# SAMPLE

# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

Set - 1

**PHYSICS**

Time: 3 Hours　　　　　　　　　　　　　　　　　　　　　　　　　　　Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$TmA$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$
vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

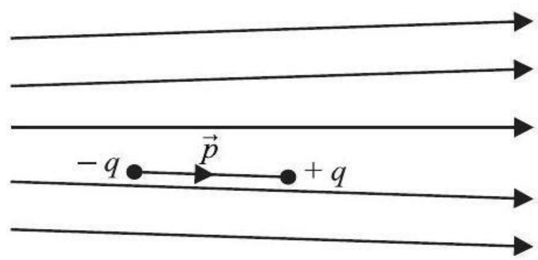
1. Figure shows electric field lines in which an electric dipole $p$ is placed as shown. Which of the following statements is correct?

(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.




2. Equipotential surfaces

   (a) are closer in regions of large electric fields compared to regions of lower electric fields

   (b) will be more crowded near sharp edges of a conductor

   (c) will always be equally spaced

   (d) both (a) and (b) are correct

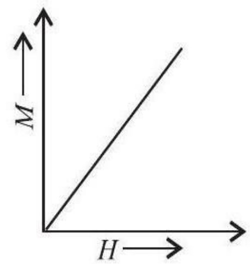
3. With increase in temperature the conductivity of
   (a) metals increases and of semiconductor decreases.
   (b) semiconductors increases and of metals decreases.
   (c) in both metals and semiconductors increases.
   (d) in both metal and semiconductor decreases.

4. A charged particle is moving on circular path with velocity $v$ in a uniform magnetic field $B$, if the velocity of the charged particle is doubled and strength of magnetic field is halved, then radius becomes
   (a) 8 times
   (b) 4 times
   (c) 2 times
   (d) 16 times

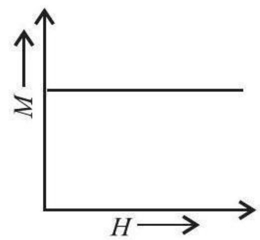
5. A strong magnetic field is applied on a stationary electron. Then the electron
   (a) moves in the direction of the field.
   (b) remains stationary.
   (c) moves perpendicular to the direction of the field.
   (d) moves opposite to the direction of the field.

6. The correct $M - H$ curve for a paramagnetic material at a constant temperature $(T)$ is represented by

   (a)




(b)

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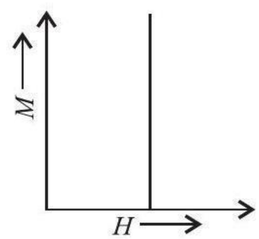
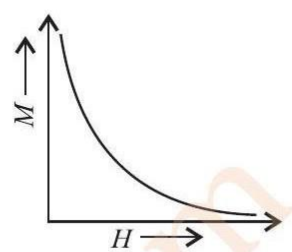



(d)




7. To reduce the resonant frequency in an series $LCR$ circuit with a generator
(a) the generator frequency should be reduced.
(b) another capacitor should be added in parallel to the first.
(c) the iron core of the inductor should be removed.
(d) dielectric in the capacitor should be removed.

8. The part of the spectrum of the electromagnetic radiation used to cook food is
(a) ultraviolet rays
(b) cosmic rays
(c) X rays
(d) microwaves

9. Which of the following statements is not correct?
(a) Whenever the amount of magnetic flux linked with a circuit changes, an emf is induced in the circuit.
(b) The induced emf lasts so long as the change in magnetic flux continues.
(c) The direction of induced emf is given by Lenz's law.
(d) Lenz's law is a consequence of the law of conservation of momentum.

10. Two slits in Young's double slit experiment have widths in the ratio $81:1$. The ratio of the amplitudes of light waves is
(a) $3:1$
(b) $3:2$
(c) $9:1$
(d) $6:1$

11. An electron is moving with an initial velocity $\vec{v} = v_0\hat{\imath}$ and is in a magnetic field $\vec{B} = B_0\hat{\jmath}$. Then its de Broglie wavelength
(a) remains constant
(b) increases with time
(c) decreases with time
(d) increases and decreases periodically

12. The radius of a spherical nucleus as measured by electron scattering is $3.6$fm. What is the mass number of the nucleus most likely to be?
(a) 27
(b) 40
(c) 56
(d) 120

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 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): The positively charged nucleus of an atom has a radius of almost $10^{-15}$ m.

Reason (R): In $\alpha$-particle scattering experiment, the distance of closest approach for $\alpha$-particles is $10^{-15}$ m.

14. Assertion (A): An alternating current shows magnetic effect.

Reason (R): Magnitude of alternating current varies with time.

15. Assertion (A): For best contrast between maxima and minima in the interference pattern of Young's double slit experiment, the intensity of light emerging out of the two slits should be equal.

Reason (R): The intensity of interference pattern is proportional to square of amplitude.

16. Assertion (A): Photosensitivity of a metal is high if its work function is small.

Reason (R): Work function $= h\nu_0$, where $\nu_0$ is the threshold frequency.

## SECTION B

17. Name the parts of the electromagnetic spectrum which is

(a) suitable for radar systems used in aircraft navigation.

(b) used to treat muscular strain.

(c) used as a diagnostic tool in medicine. Write in brief, how these waves can be produced.

18. The magnetic needle has magnetic moment $6.7 \times 10^{-2}$ A m$^2$ and moment of inertia $I = 7.5 \times 10^{-6}$ kg m$^2$. It performs 10 oscillations in 6.70 s. What is the magnitude of the magnetic field?

19. If both the number of protons and neutrons in a nuclear reaction is conserved, in what way is mass converted into energy (or vice versa)? Explain giving one example.

**OR**

In an experiment on $\alpha$-particle scattering by a thin foil of gold, draw a graph showing, the number of particles scattered versus the scattering angle $\theta$. Why is it that a very small fraction of the particles are scattered at $\theta > 90^\circ$ ?

Write two important conclusions that can be drawn regarding the structure of the atom from the study of this experiment.

20. An object of 3 cm height is placed at a distance of 60 cm from a convex mirror of focal length 30 cm. Find the (i) nature, (ii) position and (iii) size of the image formed.

21. Light of wavelength $6 \times 10^{-5}$ cm falls on a screen at a distance of 100 cm from a narrow slit. Find the width of the slit if the first minima lies 1 mm on either side of the central maximum.

## SECTION C

22. Two identical circular coils of radius 0.1 m, each having 20 turns are mounted co-axially 0.1 m apart. A current of 0.5 A is passed through both of them (i) in the same direction, (ii) in the opposite directions. Find the magnetic field at the centre of each coil.

23. A rectangular wire loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the loop. What is the emf developed across the cut if velocity of loop is 1 cm s$^{-1}$ in a direction normal to the (a) longer side (b) shorter side of the loop? For how long does the induced voltage last in each case?

24. A circuit is set up by connecting $L = 100\text{mH}, C = 5\mu\text{F}$ and $R = 100\Omega$ in series. An alternating emf of $150\sqrt{2}$ V, $\frac{500}{\pi}$ Hz is applied across this series combination. Calculate

(a) The impedance of the circuit.
(b) The peak value of the current flowing in the circuit.
(c) The power factor of this circuit.

**OR**

(a) For a given ac $i = i_0 \sin \omega t$, show that the average power dissipated in a resistor $R$ over a complete cycle is $\frac{1}{2} i_0^2 R$.

(b) A light bulb is rated at 100 W for a 220 V ac supply. Calculate the resistance of the bulb.

25. (a) An electron and a proton are accelerated through the same potential. Which one of the two has

(i) greater value of de-Broglie wavelength associated with it, and

(ii) lesser momentum? Justify your answer in each case.

(b) How is the momentum of a particle related with its de-Broglie wavelength? Show the variation on a graph.

**OR**

(a) Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation.

(b) The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from $\lambda_1$ to $\lambda_2$. Derive the expressions for the threshold wavelength $\lambda_0$ and work function for the metal surface

26. The value of ground state energy of hydrogen atom is $-13.6\text{eV}$.

(i) Find the energy required to move an electron from the ground state to the first excited state of the atom.

(ii) Determine (a) the kinetic energy and (b) orbital radius in the first excited state of the atom. (Given the value of Bohr radius $= 0.53\text{Å}$).

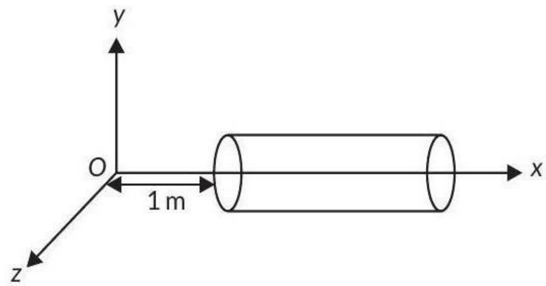
27. (i) Draw V-I characteristics of a $p - n$ junction diode.

(ii) Write the property of a junction diode which makes it suitable for rectification of ac voltages.

28. A hollow cylindrical box of length 1 m and area of cross-section 25 $\text{cm}^2$ is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 50x\hat{i}$, where $E$ is in $\text{NC}^{-1}$ and $x$ is in metres. Find

(i) net flux through the cylinder.

(ii) charge enclosed by the cylinder.



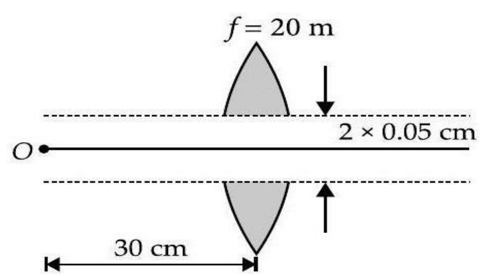

**SECTION D**

**Case Study Based Questions**

**29. Read the following paragraph and answer the questions that follow.**

A convex or converging lens is thicker at the centre than at the edges. It converges a parallel beam of light on refraction through it. It has a real focus. Convex lens is of three types : (i) Double convex lens (ii) Plano-convex lens (iii) Concavo-convex lens. Concave lens is thinner at the centre than at the edges. It diverges a parallel beam of light on refraction through it. It has a virtual focus.
(i) A point object $O$ is placed at a distance of $0.3$ m from a convex lens (focal length $0.2$ m ) cut into two halves each of which is displaced by $0.0005$ m as shown in figure.

What will be the location of the image?




(a) 30 cm right of lens
(b) 60 cm right of lens
(c) 70 cm left of lens
(d) 40 cm left of lens

(ii) Two thin lenses are in contact and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, the focal length of the other would be.
(a) $-26.7$ cm
(b) 60 cm

(c) 80 cm
(d) 20 cm

(iii) A spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a
(a) converging lens
(b) diverging lens
(c) plano-converging lens
(d) plano-diverging lens

(iv) Lens used in magnifying glass is
(a) Concave lens
(b) Convex lens
(c) Both (a) and (b)
(d) None of the above

**OR**

The magnification of an image by a convex lens is positive only when the object is placed
(a) at its focus $F$
(b) between $F$ and $2F$
(c) at $2F$
(d) between $F$ and optical centre

**30. Read the following paragraph and answer the questions that follow.**

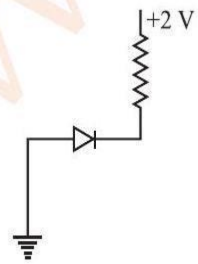
**Biasing of Diode**

When the diode is forward biased, it is found that beyond forward voltage $V = V_k$, called knee voltage, the conductivity is very high. At this value of battery biasing for $p - n$ junction, the potential barrier is overcome and the current increases rapidly with increase in forward voltage.

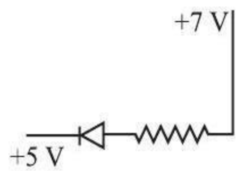
When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current.

(i) In which of the following figures, the $p - n$ diode is forward biased.

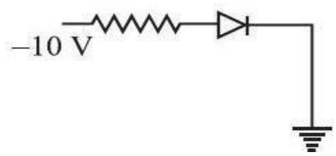
(a)




(c)




(b)

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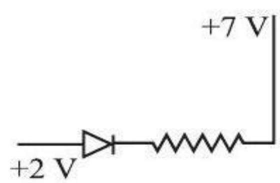
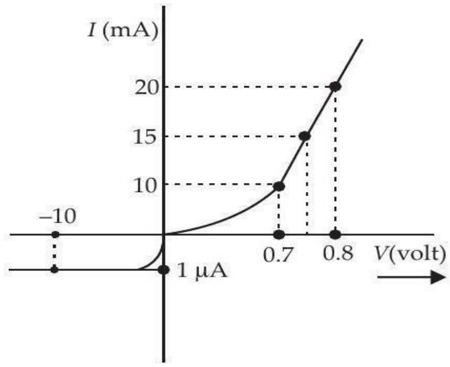



(ii) Based on the $V - I$ characteristics of the diode, we can classify diode as
(a) bi-directional device
(b) ohmic device
(c) non-ohmic device
(d) passive element
(iii) The $V - I$ characteristic of a diode is shown in the figure. The ratio of forward to reverse bias resistance is

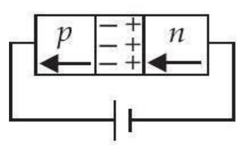



(a) 100
(b) $10^6$
(c) 10
(d) $10^{-6}$

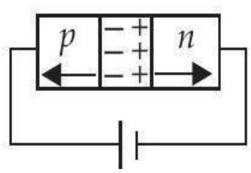
**OR**

In the case of forward biasing of a $p-n$ junction diode, which one of the following figures correctly depicts the direction of conventional current (indicated by an arrow mark)?

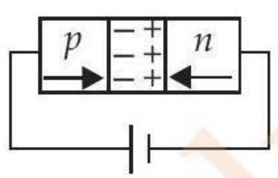
(a)



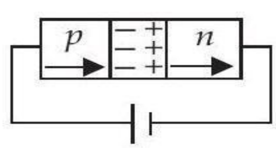

(b)



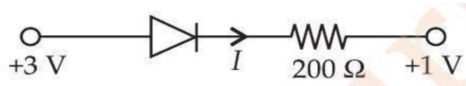

(c)




(d)



(iv) If an ideal junction diode is connected as shown, then the value of the current $I$ is




(a) 0.013 A
(b) 0.02 A
(c) 0.01 A
(d) 0.1 A

## SECTION E

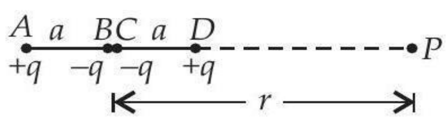
31. Consider a sphere of radius $R$ with charge density distributed as

$$\rho(r) = kr \quad \text{for} \quad r \leq R$$
$$= 0 \quad \text{for} \quad r > R.$$

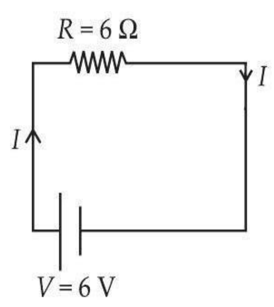
Suppose the total charge on the sphere is $2e$ where $e$ is the electron charge. Where can two protons be embedded such that the force on each of them is zero? Assume that the introduction of the proton does not alter the negative charge distribution.

**OR**

Figure shows a charge array known as an electric quadrupole. For a point on the axis of quadrupole, obtain the dependence of potential on $r$ for $r/a \gg 1$, and contrast your results with that due to an electric dipole, and an electric monopole (i.e., a single charge).



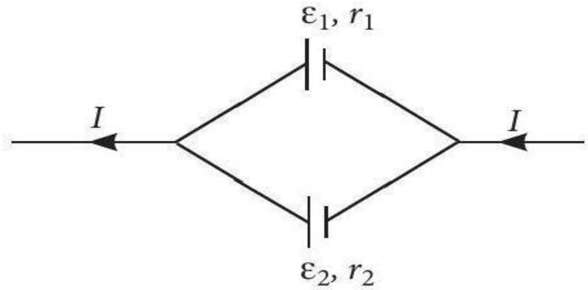

32. (a) Consider circuit shown in figure. How much energy is absorbed by electrons from the initial state of no current (ignore thermal motion) to the state of drift velocity?




(b) Electrons give up energy at the rate of $RI^2$ per second to the thermal energy. What time scale would one associate with energy in problem (a)? Given, $n$ = no. of electron / volume $= 10^{29}/\text{m}^3$, length of circuit $= 10$ cm, cross-section, $A = 1$ mm$^2$.

**OR**

Two cells of emf $\varepsilon_1, \varepsilon_2$ and internal resistance $r_1$ and $r_2$ respectively are connected in parallel in the figure.




Deduct the expression for

(i) The equivalent emf of the combination.

(ii) The equivalent resistance of the combination.

(iii) The potential difference between the points $A$ and $B$.

33. (a) Draw the intensity pattern for single slit diffraction and double slit interference. Hence, state differences between interference and diffraction patterns.

(b) What is the effect on the interference fringes in Young's double slit experiment when (i) the width of the source slit is increased; (ii) the monochromatic source is replaced by a source of white light?

**OR**

(a) Draw a ray diagram showing the image formation by an astronomical telescope when the final image is formed at infinite.

(b) (i) A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. Find the magnifying power of the telescope for viewing distant objects when the telescope is in normal adjustment and the final image is formed at the least distance of distinct vision.

(ii) Also find the separation between the objective lens and the eyepiece in normal adjustment.

# SAMPLE PAPER

# SOLUTION

# PHYSICS

## CLASS 12

Set - 1

**SOLUTIONS**

1. (c): The spacing between electric lines of force increases from left to right. Therefore, $E$ on left is greater than $E$ on right. Force on $+q$ charge of dipole is smaller and to the right. Force on $-q$ charge of dipole is bigger and to the left. Hence the dipole will experience a force towards the left.

2. (d) : Electric field, $E = -\frac{dV}{dr}$ or $dr \propto \frac{1}{E}$

i.e., equipotential surfaces are closer in regions of large electric fields compared to regions of lower electric field. At sharp edges of a conductor, charge density is more. Therefore electric field is stronger. Hence equipotential surfaces are more crowded.

3. (b) : Semiconductors having negative temperature coefficient of resistivity whereas metals are having positive temperature coefficient of resistivity with increase in temperature the resistivity of metal increases whereas resistivity of semiconductor decreases.

4. (b) : As $Bqv = \frac{mv^2}{r}$ or $r = \frac{mv}{Bq}$

According to the question, $v' = 2v$ and $B' = \frac{B}{2}$

$\therefore\ r' = \frac{mv'}{B'q} = \frac{m(2v)}{(B/2)q} = \frac{4mv}{Bq} = 4r$

5. (b) : As $\vec{F} = \vec{q}(\vec{v} \times \vec{B})$

As the electron is stationary, $\therefore$ velocity $\vec{v} = 0$.

$\therefore \vec{F} = 0$. So, electron will remain stationary.

6. (a) : Since intensity of magnetisation $(M)$ of a paramagnetic material is given by

$M = C\frac{B}{T} = C\mu_0\frac{H}{T}$ as $\frac{C\mu_0}{T}$ is constant.

Then $M \propto H$

Hence, the $M_H$ curve will be a straight line with the slope $C\mu_0$.

7. (b) : Resonant frequency in a series LCR circuit is

$$v_r = \frac{1}{2\pi\sqrt{LC}}$$

If capacitance $C$ increases the resonant frequency will reduce, which can be achieved by adding another capacitor in parallel to the first.

8. (d) : Microwaves are used to cook food. Microwave oven is a domestic application of these waves.

9. (d)

10. (c) : Width ratio, $\frac{\beta_1}{2} = \frac{I_1}{I_2} = \frac{81}{1}$

∴ Amplitude ratio, $\frac{A_1}{A_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{81}{1}} = 9:1$

11. (a): Here, $\vec{v} = v_0\hat{\imath}, \vec{B} = B_0\hat{\jmath}$

Force on moving electron due to magnetic field is

$\vec{F} = -e(\vec{v} \times \vec{B}) = -e(v_0\hat{\imath} \times B_0\hat{\jmath}) = -ev_0B_0\hat{k}$

As this force is perpendicular to $\vec{v}$ and $\vec{B}$, so the magnitude of $\vec{v}$ will not change. i.e momentum $(= mv)$ will remains constant in magnitude.

Therefore, de Broglie wavelength, $\lambda\ (= \frac{h}{mv})$ remains

12. (a): Nuclear radius, $R = R_0(A)^{1/3}$

where $A$ is the mass number of a nucleus.

Given, $R = 3.6\text{fm}$

$\therefore 3.6\text{fm} = (1.2\text{fm})(A^{1/3})$ $[\because R_0 = 1.2\text{fm}]$

or $A = (3)^3 = 27$

13. (a) : In $\alpha$-particle scattering experiment, Rutherford found a small number of $\alpha$-particles which were scattered back through an angle approaching to $180^\circ$. This is possible only if the positive charges are concentrated at the centre or nucleus of the atom.

14. (b) : Like direct current, an alternating current also produces magnetic field. But the magnitude and direction of the field goes on changing continuously with time.

15. (b) : When intensity of light emerging from two slits is equal, the intensity at minima,

$I_{\min} = (\sqrt{I_a} - \sqrt{I_b})^2 = 0$, or absolute dark.

16. (b) : Less work function means less energy is required for ejecting out the electrons.

17. (a) Microwaves are suitable for radar systems used in aircraft navigation.

These waves are produced by special vacuum tubes, namely klystrons, magnetrons and Gunn diodes.

(b) Infra-red waves are used to treat muscular pain. These waves are produced by hot bodies and molecules.

(c) X-rays are used as a diagnostic tool in medicine. These are produced when high energy electrons are stopped suddenly on a metal of high atomic number.

18. $T = 2\pi \times \sqrt{\frac{I}{MB}}, 0.67 = 2\pi\sqrt{\frac{7.5\times10^{-6}}{6.7\times10^{-2}(B)}}$

$B = 0.01$ T

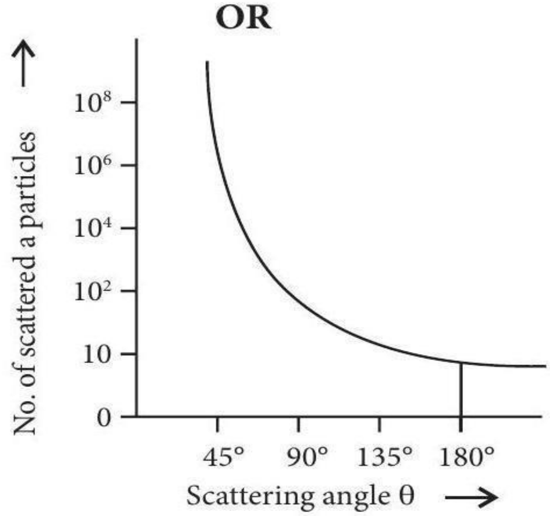
19. A certain number of neutrons and protons are brought together to form a nucleus of a certain charge and mass, an energy $\Delta E_b$ will be released in this process.

The energy $\Delta E_b$ is called the binding energy of the nucleus. If we separate a nucleus into its nucleons we would have to transfer a total energy equal to $\Delta E_b$, to the nucleons.

Example : ${}^{235}_{92}\mathrm{U} + {}_0n^1 \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^1_0n + \mathrm{Q}$

The energy (Q) released was estimated to be $200\mathrm{MeV}$ per fission (or about $0.9\mathrm{MeV}$ per nucleon) and is equivalent to the difference in masses of the nuclei before and after the fission.

**OR**




A very small fraction of $\alpha$-particles are scattered at $\theta > 90^\circ$ because the size of nucleus is very small nearly $1/8000$ times the size of atom. So, a few $\alpha$-particles experience a strong repulsive force and turn back.

Conclusions :

(i) Entire positive charge and most of the mass of the atom is concentrated in the nucleus with the electrons some distance away.

(ii) Size of the nucleus is about $10^{-15}$ m to $10^{-14}$ m, while size of the atom is $10^{-10}$ m, so the electrons are at distance $10^4$ m to $10^5$ m from the nucleus, and being large empty space in the atom, most $\alpha$ particles go through the empty space.

20. Here, height of object $h = 3$ cm

$u = -60$ cm, $f = +30$ cm

Using the mirror formula, we have

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

$$\frac{1}{v} + \frac{1}{-60} = \frac{1}{30} \Rightarrow \frac{1}{v} = \frac{1}{30} + \frac{1}{60}$$

$$\frac{1}{v} = \frac{2+1}{60} \Rightarrow \frac{1}{v} = \frac{3}{60} \quad \therefore \; v = 20 \text{ cm}$$

(i) The image is virtual and erect.

(ii) The image is at a distance of 20 cm from the mirror on the opposite side of the object.

(iii) $\frac{h^F}{h} = -\frac{v}{u} \Rightarrow \frac{h^F}{3} = -\left(\frac{20}{-60}\right) \Rightarrow \frac{h^F}{3} = \frac{1}{3}$

$\Rightarrow h' = 1$ cm

$\therefore$ Image is diminished and its size is 1 cm.

