S R Study Material

SAMPLE PAPER 3 2024-25

Class 12 - Physics

Time Allowed: 3 hours **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.

Section A

1. Which one of the following elements will require the highest energy to take out an electron from them? Pb, Ge, C and Si **[1]**

   a) C b) Ge

   c) Pb d) Si

2. Ohm's law is obeyed by **[1]**

   a) metals at low temperature b) intrinsic semiconductors

   c) extrinsic semiconductors d) metals at high temperature

3. The magnifying power of the telescope can be increased by **[1]**

   a) fitting eye-piece of high power b) fitting eye-piece of low power

   c) increasing the focal length of eyepiece d) increasing the distance of an object

4. The ratio of magnetic fields due to a small bar magnet in the end on position to the broad side on position is **[1]**

   a) 1 : 1 b) 1 : 4

   c) 2 : 1 d) 1 : 2

5. The work done to move a charge along an equipotential surface from A to B **[1]**

   a) is a negative quantity. b) is a positive quantity.

c) cannot be defined.

d) is zero.

6. 20 amp current is flowing in a long straight wire. The intensity of the magnetic field at a distance of 10 cm from the wire will be: **[1]**

a) 4×10^{-5} Wb/m^2

b) 2×10^{-5} Wb/m^2

c) 8×10^{-5} Wb/m^2

d) 6×10^{-5} Wb/m^2

7. The dimensional formula for emf ε in MKS system will be **[1]**

a) $[ML^{-2}Q^{-1}]$

b) $[MLT^{-2}Q^{-2}]$

c) $[ML^2T^{-2}Q^{-1}]$

d) $[ML^2T^{-1}]$

8. A Rowland ring of mean radius 15 cm has 3500 turns of wire wound on a ferromagnetic core of relative permeability 800. What is the magnetic field B in the core for a magnetising current of 1.2A? **[1]**

a) 3.48 T

b) 5.48 T

c) 4.08 T

d) 4.48 T

9. Intensity of light depends upon: **[1]**

a) frequency

b) wavelength

c) velocity

d) amplitude

10. If there were only one type of charge in the universe, then: **[1]**

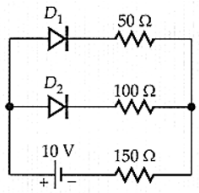
a) $\oint EdS = 0$ if the charge is outside the surface.

b) $\oint E.dS = \frac{q}{\varepsilon_0}$ if charges of magnitude q is inside the surface.

c) $\oint E.dS \neq 0$ on any surface.

d) Both $\oint E.dS = 0$ if the charge is outside the surface and $\oint E.dS = \frac{q}{\varepsilon_0}$ if charges of magnitude q is inside the surface

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



a) 0.04 A

b) zero

c) 0.05 A

d) 0.66 A

12. A fish looking up through the water sees the outside world, contained in a circular horizon. If the refractive index of water is 4/3 and the fish is 12 cm below the water surface, the radius of this circle (in cm) is: **[1]**

a) $36/\sqrt{7}$

b) $36\sqrt{5}$

c) $4\sqrt{5}$

d) $36\sqrt{7}$

13. **Assertion (A):** de-Broglie wavelength is significant for microscopic particles. **[1]**

Reason (R): de-Broglie wavelength is inversely proportional to the mass of a particle when velocity is kept constant.

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.

14. **Assertion (A):** When charged capacitors are connected in parallel, the algebraic sum of charges remains constant but there is a loss of energy. **[1]**

Reason (R): During sharing a charges, the energy conservation law does not hold.

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.

15. **Assertion (A):** Skiers use air glasses. **[1]**

Reason (R): Light reflected by snow is partially polarised.

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.

16. **Assertion (A):** Series L-C-R circuit is a **voltage magnifier**. **[1]**

Reason (R): In series L-C-R circuit at resonance voltage drop across inductance ((or capacitance) is Q (quality factor) times the applied voltage.

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

17. Two charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what point (s) on the line joining the two charges is the electrical potential zero? Take the potential at infinity to be zero. **[2]**

18. How does the **[2]**

i. pole strength and

ii. magnetic moment of each part of a bar magnet change if it is cut into two equal pieces transverse to its length?

