O. P. JINDAL SCHOOL, SAVITRI NAGAR

Half Yearly Examination

(20223-24)

Class: XII **MM: 70**

Subject: Physics **Time: 3 Hrs**

Fifteen minutes extra for reading of the question paper.

General Instruction:-

(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 MCQ 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, one question 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
ii. $m_e = 9.1 \times 10^{-31}$ kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
v. $h = 6.63 \times 10^{-34}$ Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
vii. Avogadro's number = 6.023×10^{23} per gram mole

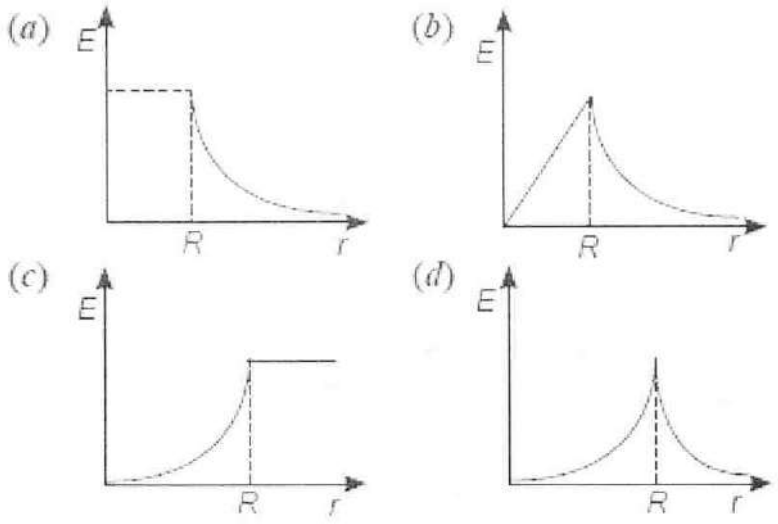
Section – A

1 Two charges of equal magnitudes kept at a distance r exert a force F on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is 1

(a) $\frac{F}{8}$ (b) $\frac{F}{4}$

(c) $4F$ (d) $\frac{F}{16}$

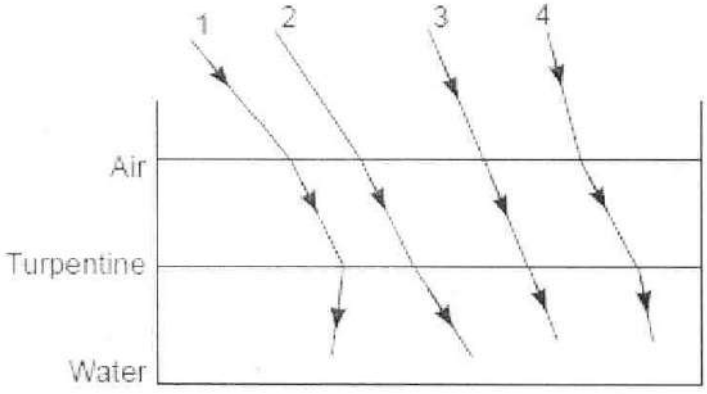
2 Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the sphere? 1



3 If a unit positive charge is taken from one point to another over an equipotential surface, then 1

(a) work is done on the charge.
(b) work is done by the charge.
(c) work done is constant.
(d) no work is done.

4 The optical density of turpentine is higher than that of water while its mass density is lower. Figure shows a layer of turpentine floating over water in a container. For which one of the four rays incident on turpentine in figure the path shown is correct? 1



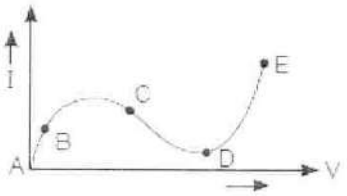
(a) 1

(b) 2

(c) 3

(d) 4

5 From the graph between current I and voltage V shown below, identify the portion corresponding to negative resistance 1



(a) AB

(b) BC

(c) CD

(d) DE

6 The terminal potential difference of a cell is greater than its e.m.f. when it is 1

(a) being discharged.
(b) in open circuit.
(c) being charged.
(d) being either charged or discharged.

7 Biot-Savart law indicates that the moving electrons (velocity v) produce a magnetic field B such that 1

(a) $B \perp v$.
(b) B || v.
(c) it obeys inverse cube law.
(d) it is along the line joining the electron and point of observation.

