Soumitra Maity (20.11.19)

ST. LAWRENCE HIGH SCHOOL

A JESUIT CHRISTIAN MINORITY INSTITUTION

FOR GOD AND COUNTRY

SELECTION TEST 2019

Model Answer

Subject: Physics **Class – XII** **Full Marks: 70**

Duration: 3 hours 15 minutes

PART-B (SECTION-I)

1. Select the correct answer out of the options given against each question(Answer all questions) **1X14=14**

i. 64 small water drops each of capacitance C and charge q coalesce to form a larger spherical drop.The charge and capacitance of the larger drop is

a. 64q,C b. 16q,4C **c. 64q,4C** d. 16q,C

ii. Two similar bar magnets of magnetic moment M each are attached at right angle with each other at their ends. The magnetic moment of the system will be

a. M b. 2M c. $M/\sqrt{2}$ **d. $\sqrt{2}$ M**

iii. The number of turns of the primary and secondary of a transformer are 500 and 5000 respectively.The primary is connected to a 20V, 50Hz A.C supply. The output of the secondary will be

a. 2V,50Hz **b. 200V,50Hz** c. 200V,5Hz d. 200V,500Hz

iv. The electric and magnetic field of electromagnetic waves are

a. in opposite phase and perpendicular to each other b. in opposite phase and parallel to each other

c. in the same phase and perpendicular to each other d. in the same phase and parallel to each other

v. Which one does not change in polarization of light?

a. Intensity b. Phase **c. Frequency** d.None of these

vi. If V be the accelerating voltage, then the maximum frequency of X-ray emitted from an X-ray tube is

a. eh/V **b. eV/h** c. h/eV d. none of these

vii. For television broadcasting, the frequency employed is

a. 30-300MHz b. 30-300Ghz c. 30-300kHz d. 30-300Hz

viii. In normal transistor operation

a. emitter-base junction and collector-base junction are both in reverse bias

b. emitter-base junction is in forward bias and collector-base junction in reverse bias

c. emitter-base junction and collector-base junction both are in forward bias

d. emitter-base junction is in reverse bias and collector-base junction in forward bias.

ix. A charge Q is situated inside a cube placed in air. The electric flux passing through the six faces is

a. Q/ε_0 b. $Q/2\varepsilon_0$ c. $Q/6\varepsilon_0$ d. $Q/8\varepsilon_0$

x. By how much will the power of an electric bulb decrease if the current drops by 0.5%?

a. 0.25% b. 0.5% **c. 1%** d. 2%

xi. An electron having charge e moves with velocity $\underset{v}{\rightarrow}$ in +x direction. An electric field acts on it along +y direction.The force on the electron acts along

a. +z direction b. -z direction c. +y direction **d. -y direction**

xii. If the rotating speed of a dynamo is doubled, the induced electromotive force will be

a. doubled b. halved c. four times as much d. unchanged

xiii. Rays from the sun subtend an angle θ(in radian) at the pole of a concave mirror of focal length f. If the diameter of the sun is D, the diameter of the image of the sun formed by the mirror is

a. Dθ b. 2Dθ **c. fθ** d. 2fθ

xiv. The wavelength of de-Broglie waves associated with a thermal neutron of mass m at absolute temperature T is given by (k is the Boltzmann constant)

a. $h/\sqrt{mkT}$ b. $h/\sqrt{2mkT}$ **c. $h/\sqrt{3mkT}$** d. $h/2\sqrt{mkT}$

Section – II
Group – A

1. Answer the following question in brief. (Alternatives are to be noted) **4 x 1 = 4**

i) Give the dimensional formula of μ_0.

Ans: $MLT^{-2}A^{-2}$

Or

What is the value of dip at the magnetic poles of earth?

Ans: 90^0

ii) A thin iron sheet is moving such that its plane is parallel to the magnetic field. Will any magnetic field be induced?

Ans: No, as flux linked will be zero.

Or

If the number of turns in the solenoid is made doubled keeping other factors constant, how does the self inductance of it be changed?

Ans: $L = \frac{\pi\mu_0 N^2 r^2}{L}$. Hence self inductance will become 4-times.

iii) A converging lens of refractive index 1.5 is kept in a liquid medium of same refractive index, then what will be the focal length of the lens in that liquid?

