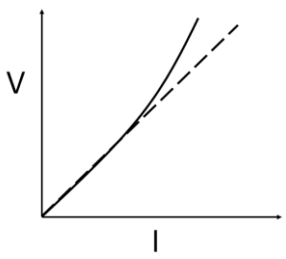
19. I The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. What is the De-Broglie's wavelength corresponds to the third level of the hydrogen atom?

[OR]

II a) Draw the energy level diagram of a hydrogen atom for levels 1 to 4.
b) Calculate the potential and kinetic energy of the electron in the ground state of a hydrogen atom.

20. a) Draw the cross sectional view of varying electric field and magnetic field between the plates of a parallel plate capacitor connected to an alternating source of emf.
b) State the generalised Ampere circuital law called as Ampere-Maxwell law.

21. In this V-I graph dashed line represents the linear Ohm's law. The solid line is the voltage V versus current I for a good conductor. This graphs shows Ohm's law is violated at high current region. Why?



SECTION 'C'

22. Four identical cells, each of emf 2 V, are joined in parallel providing supply of current to external circuit of resistance 7.5Ω The terminal voltage of the cells, as read by an ideal voltmeter is 1.6 volt. Calculate the internal resistance of each cell by drawing a correct circuit diagram of the arrangement.

23. a) Prove Snell's law using Huygens principle.

b) A ray of monochromatic light propagating in air, is incident on the surface of water and partially reflected and partially refracted. Which characteristic of the wave is same for both reflected and refracted waves?

24. a) Draw the V-I characteristics of a p-n junction diode for forward and reverse biased conditions.
b) What do you mean by cut-in voltage?
c) Why the reverse current is very small and saturated within the limit of breakdown voltage?

25. a) Draw the graph showing the binding energy per nucleon as a function of mass number.

b) If the mass defect of ${}^{16}_{8}O$ is 0.13691u calculate it's binding energy per nucleon in MeV.

26. I a) Derive an expression for self-inductance of a solenoid. Write the expression for the self-inductance of the solenoid if it's interior is a material of relative permeability μ_r.

b) Why work has to be done to vary current in a solenoid?

[OR]

II a) You are given three circuit elements X, Y and Z. They are connected one by one across a given ac source. It is found that V and I are in phase for element 'X', V leads I by ($\pi/2$) for the element 'Y' while I leads V by ($\pi/2$) for the element. Identify elements X, Y and Z.

b) Establish the expression for impedance of circuit when elements X, Y and Z are connected in series with an ac source.

27. In the experimental set up for study of photoelectric effect, the cathode is coated with cesium of threshold frequency 5.16×10^{14} Hz. Frequency of incident radiation on the cathode is 6.6×10^{14} Hz and number photons incident per second is 5×10^{15}.

a) For this data draw the graph for the variation of photoelectric current with collector plate potential.

b) If the threshold frequency of calcium is 7.7×10^{14} Hz, draw a graph showing Variation of stopping potential V_0 with frequency n of incident radiation for cesium and calcium.

28. With a circuit diagram explain the working of half wave rectifier and draw the input and output waveforms.

SECTION 'D'

Case Study Based Question

29.

Aurora Boriolis

In Polar Regions like Alaska and Northern Canada, a splendid display of colours is seen in the sky. The appearance of dancing green pink lights is fascinating, and equally puzzling. This phenomenon is called Aurora Boriolis in physics. An explanation of this natural phenomenon is now found in physics, in terms motion of charges in a magnetic field.

Consider a charged particle of mass m and charge q, entering a region of magnetic field $\vec{B}$ with an initial velocity $\vec{v}$. When $\vec{v}$ is inclined to $\vec{B}$ the velocity have a component $\vec{v}_p$ parallel to the magnetic field and a component $\vec{v}_n$ normal to it. There is no force on a charged particle in the direction of the field. Hence the particle continues to travel with the velocity $\vec{v}_p$ parallel to the field. The normal component $\vec{v}_n$ of the particle results in a Lorentz force $(\vec{v}_n \times \vec{B})$ which is perpendicular to both $\vec{v}_n$ and $\vec{B}$. Hence the particle thus has a tendency to perform a circular motion in a plane perpendicular to the magnetic field. When this is coupled with the velocity parallel to the field, the resulting trajectory will be a helix along the magnetic field line. Even if the field line bends, the helically moving particle is trapped and guided to move around the field line. Since the Lorentz force is normal to the velocity of each point, the field does no work on the particle and the magnitude of velocity remains the same.

If θ is the angle between $\vec{v}$ and $\vec{B}$, answer the following questions

I. The ratio of pitch of the helix to it's radius is

A) 2π /tan θ B) $2\pi \tan\theta$

C) $2\pi \cos\theta$ D) $2\pi \sin\theta$

II. Which one of the following is independent of θ, when the charges particle is executing helical motion

A) Pitch B) Radius

C) Frequency D) None of the above

III. A charged particle with a velocity $v\hat{\imath}$ enters a region with uniform magnetic field $B\hat{\jmath}$ then the particle will undergo

A) Helical motion in x-z plane B) Circular motion in x-y plane

C) Circular motion in y-z plane D) Circular motion in x-z plane

IV. i) If 'R' is the radius of a proton executing uniform circular motion in a uniform magnetic field. What will be the radius of an alpha particle projected in to the same field under the same condition?

