QB365

Model Question Paper 2

12th Standard CBSE

Physics

Reg.No. :

Time : 02:00:00 Hrs

Total Marks : 100

Section-A

1) The self inductance L of a solenoid of length l and area of cross-section A, with a fixed numer of turns N increase as 1

(a) l and A increase (b) l decrease and A increase (c) l increase and A decrease (d) both l and A decrease

2) A metal plate is getting heated. It can be because 1

(a) a direct current is passing through the plate (b) it is placed in a time varying magnetic field

(c) it is placed in a space varying magnetic field, but does not vary with time (d) a current is passing through the plate

3) In an alternating current circuit consisting of elements in series, the current increases on increasing the frequency of supply. Which of the following elements are likely to constitute the circuit? 1

(a) Only resistor (b) Resistor and an inductor (c) Resistor and a capacitor (d) Only a capacitor

4) The electric field intensity produced by the radiations coming from 100 W bulb at a 3m distance is E. The electric field intensity produced by the radiations coming from 50w bulb at the same distance is: 1

(a) $\frac{E}{2}$ (b) $2E$ (c) $\frac{E}{\sqrt{2}}$ (d) $\sqrt{2E}$

5) If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic wave the direction of propagation of electromagnetic wave is along 1

(a) $\vec{E}$ (b) $\vec{B}$ (c) $\vec{B} \times \vec{E}$ (d) $\vec{E} \times \vec{B}$

6) For light diverging from a point source 1

(a) The wavefront is spherical (b) The intensity decrease in proportion to the distance squared (c) The wavefront is parabolic

(d) The intensity at the wavefront does not depend on the distance

7) A source of light lies on the angle bisector of two plane mirror included at angle θThe value of θso that the light reflected from one mirror does not reach the other mirror does not reach each other mirror will be 1

(a) $\theta \geq 120°$ (b) $\theta \geq 90°$ (c) $\theta \geq 90°$ (d) None of the above

8) The relation between focal length f and radius of curvature R of a spherical mirror is 1

(a) $f = R$ (b) $f = R/2$ (c) $f = 2R$ (d) none of these

9) For any position of an object, image formed in a convex mirror is 1

(a) virtual (b) erect (c) smaller in size (d) as far behind the mirror as the object is in front

10) Image of an object in a concave mirror is 1

(a) always real (b) always virtual (c) always erect (d) real or virtual depending on position of object

Section-B

11) When is the magnetic flux crossing a given surface area held in a magnetic field maximum? 1

12) What is the dimensional formula of magnetic flux ? 1

13) A coil intercepts a magnetic flux of 0.2×10^{-2} Wb in 0.1 s. What is the emf induced in the coil ? 1

14) Give an example each of a molecular solid and an ionic solid 1

15) How many atoms per unit cell are present in bcc unit cell? 1

16) Write the features which will distinguish metallic solids from an ionic solids? 1

17) Name the scientist connected with history of an electromagnetic wave 1

18) If the intensity of the incident radio wave of $1 \quad watt/m^2$ is reflected by the surface, Find the pressure exerted on the surfaxe 1

19) What is the time period of the light for which the eye is more sensitive? 1

20) The velocity of electromagnetic waves depends entirely on the ------ and ------ properties of the medium in which these waves travel. 1

Section-C

21) An artificial satellite with a metal surface is orbiting the earth around the equator : Will the earth's magnetism induce some current in it ? 2

22) An artificial satellite with a metal surface is orbiting the earth around the poles. Will there be any induced current due to earth's magnetic field ? 2

23) A solenoid with an iron core and a bulb are connected to a d.c. source. How does the brightness of the bulb change when iron core is removed from the solenoid? 2

24) Show that the current leads the voltage in phase by $\pi/2$ in an ac circuit containing an ideal capacitor. 2

25) You are given a $2\mu F$ parallel plate capacitor. How would you establish an instantaneous displacement current of 1 mA in the space between its plates? 2

26) Show that the radiation pressure exerted by an EM wave of intensity I on a surface kept in vacuum is I/c. 2

27) An EM wave exerts pressure on the surface on which it is incident.Justify. 2

28) How are the magnitudes of the electric and magnetic fields related to the velocity of the EM wave? 2

29) Two thin lenses of power +3D and -1D are held in contact with each other.Focal length of the combination is: 2

30) Do interference effects occur for sound waves?Recall that sound is a longitudinal mechanical wave while light is transverse and non-mechanical? 2

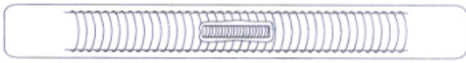
31) How does the angular width of principal maximum in the diffraction pattern vary with the width of slit? 2

