Design of Question Paper

Physics

Class XII

Time: Three Hours **Max. Marks: 70**

The weightage of the distribution of marks over different dimensions of the question paper shall be as follows:

A. **Weightage to content/subject units**

Sl. No.	Unit	Marks
1.	Electrostatics	08
2.	Current Electricity	07
3.	Magnetic Effect of Current and Magnetism	08
4.	Electromagnetic Induction and Alternating Current	08
5.	Electromagnetic Waves	03
6.	Optics	14
7.	Dual Nature of Radiation and Matter	04
8.	Atoms and Nuclei	06
9.	Semiconductor Electronics	07
10.	Communication Systems	05
	Total	70

B. **Weightage to form of questions**

Sl. No.	Form of Questions	Marks for each Question	No. of Questions	Total Marks
1	Long Answer (LA)	5	3	15
2	Short Answer SA (I)	3	09	27
3	Short Answer SA (II)	2	10	20
4	Very Short Answer (VSA)	1	08	08
	Total	–	30	70

1Mark quesiton may be Very Short Answer (VSA) type or Multiple Choice Quesition (MCQ) with only one option correct.

C. Scheme of options

1. There will be no overall option.
2. Internal choices (either or type) on a very selective basis has been given in some questions.

D. Weightage to difficulty levels of questions

Sl. No.	Estimated difficulty level	Percentage
1.	Easy	15
2.	Average	70
3.	Difficult	15

CLASS XII
PHYSICS
BLUE - PRINT I

Topic	VSA (1 mark)	SA II (2 marks)	SA I (3 Marks)	LA (5 marks)	Total
I Electrostatics	1(1)	4 (2)	3 (1)	—	8 (4)
II Current Electricity	1 (1)	—	6 (2)	—	7 (3)
III Magnetic Effect of Current and Magnetism	1 (1)	2 (1)	—	5 (1)	8 (3)
IV Electromagnetic Induction and Alternating Current	1(1)	2 (1)	—	5 (1)	8 (3)
V Electromagnetic Waves	1 (1)	2 (1)	—	—	3 (2)
VI Optics	—	—	9 (3)	5 (1)	14 (4)
VII Dual Nature of Radiation and Matter	—	4 (2)	—	—	4 (2)
VIII Atoms and Nuclei	1(1)	2 (1)	3 (1)	—	6 (3)
IX Semiconductor Electronics	2 (2)	2 (1)	3 (1)	—	7 (4)
X Systems Communication	—	2 (1)	3(1)	—	5 (2)
Total	**8 (8)**	**20 (10)**	**27 (9)**	**15 (3)**	**70 (30)**

SAMPLE PAPER I
XII - PHYSICS

Time : Three Hours **Max. Marks : 70**

General Instructions

(a) All questions are compulsory.

(b) There are 30 questions in total. Questions 1 to 8 carry one mark each, questions 9 to 18 carry two marks each, questions 19 to 27 carry three marks each and questions 28 to 30 carry five marks each.

(c) There is no overall choice. However, an internal choice has been provided in all three questions of five marks each. You have to attempt only one of the given choices in such questions.

(d) Use of calculators is not permitted.

(e) You may use the following physical constants wherever necessary :

$c = 3 \times 10^{8}$ m s^{-1}

$h = 6.6 \times 10^{-34}$ J s

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

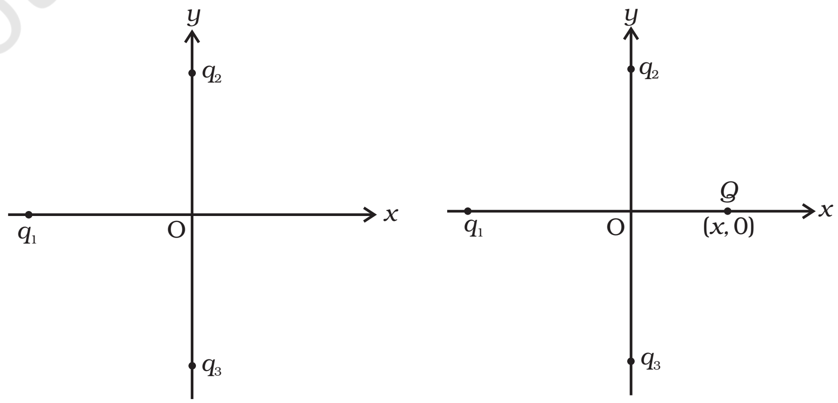
$$\frac{1}{4\pi\varepsilon_0} = 9\times10^{9}\ \frac{\text{Am}^2}{\text{C}^2}$$

