PHYSICS
PAPER – 1
(THEORY)
(Three hours)

*(Candidates are allowed additional 15 minutes for **only** reading the paper.*
They must NOT start writing during this time.)

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*Answer **all** questions in **Part I** and **ten questions** from **Part II**, choosing **four** questions*
*from **Section A, three questions from Section B** and **three questions from Section C**.*
All working, including rough work, should be done on the same sheet as, and adjacent to,
the rest of the answer.
The intended marks for questions or parts of questions are given in brackets [ ].
(Material to be supplied: Log tables including Trigonometric functions)
A list of useful physical constants is given at the end of this paper.

PART I (20 Marks)
*Answer **all** questions.*

Question 1

A. Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below:　　　　**[5]**

(i)　　Two point charges 17.7 µC and -17.7 µC, separated by a very small distance, are kept inside a large hollow metallic sphere. Electric flux emanating through the sphere is:

(a)　2×10^6 Vm

(b)　-2×10^6 Vm

(c)　Zero

(d)　4×10^6 Vm

(ii)　　Ohm's law, in vector form is:

(a)　$J = \rho E$

(b)　$J = \sigma E$

(c)　$V = IR$

(d)　$E = \sigma J$

(iii)　If the current (I) flowing through a circular coil, its radius (R) and number of turns (N) in it are each doubled, magnetic flux density at its centre becomes:

(a)　Two times

(b)　Four times

(c)　Eight times

(d)　Sixteen times

(iv) A person is suffering from the defect of myopia. His far point will be:

  (a) Infinity

  (b) 25 cm

  (c) < 25 cm

  (d) About a metre

(v) Ratio of the radius of third Bohr orbit to the radius of second Bohr orbit in hydrogen atom is:

  (a) 2:3

  (b) 4:9

  (c) 9:4

  (d) 3:2

B. Answer **all** questions given below briefly and to the point: **[15]**

  (i) A dielectric slab of relative premittivity (i.e. dielectric constant) 6 is introduced between the two plates of an $8\,\mu F$ air capacitor, in order to completely occupy the space between the two plates. Find the new capacitance of the capacitor.

  (ii) Show graphically how resistance of a piece of carbon varies with temperature.

  (iii) Current 'I' flowing through a metallic wire of area of cross-section 'a' is given by the equation $I = nae v_d$. What is the meaning of the symbols 'n' and 'v_d'?

  (iv) You are provided with four identical cells each of emf 1.5V. How will you connect all of them to obtain a battery of emf 3V?

  (v) What is the value of magnetic field around a current carrying torroid?

  (vi) What type of wave front is associated with a line source of light?

  (vii) Calculate the polarizing angle for glass whose refractive index is 1.6.

  (viii) What is the optical power in dioptre of a concave lens of focal length 50 cm?

  (ix) What is meant by *resolving power* of a telescope?

  (x) What is the angle made by a refracted ray with the normal inside a regular (equilateral) prism, in minimum deviation case?

  (xi) Name the *series* of lines in the hydrogen spectrum which lie in the *infrared* region.

  (xii) What are *isotones*?

  (xiii) Explain the statement: *Half-life of polonium is 3.8 days*.

  (xiv) In a nuclear reactor, what is the function of graphite rods?

  (xv) What is *amplitude modulation*?

*Answer **ten** questions in this part, choosing **four** questions*

*from **Section A, three** questions from **Section B** and **three** questions from **Section C**.*

SECTION A
*Answer any **four** questions.*

Question 2

(a) Obtain an expression for intensity of electric field at a point in axial position of an electric dipole. **[3]**

(b) Calculate electrostatic potential energy stored in a system consisting of two point charges 100μC and 40μC separated by a distance of 9cm, in vacuum. **[2]**

Question 3

(a) Two plates of a charged parallel plate capacitor are pulled apart with the help of insulating handles, till their separation is doubled. **[3]**

Compare the new electrostatic potential energy of the capacitor with the old.