21. Here, $n = 1, \lambda = 6 \times 10^{-5}$ cm

Distance of screen from slit $= 100$ cm

Distance of first minimum from central maxima $= 0.1$ cm

$$\sin\theta = \frac{\text{Distance of 1}^{\text{st}}\text{ minima from the central maxima}}{\text{Distance of the screen from the slit}}$$

$$\theta_1 = \frac{0.1}{100} = \frac{1}{1000}$$

We know that $a \sin\theta = n\lambda \Rightarrow a = \frac{\lambda}{\theta_1} = 0.06$ cm

22. Here; $a = 0.1$ m, $N = 20$, $r = 0.1$ m, $I = 0.5$ A

Magnetic field at the center of each coil due to its own current is,

$$B_1 = \frac{\mu_0 NI}{2a} \equiv \frac{4\pi \times 10^{-7} \times 20 \times 0.5}{2 \times 0.1} = 6.28 \times 10^{-5} \text{ T}$$

Magnetic field at the centre of one coil due to the current in the other coil is,

$$B_2 = \frac{\mu_0 N I r^2}{2(a^2 + r^2)^{3/2}} = \frac{4\pi \times 10^{-7} \times 20 \times 0.5 \times (0.1)^2}{2[(0.1)^2 + (0.1)^2]^{3/2}}$$
$$= 2.22 \times 10^{-5}\ \text{T}$$

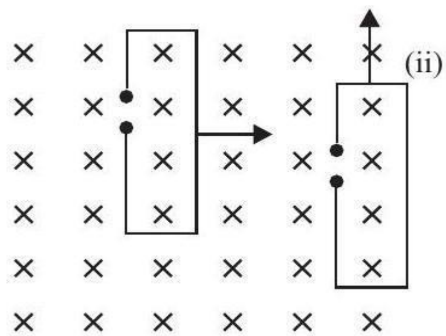
(i) When the currents are in the same direction, the resultant field at the centre of each coil is,

$B = B_1 + B_2 = 6.28 \times 10^{-5} + 2.22 \times 10^{-5} = 8.50 \times 10^{-5}$ T

(ii) When the currents are in opposite directions, the resultant field is,

$B = B_1 - B_2 = 6.28 \times 10^{-5} - 2.22 \times 10^{-5} = 4.06 \times 10^{-5}$ T

23. Here $A = 8 \times 2 = 16\ \text{cm}^2 = 16 \times 10^{-4}\ \text{m}^2, B = 0.3$ T
$v = 1\ \text{cm s}^{-1} = 10^{-2}\ \text{m s}^{-1}$




(i) When velocity is normal to longer side,

$l = 8\ \text{cm} = 8 \times 10^{-2}$ m

$\varepsilon = Blv = 0.3 \times 8 \times 10^{-2} \times 10^{-2} = 2.4 \times 10^{-4}$ V

Time, $t = \frac{\text{distance moved}}{\text{velocity}} = \frac{2\times10^{-2}}{10^{-2}} = 2\text{sec}$

(ii) When velocity is normal to shorter side,

$l = 2\ \text{cm} = 2 \times 10^{-2}$ m

$\varepsilon = Blv = 0.3 \times 2 \times 10^{-2} \times 10^{-2} = 0.6 \times 10^{-4}$ V

Time, $t = \frac{\text{distance moved}}{\text{velocity}} = \frac{8\times10^{-2}}{10^{-2}} = 8\text{sec}$

24. Here, $L = 100\text{mH}, C = 5\mu\text{F}$,
$\varepsilon_{\text{rms}} = 150\sqrt{2}$ V, $v = \frac{500}{\pi}$ Hz, $R = 100\Omega$,

$$X_L = \omega L = 2\pi v L = 2\pi \times \frac{500}{\pi} \times 100 \times 10^{-3}\Omega = 100\Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi v C} = \frac{1}{2\pi\left(\frac{500}{\pi}\right) \times 5 \times 10^{-6}}\Omega = 200\Omega$$

(a) The impedance of the circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{100^2 + (100 - 200)^2}$$
$$= 100\sqrt{2}\Omega = 141.4\Omega$$

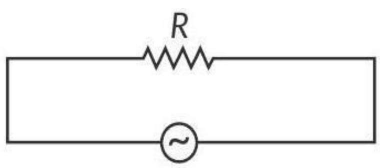
(b) $I_{rms} = \frac{\varepsilon_{rms}}{Z} = \frac{150\sqrt{2}}{100\sqrt{2}}$ A $= 1.5$ A

$I_0 = I_{rms}\sqrt{2} = 2.12$ A

(c) Power factor, $\cos\phi = \frac{R}{Z} = \frac{100}{100\sqrt{2}} = \frac{1}{\sqrt{2}}$

**OR**

(a)




Average power in one cycle,

$$P = \frac{W}{t} = \frac{\int_0^T V i dt}{\int_0^T dt}$$

where current and voltage are in same phase across resistance $R$.

If $i = i_o \sin\omega t$ then $V = V_o \sin\omega t$

Hence, $P = \frac{V_o i_o \int_0^T \sin^2 \omega t dt}{\int_0^T dt}$

$$P \frac{V_o i_o}{T} \int_0^T \left(\frac{1\cos 2\omega t}{2}\right) dt$$

$$P = \frac{V_o i_o}{2T}\left[\int_0^T dt - \int_0^T \cos 2\omega t dt\right]$$

$$P = \frac{V_o i_o}{2T}[T - 0] = \frac{V_o i_o}{2}$$

Also, $i_o = \frac{V_o}{R}$ So, $P = \frac{i_o^2 R}{2}$

(b) $P = \frac{V^2}{R}$

$$100 = \frac{(220)^2}{R} \Rightarrow R = \frac{220 \times 220}{100} = 484\Omega$$

25. (a) (i) For same accelerating potential, a proton and an electron have same kinetic energy. The de-Broglie wavelength associated with same potential $V$ is given by,

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2m(qV)}}$$

So, $\lambda = \frac{1}{\sqrt{m}}$

As electron's mass is lesser than proton. Thus $\lambda_e > \lambda_p$.

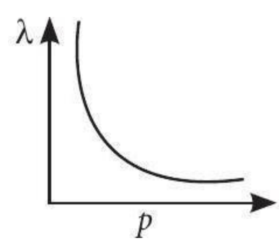
(ii) Momentum, $p = \sqrt{2mK}$ or $p \propto \sqrt{m}$

As electron's mass is lesser than proton. Thus momentum of electron is lesser than proton.

(b) de-Broglie wavelength of a particle

$\lambda = \frac{h}{p}$ or $\lambda p = h =$ constant

It shows a rectangular hyperbola.




**OR**

(a) Einstein's photoelectric equation

$K_{max} = \frac{1}{2}mv^2 = h\nu - \phi_0 = h\nu - h\nu_0$ …..(i)

$W_0 =$ work function of the target metal

Three salient features observed are

Below threshold frequency $v_0$ corresponding to $W_0$, no emission of photoelectrons takes place.

As energy of a photon depends on the frequency of light, so the maximum kinetic energy with which photoelectron is emitted depends only on the energy of photon or on the frequency of incident radiation.

(b) For a given frequency of incident radiation, intensity of light depends on the number of photons per unit area per unit time and one photon liberates one photoelectron, so number of photoelectrons emitted depend only on its intensity.

From eqn. (i)

$$K_{\max} = \frac{hc}{\lambda} - \phi_0$$

According to question,

$$K_{\max} = \frac{hc}{\lambda_1} - \phi_0 \quad \ldots..(ii)$$

$$2K_{\max} = \frac{hc}{\lambda_2} - \phi_0 \quad \ldots.(iii)$$

From eqn. (ii) and (iii),

$$2\left(\frac{hc}{\lambda_1} - \phi_0\right) = \frac{hc}{\lambda_2} - \phi_0$$

$$\phi_0 = \frac{2hc}{\lambda_1} - \frac{hc}{\lambda_2} = hc\left(\frac{2}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

Also, $\phi_0 = \frac{hc}{\lambda_0} \therefore \frac{hc}{\lambda_0} = hc\left(\frac{2}{\lambda_1} - \frac{1}{\lambda_2}\right)$

or $\frac{1}{\lambda_0} = \frac{2\lambda_2 - \lambda_1}{\lambda_1\lambda_2}$; $\lambda_0 = \frac{\lambda_1\lambda_2}{2\lambda_2 - \lambda_1}$

Work function, $W_0 \frac{hc(2\lambda_2 \ \lambda_1)}{\lambda_1 \cdot \lambda_2}$

26. (i) $\because E_n \frac{13.6}{n^2}$ eV

Energy of the photon emitted during a transition of the electron from the first excited state to its ground state is,

$$\Delta E = E_2 - E_1$$

$$= \frac{-13.6}{2^2} - \left(\frac{-13.6}{1^2}\right) = \frac{-13.6}{4} + \frac{13.6}{1} = -3.40 + 13.6$$

$= 10.2\text{eV}$

This transition lies in the region of Lyman series.

(ii) (a) The energy levels of H-atom are given by

$$E_n = -\frac{Rhc}{n^2} = -\frac{13.6}{n^2}\text{eV}$$

For first excited state $n = 2$

$$E_2 = -\frac{13.6}{(2)^2}\text{eV} = -3.4\text{eV}$$

Kinetic energy of electron in $(n = 2)$ state is

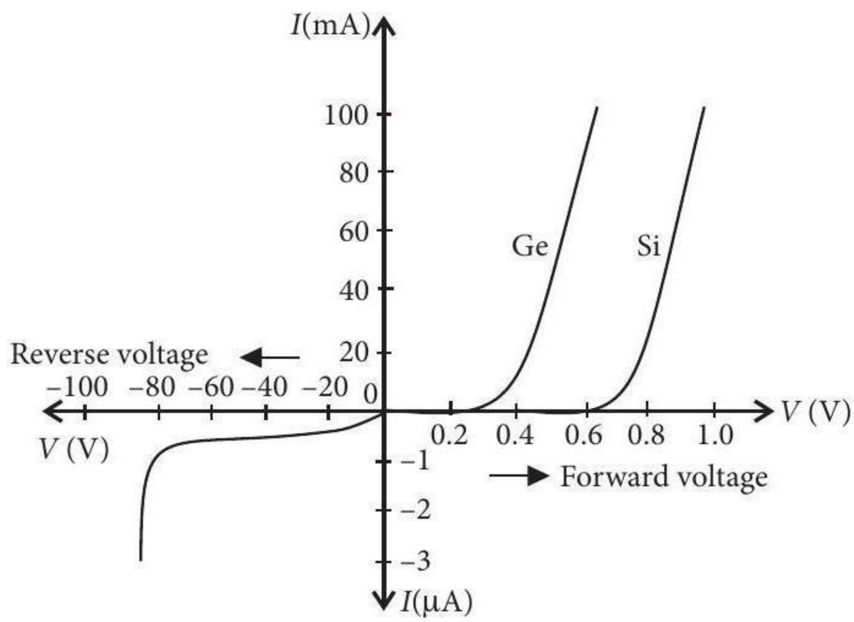
$K_2 = -E_2 = +3.4\text{eV}$

(b) Radius in the first excited state

$r_1 = (2)^2(0.53)\text{Å}$

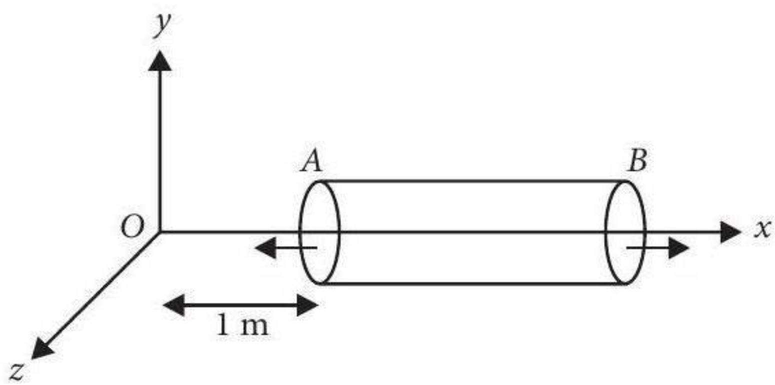
$r_1 = 2.12\text{Å}$

27. (i)




(ii) Since junction diodes conduct in forward bias and does not conduct in reverse bias, it is used in rectification of ac voltages.

28. (i)




Given, $\vec{E} = 50x\hat{i}$ and $A = 25\ \text{cm}^2 = 25 \times 10^{-4}\ \text{m}^2$

As the electric field is only along the $x$-axis, so, flux will pass only through the cross-section of cylinder.

Magnitude of electric field at cross-section $A$,

$E_A = 50 \times 1 = 50\ \text{NC}^{-1}$

Magnitude of electric field at cross-section $B$,

$E_B = 50 \times 2 = 100\ \text{NC}^{-1}$

The corresponding electric fluxes are

$\phi_A = \vec{E}_A \cdot \vec{A} = 50 \times 25 \times 10^{-4} \cos 180^\circ = -0.125\ \text{N m}^2\text{C}^{-1}$

$\phi_B = \vec{E}_B \cdot \vec{A} = 100 \times 25 \times 10^{-4} \cos 0^\circ = 0.25\ \text{N m}^2\text{C}^{-1}$

So, the net flux through the cylinder,

$\phi = \phi_A + \phi_B = -0.125 + 0.25 = 0.125\ \text{N m}^2\text{C}^{-1}$

(ii) Using Gauss's law

$$\oint E \cdot dA = \frac{q}{\varepsilon_0} \Rightarrow 0.125 = \frac{q}{8.85 \times 10^{-12}}$$
$$\Rightarrow q = 8.85 \times 0.125 \times 10^{-12} = 1.1 \times 10^{-12}\text{C}$$

29. (i) (b) : Each half lens will form an image in the same plane. The optic axes of the lenses are displaced,

$$\frac{1}{v} - \frac{1}{(-30)} = \frac{1}{20}; v = 60\ \text{cm}$$

(ii) (a): Here $f_1 = 20$ cm; $f_2 = ?$

$F = 80$ cm

As $\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{F}\Rightarrow\frac{1}{f_2}=\frac{1}{F}-\frac{1}{f_1}$

$$\frac{1}{f_2}=\frac{1}{80}-\frac{1}{20}=\frac{-3}{80}$$

$$f_2=\frac{-80}{3}=-26.7 \text{ cm}$$

(iii) (b) : The bubble behaves libe a diverging lens.

(iv) (b) : Convex lens is used in magnifying glass.

**OR**

(d) : The magnification of an image by a convex lens is positive only when object is placed between $F$ and optical centre.

30. (i) (c): The $p$ - $n$ diode is forward biased when $p$-side is at a higher potential than $n$-side.

(ii) (c) : Non-ohmic device.

(iii) (d) : Forward bias resistance,

$$R_1=\frac{\Delta V}{\Delta I}=\frac{0.8-0.7}{(20-10)\times 10^{-3}}=\frac{0.1}{10\times 10^{-3}}=10$$

Reverse bias resistance, $R_2=\frac{10}{1\times 10^{-6}}=10^7$

Then, the ratio of forward to reverse bias resistance,

$$\frac{R_1}{R_2}=\frac{10}{10^7}=10^{-6}$$

**OR**

(d) : In p-region the direction of conventional current is same as flow of holes.

In $n$-region the direction of conventional current is opposite to the flow of electrons.

(iv) (c) : In the given circuit the junction diode is forward biased and offers zero resistance.

$\therefore$ The current, $I=\frac{3\text{ V}-1\text{ V}}{200\Omega}=\frac{2\text{ V}}{200\Omega}=0.01$ A

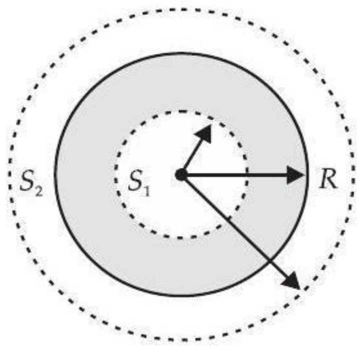
31. The given charge density distribution of the sphere of radius $R$ is

$\rho(r)=kr$ for $r\leq R$

$= 0$ for $r > R$

For point $r < R$

let us consider a spherical Gaussian surface $S_1$ of radius $r$. Then on the surface,




$$\oint \vec{E} \cdot \vec{dS} = \frac{1}{\varepsilon_0} \int \rho dV$$

As $V = \frac{4}{3}\pi r^3, dV = 4\pi r^2 dr$ and $\rho(r) = kr$

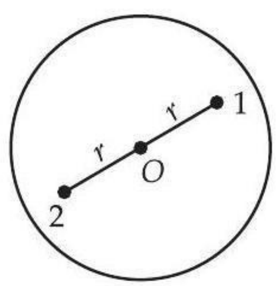
$$\therefore \oint \vec{E} \cdot \vec{dS} = \frac{1}{\varepsilon_0} 4\pi k \int_0^r r r^2 dr; (E) 4\pi r^2 = \frac{4\pi k}{\varepsilon_0} \frac{r^4}{4}$$

$$\vec{E} = \frac{1}{4_0} k r^2 \hat{r}$$

From symmetry, we find that the two protons must be on the opposite sides of the centre, along a diameter of the sphere as shown in figure.

Proceeding as above, charge on the sphere,

$$q = \int_0^R \rho dV = \int_0^R (kr) 4\pi r^2 dr; q = 4\pi k \frac{R^4}{4} = 2e$$




$$\therefore k = \frac{2e}{\pi R^4}$$

If protons 1 and 2 are embedded at distance $r$ from the centre of the sphere as shown in figure, then attractive force on proton 1 due to charge distribution is

$$F_1 = -eE = -e\frac{kr^2}{4\varepsilon_0}$$

(Using (i))

Repulsive force on proton 1 due to proton 2 is

$$F_2 = \frac{e^2}{4\pi\varepsilon_0(2r)^2} = \frac{e^2}{16\pi\varepsilon_0 r^2}$$

Net force on proton 1

$$F = F_1 + F_2$$

$$F = -e\frac{kr^2}{4\varepsilon_0} + \frac{e^2}{16\pi\varepsilon_0 r^2}$$

$$F = [-\frac{er^2}{4\varepsilon_0}\frac{2e}{\pi R^4} + \frac{e^2}{16\pi\varepsilon_0 r^2}] = 0$$

(Using (ii))

This force on proton 1 will be zero, when

$$\frac{er^2 \cdot 2e}{4\varepsilon_0 \pi R^4} = \frac{e^2}{16\pi\varepsilon_0 r^2} \text{ or } r^4 = \frac{R^4}{8} \text{ or } r \;\; \frac{R}{(8)^{1/4}}$$

This is the distance of each of the two protons from the centre of the sphere.

**OR**

$$V_P = V_{PA} + V_{PB} + V_{PC} + V_{PD}$$

$$\text{or } V_P = \frac{1}{4\pi\varepsilon_0}[\frac{+q}{r+a} - \frac{q}{r} - \frac{q}{r} + \frac{q}{r-a}]$$

$$\text{or } V_P = \frac{q}{4\pi\varepsilon_0}[\frac{r(r-a)-2(r^2-a^2)+r(r+a)}{r(r^2-a^2)}]$$

$$\text{or } V_P = \frac{q}{4\pi\varepsilon_0}[\frac{r^2-ra-2r^2+2a^2+r^2+ra}{r(r^2-a^2)}]$$

$$\text{or } V_P = \frac{1}{4\pi\varepsilon_0}\frac{q \cdot 2a^2}{r(r^2-a^2)} = \frac{1}{4\pi\varepsilon_0}\frac{p \cdot a}{r(r^2-a^2)}$$

For $r \gg> a$

$V_P \approx \frac{1}{4\pi\varepsilon_0}\frac{pa}{r^3}$ or $V_P \propto \frac{1}{r^3}$.

However, electric potential at any point on axis of electric dipole is $V = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$ or $V \propto \frac{1}{r^2}$ and due to point charge $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ or $V \propto \frac{1}{r}$

32. (a): Current in the circuit,

$$I = \frac{V}{R} = \frac{6\ \text{V}}{6} = 1\ \text{A}$$

As $I = neAv_d$,

$$v_d = \frac{I}{neA} = \frac{1\ \text{A}}{(10^{29}\ \text{m}^{-3})(1.6 \times 10^{-19}\text{C})(10^{-3}\ \text{m})^2}$$

$= 0.625 \times 10^{-4}\ \text{m s}^{-1}$

Energy absorbed by all the electrons

= number of electrons × KE of an electron

$$= [n(Al)]\left[\frac{1}{2}mv_d^2\right] = \frac{1}{2}\left[mv_d^2 nAl\right]$$

$$= \frac{1}{2}[9.1 \times 10^{-31}\ \text{kg}](0.625 \times 10^{-4}\ \text{m s}^{-1})^2$$

$$= 1.78 \times 10^{-17}\ \text{J}$$

$(1029\ \text{m}^{-3})(10^{-6}\ \text{m}^2)(10^{-1}\ \text{m})$

(b) Ohmic loss $= I^2R = (1\ \text{A})^2(6\Omega) = 6\text{Js}^{-1}$

Time taken by all the electrons to lose their kinetic energy, i.e.,

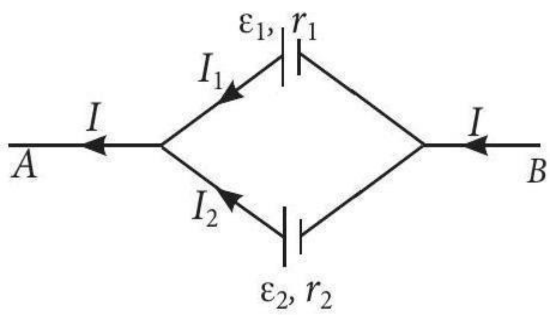
$$t = \frac{1.78 \times 10^{-17}\ \text{J}}{6\ \text{J s}^{-1}} = 0.30 \times 10^{-17}\ \text{s} \approx 10^{-17}\ \text{s}$$

**OR**

Here $I = I_1 + I_2$

Let $V$ = Potential difference between $A$ and $B$

For cell $\varepsilon_1$




$V = \varepsilon_1 - I_1 r_1; I_1 = \frac{\varepsilon_1 - V}{r_1}$

Similarly, for cell $\varepsilon_2$

$I_2 = \frac{\varepsilon_2 - V}{r_2}$

Putting these value in equation (i)

$$I = \frac{\varepsilon_1 - V}{r_1} + \frac{\varepsilon_2 - V}{r_2} \text{ or } I = \left[\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}\right] - V\left[\frac{1}{r_1} + \frac{1}{r_2}\right]$$

$$V = \left(\frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}\right) - I\left(\frac{r_1 r_2}{r_1 + r_2}\right)$$

Comparing the above equation with the equivalent circuit of emf ' $\varepsilon_{eq}$ ' and internal resistance ' $r_{eq}$ ' then $V = E_{eq} - I r_{eq}$

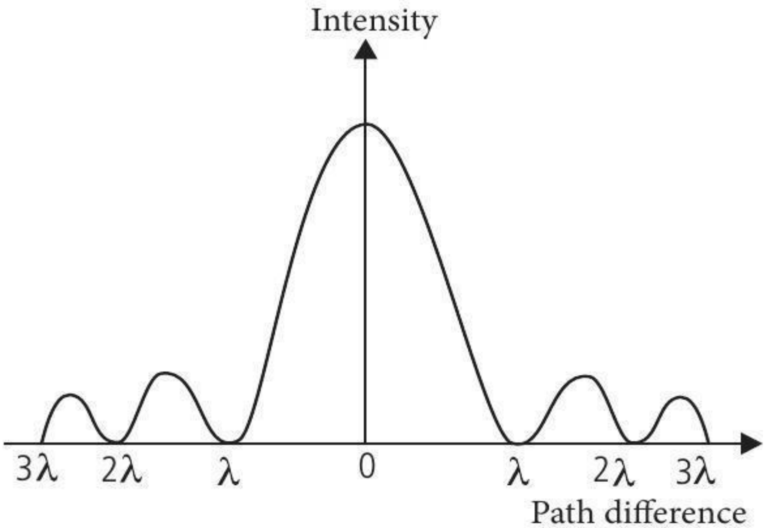
Then

(i) $\varepsilon_{eq} = \frac{s_1 r_1 + s_2 r_2}{r_1 + r_2}$; (ii) $r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$

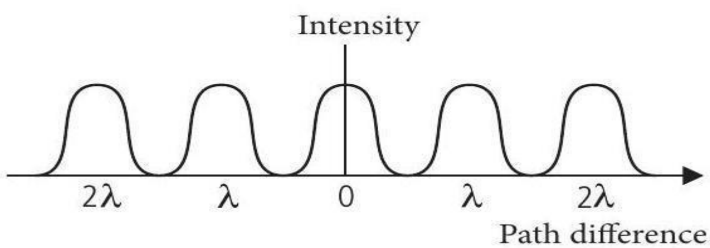
(iii) The potential difference between $A$ and $B$

$V = \varepsilon_{eq} - I_{eq} r_{eq}$

33. (a) (i) Single slit diffraction:




Double slit interference:




(ii) Difference between interference and diffraction Experiment to observe diffraction pattern

| **Interference** | **Diffraction** |
|---|---|
| 1. Interference is caused by superposition two waves starting from two coherent sources. | 1. Diffraction is caused by superposition of a number of waves starting from the slit. |
| 2. All bright and dark fringes are of equal width. | 2. Width of central bright fringe is double of all other maxima. |
| 3. All bright fringes are of same intensity. | 3. Intensity of bright fringes decreases sharply as we move away from central bright fringe. |
| 4. Dark Fringes are perfectly dark. | 4. Dark fringes are not perfectly dark. |

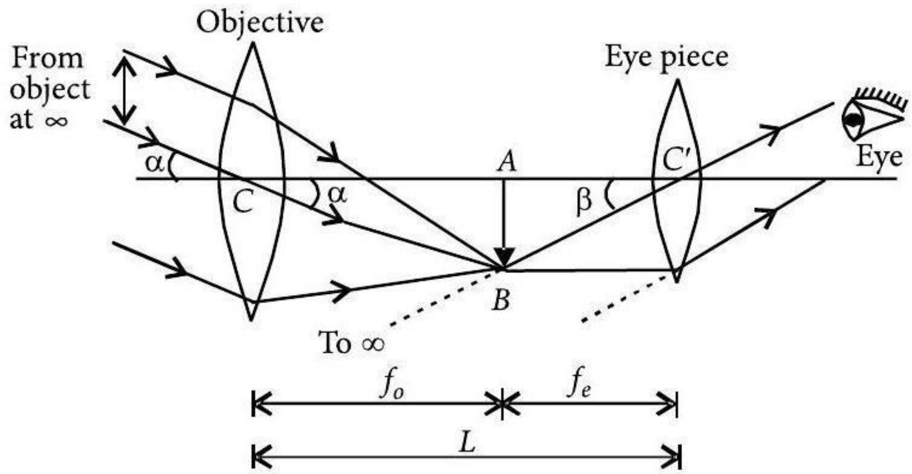
(b) Since fringe width is give by $\beta = \frac{\lambda D}{d}$

(i) On increasing the width of slit $d$, the fringe width decreases.

