ARYAN INSTITUTE

SUBJECT : – PHYSICS

CLASS – XII

Test – 1

Maximum Time : 3:00 Hrs. **Maximum Marks – 70**

General Instructions :

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. $\mu_0 = 40\pi \times 10^{-7}$ TmA^{-1} v. $h = 6.063 \times 10^{-34}$ Js vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

   vii. Avogadro's number = 6.023×10^{23} per gram mole

SECTION - A

Q1. Pure silicon at 300 K has equal electron (n_e) and hole (n_h) concentrations of 1.5 10^{16} m^{-3}. Doping by indium increases n_h to 4.5 10^{22} m^{-3}. The n_e in the doped silicon is **[1]**

a) 3×10^{19} m^{-3} b) 9×10^{-5} m^{-3} c) 2.25×10^{11} m^{-3} d) 5×10^{9} m^{-3}

Q2. The dimension of electrical resistance is: **[1]**

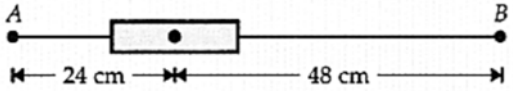
a) $[ML^2T^{-3}A^1]$ b) $[ML^2T^{-3}A^{-2}]$ c) $[ML^3T^{-3}A^{-2}]$ d) $[ML^2T^{-3}A^{-1}]$

Q3. How will the image formed by a convex lens be affected if the central portion of the lens is wrapped in a black paper ? **[1]**

a) No image is formed by the remaining portion of the lens b) Full image will be formed but will be less bright

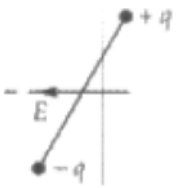
c) Two images will be formed d) Central portion of the image will be absent

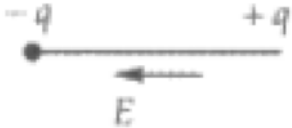
Q4. A bar magnet of length 3 cm has points A and B along its axis at distances of 24 cm and 48 cm on the opposite sides. Ratio of magnetic fields at these points will be **[1]**

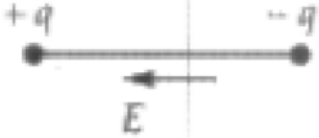


a) $\frac{1}{2\sqrt{2}}$ b) 4 c) 3 d) 8

Q5. In which of the states shown in the figure, is potential energy of an electric dipole maximum ? **[1]**

a) 

b) 

c) 

d) 

Q6. An electron having energy 10 eV is circulating in path of radius 0.105 m having magnetic field of 10^{-4} T. The speed of the electron will be : **[1]**

a) $1.9 \times 10^6\, m/s$ b) $3.8 \times 10^{12}\, m/s$ c) $1.9 \times 10^{12}\, m/s$ d) $3.8 \times 10^6\, m/s$

Q7. Two coils are placed closed to each other. The mutual inductance of the pair of coils depends upon : **[1]**

a) the currents in the two coils b) the rates at which currents are changing in the two coils

c) relative position and orientation of the two coils d) the material of the wires of the coils

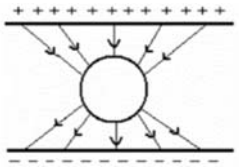
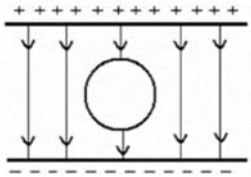
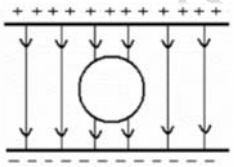
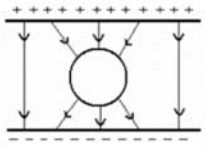
Q8. A closely wound solenoid of 800 turns and area of cross section 2.5×10^{-4} m^{-2} carries a current of 3.0 A. What is its associated magnetic moment ? **[1]**

a) 0.4 J/T b) 0.8 J/T c) 0.6 J/T d) 0.5 J/T

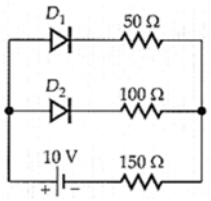
Q9. In Young's double−slit experiment, the intensity of light at a point on the screen where the path difference is λ is k (λ being the wavelength of light used). The intensity at a point where the path difference is $\frac{\lambda}{4}$, will be **[1]**

a) k b) $\frac{k}{4}$ c) $\frac{k}{2}$ d) zero

Q10. An uncharged sphere of metal is placed inside a charged parallel plate capacitor. The lines of force look like **[1]**

a)  b)  c)  d) 

