CBSE Class 12 Physic Question Paper 2020 Set 3

PHYSICS – SET 3

INSTRUCTIONS:

Read the following instructions very carefully and strictly flow them:

- This question paper comprises four Sections A, B, C and D.
- There are 37 questions in the question paper. All questions are compulsory
- Section A – Question no 1 to 20 are very short answer type questions, carrying one mark each
- Section B – Questions no 21 to 27 are short answer type questions, carrying two marks each
- Section C – Questions no 28 to 34 are long answer type questions, carrying five marks each
- There is no overall choice in the question paper. However, an internal choice has been provided in 2 questions of 1 mark, 2 questions of 2 marks, 1 question of three marks and all the 3 questions of five marks. You have to attempt only one of the choices in such questions.
- In addition to this, separate instructions are given with each, section and question, wherever necessary.
- Use of calculators and log tables is not permitted.
- You may use the following valves of physical constants wherever necessary.

$c = 3 \times 10^{8}$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9\times10^{9}\,Nm^2c^{-2}$.

Mass of electron (m_e) = 9.1×10^{-31} kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = 1.38×10^{-23} JK^{-1}

SECTION – A

1. A biconvex lens of glass having refractive index 1.47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is **[1]**
   (A) 1.47 (B) 1.62 (C) 1.33 (D) 1.51
2. For a glass prism, the angle of minimum deviation will be smallest for the light of **[1]**
   (A) red colour (B) blue colour (C) yellow colour (D) green colour
3. Which of the following statement is not correct according to Rutherford model? **[1]**
   (A) Most of the space inside an atom is empty.
   (B) The electrons revolve around the nucleus under the influence of coulomb force acting on them.
   (C) Most part of the mass of the atom and its positive charge are concentrated at its centre.
   (D) The stability of atom was established by the model.
4. Photons of energies 1 eV and 2 eV are successively incident on a metallic surface of work function 0.5 eV. The ratio of kinetic energy of most energetic photoelectrons in the two cases will be **[1]**
   (A) 1 : 2 (B) 1 : 1 (C) 1 : 3 (D) 1 : 4
5. The magnetic dipole moment of a current carrying coil does not depend upon **[1]**
   (A) number of turns of the coil. (B) cross-sectional area of the coil.
   (C) current flowing in the coil. (D) Material of the turns of the coil.
6. The conductivity of a metal decreases with the increase in temperature on account of **[1]**
   (A) decrease in number density of electrons. (B) decrease in resistivity.
   (C) decrease in relaxation time. (D) increase in mean free path.
7. Two unequal resistors are connected in series across a battery. Then the **[1]**
   (A) Potential difference across each resistor is the same.
   (B) Current in the smaller resistor is larger.
   (C) Potential difference across the bigger resistor is greater.
   (D) Power dissipated in both resistors is the same.
8. A point charge is situated at an axial point of a small electric dipole at a large distance from it. The charge experiences a force F. If the distance of the charge is doubled, the force acting on the charge will become **[1]**
   (A) 2F (B) F/2 (C) F/4 (D) F/8
9. If the net electric flux through a closed surface is zero, then we can infer **[1]**
   (A) no net charge is enclosed by the surface.
   (B) uniform electric field exists within the surface.
   (C) electric potential varies from point to point inside the surface.

(D) charge is present inside the surface.

10. The focal length of the objective of a compound microscope is **[1]**

    (A) greater than the focal length of eyepiece.

    (B) lesser than the focal length of eyepiece.

    (C) equal to the focal length of eyepiece.

    (D) equal to the length of its tube.

Fill in the blanks with appropriate answer:

11. The number of turns of a solenoid are doubled without changing its length and area of cross-section. The self-inductance of the solenoid will become _______ times. **[1]**
12. According to Bohr's atomic model, the circumference of the electron orbit is always an _______ multiple of de Broglie wavelength. **[1]**

    OR

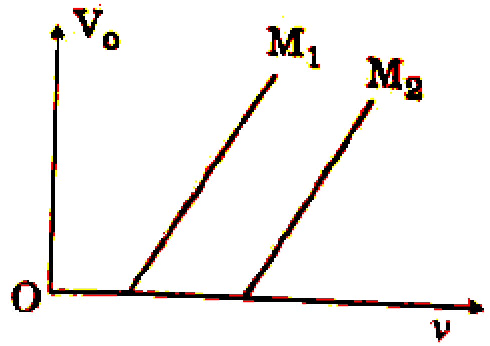
    In β-decay, the parent and daughter nuclei have the same number of ______. **[1]**
13. A ray of light on passing through an equilateral glass prism, suffers a minimum deviation equal to the angle of the prism. The value of refractive index of the material of the prism is ______ **[1]**
14. The magnetic field lines are ________ by a paramagnetic substance. **[1]**
15. Laminated iron sheets are used to minimize ________ currents in the core of a transformer. **[1]**