(ii) On replacing monochromatic light with white light, the fringes of all colours will be overlapping in interference pattern.

**OR**

(a)




(b) (i) Given $f_0 = 140$ cm, $f_e = 5$ cm

When final image is at infinity, magnifying power,

$$m = \frac{-f_0}{f_e} = -\frac{140}{5.0}; m = -28$$

Negative sign shows that the image is inverted.

When final image is at the least distance of distinct vision,

magnifying power, $m = \frac{-f_0}{f_e}(1 + \frac{f_e}{D})$

$$= \frac{-140}{5.0}(1 + \frac{5.0}{25}) = -33.6$$

(ii) Separation between objective and eyepiece when final image is formed at infinity,

$L = f_0 + f_e$

$L = 140 \text{ cm} + 5.0 \text{ cm} = 145 \text{ cm}$

# SAMPLE
# PAPER
## CLASS 12
### PHYSICS

Subject Code: 042

SET 02

**PHYSICS**

Time: 3 Hours Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section **D** contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$Tm$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$C$^2$ N$^{-1}$ m$^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

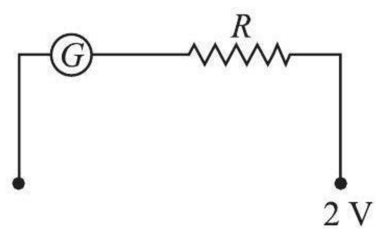
## SECTION A

1. What will happen when we rub a glass rod with silk cloth?
   (a) Some of the electrons from the glass rod are transferred to the silk cloth.
   (b) The glass rod gets positively charged and silk cloth gets negatively charged.
   (c) New charge is created in the process of rubbing.
   (d) Both (a) and (b) are correct.

2. A Convex lens of focal length 0.2 m, made of glass ( ${}^a\mu_g = 1.5$) is immersed in water ( ${}^a\mu_w = 1.33$). Find the change in the focal length of the lens.

(a) 5.8 m
(b) 0.58 cm
(c) 0.58 m
(d) 5.8 cm

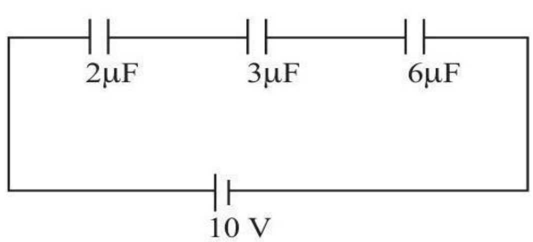
3. A voltmeter which can measure 2 V is constructed by using a galvanometer of resistance $12\Omega$ and that produces maximum deflection for the current of 2 mA, then the resistance $R$ is
(a) $888\Omega$
(b) $988\Omega$
(c) $898\Omega$
(d) $999\Omega$




4. An electromagnetic wave of frequency $\upsilon = 3$MHz passes from vacuum into a dielectric medium with permittivity $\varepsilon = 4$. Then
(a) wavelength and frequency both become half.
(b) wavelength is doubled and frequency remains unchanged.
(c) wavelength and frequency both remain unchanged.
(d) wavelength is halved and frequency remains unchanged.

5. The de-Broglie wavelength associated with a ball of mass 150 g travelling at 30 m $s^{-1}$ is
(a) $1.47 \times 10^{-34}$ m
(b) $1.47 \times 10^{-16}$ m
(c) $1.47 \times 10^{-19}$ m
(d) $1.47 \times 10^{-31}$ m

6. The charge on $3\mu$F capacitor shown in the figure is

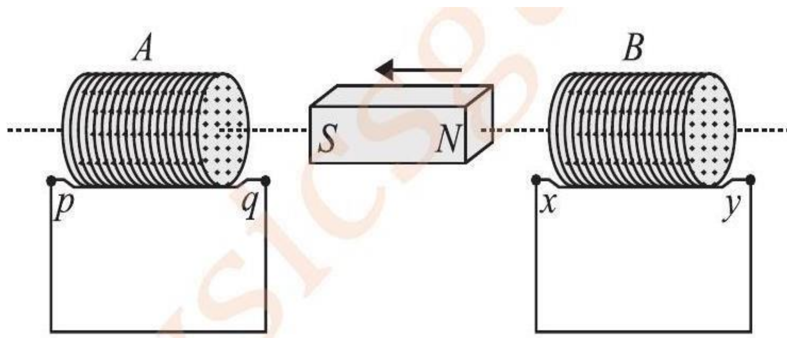



(a) $2\mu$C
(b) $10\mu$C
(c) $6\mu$C
(d) $8\mu$C

7. Which of the following statement is correct?
(a) Hole is an antiparticle of electron.
(b) Hole is a vacancy created when an electron leaves a covalent bond.
(c) Hole is the absence of free electrons.
(d) Hole is an artificially created particle.

8. Which of the following statement is not correct about the magnetic field?
(a) The magnetic lines form a closed loop.
(b) Inside the magnet, the magnetic lines go from north to south pole of the magnet.
(c) Magnetic lines of force do not intersect each other.
(d) Tangents to the magnetic lines of force give the direction of the magnetic field.

9. The direction of induced current in the coils $A$ and $B$ in the situation shown in the figure is

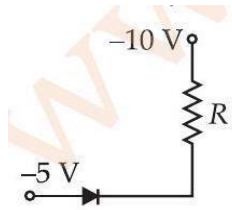



(a) $p$ to $q$ in coil $A$ and $x$ to $y$ in coil $B$
(b) $q$ to $p$ in coil $A$ and $x$ to $y$ in coil $B$
(c) $p$ to $q$ in coil $A$ and $y$ to $x$ in coil $B$
(d) $q$ to $p$ in coil $A$ and $y$ to $x$ in coil $B$.

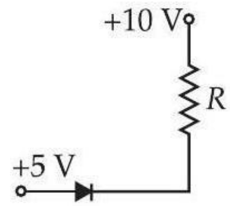
10. An electric dipole with dipole moment $1 \times 10^{-9}$Cm is aligned at $30^{\circ}$ with the direction of a uniform electric field of magnitude $6 \times 10^{4}$ $NC^{-1}$. The magnitude of the torque acting on the dipole is
(a) $7 \times 10^{-5}$ N m
(b) $2 \times 10^{-5}$ N m
(c) $6 \times 10^{-5}$ N m
(d) $3 \times 10^{-5}$ N m

11. Which of the junction diodes shown below are forward biased?

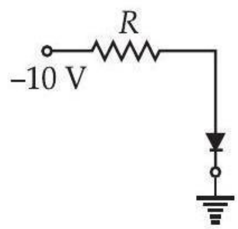
(a)



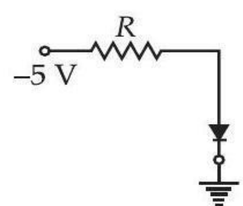

(b)



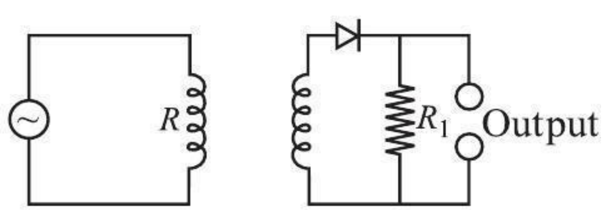

(c)




(d)




12. A sinusoidal voltage of rms value 220 V is applied to a diode and a resistor $R$ in the circuit shown in figure, so that half wave rectification occurs. If the diode is ideal, what is the rms voltage across $R_1$ ?




(a) $55\sqrt{2}$ V
(b) 110 V

(c) $110\sqrt{2}$ V
(d) $220\sqrt{2}$ V

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 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): Radio waves cannot be diffracted by the buildings.

    Reason (R): The wavelength of radio waves is very small.

14. Assertion (A): Energy is released in a nuclear reaction.

    Reason (R): In any nuclear reaction the reactants and resultant products obey the law of conservation of charge and mass only.

15. Assertion (A): The conductivity of a semi-conductor increases with rise of temperature. Reason (R): On rising temperature covalent bonds of semiconductor breaks.

16. Assertion (A): The electric flux emanating out and entering a closed surface are $8 \times 10^3$ and $2 \times 10^3$ V m respectively. The charge enclosed by the surface is $0.053 \mu$C.

    Reason (R): Gauss's theorem in electrostatics may be applied to verify.

**SECTION B**

17. (a) What is photoelectric effect?

    (b) Using photon picture of light, show that how Einstein's photoelectric equation can be established.

18. A rectangular loop of area $30$ cm $\times$ $40$ cm is placed in a magnetic field of $0.5$ T with its plane (i) normal to the field and (ii) parallel to the field.

    Find the flux linked with the coil in each case.

**OR**

A coil of area $A$ is kept perpendicular in a uniform magnetic field $B$. If the coil is rotated by $180^\circ$, what will be the change in flux?

19. Why the images formed by total internal reflection are much brighter than those formed by mirrors?

20. The refractive index of glass with respect to air is $\frac{3}{2}$. What is the refractive index of air with respect to glass?

21. Find the disintegration energy $Q$ for the fission event represented by equation

$${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{92}U^{236} \rightarrow {}^{140}_{58}Ce + {}^{90}_{40}Zr + {}_{0}n^{1}$$

If mass of ${}_{92}U^{235} = 235.0439u$, ${}_{0}n^{1} = 1.00867u$, ${}^{140}_{58}Ce = 139.9054u$ and ${}^{90}_{40}Zr = 93.9063u$, find energy released in the process.

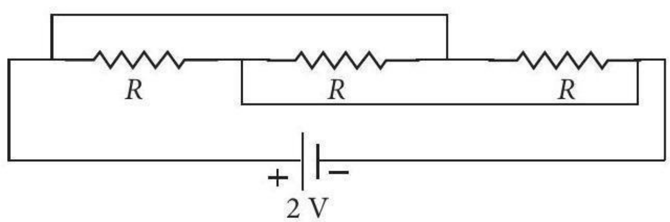
**SECTION C**

22. At what rate is energy dissipated in each of the following situations?

(i) A potential difference of $120$ V is applied across the full length of the wired?

(ii) The wire is cut in half and a potential difference of $120$ V is applied across the length of each half. If it has a resistance $R$ of $72\Omega$ in (i) and (ii).

Three equal resistors each of $R$ohm are connected as shown in figure. A battery of 2 volt and of internal resistance $0.1$ohm is connected across the circuit. Calculate the value of $R$ for which the heat generated in the circuit is maximum.




23. A small coil of radius $r$ is placed at the centre of a large coil of radius $R$, where $R >>$. The two coils are coplanar. Find the mutual inductance between the coils.

24. Draw energy band diagram of $n$-type and $p$-type semiconductor at temperature $T > 0$ K. Mark the donor and acceptor energy level with their energies.

25. For a radioactive material, its activity $A$ and rate of change of its activity $R$ are defined as $A = -\frac{dN}{dt}$ and $R = -\frac{dA}{dt}$, where $N(t)$ is the number of nuclei at time $t$. Two radioactive sources $P$ (mean life $r$ ) and $Q$ (mean life $2r$ ) have the same activity at $t = 0$. Their rate of change of activities at $t = 2r$ are $R_P$ and $R_Q$, respectively. If $\frac{RP}{RQ} = \frac{n}{e}$, then the value of $n$ is

**OR**

A freshly prepared sample of a radio isotope of half-life $1386$ s has activity $10^3$ disintegrations per second. Given that ln 2 = $0.693$, the fraction of the initial number of nuclei (expressed in earest integer percentage) that will decay in the first $80$ s after preparation of the sample is

26. Suppose that the electric field part of an electromagnetic wave in vacuum is

$E = (3.1 \text{ N/C})\cos[(1.8\text{rad/m})y + (5.4 \times 10^8 \text{rad/s})t]\hat{j}$

(a) What is the direction of propagation?
(b) What is the wavelength $\lambda$ ?
(c) What is the frequency $v$ ?

27. (a) If one of two identical slits producing interference in Young's experiment is covered with glass, so that the light intensity passing through it is reduced to 50%, find the ratio of the maximum and minimum intensity of the fringe in the interference pattern.

(b) What kind of fringes do you expect to observe if white light is used instead of monochromatic light?

28. If the relation between radius and velocity of electron is $r = \frac{e^2}{4\pi\varepsilon_0 m v^2}$, then find total energy in electron.

## SECTION D

29. Read the following paragraph and answer the questions that follow.

**Case Study Based Questions**

This energy possessed by a system of charges by virtue of their positions. When two like charges lie infinite distance apart, their potential energy is zero because no work has to be done in moving one charge at infinite distance from the other.

In carrying a charge $q$ from point $A$ to point $B$, work done $W = q(V_A - V_B)$. This work may appear as change in KE/PE of the charge. The potential energy of two charges $q_1$ and $q_2$ at a distance $r$ in air is $\frac{q_1 q_2}{4\pi\varepsilon_0 r}$. It is measured in joule. It may be positive, negative or zero depending on the signs of $q_1$ and $q_2$.

(i) Calculate work done in separating two electrons form a distance of 1 m to 2 m in air, where $e$ is electric charge and $k$ is electrostatic force constant.
(a) $ke^2$
(b) $e^2/2$
(c) $-ke^2/2$
(d) zero

(ii) Four equal charges $q$ each are placed at four corners of a square of side $a$ each. Work done in carrying a charge $-q$ from its centre to infinity is
(a) zero
(b) $\frac{\sqrt{2}q^2}{\pi\varepsilon_0 a}$
(c) $-\frac{\sqrt{2}q}{\pi\varepsilon_0 a}$
(d) $\frac{q^2}{\pi\varepsilon_0 a}$

(iii) Two points $A$ and $B$ are located in diametrically opposite directions of a point charge of $+2\mu$C at distances 2 m and 1 m respectively from it. The potential difference between $A$ and $B$ is
(a) $3 \times 10^3$ V
(b) $6 \times 10^4$ V
(c) $-9 \times 10^3$ V
(d) $-3 \times 10^3$ V

**OR**

Two point charges $A = +3$nC and $B = +1$nC are placed 5 cm apart in air. The work done to move charge $B$ towards $A$ by 1 cm is
(a) $2.0 \times 10^{-7}$ J
(c) $2.7 \times 10^{-7}$ J
(b) $1.35 \times 10^{-7}$ J
(d) $12.1 \times 10^{-7}$ J

(iv) A charge $Q$ is placed at the origin. The electric potential due to this charge at a given point in space is $V$. The work done by an external force in bringing another charge $q$ from infinity up to the point is
(a) $\frac{V}{q}$
(b) $Vq$
(c) $V + q$
(d) $V$

30. Read the following paragraph and answer the questions that follow.

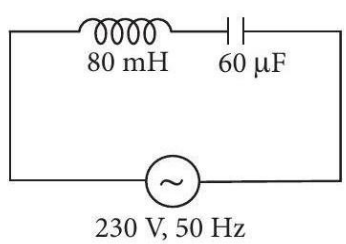
Power Associated with Inductor and Capacitor

The power averaged over one full cycle of a.c. is known as average power. It is also known as true power.

$$P_{av} = V_{rms} I_{rms} \cos\phi = \frac{V_0 I_0}{2} \cos\phi.$$

Root mean square or simply rms watts refer to continuous power.

A circuit containing a 80mH inductor and a $60\mu$F capacitor in series is connected to a 230 V, 50 Hz supply. The resistance of the circuit is negligible.



(i) The value of current amplitude is
(a) 15 A
(b) 11.63 A
(c) 17.65 A
(d) 6.33 A

(ii) Find rms value.
(a) 6 A
(b) 5.25 A
(c) 8.23 A
(d) 7.52 A

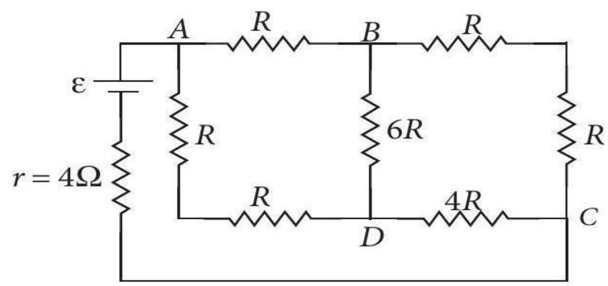
(iii) The average power transferred to inductor is
(a) zero
(b) 7 W
(c) 2.5 W
(d) 5 W

(iv) The average power transferred to the capacitor is
(a) 5 W
(b) zero
(c) 11 W
(d) 15 W

What is the total average power absorbed by the circuit?
(a) zero
(b) 10 W
(c) 2.5 W
(d) 15 W

## SECTION E

31. A battery of internal resistance $r = 4\Omega$ is connected to the network of resistances, as shown in figure. What must be the value of $R$, so that maximum power is delivered to the network? What is the maximum power?




**OR**

Deduce the relation between current $I$ flowing through a conductor and drift velocity $\vec{v}_d$ of the electron.

32. (a) Draw a schematic diagram for an $ac$ generator. Explain its working and obtain the expression for the instantaneous value of the emf in terms of the magnetic field $B$, number of turns $N$ of the coil of area $A$ rotating with angular frequency $\omega$. Show how an alternating emf is generated by a loop of wire rotating in a magnetic field.

(b) A circular coil of radius $10\ \text{cm}$ and 20 turns is rotated about its vertical diameter with angular speed of $50 \text{rads}^{-1}$ in a uniform horizontal magnetic field of $3.0 \times 10^{-2}\ \text{T}$.

(i) Calculate the maximum and average emf induced in the coil.

(ii) If the coil forms a closed loop of resistance $10\Omega$, calculate the maximum current in the coil and the average power loss due to Joule heating.

**OR**

(a) A coil of area $500\ \text{cm}^2$ and having 1000 turns is held perpendicular to a uniform magnetic field of 0.4 gauss. The coil is turned through $180^\circ$ in $1/10$ second. The average induced emf (in volt) is

(b) If a rate of change of current of 4 A $s^{-1}$ induces an emf of $20 \text{mV}$ in a solenoid, the self inductance of the solenoid is | $(x \times 10^{-3})$H. The value of $x$ is

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

**OR**

Two slits $0.125$ mm apart are illuminated by light of wavelength $4500 Å$. The screen is $1$ m away, bright fringe on both sides of the central maximum.

The ratio of intensities of minima to maxima in YDSE is $9:25$. Find the ratio of width of two slits.

# SAMPLE
# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

**SET-03**
**PHYSICS**

Time: 3 Hours Max.
Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section $\boldsymbol{D}$ contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$TmA$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

1. The electric field at a point is
(a) always continuous
(b) continuous if there is no charge at that point
(c) discontinuous if there is a charge at that point
(d) both (b) and (c) are correct.

2. Two waves having intensities in the ratio $9:1$ produce interference. The ratio of maximum to the minimum intensity is

(a) $10:8$
(b) $9:1$
(c) $4:1$
(d) $2:1$

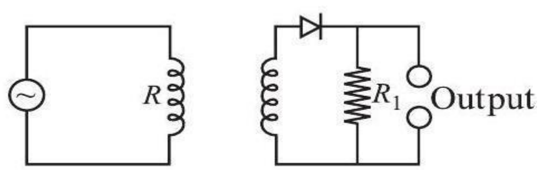
3. A current of $10$ A is flowing in a wire of length $1.5$ m. A force of $15$ N acts on it when it is placed in a uniform magnetic field of $2$ T. The angle between the magnetic field and the direction of the current is
(a) $30^\circ$
(b) $45^\circ$
(c) $60^\circ$
(d) $90^\circ$

4. An object approaches a convergent lens from the left of the lens with a uniform speed $5$ m $s^{-1}$ and stops at the focus. The image
(a) moves away from the lens with an uniform speed $5$ m $s^{-1}$
(b) moves away from the lens with an uniform acceleration
(c) moves away from the lens with a non-uniform acceleration
(d) moves towards the lens with a non-uniform acceleration.

5. The maximum value of photoelectric current is called
(a) base current
(c) collector current
(b) saturation current
(d) emitter current

6. When air is replaced by a dielectric medium of constant $K$, the maximum force of attraction between two charges separated by a distance
(a) increases $K$ times
(b) remains unchanged
(c) decreases $K$ times
(d) increases $K^{1/2}$ times

7. A sinusoidal voltage of rms value $120$ V is applied to a diode and a resistor $R$ in the circuit shown in figure, so that half wave rectification occurs. If the diode is ideal, what is the rms voltage across $R_1$ ?




(a) $55\sqrt{2}$ V
(b) $110$ V

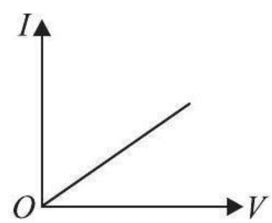
(c) $110\sqrt{2}$ V
(d) $120\sqrt{2}$ V

8. If magnetic lines of force are drawn by keeping magnet vertical, then number of neutral points will be
(a) One
(b) Two
(c) Three
(d) Four

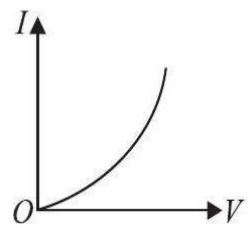
9. In a double slit experiment the distance between slits is increased ten times whereas their distance from screen is halved then the fringe width is
(a) becomes $\frac{1}{20}$
(b) becomes $\frac{1}{90}$
(c) it remains same
(d) becomes $\frac{1}{10}$

10. Which of the following $I - V$ graph represents for ohmic conductors?

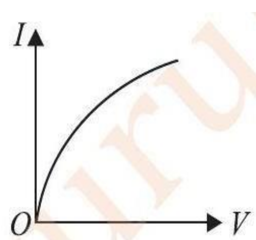
(a)



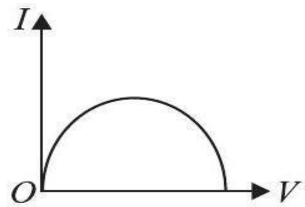

(b)




(c)




(d)




11. Which of the following statements is incorrect for the depletion region of a diode?
    (a) There are mobile charges exist.
    (b) Equal number of holes and electrons exist, making the region neutral.
    (c) Recombination of holes and electrons has taken place.
    (d) None of these

12. If $n$ cells each of emf $\varepsilon$ and internal resistance $r$ are connected in parallel, then the total emf and internal resistances will be
    (a) $\varepsilon, \frac{r}{n}$
    (b) $\varepsilon, nr$
    (c) $n\varepsilon, \frac{r}{n}$
    (d) $n\varepsilon, nr$

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 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): The crystalline solids have a sharp melting point.

    Reason (R): All the bonds between the atoms or molecules of a crystalline solids are equally strong, that they get broken at the same temperature.

14. Assertion (A): The light travelling from air to glass can not suffer total internal reflection.

    Reason (R): Air is rarer than glass.

15. Assertion (A): If the accelerating potential in an $X$-ray tube is increased, the wavelengths of the characteristic X-rays do not change.

    Reason (R): When an electron beam strikes the target in an X-ray tube, part of the kinetic energy is converted into X-ray energy.

16. Assertion (A): During reverse biasing a diode doesn't conduct current.

    Reason (R): It narrows the depletion layer.

**SECTION B**

17. What are electromagnetic waves? How they are produced?

18. A section of a sphere has a radius of curvature of 0.80 m. Both, inside and outside surfaces have a mirror like polish. What are the focal lengths of the inside and outside surfaces?

19. The wavelength of the second line of Balmer series in the hydrogen spectrum is 4861Å. What is the wavelength of first line?

20. The difference in the number of waves when yellow light propagates through air and vacuum columns of the same thickness is one. Find the thickness of the air column.

    [Refractive index of air $= 1.0003$, wavelength of yellow light in vacuum $= 6000$Å]

21. Obtain approximately the ratio of nuclear radii of the gold isotope $_{79}Au^{197}$ and the silver isotope $_{47}Ag^{107}$. What is the approximate ratio of their nuclear densities?

    **OR**

    Define packing fraction.

**SECTION C**

22. In a Wheatstone bridge arrangement the ratio of arms $P$ and $Q$ are nearly equal. The bridge is balanced when $R = 500\Omega$. On interchanging $P$ and $Q$, the value of $R$ for balancing is $505\Omega$. Find the value of $S$.

    **OR**

    A battery of emf $E$ and internal resistance $r$ when connected across an external resistance of $12\Omega$, produces a current of 0.5 A, when connected across a resistance of $25\Omega$. It produces a current of 0.25 A. Determine (i) the emf and (ii) the internal resistance of the cell.

23. A 0.5H inductor, $50\mu$F capacitor and a $50\Omega$ resistor are connected in series with a 120 V50 Hz supply. Calculate impedance and current following in the circuit.

24. Distinguish between intrinsic semiconductor and p-type semiconductor. Does p-type semiconductor is electrically neutral, although $n_h > n_e$ ?

25. Find the energy equivalent of one atomic mass unit, first in Joules and then in MeV. Using this, express the mass defect of $^{16}_{8}O$ in MeV/$c^2$.

    **OR**

    On disintegration of one atom of $U^{235}$, the amount of energy obtained is 200MeV. The power obtained in a reactor is 1000kWh. Find atoms disintegrated per second in the reactor and decay in mass per hour.

26. A laser beam has intensity $3 \times 10^{14}$ W/m$^2$. Find the amplitudes of electric and magnetic fields in the beam.

27. Two coils are wound on the same iron rod so that the flux generated by one also passes through the other. The primary coil has 100 turns and secondary coil has 200 turns. When a current of 2 A flows through the primary coil the flux in it is $2.5 \times 10^{-4}$ Wb. Find the value of mutual inductance between the coils.

28. In a Geiger-Marsden experiment, what is the distance of closest approach to the nucleus of a 7.7MeV $\alpha$-particle before it comes momentarily to rest and reverses its direction?