Ans: $\frac{1}{f} = \frac{\mu_1 - \mu_2}{\mu_2}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$. As $\mu_1 = \mu_2$ hence $f = \infty$.

iv) The output of an OR gate is connected with both of the inputs of a NAND gate. Write the truth table of this combined gate.

Ans: output will be $Y = \overline{A + B}$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Or

Why is photo diode used in reverse bias condition?

Ans: Photo diode is used to detect the presence of light source. In forward bias situation, current will flow through the diode mainly because of the bias and we can not be sure about the presence of light or its intensity. But in reverse bias, the current will be only due to incident photons. Hence we can detect the light and by the amount of current we can estimate the intensity of photons(light).

PART – A
Section – II
Group – B

Answer the following questions in short. (Alternatives are to be noted) **5 x 2 = 10**

1. What should be the value of the shunt to be connected in parallel to a galvanometer of resistance G, so that $\frac{1}{n}$ part of the main current will pass through the shunt?

Ans: if the shunt be S then, $S.\frac{I}{n} = G.I\left(1 - \frac{1}{n}\right)$

Or, $S = (n-1)G$

Or

Equal number of identical cells are joined in series and again in parallel. Under what condition, will the current in both the cases be same?

Ans: let the number be n, emf of one cell is E and r be the internal resistance of each. R = external load.

For series : $I = \frac{nE}{nr+R}$ and for parallel : $I = \frac{E}{\frac{r}{n}+R} = \frac{nE}{r+nR}$. If both are same then,

$\frac{nE}{nr+R} = \frac{nE}{r+nR}$ Or, $r = R$

Hence for the condition, external load resistance being equal to the internal resistance of one cell the current in two cases will be equal.

2. In a compact coil of 50 turns, the current strength is 10A and the radius of the coil is $25 \times 10^{-2} m$. Find the magnitude of magnetic field at its centre.

Ans: $B = \frac{\mu_0 NI}{2r} = 4\pi \times 10^{-4}\ T$

3. Mention two characteristics of electromagnetic waves.

Ans: refer to standard text book .

4. **In a hydrogen atom, an electron of charge 'e' resolves in an orbit of radius 'r' with speed 'v'. Find the magnitude of resulting magnetic moment of the electron.**

Ans: $m = I.A = \frac{e}{T}.\pi.r^2 = \frac{e}{\frac{2\pi r}{v}}.\pi.r^2 = \frac{evr}{2}$

Or

The energy of an exited hydrogen atom is $-1.5eV$. Determine the angular momentum of electron according to Bohr's hypothesis.

Ans: we know, $E_n = -\frac{13.6}{n^2}$.eV

So, $-\frac{13.6}{n^2} = -1.5$

Or $n = 3$

Hence the angular momentum $= \frac{3h}{2\pi}$

5. **Why is satellite used for TV transmission to far places?**

Ans: refer to standard text book .

Or

What do you mean by demodulation? What is the importance of modulation index?

Ans: refer to standard text book .

Group – C

Answer the following questions. (Alternatives are to be noted) **9 x 3 =27**

6. **What is an equi-potential surface? Why are the electric lines of forces always perpendicular to equipotential surface? 1+2**

Ans: refer to standard text book .

Or

An infinite number of charges each of value +q are placed on the x-axis at the points x=1cm, 2cm, 4cm, 8cm…..etc. Determine the potential at x=0cm. **3**

Ans: $V = q + \frac{q}{2} + \frac{q}{4} + \frac{q}{8} + \cdots \ldots\ldots\ldots\ldots\ldots\ldots\ldots$ Stat Volt

$=q\left[1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \cdots \ldots\ldots\ldots\ldots\ldots\right]$ stat volt

$=q\left[\frac{1}{1-\frac{1}{2}}\right] = 2q$ stat volt

Or, $V = \frac{q}{4\pi\epsilon_0}\left[100 + \frac{100}{2} + \frac{100}{4} + \frac{100}{8} + \cdots \ldots\ldots\ldots\ldots\ldots\right]$ volt

$= \frac{q}{4\pi\epsilon_0}.100.\left[1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \cdots \ldots\ldots\ldots\ldots\ldots\right]$ volt $= \frac{q}{4\pi\epsilon_0}\frac{100}{1-\frac{1}{2}} = \frac{200q}{4\pi\epsilon_0}\ volt$

7. **If a conducting slab is introduced between plates of a parallel plate capacitor, then how will its capacitance be changed? Two capacitors $5\mu F$ *and* $10\mu F$are charged to 16volts and 10volts respectively. If they are now connected in parallel, determine the common potential.** **1+2**

Ans: Capacitance will increase. (as modified capacitance $c = \frac{\epsilon_0 A}{d-t}$ if a conducting slab of thickness t is inserted) .