Answer the following:

16. The nuclear radius of $^{27}_{13}Al$ is 3.6 fermi. Find the nuclear radius of $^{64}_{29}Cu$. **[1]**

    OR

    A proton and an electron have equal speeds. Find the ratio of de Broglie wavelengths associated with them. **[1]**
17. The variation of the stopping potential (V_0) with the frequency (v) of the light incident on two different photosensitive surfaces M_1 and M_2 is shown in the figure. Identify the surface which has greater value of the work function. **[1]**



18. Why cannot we use Si and Ge in fabrication of visible LEDs? **[1]**
19. Differentiate between conduction current and displacement current. **[1]**
20. How does an increase in doping concentration affect the width of depletion layer of a p-n junction diode? **[1]**

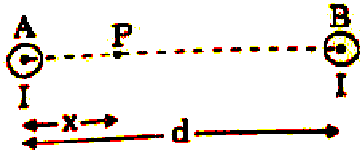
SECTION – B

21. Explain the terms 'depletion layer' and 'potential barrier' in a p-n junction diode. How are the (a) width of depletion layer, and (b) value of potential barrier affected when the p-n junction is forward biased? **[2]**
22. Using Bohr's atomic model, derive the expression for the velocity of electron revolving in the n^{th} orbit of hydrogen atom. **[2]**

OR

Explain, how the process of emission of photoelectrons is different from the process of emission of β-particles. **[2]**

23. Two long straight parallel wires A and B separated by a distance d, carry equal current I flowing in same direction as shown in the figure. **[2]**



(a) Find the magnetic field at a point P situated between them at a distance x from one wire.

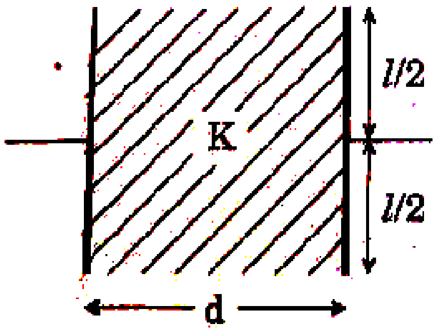
(b) Show graphically the variation of the magnetic field with distance x for $0 < x < d$.

24. Define wavefront of a travelling wave. Using Huygens principle, obtain the law of refraction at a plane interface when light passes from a denser to rarer medium. **[2]**

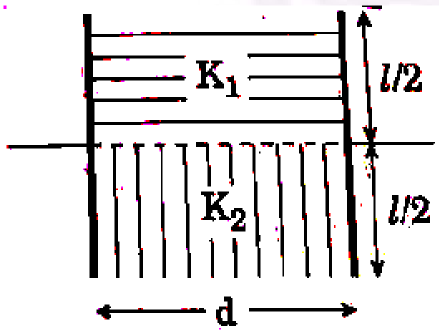
OR

Using lens maker's formula, derive the thin lens formula $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ for a biconvex lens. **[2]**

25. Define the term 'Half-life' of a radioactive substance. Two different radioactive substances have half-lives T_1 and T_2 and number of undecayed atoms at an instant N_1 and N_2, respectively. Find the ratio of their activities at that instant. **[2]**
26. The space between the plates of a parallel plate capacitor is completely filled in two ways. In the first case, it is filled with a slab of dielectric constant K. In the second case, it is filled with two slabs of equal dimensions but dielectric constants K_1 and K_2, respectively as shown in the figure. The capacitance of the capacitor is same in the two cases. Obtain the relationship between K, K_1 and K_2. **[2]**



(Case 1)



(Case 2)

27. Explain the principle of working of a meter bridge. Draw the circuit diagram for determination of an unknown resistance using it. **[2]**

SECTION – C

28. (a) Write the expression for the speed of light in a material medium of relative permittivity ε_r and relative magnetic permeability μ_r. **[3]**

    (b) Write the wavelength range and name of the electromagnetic waves which are used in (i) radar systems for aircraft navigation, and (ii) Earth satellites to observe the growth of the crops.
29. Give reasons for each of the following: **[3]**

    (a) The intensity of light at some points on the screen in Young's double slit experiment is zero.

    (b) The intensity of light transmitted by a polaroid is less than the intensity of the unpolarised light incident on it.

    (c) In the single slit diffraction experiment, some coloured fringes around the central white maximum are observed on the screen when one uses a source of white light.