## SECTION D

**Case Study Based Questions**

29. Read the following paragraph and answer the questions that follow.

Coulomb's law states that the electrostatic force of attraction or repulsion acting between two stationary point charges is given by $F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$


where $F$ denotes the force between two charges $q_1$ and $q_2$ separated by a distance $r$ in free space, $\varepsilon_0$ is a constant known as permittivity of free space. Free space is vacuum and may be taken to be air practically. If free space is replaced by a medium, then $\varepsilon_0$ is replaced by $(\varepsilon_0 k)$ or $(\varepsilon_0 \varepsilon_r)$ where $k$ is known as dielectric constant or relative permittivity.

(i) In coulomb's law, $F = k\frac{q_1 q_2}{r^2}$, then on which of the following factors does the proportionality constant $k$ depends?
(a) Electrostatic force acting between the two charges
(b) Nature of the medium between the two charges
(c) Magnitude of the two charges
(d) Distance between the two charges.

(ii) Dimensional formula for the permittivity constant $\varepsilon_0$ of free space is
(a) $[ML^{-3}\ T^4\ A^2]$
(b) $[M^{-1}\ L^3\ T^2\ A^2]$
(c) $[M^{-1}\ L^{-3}\ T^4\ A^2]$
(d) $[ML^{-3}\ T^4\ A^{-2}]$

(iii) The force of repulsion between two charges of 1C each, kept 1 m apart in vaccum is
(a) $\frac{1}{9\times10^9}$ N
(b) $9 \times 10^9$ N

(c) $9 \times 10^7$ N
(d) $\frac{1}{9\times10^{12}}$ N

OR

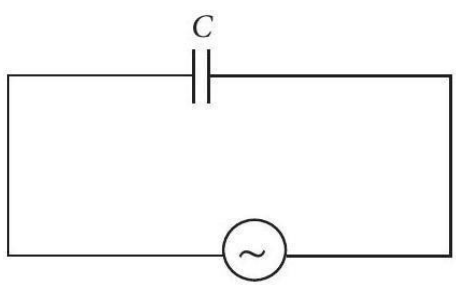
Two identical charges repel each other with a force equal to 10mgwt when they are 0.6 m apart in air. ($g = 10$ m s$^{-2}$). The value of each charge is
(a) 2mC
(b) $2 \times 10^{-7}$mC
(c) 2nC
(d) $2\mu$C

(iv) Coulomb's law for the force between electric charges most closely resembles with
(a) law of conservation of energy
(b) Newton's law of gravitation
(c) Newton's 2nd law of motion
(d) law of conservation of charge

30. Read the following paragraph and answer the questions that follow.

**AC Voltage Applied to a Capacitor**

Let a source of alternating e.m.f. $E = E_0 \sin \omega t$ be connected to a capacitor of capacitance $C$. If ' $P$ ' is the instantaneous value of current in the circuit at instant $t$, then $I = \frac{E_0}{1/\omega C} \sin\left(\omega t + \frac{\pi}{2}\right)$. The capacitive reactance limits the amplitude of current in a purely capacitive circuit and it is given by $X_C = \frac{1}{C}$.




(i) What is the unit of capacitive reactance?
(a) farad
(b) ampere
(c) ohm
(d) ohm$^{-1}$

(ii) The capacitive reactance of a $5\mu$F capacitor for a frequency of $10^6$ Hz is
(a) $0.032\Omega$
(b) $2.52\Omega$

(c) $1.25\Omega$
(d) $4.51\Omega$

(iii) In a capacitive circuit, resistance to the flow of current is offered by
(a) resistor
(b) capacitor
(c) inductor
(d) frequency

(iv) In a capacitive circuit, by what value of phase angle does alternating current leads the e.m.f?
(a) $45^{\circ}$
(b) $90^{\circ}$
(c) $75^{\circ}$
(d) $60^{\circ}$

**OR**

One microfarad capacitor is joined to a $200\text{ V}, 50\text{ Hz}$ alternator. The rms current through capacitor is
(a) $6.28 \times 10^{-2}$ A
(b) $7.5 \times 10^{-4}$ A
(c) $10.52 \times 10^{-2}$ A
(d) $15.25 \times 10^{-2}$ A

## SECTION E

31. Three point charges $+1\mu\text{C}, -1\mu\text{C}$ and $+2\mu\text{C}$ are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side $10$ cm.

**OR**

Show that the electric field due to a infinitely long sheet of charge is $\frac{\sigma}{s_0}$.

32. (i) Can we have magnetic hysteresis in paramagnetic or diamagnetic substances?

(ii) State curie law in magnetism.

**OR**

State Ampere's Circuital Law. Prove it for a regular as well as irregular coil.

33. (i) The sum (diameter $d$ ) subtends an angle $\theta$ radian at the pole of a concave mirror of focal length $f$. What is the diameter of the image of the sun formed by the mirror?

(ii) An object of height $h$ is held before a spherical mirror of focal length $|f| = 40$ cm. The image of the object produced by the mirror has same orientation as the object and has height $= 0.2$ h. Is the image real or virtual? Is the image on the same side of the mirror as the object? Is the mirror convex or concave? What is focal length of mirror with proper sign?

**OR**

(a) A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is obtained on a screen 1 m away. If the first minimum is formed at a distance of 2.5 mm from the centre of the screen, find the (i) width of the slit, and (ii) distance of first secondary maximum from the centre of the screen.

(b) (i) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band? Explain.

(ii) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot in seen at the centre of the obstacle. Explain why.

# SAMPLE
# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

**SET-04**
**PHYSICS**

Time: 3 Hours Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8\ \mathrm{m/s}$
iii. $e = 1.6 \times 10^{-19}\mathrm{C}$
v. $h = 6.63 \times 10^{-34}\mathrm{Js}$
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}\mathrm{TmA^{-1}}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

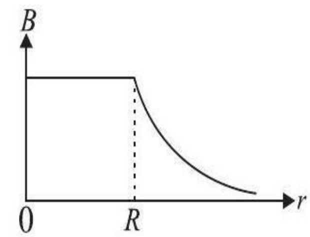
## SECTION A

1. Which of the following statements is false for a perfect conductor?
(a) The surface of the conductor is an equipotential surface.
(b) The electric field just outside the surface of a conductor is perpendicular to the surface.
(c) The charge carried by a conductor is always uniformly distributed over the surface of the conductor.
(d) None of these

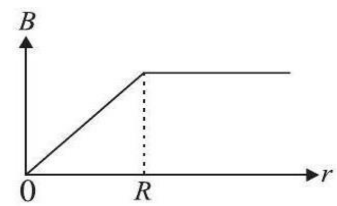
2. Point out the right statements about the validity of kirchhoff's junction rule.
   (a) It is based on conservation of charge.
   (b) Outgoing currents add up and are equal to incoming currents at a junction.
   (c) Bending or reorienting the wire does not change the validity of kirchhoff's junction rule.
   (d) All of above.

3. The correct plot of the magnitude of magnetic field $\vec{B}$ vs distance $r$ from centre of the wire is, if the radius of wire is $R$

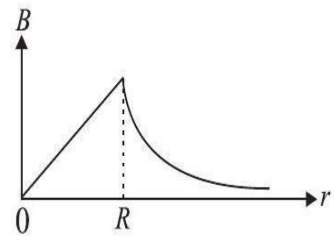
   (a)



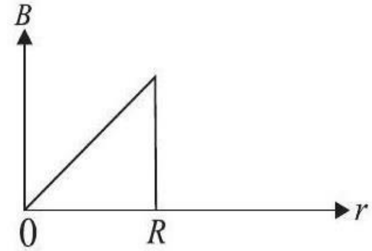

   (c)



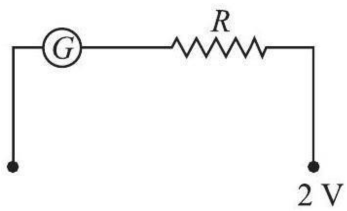

   (b)




   (d)

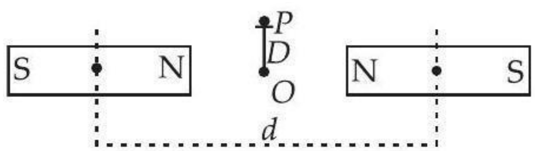


4. A voltmeter which can measure 2 V is constructed by using a galvanometer of resistance 12Ω and that produces maximum deflection for the current of 2 mA, then the resistance $R$ is




(a) 888Ω
(b) 988Ω
(c) 898Ω
(d) 999Ω

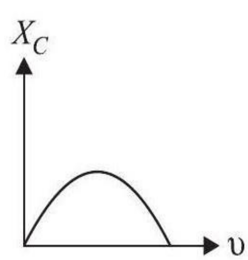
5. Two identical bar magnets are fixed with their centres at a distance $d$ apart. A stationary charge $Q$ is placed at $P$ in between the gap of the two magnets at a distance $D$ from the centre $O$ as shown in the figure. The force on the charge $Q$ is



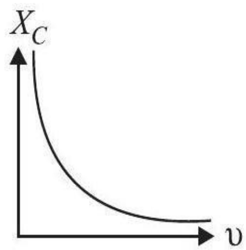

(a) zero
(c) directed along $PO$
(b) directed along $OP$
(d) directed perpendicular to the plane of paper.

6. Which of the following graphs represents the correct variation of capacitive reactance $X_C$ with frequency $\upsilon$ ?

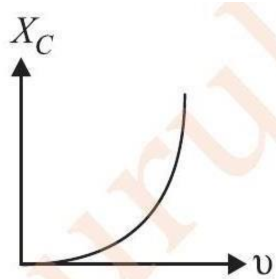
(a)




(c)




(b)

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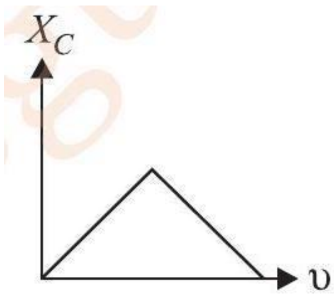
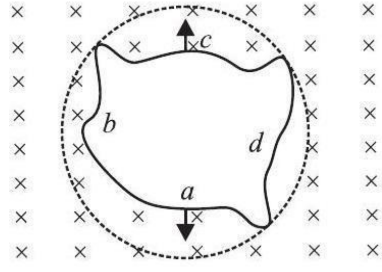



7. If a variable frequency ac source is connected to a capacitor then with decrease in frequency the displacement current will
(a) increase
(c) remains constant
(b) decrease
(d) first decrease then increase

8. A wire of irregular shape turning into a circular shape in a magnetic field which is directed into the paper. The direction of induced current is

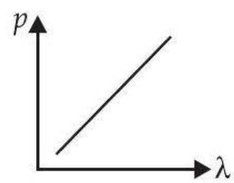


(a) along abcda
(c) into the plane of the paper
(b) along adcba
(d) out of the plane of the paper

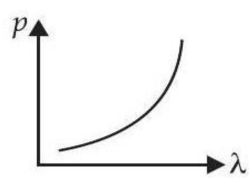
9. In a Young's double slit experiment an electron beam is used to obtain interference pattern. If the spread of electron is decreases then
(a) distance between two consecutive fringes remains the same
(b) distance between two consecutive fringes decreases
(c) distance between two consecutive fringes increases
(d) none of these.

10. Which of the following figure represents the variation of particle momentum ($p$) and associated de Broglie wavelength ($\lambda$) ?

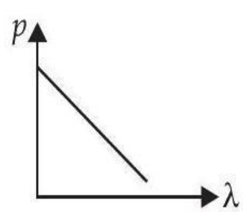
(a)



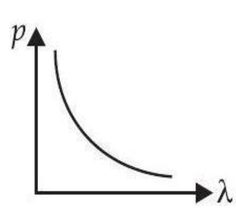

(b)




(c)




(d)



11. The radius of $n^{th}$ orbit $r_n$ in terms of Bohr radius $(a_0)$ for a hydrogen atom is given by the relation
(a) $na_0$
(b) $\sqrt{n}a_0$
(c) $n^2a_0$
(d) $n^3a_0$

12. The fission properties of $^{239}_{94}Pu$ are very similar to those of $^{235}_{92}U$. The average energy released per fission is 180MeV. If all the atoms in 1 kg of pure $^{239}_{94}Pu$ undergo fission, then the total energy released in MeV is
(a) $4.53 \times 10^{26}$MeV
(b) $2.21 \times 10^{14}$MeV
(c) $1 \times 10^{13}$MeV
(d) $6.33 \times 10^{24}$MeV 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 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): Step-down transformer increases the current.

Reason (R): Transformer obeys the law of conservation of energy.

14. Assertion (A): The tyres of aircrafts are slightly conducting.

Reason (R): If a conductor is connected to ground, the extra charge induced on conductor will flow to ground.

15. Assertion (A): Young's double slit experiment can be performed using a source of white light.

Reason (R): The wavelength of red light is less than the wavelength of other colours in white light.

16. Assertion (A): The threshold frequency of photoelectric effect supports the particle nature of light.

Reason (R): If frequency of incident light is less than the threshold frequency, electrons are not emitted

## SECTION B

17. Identify the electromagnetic waves whose wavelengths vary as
(a) $10^{-11}$ m $< \lambda < 10^{-14}$ m
(b) $10^{-4}$ m $< \lambda < 10^{-6}$ m

Write one use of each.

18. What is the name given to the curves, the tangent to which at any point gives the direction of the magnetic field at that point? Can two such curves intersect each other? Justify your answer.

19. How is the size of a nucleus experimentally determined? Write the relation between the radius and mass number of the nucleus. Show that the density of nucleus is independent of its mass number.

**OR**

Energy of electron in first excited state in Hydrogen atom is $-3.4$eV. Find K.E. and P.E. of electron in the ground state.

20. 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, find the refractive index of the material of the lens.

21. (a) Is Huygens principle valid for longitudinal sound waves?

(b) Why is the diffraction of sound waves more evident in daily experience than that of light wave?

(c) If one of the slits in Young's double slit experiment is fully closed, the new pattern has central maximum in angular size.

## SECTION C

22. State Biot-Savart law, and write its mathematical expression.

Use this law to derive an expression for the magnetic field due to a circular coil carrying current at a point along its axis.

23. A circuit is set up by connecting $L = 100$mH, $C = 5\mu$F and $R = 100\Omega$ in series. An alternating emf of $(150\sqrt{2})$V, $\frac{500}{\pi}$Hz is applied across this series combination. Calculate

(a) The impedance of the circuit.

(b) The peak value of the current flowing in the circuit.

(c) The power factor of this circuit.

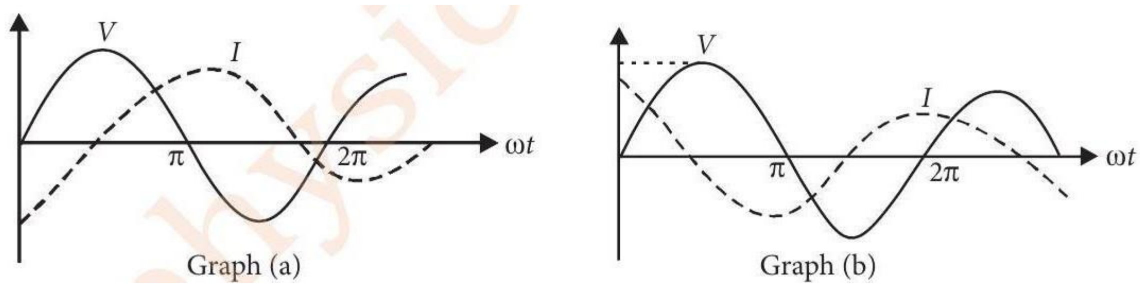
24. A series $LCR$ circuit is made by taking $R = 100\Omega, L = 2/\pi$H, $C = 100/\pi\mu$F. The series combination is connected across an a.c. source of $220$ V, $50$ Hz. Calculate

(a) the impedance of the circuit,

(b) the peak value of the current flowing in the circuit.

**OR**

For a series $LCR$ circuit, connected to a sinusoidal ac voltage source, identify the graph that corresponds to $\omega > \frac{1}{\sqrt{LC}}$. Give reason.



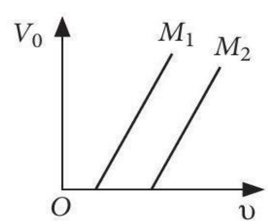

25.(a) Assuming an electron is confined to a 1 nm wide region, find the uncertainty in momentum using Heisenberg Uncertainty principle. You can assume the uncertainty in position $\Delta x$ as 1 nm. Assuming $p \simeq \Delta p$, find the energy of the electron in electron volts.

**OR**

(i) (a) Define the terms, (i) threshold frequency and (ii) stopping potential in photoelectric effect.

(b) (i) Plot a graph of photocurrent versus anode potential for a radiation of frequency $v$ and intensities $I_1$ and $I_2 (I_1 < I_2)$.

(ii) The variation of the stopping potential $(V_0)$ with the frequency $(v)$ of the light incident on two different photosensitive surfaces $M_1$ and $M_2$ is shown in the figure.

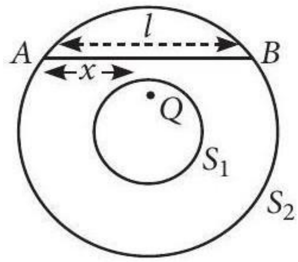



Identify the surface which has greater value of the work function.

26. In hydrogen atom, electron excites from ground state to higher energy state and its orbital velocity is reduced to $(\frac{1}{3})^{rd}$ of its initial value. The radius of the orbit in the ground state is $R$. Find the radius of the orbit in that higher energy state.

27. Write the two processes that take place in the formation of a $p - n$ junction. Explain with the help of a diagram, the formation of depletion region and barrier potential in a $p - n$ junction.

28. In the figure shown, calculate the total flux of the electrostatic field through the spheres $S_1$ and $S_2$. The wire $AB$, shown here, has a linear charge density, $\lambda$, given by $\lambda = kx$ where $x$ is the distance measured along the wire, from the end $A$.




## SECTION D

**Case Study Based Questions**

**29. Read the following paragraph and answer the questions that follow.**

An electromagnetic wave transports linear momentum as it travels through space. If an electromagnetic wave transfers a total energy $U$ to a surface in time $t$, then total linear momentum delivered to the surface is $p = \frac{U}{c}$. When an electromagnetic wave falls on a surface, it exerts pressure on the surface. In 1903, the American scientists Nichols and Hull succeeded in measuring radiation pressures of visible light where other had failed, by making a detailed empirical analysis of the ubiquitous gas heating and ballistic effects.

(i) The pressure exerted by an electromagnetic wave of intensity $I(\text{ W m}^{-2})$ on a non-reflecting surface is ( $c$ is the velocity of light)
(a) Ic
(b) $Ic^2$
(c) $I/c$
(d) $I/c^2$

(ii) Light with an energy flux of $18 \text{ W/cm}^2$ falls on a non-reflecting surface at normal incidence. The pressure exerted on the surface is
(a) $2 \text{ N/m}^2$
(b) $2 \times 10^{-4} \text{ N/m}^2$
(c) $6 \text{ N/m}^2$
(d) $6 \times 10^{-4} \text{ N/m}^2$

(iii) Radiation of intensity $0.5 \text{ W m}^{-2}$ are striking a metal plate. The pressure on the plate is
(a) $0.166 \times 10^{-8} \text{ N m}^{-2}$
(b) $0.212 \times 10^{-8} \text{ N m}^{-2}$
(c) $0.132 \times 10^{-8} \text{ N m}^{-2}$
(d) $0.083 \times 10^{-8} \text{ N m}^{-2}$

**OR**

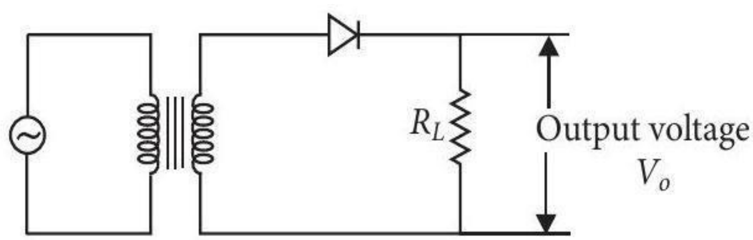
A point source of electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3 m from this source (in $Vm^{-1}$ ) is
(a) 500
(b) 100
(c) $\frac{500}{3}$
(d) $\frac{250}{3}$

(iv) The radiation pressure of the visible light is of the order of
(a) $10^{-2}$ N $m^2$
(b) $10^{-4}$ N/m
(c) $10^{-6}$ $N/m^2$
(d) $10^{-8}$ N

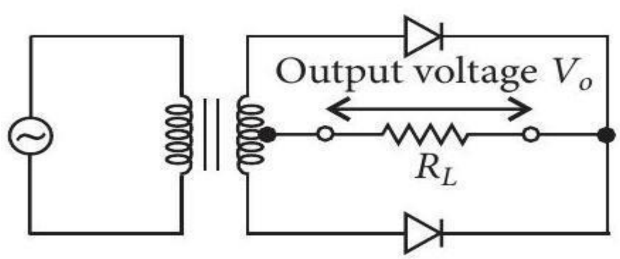
**30. Read the following paragraph and answer the questions that follow.**

**Rectifiers**

Rectifier is a device which is used for converting alternating current or voltage into direct current or voltage. Its working is based on the fact that the resistance of $p-n$ junction becomes low when forward biased and becomes high when reverse biased. A half-wave rectifier uses only a single diode while a full wave rectifier uses two diodes as shown in figures (a) and (b).




(a) Half wave rectifier

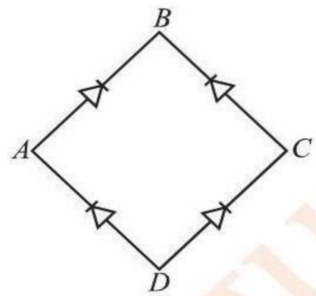



(b) Full wave rectifier

(i) If the rms value of sinusoidal input to a full wave rectifier is $\frac{V0}{\sqrt{2}}$ then the rms value of the rectifier's output is
(a) $\frac{V0}{\sqrt{2}}$
(b) $\frac{V_0^2}{\sqrt{2}}$

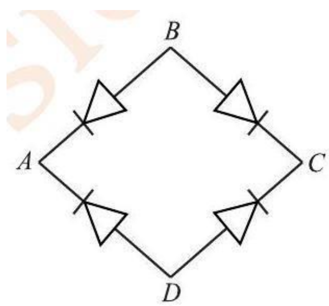
(c) $\frac{V_0^2}{2}$
(d) $\sqrt{2}V_0^2$

(ii) In the diagram, the input ac is across the terminals $A$ and $C$. The output across $B$ and $D$ is



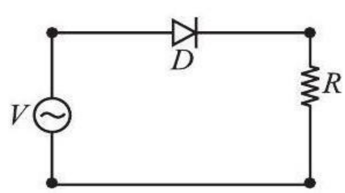

(a) same as the input
(b) half wave rectified
(c) zero
(d) full wave rectified.

(iii) A bridge rectifier is shown in figure. Alternating input is given across $A$ and $C$. If output is taken across $BD$, then it is

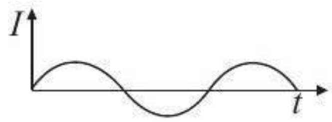



(a) zero
(b) same as input
(c) half wave rectified
(d) full wave rectified.

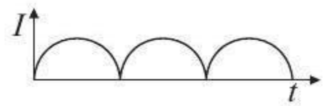
(iv) A $p-n$ junction $(D)$ shown in the figure can act as a rectifier. An alternating current source $(V)$ is connected in the circuit. The current $(I)$ in the resistor $(R)$ can be shown by



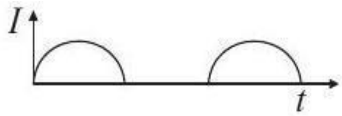

(a)



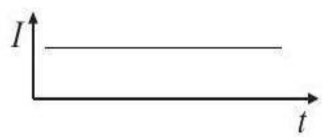

(b)




(c)




(d)




**OR**

With an ac input from 50 Hz power line, the ripple frequency is
(a) 50 Hz in the dc output of half wave as well as full wave rectifier
(b) 100 Hz in the dc output of half wave as well as full wave rectifier
(c) 50 Hz in the dc output of half wave and 100 Hz in dc output of full wave rectifier
(d) 100 Hz in the dc output of half wave and 50 Hz in the dc output of full wave rectifier.

## SECTION E

31. A parallel plate capacitor of capacitance ' $C$ ' is charged to ' $V$ ' volt by a battery. After some time the battery is disconnected and the distance between the plates is doubled. Now a slab of dielectric constant $1 < K < 2$ is introduced to fill the space between the plates. How will the following be affected?

(i) The electric field between the plates of the capacitor?

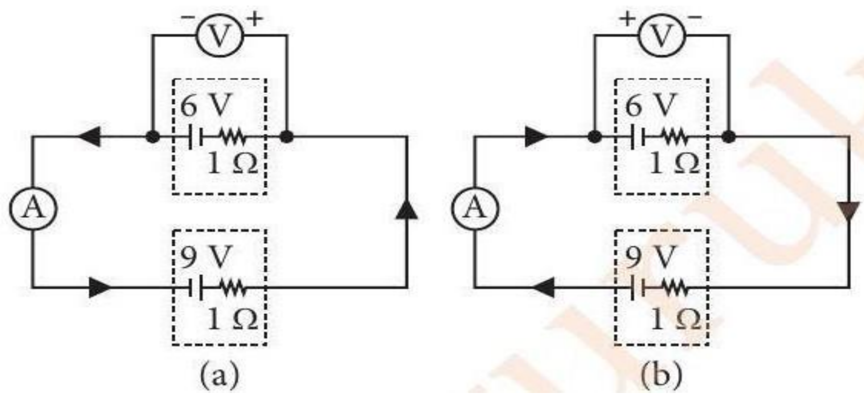
(ii) The energy stored in the capacitor. Justify your answer in each case.