Boltzmann constant $k = 1.38 \times 10^{23}$ JK^{-1}

Avogadro's number $N_A = 6.023 \times 10^{23}$/mole

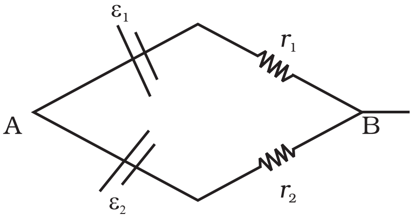
Mass of neutron $m_n = 1.6 \times 10^{-27}$ kg

1. Two positive charges q_2 and q_3 fixed along the y axis, exert a net electric force in the + x direction on a charge q_1 fixed along the x axis as shown. If a positive charge Q is added at $(x, 0)$, the force on q_1



(a) shall increase along the positive x-axis.
(b) shall decrease along the positive x-axis.
(c) shall point along the negative x-axis.
(d) shall increase but the direction changes because of the intersection of Q with q_2 and q_3.

2. Two batteries of emf ε_1 and ε_2 ($\varepsilon_2 > \varepsilon_1$) and internal resistances r_1 and r_2 respectively are connected in parallel as shown.



(a) The equivalent emf ε_{eq} of the two cells is between ε_1 and ε_2, i.e. $\varepsilon_1 < \varepsilon_{eq} < \varepsilon_2$.
(b) The equivalent emf ε_{eq} is smaller than ε_1 .
(c) The ε_{eq} is given by $\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$ always.
(d) ε_{eq} is independent of internal resistances r_1 and r_2.

3. A proton has spin and magnetic moment just like an electron. Why then its effect is neglected in magnetism of materials?

4. If a LC circuit is considered analogous to a harmonically oscillating spring-block system, which energy of the LC circuit would be analogous to potential energy and which one analogous to kinetic energy?

5. A variable frequency ac source is connected to a capacitor. How will the displacement current change with decrease in frequency?

6. In pair annihilation, an electron and a positron destroy each other to produce gamma radiation. How is the momentum conserved?

7. Can the potential barrier across a p-n junction be measured by simply connecting a voltmeter across the junction?

8. 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 increase.
(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.

9. Two charges q and $-3q$ are placed fixed on x-axis separated by distance 'd'. Where should a third charge $2q$ be placed such that it will not experience any force?

10. The battery remains connected to a parallel plate capacitor and a dielectric slab is inserted between the plates. What will be effect on its (i) potential difference, (ii) capacity, (iii) electric field, and (iv) energy stored?

11. Obtain an expression for the magnetic dipole moment of a revolving electron in a Bohr model.

12. A wire in the form of a tightly wound solenoid is connected to a DC source, and carries a current. If the coil is stretched so that there are gaps between successive elements of the spiral coil, will the current increase or decrease? Explain.

13. You are given a 2µF parallel plate capacitor. How would you establish an instantaneous displacement current of 1mA in the space between its plates?

14. There are two sources of light, each emitting with a power of 100 W. One emits X-rays of wavelength 1nm and the other visible light at 500 nm. Find the ratio of number of photons of X-rays to the photons of visible light of the given wavelength?

15. A particle is moving three times as fast as an electron. The ratio of the de Broglie wavelength of the particle to that of the electron is 1.813×10^{-4}. Calculate the particle's mass and indentify the particle.

16. Consider two different hydrogen atoms. The electron in each atom is in an excited state. Is it possible for the electrons to have different energies but the same orbital angular momentum according to the Bohr model?

17. What do the terms 'depletion region' and 'barrier potential' mean for a p-n junction?

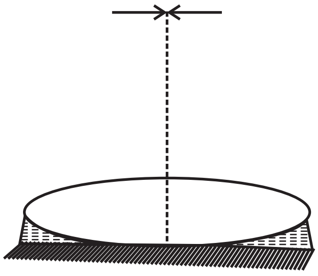
18. If the whole earth is to be connected by LOS communication using space waves (no restriction of antenna size or tower height), what is the minimum number of antennas required? Calculate the tower height of these antennas in terms of earth's radius?

19. Derive an expression (in vector form) for electric field of a dipole at a point on the equitorial plane of the dipole. How does the field vary at large distances?

20. What is relaxation time? Derive an expression for resistivity of a wire in terms of member density of free electrons and relaxation time.

21. First a set of n equal resistors of R each is connected in series to a battery of emf E and internal resistance R. A current I is observed to flow. Then the n resistors are connected in parallel to the same battery. It is observed that the current becomes 10 times. What is 'n'?

22. An equiconvex lens (of refractive index 1.50) is placed in contact with a liquid layer on top of a plane mirror as shown. A small needle with its tip on the principal axis is moved along the axis until its inverted image is found at the position of the needle. The distance of the needle from the lens is measured to be 45.0 cm. The liquid is removed and the experiment is repeated. The new distance is measured to be 30.0 cm. What is the refractive index of the liquid?



