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

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. Three charges $q - q$ *and* q_0 are placed as shown in the figure. The magnitude of the net force on the charge q_0 at point O is $\left[Take, k = \frac{1}{4\pi\epsilon_0}\right]$

a) 0 b) $\frac{2Kqq_0}{a^2}$ c) $\frac{\sqrt{2}Kqq_0}{a^2}$ d) $\frac{1}{\sqrt{2}}\frac{Kqq_0}{a^2}$

Q2. 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.

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

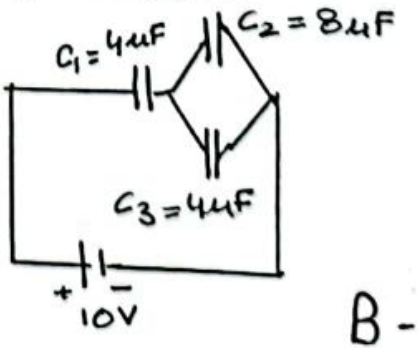
Q3. A light bulb s rated at 44 W, 220 V and a table fan is rated at 60W, 110V. Which statement is correct if each of the two devices is connected to a power supply of 220 V separately?

a) The light bulb has a greater resistance and draws a greater current than the table fan.
b) The light bulb has a greater resistance and draws a smaller current than the table fan.
c) The light bulb has a smaller resistance and draws a greater current than the table fan.
d) The light bulb has a smaller resistance and draws a smaller current than the table fan.

Q4. Which of the following actions will lead to an increase in the magnifying power of an astronomical telescope?

a) Increase in the length of the telescope tube.
b) Interchange the objective and the eyepiece of the telescope.
c) A small piece of paper on an objective of the telescope pointed towards the moon.
d) Increase in the focal length of the objective and decrease in the focal length of the eyepiece.

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

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) $\frac{9q^2}{8\pi\epsilon_0 a}$

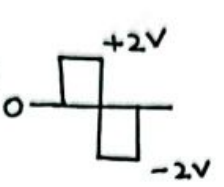
Q7. Which of the following statement is not true about the properties of electromagnetic waves?

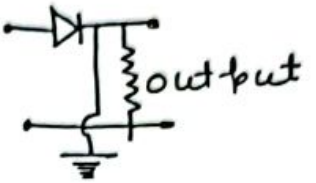
a) These waves do not require any material medium for their propagation.
b) Both electric and magnetic field vectors attain the maxima and minima at the same time.
c) The energy n electromagnetic wave is divide equally between electric and magnetic fields.
d) Both electric and magnetic field vectors are parallel to each other.

Q8. The difference in mass of ^7X nucleus and total mass of its constituent nucleons is 21.00 u. The binding energy per nucleon for this nucleus is equal to the energy equivalent of

a) 3 u b) 3.5 u c) 7 u d) 21 u

Q9. An ideal diode and a resistor are connected to an AC source as shown. The input voltage is a square wave as shown above. What will be output across the resistor?



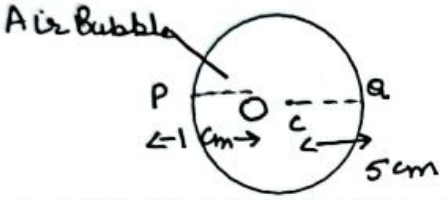


a) Only +2 V b) Only -2 V
c) Either 0 V or +2 V d) Either 0 V or -2 V

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

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

Q11. 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.

Q12. When the current is flowing through a conductor, the drift velocity is v. If 2I current flows through the same metal but having double the area of cross-section, then the drift velocity will be

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

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.

Assertion (A) : Angular momentum of single electron in any orbit of hydrogen type atoms is independent of the atomic number of the element.

Reason (R) : In ground state, angular momentum is minimum.

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. A visible light source constituted of two wavelength : $\lambda = 520\ nm$ *and* $\lambda' = 420\ nm$ is used in a double slit interference experiment. Also, distance between slits and the screen, D = 150 m and the slit width d = 0.025 mm.
Find the order n of maxima of light of λ that will overlap with n' of light of λ' on the screen.

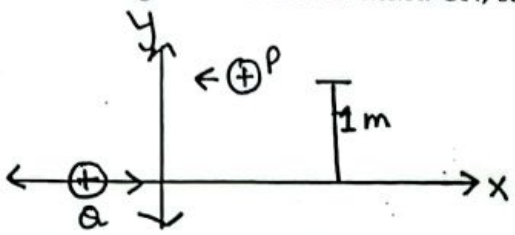
OR

Using Huygen principle prove Snells Law.

