

# PRACTICE QUESTION PAPER 2024

## भौतिक विज्ञान (सैद्धान्तिक)

### PHYSICS (Theory)

Maximum Marks: 70

Time Allowed: 3 hours.

#### 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, twelve MCQ and 4 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

- Q.1>** Charge  $Q$  is kept first in a sphere of radius 6 cm and then it is kept in a cube of side 2 cm. The outgoing flux will be-
- (a) More in case of sphere  
(b) More in case of cube  
(c) Same in both case  
(d) Information Incomplete
- Q.2>** Kirchoff's voltage law for the electric network is based on:
- (a) Law of conservation of charge  
(b) Law of conservation of energy  
(c) Law of conservation of angular momentum  
(d) Law of conservation of mass
- Q.3>** A cell supplies a current of 0.9 A through a  $2\ \Omega$  resistor and a current of 0.3 A through  $7\ \Omega$  resistor. The internal resistance of the cell is
- (a)  $2.0\ \Omega$   
(b)  $1.5\ \Omega$   
(c)  $1.0\ \Omega$   
(d)  $0.5\ \Omega$
- Q4.>** If distance between two current- carrying wires is doubled, then force between them is
- (a) halved  
(b) doubled  
(c) tripled  
(d) quadrupled
- Q5.>** S.I. unit of magnetic pole strength is
- (a) Ampere/meter  
(b) Ampere-meter  
(c) volt/meter  
(d) Ampere/meter<sup>2</sup>

- Q.6>** The wave-front due to source situated at the infinity is  
 (a) Spherical (b) Plane  
 (c) Cylindrical (d) Rectangular
- Q.7>** Colors appears on a thin film of a soap and a soap bubble is due to  
 (a) Diffraction (b) Refraction  
 (c) Dispersion (d) Interference
- Q.8>** In an experiment of scattering of alpha particle showed for the first time that the atom has,  
 (a) Electron (b) Proton  
 (c) Neutron (d) Nucleus
- Q.9>** What is the ratio of nuclear radii if the mass numbers of two nuclei are 4 and 32  
 (a) 1 : 2 (b) 1 : 3  
 (c) 1 : 4 (d) None of these
- Q.10>** A semiconductor has electron concentration of  $6 \times 10^{22}$  per  $m^3$  and hole concentration of  $8.5 \times 10^9$  per  $m^3$ . Then it is  
 a) N type semiconductor b) P type semi conductor  
 c) intrinsic semiconductor d) Not a semiconductor
- Q.11>** The element whose nucleus has the highest binding energy per nucleon is  
 (a) Helium (b) Iron  
 (c) Uranium (d) None of these
- Q.12>** The shortest possible wavelength in the UV spectrum that can be emitted from the H –atom  
 (a) 364nm (b) 819nm  
 (c) 121nm (d) 91nm

**For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.**

**Instructions for Assertion and reasoning questions**

Answer: (a) Both are correct and reason is correct explanation of assertion.

Answer: (b) Both are correct but reason is not the correct explanation of assertion.

Answer: (c) Assertion in True but Reason is False.

Answer: (d) Both are False

**Q.13>** Assertion: In an unbiased pn junction the value of diffusion current and drift current are equal  
 Reason: Direction of diffusion current is from p side to n side

**Q.14>** Assertion: Two sodium lamps can never form a sustained interference pattern  
 Reason: They don't have a constant phase relationship

**Q.15>** Assertion: When the magnetic flux through a loop is maximum, induced emf is maximum.  
 Reason: When the magnetic flux through a loop is minimum, induced emf is minimum.

- Q.16>** Assertion: A low voltage supply, from which high current is to be taken, must have very low internal resistance.  
Reason: Maximum current drawn from source is inversely proportional to internal resistance.

### Section B

- Q.17>** State the formula for electric potential at a general point of a short dipole  
(b) Hence find the potential at an (i) axial (ii) Equatorial point
- Q.18>** Draw the graph showing variation of stopping potential versus frequency of incident radiation. Write the value of slope and y-intercept of this graph
- Q.19>** Which EM waves are also called as ‘heat waves’ and why?. Give its wavelength range and mention one use
- Q.20>** The double slit experiment is performed with a combination of red and blue lights with wavelength 700nm and 400nm respectively. The slit separation is 1mm while the screen is placed at a distance of 2m. Find the least position on the screen where a red maxima will coincide with a blue maxima
- Q.21>** Draw the ray diagram of image formation by a convex lens where the image is erect and magnified.

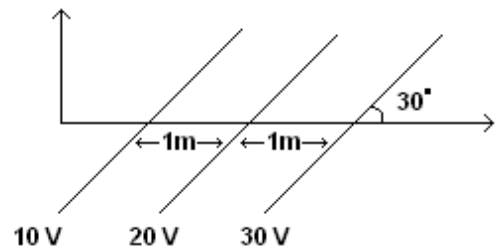
OR

A convex lens of focal length 10cm forms a real image of twice the size of the object. Find the object distance.

