Physics (042)
Class: SS2 A and B
Set-B

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(8)

M.M: 70

Time: 3 Hours

General Instructions:

1. There are 8 pages and 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 one mar each, Section B contains five questions of two marks each, Section C contains seven questions o three marks each, Section D contains two case-study based questions of four marks each and Sectio E contains three long answer questions of five marks each.
5. There is no overall choice. However, an internal choice has been provided in two questions in Sectio B, two questions in Section C, one question in each case-based question 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.
7. You may use the following values of physical constants where ever necessary.

$c = 3 \times 10^8$ m/s, $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C, $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1},

$h = 6.63 \times 10^{-34}$ Js, $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$

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

SECTION A

1. In full wave rectifier circuit operating from 50Hz main frequency, the fundamental frequency in the ripple would be 1

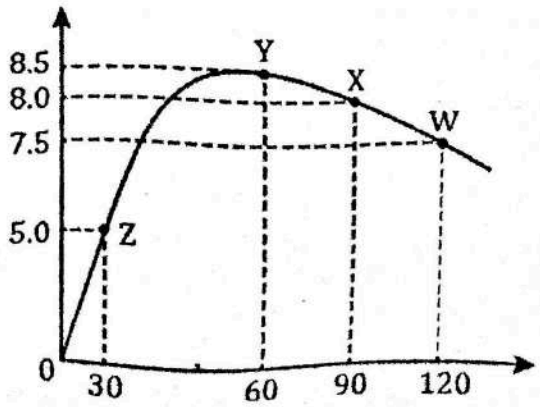
(a) 25Hz (b) 50Hz (c) 100Hz (d) 70.7Hz

2. In a single slit diffraction experiment first minimum for red light (660 *nm*) coincides with first maximum of some other wavelength λ'. The value of λ' is 1

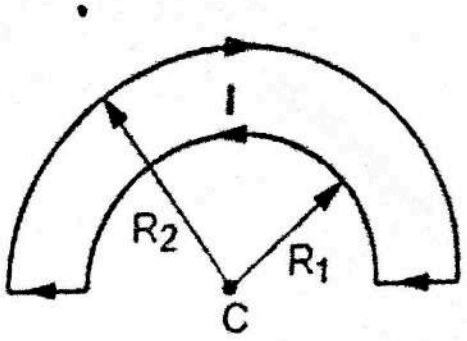
(a) 4400 Å (b) 6600 Å (c) 2000 Å (d) 3500 Å

3. Figure shows a roughly approximated curve of binding energy per nucleon with mass number. *W*, *X*, *Y* and *Z* are four nuclei indicated on the curve. According to this curve, the process that would release energy is: 1

(a) Y→2Z
(b) W→X+Z
(c) W→2Z
(d) X→Y+Z



4. The wire loop formed by joining two semicircular sections of radii R_1 and R_2, and carries a current I, as shown. The magnetic field at C has magnitude



a) $\frac{\mu_0 I}{2}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$

b) $\frac{\mu_0 I}{4}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$

c) $\frac{\mu_0 I}{2}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

d) $\frac{\mu_0 I}{4}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

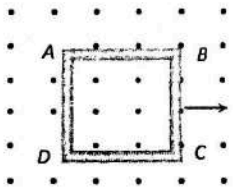
5. An alternating e.m.f. of angular frequency ω is applied across an inductance. The instantaneous power developed in the circuit has an angular frequency 1

(a) $\omega/4$ (b) $\omega/2$ (c) $\omega/4$ (d) 2ω

6. Two spheres of radii a and b respectively are charged and joined by a wire. The ratio of electric field of the sphere is 1

(a) a/b (b) b/a (c) a^2/b^2 (d) b^2/a^2

7. A metallic square loop *ABCD* is moving in its own plane with velocity *v* in a uniform magnetic field perpendicular to its plane as shown in the figure. An electric field is induced 1