19. Explain the terms depletion layer and potential barrier in a p-n junction diode. How are the **[2]**

i. width of depletion layer, and

ii. value of potential barrier affected when the p-n junction is forward biased?

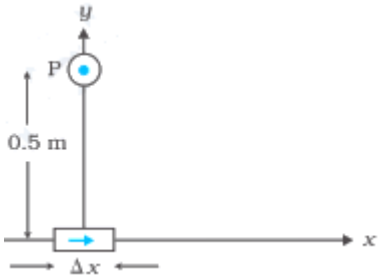
20. Suppose you are given a chance to repeat the alpha particle scattering experiment using a thin sheet of solid hydrogen in place of the gold foil. (Hydrogen is a solid at temperatures below 14 K). What results do you expect? **[2]**

21. A uniform magnetic field $\vec{B}$ is set up along the positive x-axis. A particle of charge ‘q ' and mass 'm ’ moving with a velocity $\vec{v}$ enters the field at the origin in X - Y plane such that it has velocity components both along and perpendicular to the magnetic field $\vec{B}$. Trace, giving reason, the trajectory followed by the particle. Find out the expression for the distance moved by the particle along the magnetic field in one rotation. **[2]**

OR

An element $\Delta\vec{l} = \Delta x\hat{i}$ is placed at the origin and carries a large current I = 10 A (Fig.). What is the magnetic field

on the y-axis at a distance of 0.5 m? Δx = 1 cm.



Section C

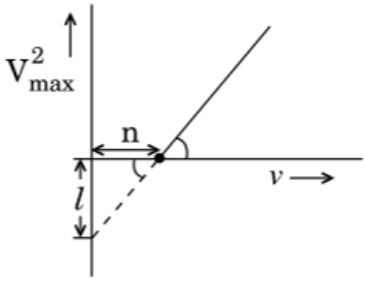
22. The temperature coefficient of resistivity, for two materials A and B, are 0.0031 / °C and 0.0068 / °C respectively. **[3]**

Two resistors R_1 and R_2 made from materials A and B, respectively, have resistances of 200 Ω and 100 Ω at 0°C. Show on a diagram, the colour code, of a carbon resistor, that would have a resistance equal to the series combination of R_1 and R_2 at a temperature of 100°C.

(Neglect the ring corresponding to the tolerance of the carbon resistor).

23. Draw a circuit diagram of a p-n junction diode under forward bias and explain its working. **[3]**

24. When a given photosensitive material is irradiated with light of frequency v, the maximum speed of the emitted photoelectrons equals V_{max}. The graph shown in the figure gives a plot of V^2_{max} varying with frequency v. **[3]**



Obtain an expression for

a. Planck's constant, and

b. The work function of the given photosensitive material in terms of the parameters **l**, **n** and the mass **m** of the electron.

c. How is threshold frequency determined from the plot?

25. i. In a typical nuclear reaction, e.g. **[3]**

$^2_1H + ^2_1H \longrightarrow ^3_2He + n + 3.27$

Although number of nucleons is conserved, yet energy is released. How? Explain.

ii. Show that nuclear density in a given nucleus is independent of mass number A.

26. State the basic assumption of the Rutherford model of the atom. Explain in brief why this model cannot account for the stability of an atom? **[3]**

27. i. Write two points to distinguish between interference and diffraction fringes. **[3]**

ii. In Young's double-slit experiment, fringes are obtained on a screen placed at a certain distance away from the slits. If the screen is moved by 5 cm towards the slits, the fringe width changes by 30 μm. Given that the slits are 1 mm apart, calculate the wavelength of the light used.

28. i. Define self-inductance of a coil and hence write the definition of Henry. **[3]**

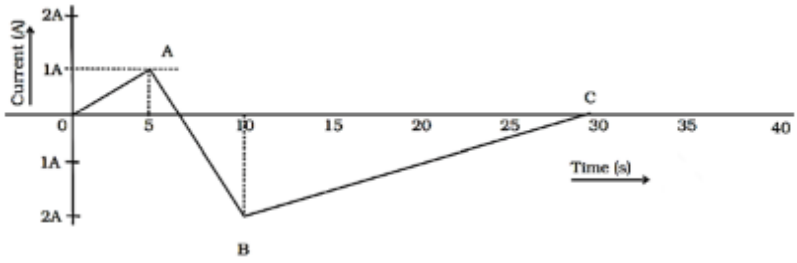
ii. Write any two factors each on which the following depends:

a. Self-inductance of a coil.

b. Mutual inductance of a pair of coils.