8 If M is magnetic moment and B is magnetic field intensity, then the torque is given by 1

(a) $\bar{M}.\bar{B}$.
(b) $\frac{|\bar{M}|}{|\bar{B}|}$
(c) $\bar{M} \times \bar{B}$
(d) MB

9 The best material for the core of a transformer is 1
(a) stainless steel

(b) mild steel

(c) hard steel

(d) soft iron

10 The current flows from A to B is as shown in the figure. The direction of the induced current in the loop is 1

(a) clockwise.
(b) anticlockwise.
(c) straight line.
(d) no induced e.m.f. produced

11 The quantity $\sqrt{\mu_0 \varepsilon_0}$ represents 1

(a) speed of sound
(b) speed of light in vacuum
(c) speed of e.m.w.
(d) inverse of speed of light in vacuum

12 Electromagnetic waves are transverse in nature is evident by 1
(a) Polarisation.

(b) Interference.

(c) Reflection.

(d) Diffraction.

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) :** In a non uniform electric field, a dipole will have translatory as well as rotatory motion. 1
Reason(R): In a non uniform electric field, a dipole experiences a force as well as torque.

14 **Assertion (A) :**An electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential. 1
Reason (R) : Electrons move from a region of higher potential to a region of lower potential.

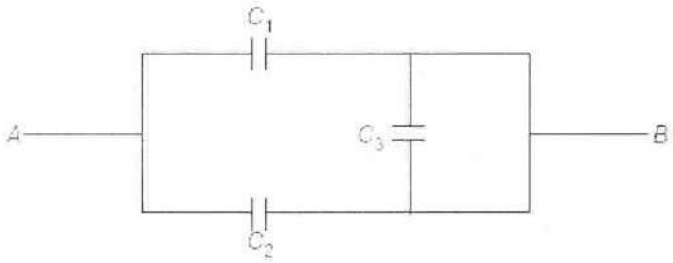
15 **Assertion(A):** A convex lens of focal length 30 cm can't be used as a simple microscope in normal setting. 1
Reason (R): For normal setting, the angular magnification of simple microscope is M=D/f

16 **Assertion (A) :**Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface. 1
Reason (R): Refractive index of the material of the cladding of the optical fibre is greater than that of the core.

Section – B

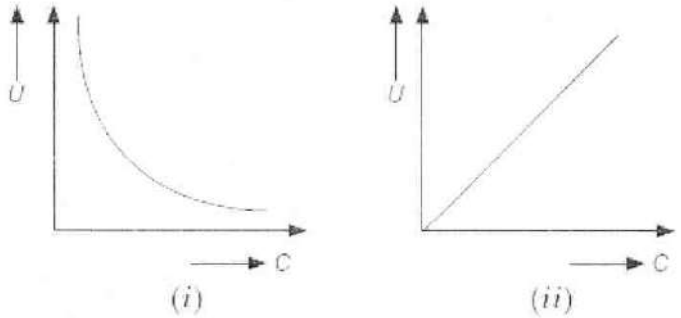
All questions are compulsory. In case of internal choices, attempt any one of them.

17 What is the net capacitance between A and B of this combination? 2



OR

The energy of a capacitor varying with its capacitance is shown by two graphs (i) and (ii). Find in which of the graphs: (a) charge is constant, and (b) potential difference is constant.

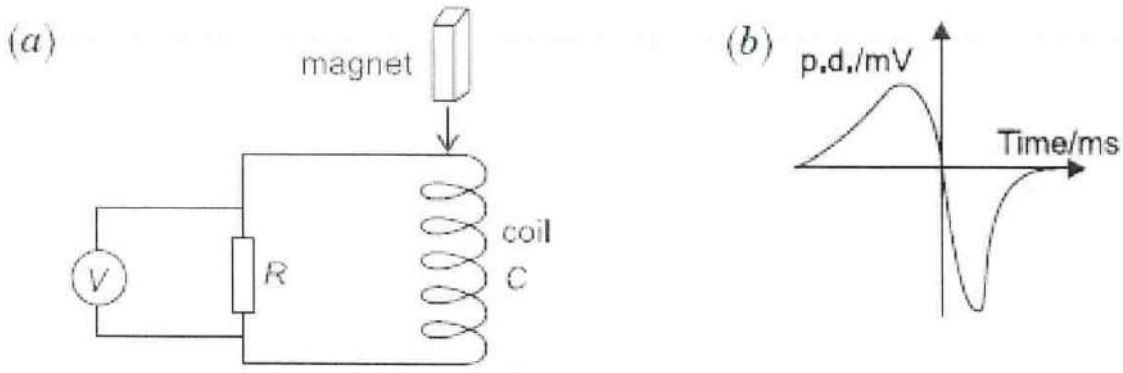


18 Draw a plot showing the variation of (*i*) electric field (E and (*ii*) electric potential (V) with distance r due to a point charge Q. 2

A bar magnet M is dropped so that it falls vertically through the coil C. The graph obtained for voltage produced across the coil vs time is shown in figure (b).