23. Obtain an expression for focal length of a combination of thin lenses in contact.

24. Three immiscible liquids of densities $d_1 > d_2 > d_3$ and refractive indices $\mu_1 > \mu_2 > \mu_3$ are put in a beaker. The height of each liquid column is $\frac{h}{3}$. A dot is made at the bottom of the beaker. For near normal vision, find the apparent depth of the dot.

25. Define 'half -life' and 'average-life' of a radioactive substance. What is the relation between the two?

26. Using a suitable combination from a NOR, an OR and a NOT gate, draw circuits to obtain the truth tables given below:

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	0

(i)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

(ii)

27. Define the terms 'modulation index' for an AM wave. What would be the modulation index for an AM wave for which the maximum amplitude is '*a*' and the minimum amplitude is '*b*'?

28. (i) Derive an expression for the magnetic field at a point on the axis of a current carrying circular loop.

(ii) A coil of 100 turns (tighty bound) and radius 10 cm. carries a current of 1A. What is the magnitude of the magnetic field at the centre of the coil?

OR

State Ampere's circuital law. Consider a long straight wire of a circular cross section (radius a) carrying steady current I. The current I is uniformly distributed across this cross section. Using Ampere's circuital law, find the magnetic field in the region $r < a$ and $r > a$.

29. An ac voltage $v = v_m \sin\omega t$ is applied to a series LCR circuit. Obtain the expression for current in the circuit and the phase angle between current and voltage. What is the resonance frequency?

OR

An ac voltage $v = v_m \sin\omega t$ is applied to a pure inductor L. Obtain an expression for the current in the circuit. Prove that the average power supplied to an inductor over one complete cycle is zero.

30. (i) State and explain Huygens Principle. Using it, obtain Snell's law of refraction.

(ii) When light travels from a rarer to a denser medium, the speed decreases. Does the reduction in speed imply a reduction in the energy carried by the light wave?

OR

With the help of a labelled ray diagram show the image formation by a compound microscope. Derive an expression for its magnifying power. How can the magnifying power be increased?

SAMPLE PAPER I
SOLUTIONS AND MARKING SCHEME

1. (a) (1)

2. (a) (1)

3. $\mu_p \approx \dfrac{e\hbar}{2m_p}$ and $\mu_e \approx \dfrac{e\hbar}{2m_e}, \hbar = \dfrac{h}{2\pi}$ (1/2)

   $\mu_e >> \mu_p$ because $m_p >> m_e$. (1/2)

4. Magnetic energy analogous to kinetic energy and electrical energy analogous to potential energy. (1/2), (1/2)

5. On decreasing the frequency, reactance $X_c = \dfrac{1}{\omega C}$ will increase which will lead to decrease in conduction current. In this case $i_D = i_C$; hence displacement current will decrease. (1/2, 1/2)

6. 2γ photons are produced which move in opposite directions to conserve momentum. (1)

7. No, because the voltmeter must have a resistance very high compared to the junction resistance, the latter being nearly infinite. (1/2, 1/2)

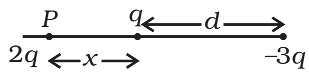
8. (d) (1)

9. At P: on $2q$, Force due to q is to the left and that due to $-3q$ is to the right.

   $$\therefore \frac{2q^2}{4\pi\varepsilon_0 x^2} = \frac{6q^2}{4\pi\varepsilon_0 (d+x)^2}$$ (1/2)

   $\therefore (d + x)^2 = 3x^2$

   $\therefore 2x^2 - 2dx - d^2 = 0$



   $$x = \frac{d}{2} \pm \frac{\sqrt{3}d}{2}$$ (1/2)

   (*Negative* sign would be between q and $-3q$ and hence is unaceptable.)

   $$x = \frac{d}{2} + \frac{\sqrt{3}d}{2} = \frac{d}{2}(1+\sqrt{3})$$ to the left of q. (1)

10. When battery remains connected,

   (i) potential difference V remains constant. (1/2)

   (ii) capacity C increases. (1/2)

(iii) electric field will decrease. (1/2)

(iv) energy stored $(1/2)CV^2$ increases as C increases. (1/2)

11. $I = e/T$ (1/2)

$T = 2\pi r/v$ (1/2)

$\mu_l = IA = I\pi r^2 = evr/2$ (1/2)

$\mu_l = \frac{e}{2m_e} l$ (1/2)

12. The current will increase. As the wires are pulled apart, the flux will leak through the gaps. Lenz's law demands that induced e.m.f. resist this decrease, which can be done by an increase in current. (1,1)

13. $i_D = C\frac{dV}{dt}$ (1/2)

