Sample Paper 1

Physics (Unsolved)

(A Highly Simulated Practice Question Paper for CBSE Class XII Examination)

General Instructions

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

Time : 3 hours

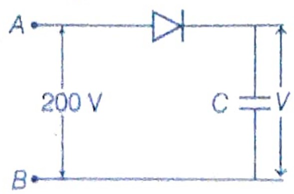
Max. Marks : 70

SECTION A

All questions are compulsory. In case of internal choices, attempt anyone of them.

1. Consider the junction diode as ideal. Find the value of current flowing through AB.

Or A 200 V AC supply is connected between points A and B as shown in the figure. What will be the potential difference V across the capacitor?



2. Two charges are kept in air at certain distance attract with a force of 20 N. If both charges are kept in a medium of dielectric constant 10, then what will be force of attraction between them?

3. An emf of 12V is induced in the coil when the current changes from $+3$ A to -3 A in 0.03 s. Calculate the coefficient of self-induction of the coil.

4. When a DC voltage is applied to the transformer instead of AC voltage, then how is its efficiency affected?

5. Which of the electromagnetic wave has minimum frequency?

6. An AC current of frequency 50 Hz is applied to a full wave rectifier, then find its output frequency.

7. A coil of resistance 10 Ω and inductance 10 H is connected to a battery of 50 V. Find the energy stored in the coil.

Or Obtain approximately the ratio of the nuclear radii of the gold isotope $^{197}_{79}\text{Au}$ and the silver isotope $^{107}_{47}\text{Ag}$.

8. Pure silicon at 300 K has equal number of electron (n_e) and hole (n_h) concentration of $1.5 \times 10^{16} \text{ m}^{-3}$. Doping by indium increases number of holes to $4.5 \times 10^{22} \text{ m}^{-3}$. Calculate the number of electrons in doped silicon.

9. If the source of light used in Young's double slit experiment is changed from red to violet, what will happen to the fringe width?

Or

Show variation of resistivity of Si with temperature in a graph.

10. A photon and an electron have the same de-Broglie wavelength, which one has higher total energy?

Or

All the photoelectrons are not emitted with same energy. The energies of photoelectrons are distributed over a certain range. Why?

For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled **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** A point charge is brought in an electric field. The field at a nearby point will increase, whatever be the nature of the charge.

Reason The electric field is independent of the nature of charge.

12. **Assertion** On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases.

Reason Electric field is inversely proportional to square of distance from the charge or an electric dipole.

13. **Assertion** Capacity of a parallel plate capacitor increases when distance between the plates is decreased.

Reason Capacitance of a capacitor is directly proportional to distance between them.

14. **Assertion** Charge on all the condensers connected in series is the same.

Reason Capacitance of capacitor is directly proportional to charge on it.

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. **Disappeared Mass**

In the year 1939, German scientist Otto Hahn and Strassmann discovered that when an uranium isotope was bombarded with a neutron, it breaks into two intermediate mass fragments. It was observed that, the sum of the masses of new fragment formed were less than the mass of the original nuclei. This difference in the mass appeared as the energy released in the process.

Thus, the phenomenon of splitting of a heavy nucleus (usually $A > 230$) into two or more lighter nuclei by the bombardment of proton, neutron, α-particle, etc with liberation of energy is called nuclear fission.

Fission reaction resulting from the absorption of neutron is known as induced fission.

$$_{92}U^{235} + {_0n^1} \rightarrow \underset{\text{Unstable nucleus}}{_{92}U^{236}}$$

$$\rightarrow {_{56}Ba^{144}} + {_{36}Kr^{89}} + 3{_0n^1} + Q$$

(i) Fission of nuclei is possible because the binding energy per nucleon in them
(a) increases with mass number at high mass numbers
(b) decreases with mass number at high mass numbers
(c) increases with mass number at low mass number
(d) decreases with mass number at low mass number

(ii) For sustaining the nuclear fission chain reaction in a sample (of small size) of $^{235}_{92}U$, it is desirable to slow down fast neutrons by using
(a) heavy water
(b) ordinary water
(c) cadmium rod
(d) None of the above