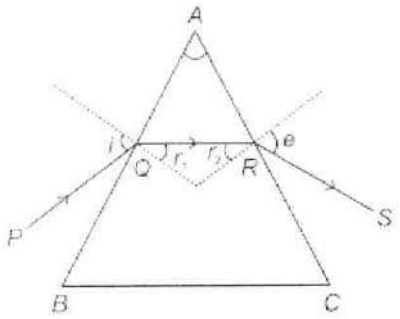
(i) Explain the shape of the graph.

(ii) Why is the negative peak longer than the positive peak? 2



20 Experimental observations have shown that X-rays:
(a) travel in vacuum with a speed of 3×10^8 ms^{-1}.
(b) exhibit the phenomenon of diffraction and can be polarized.
What conclusion can be drawn about the nature of X-rays from each of then observations? 2

21 Figure shows a ray of light passing through a prism. If the refracted ray QR is parallel to the base BC, show that (i) $r_1 = r_2 = A/2$, (ii) angle of minimum deviation, $\Delta m = 2i - A$



2

OR

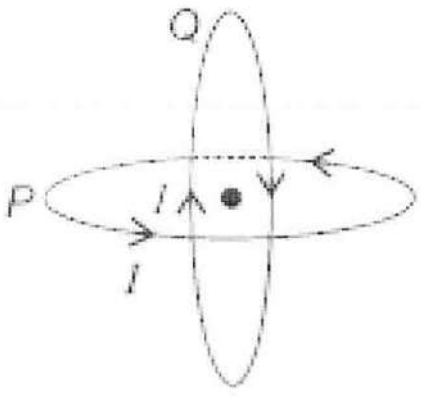
Using the data given below, state which two of the given lenses will be preferred to construct a (i) telescope, and (ii) microscope. Also indicate which is to be used as objective and as eyepiece in each case.

Lenses	Power (P)	Aperture (A)
L_1	6 D	1 cm
L_2	3 D	8 cm
L_3	10 D	1 cm

Section – C

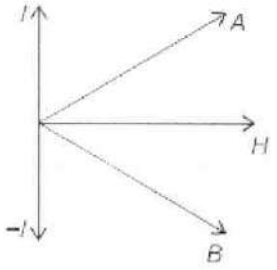
All questions are compulsory. In case of internal choices, attempt any one of them.

22 Two identical circular wires P and Q each of radius R and carrying current I are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils.



3

23 The following figure shows the variation of intensity of magnetisation versus the applied magnetic field intensity H, for two magnetic materials A and B:

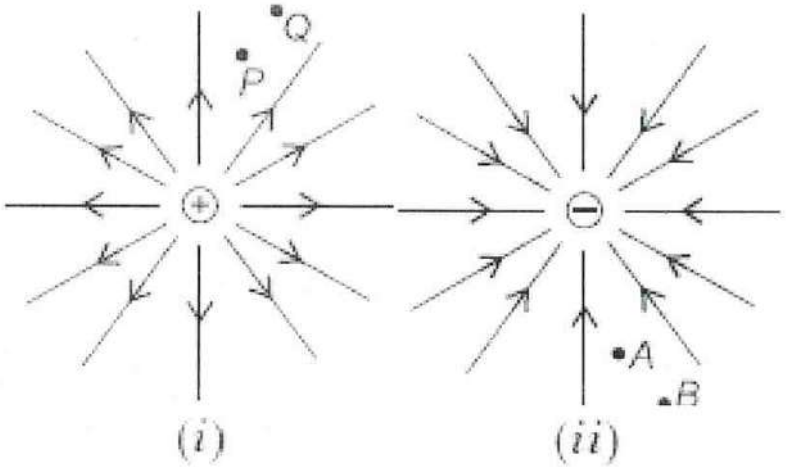


3

(a) Identify the materials A and B.

(b) Draw the variation of susceptibility with temperature for B.

24 Figures (i) and (ii) show the field lines of the positive and negative point charges respectively.



3

(a) Give the signs of the potential difference $V_P - V_Q$, $V_B - V_A$.

(b) Give the sign of the potential energy difference of a small negative charge between the points Q and P, A and B.

