BUDHA DAL PUBLIC SCHOOL, PATIALA
Pre – Board Examination (28 January 2025)
Class XII (Science)
Subject - Physics
(Set - A)

Time: 3hrs **M.M. 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 16 questions, 12 MCQ and 4 Assertion Reasoning based of 1 mark each, **Section B** contains 5 questions of two marks each, **Section C** contains 7 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) Use of calculators is not allowed.

i) $c = 3 \times 10^8$ m/s
ii) $me = 9.1 \times 10^{-31}$ kg
iii) $e = 1.6 \times 10^{-19}$ C
iv) $\mu 0 = 4\pi \times 10^{-7}$ $TmA{-}1$
v) $h = 6.63 \times 10^{-34}$ 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. A point q_0 is moving along a circular path of radius a and a point charge – Q at the centre of the circle. The kinetic energy of q_0 is

a) $\frac{q_0 Q}{4\pi\epsilon_0 a}$ b) $\frac{q_0 Q}{8\pi\epsilon_0 a}$ c) $\frac{q_0 Q}{4\pi\epsilon_0 a^2}$ d) $\frac{q_0 Q}{8\pi\epsilon_0 a^2}$

Q2. Two charges +q each are kept 2a distance apart. A third charge – 2q is placed mid-way between them. The potential energy of the system is

a) $\frac{q^2}{8\pi\epsilon_0 a}$ b) $\frac{6q^2}{8\pi\epsilon_0 a}$ c) $\frac{-7q^2}{8\pi\epsilon_0 a}$ d) $\frac{9q^2}{8\pi\epsilon_0 a}$

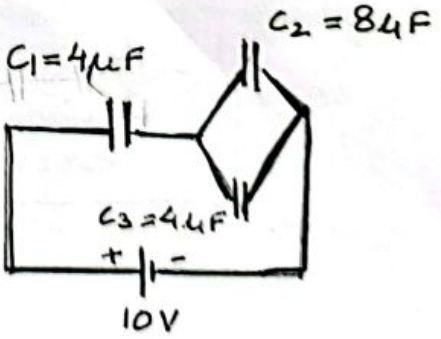
Q3. Two sources of equal emf are connected in series. This combination is in turn connected to an external resistance. R The internal resistances of two sources are r_1 and r_2 ($r_2 > r_1$). If the potential difference across the source of internal resistance r_1 is zero, then R equals to

a) $\frac{r_1 + r_2}{r_2 - r_1}$ b) $r_2 - r_1$ c) $\frac{r_1 r_2}{r_2 - r_1}$ d) $\frac{r_1 + r_2}{r_1 r_2}$

Q4. A ray of monochromatic light propagating in air is incident on the surface of water. Which of the following will be the same for the reflected and refracted rays?

a) Energy carried b) Speed c) Frequency d) Wavelength

Q5. Three capacitors C_1, C_2 and C_3 are connected in a combination as shown below.



Identify the correct statement(s).

I) The charge on capacitor C_1 is greater than that on capacitor C_2.
II) The charge on capacitor C_1 is the same as that on capacitor C_3.
III)The charge on capacitor C_1 is $30\mu C$.

a) Only (I) is correct b) Only (III) is correct c) Both (I) and (III) are correct d) Both (I) and (II) are correct

Q6. A 5Ω resistor, a 5 mH inductor and 5 μF capacitor, joined in series resonate with an AC source of frequency ω_1. If only the resistance is changed to 10 Ω, the circuit resonates at a frequency ω_1. If only the inductor is changed to 20 mH, the circuit resonates at a frequency ω_2. Find ratio $\frac{\omega_1}{\omega_2}$

a) 0.5 b) 1 c) 2 d) 4

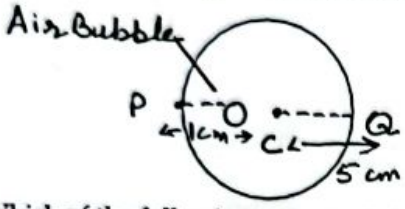
Q7. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to

a) The speed of light in vacuum
b) Reciprocal of speed of light in vacuum
c) The ratio of magnetic permeability to the electric susceptibility of vacuum
d) unity

Q8. The curve of binding energy per nucleon as a function of atomic mass number has a sharp peak for helium nucleus. This implies that helium nucleus is

a) radioactive b) unstable c) easily fissionable d) more stable nucleus than its neighbours

Q9. The air bubble is trapped at position O that is 1 cm inside the surface of glass sphere of radius 5 cm. C is the centre of the glass sphere. The air bubble is viewed from side P and then from side Q.



Which of the following statements is correct?

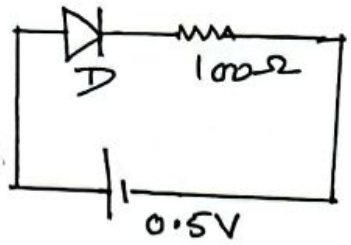
a) The bubble appears to be on the surface of the sphere when seen from side P.
b) The bubble appears to be at the centre of the sphere when seen from side Q.
c) The bubble appears at a position that is beyond 9 cm from the surface of the sphere when seen from side Q.
d) The bubble appears at a position that is more than 1 cm from the surface of the sphere when seen from side P.