### Section C

- Q.22>** What are nuclear forces? Mention 2 properties  
(b) How long can an electric lamp of 100W be kept glowing by fusion of 2.0 kg of deuterium?  
Take the fusion reaction as  ${}_1\text{H}^2 + {}_1\text{H}^2 \rightarrow {}_2\text{He}^3 + {}_0\text{n}^1 + 3.27 \text{ MeV}$

- Q.23>** Define an equipotential surface  
(b) Three equipotential surfaces are as shown in the figure. Determine the magnitude and direction of the electric field in the region.



- Q.24>** State De Broglie’s hypothesis. How was it experimentally demonstrated?  
(b) A proton and a deuteron are accelerated by the same potential difference. Find the ratio of their DeBroglie wavelength.

**Q.25>** A cell of emf  $E$  and internal resistance  $r$  is connected to two resistances  $R_1$  and  $R_2$  and a perfect ammeter. The current in the circuit is measured in four different situations:

- (a) Without any external resistance in the circuit  
 (b) With the resistance  $R_1$  only  
 (c) With the resistance  $R_1$  and  $R_2$  in series combination.  
 (d) With the resistance  $R_1$  and  $R_2$  in parallel combination.

The current measured in all the four cases are  $0.42A$ ,  $1.05A$ ,  $1.4A$  and  $4.2A$ , but not necessarily in that order. Identify the current corresponding to the four cases as mentioned above and justify.

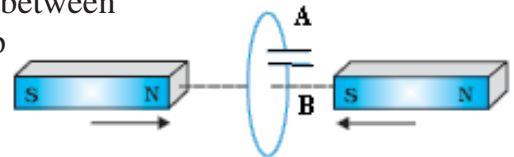
**Q.26>** Derive an expression for the force per unit length between two long straight parallel conductors carrying current. State the rule used to determine the direction of the force

(b) Hence define the SI unit of electric current

**Q.27>** A closed loop is held stationary in the magnetic field between the north and south poles of two permanent magnets held fixed. Can we hope to generate current in the loop by using very strong magnets?

(b) A closed loop moves normal to the constant electric field between the plates of a large capacitor. Is a current induced in the loop

(c) Predict the polarity of the capacitor in the situation described by the figure.



**Q.28>** Derive an expression for the average power loss in the LCR circuit

(b) Define Wattless current and state its formula

(c) Give 2 examples of wattless circuits

**OR**

A small town with a demand of  $800\text{ kW}$  of electric power at  $220\text{ V}$  is situated  $15\text{ km}$  away from an electric plant generating power at  $440\text{ V}$ . The resistance of the two wire line carrying power is  $0.5\ \Omega$  per km. The town gets power from the line through a  $4000\text{-}220\text{ V}$  step-down transformer at a sub-station in the town.

(a) Estimate the line power loss in the form of heat.

(b) How much power must the plant supply, assuming there is negligible power loss due to leakage?

(c) Characterize the step up transformer at the plant.

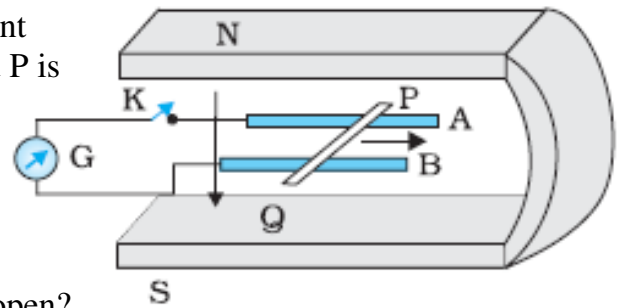
### Section D

#### Case study questions

**Q.29>** Read the following paragraph and answer the questions.

Figure shows a metal rod  $PQ$  of length  $L$  resting on the rails  $AB$  and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field  $B$  are in three mutually perpendicular directions and the circuit has a net resistance of  $R$ . A galvanometer  $G$  connects the rails through a switch  $K$ . Answer the following

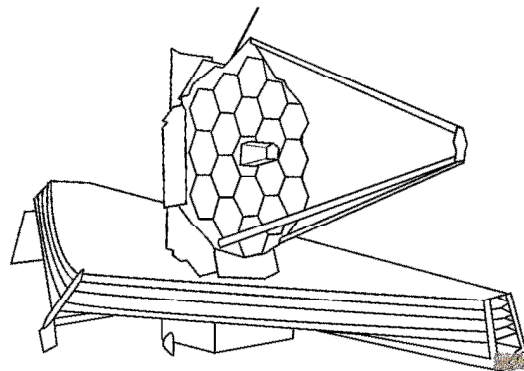
- (i) Suppose K is open and the rod moves with a constant speed  $v$  in the direction shown. The polarity of end P is
- Positive
  - Negative
  - Neutral
  - Can not be determined