$1\times 10^{-3} = 2\times 10^{-6}\frac{dV}{dt}$

$\frac{dV}{dt} = \frac{1}{2}\times 10^3 = 5\times 10^2$ V/s (1/2)

Hence, applying a varying potential difference of 5×10^2 V/s would produce a displacement current of the desired value. (1)

14. Total E is constant. (1/2)

Let n_1 and n_2 be the number of photons of X-rays and light of visible region:

$n_1E_1 = n_2E_2$ (1/2)

$n_1\frac{hc}{\lambda_1} = n_2\frac{hc}{\lambda_2}$

$\frac{n_1}{n_2} = \frac{\lambda_1}{\lambda_2}.$ (1/2)

$\frac{n_1}{n_2} = \frac{1}{500}$ (1/2)

15. de Broglie wavelength of a moving particle, having mass m and velocity v:

$\lambda = h/p = h/mv$

Mass, $m = h/\lambda v$ 1/2)

For an electron, mass $m_e = h/\lambda_e v_e$

Now, we have $v/v_e = 3$ *and* $\lambda/\lambda_e = 1.813 \times 10^{-4}$ (1/2)

Then, mass of the particle, $m = m_e\ (\lambda_e/\lambda)(v_e/v)$ (1/2)

$m = (9.11 \times 10^{-31}\,\text{kg}) \times (1/3) \times (1/1.813 \times 10^{-4})$

$m = 1 \times 1.675 \times 10^{-27}$ kg.

Thus, the particle, with this mass could be a proton or a neutron. (1/2)

16. No, because according to Bohr model, $E_n = -\frac{13.6}{n^2}$, (1)

and electons having different energies belong to different levels having different values of n.

So, their angular momenta will be different, as $mvr = \frac{nh}{2\pi}$. (1)

17. Definition : depletion region (1)

Definition : barrier potential (1)

18. $d_m^2 = 2(R + h_T)^2$ (1/2)

$8Rh_T = 2(R+h_T)^2 \quad (\because d_m = 2\sqrt{2Rh_T})$

$4Rh_T = R^2 + h_T^2 + 2Rh_T$

$(R - h_T)^2 = 0$

$R = h_T$ (1/2)

Since space wave frequency is used, $\lambda << h_T$, hence only tower height is taken to consideration. In three diamensions, 6 antenna towers of $h_T = R$ would do. (1)

19. Derivation (2)

At large distances, $E \propto 1/r^3$ (1)

20. Definition and Derivation (3)

21. $I = E/(R+nR)$ (1)

$10I = E/(R+R/n)$ (1)

$(1+n)/(1+1/n) = 10 = \{(1+n)/(n+1)\}n = n,\ n = 10.$ (1)

22. $\mu = 1.5$. 45cm is focal length of the combination of convex lens and plano convex liquid

lens. When liquid is removed, f_1= 30 cm is the focal length of convex lens only. If f_2 is the focal length of plano-convex liquid lens,

$$\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{f} \qquad (1/2)$$

$$\frac{1}{f_2}=\frac{1}{f}-\frac{1}{f_1}=\frac{1}{45}-\frac{1}{30}=\frac{-1}{90}, f_2=-90\,\text{cm} \qquad (1/2)$$

Using lens maker's formula, R_1=R, R_2=–R

$$\frac{1}{f_2}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \Rightarrow \frac{1}{30}=(1.5-1)\left(\frac{1}{R}+\frac{1}{R}\right) \Rightarrow R=30\,\text{cm} \qquad (1/2, 1/2)$$

For plano-convex lens

$$\frac{1}{f_2}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \qquad (1/2)$$

$$-\frac{1}{90}=(\mu-1)\left(\frac{1}{\infty}-\frac{1}{30}\right)=\frac{\mu-1}{-30}$$

$\mu = 1.33$ (1/2)

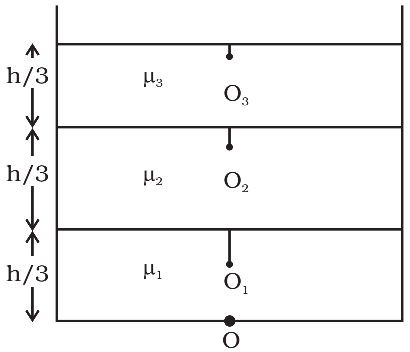
23. Derivation, $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}+\ldots$ (3)

24. Let the apparent depth be O_1 for the object seen from μ_2 then

$$O_1=\frac{\mu_2}{\mu_1}\frac{h}{3} \qquad (1)$$

If seen from μ_3, the apparent depth is O_2

$$O_2=\frac{\mu_3}{\mu_2}\left(\frac{h}{3}+O_1\right)=\frac{\mu_3}{\mu_2}\left(\frac{h}{3}+\frac{\mu_2}{\mu_1}\frac{h}{3}\right)=\frac{h}{3}\left(\frac{\mu_3}{\mu_2}+\frac{\mu_3}{\mu_1}\right) \qquad (1)$$