32) What is diffraction due to? 2

Section-D

33) A coil of inductance 0.50H and resistance 100Ω is connected to a 240V, 50 Hz ac supply. (a) What is the maximum current in the coil? (b) What is the time lag between the voltage maximum and the current maximum? 3

34) Figure shows a short solenoid of length 4cm, radius 2.0 cm and number of turns 100 lying inside on the axis of a long solenoid, 80 cm in length and number of turns 1500. What is the flux through the long solenoid if a current 3.0 A flows through the short solenoid? Also obtain the mutual inductance of the two solenoids. 3



35) What is the magnetic flux through each turn of a solenoid of self inductance $8.0X10^{-5}H,$ when a current of **3.0 A** flows through it? Assume that the solenoid has 1000 turns and is wound from wire of diameter 1.0 mm. What is the cross sectional area of the solenoid? 3

Section-E

36) Suppose the loop in Q.4 is stationary, but the current feeding the electromagnet that produces the magnetic field is gradually reduced so that the field decreases from its initial value of 0.3 T at the rate of 0.02T/sec. If the cut is joined and loop has a resistance of 1.6Ω, how much power is dissipated by the loop as heat? What is the source of this power? 3

37) A 44 m H inductor is connected to 220V, 50Hz a.c. supply. Determine the r.m.s. value of current in the circuit. 3

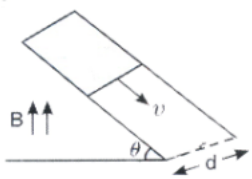
38) A 60μF capacitor is connected to a 110V, 60Hz a.c.supply. Determine the r.m.s. value of current in the circuit. 3

39) A plane electromagnetic wave travels in vacum along z-direction. What can you say about the direction of its electric and magnetic field vectors? If the frequency of the wave is 30 MHz, what is its wavelength? 3

Section-F

40) A series LCR circuit with L=0.12 H, C=480 nF, R=23 Ω is connected to a 230 V variable frequency supply. (a) What is the source frequency for which current amplitude is maximum? Obtain this maximum value. (b) What is the source frequency for which average power absorbed by the circuit is maximum? Obtain the value of this maximum power. (c) For which frequencies of the source is the power transferred to the circuit half the power at resonant frequency? What is the current amplitude at these frequencies? (d) What is the Q-factor of the given circuit? 5

41) A rod of mass m and resistance R slides smoothly over two parallel perfectly conducting wires kept sloping at an angle θ with respect to the horizontal. The circuit is closed through a perfect conductor at the top. There is a constant magnetic field B along the vertical direction. If the rod is initially at rest, find the velocity of the rod as a function of time. 5



42) A long solenoid 'S' has 'N' turns per metre, with diameter 'a'. At the centre of this coil we place a smaller coil of 'N' turns and diameter 'b' (where b<a). If the current in the solenoid increases linearly, with time, what is the induced emf appearing in the smaller coil. Plot graph showing nature of variation in emf, if current varies as a function of $mt^2 + C.$ 5

43) The magnetic flux through a coil perpendicular to its plane and directed into paper is varying according to the relation $\phi = (5t^2 + 10t + 5)$ milliweber. Calculate the e.m.f. induced in the loop at t = 5s. 5

Section-G

44) A square loop of side 10cm and resistance 0.70ohm is placed vertically in the east-west plane. A uniform magnetic field of 0.10T is set up across the plane in north-east direction. The magnetic field is decreased to zero in 0.7 sec. at a steady rate. Determine the magnitudes of induced e.m.f. and current during this time interval. 5

45) Obtain the temperature ranges for ultraviolet part of radiation of e.m. waves. Use the formulae $\lambda_m T = 2.9 \times 10^{-3} mK.$ Take frequency of ultraviolet part of radiations as 8 x 10^{14} Hz to 5 x 10^{17} Hz. 5

46) Calculate the separation of two points on the moon that can be resolved using 600 cm telescope. Given distance of moon from earth=$3.8 \times 10^{10} cm$ The wavelength most sensitive to eye is $5.5 \times 10^{-5} cm$ 5

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Section-A

1) (b) l decrease and A increase 1

2) (a) a direct current is passing through the plate 1

3) (c) Resistor and a capacitor 1

4) (a) $\frac{E}{2}$ 1

5) (a) $\vec{E}$ 1

6) (a) The wavefront is spherical 1

7) (a) $\theta \geq 120°$ 1

8) (b) $f = R/2$ 1

9) (d) as far behind the mirror as the object is in front 1

10) (d) real or virtual depending on position of object **1**

Section-B

11) The magnetic flux is maximum when area is held perpendicular to the direction of magnetic field. **1**

