Roll Number		

SET A

INDIAN SCHOOL MUSCAT
FIRST PRE-BOARD EXAMINATION
PHYSICS

CLASS: XII | Sub. Code: 042 | Time Allotted: 3 Hrs.

22.02.2021 | Max. Marks: 70

General Instructions:

- All questions are compulsory. There are 33 questions in all.
- This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
- Section A contains ten very short answer questions (Q-1 to Q-10) and four assertion reasoning MCQs (Q-11 to Q-14) of 1 mark each.
- Section B has two case-based questions (Q-15 to Q-16) of 4 marks each.
- Section C contains nine short answer questions (Q-17 to Q-25) of 2 marks each.
- Section D contains five short answer questions (Q-26 to Q-30) of 3 marks each.
- Section E contains three long answer questions (Q-30 to Q-33) of 5 marks each.
- There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

Charge of an electron, e = 1.6×10^{-19} C; $h = 6.63 \times 10^{-34} Js$; $1eV = 1.6 \times 10^{-19} J$

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

SECTION – A

(All questions are compulsory (1mark each). In case of internal choices, attempt any one of them.)

1 Write a relation for polarization $\vec{P}$ of a dielectric material in the presence of an external electric field $\vec{E}$. 1

2 Write the expression for the Lorentz magnetic force $\vec{F}$ du e to a charge moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$ in vector form. What is the direction of the magnetic force? 1

OR

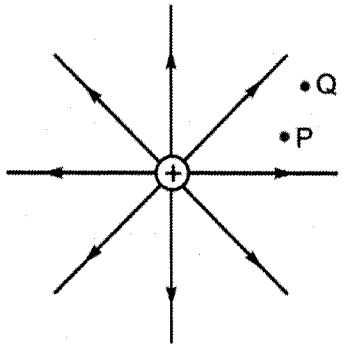
Where on the earth's surface is the value of vertical component of earth's magnetic field zero?

3 Write the expression for the Lorentz magnetic force $\vec{F}$ due to a charge moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$ in vector form. What is the direction of the magnetic force? 1

OR

Where on the earth's surface is the value of vertical component of earth's magnetic field zero?

4 The figure shows the field lines of a positive point charge. What will be the sign of the potential energy difference of a small negative charge between the points Q and P? Justify your answer. 1



5 A solenoid with **N** loops of wire tightly wrapped around an iron-core is carrying an electric current **I.** If the current through this solenoid is reduced to half, then what change would you expect in inductance **L** of the solenoid? 1

OR

An instantaneous current from an ac source is given by $I = 6 \sin 314t$. What is the rms value of current?

6 Name the electromagnetic radiations used for (a) water purification and (b) taking photographs during foggy conditions also. 1

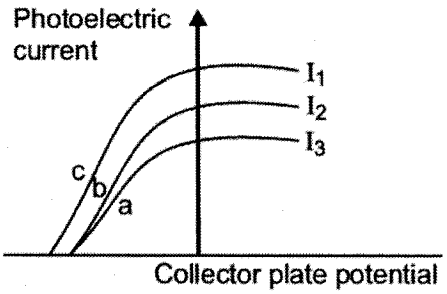
7 Why are infra-red radiations referred to as heat waves? 1

OR

The frequency of oscillation of the electric field vector of a certain electromagnetic wave is 5×10^{14} Hz. What is the frequency of oscillation of the corresponding magnetic field vector? Which part of the electromagnetic spectrum does it belong?

8 A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. What is the nature of the lens? 1

9 The figure shows a plot of three curves *a, b, c* showing the variation of photocurrent versus collector plate potential for three different intensities I_1 , I_2 and I_3 having frequencies υ_1 , υ_2 and υ_3 respectively incident on a photosensitive surface. Point out the two curves for which the incident radiations have same frequency but different intensities. 1



OR

The stopping potential in an experiment on photoelectric effect is 2 V. What is the maximum kinetic energy of the photoelectrons emitted? Express it in Joule.

10 How does the depletion region of a p-n junction diode get affected under reverse bias? 1

For question numbers 11, 12, 13 and 14, (1 mark each) two statements are given-one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true but R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

11 **Assertion :** Electron has higher mobility than hole in a semiconductor. 1
Reason : Mass of electron is less than mass of hole.