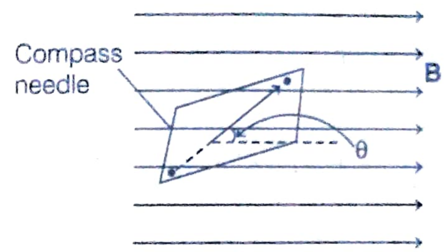
(iii) Which of the following is/are fission reaction(s)?
I. $^{1}_{0}n + ^{235}_{92}U \rightarrow ^{236}_{92}U \rightarrow ^{133}_{51}Sb + ^{99}_{41}Nb + 4^{1}_{0}n$
II. $^{1}_{0}n + ^{235}_{92}U \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + 2^{1}_{0}n$
III. $^{3}_{2}He + ^{3}_{2}He \rightarrow ^{4}_{2}He + 2^{1}_{1}H + 12.86$ MeV
(a) Both II and III
(b) Both I and III
(c) Only II
(d) Both I and II

(iv) If a nucleus with mass number $A = 240$ with $E_{bn} = 7.6$ MeV breaks into two fragments of $A = 120$ and $E_{bn} = 8.5$ MeV, then released energy is around
(a) 216 MeV
(b) 200 MeV
(c) 100 MeV
(d) Cannot be estimated from given data

(v) In any fission process, ratio of mass of parent nucleus to mass of daughter nucleus is
(a) less than 1
(b) greater than 1
(c) equal to 1
(d) depends on the mass of parent nucleus

16. Dipole in Magnetic Fields

To determine the magnitude of B accurately, a small compass needle of known magnetic moment m and moment of inertia I is allowed to oscillate in the magnetic field. This arrangement is shown in figure.



(i) The torque on the needle is maximum, when
(a) $\theta = 0°$
(b) $\theta = 90°$
(c) $\theta = 180°$
(d) $\theta = 45°$

(ii) Which of the following represents a simple harmonic motion?
(a) $\frac{d^2\theta}{dt^2} = -\frac{mB}{I}\theta$
(b) $\frac{d\theta}{dt^2} = -\frac{mB}{I}\theta$
(c) $\frac{d^2\theta}{dt} = -mB\theta I$
(d) $\frac{d^2\theta}{dt^2} = \frac{mB}{I}\theta$

(iii) The time period of oscillation of the dipole is
(a) $2\pi\sqrt{\frac{2I}{mB}}$
(b) $2\pi\sqrt{\frac{I}{mB}}$
(c) $4\pi\sqrt{\frac{I}{mB}}$
(d) $2\pi\sqrt{\frac{2I}{mB}}$

(iv) The magnitude of the magnetic field in terms of time period T is
(a) $B = \frac{4\pi^2 I}{mT^2}$
(b) $B = \frac{2\pi^2 I}{mT^2}$
(c) $B = \frac{\pi^2 I}{2mT^2}$
(d) $B = \frac{3\pi^2 I}{2\,mT^2}$

(v) The magnetic potential energy U_m is given by
(a) $U_m = -\mathbf{m} \cdot \mathbf{B}$
(b) $U_m = \mathbf{m} \cdot \mathbf{B}$
(c) $U_m = \mathbf{B} \cdot 2\mathbf{m}$
(d) $U_m = -2\mathbf{m} \cdot \mathbf{B}$

SECTION C

All questions are compulsory. In case of internal choices, attempt anyone.

17. Semiconductors obey Ohm's law at only low fields. Why?

18. Find the wavelength of electromagnetic waves of frequency 4×10^9 Hz in free space. Give its two applications.

Or

The intensity at the central maxima (O) in a Young's double slit set up is I_0. If the distance OP equals to one-third of the fringe width of the pattern, then show that the intensity at point P would be equal to $\frac{I_0}{4}$.

19. A particle is moving three times as fast as an electron. The ratio of the de-Broglie wavelength of the particle to that of the electron is 1.813×10^{-4}. Calculate the particle's mass and identify the particle.

20. It is found that 13.6 eV energy is required to separate a hydrogen atom into a proton and electron. Compute the orbital radius of the electron in a hydrogen atom.

Or

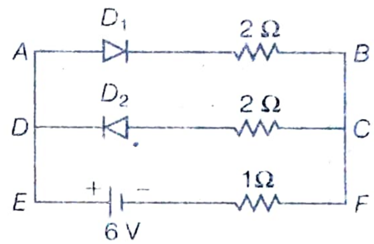
Using the Bohr's model, calculate the speed of the electron in a H-atom in the $n = 1$ and 2 levels.

21. Why electrostatic potential is constant throughout the volume of the conductor and has the same value as on its surface?

Or

Calculate the binding energy of nucleus $_{20}Ca^{40}$. Given m_n and m_p are 1.008665 u and 1.007825 u respectively and $m(_{20}Ca^{40}) = 39.962589$ u.