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

[OR]

ii) If the proton is moving parallel to uniform magnetic field with constant velocity $\vec{v}$, the force acting on the proton is

A) Be/v B) Bev C) B/ev D) Zero

30. **Lenses and lens maker's formula**

A lens is a transparent optical medium bounded by two surfaces; at least one of which should be spherical. There are different types of lenses, double convex lens, double concave lens, plano-convex lens, plano-concave lens and concavo convex lens. Lens makers formula is applicable to all these lenses. It is useful to design lenses of desired focal length using surfaces of suitable radii of curvature and medium of suitable refractive index. For concavo-convex one surface is convex and the other surface is concave, the nature of the lens depends on the radius of curvature of these surfaces when other factors remain the same.

I. Is it possible to have two lenses of same radius of curvature (equi-convex or equi-concave) can have different focal length when kept in the same medium.

A) No they should have different radius of curvature.

B) Yes they should have different refractive index.

C) Yes they should have same refractive index.

D) No the surrounding medium should be different.

II. Concavo-convex lenses are used to make

A) spectacles with power

B) spectacles without power

C) spectacles with protection from various hazards like uv radiation etc.

D) all the above

III. When a plano-convex lens of made of a material of refractive index 1.47 disappears when immersed in a liquid

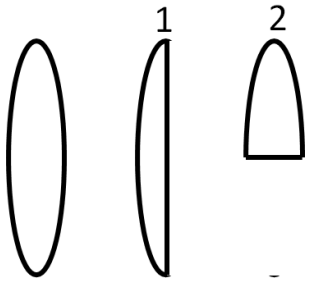
A) then the refractive index of the liquid is equal to 1.47

B) then the refractive index of the liquid is greater than 1.47

C) then the refractive index of the liquid is less than 1.47

D) then the refractive index of the liquid must be 1.

IV i. Two double convex lenses (both spherical has same radius of curvature) of focal length 'f' is made-up of transparent medium of refractive index n_2 kept in a medium of refractive index n_1. The lenses are cut in to two equal halves as shown. What will happen to the focal length and the brightness of the image formed by the pieces of these lenses marked as '1' and '2'? (neglect the thickness of the lens)



Options	For the piece '1'		For the piece '2'	
	Focal length	Brightness	Focal length	Brightness
A)	Doubles	Same	Same	Same
B)	Same	Becomes half	Becomes half	Becomes half
C)	Doubles	Same	Same	Becomes half
D)	Doubles	Becomes half	Doubles	Becomes half

[OR]

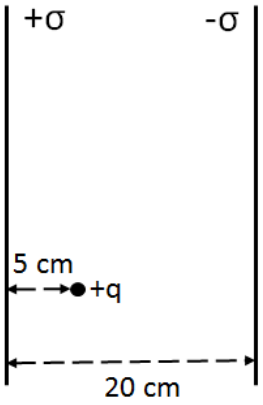
IV. ii. Focal length of double convex lens in air is 'f'. What will happen to the focal length of this lens when it is immersed in water of refractive index 1.33, the refractive index of glass is 1.5.

A) no change
B) 3.9 f
C) f becomes infinity
D) f / 3.9

SECTION 'E'

31 I a) Using Gauss law drive the expression for electric field due to charged conducting sphere of radius 'R' on a point with a position vector $\vec{r}$ with respect to the centre of the sphere when r > R and r < R.

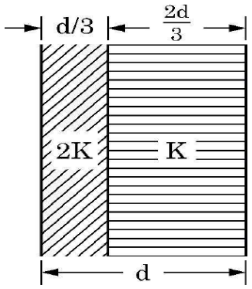
b) A charge of +q coulomb is kept between two uniformly charged infinite parallel plane sheets of surface charge density + σ and – σ. Find the magnitude and direction of the force acting on the charge q.
What will happen to the electric field outside the plates when the space between the plates is filled with a dielectric material with a dielectric constant 'K'.



[OR]

II a) Derive an expression for the capacitance of a capacitor when dielectric slab of dielectric constant 'K' inserted between the plates of the capacitor fully occupying the intervening region.

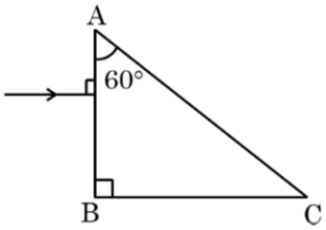
b) Two slabs of dielectric constants 2K and K fill the space between the plates of a parallel plate capacitor of plate area 'A' and plate separation 'd' as shown in figure. Find an expression for capacitance of the system.



32 I a) i. Trace the path of a ray of light showing refraction through a triangular prism and hence obtain an expression for angle of deviation (δ) in terms of A, i and e, where symbols have their usual meanings.

ii. Draw a graph showing the variation of angle of deviation with the angle of incidence.

b) Complete the ray diagram if the refractive index of the material of the prism is $\sqrt{2}$. Explain what happens to the ray of light whenever it under goes refraction at different interfaces.



[OR]

II a) Derive an expression for resultant amplitude due to interference of two light waves of amplitude 'a' and angular frequency 'ω' with a phase difference Φ
If I_0 is the intensity of the interfering waves what is the intensity of the resultant if i) Φ is constant and ii) Φ is varying with time

b) Why two identical independent ordinary light sources like sodium lamp never be coherent.

c) In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of light at a point where path difference is λ/3?

33 I a) With a labelled diagram of an ac generator briefly explain the working of the generator and derive the expressions for instantaneous emf.

b) A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s^{-1} in a uniform horizontal magnetic field of magnitude 3.0×10^{-2} T. Obtain the maximum and average emf induced in the coil. If the coil forms a closed loop of resistance 10 Ω, calculate i_{max} and i_{rms}.

[OR]

II a) With a labelled diagram of a transformer briefly explain the working of the transformer and derive an expression for transformer ratio.

b) A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5 Ω per km. The town gets power from the line through a 4000-220 V step-down transformer at a sub-station in the town. If the town gets power from the line through 40,000-220 V step down transformer, how much power could be saved?