Soumitra Maity. 13.11.18

FOR GOD AND COUNTRY

ST. LAWRENCE HIGH SCHOOL

Answer Key

Selection Test Exam – 2018

Sub: Physics | **Class: XII** | **F. M. : 70**
Duration: 3hrs 15 min | **Date: 10.11.18**

PART – A

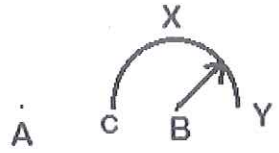
(Marks : 52)

Section – II

Group – B

Answer the following questions in short. (Alternatives are to be noted) **2x5 =10**

1. **Charges +q and – q are placed at points A and B respectively which are at 2L distance apart. C is the mid-point between A and B. what will be the work done in moving a +Q charge along a semicircular path CXY of radius L?**



Ans: The potential at the point C is $V_C = \frac{1}{4\pi\epsilon_0}\left\{\frac{+q}{L}+\frac{-q}{L}\right\} = 0$

Potential at Y is $V_Y = \frac{1}{4\pi\epsilon_0}\left\{\frac{+q}{3L}+\frac{-q}{L}\right\} = -\frac{q}{6\pi\epsilon_0 L}$.

As electrostatic force is conservative i.e. path independent,

so the work done = charge x potential difference = $-\frac{q}{6\pi\epsilon_0 L}.Q = -\frac{qQ}{6\pi\epsilon_0 L}$. [Ans]

Or

A charged particle of charge 'q' and mass 'm' enters perpendicularly in a magnetic field of intensity 'B'. If kinetic energy of the particle is 'E', then calculate the angular frequency of rotation of the charged particle in terms of q, m, B and E .

Ans: We have ,

$E = \frac{1}{2}mv^2$ ..... (1), $\frac{mv^2}{r} = qvB$ ..... (2) and $v = \omega r$ ..... (3)

By eqn (2) , $\frac{1}{2}\frac{mv^2}{r} = \frac{1}{2}qvB$

Or, $\frac{E}{r} = \frac{1}{2}qB\omega r$

Or, $\omega = \frac{2E}{qBr^2}$. [Ans]

2. **What do you mean by displacement current? Can this current produce magnetic effect?**
Ans: Displacement current is the current that comes into existence, in addition to the conduction current, whenever the electric field and hence the electric flux changes with time.
Yes, it can produce magnetic field like the conduction current does.
3. **What is the phase difference between the voltage across the resistance and current in an L-C-R circuit at resonance condition? – Give reason.**
Ans: The phase difference is zero at resonance condition.
This is because, at this condition the phase differences created by inductor and capacitor get balanced and the circuit behaves like a purely resistive network.
4. **"n" number of identical cells each of e.m.f 9v and internal resistance 0.5 ohm are connected in series with one load resistance of 10 ohm. If the current through the load is 6A, find out the value of "n".**
Ans: The expression of current will be, $I = \frac{nV}{nr+R}$ So, $6 = \frac{9n}{0.5\times n+10}$
Solving, $n = 10$ $[Ans]$
5. **What do mean by coherent source?**
Ans: If the phase difference between two waves is zero or constant in time, then two waves are known as coherent source.
Or
Draw the diagram showing the variation of stopping potential with frequency of incident radiation for photoelectric effect.
Ans: Refer to any standard text book.

Group – C

Answer the following questions. (Alternatives are to be noted) **3x9=27**

6. **What do you mean by equipotential surface? Why are the electric field lines perpendicular to an equipotential surface?** [1+2]
Ans: Equipotential surface is the surface, the electrostatic potential of each and every point of which is constant.

If the electric field lines i.e. the electric field were not normal to the equipotential surface, it would have a non – zero component along the surface. Now to move a test charge against this component, work would have to be done. But we know, no work is needed to move a text charge on an equipotential surface. Hence, electric field i.e. the field lines must be normal to equipotential surface.

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: ATP, the total potential at x=0 will be

$$V = q\left\{\frac{1}{1}+\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+ \ \dots\dots\dots\right\} \text{ Stat Volt}$$

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

7. **What do you mean by drift velocity and mobility of charge carrier? Write down the relation between drift velocity, mobility and electric current.** [1+1+1]

Ans: Refer to any standard text book.