12 **Assertion:** Increasing the current sensitivity of a galvanometer necessarily increases the voltage sensitivity. 1
Reason: Voltage sensitivity is inversely proportional to current sensitivity.

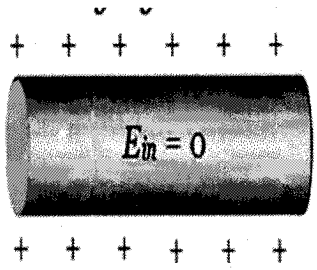
13 **Assertion:** The positively charged nucleus of an atom has a radius of almost 10^{-15}m. 1
Reason: In α-particle scattering experiment, the distance of closest approach for α-particles is $\approx 10^{-15}$m.

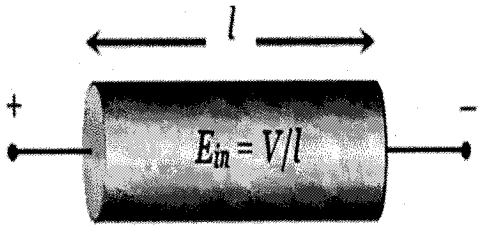
14 **Assertion:** A p-n junction with reverse bias can be used as a photo-diode to measure light intensity. 1
Reason: In reverse bias condition even though the current is small it is more sensitive to change in incident light intensity.

SECTION - B

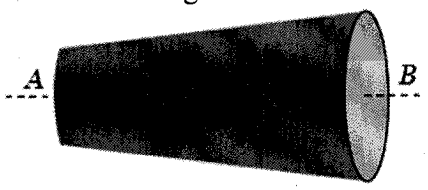
Questions 15 and 16 are case study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15 Human body, though has a large resistance of the order of k Ω (say 10 k Ω), is very sensitive to minute currents even as low as a few m A. Electrocution, excites and disorders the nervous system of the body and hence one fails to control the activity of the body. Direct current flows uniformly throughout the cross-section of conductor while alternating current mainly flows through the outer surface area of the conductor. This is known as skin effect. It is worth noting that electric field inside a charged conductor is zero, but it is non zero inside a current carrying conductor and is given by E= V/*l* where V = potential difference across the conductor and *l* = length of the conductor.
The small value of drift velocity produces a large amount of electric current, due to the presence of extremely large number of free electrons in a conductor. The propagation of current is almost at the speed of light and involves electromagnetic process. It is due to this reason that the electric bulb glows immediately when switch is on. In the absence of electric field, the paths of electrons between successive collisions are straight line while in presence of electric field the paths are generally curved.





(i) A wire has a non-uniform cross-sectional area as shown in figure. A steady current i flows through it. Which one of the following statement is correct?



(a) The drift speed of electron is constant
(b) The drift speed increases on moving from A to B
(c) The drift speed decreases on moving from A to B
(d) The drift speed varies randomly

(ii) In a wire of circular cross-section with radius r, free electrons travel with a drift velocity v, when a current i flows through the wire. What is the current in another wire of half the radius and of the same material when the drift velocity is $2v$?

(a) $2i$ (b) i (c) $i/2$ (d) $i/4$

(iii) A potential difference of V is applied at the ends of a copper wire of length l and diameter d. On doubling only d, drift velocity

(a) Becomes two times (b) Becomes half
(c) Does not change (d) Becomes one fourth

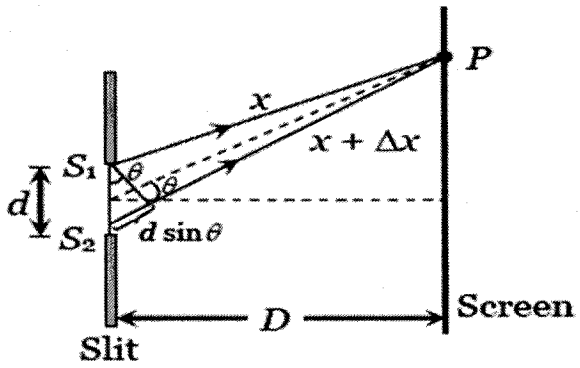
(iv) Two wires A and B of the same material, having radii in the ratio 1 : 2 and carry currents in the ratio 4: 1. The ratio of drift speeds of electrons in A and B is

(a) 16 : 1 (b) 1 : 16 (c) 1 : 4 (d) 4 : 1

(v) Number of electrons crossing a cross section of a conductor per second to constitute 1 ampere current are

(a) 6.25×10^{19} (b) 6.25×10^{18} (c) 6.25×10^{20} (d) 6.25

16 Diffraction is the phenomenon of bending of light around the corners of an obstacle/aperture of the size of the wavelength of light. Diffraction is the characteristic of all types of waves.Greater the wavelength of wave, higher will be it's degree of diffraction. Experimental study of diffraction was extended by Newton as well as Young. Most systematic study was carried out by Huygens on the basis of wave theory. In case of diffraction at a single slit, we get a central bright band with alternate bright (maxima) and dark (minima) bands of decreasing intensity.