OR

A (current vs time) graph of the current passing through a solenoid is shown in Figure. For which time is the back electromotive force (u) a maximum. If the back emf at t = 3s is e, find the back emf at t = 7 s, 15s, and 40s. OA, AB, and BC are straight line segments.



Section D

29. **Read the text carefully and answer the questions:** **[4]**

Microwave oven: The spectrum of electromagnetic radiation contains a part known as microwaves. These waves have frequency and energy smaller than visible light and wavelength larger than it. What is the principle of a microwave oven and how does it work? Our objective is to cook food or warm it up. All food items such as fruit, vegetables, meat, cereals, etc., contain water as a constituent. Now, what does it mean when we say that a certain object has become warmer? When the temperature of a body rises, the energy of the random motion of atoms and molecules increases and the molecules travel or vibrate or rotate with higher energies. The frequency of rotation of water molecules is about 2.45 gigahertz (GHz). If water receives microwaves of this frequency, its molecules absorb this radiation, which is equivalent to heating up water. These molecules share this energy with neighbouring food molecules, heating up the food. One should use porcelain vessels and non-metal containers in a microwave oven because of the danger of getting a shock from accumulated electric charges. Metals may also melt from heating. The porcelain container remains unaffected and cool, because its large molecules vibrate and rotate with much smaller frequencies, and thus cannot absorb microwaves. Hence, they do not get eaten up. Thus, the basic principle of a microwave oven is to generate microwave radiation of appropriate frequency in the working space of the oven where we keep food. This way energy is not wasted in heating up the vessel. In the conventional heating method, the vessel on the burner gets heated first and then the food inside gets heated because of transfer of energy from the vessel. In the microwave oven, on the other hand, energy is directly delivered to water molecules which is shared by the entire food.

(a) As compared to visible light microwave has frequency and energy

a) Frequency is less but energy is more
b) less than visible light
c) more than visible light
d) equal to visible light

(b) When the temperature of a body rises

a) the energy of the random motion of atoms and molecules decreases.
b) the energy of the random motion of atoms and molecules remains same.
c) the energy of the random motion of atoms and molecules increases
d) the random motion of atoms and molecules becomes streamlined.

(c) The frequency of rotation of water molecules is about

a) 2.45 THz
b) 2.45 kHz
c) 2.45 MHz
d) 2.45 GHz

OR

In the microwave oven

a) Energy is directly delivered to the food grains.

b) The vessel gets heated first and then the water molecules collect heat from the body of the vessel

c) Energy is directly delivered to water molecules which is shared by the entire food

d) The vessel gets heated first, and then the food grains inside

(d) Why should one use porcelain vessels and non-metal containers in a microwave oven?

a) Because it will prevent the food items to become hot

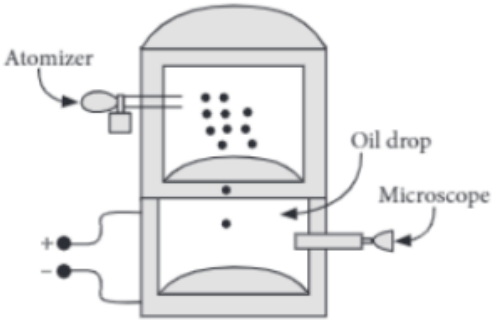
b) Because it will get too much hot

c) Because of the danger of getting a shock from accumulated electric charges

d) Because it may crack due to high frequency

30. **Read the text carefully and answer the questions:** **[4]**

In 1909, Robert Millikan was the first to find the charge of an electron in his now-famous oil-drop experiment. In that experiment, tiny oil drops were sprayed into a uniform electric field between a horizontal pair of oppositely charged plates. The drops were observed with a magnifying eyepiece, and the electric field was adjusted so that the upward force on some negatively charged oil drops was just sufficient to balance the downward force of gravity. That is, when suspended, upward force qE just equaled Mg. Millikan accurately measured the charges on many oil drops and found the values to be whole number multiples of 1.6×10^{-19} C the charge of the electron. For this, he won the Nobel prize.