The relation is $I = \frac{v_d A\sigma}{\mu}$.

{** for your understanding –

We know, $\mu = \frac{v_d}{E}$, $\quad J = \sigma E$,

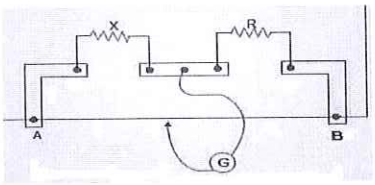
Or, $\frac{I}{A} = \sigma E$

Or, $E = \frac{I}{A\sigma}$

So, $\mu = \frac{v_d}{E} = \frac{v_d}{\left(\frac{I}{A\sigma}\right)} = \frac{A\sigma v_d}{I}$ }

Or

In a meter bridge, the null point is found at a distance of 60cm from left end A. If now a resistance of 5 ohm is connected in series with R, the null point occurs at 50cm. determine the values of R and X. **[3]**



Ans: from the firs condition, $\frac{x}{60} = \frac{R}{40} \dots\dots\dots\dots (1)$

From the 2nd condition, $x = R + 5 \dots\dots\dots\dots\dots (2)$

Solving, $x = 15\ ohm \quad and\ R = 10\ \ ohm$

8. **What do you mean by magnetic susceptibility? Which type of magnetic materials has negative magnetic susceptibility at normal temperature? What does " dip at Kolkata is 31^0N" mean?** **[1+1+1]**

Ans: Diamagnetic materials have negative susceptibility at normal temperature.

Rest – refer to standard text book.

Or

Determine the magnetic field intensity of a toroid at a distance r from its centre inside it. Consider N as total number of turns in toroid and I is the current in it. **[3]**

Ans: Refer to any standard text book.

9. **What do you mean by mutual inductance? Derive the dimension of it.** [1+2]

Ans: We know, $F = BIl$ so, [B]= $MT^{-2}A^{-1}$

Now, $B.S = \emptyset = MI$ so, [M] = $MT^{-2}A^{-1}.L^2.A^{-1} = ML^2T^{-2}A^{-2}$

Or

Determine the amount of energy stored in an inductor of self inductance L, when it carries a current I. [3]

Ans: Refer to any standard text book.

10. **Prove the laws of refraction by using Huygens ' Principle.** [3] .

Ans: Refer to any standard text book.

11. **What will be colour of the central fringe if white light is introduced in Youngs' double slit experiment? What will be the effect on the fringes formed in single slit diffraction, if the apparatus is immersed in water compared to when it was in air?** [1+2]

Ans: For all colour (i.e. wave length), central point will be a point correspond to zero path difference. Hence, all waves will meet there constructively and it will be bright white.

If the apparatus is immersed in water, then wavelength decreases. As the width of the central maxima is directly proportional to the wave length, hence the width of the central maxim and also of the other secondary maxima, will decrease.

12. **What do you mean by threshold frequency in photoelectric effect? How do threshold frequency and stopping potential depend upon intensity of incident beam?** [1+1+1]

Ans: threshold frequency and stopping potential, both depends upon the energy of the photon, hence on the frequency of the photon (as $E = h\nu$). But, intensity means the number of photons coming in unit time. Hence, both threshold frequency and stopping potential, are independent of intensity.

13. **What do you mean by output characteristics of a common emitter transistor? Draw the output characteristic for a CE, n-p-n transistor.** [1+2]

Ans: Refer to any standard text book.

14. **What is " modulation" in communication system? Define "modulation index" or "modulation factor" for frequency modulation. For amplitude modulation, what is the value of modulation index for which distortion occurs in modulated wave?** [1+1+1]

Ans:

Modulation index for an F.M. wave is defined as the ratio of the maximum frequency deviation to the modulating frequency.

If the modulation index becomes greater than 1 (m>1), then distortion occurs in case of amplitude modulation.

