

CBSE Class 12 Physics 2020 - 55/B/1 - Compartment



Question Paper

Conducted by the Central Board of Secondary Education (CBSE)

Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **37 questions**. All questions are **compulsory**.
- (ii) The question paper is divided into Sections A, B, C, D.
- (iii) Section A - Questions 1 to 20 carry 1 mark each.
- (iv) Section B - Questions 21 to 27 carry 2 marks each.
- (v) Section C - Questions 28 to 34 carry 3 marks each.
- (vi) Section D - Questions 35 to 37 carry 5 marks each.
- (vii) There is no overall choice. Where an internal choice is provided, attempt only one of the alternatives.
- (viii) Use of calculators is not permitted.

You may use the following values of physical constants wherever necessary:

$$\begin{aligned}c &= 3 \times 10^8 \text{ m/s} \\h &= 6.63 \times 10^{-34} \text{ Js} \\e &= 1.6 \times 10^{-19} \text{ C} \\\mu_0 &= 4\pi \times 10^{-7} \text{ T m A}^{-1} \\\epsilon_0 &= 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2} \\\frac{1}{4\pi\epsilon_0} &= 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}\end{aligned}$$

$$\begin{aligned}\text{Mass of electron } (m_e) &= 9.1 \times 10^{-31} \text{ kg} \\\text{Mass of neutron} &= 1.675 \times 10^{-27} \text{ kg} \\\text{Mass of proton} &= 1.673 \times 10^{-27} \text{ kg} \\\text{Avogadro's number} &= 6.023 \times 10^{23} \text{ per gm mole} \\\text{Boltzmann constant} &= 1.38 \times 10^{-23} \text{ JK}^{-1}\end{aligned}$$

Section A

1. The potential difference applied across a given conductor is doubled. The mobility of the electrons in the conductor

- (A) is doubled. (B) is halved.
(C) remains unchanged. (D) becomes four times.

2. A charge particle is placed between the plates of a charged parallel plate capacitor. It experiences a force F . If one of the plates is removed, the force on the charge particle becomes

- (A) F (B) $2F$
(C) $\frac{F}{2}$ (D) Zero

3. Two electrons of charge ' e ' each move in the same circular path of radius ' r ' with a constant speed ' v ' each. The magnetic moment associated with the motion of these electrons is

- (A) evr (B) $\frac{evr}{2}$
(C) ev (D) $\frac{4\pi^2 r^3 e}{v}$

4. Two particles of masses m_1 and m_2 have equal charges. They are accelerated from rest through a potential difference V and then enter in a region of uniform magnetic field $\vec{B}$. If they describe circular paths of radii r_1 and r_2 , respectively, then the value of m_1/m_2 is

- (A) $\left(\frac{r_2}{r_1}\right)^2$ (B) $\frac{r_1 V}{r_2 B}$
(C) $\left(\frac{r_1}{r_2}\right)^2$ (D) $\frac{r_1^2 V}{r_2^2 B}$

5. The oscillating electric and magnetic field vectors in an electromagnetic wave are

- (A) perpendicular to each other and opposite in phase. (B) parallel to each other and opposite in phase.
(C) perpendicular to each other and in the same phase. (D) parallel to each other and in the same phase.

6. A window is provided in the middle of a wall. Its image is obtained on the opposite wall at a distance ' d ' from it using a lens. If the window and its image are of the same size, then the focal length of the lens used is

- (A) $+\frac{d}{4}$ (B) $+\frac{d}{2}$
(C) $-\frac{d}{4}$ (D) $-\frac{d}{2}$

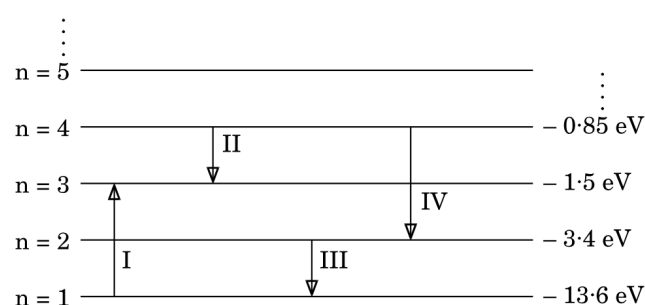
7. A heavy particle initially at rest in a state of rest spontaneously splits into two particles of masses m_1 and m_2 having non-zero velocities. The ratio of de Broglie wavelengths associated with the particles is