30. Draw the circuit diagram of a full wave rectifier using two p-n junction diodes. Explain its working and show input and output voltage variations. **[3]**
31. (a) Two cells of emf E_1 and E_2 have their internal resistances r_1 and r_2, respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across an external resistance R. Assume that the two cells are supporting each other.

    (b) In case the two cells are identical, each of emf E = 5 V and internal resistance r = 2 Ω, calculate the voltage across the external resistance R = 10 Ω. **[3]**
32. A resistance R and a capacitor C are connected in series to an ac source $V = V_0 \sin \omega t$. **[3]**

    (a) Obtain the expression for the instantaneous current (I) in the circuit.

    (b) Show graphically variations of V and I as a function of ωt.
33. (a) Write an expression of magnetic moment associated with a current (I) carrying circular coil of radius r having N turns. **[3]**

    (b) Consider the above mentioned coil placed in YZ plane with its centre at the origin. Derive expression for the value of magnetic field due to it at point (x, 0, 0).

    (OR)

    (a) Define current sensitivity of a galvanometer. Write its expression. **[3]**

    (b) A galvanometer has resistance G and shows full scale deflection for current I_g.

    (i) How can it be converted into an ammeter to measure current up to $I_0 \left(I_0 > I_g\right)$?

    (ii) What is the effective resistance of this ammeter?
34. The nucleus $^{235}_{92}Y$, initially at rest, decays into $^{231}_{90}X$ by emitting an α-particle.

    $^{235}_{92}Y \longrightarrow ^{231}_{90}X + ^{4}_{2}He +$ energy. **[3]**

SECTION – D

35. (a) Draw the ray diagram of an astronomical telescope when the final image is formed at infinity. Write the expression for the resolving power of the telescope. **[5]**

    (b) An astronomical telescope has an objective lens of focal length 20 m and eyepiece of focal length 1 cm.

    (i) Find the angular magnification of the telescope.

    (ii) If this telescope is used to view the Moon, find the diameter of the image formed by the objective lens. Given the diameter of the Moon is 3.5×10^6 m and radius of lunar orbit is 3.8×10^8 m.

    (OR)

(a) An object is placed in front of a concave mirror. It is observed that a virtual image is formed. Draw the ray diagram to show the image formation and hence derive the mirror equation $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$. **[5]**

(b) An object is placed 30 cm in front of a plano-convex lens with its spherical surface of radius of curvature 20 cm. If the refractive index of the material of the lens is 1.5, find the position and nature of the image formed.

36. (a) Using Gauss law, derive expression for electric field due to a spherical shell of uniform charge distribution σ and radius R at a point lying at a distance x from the centre of shell, such that **[5]**

(i) $0 < x < R$, and (ii) $x > R$.

(b) An electric field is uniform and acts along +x direction in the region of positive x. It is also uniform with the same magnitude but acts in –x direction in the region of negative x. The value of the field is E = 200 N/C for x > 0 and E = -200 N/C for x < 0. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one flat face is at x = + 10 c and the other is at x = -10 cm.

Find:

(i) The net outward flux through the cylinder.

(ii) The net charge present inside the cylinder.

(OR)

(a) Find the expression for the potential energy of a system of two point charges q_1 and q_2 located at $\vec{r_1}$ and $\vec{r_2}$, respectively in an external electric field $\vec{E}$. **[5]**

(b) Draw equipotential surfaces due to an isolated point charge (-q) and depict the electric field lines.

(c) Three point charges +1 μC, -1 μC and +2 μC are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side 10 cm.

37. (a) Derive the expression for the torque acting on the rectangular current carrying coil of a galvanometer. Why is the magnetic field made radial? **[5]**

(b) An α-particle is accelerated through a potential difference of 10 kV and moves along x-axis. It enters in a region of uniform magnetic field B = 2 × 10^{-3} T acting along y-axis. Find the radius of its path. (Take mass of α-particle = 6.4 × 10^{-27} kg)

(OR)

(a) With the help of a labelled diagram, explain the working of a step-up transformer. Give reasons to explain the following: **[5]**

(i) The core of the transformer is laminated.

(ii) Thick copper wire is used in windings.

(b) A conducting rod PQ of length 20 cm and resistance 0.1 Ω rests on two smooth parallel rails of negligible resistance AA' and CC'. It can slide on the rails and the arrangement is positioned between the poles of a permanent magnet producing uniform magnetic field B = 0.4 T. The rails, the rod and the magnetic field are in three mutually perpendicular directions as shown in the figure. If the ends A and C of the rails are short circuited, find the

(i) external force required to move the rod with uniform velocity v = 10 cm/s, and

(ii) power required to do so.