Subject: PHYSICS   M.M: 70
Date :   11 /01/ 2016   Time: 3 Hour

General Instructions
1. All questions are compulsory. There are 26 questions in all.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A contains five questions of one mark each, Section B contains five questions of two marks each, Section C contains twelve questions of three marks each, Section D contains one value based question of four marks and Section E contains three questions of five marks each.
4. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
5. You may use the following values of physical constants wherever necessary.
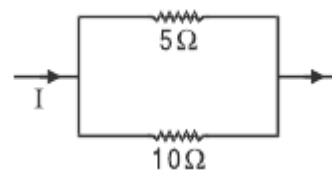
$c = 3 \times 10^8$ m/s	$m_e = 9.1 \times 10^{-31}$ kg
$h = 6.63 \times 10^{-34}$ Js	mass of neutron $= 1.675 \times 10^{-27}$ kg
$e = 1.6 \times 10^{-19}$ C	mass of proton $= 1.673 \times 10^{-27}$ kg
$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}	Avogadro's number $= 6.023 \times 10^{23}$ per
$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}	gram mole
$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}	Boltzmann constant $= 1.38 \times 10^{-23}$ JK^{-1}

Section A

1. What is the direction of magnetic Lorentz force acting on a moving charge with respect to the magnetic field and its velocity?   1
2. An electric current flows in a horizontal wire from east to west. What will be the direction of magnetic field due to the current at a point north of the wire?   1
3. A concave mirror, of aperture 4 cm, has a point object on its principal axis at a distance of 10 cm from the mirror. The image formed by the mirror is not likely to be sharp image. State the likely reason for the same.   1
4. Two metals A and B have work function 4 eV and 10 eV respectively. Which metal has the higher threshold frequency?   1
5. What is GPS?   1

Section B

6. The sum of two point charges is 7μC. They repel each other with force of 1N when kept 30 cm apart in free space. Calculate the value of each charge.   2
7. In the arrangement shown in the figure, what fraction of current I flows through 5 ohm resistor?   2

8. Define: (i) retentivity and (ii) Coercivity.   2
9. Two identical waves each of intensity I are producing an interference pattern. Find the value of the resultant intensity at a point of (i) constructive interference and (ii) destructive interference.   2
    OR
A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is at a distance of 2.5 mm from the center of the screen, Find the width of the slit.

10. Which mode of propagation is used for frequencies ranging from few MHz to 30 MHz? Explain diagrammatically how long distance communication can be achieved by this mode. Why is there an upper limit to frequency of wave used in this mode?   2

Section C

11. Figure shows gaussian surface for an infinitely long thin straight wire of uniform linear charge density. Answer the following: 3
    - (i) For which surface is the electric flux zero?
    - (ii) Over which surface is $E = 0$?
    - (iii) Over which surface is $\left|\vec{E}\right| = constant$?

12. An ammeter of resistance 0.8 ohms can measure current up to 1.0 A.   3
    - (i) What must be the value of shunt resistance to enable the ammeter can measure current up to 5.0 A?
    - (ii) What is the combined resistance of the ammeter and the shunt?

<div align="center">OR</div>

For the circuit shown in figure, would the balancing length increase, decrease or remain the same, if (i) R_1 is decreased (ii) R_2 is increased, without any other change in the rest of the circuit? Justify your answer in each case.
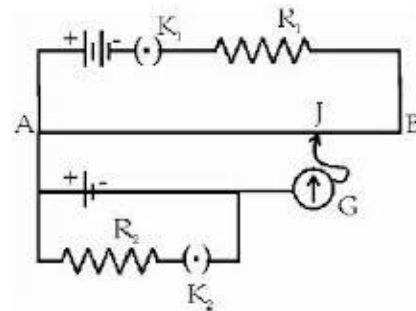
13. A conducting rod XY slides freely on two parallel rails, A and B, with uniform velocity 'v'. A galvanometer 'G' is connected as shown in figure and the closed circuit has a total resistance of 'R'. A uniform magnetic field, perpendicular to the plane defined by the rails A and B and the rod XY (which are mutually perpendicular is present over the region as shown.   3
    - (i) With key 'K' open:
        - (a) Find the nature of charges developed at the ends of the rod XY.
        - (b) Why do the electrons in the rod XY experience no net force even though the magnetic force is acting on them due to the motion of the rod?
    - (ii) How much power needs to be delivered by the external agency to keep the rod moving at its uniform speed when the key is (a) closed and (b) open?
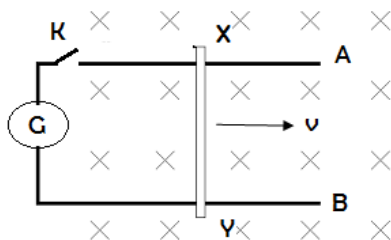

14. Three students X, Y and Z performed an experiment for studying the variation of alternating currents with angular frequency in a series LCR circuit and obtained the graphs shown.   3
    They all used ac source of the same rms value and inductance of same value.
    What can you say about the
    - (i) Capacitance value
    - (ii) Resistance value
    Used by them? In which case will the quality factor be maximum? What can you say about nature of the impedance at frequency f_r?
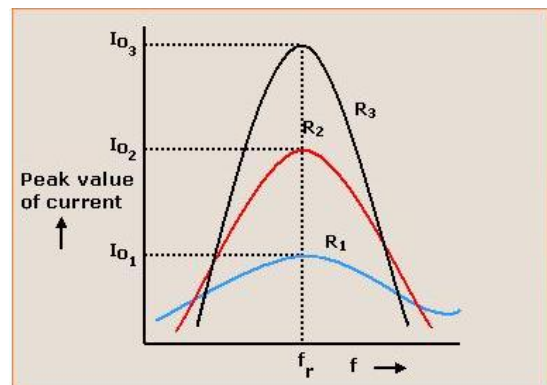
15. When a circuit element 'X' is connected across an ac source, a current of $\sqrt{2}$ A flows through it and this current is in phase with the applied voltage. When another element 'Y' is connected across the same ac source, the same current flows in the circuit but it leads the voltage by $\frac{\pi}{2}$ 3

radians.
- (i) Name the circuit elements X and Y.
- (ii) Find the current that flows in the circuit when the series combination of X and Y is connected across the same ac source.
- (iii) Plot a graph showing variation of the net impedance of this series combination of X and Y as a function of the angular frequency ω of the applied voltage.