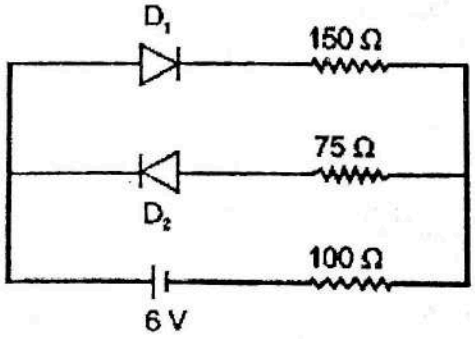
(a) In *AD*, but not in *BC*

(b) In *BC*, but not in *AD*

(c) Neither in *AD* nor in *BC*

(d) In both *AD* and *BC*

8. The circuit shown in the fig. contains two diodes each with a forward resistance of 50Ω and with infinite backward resistance. If the battery voltage is 6V, the current through the 100Ω is 1



(a) zero (b) 0.03A (c) 0.02A (d) 0.036A

9. In photoelectric effect when photons of energy $h\nu$ fall on a photosensitive surface (work function $h\nu_o$ electrons are emitted from the metallic surface with a kinetic energy. It is possible to say that: 1

a) All ejected electrons have same kinetic energy equal to $h\nu - h\nu_o$

b) The ejected electrons have a distribution of kinetic energy from zero to $(h\nu - h\nu_o)$

c) The most energetic electrons have kinetic energy equal to $h\nu_0$
d) (d) All ejected electrons have kinetic energy $h\nu_0$

10. Proper arrangement of Gamma rays, Microwave, IR wave and UV rays in ascending order of frequency is 1
a) Gamma rays > UV rays > IR rays > Microwave
b) Microwave > IR rays > UV rays > Gamma rays
c) UV rays > Gamma rays > Microwave > IR rays
d) IR rays > UV rays > Microwave > Gamma rays

11. Which of the following series in the spectrum of the hydrogen atom lies in the visible region of the electromagnetic spectrum? 1
a) Paschen series
b) Balmer series
c) Lyman series
d) Brackett series

12. Two point charges +q and -q are held fixed at (-d,0) and (d,0) respectively of a (x,y) coordinate system. Then 1
a) The electric field E at all points on the y-axis is along $\hat{i}$
b) The electric field E at all points on the x-axis has the same direction
c) Dipole moment is 2qd directed along $\hat{i}$
d) Work has to be done in bringing a test charge from infinity to the origin

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.
a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
c) If assertion is true but reason is false.
d) If the assertion and reason both are false.

13. Assertion: The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased. 1
Reason: On increasing temperature, conductivity of metallic wire decreases.

14. Assertion: Torque on a coil is minimum, when coil is suspended in a radial magnetic field. 1
Reason: The Torque tends to rotate the coil about its own axis.

15. Assertion: Interference pattern is made by using blue light instead of red light, the fringes becomes narrower. 1
Reason: In Young's double slit experiment, fringe width is given by relation $\beta = \frac{\lambda D}{d}$.

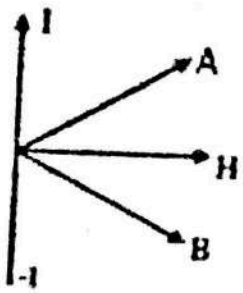
16. Assertion: When a dielectric is placed in an electric field, the electric field with in the dielectric as well as potential difference across the capacitor plates are reduced by a factor of K (battery is not connected) 1
Reason: the Dielectric constant is the ratio of the absolute permittivity of the dielectric to

the permittivity of the free space.

SECTION B

17. Name the constituent radiation of electromagnetic spectrum which 2
    a) is used in satellite communication.
    b) is used for studying crystal structure.
    c) 21cm (wavelength emitted by atomic hydrogen in interstellar space).
    d) Produces intense heating effect.

18. The following fig. shows the variation of intensity of magnetization v/s the applied magnetic field intensity H for two magnetic materials A and B. 2
    (i) Identify the material A and B.
    (ii) Draw the variation of susceptibility with temperature for both A and B.