Common potential $= \frac{C_1V_1+C_2V_2}{C_1+C_2} = \frac{180}{15} = 12\ volt.$

8. **State Ampere's circuital law. Using this law find the magnetic field at a particular distance 'r' from an infinite wire carrying I current.** **1+2**

Ans: refer to standard text book .

Or

Define magnetic permeability and susceptibility. Determine the relation between them. **1+2**

Ans: refer to standard text book.

9. **If a point object is kept at the bottom of a container containing water, then for nearly normal view, prove that refractive index of water is the ratio of real depth to apparent depth. And hence prove that the height by which the object will appear to rise up $= d\left(1 - \frac{1}{\mu}\right)$. [d = real depth, μ = r.i. of water.]** **2+1**

Ans: refer to standard text book .

Or

A convex lens is placed in between an object and a screen. Two real images of the object are formed for two positions of the lens. If L_1 *and* L_2 be the lengths of two real images and L be the length of the object then prove that $L = \sqrt{L_1.L_2}$.

Ans: Let a convex lens of focal length f is producing real images on the screen kept D distance apart from the object.

Then, object distance for those two positions will be $u_1 = \frac{D+\sqrt{D^2-4Df}}{2}$ and $u_2 = \frac{D-\sqrt{D^2-4Df}}{2}$

So the corresponding image distances will be $v_1 = D - u_1 = \frac{D-\sqrt{D^2-4Df}}{2} = u_2$ and $v_2 = D - u_2 = \frac{D+\sqrt{D^2-4Df}}{2} = u_1$

So the length of images $L_1 = \frac{v_1}{u_1}L$ and $L_2 = \frac{v_2}{u_2}L$

So, $L_1L_2 = \frac{v_1v_2}{u_1u_2}L^2 = \frac{u_2u_1}{u_1u_2}L^2 = L^2$

Hence $L = \sqrt{L_1L_2}$

10. **What is meant by interference of light? Write down the condition for sustained interference.** 1+2

Ans: refer to standard text book .

Or

What is an optical fibre? Mention its uses. Which portion will have greater r.i., core or cladding of optical fibre? 1+1+1

Ans: refer to standard text book .

Core will have greater r.i for total internal reflection to take place.

11. **Write down Einstien's photoelectric equation and mention the symbols used. The photoelectric threshold wavelength for a certain material is 400nm. Find the maximum kinetic energy of the emitted electrons from the metal surface by UV-light of wavelength 200nm. h = 6.63×10^{-34} J.s** 1+2

Ans: $KE_{max} = h\nu - h\nu_0 = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right] = 6.63 \times 10^{-34} \times 3 \times 10^8 \times 10^9 \left[\frac{1}{200} - \frac{1}{400}\right]$

$\approx \frac{20}{400} \times 10^{-17}\, J = 5 \times 10^{-19} J$ {Ans}

$= \frac{5}{1.6} eV = 3.125\, eV$ $\{Ans\}$

Alternative method :

$KE_{max} = h\nu - h\nu_0 = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right] = 1243\left[\frac{1}{200} - \frac{1}{400}\right]$ eV $= \frac{1243}{400} eV = 3.1078\, eV$ {Ans}

12. **State the postulates of Bohr's model of hydrogen atom.** 3

Ans: refer to standard text book .

Or

Define binding energy and mass defect of a nucleus. What is the relation among them? 2+1

Ans: refer to standard text book .

13. **What is a p-n junction diode? Draw the circuit diagram of full wave rectifier using p-n junction diodes. Show the input and output voltage waveforms.** 1+1+1

Ans: refer to standard text book .

14. **What is an AND gate? Draw the circuit symbol and prepare the truth table.** 1+1+1

Ans: refer to standard text book .

Or

What is the difference between a normal diode and Zener diode? What is its use? What do you mean by reverse saturation current? 1+1+1

Ans: Ans: refer to standard text book .

