PRE-BOARD EXAMINATION – JAN/FEB 2018

PHYSICS

Class: XII   SET A   M.Marks: 70

Date: Time: 3 Hours

General Instructions:

(i)   *There are 26 questions in all. All questions are compulsory.*

(ii)   *This question paper has five sections: Section A, Section B, Section C, Section D and Section E.*

(iii) *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.*

(iv)   *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.*

Section A

1. Write the expression for the torque $\vec{\tau}$ acting on a dipole of dipole moment $\vec{p}$ placed in an electric field $\vec{E}$.   1

2. A transparent solid cylindrical rod has a refractive index of $2/\sqrt{3}$. It is surrounded by air. A light ray is incident at the mid-point of one end of the rod as shown.
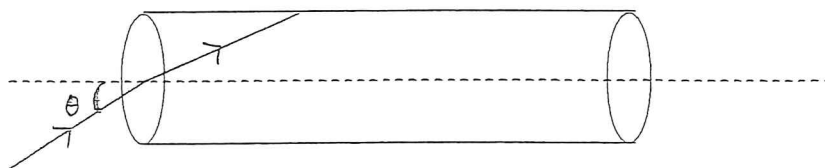
   What is the incident angle θ for which the light ray grazes along the wall of the rod?   1

3. How are radio waves produced?   1

4. Draw a graph to show the variation of resistance of a metal wire as a function of its diameter keeping its length and material constant.   1

5. Show the variation of photocurrent with collector plate potential for different intensity but same frequency of incident radiation. 1

Section B

6. Draw a graph between the amplitude of current versus angular frequency of LCR series circuit connected to ac for two different resistors R1 and R2 (R1> R2). When $\omega < \frac{1}{\sqrt{LC}}$, does the current lead or lag or in phase with voltage? Explain. 2

7. The magnetic field in a plane electromagnetic wave is given by : $B_y = 12 \times 10^{-8} \sin(1.2 \times 10^7 z + 3.60 \times 10^{15} t) \, T$. Calculate the (i) energy density associated with the electromagnetic wave and (ii) speed of the wave. 2

8. (a) When a low flying aircraft passes overhead, we sometimes notice a slight shaking of the picture on our TV screen. Why?

(b) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the shadow of the obstacle. Explain why.

OR

The focal length of a convex lens made of glass is 20 cm. What will be its new focal length when placed in a medium of refractive index 1.25? 2

9. Is it necessary for the transmitting antenna and the receiving antenna to be of the same height for the line of sight communication? Find an expression for maximum line of sight distance d_m between these two antennas of height h_T and h_R. 2

10. Write two points of difference between intrinsic and extrinsic semiconductors. 2

Section C

11. (a) Which mode of propagation is used by shortwave broadcast services having frequency range from few MHz to 30 MHz? Why is there upper limit to frequency of waves used in this mode?

(b) A message signal of frequency 10 kHz and peak voltage of 10 Vis used to modulate a carrier of frequency 1 MHz and peak voltage of 20 V. Determine the modulation index and the sidebands frequency.　　　　　　　　　　3

12. Draw a graph showing the variation of binding energy per nucleon versus the mass number A. Explain with the help of this graph, the release of energy in the process of nuclear fission and fusion.　　　　　　　　　　3

13. Derive an expression for the electric potential at any point along an electric dipole. 5 J of work is done in moving a positive charge of 0.5 C between two points. What is the potential difference between these two points?　　　　　　　　　　3

14. In the following arrangement of capacitors, the energy stored in the 6 μF capacitor is E. Find the value of the following:

  (i) Energy stored in 12 μF capacitor.

  (ii) Energy stored in 3 μF capacitor.

  (iii) Total energy drawn from the battery.
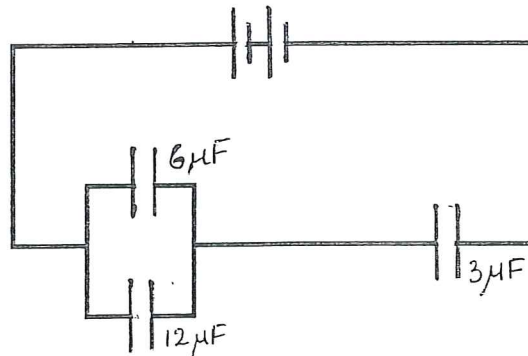
OR

Net capacitance of three identical capacitors in series is 1 μF. What will be their net capacitance if connected in parallel?