**OR**

(a) An infinitely large thin plane sheet has a uniform surface charge density $+\sigma$. Obtain the expression for the amount of work done in bringing a point charge $q$ from infinity to a point, distant $r$, in front of the charged plane sheet.

(b) The electric field inside a parallel plate capacitor is $E$. Find the amount of work done in moving a charge $q$ over a closed rectangular loop $abcda$.

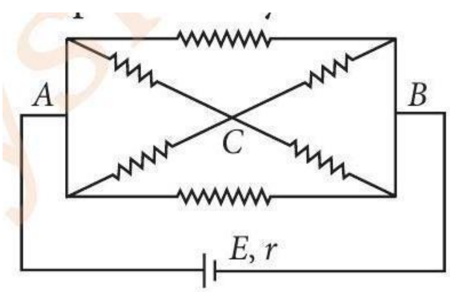
32. (a) In the two electric circuits shown in the figure, determine the readings of ideal ammeter (A) and the ideal voltmeter $(V)$.




(b) Write a relation between current and drift velocity of electrons in a conductor. Use this relation to explain how the resistance of a conductor changes with the rise in temperature.

**OR**

(i) State the two Kirchhoff's laws. Explain briefly how these rules are justified.




(ii) The current is drawn from a cell of emf $E$ and internal resistance $r$ connected to the network of resistors each of resistance $r$ as shown in the figure. Obtain the expression for (a) the current drawn from the cell and (b) the power consumed in the network.

33. (a) Use Huygen's geometrical construction to show how a plane wave-front at $t = 0$ propagates and produces a wave-front at a later time.

(b) Verify, using Huygen's principle, Snell's law of refraction of a plane wave propagating from a denser to a rarer medium.

(c) When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have the same frequency. Explain why.

**OR**

Draw a graph to show variation in the angle of deviation $\delta$ with the variation of angle of incidence $i$ for a monochromatic ray of light passing through a prism of refracting angle $A$. Deduce the relation $\mu = \frac{\sin\frac{A+\delta m}{2}}{\sin\frac{A}{2}}$.

# SAMPLE

# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

SET 05

# PHYSICS

Time: 3 Hours Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section $\boldsymbol{D}$ contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$Tm$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$C$^2$ N$^{-1}$ m$^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

1. The number of electrons present in $-1$C of charge is
(a) $6 \times 10^{18}$
(b) $1.6 \times 10^{19}$
(c) $6 \times 10^{19}$
(d) $1.6 \times 10^{18}$

2. A parallel plate capacitor is charged and then isolated. The effect of increasing the plate separation on charge, potential, capacitance respectively are

(a) constant, decreases, decreases
(b) increases, decreases, decreases
(c) constant, decreases, increases
(d) constant, increases, decreases.

3. The magnetic force $\vec{F}$ on a current carrying conductor of length $l$ in an external magnetic field $\vec{B}$ is given by
(a) $\frac{I \times \vec{B}}{l}$
(b) $\frac{\vec{l} \times \vec{B}}{I}$
(c) $I(\vec{l} \times \vec{B})$
(d) $I^2 \vec{l}\, \vec{B}$

4. The source of electromagnetic waves can be charge, when
(a) moving with a constant velocity
(c) falling in an electric field
(b) moving in a circular orbit
(d) both (b) and (c).

5. The photoelectric cut off voltage in a certain experiment is 1.5 V. The maximum kinetic energy of photoelectrons emitted is
(a) 2.4eV
(b) 1.5eV
(c) 3.1eV
(d) 4.5eV

6. Nature of equipotential surface for a point charge is

(a) ellipsoid with charge at foci
(b) sphere with charge at the centre of the sphere
(c) sphere with charge on the surface of the sphere
(d) plane with charge on the surface.

7. In half wave rectification, if the input frequency is 60 Hz, then the output frequency would be
(a) zero
(b) 30 Hz
(c) 60 Hz
(d) 120 Hz

8. Which of the following statements is incorrect for the depletion region of a diode?
(a) There are mobile charges exist.
(b) Equal number of holes and electrons exist, making the region neutral.
(c) Recombination of holes and electrons has taken place.
(d) None of these

9. The magnetic flux through a coil perpendicular to its plane and directed into paper is varying according to the relation $\phi = (2t^2 + 4t + 6)$mWb. The emf induced in the loop at $t = 4$ s is
(a) 0.12 V
(b) 2.4 V
(c) 0.02 V
(d) 1.2 V

10. From Ampere's circuital law for a long straight wire of circular cross-section carrying a steady current, the variation of magnetic field in the inside and outside region of the wire is
(a) uniform and remains constant for both the regions
(b) a linearly increasing function of distance upto the boundary of the wire and then linearly decreasing for the outside region
(c) a linearly increasing function of distance $r$ upto the boundary of the wire and then decreasing one with $1/r$ dependence for the outside region
(d) a linearly decreasing function of distance upto the boundary of the wire and then a linearly increasing one for the outside region.

11. A potential barrier of 0.3 V exists across a $p - n$ junction. If the depletion region is $1\mu$m wide, what is the intensity of electric field in this region?
(a) $2 \times 10^5$ V m$^{-1}$
(b) $3 \times 10^5$ V m$^{-1}$
(c) $4 \times 10^5$ V m$^{-1}$
(d) $5 \times 10^5$ V m$^{-1}$

12. Mark the incorrect statement.

When a potential difference is applied, the current passing through
(a) an insulator at 0 K is zero
(b) a semiconductor 0 K is zero
(c) a metal at 0 K is zero
(d) a $p - n$ junction diode at 300 K is finite, if it is reverse biased

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 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): Induced electric field due to changing magnetic flux are more readily observed than induced magnetic field due to changing electric field.

Reason (R): The induced field depends on change in magnetic flux.

14. Assertion (A): Neutrons penetrate matter more readily as compared to protons.

Reason (R): A neutron has no charge.

15. Assertion (A): A beam of charged particles is employed in the treatment of cancer.

Reason (R): Charged particles on passing through a material medium lose their energy by causing ionization of the atoms along their path.

16. Assertion (A): As force is a vector quantity, hence electric field intensity is also a vector quantity.
Reason (R): The unit of electric field intensity is newton per coulomb.

## SECTION B

17. (a) What determines the maximum velocity of the photoelectrons?

(b) Can X-rays cause photoelectric effect?

18. Why an induced emf has no direction of its own?

**OR**

A 140 turn of coil with average radius of $0.01$ m is placed perpendicular to the magnetic field of $10000$ T. If the magnetic field is changed to $5000$ T in $5$ s, what is the magnitude of induced emf?

19. When an object is placed at a distance of $60$ cm from a convex spherical mirror, the magnification produced is $\frac{1}{2}$. Where should the object be placed to get a magnification of $\frac{1}{3}$ ?

20. What is the speed of light in glass of refractive index 1.5? Given speed of light in water $2.25 \times 10^8$ m/s and refractive index of water is 1.3.

21. Which property of nuclear force explains the approximate constance of binding energy per nucleon with mass number $A$ for nuclei in the range $30 < A < 170$ ?

## SECTION C

22. (i) Two point charges $+Q_1$ and $-Q_2$ are placed $r$ distance apart. Obtain the expression for the amount of work done to place a third charge $Q_3$ at the midpoint of the line joining the two charges.

(ii) At what distance from charge $+Q_1$ on the line joining the two charges (in terms of $Q_1, Q_2$ and $r$ ) will this work done be zero.

**OR**

Differentiate between electrical resistance and resistivity of a conductor.

23. A coil of area $100 \text{ cm}^2$ is kept at an angle of $30^\circ$ with a magnetic field of $10^{-1}$ T. The magnetic field is reduced to zero in $10^{-4}$ s. Find the induced emf in the coil.

24. Carbon and silicon both have four valence electrons each, then how are they distinguished?

25. A heavy nucleus $P$ of mass number 240 and binding energy 7.6MeV per nucleon splits into two nuclei $Q$ and $R$ of mass number 110 and 130 and binding energy per nucleon 8.5MeV and 8.4MeV respectively. Calculate the energy released in the fission.

**OR**

Calculate for how many years will the fusion of 2.0 kg deuterium keep 800 W electric lamp glowing. Take the fusion reaction as

$$^2_1\text{H} + {}^2_1\text{H} \longrightarrow {}^3_2\text{He} + {}^1_0n + 3.27\text{MeV}$$

26. Name the types of em radiations which

(a) are used in destroying cancer cells,

(b) cause tanning of the skin and

(c) maintain the earth's warmth.

Write briefly a method of producing any one of these waves.

27. In single slit diffraction, explain why the maxima at $\theta = (n + \frac{1}{2})(\frac{\lambda}{a})$ becomes weaker and weaker as $n$ increases.

State two important difference between interference and diffraction pattern.

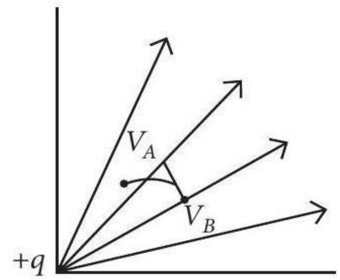
28. Using Bohr's postulates, derive the expression for the orbital period of the electron moving in the $n^{\text{th}}$ orbit of hydrogen atom.

## SECTION D

**Case Study Based Questions**

**29. Read the following paragraph and answer the questions that follow.**

Electrostatic potential energy of a system of point charges is defined as the total amount of work done in bringing the different charges to their respective positions from infinitely charge mutual separations. The work is stored in the system of two point charges in the form of electrostatic potential energy $U$ of the system. Electric potential difference between any points $A$ and $B$ in an electric field is the amount of work done in moving a unit positive test charge from $A$ to $B$ along any path agents the electrostatic force $V_B - V_A = \frac{W_{AB}}{q_o} = \int \vec{E} \cdot \vec{dl}$.




(i) A test charge is moved from lower potential point to a higher potential point. The potential energy of test charge will

(a) remain the same
(b) increase
(c) decrease
(d) become zero.

(ii) Which of the following statement is not true?

(a) Electrostatic force is a conservative force.
(b) Potential energy of charge $q$ at a point is the work done per unit charge in bringing a charge from any point to infinity.
(c) Spring force and gravitational force are conservative force.
(d) Both (a) and (c).

(iii) Work done in moving a charge from one point to another inside a uniformly charged conducting sphere is

(a) always zero
(b) non-zero
(c) may be zero
(d) none of these.

**OR**

The work done in bringing a unit positive charge from infinite distance to a point at distance $x$ from a positive charge $Q$ is $W$. Then the potential $\phi$ at that point is

(a) $\frac{WQ}{x}$
(b) $W$
(c) $\frac{W}{x}$
(d) WQ

(iv) If $1\mu$C charge is shifted from $A$ to $B$ and it is found that work done by an external force is $40\mu$J. In doing so against electrostatics force, the potential difference $V_A - V_B$ is

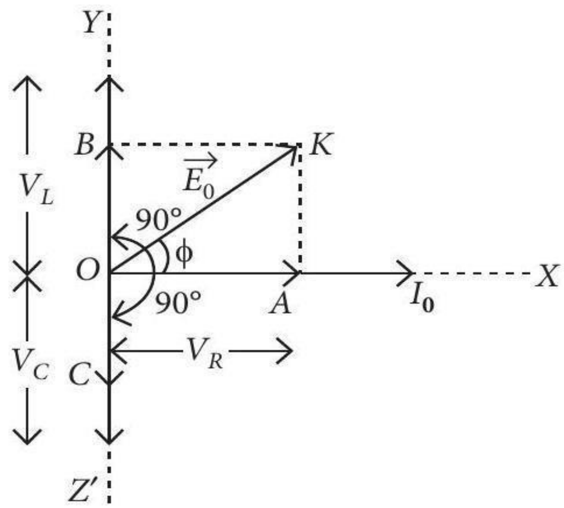
(a) 40 V
(b) $-40$ V
(c) 20 V
(d) $-60$ V

30. Read the following paragraph and answer the questions that follow.

**LCR Circuit**

When a pure resistance $R$, pure inductor $L$ and an ideal capacitor of capacitance $C$ is connected in series to a source of alternating e.m.f., then current at any instant through the three elements has the same amplitude and is represented as $I = I_0 \sin \omega t$. However, voltage across each element has a different phase relationship with the current as shown in graph.

The effective resistance of $LCR$ circuit is called impedance $(Z)$ of the circuit and the voltage leads the current by a phase angle $\phi$.




A resistor of $12\Omega$, a capacitor of reactance $14\Omega$ and a pure inductor of inductance $0.1$H are joined in series and placed across $200$ V, $50$ Hz a.c. supply.

(i) The value of inductive reactance is
(a) $15\Omega$
(b) $31.4\Omega$
(c) $20\Omega$
(d) $30\Omega$

(ii) The value of impedance is
(a) $20\Omega$
(b) $15\Omega$
(c) $30\Omega$
(d) $21.13\Omega$

(iii) What is the value of current in the circuit?
(a) 5 A
(b) 15 A
(c) 10 A
(d) 9.46 A

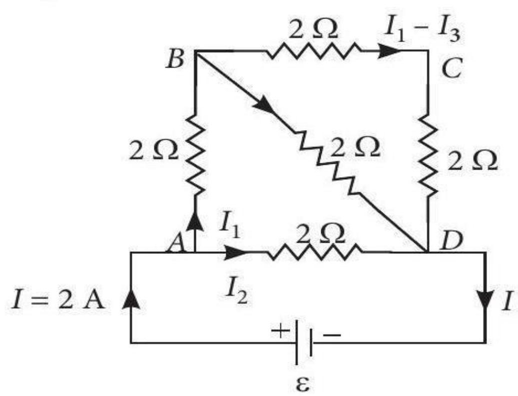
(iv) What is the value of the phase angle between current and voltage?
(a) $53^\circ 9'$
(b) $63^\circ 9'$
(c) $55^\circ 4'$
(d) $50^\circ$

**OR**

From graph, which one is true from following?
(a) $V_L \geq V_C$
(b) $V_L < V_C$
(c) $V_L > V_C$
(d) $V_L = V_C$

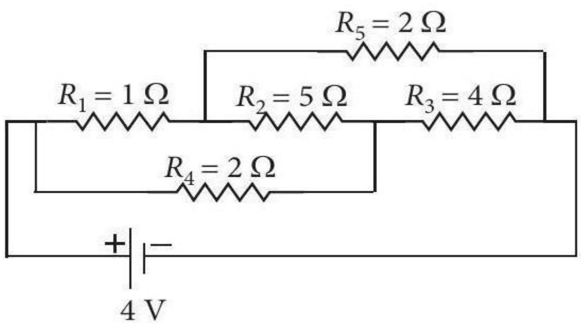
**SECTION E**

31. A network of resistors is connected to a battery of negligible internal resistance, as shown in figure. Calculate the equivalent resistance between the points $A$ and $D$, and the value of the current $I_3$.




**OR**

Calculate the current drawn from the battery in the given network.




32. (a) Define capacitive reactance. Write its S.I. units.

(b) A resistor $R$ and an inductor $L$ are connected in series to a source $V = V_0 \sin \omega t$. Find the

(i) peak value of the voltage drops across $R$ and across $L$

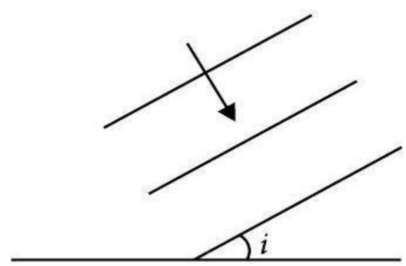
(ii) phase difference between the applied voltage and current. Which of them is ahead?

**OR**

(a) A long solenoid of 20 turns/ cm has a small loop of area $2\ \text{cm}^2$ placed inside it with the normal of the loop parallel to the axis. Find the voltage across the small loop, if the current in the solenoid varies from $2$ A to $4$ A in $0.2$ s.

(b) If the magnetic flux of a coil changes from $10 \times 10^{-2}$ Wb to $5 \times 10^{-2}$ Wb in $0.26$ s, find the induced emf.

33. A plane wavefront propagating in a medium of refractive index ' $\mu_1$ ' is incident on a plane surface making the angle of incidence $i$ as shown in the figure. It enters into a medium of refraction of refractive index ' $\mu_2$ ' $(\mu_2 > \mu_1)$. Use Huygens construction of secondary wavelets to trace the propagation of the refracted wavefront. Hence verify Snell's law of refraction.




**OR**

(a) In Young's double slit experiment, deduce the condition for (i) constructive, and (ii) destructive interference at a point on the screen. Draw a graph showing variation of intensity in the interference pattern against position ' $x$ ' on the screen.

(b) Light waves from two coherent surface arrive at two points on a screen with path differences zero and $\lambda/2$. Find the ratio of intensities at the points.

# SAMPLE

# PAPER

## CLASS 12

### PHYSICS

SET 06

# PHYSICS

Time: 3 Hours                                                                 Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section **E** contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
ii. $m_e = 9.1 \times 10^{-31}$ kg
v. $h = 6.63 \times 10^{-34}$Js
iv. $\mu_0 = 4\pi \times 10^{-7}$Tm$^{-1}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

1. Four equal charges $q$ each are placed at four corners of a square of side $a$ each. Work done in carrying a charge $-q$ from its centre to infinity is
(a) zero
(b) $\frac{\sqrt{2}q^2}{\pi \varepsilon_0 a}$
(c) $\frac{\sqrt{2}q}{\pi \varepsilon_0 a}$
(d) $\frac{q^2}{\pi \varepsilon_0 a}$

2. When a magnetic compass needle is carried nearby to a straight wire carrying current, then (I) the straight wire cause a noticeable deflection in the compass needle.

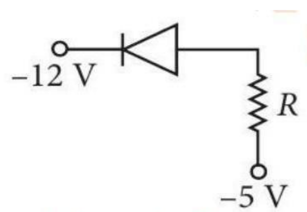
(II) the alignment of the needle is tangential to an imaginary circle with straight wire as its centre and has a plane perpendicular to the wire.
(a) (I) is correct
(b) (II) is correct
(c) both (I) and (II) are correct
(d) neither (I) nor (II) is correct

3. Electromagnetic waves used as a diagnostic tool in medicine are
(a) X-rays
(b) ultraviolet rays
(c) infrared radiation
(d) ultrasonic waves.

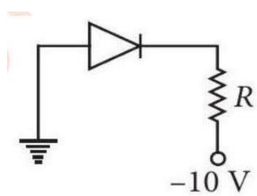
4. If voltage across a bulb rated 220 V − 100 W drops by 2.5% of its rated value, the percentage of the rated value by which the power would decrease is
(a) 20%
(b) 2.5%
(c) 5%
(d) 10%

5. Of the diodes shown in the following figures, which one is reverse biased?

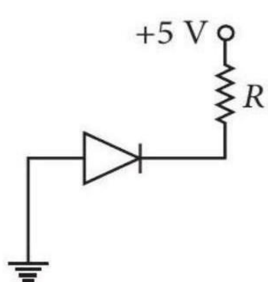
(a)



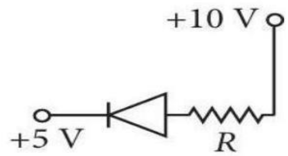

(b)




(c)



(d)



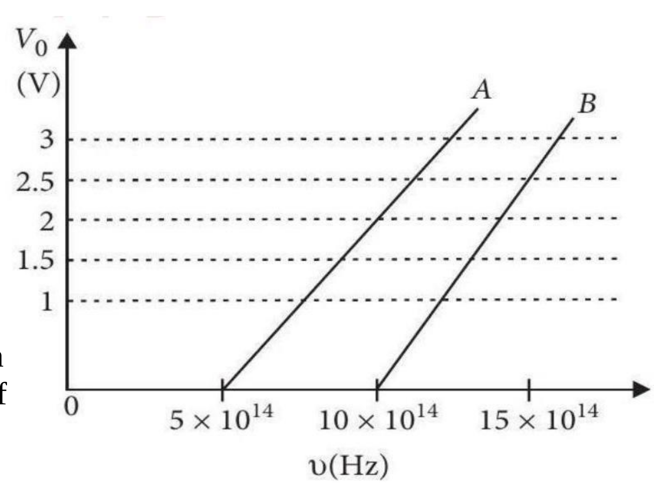

6. Out of given paramagnetic substance (calcium, chromium oxygen and Tungsten) which substance has maximum susceptibility?
(a) Calcium
(b) Chromium
(c) Oxygen
(d) Tungsten

7. In the given reactions, which of the following nuclear fusion reaction is not possible?
(a) ${}^{13}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{14}_{6}\mathrm{C} + 4.3\mathrm{MeV}$
(b) ${}^{12}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{13}_{7}\mathrm{N} + 2\mathrm{MeV}$
(c) ${}^{14}_{7}\mathrm{N} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{15}_{8}\mathrm{O} + 7.3\mathrm{MeV}$
(d) ${}^{235}_{92}\mathrm{C} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{140}_{54}\mathrm{Xe} + {}^{94}_{38}\mathrm{Sr} + {}^{1}_{0}\mathrm{n} + {}^{1}_{0}\mathrm{n} + 200\mathrm{MeV}$

8. A student performs an experiment on photoelectric effect using two materials $A$ and $B$. A plot of stopping potential $(V_{(0)} vs_{\text{frequency}}\ v)$ is as shown in the figure.

The value of $h$ obtained from the experiment for both $A$ and $B$ respectively is

(Given electric charge of an electron $= 1.6 \times 10^{-19}\mathrm{C}$ )
(a) $3.2 \times 10^{-34}$ J s, $4 \times 10^{-34}$ J s
(b) $6.4 \times 10^{-34}$ J s, $8 \times 10^{-34}$ J s
(c) $1.2 \times 10^{-34}$ J s, $3.2 \times 10^{-34}$ J s
(d) $4.2 \times 10^{-34}$ J s, $5 \times 10^{-34}$ J s




9. In an inductor of self-in ... rding to relation, $I =$
$t^2 e^{-t}$ At what time emf
(a) 4 s

(b) 3 s
(c) 2 s
(d) 1 s

10. A plane electromagnetic wave travels in vacuum along $z$-direction. If the frequency of the wave is 40MHz then its wavelength is
(a) 5 m
(b) 7.5 m
(c) 8.5 m
(d) 10 m

11. An electric dipole of length 20 cm having $\pm 3 \times 10^{-3}$C charge placed at $60^{\circ}$ with respect to a uniform electric field experiences a torque of magnitude 6 N m. The potential energy of the dipole is
(a) $-2\sqrt{3}J$
(b) $5\sqrt{3}$ J
(c) $-3\sqrt{2}$ J
(d) $3\sqrt{5}$ J

12. The work function for $Al, K$ and $Pt$ is 4.28eV, 2.30eV and 5.65eV respectively. Their respective threshold frequencies would be
(a) Pt $>$ Al $>$ K
(b) Al $>$ Pt $>$ K
(c) K $>$ Al $>$ Pt
(d) Al $>$ K $>$ Pt

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 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): The core of transformer is made laminated in order to increase the eddy currents.
Reason (R): The sensitivity of transformer increases with increase in the eddy currents.

14. Assertion (A): A point charge is brought in an electric field. The field at a nearby point increase, whatever be the nature of the charge.

Reason (R): The electric field is independent of the nature of charge.

15. Assertion (A): A solenoid tends to expand, when a current passes through it.

Reason (R): Two straight parallel metallic wires carrying current in same direction repel each other.

16. Assertion (A): For the scattering of $\alpha$-particles at a large angles, only the nucleus of the atom is responsible.

Reason (R): Nucleus is very heavy in comparison to electrons.

**SECTION B**

17. A galvanometer of resistance $16\Omega$ shows full scale deflection for a current of 4 mA. How will you convert it into a voltmeter to measure a voltage up to 3 V ?

18. (a) How are electromagnetic waves produced?

(b) How do you convince yourself that electromagnetic waves carry energy and momentum?

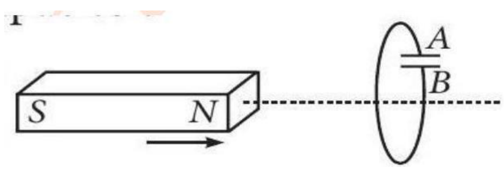
19. Two point charges $q$ and $-2q$ are kept ' $d$ ' distance apart. Find the location of point relative to charge ' $q$ ' at which potential due to this system of charges is zero.

**OR**

A parallel plate capacitor of capacitance $C$ is charged to a potential $V$. It is then connected to another uncharged capacitor having the same capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor.

20. Define the magnifying power of a compound microscope when the final image is formed at infinity. Why must both the objective and the eyepiece of a compound microscope has short focal lengths? Explain.

21. In the given figure, a bar magnet is quickly moved towards a conducting loop having a capacitor. Predict the polarity of the plates $A$ and $B$ of the capacitor.




**SECTION C**

22. According to the classical electromagnetic theory, calculate the initial frequency of the light emitted by the electron revolving around a proton in hydrogen atom.

23. There are two current carrying planer coils each made from identical wires of length L.C is circular (radius $R$ ) and $C_2$ is square (side $a$ ). They are so constructed that they have same frequency of oscillation when they are placed in the same uniform magnetic field and carry the same current. Find $a$ in term of $R$.

**OR**

The magnetic susceptibility of a paramagnetic substance at $-173^{\circ}\mathrm{C}$ is $1.5 \times 10^{-2}$ then what will be its value at $-73^{\circ}\mathrm{C}$ ?

24. (a) When the oscillating electric and magnetic fields are along the $x$-and $y$-direction respectively. (i) point out the direction of propagation of electromagnetic wave.

(ii) express the velocity of propagation in terms of the amplitudes of the oscillating electric and magnetic fields.

(iii) How do you show that the e.m. wave carries energy and momentum?

25. How is forward biasing different from reverse basing in a $p$ - $n$ junction diode?

26. An electric heater and an electric bulb are rated $500 \mathrm{~W}, 220 \mathrm{~V}$ and $100 \mathrm{~W}, 220 \mathrm{~V}$ respectively. Both are connected in series to a $220 \mathrm{~V}$ d.c. mains. Calculate the power consumed by (i) the heater and (ii) electric bulb.