Seen from outside, the apparent height is

$$O_3=\frac{1}{\mu_3}\left(\frac{h}{3}+O_2\right)=\frac{1}{\mu_3}\left[\frac{h}{3}+\frac{h}{3}\left(\frac{\mu_3}{\mu_2}+\frac{\mu_3}{\mu_1}\right)\right]$$

$$=\frac{h}{3}\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}+\frac{1}{\mu_3}\right) \qquad (1)$$

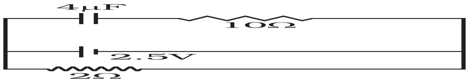
25. Definition and expression: Half Life (1/2,1/2)

Definition and expression: Average life (1/2,1/2)

Relation between the two. (1)

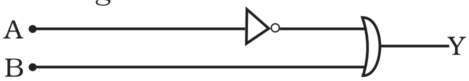
26. Output not symmetric for A, B = (0,1) and (1,0). NOT gate in one input. (1)

(i) has three zero. NOR gate.

Thus 

(1)

(ii) has three ones. OR gate.

Thus 

(1)

27. $\mu = A_m/A_c$ (1)

$a = A_c + A_m$

$b = A_c - A_m$ (1/2)

$A_c = (a + b)/2,\ A_m = (a–b)/2$ (1/2)

$\mu = (a - b)/(a+b)$ (1)

28. (i) Derivation (3)

(ii) Since the coil is tighty bound, we may take each circular element to have the same radius R = 10cm = 0.1m. N=100. The magnitude of the magnetic field is

$B = \mu_0 N\, I/(2\ R) = 4\pi\times10^{-7}\times10^{-2}\times 1/(2\times10^{-1}) = 2\pi\times10^{-4} = 6.28\times\ 10^{-4}$ T. (2)

OR

Statement of Ampere's law (1)

Derivation of $B = \mu_0\, I/2\pi r$, for $r > a$ (2)

Derivation of $B = (\mu_0\, I/2\pi a^2)\, r$, for $r < a$ (2)

29. Derivation (4)

Resonance frequency (1)

OR

Derivation (3)

Proof (2)

30. (i) Statement and explanation (1)

Derivation of Snell's law (3)

(ii) No. Energy carried by a wave depends on the amplitude of the wave, not on the speed of wave propagation. (1)

OR

(iii) Labelled ray diagram (1)

Derivation $m = \frac{L}{f_o}\left(1 + \frac{D}{f_e}\right)$ (2)

To Increase magnifying power, the objective and eyepice should have small focal lengths. In practice, it is difficult ot make the focal length much smaller than 1 cm. Also large lenses are required to make L large. (1)

Class XII
Physics
Blue - Print II

Topic	VSA (1 mark)	SA II (2 marks)	SA I (3 Marks)	LA (5 marks)	Total
I Electrostatics	1(1)	2 (1)	—	5 (1)	8 (3)
II Current Electricity	—	4 (2)	3 (1)	—	7 (3)
III Magnetic Effect of Current and Magnetism	1 (1)	4 (2)	3 (1)	—	8 (4)
IV Electromagnetic Induction and Alternating Current	1(1)	2 (1)	—	5 (1)	8 (3)
V Electromagnetic Waves	1 (1)	2 (1)	—	—	3 (2)
VI Optics	2 (2)	4 (2)	3 (1)	5 (1)	14 (6)
VII Dual Nature of Radiation and Matter	1 (1)	—	3 (1)	—	4 (2)
VIII Atoms and Nuclei	—	—	6 (2)	—	6 (2)
IX Semiconductor Electronics	1 (1)	—	6 (2)	—	7 (3)
X Communication Systems	—	2 (1)	3(1)	—	5 (2)
Total	**8 (8)**	**20 (10)**	**27 (9)**	**15 (3)**	**70 (30)**

SAMPLE PAPER II
XII - PHYSICS

Time : Three Hours **Max. Marks : 70**

General Instructions

(a) All questions are compulsory.

(b) There are 30 questions in total. Questions 1 to 8 carry one mark each, questions 9 to 18 carry two marks each, questions 19 to 27 carry three marks each and questions 28 to 30 carry five marks each.

(c) There is no overall choice. However, an internal choice has been provided in all three questions of five marks each. You have to attempt only one of the given choices in such questions.

(d) Use of calculators is not permitted.