19. Four charges q, -q, q, -q are arranged at the four corners A, B, C, D of square of sided d. Find the work required to put together this arrangement. 2

OR

Two-point charges q_1 and q_2 located at r_1 and r_2 respectively in an external electric field E. Obtain the expression for the total work done in assembling this configuration.

20. With the help of suitable diagram, describe briefly the two important processes involved in the formation of a p-n junction. 2

OR

Three diodes are made of semiconductor having band gaps of 2.5eV, 2eV and 3eV respectively. Which ones will be able to detect light of wavelength 6000A°? 2

21. The rated values of two bulbs are (P_1, V) and (P_2, V). Find actual power consumed by both of them if they are connected in 2
    a) Series
    b) Parallel, and V is the potential difference is applied across both of them.

SECTION C

22. (a) Compute the ratio of radii of two nuclei with mass number 1 and 27, respectively.
    (b) A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV is split into two fragments Y and Z of mass number 110 and 130. The binding energy of nucleons in Y and Z is 8.85 MeV per nucleon. Calculate the energy Q released per fission in MeV. 3

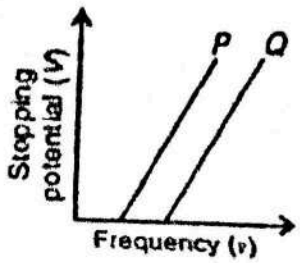
23. State Biot- Savart law and apply it to find the magnetic field due to a circular loop carrying current at any axial point. 3

24. State Huygen's Principle. Using this principle explain the laws of refraction. 3

25. The wavelength λ of a photon and the de Broglie wavelength of an electron have the same value. Show that energy of the photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of the electron. 3

OR

Two graphs between the stopping potential V and frequency ν of the incident radiation on two different metal plates P and Q are as shown in fig. (a) Which metal, out of P and Q has the greater value of work functions and larger threshold wavelength? (b) What does the slope of the line depict? (c) Explain giving reason which metal gives out electrons having larger kinetic energy, for the same wavelength of the incident radiation.



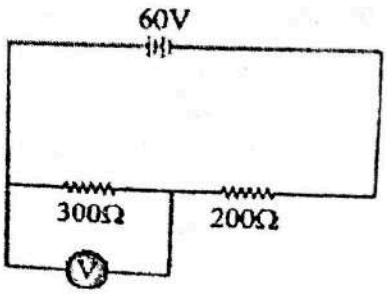
26. Draw a circuit diagram of full wave rectifier. Explain its working principle. Draw the input and output waveforms indicating the functions of two diodes used. 3

27. The electron in a given Bohr orbit has a total energy of -1.5eV. Calculate its (a)kinetic energy, (b) Potential energy & (c) Wavelength of light emitted, when the electron makes a transition to the ground state. Ground state energy is -13.6eV? 3

28. Two cells of emf 1.5V and 2V and internal resistance 1Ω and 2Ω respectively are connected in parallel to pass a current in the same direction through and external resistance of 5Ω. (i) Draw the circuit diagram. (ii) Using Kirchhoff's laws, calculate the current through each branch of the circuit and potential difference across the 5Ω resistor. 3

OR

In the circuit shown, the reading of voltmeter is 20V. Calculate resistance of voltmeter. What will be the reading of voltmeter if this is put across 200Ω resistance? 3



SECTION D

29. A microscope is an instrument that gives a magnified image of an object. A simple microscope consists of one convex lens of small focal length but a compound microscope consists of two convex lenses (one objective and other as eyepiece) of small focal length. Objective lens forms the inverted magnified image of object and eye lens forms the inverted image of the object. Magnification of microscope is inversely proportional to the focal lengths of lens.

i. For which color the magnification of a simple microscope is highest? 1
a) red b) violet c) yellow d) green

ii. Which pair of lenses is best suitable for compound microscope?

