

Series: SSO/1

Code No. **55/1/2**

Roll No.

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Candidates must write the Code No. on the title page of the answer-book.

- Please check that this question paper contains **15** printed pages maps.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **30** questions.
- **Please write down the serial number of the question before attempting it.**
- 15 minutes time has been allotted to read this question paper. The question paper will be distributed a 10.15 a. From 10.15 a.m. to 10.30 a.m. the student will read the question paper only and will not write any answer on the answer script during this period.

PHYSICS (Theory)

Time allowed: 3 hours]

[Maximum marks: 70

General Instruction:

- (i) **All** questions are compulsory.
- (ii) There are **30** questions in total. Questions **1** to **8** carry **one** marks 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.
- (iii) There is no overall choice. However, an internal choice has been provided in **one** question of **two** marks; one question of **three** marks and all **three** questions of **five** marks each. You have to attempt only **one** of the choices in such questions.
- (iv) Use of calculator's is **not** permitted.
- (v) You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$h = 6.626 \times 10^{-34} \text{ Js}$$

$$e = 1.602 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ TmA}^{-1}$$

$$\frac{1}{4\pi\epsilon_0} 9 \times 10^9 \text{ Nm}^2\text{C}^{-2}$$

Mass of electron $m_e = 9.1 \times 10^{-31} \text{ kg}$

Mass of neutron $m_n = 1.675 \times 10^{-27} \text{ kg}$

Boltzmann's constant $k = 1.381 \times 10^{-23} \text{ JK}^{-1}$

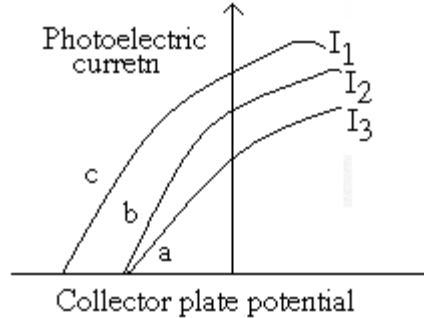
Avogadro's number $N_A = 6.022 \times 10^{23} / \text{mol}^{-1}$

Radius of earth = 6400 km

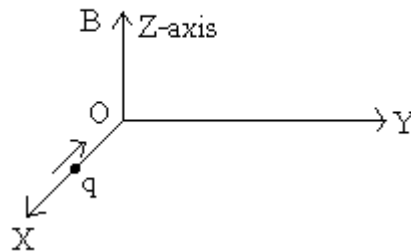
- Q1. Name the electromagnetic radiation to which waves of wavelength in the range of 10-2 m belong. Give on use of this part of EM spectrum. [1]
- Q2. What is ground wave propagation? [1]
- Q3. You are given following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct an astronomical telescope? [1]

Lenses	Power (P)	Aperture (A)
L1	3D	8 cm
L2	6D	1 cm
L3	10D	1 cm

- Q4. Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why? [1]
- Q5. Unpolarized light is incident on a plane surface of glass of refractive index μ at angle i . If the reflected light gets totally polarized, write the relation between the angle i and refractive index μ . [1]
- Q6. Draw a diagram to show refraction of a plane wave front incident in a convex lens and hence draw the refracted wave front. [1]
- Q7. the figure shows a plot of three curves a, b, c showing the variation of photocurrent vs collector plate potential for three different intensities I_1 , I_2 and I_3 having frequencies ν_1 , ν_2 and ν_3 respectively incident on a photosensitive surface. Point out the two curves of which the incident radiations have same frequency but different intensities. [1]