(e) You may use the following physical constants wherever necessary :

$c = 3 \times 108 \text{ms}^{-1}$

$h = 6.6 \times 10^{-34} \text{Js}$

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \frac{\text{Am}^2}{\text{C}^2}$$

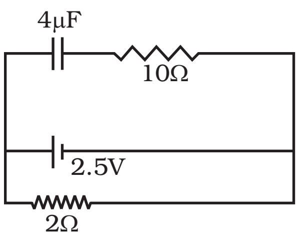
Boltzmann constant $k = 1.38 \times 10^{23}$ JK^{-1}

Avogadro's number $N_A = 6.023 \times 10^{23}$/mole

Mass of neutron $m_n = 1.6 \times 10^{-27}$ kg

1. A capacitor of 4 μ F is connected in a circuit as shown. The internal resistance of the battery is 0.5 Ω. The amount of charge on the capacitor plates will be

(a) 0
(b) 4 μ C
(c) 16 μ C
(d) 8 μ C



2. Two charged particles traverse *identical* helical paths in a completely opposite sense in a uniform magnetic field $\mathbf{B} = B_0\hat{\mathbf{k}}$.

(a) They have equal z-components of momenta.
(b) They must have equal charges.
(c) They necessarily represent a particle-antiparticle pair.
(d) The charge to mass ratio satisfy : $\left(\frac{e}{m}\right)_1 + \left(\frac{e}{m}\right)_2 = 0$.

3. A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid, will the current increase or decrease? Explain.

4. Professor C.V Raman surprised his students by suspending freely a tiny light ball in a transparent vacuum chamber by shining a laser beam on it. Which property of EM waves was he exhibiting? Give one more example of this property.

5. A passenger in an aeroplane shall

(a) never see a rainbow.
(b) may see a primary and a secondary rainbow as concentric circles.
(c) may see a primary and a secondary rainbow as concentric arcs.
(d) shall never see a secondary rainbow.

6. What is the shape of the wavefront on earth for sunlight?

7. An electron (mass m) with an initial velocity $\mathbf{v} = v_0\hat{\mathbf{i}}\,(v_0 > 0)$ is in an electric field $\mathbf{E} = -E_0\hat{\mathbf{i}}(E_0 = \text{constant} > 0)$. It's de Broglie wavelength at time t is given by

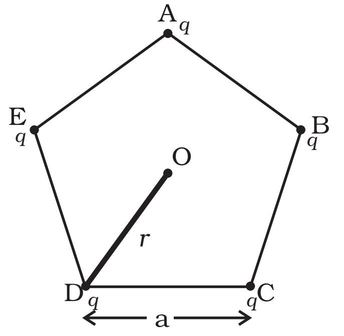
(a) $\dfrac{\lambda_0}{\left(1+\dfrac{eE_0}{m}\dfrac{t}{v_0}\right)}$

(b) $\lambda_0\left(1+\dfrac{eE_0 t}{mv_0}\right)$

(c) λ_0
(d) $\lambda_0 t$.

8. Explain why elemental semiconductors cannot be used to make visible LED's.

9. Five charges, q each are placed at the corners of a regular pentagon of side 'a' as shown.



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

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

10. Two cells of *emf* E_1 and E_2 have internal resistance r_1 and r_2. Deduce an expression for equivalent *emf* of their parallel combination.

11. Draw a circut diagram of a potential divider using a cell and a rheostat. Also mark the output terminals.

12. If magnetic monopoles existed, how would the Gauss's law of magnetism be modified?

13. From molecular viewpoint, discuss the temperature dependence of susceptibility for diamagnetism, paramagnetism and ferromagnetism.

14. A lamp is connected in series with a capacitor. Predict your observations for dc and ac connections. What happens in each case if the capacitance of the capacitor is reduced?

15. A plane electromagnetic wave of frequency 25 MHz travels in free space along the x-direction. At a particular point in space and time. $\mathbf{E} = 6.3\,\hat{\mathbf{j}}$ V/m. What is $\mathbf{B}$ at this point?

16. Define power of a lens. Show that it is inversaly proportional to the focal length of the lens.

17. Two slits are made one millimetre apart and the screen is placed one metre away. What is the fringe separation when blue-green light of wavelength 500 nm is used?

18. A message signal of frequency 10 kHz and peak voltage of 10 volts is used to modulate a carrier of frequency 1 MHz and peak voltage of 20 volts. Determine (a) modulation index, and (b) the side bands produced.

19. Draw a curcuit for determining internal resistance of a cell using a potentiometer. Explain the principle on which this method is based.

20. What do you mean by diamagnetism, paramagnetism and ferromagnetism?

21. For the same objective, find the ratio of the least separation between two points to be distinguished by a microscope for light of 5000 Å and electrons accelerated through 100V used as the illuminating substance.

22. Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2.0×10^{-3} W. (i) What is the energy of a photon in the light beam? (ii) How many photons per second, on an average, are emitted by the source?