**OR**

Write the mathematical relation for the resistivity of a material in terms of relaxation time, number density and mass and charge or charge carriers in it. Explain using this relation, why the resistivity of a metal increases and that of a semiconductor decreases with rise in temperature?

27. Distinguish between a metal and an insulator on the basis of energy band diagrams.

28. A copper wire of radius $0.1$ mm and resistance $1 \mathrm{k\Omega}$ is connected across a power supply of $20$ V.

(a) How many electrons are transferred per second between the supply and the wire at one end?

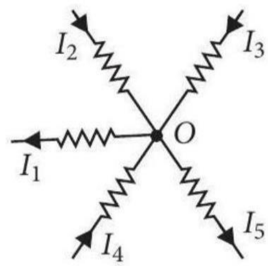
(b) What is the current density in the wire?

## SECTION D

**Case Study Based Questions**

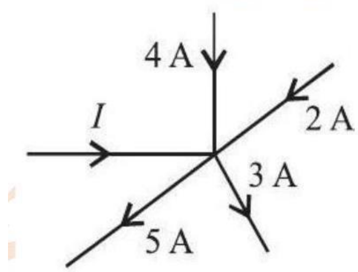
**29. Read the following paragraph and answer the questions that follow.**

In 1942, a German physicist Kirchhoff extended Ohm's law to complicated circuits and gave two laws, which enable us to determine current in any part of such a circuit. According to Kirchhoff's first rule, the algebraic sum of the currents meeting at a junction in a closed electric circuit is zero. The current flowing in a conductor towards the junction is taken as positive and the current flowing away from the junction is taken as negative. According to Kirchhoff's second rule, in a closed loop, the algebraic sum of the emf's and algebraic sum of the products of current and resistance in the various arms of the loop is zero. While traversing a loop, if negative pole of the cell is encountered first, then its emf is negative, otherwise positive.



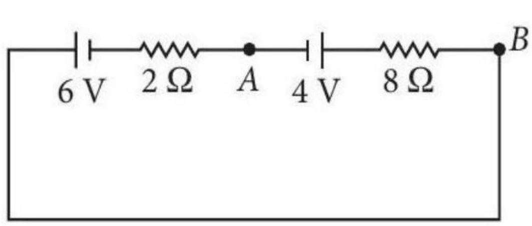

(i) Kirchhoff's $I^{st}$ law follows
(a) law of conservation of energy
(c) law of conservation of momentum
(b) law of conservation of charge
(d) Newton's third law of motion

(ii) The value of current $I$ in the given circuit is
(a) 4.5 A
(b) 3.7 A
(c) 2.0 A
(d) 2.5 A




(iii) Kirchhoff's II $^{nd}$ law is based on
(a) law of conservation of momentum of electron
(b) law of conservation of charge and energy
(c) law of conservation of energy
(d) none of these.

(iv) Potential difference between $A$ and $B$ in the circuit shown here is
(a) 4 V
(b) 5.6 V
(c) 2.8 V
(d) 6 V



**OR**

Point out the right statements about the validity of Kirchhoff's Junction rule.

(a) The current flowing towards the junction are taken as positive.

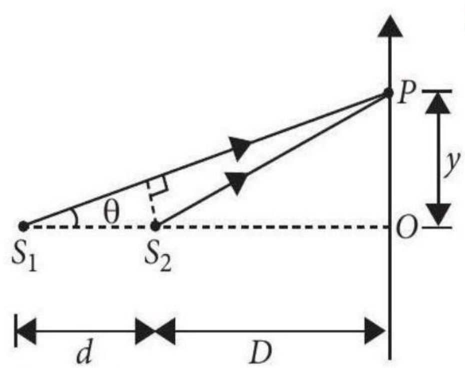
(b) The currents flowing away from the junction are taken as negative.

(c) bending or reorienting the wire does not change the validity of Kirchhoff's Junction rule.

(d) All of the above

30. Read the following paragraph and answer the questions that follow. Interference Pattern

In Young's double slit experiment, the width of the central bright fringe is equal to the distance between the first dark fringes on the two sides of the central bright fringe. In given figure below a screen is placed normal to the line joining the two point coherent source $S_1$ and $S_2$. The interference pattern consists of concentric circles.




(i) The optical path difference at $P$ is

(a) $d\left[1+\frac{y^2}{2D}\right]$

(b) $d\left[1+\frac{2D}{y^2}\right]$

(c) $d\left[1-\frac{y^2}{2D^2}\right]$

(d) $d\left[2D-\frac{1}{y^2}\right]$

(ii) Find the radius of the $n^{\text{th}}$ bright fringe.

(a) $D\sqrt{1\left(1-\frac{n\lambda}{d}\right)}$

(b) $D\sqrt{2\left(1-\frac{n\lambda}{d}\right)}$

(c) $2D\sqrt{2\left(1-\frac{n\lambda}{d}\right)}$

(d) $D\sqrt{2\left(1-\frac{n\lambda}{2d}\right)}$

(iii) The coherence of two light sources means that the light waves emitted have
(a) same frequency
(b) same intensity
(c) constant phase difference
(d) same velocity.

**OR**

The phenomenon of interference is shown by
(a) longitudinal mechanical waves only
(b) transverse mechanical waves only
(c) electromagnetic waves only
(d) all of these

(iv) If $d = 0.5$ mm, $\lambda = 5000$Å and $D = 100$ cm, find the value of $n$ for the closest second bright fringe
(a) 888
(b) 830
(c) 914
(d) 998

## SECTION E

31. (a) Define linear magnification of a lens.

(b) A real image of an object is formed at a distance of 20 cm from a lens. On putting another lens in contact with it, the image is shifted 10 cm towards the combination. Determine the power of the second lens.

**OR**

Derive the prism formula.

32. (a) In a series $LCR$ circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with frequency of the ac source.

(b) What is the phase difference between the voltages across inductor and the capacitor at resonance in the LCR circuit?

(c) When an inductor is connected to a 200 V dc voltage, a current of 1 A flows through it. When the same inductor is connected to a 200 V, 50 Hz ac source, only 0.5 A current flows. Explain, why? Also, calculate the self inductance of the inductor.

**OR**

(a) A series $LCR$ circuit is connected to an ac source of variable frequency. Draw a suitable phasor diagram to deduce the expressions for the amplitude of the current and phase angle.
(b) Obtain the condition of resonance. Draw a plot showing the variation of current with the frequency of a.c. source for two resistances $R_1$ and $R_2 (R_1 > R_2)$. Hence define the quality factor, $Q$ and write its role in the tuning of the circuit.

33. (a) What is the de-Broglie wavelength of a nitrogen molecule in air at $300$ K ? Assume that the molecule is moving with root mean square speed of molecules at this temperature.

(Atomic mass of nitrogen $= 14.0096$u )

(b) A photon and electron have got the same de-Broglie wavelength. Explain which has greater total energy.

**OR**

(a) A photon and an electron both have energy of $100$eV. Which has the longer wavelength and higher linear momentum?

(b) A proton and a $\alpha$-particle are accelerated through same potential difference. Find the ratio of their de-Broglie wavelengths.

# SAMPLE
# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

**SET-07**

**PHYSICS**

Time: 3 Hours Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section $\boldsymbol{D}$ contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$Tm$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$C$^2$ N$^{-1}$ m$^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

1. Object may acquire an excess or deficiency of charge by
(a) electric force
(b) heating
(c) shaking
(d) rubbing

2. Critical angle for light going from medium (i) to (ii) is $\theta$. The speed of light in medium (i) is $v$, then the speed of light in medium (ii) is
(a) $v(1 - \cos\theta)$

(b) $\frac{v}{\sin\theta}$
(c) $\frac{v}{\cos\theta}$
(d) $\frac{v}{(1-\sin\theta)}$

3. A bar magnet of magnetic moment $M$ is cut into two parts of equal length. The magnetic moment of each part will be
(a) $M$
(b) $1M$
(c) Zero
(d) 0.5M

4. Two slits in young's double slit experiment have widths in the ratio $81:1$. The ratio of the amplitudes of light waves is
(a) $3:1$
(b) $3:2$
(c) $9:1$
(d) $6:1$

5. If a charged spherical conductor of radius $10$ cm has potential $V$ at a point distant $5$ cm from its centre, then the potential at a point distance $15$ cm from the centre will be
(a) 3 V
(b) $\frac{3}{2}$ V
(c) $\frac{2}{3}$ V
(d) $\frac{1}{3}V$

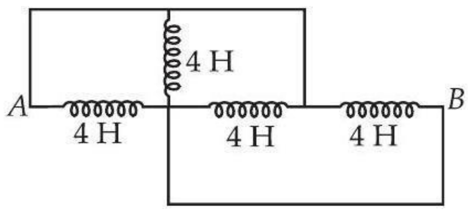
6. A forward biased $p-n$ junction diode has a resistance of the order of
(a) 1Ω
(b) 1kΩ
(c) 1MΩ
(d) none of these

7. Biot-Savart law indicates that the moving electrons (velocity $\vec{v}$ ) produce a magnetic field $\vec{B}$ such that
(a) $\vec{B} \perp \vec{v}$
(b) $\vec{B} \parallel \vec{v}$
(c) it obeys inverse cube law.
(d) it is along the line joining the electron and point of observation.

8. Two coherent sources of intensity ratio $\beta$ interfere. Then the value of $(I_{\max} - I_{\min})/(I_{\max} + I_{\min})$ is
(a) $\frac{1+\beta}{\sqrt{\beta}}$
(b) $\sqrt{(\frac{1+\beta}{\beta})}$

(c) $\frac{1+\beta}{2\sqrt{\beta}}$
(d) $\frac{2\sqrt{\beta}}{1+\beta}$

9. The equivalent inductance between $A$ and $B$ is




(a) 1H
(b) 4H
(c) 0.8H
(d) 16H

10. In a parallel plate capacitor, the capacity increases if
(a) area of the plate is decreased
(b) distance between the plates increases
(c) area of the plate is increased
(d) dielectric constant decreases.

11. In the depletion region of a $p-n$ junction there is a shortage of
(a) acceptor ions
(b) holes and electrons
(c) donor ions
(d) none of these

12. The resistivity of pure germanium atom when its conductivity is $0.0166 \mathrm{~S/cm}$ is
(a) $1.6 \times 10^4 \Omega\mathrm{cm}$
(b) $60 \Omega\mathrm{cm}$
(c) $3 \times 10^6 \Omega\mathrm{cm}$
(d) $6 \times 10^{-4} \Omega\mathrm{cm}$ 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 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): The majority current carriers diffuse from a region of higher concentration to a region of lower concentration.

Reason (R): The direction of diffusion current in a junction diode is from $n$-region to $p$-region.

14. Assertion (A): Coloured spectrum is seen when we look through a muslin cloth. Reason (R) : It is due to the diffraction of white light on passing through fine slits.

15. Assertion (A): The kinetic energy of the emitted photo-electrons changes only with a change in the frequency of the incident radiations.

    Reason (R): The kinetic energy of photoelectrons emitted by a photo-sensitive surface depends upon the intensity of the incident radiation.

16. Assertion (A): $p-n$ junction diode can be used even at ultra high frequencies.

    Reason (R): Capacitive reactance of a $p-n$ junction diode increases as frequency increases.

## SECTION B

17. If $h$ is the Planck's constant, then find the momentum of photon of wavelength $0.01 Å$.

18. A closely $70$ cm long wound solenoid has three layers of winding of 400 turns each. The diameters of the solenoid is 1.8 cm. If the current carried is $7$ A, estimate the magnetic field
    (a) inside the solenoid
    (b) on the axial end points of the solenoid.

    **OR**

    A galvanometer with a coil resistance of $100 \Omega$ gives a full-scale deflection when a current of 1 mA is passed through it. Calculate the resistance of the shunt needed to convert this galvanometer into an ammeter of range $10$ A.

19. Monochromatic light of wavelength $560$ nm is incident from air on a water surface. If refractive index of water is 1.33, find the wavelength, frequency and speed of refracted light.

20. A $5$ cm long needle is placed $10$ cm from a convex mirror of focal length $40$ cm. Find the position, nature and size of image of the needle. What happens to the size of image when needle is moved farther away from the mirror?

21. A ray of light passes through an equilateral prism (refractive index 1.5) such that angle of incidence is equal to angle of emergence and the latter is equal to $3/4^{\text{th}}$ of the angle of prism. Calculate the angle of deviation.

## SECTION C

22. A current of 1.0 A exists in a copper wire of cross-section 1.0 $mm^2$. Assuming one free electron per atom calculate the drift speed of the free electrons in the wire. The density of copper is $9000 \text{ kg m}^{-3}$.

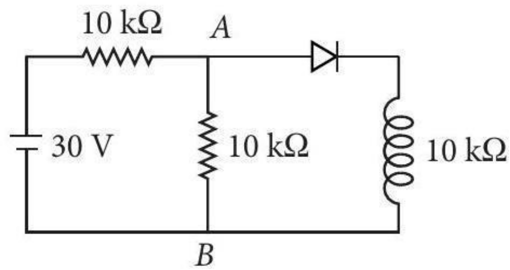
    **OR**

A beam of electrons moving at a speed of $10^6$ m/s along a line produces a current of $1.6 \times 10^{-6}$ A. What are the number of electrons in the 1 metre of the beam?

23. (a) Three identical specimens of magnetic material nickel, antimony and aluminum are kept in a nonuniform magnetic field. Draw the modifications in the field lines in each case. Justify your answer.

(b) The susceptibility of a ferromagnetic substance is

24. In the given figure, calculate the potential difference between $A$ and $B$.




25. Calculate the binding energy in MeV of Uranium = 238 from the following data:

Mass of ${}_1^1\mathrm{H} = 1.008142\mathrm{amu}$,

Mass of ${}_0^1\mathrm{H} = 1.008982\mathrm{amu}$

Mass of ${}_{92}^{238}\mathrm{U} = 238.124930\mathrm{amu}$

Also calculate the packing fraction.

**OR**

In a nuclear reactor, fission is produced in 1 g for $U^{235}$ (235.0439) in 24 hours by slow neutrons (1.0087u). Assume than ${}_{35}Kr^{92}(91.89734)$ and ${}_{56}Ba^{141}(140.9139\mathrm{amu})$ are produced in all and no energy is last.

(i) Write the complete reaction.

(ii) Calculate the total energy produced in Kilowatt hour. Given: $1\mathrm{u} = 931\mathrm{MeV}$

26. Monochromatic light of wavelength 589 nm is incident from air on a water surface. If $\mu$ for water is 1.33, find the wavelength, frequency and speed of the refracted light.

27. According to the classical electromagnetic theory, calculate the initial frequency of the light emitted by the electron revolving around a proton in hydrogen atom.

28. In a Geiger-Marsden experiment, what is the distance of closest approach to the nucleus of a 7.7MeV $\alpha$-particle before it comes momentarily to rest and reverses its direction?

## SECTION D

**Case Study Based Questions**

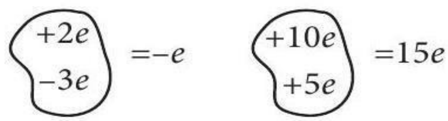
**Read the following paragraph and answer the questions that follow.**

Smallest charge that can exist in nature is the charge of an electron. During friction it is only the transfer of electrons which makes the body charged. Hence net charge on any body is an integral multiple of charge of an electron [$1.6 \times 10^{-19}$C]

i.e., $q = \pm ne$

where $n = 1,2,3,4, \ldots$

Hence no body can have a charge represented as $1.1e, 2.7e, \frac{3}{5}e$, etc.




Recently, it has been discovered that elementary particles such as protons or neutrons are composed of more elemental units called quarks.

(i) Which of the following properties is not satisfied by an electric charge?
(a) Total charge conservation.
(b) Quantization of charge.
(c) Two types of charge.
(d) Circular line of force.

(ii) Which one of the following charges is possible?
(a) $5.8 \times 10^{-18}$C
(b) $3.2 \times 10^{-18}$C
(c) $4.5 \times 10^{-19}$C
(d) $8.6 \times 10^{-19}$C

(iii) If a charge on a body is 1nC, then how many electrons are present on the body?
(a) $6.25 \times 10^{27}$
(b) $1.6 \times 10^{19}$
(c) $6.25 \times 10^{28}$
(d) $6.25 \times 10^{9}$

**OR**

If a body gives out $10^9$ electrons every second, how much time is required to get a total charge of 1C from it?
(a) 190.19 years
(b) 150.12 years

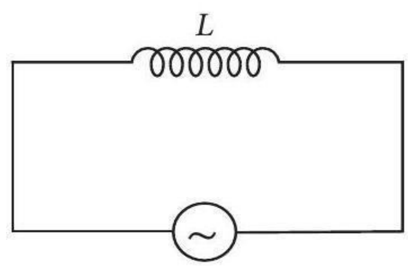
(c) 198.19 years
(d) 188.21 years

(iv) A polythene piece rubbed with wool is found to have a negative charge of $3.2 \times 10^{-7}$C. Calculate the number of electrons transferred.
(a) $2 \times 10^{12}$
(b) $3 \times 10^{12}$
(c) $2 \times 10^{14}$
(d) $3 \times 10^{14}$

**30. Read the following paragraph and answer the questions that follow.**

**AC Voltage Applied to an Inductor**

Let a source of alternating e.m.f. $E = E_0 \sin \omega t$ be connected to a circuit containing a pure inductance $L$. If $I$ is the value of instantaneous current in the circuit, then $I = I_0 \sin(\omega t - \frac{\pi}{2})$. The inductive reactance limits the current in a purely inductive circuit and is given by $X_L = \omega L$.




(i) A 100 hertz a.c. is flowing in a 14mH coil. The reactance is
(a) $15\Omega$
(b) $7.5\Omega$
(c) $8.8\Omega$
(d) $10\Omega$

(ii) In a pure inductive circuit, resistance to the flow of current is offered by
(a) resistor
(b) inductor
(c) capacitor
(d) resistor and inductor

**OR**

In a inductive circuit, by what value of phase angle does alternating current lags behind e.m.f.?
(a) $45^\circ$
(b) $90^\circ$
(c) $120^\circ$
(d) $75^\circ$

(iii) How much inductance should be connected to $200 \text{ V}, 50$ Hz a.c. supply so that a maximum current of 0.9 A flows through it?
(a) 5H
(b) 1H
(c) 10H
(d) 4.5H

(iv) The maximum value of current when inductance of 2H is connected to 150 volt, 50 Hz supply is
(a) 0.337 A
(b) 0.721 A
(c) 1.521 A
(d) 2.522 A

## SECTION E

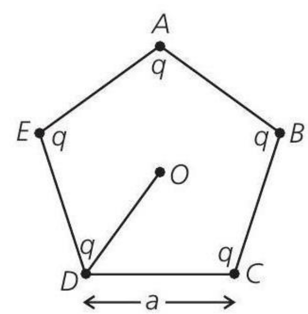
**31.** Five charges, $q$ each are placed at the corners of a regular pentagon of side ' $a$ ' as shown in figure.

(a) (i) What will be the electric field at $O$, the centre of the pentagon?

(ii) What will be the electric field at $O$ if the charge from one of the corners ( say $A$) is removed?

(iii) What will be the electric field at $O$ if the charge $q$ at $A$ is replaced by $-q$ ?

(b) How would your answer to (a) be affected if pentagon is replaced by $n$-sided




regular polygon with charge $q$ at each of its corners?

**OR**

(a) How would you combine 8, 12 and $24 \mu\text{F}$ capacitors to obtain (I) minimum capacitances (II) maximum capacitance? (III) If a p.d. of $100 \text{ V}$ be applied across the system, what would be the charges on the capacitors in each case?

(b) The electric field intensity at a point $B$ due to a point charge $Q$ kept at point $A$ is $24 \text{ N/C}$, and electric potential at $B$ due to the same charge is $12 \text{ J/C}$. Find the distance $AB$ and magnitude of charge.

**32.** (a) How does the mutual inductance of a pair of coil change when

(i) the number of turns of each coil is decreased

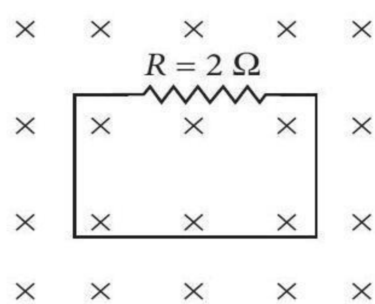
(ii) the distance between the coils is increased

(iii) a thin iron sheet is placed between the two coils and other factors remaining the same?

(b) A 5 V battery connected to a $10\Omega$, $10\text{H}$ coil through a switch drives a constant current through the circuit. The switch is suddenly opened. If it takes $1\ \text{ms}$ to open the switch, find the emf induced across the coil.

**OR**

(a) A conducting wire of 200 turns is wound over and near the centre of a solenoid of $100$ cm length and $4$ cm radius having 1000 turns. Calculate the mutual inductance of the two coils.
(b) In the given figure, the magnetic flux through the loop increases according to the relation $\phi_\beta(t) = 10t^2 + 20t$, where $\phi_\beta$ is in milli webers and $t$ is in seconds.




Calculate the magnitude of current through $R = 2\Omega$ resistor at $t = 5$ s.

**33.** A circular parallel-plate capacitor with plate, radius $R$ is being charged with a current $I$.

(a) Between the plates, what is the magnitude of magnetic field in terms of $\mu_0$ and $I$ at a radius $r = R/5$ from their center?

(b) In terms of the maximum induced magnetic field. What is the magnitude of the magnetic field induced at $r = R/5$ inside the capacitor?

**OR**

A long straight cable of length $l$ is placed symmetrically along $z$-axis and has radius $a(<< l)$. The cable consists of a thin wire and a co-axial conducting tube. An alternating current $I(t) = I_o \sin(2\pi\nu t)$ flows down the central thin wire and returns along the co-axial conducting tube. The induced electric field at a distance $s$

$s$ $\hat{}$

$(\ )\ k$

$a$

(i) Calculate the displacement current density inside the cable.

(ii) Integrate the displacement current density across the cross-section of the cable to find the total displacement current $I^d$.

(iii) Compare the conduction current $I_0$ with the displacement current $I_0^d$.

# SAMPLE
# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

**SET-08**

**PHYSICS**

Time: 3 Hours Max.
Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section $\boldsymbol{D}$ contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

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(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$TmA$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$

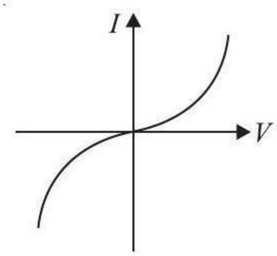
vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

1. The electric field that can balance an electron of mass $3.2 \times 10^{-27}$ kg is
(a) $19.6 \times 10^{-8}$ NC$^{-1}$
(b) $20 \times 10^{-6}$ NC$^{-1}$
(c) $19.6 \times 10^{8}$ NC$^{-1}$
(d) $20 \times 10^{6}$ NC$^{-1}$

2. If a conductor has a potential $V \neq 0$ and there are no charges anywhere else outside, then
(a) there must be charges on the surface or inside itself.
(b) there cannot be any charge in the body of the conductor.
(c) there must be charges only on the surface.
(d) both (a) and (b) are correct.

3. The $I - V$ characteristics shown in figure is represent for




(a) ohmic conductors
(c) insulators
(b) non-ohmic conductors
(d) superconductors

4. A moving coil galvanometer can be converted into an ammeter by
(a) introducing a shunt resistance of large value in series.
(b) introducing a shunt resistance of small value in parallel.
(c) introducing a resistance of small value in series.
(d) introducing a resistance of large value in parallel.

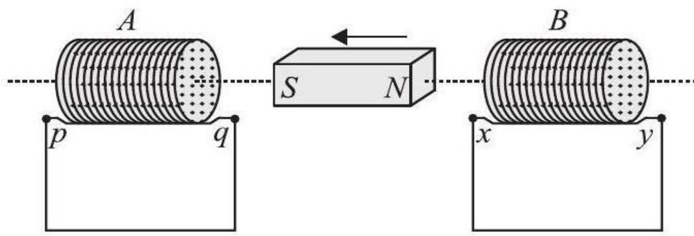
5. If electron moving with velocity $\vec{v}$ produces a magnetic field $\vec{B}$, then
(a) the direction of field $\vec{B}$ will be same in the direction of velocity $\vec{v}$.
(b) the direction of field $\vec{B}$ will be opposite to the direction of velocity $\vec{v}$.
(c) the direction of field $\vec{B}$ will be perpendicular to the direction of velocity $\vec{v}$.
(d) the direction of field $\vec{B}$ does not depend upon the direction of velocity $\vec{v}$.

6. Magnetic susceptibility of a diamagnetic substances
(a) increases with increase in temperature
(b) increases with decrease in temperature
(c) remains constant with change in temperature
(d) none of these

7. At resonance frequency the impedance in series $LCR$ circuit is
(a) maximum
(b) minimum
(c) zero
(d) infinity

8. An electromagnetic wave in vacuum has the electric and magnetic fields $\vec{E}$ and $\vec{B}$, which are always perpendicular to each other. The direction of polarization is given by $\vec{X}$ and that of wave propagation by $\vec{k}$. Then :
(a) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$
(b) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
(c) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
(d) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

9. The direction of induced current in the coils $A$ and $B$ in the situation shown in the figure is
(a) $p$ to $q$ in coil $A$ and $x$ to $y$ in coil $B$
(b) $q$ to $p$ in coil $A$ and $x$ to $y$ in coil $B$
(c) $p$ to $q$ in coil $A$ and $y$ to $x$ in coil $B$
(d) $q$ to $p$ in coil $A$ and $y$ to $x$ in coil $B$




10. The de Broglie wavelength of a photon is twice the de Broglie wavelength of an electron. The speed of the electron is $v_e = \frac{c}{100}$. Then
(a) $\frac{E_e}{E_p} = 10^{-4}$
(b) $\frac{E_e}{E_p} = 10^{-2}$
(c) $\frac{p_e}{m_e c} = 10^{-1}$
(d) $\frac{p_e}{m_e c} = 10^{-4}$

11. If 13.6eV energy is required to separate a hydrogen atom into a proton and an electron, then the orbital radius of electron in a hydrogen atom is
(a) $5.3 \times 10^{-11}$ m
(b) $4.3 \times 10^{-11}$ m
(c) $6.3 \times 10^{-11}$ m
(d) $7.3 \times 10^{-11}$ m

12. The binding energy per nucleon of deuterium and helium nuclei are 1.1MeV and 7.0MeV respectively. When two deuterium nuclei fuse to form a helium nucleus the energy released in the fusion is
(a) 23.6MeV
(b) 2.2MeV
(c) 28.0MeV
(d) 30.2MeV

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 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): The division are equally marked on the scale of A.C. ammeter.