Q11. Assume that each diode shown in the figure has a forward bias resistance of 50 Ω and an infinite reverse bias resistance. The current through the 150 Ω resistance is **[1]**



a) 0.04 A b) zero

c) 0.05 A d) 0.66 A

Q12. A lamp and a screen are set up 100 cm apart and a convex lens is placed between them. The two positions of the lens forming real images on the screen are 40 cm apart. What is the focal length of the lens ? **[1]**

a) 15 cm b) 21 cm c) 18 cm d) 12 cm

Q13. **Assertion (A):** The process of photoelectric emission is different to that of thermionic emission.
Reason (R): The process of thermionic emission is temperature-dependent but photoelectric emission is independent of temperature. **[1]**

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 but R is true.

Q14. **Assertion (A) :** When a capacitor is filled completely with a metallic slab its capacity becomes very large.
Reason (A) : Dielectric constant for metal is zero. **[1]**

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

Q15. **Assertion (A):** Young's double slit experiment can be performed using a source of white light.
Reason (R): The wavelength of red light is less than the wavelength of other colours in white light. **[1]**

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

Q16. **Assertion (A):** If the frequency of the applied AC is doubled, then the power factor of a series R–L circuit decreases.
Reason (R): Power factor of series R-L circuit is given by $\cos \emptyset = \frac{2R}{R^2 + \omega^2 L^2}$ **[1]**

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 but R is true.

SECTION–B

Q17. Identify the electromagnetic waves whose wavelengths lie in the range.
i. 10^{-11} m < λ < 10^{-14} m ii. 10^{-4} m < λ < 10^{-6} m
Write one use of each. **[2]**

Q18. A muon is a particle that has the same charge as an electron but is 200 times heavier than it. It we had an atom in which the muon revolves around a proton instead of an electron, what would be the magnetic moment of the muon in the round state of such an atom ? **[2]**

Q19. Define barrier potential. Why does the thickness of the depletion layer in a p-n junction diode vary with increase in reverse bias ? **[2]**

Q20. Consider two different hydrogen atoms. The electron in each atom is in an excited state possible for the electrons to have different energies, but the same orbital angular momentum according to the Bohr model ? **[2]**

Q21. A coil of N turns and radius R carries a current T. It is unwound and rewound to make a square coil of side a having the same number of turns (N). Keeping the current I same, find the ratio of the magnetic moments of the square coil and the circular coil. **[2]**

OR

Is the force between two parallel current-carrying wires affected by the nature of the dielectric medium between them ?

SECTION – C

Q22. AB, BC, CD and DA are resistors of 1, 1, 2 and 2 Ω respectively connected in series. Between A and C is a 1 volt cell of resistance 2 Ω, A being positive. Between B and D is a 2 V cell of 1 Ω resistance, B being positive. Find the current in each branch of the circuit. **[3]**

Q23. Define the terms **potential barrier** and **depletion region** for a p–n junction diode. State how the thickness of the depletion region will change when p-n junction diode is
i. forward biased and ii. reverse biased **[3]**

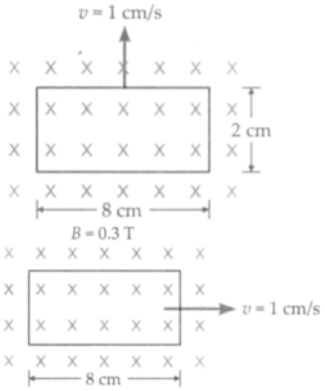
Q24. Draw the graph showing the variation of photoelectric current with anode potential of a photocell for
1. the same frequencies but different intensities $I_3 > I_2 > I_1$ of incident radiation, and
2. the same intensity but different frequencies $\nu_1 > \nu_2 > \nu_3$ of incident radiation. **[3]**