Find the ratio of energy stored in the two configurations if they are both connected to the same source.　　　　　　　　　　3

15. Using Bohr's postulates, obtain the expression for the total energy of the electron in the stationary states of the hydrogen atom. Hence draw the energy level diagram showing how the line spectra corresponding to Balmer series occur due to transition between energy levels.　　　　　　　　　　3

16. (i) Define self-inductance. Write its SI units.

(ii) A long solenoid with 15 turns per cm has a small loop of area 2 cm² placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2.0 A to 4.0 A in 0.1 s, what is the induced emf in the loop while the current is changing?

17. (a) The number density of conduction electrons in a copper conductor is 8.5×10^{28} m^{-3}. How long does an electron take to drift from one end of a wire 3 m long to its other end? The area of cross section of the wire is 2×10^{-6} m² and it is carrying a current 3 A.

(b) A wire of resistance 20 Ω is drawn out so that its length is increased to twice its original length. Determine its new resistance.   3

18. (a) Two identical bar magnets of equal magnetic moment are placed one over the other as shown in figure. The system of two bar magnets is made to oscillate freely in external uniform magnetic field, what is the frequency of oscillation?
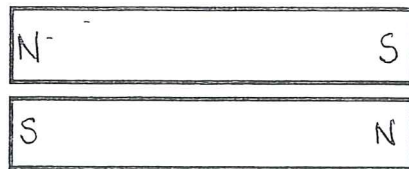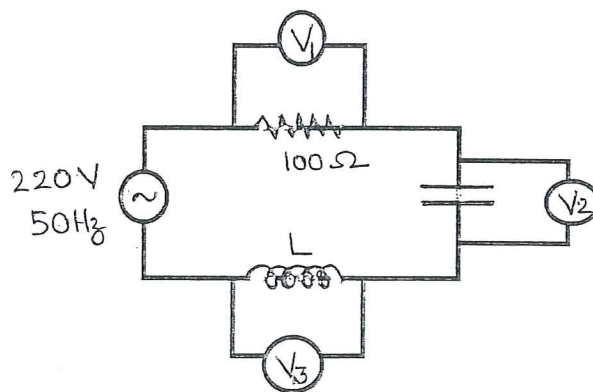

(b) At which place on the earth's surface, the vertical component of magnetic field is zero? What is the angle of dip at that place?

(c) Why do you prefer materials having high retentivity and high coercivity to make permanent magnet?   3

19. A series LCR circuit is connected to an ac source (220 V – 50 Hz) as shown.

If the voltages of the three voltmeters V₁, V₂ and V₃ are 65 V, 415 V and 204 V respectively, calculate:

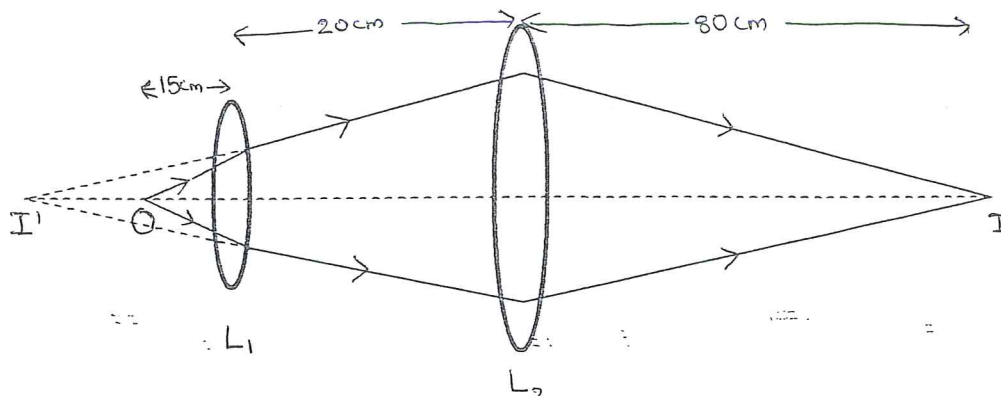(a) the current in the circuit,

(b) the value of the inductance, L

(c) the value of the capacitance, C.   3

20. In the following diagram, an object 'O' is placed 15 cm in front of a convex lens L_1 of focal length 20 cm and the final image is formed at 'I' at a distance of 80 cm from the second lens L_2. Find the focal length of the lens L_2.   3