    Reason (R): Heat produced is directly proportional to the current.

14. Assertion (A): Sharper is the curvature of spot on a charged body lesser will be the surface charge density at that point

    Reason (R): Electric field is non-zero inside a charged conductor.

15. Assertion (A): No interference pattern is detected when two coherent sources are infinitely close to each other. Reason (R): The fringe width is inversely proportional to the distance between the two slits.

16. Assertion (A): In photoelectric effect, on increasing the intensity of light, both the number of electrons emitted and kinetic energy of each of them get increased but photoelectric current remains unchanged.

    Reason (R): The photoelectric current depends only on wavelength of light.

## SECTION B

17. What are the directions of electric and magnetic field vectors relative to each other and relative to the direction of propagation of electromagnetic waves?

18. A bar magnet of magnetic moment $M$ is aligned parallel to the direction of a uniform magnetic field $B$. What is the work done to turn the magnet, so as to align its magnetic moment
    (i) opposite to the field direction and
    (ii) normal to the field direction?

19. The fission properties of $^{239}_{94}Pu$ are very similar to those of $^{235}_{92}U$. The average energy released per fission is $180 MeV$. How much energy, in MeV, is released if all the atoms in 1 kg of pure $^{239}_{94}Pu$ undergo fission?

**OR**

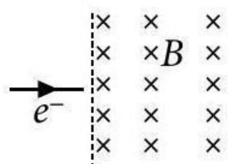
Calculate the ratio of energies of photons produced due to transition of electron of hydrogen atom from its, second permitted energy level to the first level, and highest permitted energy level to the second permitted level.

20. For a single slit of width ' $a$ ', the first minimum of the interference pattern of a monochromatic light of wavelength $\lambda$ occurs at an angle of $\frac{\lambda}{a}$. At the same angle of $\frac{\lambda}{a}$, we get a maximum for two narrow slits separated by a distance ' $a$ '. Explain.

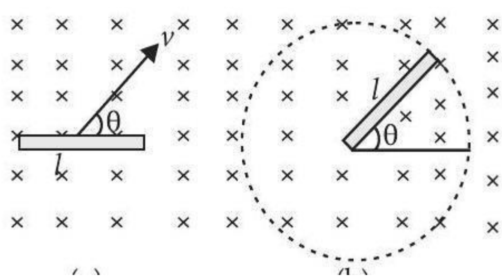
21. An electric dipole of length $2 \text{ cm}$ is placed with its axis making an angle of $60^{\circ}$ to a uniform electric field of $105 \text{ N/C}$. If it experiences a torque of $8\sqrt{3} \text{ N m}$. Calculate the (i) magnitude of the charge on the dipole and (ii) potential energy of the dipole.

## SECTION C

22. An electron moving horizontally with a velocity of $4 \times 10^4 \text{ m s}^{-1}$ enters a region of uniform magnetic field of $10^{-5}$ T acting vertically downward as shown in the figure. Draw its trajectory and find out the time it takes to come out of the region of magnetic field.




23. Calculate the rate at which the flux linked with the generated area changes with time when a rod of length $l$ is (i) translated (ii) rotated clockwise in a uniform magnetic field of induction $B$ as shown in figure.




(a) (b)

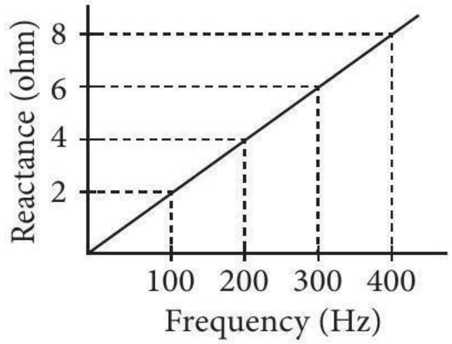
24. A capacitor of capacitance $100\mu\text{F}$ and a coil of resistance $50\Omega$ and inductance $0.5\text{H}$ are connected in series with a $110 \text{ V}, 50 \text{ Hz}$ source. Calculate the rms value of the current in the circuit.

**OR**

Figure shows how the reactance of an inductor varies with frequency.

(i) Calculate the value of the inductance of the inductor using the information given in the graph.

(ii) If this inductor is connected in series to a resistor of 8ohm, find what would be the impedance at 300 Hz.




25. Plot a graph showing the variation of photoelectric current with intensity of light. The work function for the following metals is given.

Na: 2.75eV and Mo: 4.175eV.

Which of these will not give photoelectron emission from a radiation of wavelength 3300Å from a laser beam? What happens if the source of laser beam is brought closer?

**OR**

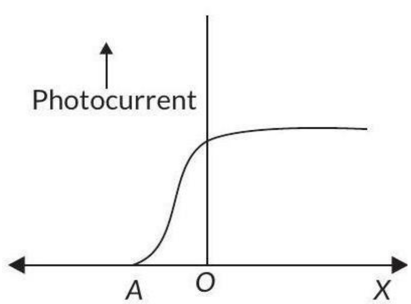
The following graph shows the variation of photocurrent for a photosensitive metal:

(a) Identify the variable $X$ on the horizontal axis.

(b) What does the point $A$ on the horizontal axis represent?

(c) Draw this graph for three different values of frequencies of incident radiation $v_1, v_2$ and $v_3 (v_1 > v_2 > v_3)$ for same intensity.

(d) Draw this graph for three different values of intensities of incident radiation $I_1, I_2$ and $I_3 (I_1 > I_2 > I_3)$ having same frequency.




26. The kinetic energy of the electron orbiting in the first excited state of hydrogen atom is 3.4eV. Determine the de-Broglie wavelength associated with it.

27. 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.

28. (i) Distinguish between $n$-type and $p$-type semiconductors on the basis of energy band diagrams.

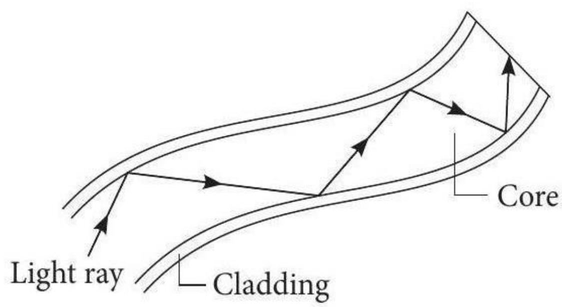
(ii) Compare their conductivities at absolute zero temperature and at room temperature.

## SECTION D

**Case Study Based Questions**

29. Read the following paragraph and answer the questions that follow.

An optical fibre is a thin tube of transparent material that allows light to pass through, without being refracted into the air or another external medium. It make use of total internal reflection. These fibres are fabricated in such a way that light reflected at one side of the inner surface strikes the other at an angle larger than critical angle. Even, if fibre is bent, light can easily travel along the length.




(i) Which of the following is based on the phenomenon of total internal reflection of light?
(a) Sparkling of diamond
(b) Optical fibre communication
(c) Instrument used by doctors for endoscopy
(d) All of these

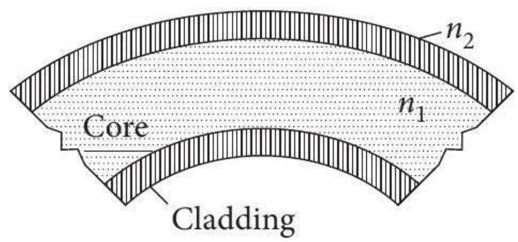
(ii) A ray of light will undergo total internal reflection inside the optical fibre, if it
(a) goes from rarer medium to denser medium
(b) is incident at an angle less than the critical angle
(c) strikes the interface normally
(d) is incident at an angle greater than the critical angle

(iii) If in core, angle of incidence is equal to critical angle, then angle of refraction will be
(a) $0^\circ$
(b) $45^\circ$
(c) $90^\circ$
(d) $180^\circ$

**OR**

If the value of critical angle is $30^\circ$ for total internal reflection from given optical fibre, then speed of light in that fibre is
(a) $3 \times 10^8$ m s$^{-1}$
(b) $1.5 \times 10^8$ m s$^{-1}$
(c) $6 \times 10^8$ m s$^{-1}$
(d) $4.5 \times 10^8$ m s$^{-1}$

(iv) In an optical fibre (shown), correct relation for refractive indices of core and cladding is



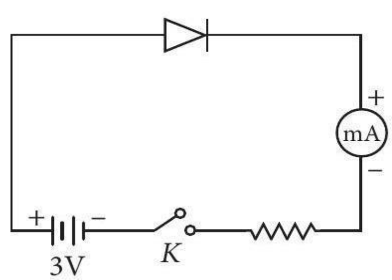

(a) $n_1 = n_2$
(b) $n_1 > n_2$
(c) $n_1 < n_2$
(d) $n_1 + n_2 = 2$

**30. Read the following paragraph and answer the questions that follow.**

**Potential Barrier**

The potential barrier in the $p-n$ junction diode is the barrier in which the charge requires additional force for crossing the region. In other words, the barrier in which the charge carrier stopped by the obstructive force is known as the potential barrier.

When a $p$-type semiconductor is brought into a close contact with $n$-type semiconductor, we get a $p-n$ junction with a barrier potential 0.4 V and width of depletion region is $4.0 \times 10^{-7}$ m. This $p-n$ junction is forward biased with a battery of voltage 3 V and negligible internal resistance, in series with a resistor of resistance $R$, ideal millimeter and key $K$ as shown in figure. When key is pressed, a current of 20 mA passes through the diode.



(i) The intensity of the electric field in the depletion region when $p-n$ junction is unbiased is
(a) $0.5 \times 10^6$ V m$^{-1}$
(b) $1.0 \times 10^6$ V m$^{-1}$
(c) $2.0 \times 10^6$ V m$^{-1}$
(d) $1.5 \times 10^6$ V m$^{-1}$

(ii) The resistance of resistor $R$ is
(a) $150\Omega$
(b) $300\Omega$
(c) $130\Omega$
(d) $180\Omega$

(iii) If the voltage of the potential barrier is $V_0$. A voltage $V$ is applied to the input, at what moment will the barrier disappear?
(a) $V < V_0$
(b) $V = V_0$
(c) $V > V_0$
(d) $V << V_0$

(iv) If an electron with speed $4.0 \times 10^5$ m s$^{-1}$ approaches the $p$ - $n$ junction from the $n$-side, the speed with which it will enter the $p$-side is
(a) $1.39 \times 10^5$ m s$^{-1}$
(b) $2.78 \times 10^5$ m s$^{-1}$
(c) $1.39 \times 10^6$ m s$^{-1}$
(d) $2.78 \times 10^6$ m s$^{-1}$

**OR**

In a $p-n$ junction, the potential barrier is due to the charges on either side of the junction, these charges are
(a) majority carriers
(b) minority carriers
(c) both (a) and (b)
(d) fixed donor and acceptor ions.

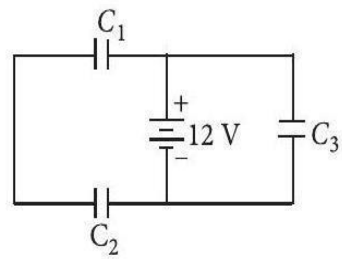
## SECTION E

31. Three identical capacitors $C_1, C_2$ and $C_3$ of a capacitance $6\mu$F each are connected to a 12 V battery as shown. Find

(i) charge on each capacitor

(ii) equivalent capacitance of the network

(iii) energy stored in the network of capacitors



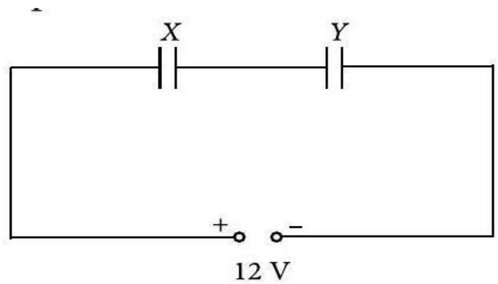

**OR**

Two parallel plate capacitors, $X$ and $Y$, have the same area of plates and same separation between them. $X$ has air between the plates while $Y$ contains a dielectric medium of $K = 4$

(i) Calculate capacitance of each capacitor if equivalent capacitance of the combination is $4\mu$F.

(ii) Calculate the potential difference between the plates of $X$ and of $Y$.

(iii) What is the ratio of electrostatic energy stored in $X$ and $Y$.




32. Derive condition of balance for a Wheatstone bridge.

**OR**

Draw the circuit diagram of potentiometer which can be used to determine the internal resistance $(r)$ of a given cell of emf $(\varepsilon)$. With the help of this diagram describe the method to find the internal resistance of the primary cell.

33. (a) In Young's double slit experiment, the two slits are kept 2 mm apart and the screen is positioned 140 cm away from the plane of the slits. The slits are illuminated with light of wavelength 600 nm. Find the distance of the third bright fringes, from the central maximum, in the interference pattern obtained on the screen. If the wavelength of the incident light were changed to 480 nm, find out the shift in the position of third bright fringe from the central maximum.

(b) Laser light of wavelength 630 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 7.2 mm. Calculate the wavelength of another source of laser light which produces interference fringes separated by 8.1 mm using same pair of slits.

**OR**

(a) Draw a ray diagram showing image formation in a compound microscope. Define the term limit of resolution' and name the factors on which it depends. How is it related to resolving power of a microscope?

(b) Suggest two ways by which the resolving power of a microscope can be increased.

(c) 'A telescope resolves whereas a microscope magnifies.' Justify this statement.

# SAMPLE
# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

**SET-09**

**PHYSICS**

Time: 3 Hours | Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section $\boldsymbol{D}$ contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

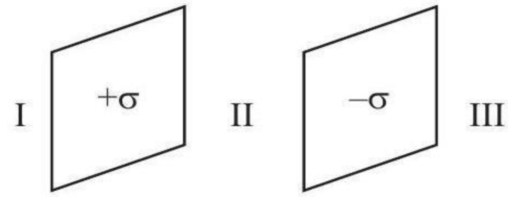
(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$TmA$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$C$^2$ N$^{-1}$ m$^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

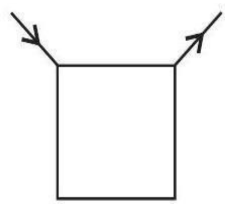
1. Two large thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and magnitude $27 \times 10^{-22}$Cm$^{-2}$. The electric field $\vec{E}$ in region II in between the plates is



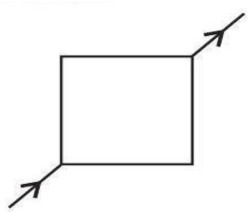

(a) $4.25 \times 10^{-8}$ NC$^{-1}$
(b) $6.28 \times 10^{-10}$ NC$^{-1}$
(c) $3.05 \times 10^{-10}$ NC$^{-1}$
(d) $5.03 \times 10^{-10}$ NC$^{-1}$

2. Current flows through uniform, square frames as shown in the figure. In which case is the magnetic field at the centre of the frame is not zero?

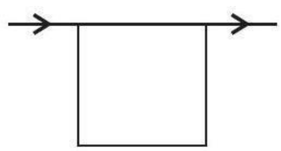
(a)



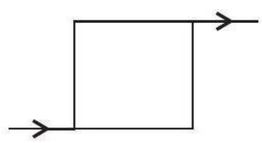
(b)



(c)



(d)

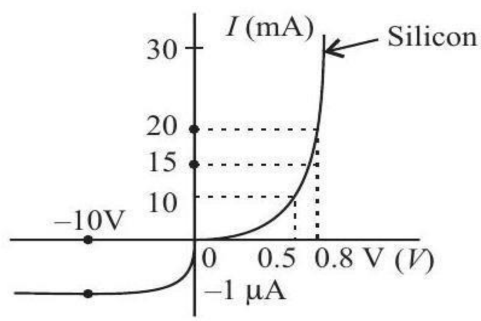


3. A plane electromagnetic wave of frequency 25MHz travels in free space along the $x$-direction. At a particular point in space and time, $\vec{E} = 6.3\hat{j}$ V m$^{-1}$. At this point $\vec{B}$ is equal to
(a) $8.33 \times 10^{-8}\hat{k}$ T

(b) $18.9 \times 10^{-8}\hat{k}$ T
(c) $2.1 \times 10^{-8}\hat{k}$ T
(d) $2.1 \times 10^{-8}\hat{k}$ T

4. The resistance of a heating element is $99\Omega$ at room temperature. What is the temperature of the element if the resistance is found to be $116\Omega$ ? (Temperature coefficient of the material of the resistor is $1.7 \times 10^{-4}$ $°C^{-1}$)
(a) $999.9°C$
(b) $1005.3°C$
(c) $1020.2°C$
(d) $1037.1°C$

5. The $V - I$ characteristic of a silicon diode is shown in figure. The resistance of the diode at $I_D = 15$ mA is




(a) $5\Omega$
(b) $10\Omega$
(c) $2\Omega$
(d) $20\Omega$

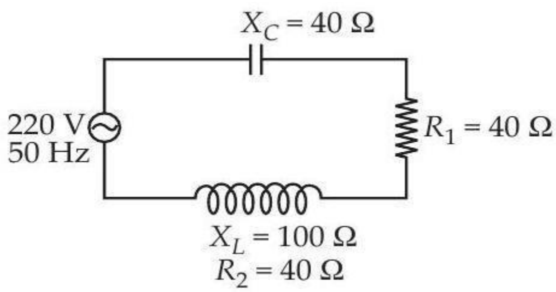
6. Ten million electrons pass from point $P$ to point $Q$ in one micro second. The current and its direction is


(a) $1.6 \times 10^{-14}$ A, from point $P$ to point $Q$
(c) $1.6 \times 10^{-6}$ A, from point $Q$ to point $P$
(b) $3.2 \times 10^{-14}$ A, from point $P$ to point $Q$
(d) $3.2 \times 10^{-12}$ A, from point $Q$ to point $P$

7. Fission of nuclei is possible because the binding energy per nucleon in them
(a) increases with mass number at low mass numbers
(b) decreases with mass number at low mass numbers
(c) increases with mass number at high mass numbers
(d) decreases with mass number at high mass numbers.

8. The photoelectric threshold frequency of a metal is $v$. When light of frequency $4v$ is incident on the metal, the maximum kinetic energy of the emitted photoelectron is
(a) $4hv$
(b) $3hv$
(c) 5hv
(d) $\frac{5hv}{2}$

9. The power factor of the circuit as shown in figure is




(a) 0.2
(b) 0.4
(c) 0.8
(d) 0.6

10. Two thin lenses of power $-4$D and 2D are placed in contact coaxially. Find the focal length of the combination.
(a) $-10$ cm
(b) $-50$ cm
(c) $+50$ cm
(d) $+10$ cm

11. Two tiny spheres carrying charges $1.8\mu$C and $2.8\mu$C are located at 40 cm apart. The potential at the midpoint of the line joining the two charges is
(a) $3.8 \times 10^4$ V
(b) $2.1 \times 10^5$ V
(c) $4.3 \times 10^4$ V
(d) $3.6 \times 10^5$ V

12. A particle of mass $4m$ at rest decays into two particles of masses $m$ and $3m$ having non-zero velocities. The ratio of the de Broglie wavelengths of the particles 1 and 2 is
(a) $\frac{1}{2}$
(b) $\frac{1}{4}$
(c) 2
(d) 1

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 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): At a fixed temperature, silicon will have a minimum conductivity when it has a smaller acceptor doping.

Reason (R): The conductivity of an intrinsic semiconductor is slightly higher than that of a lightly doped p-type.

14. Assertion (A): Range of Coulomb force is infinite.

Reason (R): Coulomb force acts between two charged particles.

15. Assertion (A): When current is represented by a straight line, the magnetic field will be circular.

Reason (R): According to Fleming's left hand rule, direction of force is parallel to the magnetic field.

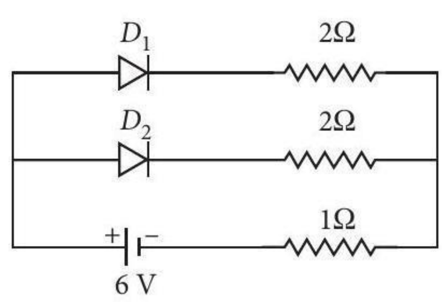
16. Assertion (A): A fission reaction can be more easily controlled than a fusion reaction.

Reason (R): The percentage of mass converted to energy in a fission reaction is 0.1% whereas in a fusion reaction it is 0.4%.

**SECTION B**

17. A thin prism of angle $A = 6^\circ$ produces a deviation $\delta = 3^\circ$. Find the refractive index of the material of prism.

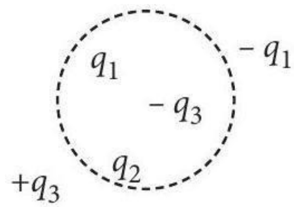
18. Assuming that the two diodes $D_1$ and $D_2$ used in electric circuit shown in the figure are ideal. Find out the value of the current flowing through $1\Omega$ resistance.




19. Two bodies $A$ and $B$ carry $-3\mu C$ and $-0.44\mu C$. How many electrons should be transferred from $A$ to $B$ so that they acquire equal charges?

**OR**

In the gaussian surface shown by dotted line, some charges are inside and some are outside the question surface. Find the total flux.




20. Light of wavelength $6000\text{Å}$ is incident on a thin film of refractive index 1.5, such that angle of refraction into the film is $60^\circ$. Calculate the smallest thickness of film which will make it appear dark by reflection.

21. The capacitance of a parallel plate capacitor with air as medium is $6\mu$F. With the introduction of a dielectric medium, the capacitance becomes $30\mu$F. Find the permittivity of the medium.

    (Given $\varepsilon_0 = 8.85 \times 10^{-12} C^2\ N^{-1}\ m^{-2}$ )

## SECTION C

22. What is the difference in energy for a hydrogen atom with its electron in the ground state and a hydrogen atom with its electron in the $n = 3$ state?

23. (a) Define the current sensitivity of a galvanometer.

    (b) The coil area of a galvanometer is $16 \times 10^{-4}\ m^2$. It consists of 200 turns of a wire and is in a magnetic field of $0.2$ T. The restoring torque constant of the suspension fibre is $10^{-6}$ N m per degree. Assuming the magnetic field to be radial, calculate the maximum current that can be measured by the galvanometer if the scale can accommodate $30^\circ$ deflection.

    **OR**

    (a) Write an expression of magnetic moment associated with a current $(I)$ carrying circular coil of radius $r$ having $N$ turns.

    (b) Consider the above mentioned coil placed in $YZ$ plane with its centre at the origin. Derive expression for the value of magnetic field due to it at point $(x, 0,0)$.

24. Write the wavelength range and name of the electromagnetic waves which are used in

    (i) radar systems for aircraft navigation, and

    (ii) Earth satellites to observe the growth of the crops.

Welders wear special goggles or face masks with glass windows to protect their eyes from electromagnetic radiations. Name the radiations and write the range of their frequency.

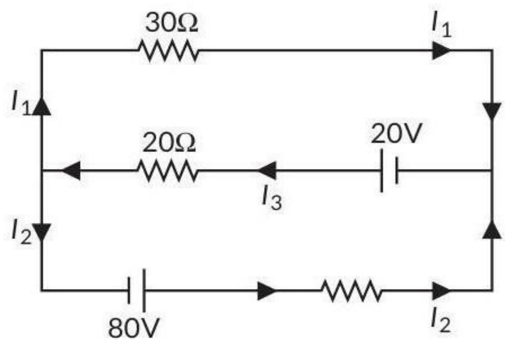
25. Name the important process that occur during the formation of a $p-n$ junction. Explain briefly, with the help of a suitable diagram, how a $p$ - $n$ junction is formed. Define the term 'barrier potential'.

26. A cell of emf ' $E$ ' and internal resistance ' $r$ ' is connected across a variable load resistor $R$. Draw the plots of the terminal voltage $V$ versus (i) $R$ and (ii) the current $I$.

It is found that when $R=4\Omega$, the current is 1 A and when $R$ is increased to $9\Omega$, the current reduces to 0.5 A. Find the values of the emf $E$ and internal resistance $r$.

**OR**

Use Kirchhoff's rules to determine the value of the current $I_1$ flowing in the circuit shown in the figure.




27. Two long straight parallel wires $A$ and $B$ separated by a distance $d$, carry equal current $I$ flowing in same direction as shown in the figure.

(a) Find the magnetic field at a point $P$ situated between them at a distance $x$ from one wire.

(b) Show graphically the variation of the magnetic field with distance $x$ for $0<x<d$.

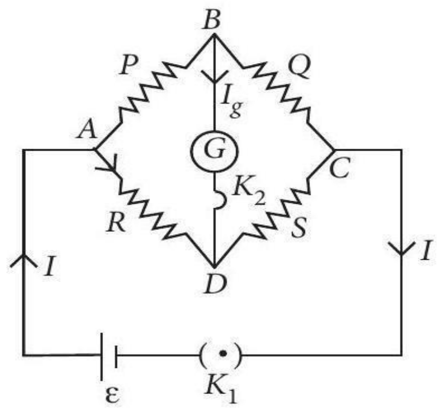
28. State Faraday's laws of electromagnetic induction.