(b) Draw a labelled diagram of a potentiometer circuit used to measure internal resistance of a cell. **[2]**

Question 4

In *Figure 1* below, power developed in resistor R_1 is 120W. Find the power developed in resistor R_3. **[3]**
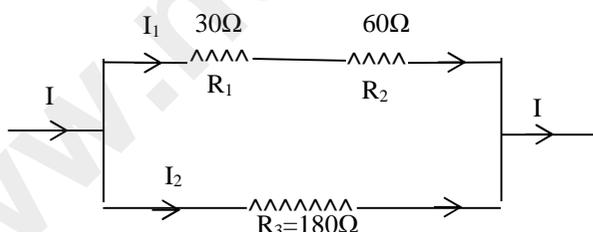

Figure 1

In a metre bridge experiment to determine unknown resistance of a coil, how is position of the null point affected if: **[2]**

(i) Galvanometer and cell are interchanged?

(ii) Known and unknown resistances are interchanged?

Question 5

(a) Apply Kirchoff's Laws to calculate the currents I_1 and I_2 in the circuit shown in *Figure 2* below: **[3]**
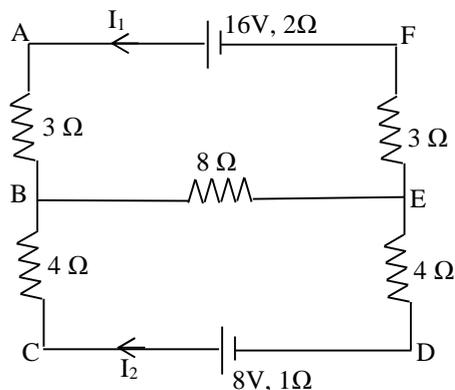

Figure 2

(b) You are given a bar. How will you identify experimentally whether it is made of a ferro-magnetic, paramagnetic or a diamagnetic material? **[2]**
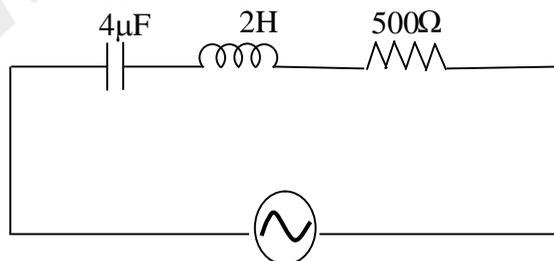
Question 6

(a) Using Ampere's Circuital Law and with the help of a labelled diagram, show that magnetic flux density 'B' at a distance r from a long straight conductor is given by: **[3]**

$$B = \frac{\mu_o I}{2\pi r}$$, where the terms have their usual meaning.

(b) Define *time constant* of an RC circuit. What is its **SI** unit? **[2]**

Question 7

(a) (i) In the circuit shown in *Figure 3* below, calculate phase difference between the current and the supply voltage: **[4]**

$\varepsilon = 300 \sin (500t)$
Figure 3

(ii) State whether current is leading or lagging behind the supply voltage

(b) What is meant by *quality factor* of an LCR circuit? **[1]**

Question 8

(a) Prove the law of reflection of light on the basis of Huygens wave theory of light. **[4]**

(b) Why can't two independent monochromatic sources of light emitting light of one and the same wavelength behave as coherent sources? **[1]**

Question 9

(a) In Young's double slit experiment, using light of wavelength 600 nm, 10th bright fringe is obtained on a screen, 3mm from the centre of the pattern. If the screen is 120 cm away from the slits, calculate: **[3]**

   (i) Distance between the two slits;

   (ii) Fringe width, i.e. fringe separation.

(b) Show graphically how intensity of light varies in Fraunhofer diffraction. **[2]**

Question 10

(a) An optical system consists of a thin convex lens '**L**' of focal length f = 15 cm and a convex mirror **M** having radius of curvature **R**=36 cm, arranged co-axially, at a distance of 24 cm. (See *Figure 4* below). **[3]**