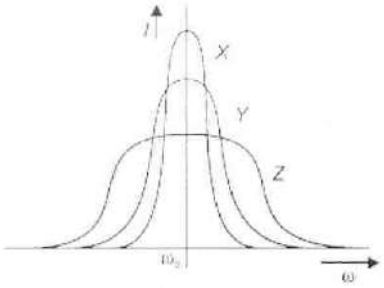
(c) Give the sign of the work done by the field in moving a small positive charge from Q to P.

25 A power transmission line feeds power at 2200 V with a current of 5 A to a step down transformer with its primary winding having 4000 turns. Calculate the number of turns and the current in the secondary in order to get output power at 220 V.

OR

3

Three students X, Y, Z performed an experiment for studying the variation of alternating currents with angular frequency in a series LCR circuit and obtained the graphs shown below. They all used AC sources of the same rms value and inductances of the same value.



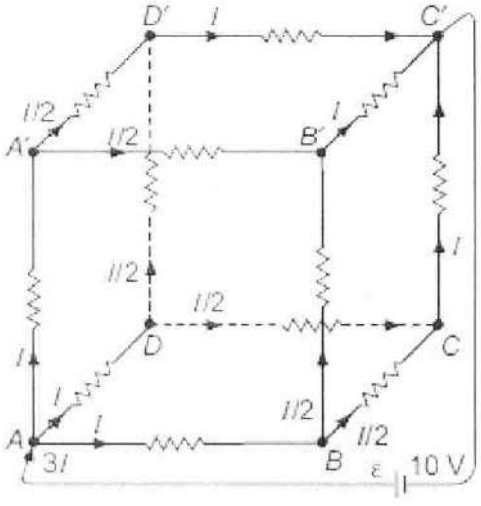
What can we (qualitatively) conclude about the

(i) capacitance values
(ii) (ii) resistance used by them? In which case will the quality factor be maximum?

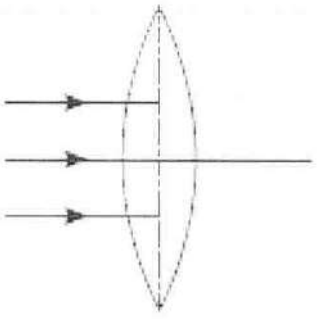
What can we conclude about nature of the impedance of the set up at the frequency ω_0?

26 (a) State the Kirchoff 's law.

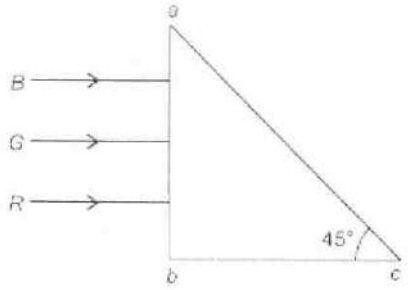
(b) A battery of 10V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistance 1Ω in figure. Determine the equivalent resistance of the network and the current along each edge of the cube. 3



27 A convex lens of material of refractive index n_1 is kept in a medium of refractive index n_2. The parallel rays of light are incident on the lens. Complete the path of rays of light refracted from the lens when (i) $n_2 = n_1$, (ii) $n_2 > n_1$ and (iii) $n_2 < n_1$. 3



28 Three light rays red (R), green (G) and blue (B) are incident on the right angled prism abc at face ab. The refractive indices of the material of the prism for red, green and blue wavelengths are respectively 1.39, 1.44 and 1.47. Trace the paths of these rays reasoning out the difference in their behavior. 3



Section – D

29 **Read the following paragraph and answer the questions that follow.** 4
Types of Lenses and their combination

A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex lens is of three types: Double convex lens, Plano convex lens and Concavo-convex lens. Concave lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types: Double concave lens, Plano concave lens and Convexo-concave lens. When two thin lenses of focal lengths f1 and f2 are placed in contact with each other along their common principal axis, then the two lens system is regarded as a single lens of focal length *f* and

$$1/f = 1/f1 + 1/f2$$

If several thin lenses of focal length *f*1, *f*2, ...*f*nare placed in contact, then the effective focal length of the combination is given by

$$1/F = 1/f_1 + 1/f_2 + 1/f_3 + \ldots\ldots\ldots\ldots 1/fn$$

and in terms of power, we can write

$$P = P1 + P2 + \ldots\ldots\ldots\ldots + Pn$$

The value of focal length and power of a lens must be used with proper sign consideration.

i. Two thin lenses are kept coaxially in contact with each other 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) -26.7cm
(b) 60cm
(c) 80cm
(d) 30cm

ii. 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) mirror
(d) thin plane sheet of glass

iii. Lens generally used in magnifying glass is

(a) single concave lens
(b) single convex lens
(c) combination of convex lens of lower power and concave lens of lower focal length
(d) Planoconcave lens

iv. 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

OR

A convex lens of 20 cm focal length forms a real image which is three times magnified. The distance of the object from the lens is