- (ii) What is the retarding force on the rod when key is open?
- $F = B^2 L^2 v / R$
  - No force
  - $F = B^2 L v / R$
  - None
- (iii) In what form is the energy dissipated when the rod moves with the key closed
- Sound energy
  - Magnetic energy
  - Heat energy
  - Light energy
- (iv) What is the induced emf in the rod with key open
- $BLv$
  - $B^2 L^2 v$
  - Zero
  - None of these

**Q.30>** Optical instruments are usually made by a combination of several lenses. For example, a compound microscope consists of two lenses. A lens of short aperture and short focal length facing the object is called the object lens and another lens of short focal length but larger aperture is called the eye lens. Magnifying power is defined as the ratio of angle subtended by the final image at the eye to the angle subtended by the object if seen directly, when both are placed at least distance of distinct vision. An astronomical telescope also used two convex lenses and the objective has a very large aperture.

Since its difficult to have large apertures in lenses and due to the aberrations, we prefer a telescope having an objective mirror. The recently made James Webb Telescope is one such example which has been successfully deployed in space.



- (i) A reflecting telescope uses which shape of primary objective mirror
- Convex
  - Concave
  - Elliptical
  - Parabolic

- (ii) The basic advantage of preferring the above shape is
- To reduce spherical aberration
  - To eliminate chromatic aberration
  - To increase the magnification
  - All of these
- (iii) For a refracting telescope which combination would be preferred
- Objective lens of high focal length and eye piece of low focal length
  - Objective lens of low focal length and eye piece of high focal length
  - Both lenses of low focal length
  - Both lenses of high focal length
- (iv) If a convex lens and a convex mirror are immersed in water, what is the effect on focal length
- Increases for convex lens and decreases for convex mirror
  - Increases for convex mirror and decreases for convex lens
  - Increases for convex lens and remains same for convex mirror
  - Decreases for convex lens and remains same for convex mirror

### Section E

**Q.31>** Using phasor diagram approach, derive an expression for the net impedance of LCR circuit

- Derive the expression for source frequency  $f_0$  when the net impedance of circuit is minimum
- Draw on separate graphs, the variation of current with source frequency for two similar LCR circuits having just different values of resistances  $R_1$  and  $R_2$ .

OR

When a circuit element 'X' is connected across an AC source, a current of  $\sqrt{2}A$  flows through it and this current is in phase with the applied voltage. When another element 'Y' is connected across the same AC source, the same current flows in the circuit but it leads the voltage by  $\pi/2$  radians.

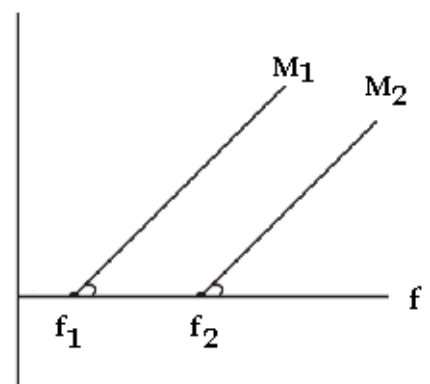
- Name the circuit elements X and Y.
- Find the current that flows in the circuit when series combination of X and Y is connected across same AC voltage.
- Plot a graph showing variation of the obstruction offered by X versus the source frequency

**Q.32>** The given graph shows the variation of stopping potential  $V_s$  versus frequency for two different metal  $M_1$  and  $M_2$ .

- What is the work function of  $M_1$  and  $M_2$ ?
- The value of stopping potential for  $M_1$  and  $M_2$  for a frequency  $f_3 > f_2$  are  $V_1$  and  $V_2$  respectively.

Show that the slope of the graph equals  $\frac{V_1 - V_2}{f_2 - f_1}$

- Why is the slope of both the graphs same?



**OR**

Draw Einstein's experimental setup for studying the photoelectric effect.

(b) State the 4 laws of photoelectric effect

(c) What conclusion can be drawn from these experimental observations?

**Q.33>** An early model for an atom considered it to have a positively charged point nucleus of charge  $Ze$ , surrounded by a uniform density of negative charge up to a radius  $R$ . The atom as a whole is neutral. For this model, apply Gauss theorem and find electric field at a distance  $r$  from the nucleus for cases where  $r < R$  and  $r > R$

**OR**

State Gauss theorem and write its mathematical expression

(b) Justify why the flux of a closed surface is not affected by the presence of an outside charge

(c) Use this theorem to prove that the electric field due to a large plane surface charge density is independent of the distance from the charge

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ALL THE BEST

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