   Where should an object **O** be kept so that its inverted image **I** formed by the lens mirror combination coincides with the object itself?
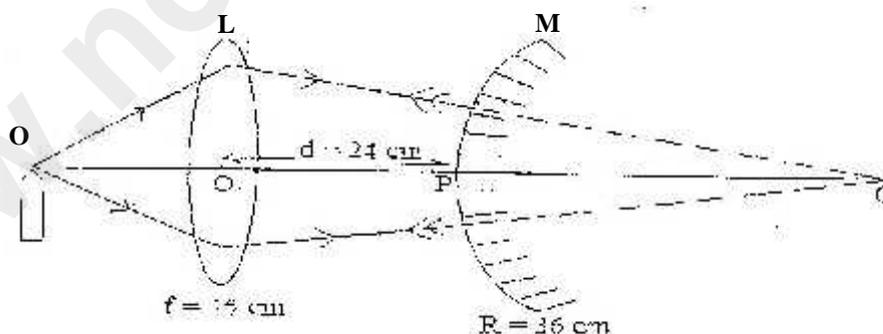

Figure 4

(b) A narrow and parallel beam of white light is incident on a convex lens, parallel to its principal axis. Draw a labelled diagram to show how coloured images are formed by the lens. **[2]**

Question 11

(a) Find the distance between the two lenses of a compound microscope if the final image formed by the microscope is virtual and lies at a distance of 25cm to the left of the eyepiece. Magnifying power of the microscope is 30 and focal lengths of objective and eyepiece are 2cm and 5cm, respectively. **[4]**

(b) You are provided with two convex lenses having focal lengths 4cm and 80cm, respectively, to form an astronomical telescope. **[1]**

Calculate its magnifying power for normal adjustment.

SECTION C

*Answer any **three** questions.*

Question 12

(a) (i) Explain the statement: "*Work function of a certain metal is 2.0 eV.*" **[3]**

(ii) Calculate the maximum wavelength of the electro-magnetic radiation which will cause emission of photoelectrons from this metal.

(b) What is *de Broglie hypothesis*? What conclusion can be drawn from *Davisson and Germer's* experiment? **[2]**

Question 13

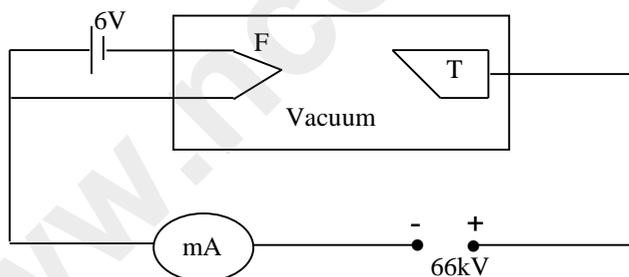(a) *Figure 5* below shows a simple diagram of a modern X ray tube. (i.e. Coolidge tube). **[3]**

Figure 5

(i) Find the *minimum* wavelength of the X rays emitted by the X ray tube.

(ii) What will be the effect of replacing the 6V battery with a 9V battery on the emitted X rays?

(b) What is meant by *mass defect* of a nucleus? How is it related to its binding energy? **[2]**

Question 14

(a) Starting with the Law of Radioactive Disintegration, show that: **[3]**

$N = N_o e^{-\lambda t}$, where the terms have their usual meaning.

(b) Calculate the energy released in the following nuclear reaction: **[2]**

$^2_1H + ^2_1H = ^4_2He$

Mass of $^2_1H = 2.01419u$, Mass of $^4_2He = 4.00277\ u$

Question 15

(a) Draw a labelled circuit diagram of a transistor as a switch and draw its input and output graphs. **[3]**

(b) What is the symbol of a NOR gate? Write its truth table. **[2]**

Useful Constants and Relations:

1.	Planck's constant	(h)	$= 6.6 \times 10^{-34}$ Js
2.	Speed of Light in vacuum	(c)	$= 3.0 \times 10^8$ ms^{-1}
3.	Charge of a proton	(e)	$= 1.6 \times 10^{-19}$ C
4.	Mass of an electron	m_e	$= 9.1 \times 10^{-31}$ kg
5.	Permittivity of free space	$\in_o$	$= 8.85 \times 10^{-12}$ Fm^{-1}
6.	Constant for Coulomb's Law	$\dfrac{1}{4\pi\varepsilon_0}$	$= 9 \times 10^9$ mF^{-1}
7.	One electron volt	leV	$= 1.6 \times 10^{-19}$ J
8.	Unified atomic mass unit	lu	$= 931$ MeV