23. State Bohr's postulate for the 'permitted orbits' for electrons in a hydrogen atom. How this postulate was explained by de Broglie?

24. Explain a beta decay process with an example. Tritium has a half life of 12.5y undergoing beta decay. What fraction of a sample of pure tritium will remain undecayed after 25 y?

25. What is rectification? With the help of a labelled circuit diagram, explain full wave rectification using junction diode.

26. Explain briefly, with the help of a circuit diagram, how *V-I* characteristics of a p-n junction diode are obtained in (i) forward bias, and (ii) reverse bias. Draw the shapes of the curves obtained.

27. (i) Draw a block diagram of a communication system.

    (ii) What is meant by 'detection' of amplitude modulated wave? Describe briefly the essential steps for detection.

28. Derive an expression for potential due to a dipole for distances large compared to the size of the dipole. How is the potential due to a dipole different from that due to a single charge?

OR

Obtain an expression for potential energy of a system of two charges in an external field.

A system consisting of two chargs 7μ C and –2 μC are placed at (-9 cm, 0,0) and (9 cm,0,0) respectively in an external electric field $E = A\,(1/r^2)$ where $A = 9 \times 10^5$ C m². Calulate the potential energy of this system.

29. Define 'self inductance' of a coil. Obtain an expnession for self inductance of a long solenoid of cross sectional area *A*, length *l* having *n* turns for unit length. Prove that self inductance is the analogue of mass in mechanics.

OR

Define 'mutual inductance' of to coil. On what factors it depends?

Two concentric circular coils, one of small radius r_1 and the other of large radius r_2, such that $r_1 << r_2$, are placed co-axially with centres coinciding. Obtain the mutual inductance of the arrangement.

30. Draw a ray diagram to show two refraction of light through a glass prism. Explain with help of a diagram the dependence of angle of deviation on the angle of incidence. Hence obtain the relation for the angle of minimum deviation in terms of angle of prism and refractive index of prism.

OR

(i) Using the relation for refraction at a single spherical refracting surface, derive the lens maker's formula.

(ii) Double convex lenses are to be manufactured from a glass of refraction index 1.55 with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20.0 cm?

SAMPLE PAPER II
SOLUTIONS AND MARKING SCHEME

1. (a) (1)

2. (d) (1)

3. The current will decrease. As the iron core is inserted in the solenoid, the magnetic field increases and the flux increases. Lent's law implies that induced e.m.f. should resist this increase, which can be achieved by a decrease in current. (1)

4. EM waves exert radiation pressure. Tails of comets are due to solar solar radiation. (1/2, 1/2)

5. (b) (1)

6. Spherical with huge radius as compared to the earth's radius so that it is almost a plane. (1/2, 1/2)

7. (a) (1)

8. Elemental semiconductor's band-gap is such that emissions are in infra-red region. (1/2, 1/2)

9. (i) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ along **OA** (1)

   (ii) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{r^2}$ along **OA** (1)

10. $I = I_1 + I_2$ (1/2)

$$= \frac{E_1 - V}{r_1} + \frac{E_2 - V}{r_2}$$

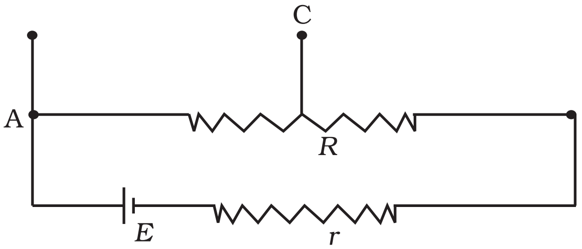
$$I = \left(\frac{E_1}{r_1} + \frac{E_2}{r_2}\right) - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$V = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2} - I\left(\frac{r_1 + r_2}{r_1 + r_2}\right)$$ (1/2)

Comparing with $V = E_{eq} - Ir_{eq}$ (1/2)

We get, $E_{eq} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$ (1/2)

11. Figure shows the desired circuit. The output volage is obtained across. A and C. (1,1)



12. Gauss's law of magnetism states that the flux of **B** through any closed surface is always zero, $\oint \mathbf{B}.d\mathbf{s} = 0$ (1)

If monopole existed, the right hand side would be equal to monopole (magnetic charge, q_m) multiplied by μ_o.

$$\oint \mathbf{B}.d\mathbf{s} = \mu q_m \; .$$ (1)

13. Diamagnetism is due to orbital motion of electrons developing magnetic moments opposite to applied field and hence is not much affected by temperature. (1)

Paramagnetism and ferromagnetism is due to alignments of atomic magnetic moments in the direction of the applied field. As temperature increases, this aligment is disturbed and hence susceptibilities of both decrease as temperature increases. (1)