12) $\Phi = BAcos\Phi = (\frac{F}{Il})A = \frac{MLT^{-2}}{AL}.L^2$ $= [ML^2T^{-2}A^{-1}]$ **1**

13) $|e| = \frac{d\Phi}{dt} = \frac{0.2\times10^{-2}}{0.1} = 0.02 \quad V$ **1**

14) Examples of Molecular solid : Solid SO_2, NH_3, I_2 Examples of Ionic solid : NaCI,ZnS,CuCI **1**

15) 2 **1**

16) Metallic solids are ductile malleable whereas ionic solids are not **1**

17) Maxwell, Hertz, Bose and Marconi **1**

18) Pressure exerted by reflected wave on the surface is $P = \frac{2I}{c} = \frac{2\times1}{3\times10^8} = 6.67\times10^{-9}N/m^2$ **1**

19) Eye is most sensitive to the light of wavelength $\lambda = 5600 \quad \dot{A}$ Time period. $T = \frac{1}{v} = \frac{\lambda}{c} = \frac{5600\times10^{-10}}{3\times10^8} \quad = 1.87\times10^{-15}s$ **1**

20) electric ; magnetic **1**

Section-C

21) No, current is induced. This is because orbiting satellite intercepts only the vertical component of earth's magnetic field, which is zero at the equator. **2**

22) **2**

Yes, induced current will be there. This is because, at poles, earth's magnetic field is totally vertical. The orbiting satellite will intercept this field and emf will be induced.

23) The brightness of bulb remains unchanged because the solenoid does not offer any reactance $\left(X_L = 2\pi vL\right)$ to d.c. source $(v = 0)$ **2**

24) $V = V_0 sin\omega t q = CV = CV_0 sin\omega t I = \frac{dq}{dt} = \omega CV_0 cos\omega t$ **2**

So, the current leads the applied voltage, in phase by $\pi/2$.

25) Here, I_D = 1 mA = 10^{-3}A ; C = $2\mu F$ = 2 x 10^{-6} F, $I_D = I = \frac{d}{dt}(CV) = C\frac{dV}{dt}$ **2**

Therefore, $\frac{dV}{dt} = \frac{I_D}{C} = \frac{10^{-3}}{2\times10^{-6}} = 500V/s$

Therefore, applying a varying potential difference of 500 V/s would produce a displacement current of desired value.N

26) Pressure **2**

$P = \frac{force}{area} = \frac{F}{A} = \frac{1}{A}(\Delta p/\Delta t)\times\frac{c}{c}$ $\left[\because F = \frac{\Delta p}{\Delta t} = rate \quad of \quad change \quad of \quad momentum\right]$

$\therefore \quad P = \frac{1}{Ac\Delta t}\times c\Delta p = \frac{1}{Ac\Delta t}\times\Delta U \qquad ..(i)$

(where c $\Delta p = \Delta U$= energy imparted by wave in time Δt

Intensity, $I = \frac{energy \quad imparted}{area\times time} = \frac{\Delta U}{A\Delta t} = Pc$

P = I/c

27) Since electromagnetic waves carry both energy and momentum, therefore, they exert pressure on the surface on which they are incident. **2**

28) $\frac{E^0}{B^0} = c$ **2**

29) P=P_1+P_2=+3-1 = 2D **2**

F= 100/P=100/2=**50 cm**

30) **2**

Yes, because interference is a wave phenomenon, which takes place for waves which may be longitudinal or transverse; mechanical or non-mechanical.Waves should be of same type and coherent.

31) Angular width of principal maximum **2**

$= 2\theta = \frac{2\lambda}{a}$

Clearly it is inversely proportional to width (a) of the slit.

32) **2**

Diffraction is due to interference of secondary wavelets from the portion of wavefront allowed to pass through aperture or from the portion of wave front not blocked by the obstacle.