Group – D

Answer the following questions. (Alternatives are to be noted) **5x3=15**

15. **Using Gauss's theorem, determine the electric field intensity due to an infinitely long straight charged wire of line charge density λ, at a perpendicular 'r' from the wire. 64 identical water drops (each containing '+q' amount of charge) coalesce to form a larger drop. Find out the capacitance, potential and stored energy of the larger drop.** [2+3]

Ans: let, $r = radius\ of\ small\ drop$

$V = potential\ of\ each\ drop = \frac{q}{c}$

$c = capacitance\ of\ each\ drop = 4\pi\epsilon_0 r$

$R = radius\ of\ the\ larger\ drop$

$Q = charge\ in\ the\ larger\ drop$

Then from volume conservation, $64 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

Or, $R = 4r$

Also, from the charge conservation, $Q = 64q$

So, the capacitance of the larger drop $C_1 = 4\pi\epsilon_0 R = 4\pi\epsilon_0 . 4r = 4c$

Potential of the larger drop $V_1 = \frac{Q}{C_1} = \frac{64q}{4c} = 16.V$

Energy stored $= \frac{1}{2}C_1 V_1^2 = \frac{1}{2} \times 4c \times (16V)^2 =$ $512\ c\,V^2$

Or

What do you mean by excitation potential and ionization potential of any atom? A 12.9eV beam of electrons is used to bombard gaseous hydrogen at room temperature. Up to which energy level the hydrogen atoms would be excited? Calculate the shortest wavelength of Lyman series for hydrogen atom. (R=1.097x10^{7}m^{-1}) $\left[\frac{1}{2}+\frac{1}{2}+2+2\right]$

Ans: we know, the energy levels of the hydrogen atom are as follows –

$$E_1 = -13.6\ eV$$

$$E_2 = -\frac{13.6}{4} = -3.4\ eV$$

$$E_3 = -\frac{13.6}{9} = -1.51eV$$

$$E_4 = -\frac{13.6}{16} = -0.85\ eV$$

$$E_5 = -\frac{13.6}{25} = -0.544\ eV$$

So, $E_4 - E_1 = 12.75\ eV$

But $E_5 - E_1 = 13.056\ eV$

The supplied energy is 12.9 eV, which is a little more than $E_4 - E_1$, but it is less than $E_5 - E_1$. Hence the atom will be exited to 4th energy level.

For the shortest wavelength of Lyman series for hydrogen atom –

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left[1 - \frac{1}{2^2}\right]$$

Calculating $\lambda = 1.215 \times 10^{-7}\ m$

16. **Determine the magnetic field intensity inside a long solenoid of total number of turns N and carrying a current I. At what condition the impedance of a series L-C-R circuit becomes minimum? What is the value of power factor at that condition?** [3+1+1]

Ans: At resonance condition, i.e. when the capacitive impedence becomes equal to the inductive impedence ($\omega L = \frac{1}{\omega C}$) , the impedance of series L-C-R circuit becomes minimum.

The value of power factor at that condition is '1' as the phase difference is zero then.

17. **For a prism establish the relation** $\mu = \frac{\sin\frac{(A+\delta_m)}{2}}{\sin\frac{A}{2}}$**. Symbols have usual significance. How will the angular width of central maxima vary in single slit diffraction pattern if the slit width is increased? Give reason.** 3+2]

Ans: The width of the central maxima varies inversely with the slit width. Hence, the width of the central maxima will decrease if the slit width is increased.

Or

Among the core and cladding of optical a fiber, which one will be optically denser and why? 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+1+3]

Ans: core will be optically denser than cladding such that the total internal reflection could take place inside the core.

The tip of the pen is at 30cm in front of the concave mirror of focal length 15cm. Hence image of the tip will also be at 30cm away.

For the back of the pen,

$u = -(30 + 10) = -40cm$

$f = -15cm$

So, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ gives $\frac{1}{v} = \frac{1}{-15} + \frac{1}{40} = -\frac{1}{24}$

So, $v = -24\ cm$

So the length of the image of the pen is = 30-24 = 6cm

Hence the longitudinal magnification $= \frac{6}{10} = \frac{3}{5}$ [Ans]

******

PART-B

(Marks : 18)

Section - I

1. **MCQ Questions each of 1 mark.(Answer all the question)** **1x14=14**

i) A charged wire is bent in the form of a semi circular arc of radius 'r'. If the charge per unit length is 'λ'then the electric field at the centre of the arc will be

a) $\frac{\lambda}{2\pi\epsilon_0 r^2}$ b) $\frac{\lambda}{4\pi^2\epsilon_0 r}$ c) $\frac{\lambda}{2\pi\epsilon_0 r}$ d) $Zero$