Lenses	Power	Aperture
L_1	3D	8cm
L_2	6D	1cm
L_3	10D	1cm

a) L_1 & L_2 b) L_2 & L_3 c) L_1 & L_3 d) Any two lenses.

iii. Magnification of eyepiece in compound microscope is 1
a) Positive b) Negative c) Zero d) It can have any value.

iv. Total magnification of compound microscope is 1
a) Positive b) Negative c) Zero d) It can have any value.

30. Metal Detector

At an airport, Akshita is made to walk through the doorway of a metal detector, for security reasons. If Akshita is carrying anything made of metal, the metal detector produces a sound. Being a science student, she found that when you walk through a metal detector, you are, in fact, walking through a coil of many turns. When you walk through with metal in your pocket, the resistance of the circuit changes – resulting in significant change in current in the circuit. This change in current is detected and the electronic circuitry causes a sound to be emitted as an alarm.

i. On what principle does this metal detector work? 1
(a) Electromagnetic Induction
(b) Resonance in AC circuit
(c) Mutual Induction
(d) Lenz's Law

ii. A circuit is said to be in Resonance if 1
(a) Current is maximum
(b) Impedance is maximum
(c) Emf lags the current
(d) Current lags the emf

iii. Resonance phenomenon is exhibited by a circuit only
(a) if both R and L are present in the circuit
(b) if both R and C are present in the circuit 1
(c) if both L and C are present in the circuit
(d) if L is present in the circuit

iv. Selectivity of circuit is large if
(a) Both L and R both are large 1
(b) L is large and R is small

(c) L is small and R is large
(d) Both L and R are small

31. (a) what is induced emf? Write Faraday's law of electromagnetic induction. Express it mathematically. 2

(b) a conducting rod of length 'l' with one end pivoted, is rotated with a uniform angular speed 'ω' in a vertical plane, normal to a uniform magnetic field 'B'. Deduce an expression for the emf induced in this rod. If resistance of rod is R. what is the current induced in it. 3

OR

(a) Explain with the help of a labelled diagram the underlying principle and working of a step-up transformer. Why cannot such a device be used to step up dc voltage? 3

(b) Explain with an example, how power loss is reduced if the energy is transmitted over long distances as an alternating current rather than a direct current. 2

32. (a)Using Gauss's law derive an expression for the electric field at any point due to an infinite plane sheet of surface charge density σ C/m^2. Draw the field lines when the charge density of sheet is (i) positive (ii) negative. 3

(b) A uniformly charged conducting sphere of 2.5m in diameter has a surface charge density of 100μC/m^2. Calculate the 2

i. Charge on the sphere,
ii. Total electric flux passing through the sphere.

OR

(a)Establish a relation for electric potential due to a short dipole at a distance 'r' from the center of dipole inclined at an angle θ from the dipole axis. Hence obtain value of electric potential at a point lying along (i) axial line, (ii) equatorial line of dipole. 3

(b) Two-point charges +4μC and -2μC are separated by a distance of 1m in air. Calculate at what point on the line joining the two charges is the electric potential zero. 2

33. (a) Two independent monochromatic sources of light cannot produce a sustained interference pattern. Give reason. 1

(b) Light waves each of amplitude "a" and frequency "ω" emanating from two coherent light sources superpose at a point. If the displacements due to these waves is given by y_1 = a cosωt and y_2 = a cos(ωt+ϕ), where ϕ is the phase difference between the two, obtain the expression for the resultant intensity at the point. 2

(c) In young's double slit experiment, using monochromatic light of wavelength λ, the intensity of light at a point on the scene where path difference isλ,is K units. Find out the intensity of light at a point where path difference is $\lambda/3$ 2

OR

Fig. shows an equiconvex lens of refractive index 1.5 in contact with a liquid layer on top of a plane mirror. A small needle with its tip on the principal axis is moved along the axis until its final inverted image is found at the position of the needle. The distance of the 5

needle from the lens is measured to be 45cm. The liquid is removed and the experiment is repeated. The new distance is measured to be 30cm. What is the refractive index of the liquid?