Section-D

33) (a) I_o=1.82 A (b) 3.2 ms **3**

34) $l_1 = 4cm = 4 \times 10^{-2}m, \quad R_2 = 2 \times 10^{-2}m$ Importance of the symmetry of mutual inductance defined by N_2 is given by $\phi_2 = M_{21}I_1$ and defined by N_1 is given by $\phi_1 = M_{12}I_2$ Suppose 1 represents the long solenoid and 2 the short solenoid. We are given I_2 and asked to find $N_1\phi$. The long solenoid produces a (simple) uniform field inside given by $\mu_0 N_1 I_1$. Flux through each turn of the short solenoid $= BA$ $= \left(\mu_0 N_1 I_1 l_1\right)\pi R_2^2$ where R_2 is the radius of the short solenoid. Therefore $\left(\frac{\mu_0 N_1 I_1}{l_1}\right) \times \pi R_2^2 \times N_2 = M_{21}I_1$ $M_{21} = M_{12} = \frac{\mu_0 \pi R_2^2 N_1 N_2}{l_1}$ $= \frac{4\pi \times 10^{-7} \times 3.14 \times 2^2 \times 100 \times 1500 \times 100}{100 \times 100 \times 4}$ $= 296 \times 10^{-4}H$ The total flux linked with the long solenoid is $N_1\phi_1 = M_{12}I_1$ $= \frac{\mu_0 \pi R_2^2 N_1 N_2}{l_2} I_2$ $\phi = \frac{4\pi 10^{-7} \times 3.14 \times 2^2 \times 100 \times 1500 \times 3}{4 \times 100 \times 100}$ $= 8.9 \times 10^{-4}Wb.$ **3**

35) $2.4X10^{-7}Wb; 6.37X10^{-5}m^2$ **3**

Section-E

36) **3**

$Here, \quad A = 8 \times 2 = 16cm^2 = 16 \times 10^{-4}m^2 \frac{dB}{dt} = \quad 0.02telsa/sec, \quad e = ? \quad e = \frac{d\phi}{dt} = \frac{AdB}{dt} = 16 \times 10^{-4} \times 0.02 = 0.32 \times 10^{-4}voltNow, \quad R = 1.6\Omega Induced \quad current, \quad i = \frac{e}{R} = \frac{0.32 \times 1}{1.6}$

Power dissipated as heat = $i^2R = (0.2 \times 10^{-4})^2 \times 1.6 = 0.064 \times 10^{-8}$ watt = 6.4×10^{-10} watt

37) $Here, \quad L = 44mH = 44 \times 10^{-3}H, \ E_v = 220V, \ v = 50Hz, \ I_v = ?X_L = \omega L = 2\pi vL = 2 \times \frac{22}{7} \times 50 \times 44 \times 10^{-3} = 13.83ohm I_v = \frac{E_v}{X_L} = \frac{220}{13.83} = 15.9A$ **3**

38) Here, C=60μ F=60 × 10^{-6} F, E_v=110V, v=60hz, I_v=? **3**

$I_v = \frac{E_v}{X_C} = \frac{E}{1/2\pi vC} = (2\pi vC)E_v = 2 \times 3.14 \times 60 \times \left(60 \times 10^{-6}\right) \times 110 = 2.49A$

39) E and B are in $x - y$ plane and are mutually perpendicular. Given $v = \quad 30 \quad MHz = \quad 30 \quad \times \quad 10^6 \quad Hz c = \quad 3 \quad \times \quad 10^8 \quad ms^{-1} \lambda = \quad \frac{c}{v} = \frac{3 \times 10^8}{30 \times 10^6} = 10 \quad m$ **3**

Section-F

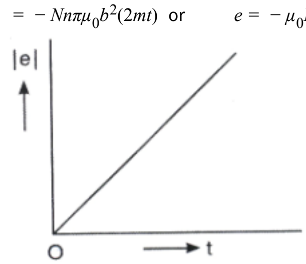
40) (a) V_o=663 Hz; I_o=14.14 A (b) V_o=663 Hz; P_{max}=2300 W (c) 648 Hz; 678 Hz; 10 A (d) 21.7 **5**

41) **5**

Component of magnetic field perpendicular to the plane $= B\cos\theta$ $\therefore$ Motional emf across two ends of rod $= v(B\cos\theta)d$ So induced current $I = \frac{v(B\cos\theta)d}{R}$ The current carrying rod experience force $F = IBd$ (horizontally backward) Component of magnetic force parallel to inclined plane along upward $= F\cos\theta = IBd\cos\theta$ $= \frac{v(B\cos\theta)dBd\cos\theta}{R}$ Also component of weight (mg) parallel to inclined plane along downward $= mg\sin\theta$ From Newton's second law of motion $m\frac{d^2x}{dt^2} = mg\sin\theta - \frac{B^2\cos^2\theta . d}{R}\left(\frac{dx}{dt}\right)$ or $\frac{dv}{dt} = g\sin\theta - \frac{B^2d^2}{mR}cos^2\theta. v$ or $\frac{dv}{dt} + \frac{B^2d^2}{mR}cos^2\theta. v = g\sin\theta$ or $v = \frac{g\sin\theta}{\frac{B^2d^2\cos^2\theta}{mR}} + Ae^{-\frac{B^2d^2\cos^2\theta . t}{mR}}$ where A is an arbitrary constant whose value is to be determined from initial conditions. or $v = \frac{mgR\sin\theta}{B^2d^2\cos^2\theta}\left[1 - e^{-\frac{B^2d^2\cos^2\theta . t}{mR}}\right]$