- (A) m_1/m_2 (B) m_2/m_1
(C) 1 (D) $\sqrt{m_2}/\sqrt{m_1}$

8. During the process of β^- decay,

- | | |
|--|--|
| (A) an atomic electron is ejected. | (B) an electron which was already present in the nucleus, is ejected. |
| (C) a neutron is converted into a proton and the created electron is ejected from the nucleus. | (D) a proton is converted into a neutron and the created electron is ejected from the nucleus. |

9. The figure shows the energy level diagram of hydrogen atom with a few transitions marked. Which transition shows the emission of a photon with maximum energy?



- | | |
|---------|--------|
| (A) I | (B) II |
| (C) III | (D) IV |

10. When the temperature of an n-type semiconductor is increased, then the

- | | |
|---|---|
| (A) number of free electrons increases while that of the holes decreases. | (B) number of holes increases while that of the free electrons decreases. |
| (C) number of free electrons and holes remains unchanged. | (D) number of both the free electrons and the holes increase equally. |

11. In an unbiased p-n junction diode, the p-side of the junction is at _____ potential as compared to that on the n-side of the junction.

12. An electron in hydrogen atom jumps from the state $n = 3$ to the state $n = 1$. The change in the angular momentum of the electron will be _____.

OR

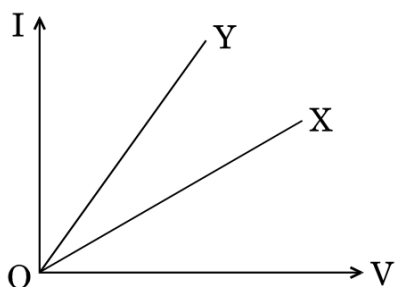
The energy equivalent of 10 g of a substance is _____ J.

13. Young's double slit experiment is performed by using green, red and blue monochromatic light sources, one at a time. The value of the fringe width will be maximum in case of _____ light.

14. In a single slit diffraction experiment, the phase difference between the waves originating from the two edges of the slit at the first minimum of the diffraction pattern is _____ rad.

15. A magnetic needle free to rotate in a vertical plane orients itself vertically at a certain place on earth. The value of angle of dip at this place is _____.

16. The I-V characteristics of two wires X and Y at constant temperature are shown in the figure. The two wires have equal lengths and diameters. Which of them is made up of material of larger resistivity?

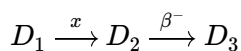


17. Write the dimensions of self-inductance of a coil.

18. A cell of emf 'E' and internal resistance 'r' is connected across a variable external resistor 'R'. Plot the variation of voltage drop 'V' across the resistor as a function of 'R'.

19. A biconvex lens made up of glass of refractive index 1.5 forms a real image of an object in air. If the whole set-up were immersed in a liquid of refractive index 1.7, then how will the nature of the image be affected?

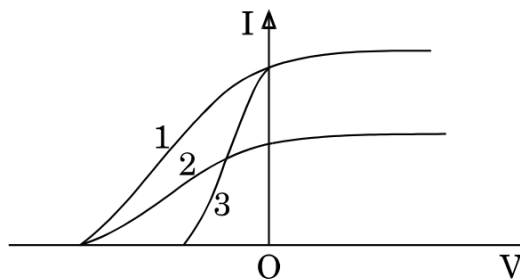
20. The sequence of successive decay of a radioactive nucleus is shown as under:



If the atomic number and mass number of D_1 are 72 and 180 and those of D_3 are 71 and 176 respectively, identify the particle x.

OR

The three curves shown below represent the variation of photocurrent and applied voltage for two different materials using two different intensities of a monochromatic light. Identify the two curves which are for the same material.



Section B

21. Two point charges q and $-q$ are located at $(0, 0, -a)$ and $(0, 0, a)$ respectively.

(a) Depict the equipotential surfaces due to this arrangement.

(b) Find the amount of work done in moving a small test charge q_0 from point $(l, 0, 0)$ to $(0, 0, 0)$.

22. (a) Give the sequence of colour bands found on a $47\text{ k}\Omega \pm 10\%$ carbon resistor.

(b) Write two properties of manganin which make it a suitable material for making standard resistors.