Q25. Plot a graph showing the variation of binding energy per nucleon as a function of mass number. Which property of nuclear force explains the approximate constancy of binding energy in the range 30 < A < 170 ?
How does one explain the release of energy in both processes of nuclear fission and fusion from the graph ? **[3]**

Q26. It is found experimentally that 13.6 eV energy is required to separate a hydrogen atom into a proton and an electron. Compute the orbital radius and the velocity of the electron in a hydrogen atom. **[3]**

Q27. Explain by drawing a suitable diagram that the interference pattern in a double–slit is actually a superposition of single–slit diffraction from each slit.
Write two basic features that distinguish the interference pattern from those seen in a coherently illuminated single slit. **[3]**

Q28. A rectangular loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 tesla directed normal to the loop. What is the voltage developed across the cut if velocity of loop is 1 $cm\ s^{-1}$ in a direction normal to the (i) longer side (ii) shorter side of the loop ? For how long does the induced voltage last in each case ? **[3]**



OR

The current flowing through an inductor of self–inductance L is continuously increasing. Plot a graph showing the variation of :

i. Magnetic flux versus the current

ii. Induced emf versus dI/dt

iii. Magnetic potential energy stored versus the current.

SECTION – D

CASE STUDY BASED QUESTIONS

Q29. Read the text carefully and answer the questions :

Maxwell showed that the speed of an electromagnetic wave depends on the permeability and permittivity of the medium through which it travels. The speed of an electromagnetic wave in free space is given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. The fact led Maxwell to predict that light is an electromagnetic wave. The emergence of the speed of light from purely electromagnetic considerations is the crowning achievement of Maxwell's electromagnetic theory. The speed of an electromagnetic wave in any medium of permeability μ and permittivity ε will be $\frac{c}{\sqrt{K\mu_r}}$ where K is the dielectric constant of the medium and μ_r is the relative permeability.

(i) The dimensions of $\frac{1}{2}\varepsilon_0 E^2$ (ε_0 : permittivity of free space; E = electric field) is

a) MLT^{-1} b) $ML^{-1}T^{-2}$ c) ML^2T^{-2} d) ML^2T^{-1}

(ii) Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of the vacuum. If M = mass, L = length, T = time and A = electric current, then

a) $[\varepsilon_0] = ML^2T^{-1}$ b) $[\varepsilon_0] = MLT^{-2}A^{-2}$ c) $[\varepsilon_0] = M^{-1}L^{-3}T^4A^2$ d) $[\varepsilon_0] = M^{-1}L^{-3}T^2A$

(iii) An electromagnetic wave of frequency 3 MHz passes from vacuum into a dielectric medium with permittivity ε= 4. Then **[4]**

a) wavelength is halved and the frequency remains unchanged.

b) wavelength and frequency both remain unchanged

c) wavelength is doubled and the frequency remains unchanged

d) wavelength is doubled and the frequency becomes half

OR

The electromagnetic waves travel with

a) the speed of light $c = 3 \times 10^8$ m s^{-1} in fluid medium.

b) the speed of light $c = 3 \times 10$ m s^{-1} in solid medium

c) the speed of light $c = 3 \times 10^8$ m s^{-1} in free space

d) the same speed in all media

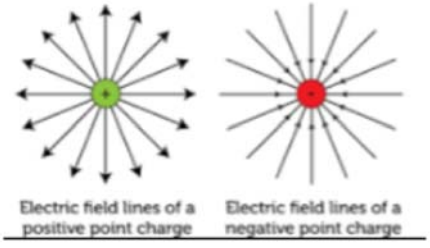
(iv) Which of the following are not electromagnetic waves ?