42) **5**

Magnetic field due to a solenoid S $B = \mu_0 nI$ Magnetic flux in smaller coil $\phi = NBA$ $\left[A = \pi b^2\right]$ $\therefore$ Induced emf in smaller coil $e = -\frac{d\phi}{dt} = -\frac{d}{dt}(NBA)$ $= -N\pi b^2\frac{dB}{dt} = -N\pi b^2\frac{d}{dt}\left(\mu_0 nI\right)$ $= -N\pi b^2\mu_0 n\frac{dI}{dt}$ As $I = mt^2 + c$ $\therefore$ $e = -N\pi b^2\mu_0 b^2\left(mt^2 + c\right)$ $= -Nn\pi\mu_0 b^2(2mt)$ or $e = -\mu_0 Nn\pi b^2(2mt)$ or $e \propto t$ The graph between (e) and t is a straight line passing through the origin as shown in figure.



43) $Here, \quad \phi = (5t^2 + 10t + 5)\ milli\ water$ **5**

$\phi = (5t^2 + 10t + 5) \times 10^{-3}Wb$

$As \quad e = \frac{d\phi}{dt}(in \quad magnitude)$

$\therefore \quad e = \frac{d\phi}{dt}(5t^2 + 10t + 5) \times 10^{-3}Wb/sec$

$= (10t + 10) \times 10^{-3}volt$

$At \quad t = 5sec\ ; \quad e = (10 \times 5 + 10)10^{-3}volt = 0.06\ volt$

Section-G

44) $Here, \quad A = (10cm)^2 = 100cm^2 = 10^{-2}m^2$ **5**

$R = 0.70ohm, \quad B_1 = 0.10t, \quad \theta = 45°$

$B_2 = 0, \quad dt = 0.7s, \quad e = ?, \quad I = ?$

$Initial\ flux, \quad \phi_1 = B_1 A\cos\theta = 0.10 \times 10^{-2} cos45° = \frac{10^{-3}}{\sqrt{2}} Wb$

$Final\ flux, \quad \phi_2 = 0 \quad \left(\because \quad B_2 = 0\right)$

$e = \frac{|d\phi|}{dt} = \frac{|\phi_2 - \phi_1|}{dt} = \frac{10^{-3}}{\sqrt{2} \times 0.7} = 10^{-3}V$

$I = \frac{e}{R} = \frac{10^{-3}}{0.7} = 1.4 \times 10^{-3}A$

45) The corresponding wavelength to the frequency 8 x 10^{14} Hz is **5**

$\lambda_1 = \frac{c}{v_1} = \frac{3 \times 10^8}{8 \times 10^{14}} = 3.75 \times 10^{-7}m$

The corresponding wavelength to the frequency 5 x 10^{17} is

$\lambda_2 = \frac{c}{v_2} = \frac{3 \times 10^8}{5 \times 10^{17}} = 6 \times 10^{-10}m$

As, $\lambda_m T = 2.9 \times 10^{-3} \quad or \quad T = \frac{2.9 \times 10^{-3}}{\lambda_m}$

For, $\lambda_1 = 3.75 \times 10^{-7}m;$

$T_1 = \frac{2.9 \times 10^{-3}}{3.75 \times 10^{-7}} = 7.73 \times 10^3 K$

$\lambda_2 = 6 \times 10^{-10}m;$

$T_2 = \frac{2.9 \times 10^{-3}}{6 \times 10^{-10}} = 4.83 \times 10^6 K$

Temperature range is $7.73 \times 10^3 K \quad to \quad 4.83 \times 10^6 K$

46) **5**

$Here, \quad x = ? \quad D = 600cm, \lambda = 5.5 \times 10^{-5} cm Limit \quad of \quad resolution, d\theta = \frac{1.22\lambda}{D} = \frac{1.22 \times 5.5 \times 10^{-5}}{600} = 1.1 \times 10^{-7} rad$

If x is separation of two points on the moon that can be resolved and d is distance of moon from objective of telescope, then

$d\theta = \frac{x}{d} x = (d\theta)d = 1.1 \times 10^{-7} \times 3.8 \times 10^{10} cm = 4180cm.$