23. An ac source, $V = 40 \sin(1000t + \pi/3)$ volt, is connected in series with an inductor $L = 0.4\text{ H}$, a capacitor $C = 10\text{ }\mu\text{F}$ and a resistor $R = 400\text{ }\Omega$. Calculate:

(a) the impedance of the circuit, and

(b) the peak value of current.

24. Why are infrared radiations also referred to as heat waves? Write the names of radiations which lie next to infrared radiations in the electromagnetic spectrum on

(a) shorter wavelength side, and

(b) longer wavelength side.

25. A radioactive substance is reduced to $\frac{1}{16}$ th of its original mass after 4 days. Find the critical mass of the substance so that 4 g of substance is left after 6 days.

OR

In the Geiger-Marsden experiment, an α -particle of 5.12 MeV energy approaches a gold target ($Z = 79$), comes momentarily to rest and then reverses its direction. Find the distance of closest approach of the α -particle to the target nucleus.

26. Draw the plot of the binding energy per nucleon as a function of mass number for different nuclei. The nuclei lying at the middle flat portion of the curve are more stable. Explain.

27. Give reasons for the following facts:

(a) The zener diode is fabricated using heavily doped p-side and n-side of the junction.

(b) A photodiode used as a detector of optical signals, is operated under reverse bias.

OR

With the help of a circuit diagram, explain the working of a silicon p-n junction diode in forward biasing and draw its I-V characteristics.

Section C

28. The thickness of a conductor continuously decreases from one end (A) to another end (B). It is connected across the terminals of a battery. What will be the effect on the values of

- (a) electric field,
- (b) current density, and
- (c) mobility of the electrons

at a point on the conductor as one moves from end A to end B?

29. (a) With the help of a diagram, explain the working of a cyclotron used to accelerate ions.

(b) What will happen to the motion of the ions if the applied frequency of the alternating voltage is not equal to the resonance frequency?

30. (a) Write the principle of working of an ac generator. Derive the expression for the induced emf generated in it.

(b) Write the function of slip rings in an ac generator.

OR

In a step-up voltage transformer, explain, giving reasons, the following facts:

- (a) The output current is less than the input current.
- (b) The iron core is laminated.
- (c) The input power is more than the output power.

31. A concave mirror produces a two times enlarged virtual image of an object kept 10 cm away from the mirror.

- (a) Find the focal length of the mirror.
- (b) By how much distance should the object be displaced, and in what direction, in order to get a two times enlarged real image of the object?

32. With the help of a ray diagram, explain the formation of image in a compound microscope when the final image is formed at the near point. Obtain the expression for the magnifying power in this case.

33. Light of wavelength $2000 \text{ \AA}$ is incident on a metal surface of work function 4.2 eV in an experiment on photoelectric effect.

- (a) Find the maximum kinetic energy (in eV) of ejected photoelectrons.
- (b) If the intensity of light is doubled, find the change in stopping potential.

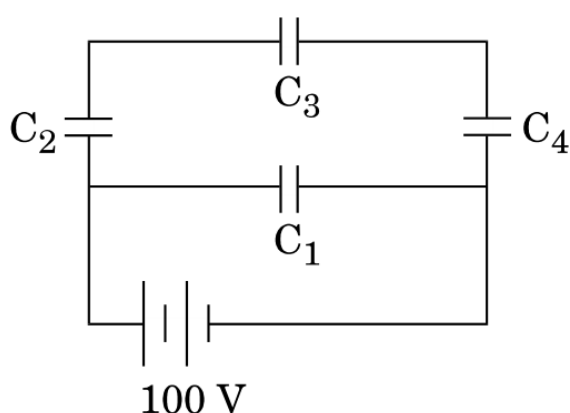
34. Draw the circuit diagram of a full-wave rectifier using two p-n junction diodes. Explain its working and draw its input and output waveforms.

Section D

35. (a) Consider a system of two parallel metal plates of area 'A', each placed at a separation 'd' in air. Derive the expression for the capacitance of this parallel plate capacitor.

(b) If the two plates of the capacitor have $+q$ and $-q$ charges, respectively, find the force experienced by the negative plate due to the positive plate.

(c) A network of four capacitors, each of capacitance $12\ \mu\text{F}$, is connected to a battery of $100\ \text{V}$ as shown in the figure. Find the total charge stored in the network.