Group – D

Answer the following questions. (Alternatives are to be noted) $3 \times 5 = 15$

(N.B : The word limit for each 5marks question is 100 words)

15. **i) Establish Ohm's law from the concept of drift velocity of free electron. ii) What do you mean by mobility of free electron? iii) A potential difference of 5volts is applied across a conductor of length 10cm. Find the mobility of an electron if the drift velocity of it is $2.5 \times 10^{-2}\ cm/s$.** 2+1+2

Ans: i) If E field is applied across a conductor of length L and area of cross-section A, then the drift velocity will be $v_d = \frac{eE}{m}t$, where m is the mass and e is the charge of electron and t is the relaxation time.

So, potential difference $V = E.L = \frac{v_d m}{et}L = neA.\ \frac{1}{neA}.\frac{v_d m}{et}L = I.\frac{m}{ne^2t}.\frac{L}{A} = I.\rho\frac{L}{A} = I.R$

Where, we used $I = neAv_d$ and $\rho = \frac{m}{ne^2t}$

ii) It is the drift velocity per unit electric field.

iii) $\mu = \frac{v_d}{E} = \frac{2.5\times10^{-4}}{5\times\frac{10}{100}} = 5 \times 10^{-4}\ m^2/Vs$

16. **i) State Faraday's laws of electromagnetic induction. ii) The magnetic flux through a coil is varying according to the relation $\varphi = (4t^2 + 2t - 5)\ wb$, where t is in sec. Calculate the induced current through the coil at $t = 2\ sec$, if the resistance of the coil is 5Ω. iii) What do you mean by resonance in L-C-R circuit?** 2+2+1

Ans: i) refer to standard text book .

ii) $I = \frac{1}{R}\frac{d\varphi}{dt}\Big]_{t=2} = \frac{1}{5} \times 18 = 3.6\ Amp$

iii) refer to standard text book .

Or

i)Define the term r.m.s value of alternating current. ii) An ac source $E = E_0 Sin\omega t$ is applied across an ideal inductor of inductance L. Show mathematically that the current lags the voltage by a phase angle of $\frac{\pi}{2}$. iii) If L is 100mH and the frequency of the applied ac source is 50Hz, find the inductive reactance in the above case. 1+3+1

Ans: i) refer to standard text book .

ii) refer to standard text book .

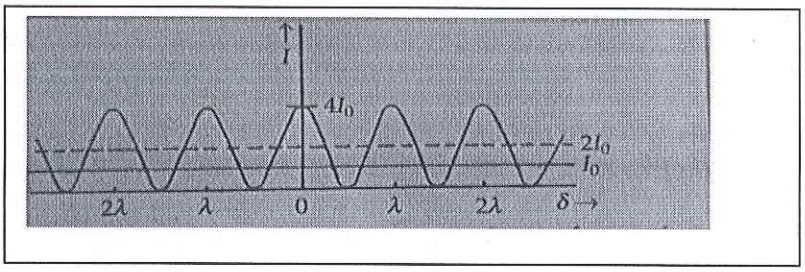
iii) $Z = wL = 50 \times 100 \times 10^{-3} = 5\ ohm$

17. i) State Huygence's principle for propagation of light wave. ii) Prove the laws of reflection with the help of Huygence's principle. iii) Draw the " Intensity (I) vs Path difference(in terms of λ)" curve in case of Young's double slit experiment. 1+3+1

Ans: i) refer to standard text book .

ii) refer to standard text book .

iii)



Or

i) Define power of a lens. ii) Deduce the relation $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ for two thin lenses of focal lengths f_1 and f_2 kept in contact coaxially. iii) A pen of length 10cm is placed along the principal axis of a concave mirror such that the tip which is at a distance 30cm, faces the mirror. If the focal length be 15cm, determine the longitudinal magnification. 1+2+2

Ans: i) refer to standard text book .

ii) refer to standard text book .

iii) for the tip

$u = -30cm,\ f = -15cm, so\ v = -30cm$

For the back

$u = -(30 + 10) = -40,\ f = -15$, then $\frac{1}{v} + \frac{1}{-40} = \frac{1}{-15}$. This gives $v = -24cm$

Hence the length of the image of the pen = 6cm

So the longitudinal magnification $= \frac{6}{10} = 0.6$