(a) 13.33 cm
(b) (b) 14 cm
(c) (c) 26.66 cm
(d) (d) 25 cm

30 Although a single piece of an isolated conductor can store charge on its surface. The ability to store charge is called capacitance (C). If Q is the charge and potential V then C = Q / V ...(i) If we increase the charge, the potential on the surface increases, we can store charge only up to some maximum value which is due to some limited maximum potential. Hence, instead of one conductor we use two conductors to form a capacitor, so that more charge can be stored. 4

(i) If we place an earthed uncharged conductor near a charged conductor, then the capacitance of a charge conductor increases due to

(a) increase in potential of a charged conductor.

(b) decrease in potential of a charged conductor.

(c) increase in charge on the conductor.

(d) decrease in charge on the conductor.

(ii) Dielectric strength of an air is 3×10^6 V/ms. If we increase the potential difference such that electric field reaches its maximum value, then

(a) nothing will happen.

(b) air will get ionised and electric charge stored will get leaked away.

(c) No charge will be last as air is an insulator.

(d) None of the above

(iii) The process of breakdown is accelerated by the presence of

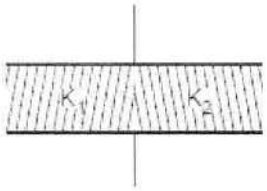
(a) impurities (b) conduction (c) humidity (d) magnetic field

(iv) Which of the following is the correct expression of dielectric strength?

(a) $\frac{d}{V}$ (b) $\frac{V}{d}$ (c) V : d (d) $\frac{V}{d^2}$

OR

A parallel plate capacitor with air as medium between the plates has a capacitance of 10 μF. The area of capacitor is divided into two equal halves and filled with two media having dielectric constant $k_1 = 2$ and $k_2 = 4$ as shown in the figure. The capacitance of the system will now be



(a) 10 μF

(b) 20 μF

(c) 30 μF

(d) 40 μF

Section – E

All questions are compulsory. In case of internal choices, attempt any one of them.

31 (a) Define electric flux. Write its SI units.

(b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.

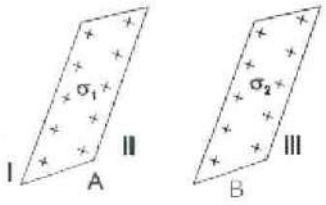
(c) How is the field directed if (i) the sheet is positively charged, (ii) negatively charged?

5

OR

(a) A point charge ($+Q$) is kept in the vicinity of uncharged conducting plate. Sketch electric field lines between the charge and the plate.

(b) Two infinitely large plane thin parallel sheets having surface charge densities σ_1 and σ_2 ($\sigma_1 > \sigma_2$) are shown in the figure. Write the magnitudes and directions of net fields in the regions marked II and III.



32 (a) Using Biot–Savart's law, derive the expression for the magnetic field in the vector form at a point on the axis of a circular current loop.

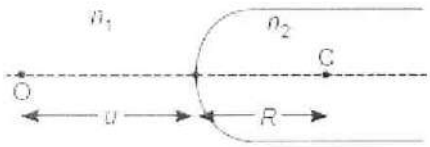
(b) What does a toroid consist of? Find out the expression for the magnetic field inside a toroid for N turns of the coil having the average radius r and carrying a current I. Show that the magnetic field in the open space inside and exterior to the tortoid is zero. 5

OR

(a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(b) Answer the following:
(i) Why is it necessary to introduce a cylindrical soft iron core inside the coil of galvanometer?
(ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

33 (a) A point object O is kept in a medium of refractive index n_1 in front of a convex spherical surface of radius of curvature R which separates the second medium of refractive index n_2 from the first one, as shown in the figure. 5



Draw the ray diagram showing the image formation and deduce the relationship between the object distance and the image distance in terms of n_1, n_2 and R.

(b) When the image formed above acts as a virtual object for a concave spherical surface separating the medium n_2 from $n_1 (n_2 > n_1)$, draw this ray diagram and write the similar (similar to (a)) relation. Hence obtain the expression for the lens maker's formula.

OR

(i) Draw an astronomical telescope, when the final image is formed at the least distance of distinct vision (D) from the eye.
(ii) Define the magnifying power of the astronomical telescope and derive its formula.
(iii) Refracting type of telescope is better than reflecting type of telescope. Justify your answer by giving any two reasons.