Q18. 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.

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



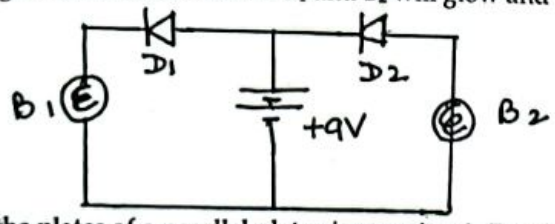
Q20.
a) The photoelectric current at distances r_1 and r_2 of light source from photoelectric cell are I_1 and I_2, respectively. Find the value of I_1/I_2.

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

Q21. Two electric heaters have power ratings P_1 and P_2, at voltage V. They are connected in series to a DC source of voltage V. Find the power consumed by the combination. Will they consume the same power, if connected in parallel across the same source? Explain.

Section - C

Q22. In the following diagram, which bulb out of B_1 and B_2 will glow and why?



Q23. The area of each of the plates of a parallel plate air capacitor is 7 cm^2.

a) Determine the maximum charge this capacitor can store without breakdown.

b) A material of dielectric constant 2 and dielectric strength 15×10^6 V/m is inserted into the capacitor. Find the percentage change in the maximum charge that can be stored in the capacitor with the dielectric material

(Take, dielectric strength of air = 3×10^6 V/m, $\epsilon_0 = 8.8 \times 10^{-12} C^2/N - m^2$)

Q24. Prove lens makers formula.

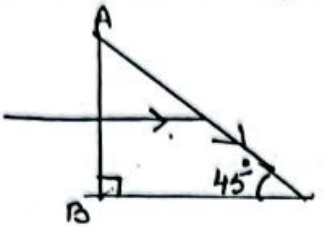
Q25. Draw energy band diagram for p and n-type semiconductors. Also, write two differences between p and n-type semiconductors.

Q26. a) Briefly describe how the current sensitivity of a moving coil galvanometer can be increased.

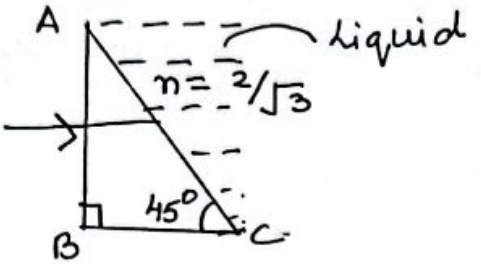
b) A galvanometer show full sale deflection for current I_g. A resistance R_1 is required to convert it into a voltmeter of range (0-V) and a resistance R_2 to convert it into a voltmeter of range (0-2V). Find the resistance of the galvanometer.

Q27. A light ray entering a right-angled prism undergoes refraction at the face AC as shown in figure 1.

I) What s the refractive index of the material of the prism in figure 1?



II) a) If the side AC of the above prism is now surrounded by a liquid of refractive index $2/\sqrt{3}$ as 3 shown in figure 2, determine if the light ray continues to graze along the interface AC or undergoes total internal reflection or undergoes refraction into the liquid.



[Given $\sin^{-1}\frac{\sqrt{2}}{\sqrt{3}} = 54.6$]

Q28. An electron is projected in the positive x-direction in a region of uniform electric field $E = 50\ N/C\ \hat{\imath}$.

a) In which direction will the electron experience force?
b) Find the acceleration of the electron.
c) If the electron covers 5m before coming to rest, find the initial speed of the electron.

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) $\hat{\jmath}$ b) $\hat{\imath}$ c) $\hat{\imath} \times \hat{\jmath}$ d) $\hat{k}$

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

Q32. Derive an expression for the torque experienced by a magnetic dipole placed in a uniform magnetic field. Hence obtain the expression for the potential energy of the dipole.

OR

a) A magnetic field that varies in magnitude from point to point but has a constant direction (east to west) is set up in a chamber. A charged particle enters the chamber and travels undeflected along a straight path with constant speed. What can you say about the initial velocity of the particle?

b) A charged particle enters an environment of a strong and non-uniform magnetic field varying from point to point both in magnitude and direction, and comes out of it following a complicated trajectory. Would its final speed equal the initial speed if it suffered no collisions with the environment?

c) An electron travelling west to east enters a chamber having a uniform electrostatic field in north to south direction. Specify the direction in which a uniform magnetic field should be set up to prevent the electron from deflecting from its straight line path.

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?

Q33. 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?