21. What do you understand by the statement 'Light from the sun is unpolarised'? Explain how does sunlight gets polarised by the process of scattering?   3

22. Find the number of photons emitted per second by a 25 W source of monochromatic light of wavelength 6600 Å. What is the photoelectric current assuming 3% efficiency for photoelectric effect?   3

Section D

23. Rakesh purchased cells for his transistor. He felt that cells are not working properly. He wanted to check their e.m.f. So, he took the cell to the physics lab and with the help of potentiometer found their e.m.f. To his surprise e.m.f. was less than the value claimed by the manufacturer. He lodged the complaint with consumer forum and received the deserving response.

(a) What values are displayed by Rakesh ?

(b) What do you think, why Rakesh used potentiometer instead of voltmeter to find out e.m.f. of the cell? For more precise measurement the potential gradient of the potentiometer should be high or low?   4

Section E

24. Draw a ray diagram showing the image formation of a distant object by a refracting telescope. Define its magnifying power and write the two important factors considered

to increase the magnifying power. Describe briefly the two main limitations and explain how far these can be minimized in a reflecting telescope.

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

(a) What is the effect on the interference fringes in a Young's double slit experiment when

    i.   the separation between the two slits is decreased ?

    ii.   the width of the source slit is increased?

   iii.   the monochromatic source is replaced by a source of white light?

    Justify your answer in each case.

(b) The intensity at the central maxima in Young's double slit experimental set up is I_0. Show that the intensity at a point where the path difference is $\lambda/3$ is $I_0/4$.   5

25. (a) A particle of charge q is moving with a velocity v in the presence of crossed electric field E and magnetic field B as shown. Write the condition under which the particle will continue moving along x-axis. How would the trajectory of the particle be affected if the electric field is switched off?
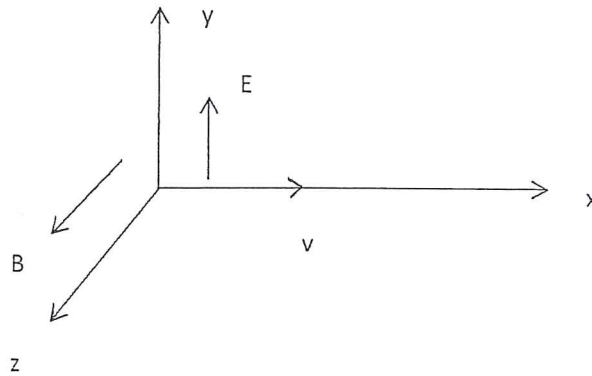
(b) A horizontal wire AB of length l and mass m carries a steady current I_1, free to move in vertical plane is in equilibrium at a height of h over another parallel long wire CD carrying a steady current I_2, which is fixed in a horizontal plane as shown. Derive the expression for the force acting per unit length on the wire AB and write the condition for which wire AB is in equilibrium.
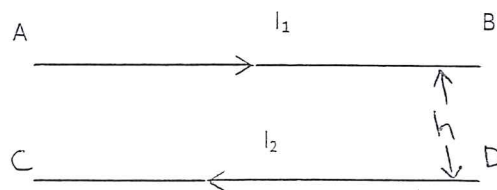
(a) A electron in the ground state of hydrogen atom is revolving in a circular orbit of radius R. Obtain the expression for the orbital magnetic moment of the electron in terms of fundamental constants.

(b) Draw the magnetic field lines for a current carrying solenoid when a rod made of (i) copper, (ii) aluminium and (iii) iron are inserted within the solenoid. 5

26. Draw a circuit diagram to study the input and output characteristics of an n-p-n transistor in its common emitter configuration.

Draw the typical input and output characteristics and explain how these graphs are used to calculate current amplification factor of the transistor.

OR

(a) Define the terms depletion region and barrier potential for a pn junction diode. How does an increase in the doping concentration affect the width of the depletion region?

(b) Draw the circuit of a full wave rectifier. Explain its working. 5