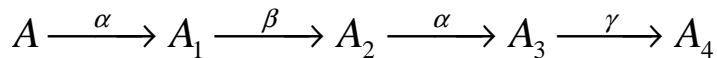
- Q8. Two nuclei have mass numbers in the ratio 1:3. What is the ratio of their nuclear densities? [1]
- Q9 (i) can two equi – potential surfaces intersect each other? Give reasons. [2]
- (ii) Two charges $-q$ and $+q$ are located at points A $(0, 0, -a)$ and B $(0, 0, +a)$ respectively. How much work is done in moving a test charge from point P $(7, 0, 0)$ to Q $(-3, 0, 0)$?
- Q10. A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing the variation of terminal potential 'V' with Resistance R. [2]
- Q11. The output of a 2 – input AND gate is fed to a NOT gate. Give the name of the combination and its logic symbol. Write down its truth table. [2]
- Q12. A charge 'q' moving along the X-axis with a velocity \vec{v} is subjected to a uniform magnetic field B acting along the Z-axis as it crosses the origin O. [2]



- (i) Trace its trajectory.
- (ii) Does the charge gain kinetic energy as it enters the magnetic field? Justify your answer.
- Q13. How does a charge q oscillating at certain frequency produce electromagnetic waves? [2]
 Sketch a schematic diagram depicting electric and magnetic field for an electromagnetic wave propagating along the Z-direction.
- Q14. Derive an expression for drift velocity of the free electrons in a conductor in terms of relaxation time. [2]

Q15. By what percentage will the transmission range of a TV tower be affected when the height of tower is increased by 21%? [2]

Q16. A radioactive nucleus 'A' undergoes a series of decays according to the following scheme: [2]



The mass number and atomic number of A4 are 172 and 69 respectively. What are these numbers for A?

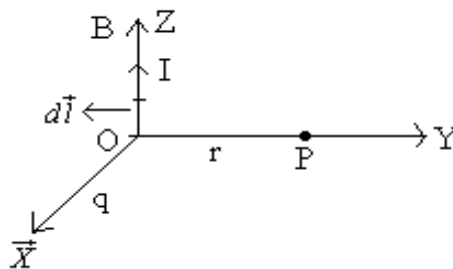
Q17. Why is high frequency carrier waves used for transmission? [2]

OR

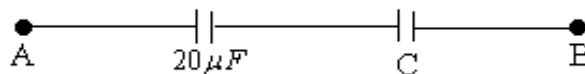
What is meant by term 'modulation'? Draw a block diagram of a simple modulator for obtaining an AM signal.

Q18. State Biot-Savart law. [2]

A current I flows in a conductor placed perpendicular to the plane of the paper. Indicate the direction of the magnetic field due to a small element $d\vec{l}$ at point P situated at a distance \vec{r} from the element as shown in the figure.



Q19. The equivalent capacitance of the combination between A and B in the given figure is $4\mu\text{F}$. [3]



- Calculate capacitance of the capacitor C.
- Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B.
- What will be the potential drop across each capacitor?

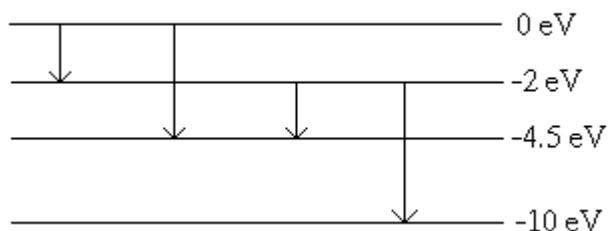
Q20. State Gauss's law in electrostatics. Using this law derive an expression for the electric field due to a uniformly charged infinite plane sheet. [3]

Q21. In a single slit diffraction experiment, when a tiny circular obstacle is placed in the path of light from distant source, a bright spot is seen at the centre of the shadow of the obstacle. Explain why? [3]

State two points of difference between the interference patterns obtained in Young's double slit experiment and the diffraction pattern due to a single slit.