(i) A single slit diffraction pattern is obtained using a beam of red light. What happens if the red light is replaced by the blue light?

(a) There is no change in diffraction pattern
(b) Diffraction fringes become narrower and crowded
(d) Diffraction fringes become broader and farther apart
(d) The diffraction pattern disappear

(ii) To observe diffraction, the size of the obstacle

(a) should be X/2, where X is the wavelength.
(b) should be of the order of wavelength.
(c) has no relation to wavelength.
(d) should be much larger than the wavelength.

(iii) If the width of the slit in single slit diffraction experiment is doubled, then the central maximum of diffraction pattern becomes

(a) broader and brighter
(b) sharper and brighter
(c) sharper and fainter
(d) broader and fainter.

(iv) Two students are separated by a 5m partition wall in a room 10 m high. If both light and sound waves can bend around obstacles, we find that the students are unable to see each other even though they can converse easily. It is due to

(a) Diffraction of sound
(b) Diffraction of light
(c) Diffraction of both sound and light
(d) Interference of light

(v) If a tiny obstacle is placed in the path of light from a distant source, a bright spot is seen. It is due to the wave diffracted from the edge of circular obstacle

(a) interfere constructively at the centre of the shadow
(b) interfere destructively at the centre of the shadow
(c) only due to diffracted beam
(d) only due to interference of light

SECTION – C

All questions are compulsory (2 marks each). In case of internal choices, attempt anyone.

17 Obtain the expression for the energy stored in a capacitor connected across a battery. Hence define energy density of the capacitor. 2

OR

Derive the expression for the torque acting on an electric dipole, when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field, in which it attains a stable equilibrium.

18 (i) In what respect is a toroid different from a solenoid? 2
(ii) How is the magnetic field inside a given solenoid made strong?

19 Define the following using suitable diagram: 2
(i) magnetic declination and (ii) angle of dip.

OR

Horizontal component of earth's magnetic field at a place is $1/\sqrt{3}$ times the vertical component. What is the value of inclination at that place?

20 An electric lamp connected in series with a capacitor and an ac source is glowing with a certain brightness. How does the brightness of the lamp change on reducing the (i) capacitance and (ii) frequency? 2

21 Which segment of electromagnetic waves has highest frequency? How are these waves produced? Give one use of these waves. Which electromagnetic waves lie near the high frequency end of visible part of electromagnetic spectrum? 2

22 Draw a labelled ray diagram of a reflecting type telescope. 2

23 The radii of curvature of both the surfaces of a lens are equal. If one of the surfaces is made plane by grinding, then by what factor will the focal length of lens change? What change will occur for the power? 2

24 Give two advantages of a light emitting diode over conventional incandescent lamps. 2

OR

Give any two differences between intrinsic and extrinsic semiconductors.

25 Draw energy band diagrams of an n-type and p-type semiconductor at temperature $T > 0K$. Mark the donor and acceptor energy levels with their energies. 2

SECTION – D

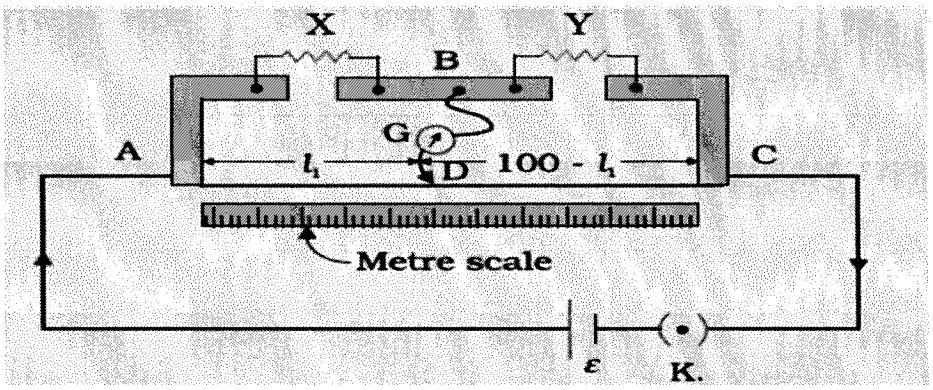
All questions are compulsory (3 marks each). In case of internal choices, attempt anyone

26 (i) State the principle on which potentiometer works. 3
(ii) In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell?
(iii) Draw a graph to show the variation of resistance of a metal wire as a function of its diameter keeping its length and material constant.