16. (a) Write the formula for the velocity of light in a material medium of relative permittivity ε_r and relative magnetic permeability μ_r. **3**
(b) The following table gives the wavelength range of some constituents of the electromagnetic spectrum.

S. No.	Wavelength range
1	1 mm to 700 nm
2	0.1 m to 1 mm
3	400 nm to 1 nm
4	$< 10^{-3}$ nm

Select the wavelength range and the name the electromagnetic waves that are used in
- (i) Radar system for aircraft navigation
- (ii) Satellites to observe growth of crops.

17. Use the mirror equation to show that **3**
(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) An object placed between the pole and focus of a concave mirror produces a virtual and enlarged image.

18. Two convex lenses of equal focal length but of aperture A1 and A2 (A2 < A1) are used as the objective of in two astronomical telescopes having identical eyepieces. **3**
Compare the ratio of their (i) normal magnifying power and (ii) intensity of images formed by them. Which one of the two telescopes should be preferred?

19. The spectrum of a star in the visible and the UV region was observed and the wavelength of some of the lines that could be identified were found to be: **3**
824 °A, 970 °A, 1120 °A, 2504 °A, 5173 °A, 6100 °A
Which of these lines cannot belong to hydrogen atom spectrum? Given Rydberg constant R = 1.03×10^7 m^{-1} and 1/R = 970 °A. Support your answer with suitable calculations.

20. Explain with the help of a circuit diagram, the use of p-n junction diode as a full wave rectifier. Sketch the input and the output waveforms. **3**

21. Answer the following: **3**
a) In a transistor doping level in base is increased slightly. How will it affect (i) the collector current and (ii) base current?
b) What will be the change in collector current if the size of the base if increased?
c) For a CE mode amplifier has β = 50. The base current and collector resistance are 30 μA and 1000 Ω respectively. Determine the voltage across collector resistance.

22. Show through a diagram the Amplitude modulated wave and Frequency modulated wave. Give one advantage of FM over AM. **3**

Section D

23. Murugan, a resident of Kudankulam was all set to leave everything and shift to another place in view of the decision of Government to start a nuclear thermal power plant at Kudankulam. His granddaughter Laxmi, a science student, was really upset on the ignorant decision of her grandfather. She could finally convince him not to shift since adequate safety measures to avoid any nuclear mishap had already been taken by the Government before starting the nuclear thermal plant. **4**
- (i) What is the value displayed by Laxmi in convincing her grandfather?
- (ii) What is the principle behind working of a nuclear reactor?
- (iii) What are the main components of nuclear reactor?

Section E

24. a) The figure shows the Q (charge) versus V (potential) graph for a combination of two capacitors. Identify the graph representing the parallel combination.
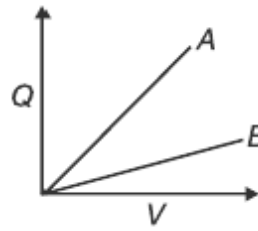
5

b) Two metal spheres A and B of radius r and 2r whose centres are separated by a distance of 6r are given charge Q each, are at potential V_1 and V_2. Find the ratio of V1/ V2. These spheres are connected to each other with the help of a connecting wire keeping the separation unchanged. What is the amount of charge that will flow through the wire?
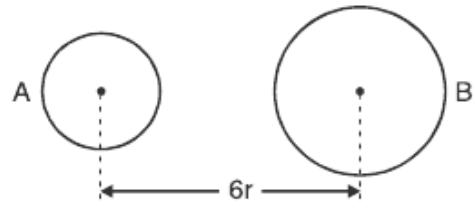
OR

Find the expression for the capacitance of a parallel plate capacitor of area A and distance between the plates 'd', if (i) a dielectric slab of thickness 't' and (ii) a metallic slab of thickness 't' where (t < d) are introduced one by one between plates. In which case would the capacitance be more and why?

25. A moving coil galvanometer has resistance G, number of turns N and radial magnetic field B. Derive an expression for its current sensitivity. If the current sensitivity is increased will the voltage sensitivity also increase?

5

A galvanometer coil has resistance 50 ohms. If the maximum current that can pass through the galvanometer is 30 micorampere, how will you convert it into an ammeter of range (0 – 100 mA)?

OR

A rectangular coil of N turns and carrying a current I is placed in a uniform magnetic field B. Derive the torque experienced by the coil.

Two coils has the following parameter:

Coil A: Number of turns = N, Area of the coil = A and Current passing through = I

Coil B: Number of turns = N/2, Area of the coil = A/2 and Current passing through = 2I

These two coils are placed in a uniform magnetic field B. What is ratio of the torques experienced by them?

26. With the help of a ray diagram, show the formation of image of a point object due to a refraction of light at a spherical surface separating two media of refractive index n1 and n2 (n2 > n1) respectively. Using this diagram, derive the relation

5

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

Write the sign conventions used. What happens to the focal length of convex lens when it is immersed in water?

OR

Draw a graph showing the angle of deviation δ with the variation of angle of incidence i for a monochromatic ray of light passing through a prism of refracting angle A. deduce the relation

$$n = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$