Q22. An electron and a proton are accelerated through the potential. Which one of the two has (i) greater value of de-Broglie wavelength associated with it and (ii) less momentum? Justify your answer. [3]

Q23. (a) The energy levels of an atom are as shown below. Which of them will result in the transition of a photon of wavelength 275 nm? [3]



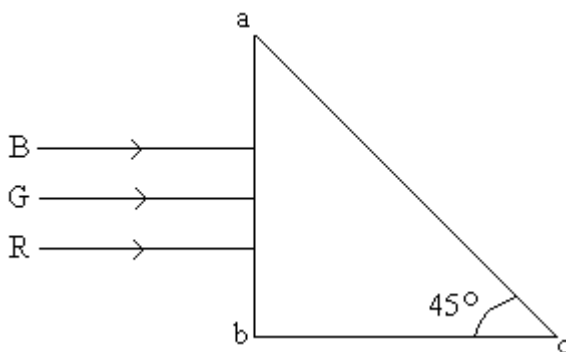
(b) Which transition corresponds to emission of radiation of maximum wavelength?

Q24. Derive the expression for force per unit length between two long straight parallel current carrying conductors. Hence define one ampere. [3]

OR

Explain the principle and working of a cyclotron with the help of a schematic diagram. Write the expression for cyclotron frequency.

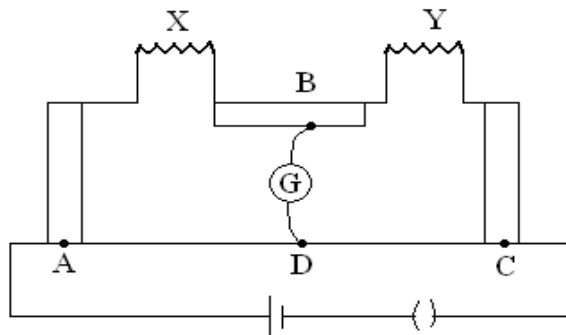
Q25. Three light rays red (R), green (G) and blue (B) are incident on a right angled prism 'abc' at face 'ab'. The refractive indices of the material of the prism for red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. Out of the three which colour ray will emerge out of face 'ac'? Justify your answer. Trace the path of these rays after passing through face 'ab'. [3]



Q26. (a) Define self inductance. Write its S.I. units.

(b) Derive an expression for self inductance of a long solenoid of length l , cross-sectional area A having N number of turns.

Q27.



The figure shows experimental set up of a bridge. When the two unknown resistances X and Y are inserted, the null point D is obtained 40 cm from the end A . when a resistance of 10 is connected in series with X , the null point shifts by 10 cm. find the position of the null point when the 10 resistance is instead connected in series with resistance ' Y '. Determine the values of the resistances X and Y . [3]

Q28. (i) Draw a circuit diagram to study the input and output characteristics of an $n - p - n$ transistor in its common emitter configuration. Draw the typical input and output characteristics. [5]

(ii) Explain, with the help of a circuit diagram, the working of $n - p - n$ transistor as a common emitter amplifier.

OR

How is a zener diode fabricated so as to make it a special purpose diode? Draw $I - V$ characteristics for zener diode and explain the significance of breakdown voltage. Explain briefly, with the help of a circuit diagram, how a $p - n$ junction diode works as a half wave rectifier.

Q29. (a) Derive an expression for the average power consumed in a series LCR circuit connected to a.c. source, in which the phase difference between the voltage and the current in the circuit is ϕ .

(b) Define the quality factor in an a.c. circuit. Why should the quality factor have high value in receiving circuits? Name the factors on which it depends.

OR

(a) Derive the relationship between the peak and the rms value of current in an a.c. circuit.

(b) Describe briefly, with the help of a labeled diagram, working of a step – up

A step – up transformer converts a low voltage into high voltage. Does it not violate the principle of conservation of energy? Explain.

Q30. Trace the rays of light showing the formation of an image due to a point object placed on the axis of a spherical surface separating the two media of refractive indices n_1 and n_2 . Establish the relation between the distances of the object, the image and the radius of curvature from the central point the spherical surface.

Hence derive the expression of lens maker's formula. [5]

OR

Draw the labeled ray diagram for the formation of image by a compound microscope.

Derive the expression for the total magnification of a compound microscope. Explain why both the objective and the eyepieces of a compound microscope must have short focal lengths.