Q10. Colours observed on a CD (compact disk) is due to

a) Reflection b) diffraction c) interference d) absorption

Q11. The threshold voltage for p-n junction diode used in the circuit is 0.7 V. This type of biasing and current in the circuit are:

a) Forward biasing, 0 A
b) Reverse biasing, 0 A
c) Forward biasing, 5 mA
d) Reverse biasing, 2 mA



Q12. A resistor with resistance R is made from a length L of resistance wire with a cross-sectional area A. A second resistor with resistance 2R is made from wire of the same material with a cross-sectional area of A/4. What length of wire in needed for the second resistor?

a) $\frac{L}{2}$ b) L c) $2L$ d) $8L$

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a) Both Assertion (A) and Reason (R) true and Reason (R) is the correct explanation of Assertion (A).
b) Both Assertion (A) and Reason (R) are true but Reason (R) is not a correct explanation of Assertion (A).
c) Assertion (A) is true but Reason (R) is false.
d) Assertion (A) is false and Reason (R) is also false.

Q13. Assertion (A) : In the path of a charged particle in a region of uniform electric and magnetic field is not a circle, then its kinetic energy will not remain constant.

Reason (R) : In a combination electric and magnetic field region, a moving charge experiences a net force $F = qE + q(V \times B)$, where symbols have their usual meanings.

Q14. Assertion (A) : For the scattering of α-particles at a large angles, only the nucleus of the atom is responsible.

Reason (R) : Nucleus is very heavy in comparison to α-particles

Q15. Assertion (A) : Binding energy per nucleon is practically constant for middle mass numbers $(30 < A < 170)$

Reason (R) : Nuclear force is short ranged in nature.

Q16. Assertion (A) : The images formed due to total internal reflections are much brighter than those formed by mirrors or lenses.

Reason (R) : There is no loss of intensity in total internal reflection.

Section - B

Q17. The photon emitted during the de-excitation from the first excited level to the ground state of hydrogen atom is used to irradiate a photo cathode in which stopping potential is 5 V. Calculate the work function of the cathode used.

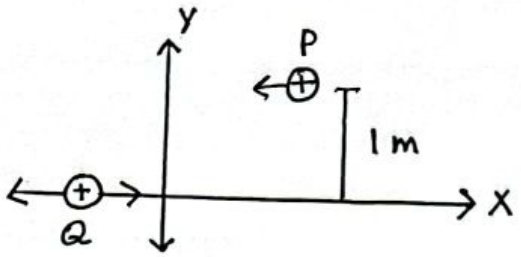
Q18. In a Young's double slit experiment, the separation between the two slits is d and distance of the screen from the slits is 1000 d. If the first minima falls at a distance d from the central maximum, obtain the relation between d and λ.

OR

Using Huygen principle prove Snell's Law.

Q19. P and Q are two identical charged particles each of mass 4×10^{-26} kg and charge 4.8×10^{-19} C, each moving with the same speed of 2.4×10^5 m/s as shown in the figure. The two particles are equidistant (0.5m) from the vertical Y-axis. At some instant, a magnetic field B is switched ON, so that the two particles undergo head-on-collision.

Find
a) the direction of the magnetic field and
b) the magnitude of the magnetic field applied in the region



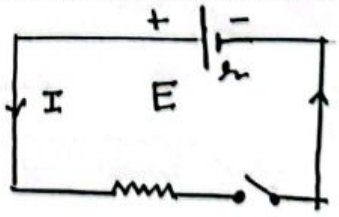
Q20. a) The photoelectric current at distances r_1 and r_2 of light source from photoelectric cell are I_1 and I_2, respectively. Find the value of I_1/I_2.

b) If the frequency of incident radiation is equal to the threshold frequency, what will be the value of stopping potential?

Q21. A cell of emf E and internal resistance r is connected across a variable resistor R as shown below:

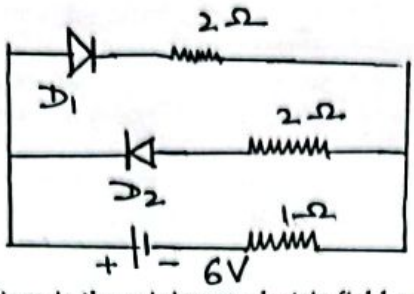
a) Plot a graph showing the variation of terminal potential V with resistance R.

b) Predict from the graph, the condition under which V becomes equal to E.



Section - C

Q22. Assuming that the two diodes D_1 and D_2 used in the electric circuit shown in the figure are ideal, find out the value of the current flowing through 1Ω resistor.



Q23. The dielectric strength of a medium is the minimum electric field required to cause ionization of the medium. For air, this value is taken as 3 million V/m.

With this information, find out if a metal sphere of radius 1 cm, surrounded by air, can hold a charge of 1 C.

Q24. Prove lens makers formula.