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



23. (i) An old saying suggests that it is more safe to run fast than walk during an overhead lightning storm and it has been observed that cattles are more likely to be killed by a nearby lightning strike than humans. Comment.
(ii) Why a person sitting in a car during thunderstorm, not likely to be struck by lightning?

24. (i) The power factor of an AC circuit is 0.5. What is the phase difference between voltage and current of the circuit?
(ii) Define the term wattless current.

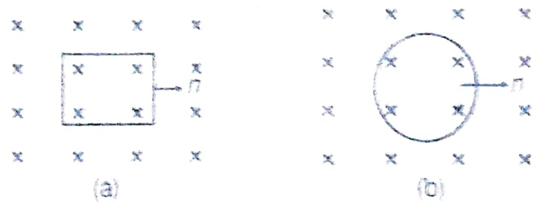
25. A circular coil of N turns and radius R is kept normal to a magnetic field is given by $B = B_0 \cos\omega t$. Deduce an expression for the emf induced in this coil. State the rule which helps to detect the direction of induced current.

SECTION D

All questions are compulsory. In case of internal choices, attempt anyone.

26. A rectangular loop and a circular loop are moving out of a magnetic field to a field free region with a constant velocity.

It is given that, the field is normal to the plane of both the loops.

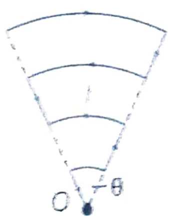


(a) (b)

Draw the expected shape of the graphs, showing the variation of the flux with the time in both the cases. What is the cause of the difference in the shape of the two graphs?

Or

A conductor carrying a current I is of types as shown below. Find the magnetic field induction at the common centre O of all the three arcs.



27. A convex lens of focal length 20 cm is placed coaxially with a convex mirror of radius of curvature 20 cm. The two are kept at 15 cm from each other. A point object lies 60 cm infront of the convex lens. Draw a ray diagram to show the formation of the image by the combination. Determine the nature and position of the image formed.

28. Plot a graph showing the variation of stopping potential with frequency of incident radiation for two different photosensitive materials having work functions W_{01} and W_{02} ($W_{01} > W_{02}$). On what factors, does the

(i) slope and

(ii) intercept of the lines depend?

Or

A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element, if the room temperature is 27°C? Temperature coefficient of resistance of nichrome averaged over the temperature range involved is 1.70×10^{-4} °C^{-1}.

29. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released.

Calculate the energy release in MeV in the deuterium-tritium fusion reaction.

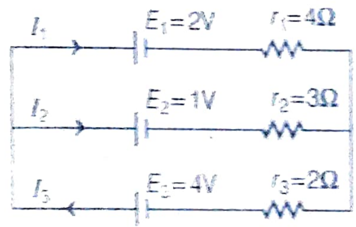
$$ {}_1^2\mathrm{H} + {}_1^3\mathrm{H} \longrightarrow {}_2^4\mathrm{He} + n $$

Using the data,

$$ m({}_1^2\mathrm{H}) = 2.014102\ \mathrm{u}, $$
$$ m({}_1^3\mathrm{H}) = 3.016049\ \mathrm{u}, $$
$$ m({}_2^4\mathrm{He}) = 4.002603\ \mathrm{u}, $$
$$ m_n = 1.008665\ \mathrm{u}, $$
and $1\ \mathrm{u} = 931.5 \dfrac{\mathrm{MeV}}{c^2}$.

30. (i) The emf of a cell is always greater than its terminal voltage, why? Give reason.

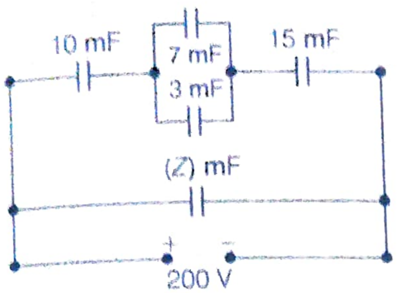
(ii) State Kirchhoff's rules. Use these rules to write the expressions for the currents I_1, I_2 and I_3 in the circuit diagram shown in figure below



SECTION E

All questions are compulsory. In case of internal choices, attempt anyone.

31. (i) A system of capacitors connected as shown in the figure has a total energy of 160 mJ stored in it. Obtain the value of the equivalent capacitance of this system and the value of Z.



(ii) Two point charges 3 μC and −3 μC are placed at points A and B, 5 cm apart.

(a) Draw the equipotential surfaces of the system.