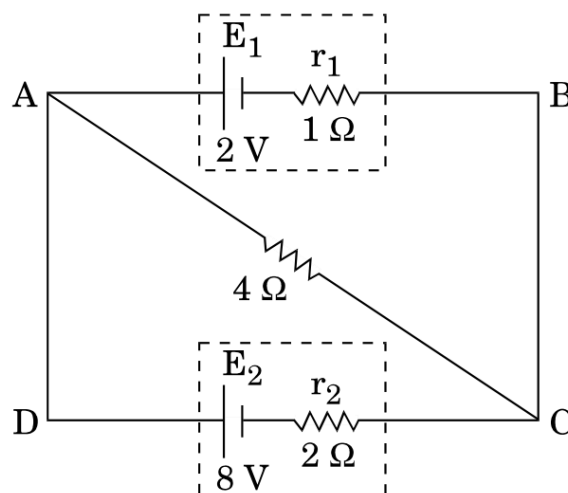


OR

(a) State the principle of working of Wheatstone bridge. With the help of a circuit diagram, explain how it is used in the determination of the specific resistance of the material of a wire using a metre bridge.

(b) A cell of emf $E_1 = 2\ \text{V}$ and internal resistance $r_1 = 1\ \Omega$ is connected to another cell of emf $E_2 = 8\ \text{V}$ and internal resistance $r_2 = 2\ \Omega$ through an external resistance of $4\ \Omega$ as shown in the figure. Find the potential difference between point A and point C.

35. (continued)



36. (a) With the help of a diagram, explain the working of a moving coil galvanometer. Justify the necessity of using a radial magnetic field in it.

(b) A galvanometer can be converted into a voltmeter to measure up to

(i) V volt by connecting a resistance of $2\text{ k}\Omega$ in series with the galvanometer.

(ii) 2 V volt by connecting a resistance of $5\text{ k}\Omega$ in series with the galvanometer.

Calculate the resistance that should be connected in series with the galvanometer to convert it into a voltmeter to measure up to $\frac{V}{2}$ volt.

OR

(a) A conducting rod XY of length l slides on two smooth parallel rails PM and QN with a uniform velocity v . The resistances of the rod and the rails are negligible. A uniform magnetic field $\vec{B}$ perpendicular to the plane $PMNQ$ is present in the region pointing vertically upwards. A small resistance r is connected between the ends M and N of the rails. Obtain

(i) the expression for emf induced across the ends of the rod and its polarity.

(ii) the magnitude and direction of induced current that flows through resistance r .

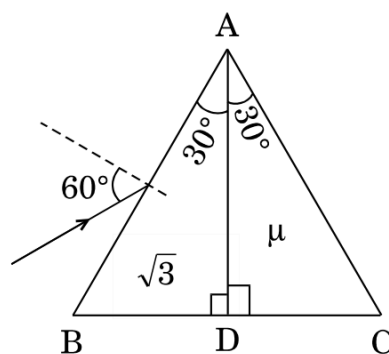
(b) Two coplanar and concentric circular loops are of radii 0.5 cm and 11 cm , respectively. These loops are placed in a uniform external magnetic field of 0.4 T acting perpendicular to their plane. Calculate the mutual inductance of the arrangement.

37. (a) Draw ray diagrams to show the use of total internal reflection for:

(i) an optical fibre

(ii) a prism which turns a ray through 90°

(b) A composite prism ABC is made of two identical right-angled prisms ABD and ADC joined together, made of different materials of refractive indices $\sqrt{3}$ and μ . A ray of light is incident on face AB of this prism at 60° as shown in the figure. It is observed that the final emergent ray grazes along face AC . Find the value of μ .



OR

(a) A point object is situated on the principal axis of a convex spherical surface of radius of curvature R . This spherical surface separates the medium in which the object is situated (refractive index μ_1) from a medium of refractive index μ_2 . This surface forms a real image of the object. Draw the ray diagram to show the formation of the image and derive the relation connecting object distance and image distance in terms of μ_1 , μ_2 and R .

(b) An unpolarised light beam of intensity 2 mW passes successively through two parallel polarising sheets P_1 and P_2 . If the angle between the pass-axes of P_1 and P_2 is made 60° , find the intensity of light transmitted by P_1 and P_2 .

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