Q25. Draw energy band diagram for p and n-type semiconductors. Also, write two differences between p and n-type semiconductors.

Q26.

a) Briefly describe how the current sensitivity of a moving coil galvanometer can be increased.

b) A galvanometer show full sale deflection for current I_g. A resistance R_1 is required to convert it into a voltmeter of range (0-V) and a resistance R_2 to convert it into a voltmeter of range (0-2V). Find the resistance of the galvanometer.

Q27. Lens Q when placed in contact with a converging lens P of focal length = 20 cm makes a combination that behaves as a converging lens system of foal length 30 cm.

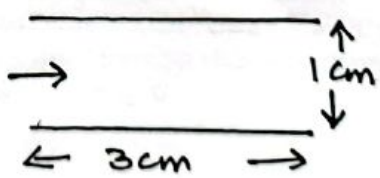
Lens Q when placed in contact with another lens R makes a combination that behaves as a diverging lens system of focal length 10cm. Identify the nature of lenses Q and R and determine their focal lengths

Q28. If a dipole is kept in a uniform external electric field E_0, diagrammatically represent the position of the dipole in stable and unstable equilibrium and prove the expressions for the torque acting on the dipole in both the cases.

Section - D

Q29. **Read the following paragraph and answer the questions that follow.**

A beam of electrons moving horizontally with the velocity of 3×10^7 m/s enters a region between two plates as shown in the figure. A suitable potential difference is applied across the plates, such that the electron beam just strikes the edge of the lower plate.



1. How long does an electron take to strike the edge?

a) 10^{-9} s b) 10^{-7} s c) 10^{-6} s d) 10^{-8} s

2. What is the shape of the path followed by the electron?

a) Circular b) Helix c) Square d) Oval

3. The potential difference applied is

a) 0 V b) 2531.25 V c) 286.46 V d) 28846

OR

3. The magnitude and direction of the magnetic field which should be created in the space between the plates, so that the electron beam goes straight undeviated is

a) $\hat{j}$ b) $\hat{i}$ c) $\hat{i} \times \hat{j}$ d) $\hat{k}$

30. **Read the following paragraph and answer the questions that follow.**

We know that metals have free electrons, which contribute towards conduction of electricity and heat. The electrons cannot normally escape from the metal surface. When an electron escapes from the metal surface, it is quite likely to be quickly absorbed back as the metal becomes positive. One can thus understand that it is captive within the metal even though it can freely move within the metal. A certain minimum (external) energy is required to be given to an electron for it to escape a given metal surface. This is known as the work function for that metal. It is denoted by ϕ and is measured in electron volt (eV). 1 eV is the energy gained by an electron when it si accelerated by a potential difference of 1 V.

1. Does the size of the atom affects the value of work function?
   a) Yes b) No c) Sometimes d) Remains same
2. From which type of metal, electron emission would be easier?
   a) Caesium b) Potassium c) Sodium d) Calcium
3. The work function would depend upon the following:
   a) material of the metal b) temperature c) the nature of its surface d) all of the above
4. Work function of platinum is the highest (-5.65 eV) and is least for caesium (02.1 eV). If energy, equal to the work function is required by electrons to escape, which of the two will need lesser energy?
   a) Caesium b) Platinum c) Same for both d) Can't be calculated

Section - E

Q31. a) Mention the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing variation or impedance of a series LCR circuit with the frequency of the applied a.c. source.

b) With the help of suitable diagram, explain the working of a step-up transformer.

c) Write two causes of energy loss in a real transformer.

OR

a) Resonance frequency of a circuit is v. If the capacitance is made 4 times the initial value, find the change in the resonance frequency.

b) A 100 Ω resistor is connected to 220 V, 50 Hz supply.
   i) What is rms value of current in the circuit?
   ii) What is the net power consumed over a full cycle?

Q32. a) A giant refracting telescope at an observatory has an objective lens of focal length 15m. If an eyepiece of focal length 1.0 cm is used, what is angular magnification of the telescope in normal adjustment?

b) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens? The diameter of the moon is 3.48×10^{6} m, and the radius of lunar orbit is 3.8×10^{8} m.

OR

A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at

a) The least distance of distinct vision (2.5 cm) and

b) Infinity? What is the magnifying power of the microscope in each case?

Q33. a) Write two limitations of Ohm's law. Plot their I-V characteristics.

b) A heating element connected across a battery of 100 V having an internal resistance of 1Ω draws an initial current of 10 A at room temperature 20.0 ^{0}C which settles after a few seconds to a steady value. What is the power consumed by battery itself after the steady temperature of 320.0 ^{0}C is attained? Temperature coefficient of resistance averaged over the temperature range involved is 3.70×10^{4} $^{0}C^{-1}$.

OR

a) Using Kirchhoff's laws obtain the equation of the balanced state in Wheatstone bridge.

b) A wire of uniform cross-section and resistance of 12 ohm is bent in the shape of circle as shown in the figure. A resistance of 10 ohm is connected to diametrically opposite ends C and D. A battery of emf 8V is connected between A and B. Determine the current flowing through arm AD.