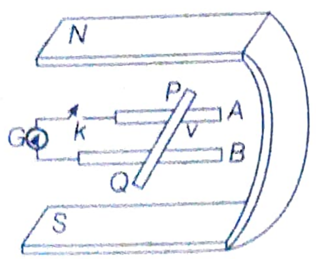
(b) Why do equipotential surfaces get close to each other near the point charge?

Or

(i) Find the electric field intensity due to electric dipole on equatorial line.

(ii) Derive the expression for torque acting on a electric dipole placed in uniform electric field, when torque on dipole is maximum and minimum.

32. Figure below shows a metal rod PQ resting on the metal rails AB and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutual perpendicular directions.



A galvanometer G connects the rails through a switch k. Length of the rod is l, magnetic field is B and resistance of the closed loop containing the rod is R. Assume the field to be uniform.

(i) Suppose k is open and the rod moves with a speed v in the direction shown. Give the polarity and magnitude of the induced emf.

(ii) What is the retarding force on the rod, when k is closed?

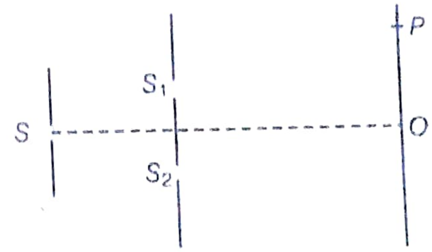
(iii) How much power is required (by an external agent) to keep the rod moving at the same speed v when k is closed?

(iv) How much power is dissipated as heat in the closed circuit? What is the source of the power?

Or (i) State using a suitable diagram, the working principle of a moving coil galvanometer. What is the function of a radial magnetic field and the soft iron core used in it?

(ii) For converting a galvanometer into an ammeter, a shunt resistance of small value is used in parallel, whereas in the case of a voltmeter a resistance of large value is used in series. Explain, why.

33. In a modified set-up of Young's double slit experiment, it is given that $SS_2 - SS_1 = \frac{2\lambda}{3}$, i.e. the source S is not equidistant from the slits S_1 and S_2.

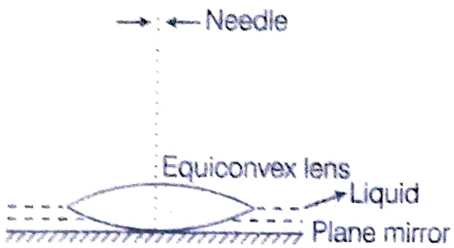


(i) Obtain the conditions for constructive and destructive interference at any point P on the screen in terms of the path difference. $\delta = S_2P - S_1P$.

(ii) Does the observed central bright fringe lie above or below O? Give reason to support your answer.

Or (i) An equiconvex lens with radii of curvature of magnitude r each is put over a liquid layer poured on top of a plane mirror. A small needle, with its tip on the principal axis of the lens, is moved along the axis until its inverted real image coincides with the needle itself.

The distance of the needle from the lens is measured to be a. On removing the liquid layer and repeating the experiment, the distance is found to be b. Derive an expression for refractive index of the liquid in terms of r, a and b.



(ii) A small pin fixed on a table top is viewed from above from a distance of 50 cm.
By what distance the pin appear to be raised, if it is viewed from the same point through a 15 cm thick glass slab held parallel to the table? Refractive index of glass = 1.5. Does the answer depend on the location of the slab?

Answers

1. 10^{-2} A *Or* $200\sqrt{2}$ V **2.** 2 N

3. 0.06 H **4.** Becomes zero

5. Radio waves **6.** 100 Hz

7. 125 J *Or* 1.23 **8.** 5×10^9

10. Photon **11.** (d)

12. (d) **13.** (c) **14.** (c)

15. (i) (b) (ii) (a) (iii) (d) (iv) (a) (v) (b)

16. (i) (b) (ii) (a) (iii) (b) (iv) (a) (v) (a)

18. 0.075 m

19. 1.673×10^{-27} kg, proton

20. 5.3×10^{-11} m *Or* 2.18×10^{6} m/s and 1.09×10^{6} m/s

21. *Or* 8.55 MeV

22. 2A

24. (i) 60°

27. 30 cm, right of convex mirror

28. *Or* 867.5°C

29. 17.589 MeV

30. (ii) $I_1 = (2/13)$ A, $I_2 = (7/13)$ A and $I_3 = (9/13)$ A

31. (i) 8μF, $\frac{17}{4}$μF

33. *Or* (ii) 5 cm, No