cosmic rays, γ–rays, β–rays, X–rays

a) β–rays b) X–rays c) γ–rays d) cosmic rays

Q30. Read the text carefully and answer the questions :

A charge is a property associated with the matter due to which it experiences and produces an electric and magnetic field. Charges are scalar in nature and they add up like real numbers. Also, the total charge of an isolated system is always conserved. When the objects rub against each other charges acquired by them must be equal and opposite. **[4]**



(i) The cause of charging is :

a) none of these b) the actual transfer of protons

c) the actual transfer of electrons d) the actual transfer of neutrons

(ii) Pick the correct statement.

i. The glass rod gives protons to silk when they are rubbed against each other.

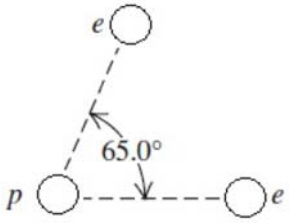
ii. The glass rod gives electrons to silk when they are rubbed against each other.

iii. The glass rod gains protons from silk when they are rubbed against each other.

iv. The glass rod gains electrons when they are rubbed against each other.

a) Option (i) b) Option (iv) c) Option (iii)
d) Option (ii)

(iii) If two electrons are each 1.5×10^{-10} m from a proton, as shown in Figure, magnitude of the net electric force they will exert on the proton is



a) 1.97×10^{-8} N b) 3.83×10^{-8} N
c) 4.63×10^{-8} N d) 2.73×10^{-8} N

(iv) A charge is a property associated with the matter due to which it produces and experiences:

a) electric effects only b) magnetic effects only
c) both electric and magnetic effects d) none of these

OR

The cause of quantization of electric charges is:

a) transfer of an integral number of electrons b) transfer of an integral number of neutrons
c) transfer of an integral number of protons c) none of these

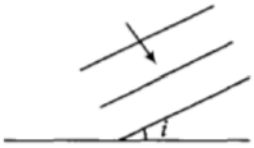
SECTION – E

Q31. **a.** Draw the ray diagram showing the refraction of light through a glass prism and hence obtain the relation between the refractive index μ of the prism, angle of prism and angle of minimum deviation.

b. Determine the value of the angle of incidence for a ray of light travelling from a medium of refractive index $\mu_0\sqrt{2}$ into the medium of refractive index $\mu_2 = 1$, so that it just grazes along the surface of separation.

OR

i. In a double slit experiment using the light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits. **[5]**



ii. Light of wavelength 500 Å propagating in air gets partly reflected from the surface of water. How will the wavelengths and frequencies of the reflected and refracted light be affected ?

Q32. **i.** A parallel plate capacitor is charged by a battery to a potential. The battery is disconnected and a dielectric slab is inserted to completely fill the space between the plates. How will

a. its capacitance

b. electric field between the plates and

c. energy stored in the capacitor be affected?

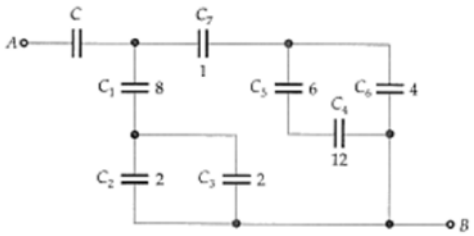
Justify your answer giving necessary mathematical expressions for each case

ii. **a.** Draw the electric field lines due to a conducting sphere.

b. Draw the electric field lines due to a dipole.

OR

From the network shown in Fig. find the value of the capacitance C if the equivalent capacitance between points A and B is to be 1 μF. All the capacitances are in μF.



[5]

Q33. An ac voltage $V = V_0 \sin \omega t$ 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.

OR

i. Describe, with the help of a suitable diagram, the working principle of a step–up transformer. Obtain the relation between input and output voltages in terms of the number of turns of primary and secondary windings and the currents in the input and output circuits. **[5]**

ii. Given the input current 15 A and the input voltage of 100 V for a step–up transformer having 90% efficiency, find the output power and the voltage in the secondary if the output current is 3 A.