## SECTION D

**Case Study Based Questions**

**29. Read the following paragraph and answer the questions that follow.**

Wheatstone bridge is an arrangement of four resistances $P, Q, R$ and $S$ connected as shown in the figure. Their values are so adjusted that the galvanometer $G$ shows no deflection. The bridge is then said to be balanced when this condition is achieved. In the setup shown here, the points $B$ and $D$ are at the same potential and it can be shown that $\frac{P}{Q}=\frac{R}{S}$




This is called the balancing condition. If any three resistances are known, the fourth can be found.

The practical form of Wheatstone bridge is slide wire bridge or meter bridge. Using this the unknown resistance can be determined as $S = (\frac{100-l}{l}) \times R$, where $l$ is the balancing length of the Meter bridge.

(i) In a Wheatstone bridge circuit, $P = 5\Omega$, $Q = 6\Omega$, $R = 10\Omega$ and $S = 5\Omega$. What is the value of additional resistance to be used in series with $S$, so that the bridge is balanced?
(a) $9\Omega$
(b) $7\Omega$
(c) $10\Omega$
(d) $5\Omega$

(ii) A Wheatstone bridge consisting of four arms of resistances $P, Q, R, S$ is most sensitive when
(a) all the resistances are equal
(b) all the resistances are unequal
(c) the resistances $P$ and $Q$ are equal but $R >> P$ and $S >> Q$
(d) the resistances $P$ and $Q$ are equal but $R << P$ and $S << Q$.

(iii) When a metal conductor connected to left gap of a meter bridge is heated, the balancing point
(a) shifts towards right
(b) shifts towards left
(c) remains unchanged
(d) remains at zero.

(iv) In a meter bridge experiment, the ratio of left gap resistance to right gap resistance is 2: 3. The balance point from left is
(a) 20 cm
(b) 50 cm
(c) 40 cm
(d) 60 cm

**OR**

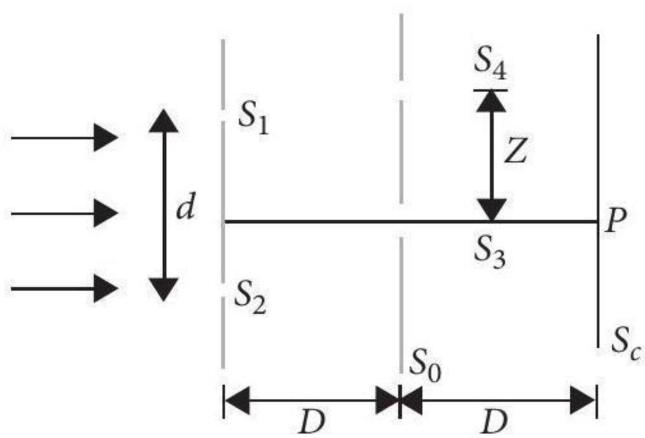
The percentage error in measuring resistance with a meter bridge can be minimized by adjusting the balancing point close to

(a) 0
(b) 20 cm
(c) 50 cm
(d) 80 cm

**30. Read the following paragraph and answer the questions that follow.**

**Modified YDSE**

Consider the situation shown in figure. The two slits $S_1$ and $S_2$ placed symmetrically around the central line are illuminated by monochromatic light of wavelength $\lambda$. The separation between the slits is $d$. The light transmitted by the slits falls on a screen $S_0$ placed at a distance $D$ from the slits. The slits $S_3$ is at the central line and the slit $S_4$ is at a distance $z$ from $S_3$. Another screen $S_c$ is placed a further distance $D$ away



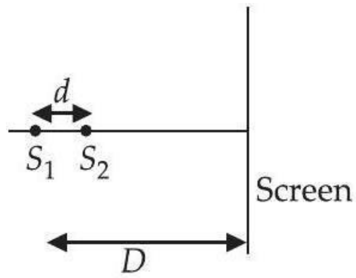

(i) Find the path difference if $z = \frac{\lambda D}{2d}$.

(a) $\lambda$
(b) $\lambda/2$
(c) $3/2\lambda$
(d) $2\lambda$

(ii) Find the ratio of the maximum to minimum intensity observed on $S_c$ if $z = \frac{\lambda D}{d}$

(a) 4
(b) 2
(c) $\infty$
(d) 1

(iii) Two coherent point sources $S_1$ and $S_2$ are separated by a small distance $d$ as shown in figure. The fringes obtained on the screen will be




(a) concentric circles (b) points
(c) straight lines
(d) semi-circles

**OR**

Two monochromatic light waves of amplitudes $3A$ and $2A$ interfering at a point have a phase difference of $60^\circ$. The intensity at that point will be proportional to
(a) $5A^2$
(b) $13A^2$
(c) $7A^2$
(d) $19A^2$

(iv) In the case of light waves from two coherent sources $S_1$ and $S_2$, there will be constructive interference at an arbitrary point $P$, if the path difference $S_1P - S_2P$ is
(a) $(n + \frac{1}{2})\lambda$
(b) $n\lambda$
(c) $(n - \frac{1}{2})\lambda$
(d) $\frac{\lambda}{2}$

**SECTION E**

31. (a) A point object is placed in front of a double convex lens (of refractive index $n = n_2/n_1$ with respect to air) with its spherical faces of radii of curvature $R_1$ and $R_2$. Show the path of rays due to refraction at first and subsequently at the second surface to obtain the formation of the real image of the object. Hence obtain the lens-maker's formula for a thin lens.

(b) A double convex lens having both faces of the same radius of curvature has refractive index 1.55. Find out the radius of curvature of the lens required to get the focal length of 30 cm.

**OR**

(a) What is meant by refraction of light? State the laws of refraction.

(b) What is refractive index. Give the formula of relative refractive index and explain the behaviour of light when it travel from one medium to another.

32. (a) Prove mathematically that the average value of alternating current over one complete cycle is zero.

(b) Show that in an a.c. circuit containing a pure inductor, the voltage is ahead of current by $\pi/2$ in phase.

**OR**

Prove that the motional emf produced due to rotational motion of a rod is $\frac{B\omega l^2}{2}$.

33. A photon of wavelength $3310Å$ falls on a photo-cathode and an electron of energy $3 \times 10^{-19}$ J is ejected. If the wavelength of the incident photon is changed to $5000Å$, the energy of the ejected electron is $9.72 \times 10^{-20}$ J. Calculate the value of Planck's constant and threshold wavelength of the photon.

**OR**

(a) Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation.

(b) The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from $\lambda_1$ to $\lambda_2$. Derive the expressions for the threshold wavelength $\lambda_0$ and work function for the metal surface.

# SAMPLE

# PAPER

## CLASS 12

### PHYSICS

Subject Code: 042

**SET-10**

**PHYSICS**

Time: 3 Hours | Max. Marks: 70

**General Instructions:**

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section $C$ contains seven questions of three marks each, Section $\boldsymbol{D}$ contains two case study based questions of four marks each and Section $\boldsymbol{E}$ contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

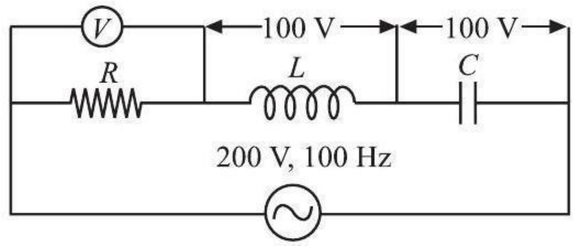
(7) You may use the following values of physical constants where ever necessary
i. $c = 3 \times 10^8$ m/s
iii. $e = 1.6 \times 10^{-19}$C
v. $h = 6.63 \times 10^{-34}$Js
ii. $m_e = 9.1 \times 10^{-31}$ kg
iv. $\mu_0 = 4\pi \times 10^{-7}$TmA$^{-1}$
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$C$^2$ N$^{-1}$ m$^{-2}$

vii. Avogadro's number $= 6.023 \times 10^{23}$ per gram mole

## SECTION A

1. Electric flux emanating through a surface element $d\vec{S} = 5\hat{\imath}$ placed in an electric field $\vec{E} = 4\hat{\imath} + 4\hat{\jmath} + 4\hat{k}$ is
(a) 10 units
(b) 20 units
(c) 4 units
(d) 16 units

2. In the circuit shown in figure, what will be the reading of the voltmeter?




(a) 300 V
(b) 900 V
(c) 200 V
(d) 400 V

3. The YDSE arrangement is contained in a transparent chamber. If the chamber is evacuated, then
(a) fringes will disappear
(b) fringe width will increase
(c) fringe width will decrease
(d) there in no effect.

4. The final image in an astronomical telescope with respect to object is
(a) virtual and erect
(b) real and erect
(c) real and inverted
(d) virtual and inverted

5. The potential at a point due to a charge of $5 \times 10^{-7}$C located 10 cm away is
(a) $3.5 \times 10^5$ V
(b) $3.5 \times 10^4$ V
(c) $4.5 \times 10^4$ V
(d) $4.5 \times 10^5$ V

6. At equilibrium, in a $p-n$ junction diode the net current is
(a) due to diffusion of majority charge carriers.
(b) due to drift of minority charge carriers.
(c) zero as diffusion and drift currents are equal and opposite.
(d) zero as no charge carriers cross the junction.

7. A jet plane is travelling west at the speed of 1600 km $h^{-1}$. The voltage difference developed between the ends of the wing having a span of 20 m, if the earth's magnetic field at the location has a magnitude of $5 \times 10^{-4}$ T and the dip angle is $30^\circ$ is
(a) 4.1 V
(b) 2.2 V
(c) 3.2 V
(d) 3.8 V

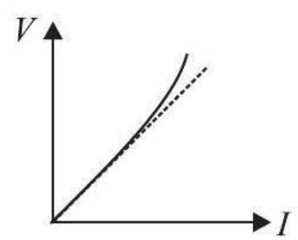
8. A long solenoid has a radius $a$ and number of turns per unit length $n$. If it carries a current $I$, then the magnetic field on its axis is directly proportional to

(a) anI
(b) $nI$
(c) $nI/a$
(d) $n^2I$

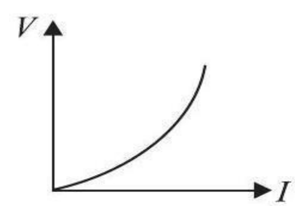
9. Number of possible spectral lines emitted on de-excitation of electron from energy level $n$ to ground state is equal to
(a) $\frac{n}{2}$
(b) $\frac{n-1}{2}$
(c) $\frac{n(n-1)}{2}$
(d) $\frac{n(n+1)}{2}$

10. Which of the following correctly represents $V$-I graph for a good conductor?

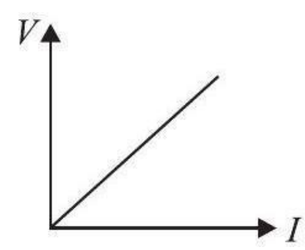
(a)



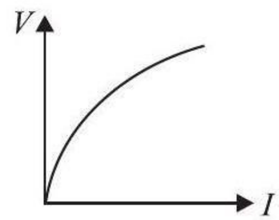

(b)




(c)




(d)




11. Identify the wrong statement.
    (a) In conductors, the valence and conduction bands overlap.
    (b) Substances with energy gap of the order of 10eV are insulators.
    (c) The resistivity of semiconductors is lower than metals.
    (d) The conductivity of metals is high.

12. The conductivity of a semiconductor increases with increase in temperature because
    (a) number density of free current carriers increases
    (b) relaxation time increases
    (c) both number density of carriers and relaxation time increases
    (d) number density of current carriers increases, relaxation time decreases but effect of decrease in relaxation time is much less than increase in number density.

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 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): If an electron and proton possessing same kinetic energy enter an electric field in a perpendicular direction, the path of the electron is more curved than that of the proton.

    Reason (R): Electron forms a larger curve due to its small mass.

14. Assertion (A): When a light wave travels from a rarer to a denser medium, it loses speed. The reduction in speed imply a reduction in energy carried by the light wave.

    Reason (R): The energy of a wave is proportional to velocity of wave.

15. Assertion (A): The de-Broglie wavelength of particle having kinetic energy $K$ is $\lambda$. If its kinetic energy becomes $4K$ then its new wavelength would be $\lambda/2$.

    Reason (R): The de-Broglie wavelength $\lambda$ is inversely proportional to square root of the kinetic energy.

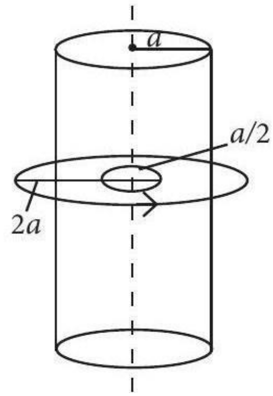
16. Assertion (A): In a $p-n$ junction with open ends there is no motion of charge carriers.

    Reason (R): In a $p-n$ junction with open ends the electric field is varying.

**SECTION B**

17. If we need a magnification of 375 from a microscope of tube length $15$ cm and an objective of focal length $0.5$ cm, what focal length of eye lens should be used?

18. A long straight wire of radius $a$ carries steady current $i$. The current is uniformly distributed across its cross-section. Find the ratio of magnetic field at distance $a/2$ and $2a$ from the axis.




**OR**

A student is given voltmeter having range $V$ and resistance $G$. Determine the resistance that she should connect in parallel to convert it into a voltmeter of range $V/n$.

19. The work function of copper is $4.0\text{eV}$. If two photons, each of energy $2.5\text{eV}$ strike with some electrons of copper, will the emission of electron be possible?

20. Use the mirror equation to show that an object placed between $f$ and $2f$ of a concave mirror produces a real image beyond $2f$.

21. What is the angular momentum of an electron in Bohr's hydrogen atom whose energy is $-3.4\text{eV}$ ?

## SECTION C

22. A $n$-type silicon sample of width $4 \times 10^{-3}$ m, thickness $25 \times 10^{-4}$ m and length $6 \times 10^{-2}$ m carries a current of $4.8$ mA. When the voltage is applied across the length of the sample, what is the current density? If the free electron density is $10^{22}$ m$^{-3}$, then find how much time does it take for the electrons to travel the full length of the sample?

**OR**

The resistance of a conductor is $5\text{ohm}$ at $50^{\circ}\text{C}$ and $6\text{ohm}$ at $100^{\circ}\text{C}$. What is the resistance at $0^{\circ}\text{C}$ ?

23. The magnetic susceptibility of a paramagnetic material at $-73^{\circ}\text{C}$ is 0.0075. Find its susceptibility at $-173^{\circ}\text{C}$.

24. Write difference between $p$ and $n$-type semiconductors.

25. Calculate the binding energy per nucleon of an $\alpha$-particle from the following data.

Mass of the helium nucleus $= 4.001265 \mathrm{amu}$

Mass of proton $= 1.007277 \mathrm{amu}$

Mass of neutron $= 1.008666 \mathrm{amu}$

$(1 \mathrm{amu} = 931.4812 \mathrm{MeV})$

**OR**

It is proposed to use the nuclear fusion reaction,

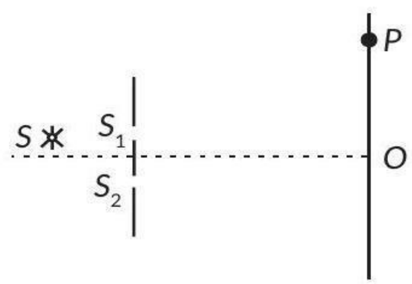
${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4$ in a nuclear reactor of $200 \mathrm{MW}$ rating. If the energy from above reaction is used with at $25\%$ efficiency in the reactor, how many grams of deuterium fuel will be needed per day.

(Mass of ${}_1H^2$ is $2.0141 \mathrm{u}$ and mass of ${}_2He^4$ is $4.0026 \mathrm{u}$ )

26. Define the term 'critical angle' for a pair of media.

A point source of monochromatic light ' $S$ ' is kept at the centre of the bottom of a cylinder of radius $15.0$ cm. The cylinder contains water (refractive index $4/3$ ) to a height of $7.0$ cm. Draw the ray diagram and calculate the area of water surface through which the light emerges in air.

27. The figure shows a modified Young's double slit experimental set-up. Here $SS_2 - SS_1 = \lambda/4$.




Write the condition for constructive interference.

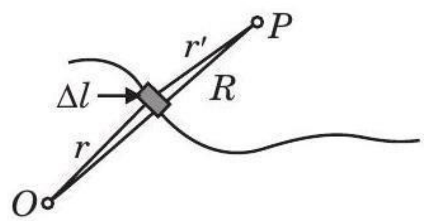
28. A beam of some kind of particle of velocity $2.1 \times 10^7 \mathrm{~m/s}$ is scattered by a gold $(Z = 79)$ foil. What is the specific charge of this particle (charge/mass), if the distance of closet approach is $2.5 \times 10^{-14} \mathrm{~m}$ ?

## SECTION D

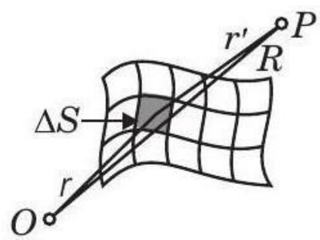
**Case Study Based Questions**

29. Read the following paragraph and answer the questions that follow.

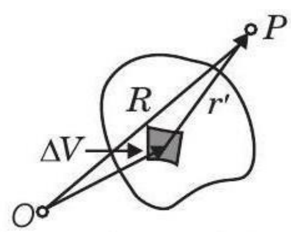
In practice, we deal with charges much greater in magnitude than the charge on an electron, so we can ignore the quantum nature of charges and imagine that the charge is spread in a region in a continuous manner. Such a charge distribution is known as continuous charge distribution. There are three types of continuous charge distribution : (i) Line charge distribution (ii) Surface charge distribution (iii) Volume charge distribution as shown in figure.




Line charge $\Delta Q = \lambda \Delta l$




Surface charge $\Delta Q = \sigma \Delta S$




Volume charge $\Delta Q = \rho \Delta V$

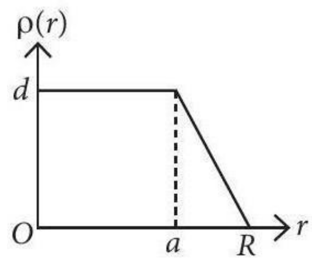
Volume charge $\Delta Q = \rho \Delta V$

(i) Statement 1: Gauss's law can't be used to calculate electric field near an electric dipole.

Statement 2: Electric dipole don't have symmetrical charge distribution.
(a) Statement 1 and statement 2 are true.
(b) Statement 1 is false but statement 2 is true.
(c) Statement 1 is true but statement 2 is false.
(d) Both statements are false.

(ii) An electric charge of $8.85 \times 10^{-13}$C is placed at the centre of a sphere of radius 1 m. The electric flux through the sphere is
(a) $0.2\ NC^{-1}\ m^2$
(b) $0.1\ NC^{-1}\ m^2$
(c) $0.3\ NC^{-1}\ m^2$

(d) $0.01 \mathrm{~NC}^{-1} \mathrm{~m}^2$
(iii) The electric field within the nucleus is generally observed to be linearly dependent on $r$. So,
(a) $a=0$
(b) a $\frac{R}{2}$
(c) $a=R$
(d) $a \frac{2R}{3}$



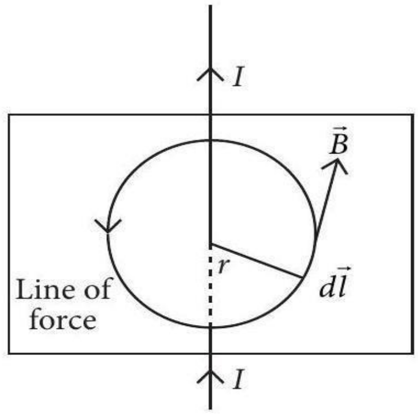

(iv) The SI unit of linear charge density is
(a) C m
(b) $\mathrm{Cm}^{-1}$
(c) $\mathrm{Cm}^{-2}$
(d) $\mathrm{Cm}^{-3}$

**OR**

What charge would be required to electrify a sphere of radius 25 cm so as to get a surface charge density of $\frac{3}{\pi} \mathrm{Cm}^{-2}$ ?
(a) 0.75C
(b) 7.5C
(c) 75C
(d) zero

**30. Read the following paragraph and answer the questions that follow. Ampere's Circuital Law**

Ampere's law gives a method to calculate the magnetic field due to given current distribution. According to it, the circulation $\oint \vec{B} \cdot d\vec{l}$ of the resultant magnetic field along a closed plane curve is equal to $\mu_0$ times the total current crossing the area bounded by the closed curve provided the electric field inside the loop remains constant. Ampere's law is more useful under certain symmetrical conditions. Consider one such case of a long Straight wire with circular cross-section (radius $R$ ) carrying current $I$ uniformly distributed across this cross-section.




(i) The magnetic field at a radial distance $r$ from the centre of the wire in the region $r > R$, is

(a) $\frac{\mu 0 I}{2r}$

(b) $\frac{\mu_0 I}{2\pi R}$

(c) $\frac{\mu_0 I R^2}{2\pi r}$

(d) $\frac{\mu_0 I r^2}{2\pi R}$

(ii) The magnetic field at a distance $r$ in the region $r < R$ is

(a) $\frac{\mu 0 I}{2r}$

(b) $\frac{\mu_0 I r^2}{2\pi R^2}$

(c) $\frac{\mu 0 I}{2r}$

(d) $\frac{\mu_0 I r}{2\pi R^2}$

(iii) A long straight wire of radius $R$ carries a steady current $I$. The current is uniformly distributed across its cross-section. The ratio of magnetic field at $R/2$ and $2R$ is

(a) $\frac{1}{2}$

(b) 2

(c) $\frac{1}{4}$

(d) 1

**OR**

A direct current $I$ flows along the length of an infinitely long straight thin walled pipe, then the magnetic field is

(a) uniform throughout the pipe but not zero

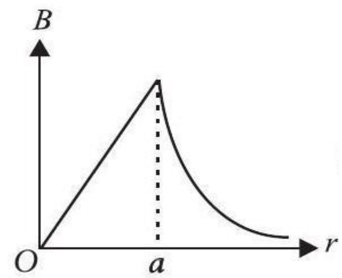
(b) zero only along the axis of the pipe

(c) zero at any point inside the pipe

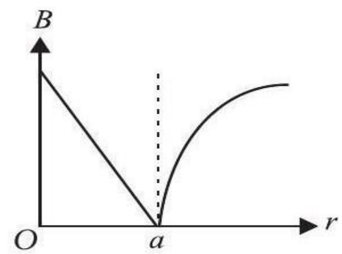
(d) maximum at the centre and minimum at the edges.

(iv) A long straight wire of a circular cross section (radius $a$ ) carries a steady current $I$ and the current $I$ is uniformly distributed across this cross-section. Which of the following plots represents the variation of magnitude of magnetic field $B$ with distance $r$ from the centre of the wire?

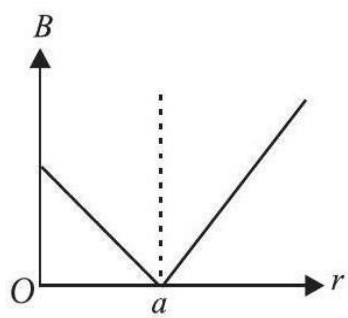
(a)



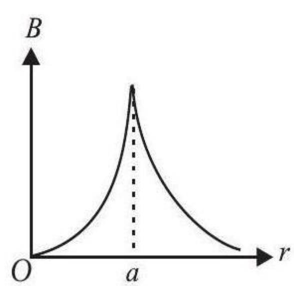

(b)




(c)

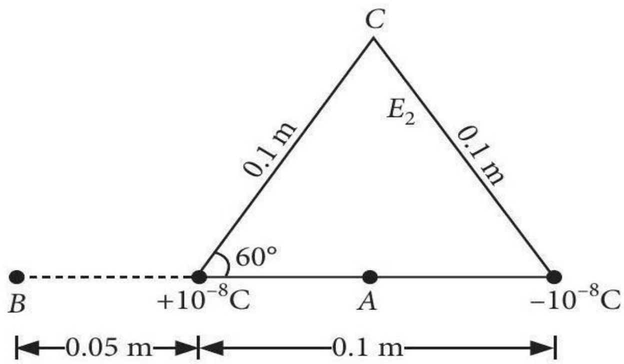



(d)



**SECTION E**

31. Two point charges $+10^{-8}$C and $-10^{-8}$C are placed 0.1 m apart. Calculate the electric fields at points (i) $A$ (ii) $B$ and (iii) $C$.




**OR**

(a) Three capacitors of $1\mu$F, $2\mu$F and $3\mu$F are connected in series. How many times will the capacity become when they are joined in parallel?

(b) Calculate the electric potential at the centre of a square of side $\sqrt{2}$ m, having charges $100\mu$C, $-50\mu$C, $20\mu$C, and $-60\mu$C at the four corners of a square.

32. (a) A coil has a self inductance of 10mH. What is the maximum magnitude of the induced emf in the inductor, when a current $i = 0.1\sin 200t$ A is sent through it.

(b) The self inductance of an inductor coil having 50 turns is 10mH. Calculate the magnetic flux through the cross-section of the coil corresponding to a current of 2 mA. Also find the total flux linked with the coil.

**OR**

(a) You are given an air coil, a bulb, an iron rod and a source of electricity. Suggest a method to find whether the given source is d.c. or a.c. Explain your answer.

(b) Why high frequency alternating current can pass through pure capacitor easily but not through a pure inductor?

33. A plane e.m. wave travelling along $z$-direction is described by $E = E_0\sin(kz - \omega t)\hat{i}$ and $B = B_0\sin(kz - \omega t)\hat{j}$. Show that

(i) The average energy density of the wave is given by $u_{av} = \frac{1}{4}\varepsilon_0 E_0^2 + \frac{1}{4}\frac{B_0^2}{\mu_0}$.

(ii) The time averaged intensity of the wave is given by $I_{av} = \frac{1}{2}c\varepsilon_0 E_0^2$.

**OR**

State Maxwell's equations and explain them.