14. When a dc source is connected to a capacitor, the capacitor gets charged and after charging no current flows in the circuit and the lamp will not glow. There will be no change even if C is reduced. (1)

With ac source, the capacitor offers capacitative reactance ($1/\omega C$) and the current flows in the circuit. Consquently, the lamp will shine. Reducing C will increase reactance and the lamp will shine less brightly than before. (1)

15. The magnitude of **B** is

$$B = \frac{E}{c}$$

$$= \frac{6.3\text{V}/\text{m}}{3\times10^{8}\text{m}/\text{s}} = 2.1\times10^{-8}\text{T}$$ (1)

To find the direction, we note that **E** is along y-direction and the wave propagated along x-axis. Therefore, **B** should be in a direction perpendicular to both x-, and y-axes. Using vector algebra, **E** × **B** should be along x-direction. Since, $(+\hat{\mathbf{j}}) \times (+\hat{\mathbf{k}}) = \hat{\mathbf{i}}$, **B** is along the z-direction.

Thus, $\mathbf{B} = 2.1\times10^{-8}\ \hat{\mathbf{k}}$ T. (1)

16. $P = \tan\delta$ with diagram (1)

$$= h/f = \frac{1}{f}$$

For small δ, $\tan\delta \sim \delta$. $P = 1/f$ (1)

17. Fringe spacing $= \dfrac{D\lambda}{d}$ (1)

$$= \frac{1\times5\times10^{-7}}{1\times10^{-3}}0.5\text{mm}$$ (1)

18. Modulation index = 10/20 = 0.5 (1)

Side bands are at 1010 kHz and 990 kHz. (1)

19. Diagram (1)

$E = \phi\, l_1$ (1/2)

$V = \phi\, l_2 \quad E/V = l_1/l_2$ (1/2)

$E = I\,(r+R)$, $V = IR$

$E/V = (r+R)/R$ (1/2)

$r = R\,\{(l_1/l_2)-1\}$. (1/2)

20. Diamgnetism (1)

Paramagnetism (1)

Ferromagnetism (1)

21. $d_{min} = \dfrac{1.22\lambda}{2\sin\beta}$ (1/2)

where β is the angle subtended by the objective at the object.

For light of 5500 $\mathring{A}$

$$d_{min} = \frac{1.22\times5.5\times10^{-7}}{2\sin\beta}\text{m}$$ (1)

For electrons accelerated through 100V, the deBroglie wavelength is

$$\lambda = \frac{h}{p} = \frac{1.227}{\sqrt{100}} = 0.13\text{nm} = 0.13\times10^{-9}\text{m}$$ (1/2)

$$\therefore d'_{\min} = \frac{1.22\times1.3\times10^{-10}}{2\sin\beta}$$ (1/2)

$$\frac{d_{\min}}{d'_{\min}} = 0.2\times10^{-3}$$ (1/2)

22. (i) Each photon has an energy

$E = h\upsilon = (6.63 \times 10^{-34}\text{ J s})\ (6.0 \times 10^{-14}\text{ Hz})$

$= 3.98 \times 10^{-19}\text{ J}$ (1)

(ii) If N is the number of photons emitted by the source per second, the power P transmitted in the beam equals N times the energy per photon E, so that P = NE. Then

$$N = \frac{P}{E}$$ (1)

$$= \frac{2.0\times10^{-3}\text{W}}{3.98\times10^{-19}\text{J}} = 5.0\times 10^{15}\text{ photons per second.}$$ (1)

23. Postutate (1)

de Broglie explanation (2)

24. Explanation (1)

Example (1)

Answer : 1/4 of sample (1)

25. Rectification (1/2)

Labelled diagram (1/2)

Explanation (2)

26. Circuit diagram for obtaining characteristic curves (1)

Explanation (1)

	Shape of corves	(1)
27.	(i) Block diagram of communication system	(1)
	(ii) Block diagram of a detector	(1)
	Explanation	(1)
28.	Derivation	(4)
	Difference	(1)
	OR	
	Derivation	(3)
	Numerical	(2)
29.	Definition	(1)
	Derivation of expression	(2)
	Proof	(2)
	OR	
	Definition of mutual inductance	(1)
	Dependence on factors	(1)
	Numerical	(3)
30.	Labelled diagram	(1)
	Diagram of δ versus e	(1)
	Derivation $\delta_m = (\mu\text{-}1)A$	(3)
	OR	
	(i) Derivation	(3)
	(ii) $\mu = 1.55$, $R_1 = R$	(1/2)
	$R_2 = -R$, $f = 20$ cm.	
	$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	(1/2)
	$\frac{1}{20} = (1.55 - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{1.10}{R}$	(1/2)
	$R = 20 \times 1.1 = 22$ cm.	(1/2)