OR

(i) State the principle of working of a metre bridge.

(ii) In a meter bridge, the balance point is found to be at 39.5 cm from the end *A*, when the resistor *Y* is of 12.5 Ω. Determine the resistance of *X*.



(iii) Why are the connections between resistors in a Wheatstone or meter bridge made of thick copper strips?

27 (i) Derive the equation for de Broglie wavelength associated with an electron accelerated through a potential of V volt. 3

(ii) The work function of caesium is 2.14eV. Find the threshold frequency of caesium.

OR

(i) Write Einstein's photoelectric equation and state any two experimentally observed features in the phenomenon of photoelectric effect.

(ii) Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2.0×10^{-3} W. Estimate the number of photons emitted per second on an average by the source.

28 (i) Show that the density of nucleus over a wide range of nuclei is constant independent of mass number A. 3

(ii) Distinguish between isotopes and isobars, giving one example for each.

OR

(i) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Indicate the regions in which the nuclear force is (a) attractive and (b) repulsive.

(ii) Write two important conclusions that can be drawn from the graph.

29 Draw a schematic diagram of a step-up transformer. State its working principle. Derive the expression for the secondary to primary voltage in terms of the number of turns in the two coils. 3

30 Using Bohr's postulates, obtain the expressions for kinetic energy and potential energy of the electron in stationary states of the hydrogen atom and thereby prove that the total energy of electron in the stationary states of hydrogen atom is inversely proportional to square of principal quantum number 'n'. 3

SECTION – E

All questions are compulsory (5 marks each). In case of internal choices, attempt anyone.

31 (i) Define mutual inductance and write its S.I. unit. 5

(ii) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other.

(iii) A toroidal solenoid with an air core has an average radius of 15 cm, area of cross-section $12cm^2$ and 1200 turns. Ignoring the field variation across the cross- section of the toroid, calculate the self-inductance of the toroid.

OR

(i) State the principle of an a.c. generator.

(ii) Explain briefly, with the help of labelled diagram, its working and obtain the expression for the emf generated in the coil.

(iii) A long solenoid with 15turns per cm has a small loop of area $2cm^2$placed inside, normal to the axis of the solenoid. If current carried by the solenoid changes steadily from 2 A to 4 A in 0.1 s, what is the induced voltage in the loop, while the current is changing?

32 (i) Define a wave front. 5

(ii) Using Huygens' principle, draw the diagrams to show the nature of the wave fronts when an incident plane wave front gets

(a) reflected from a concave mirror

(b) refracted from a convex lens.

(iii) Draw a diagram showing the propagation of a plane wave front from denser to a rarer medium and verify Snell's law of refraction.

OR

(i) In Young's double slit experiment, derive the conditions for obtaining constructive and destructive interference fringes at a point on the screen.

(ii) Draw the intensity distribution for (a) the fringes produced in interference and (b) the diffraction bands produced due to single slit.

33 (i) Define equipotential surface. Why the electric field at any point on the equipotential surface is directed normal to the surface? 5

(ii) Draw the equipotential surfaces for an electric dipole. Why does the separation between successive equipotential surfaces get wider as the distance from the charges increases?

(iii) Draw 3 equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z- direction.

OR

(i) Show, using Gauss's law, that for a parallel plate capacitor consisting of two large plane parallel conductors having surface charge densities $+\sigma$ and $-\sigma$, separated by a small distance in vacuum, the electric field.

(a) in the outer regions of both the plates is zero.

(b) is σ/ε_0 in the inner region between the charged plates.

(ii) Explain what is the effect of inserting a dielectric slab of dielectric constant 'k' in the intervening space inside the plates on

(a) the electric field,

(b) the capacitance of the capacitor.

End of the Question Paper