(a) If a drop of mass 1.08×10^{-14} kg remains stationary in an electric field of 1.68×10^{5} NC^{-1}, then the charge of this drop is

a) 6.40×10^{-19} C

b) 4.8×10^{-19} C

c) 3.2×10^{-19} C

d) 1.6×10^{-19} C

(b) Extra electrons on this particular oil drop (given the presently known charge of the electron) are

a) 4

b) 5

c) 8

d) 3

(c) A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field 100 V m^{-1}. If the mass of the drop is 1.6×10^{-3} g, the number of electrons carried by the drop is (g = 10

ms^{-2})

a) 10^9 b) 10^{18}

c) 10^{12} d) 10^{15}

(d) The important conclusion given by Millikan's experiment about the charge is

a) charge has no definite value b) charge is quantized

c) charge is never quantized d) charge on oil drop always increases

OR

If in Millikan's oil drop experiment, charges on drops are found to be $8\mu C, 12\mu C, 20\mu C$, then quanta of charge is

a) $20\mu C$ b) $12\mu C$

c) $8\mu C$ d) $4\mu C$

Section E

31. Use the mirror equation to deduce that: **[5]**

a. an object placed between f and 2f of a concave mirror produces a real image beyond 2f.

b. a convex mirror always produces a virtual image independent of the location of the object.

c. the virtual image produced by a convex mirror is always diminished in size and is located between the focus and the pole.

d. an object placed between the pole and focus of a concave mirror produces a virtual and enlarged image.

[**Note:** This exercise helps you deduce algebraically properties of images that one obtains from explicit ray diagrams.]

OR

i. Define a wavefront. How is it different from a ray?

ii. Depict the shape of a wavefront in each of the following cases.

a. Light diverging from point source.

b. Light emerging out of a convex lens when a point source is placed at its focus.

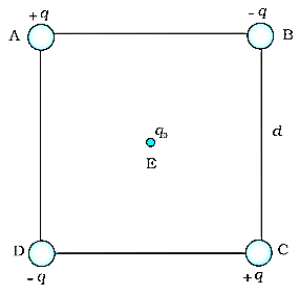
c. Using Huygen's construction of secondary wavelets, draw a diagram showing the passage of a plane wavefront from a denser into a rarer medium.

32. a. Derive an expression for the energy stored in a parallel plate capacitor of capacitance C when charged up to voltage V. How is this energy stored in the capacitor? **[5]**

b. A capacitor of capacitance 1 μF is charged by connecting a battery of negligible internal resistance and emf 10 V across it. Calculate the amount of charge supplied by the battery in charging the capacitor fully.

OR

Four charges are arranged at the corners of a square ABCD of side d, as shown in fig.



a. Find the work required to put together this arrangement.

b. A charge q_0 is brought to the center E of the square, the four charges being held fixed at its corners. How much extra work is needed to do this?

33. **[5]**

i. Draw an arrangement for winding of primary and secondary coils in a transformer with two coils on a separate limb of the core. State the underlying principle of a transformer. Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding. For an ideal transformer, obtain the ratio of primary and secondary currents in terms of the ratio of the voltages in the secondary and primary voltages.

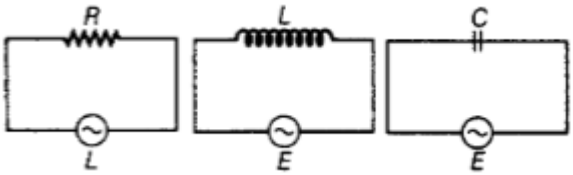
ii. Write any two reasons for the energy losses which occur in actual transformers.

iii. A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.

OR

i. What do you understand by the sharpness of resonance in a series L-C-R circuit? Derive an expression for Q-factor of the circuit.

ii. Three electrical circuits having AC sources of variable frequency are shown in the figures. Initially, the current flowing in each of these is same. If the frequency of the applied AC source is increased, how will the current flowing in these circuits be affected? Give the reason for your answer.



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