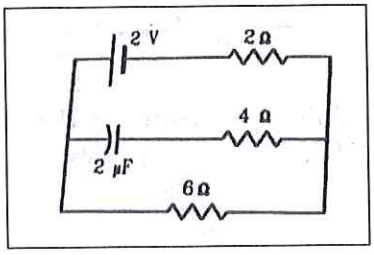
Ans: c) $\frac{\lambda}{2\pi\epsilon_0 r}$

ii) A capacitor of capacitance 'C_1' is charged to a potential 'V' and then connected in parallel to an uncharged capacitor of capacitance 'C_2'. The final potential difference across each capacitor will be ,

a) $\frac{C_1 V}{C_1+C_2}$ b) $\frac{C_2 V}{C_1+C_2}$ c) $\frac{C_1+C_2}{C_1}.V$ d) $\frac{C_1+C_2}{C_2}.V$

Ans: a) $\frac{C_1 V}{C_1+C_2}$

iii) The current supplied by the battery in the given network, at steady state will be

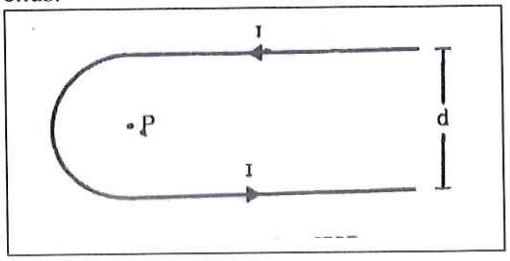


a) 2.5 Amp b) 0.25 Amp

c) 1.5 Amp d) 0.15 Amp

Ans: b) 0.25 Amp

iv) What will be the magnetic field at the point 'P', if 'I' be the current through the wire. The curved portion is a semicircle and straight wires are infinitely long at the right ends.

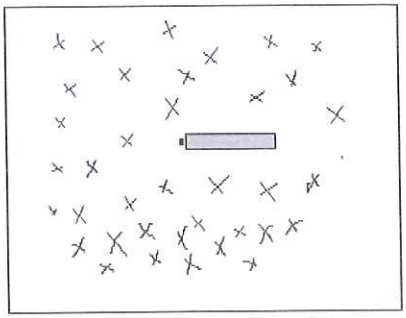


a) $\frac{\mu_0 I}{4d}\left(1+\frac{2}{\pi}\right)$ b) $\frac{\mu_0 I}{2d}\left(1+\frac{2}{\pi}\right)$

c) $\frac{\mu_0 I}{2d}\left(2+\frac{1}{\pi}\right)$ d) $\frac{\mu_0 I}{2d}$

Ans: b) $\frac{\mu_0 I}{2d}\left(1+\frac{2}{\pi}\right)$

v) A metal rod of length 'l' rotates about its left end with a uniform angular velocity 'w'. A uniform magnetic field of magnitude 'B' exists in the direction of the axis of the rotation. What will be the emf induced between the ends of the rod ? (Neglecting the centripetal force acting on the free electrons as they move in circular path).



a) Bwl^2 b) Bw^2l

c) $\frac{1}{2}Bw^2l$ d) $\frac{1}{2}Bwl^2$

Ans: d) $\frac{1}{2}Bwl^2$

vi) An AC voltage source of variable angular frequency 'w' and fixed amplitude 'V' is connected in series with a capacitor of capacitance 'C' and an electric bulb of resistance 'R'(inductance zero). When 'w' is increased -

a) The bulb glows dimmer b) the bulb glows brighter

c) total impedance of the circuit is unchanged d) total impedance of the circuit increases.

Ans: b) the bulb glows brighter

vii) Two concentric co-planar circular current carrying loops of diameters 2m and 4m respectively carrying same current of 1A are placed on the plane of paper. Current in the inner loop is in anti-clock wise direction and that in outer loop is in clock-wise direction. The magnetic field at the centre will be

a) $\pi \times 10^{-7}T$, perpendicularly outward to the plane of paper

b) $2\pi \times 10^{-7}T$, perpendicularly inward to the plane of paper

c) $3\pi \times 10^{-7}T$, perpendicularly outward to the plane of paper

d) $4\pi \times 10^{-7}T$, perpendicularly inward to the plane of paper

Ans: a) $\pi \times 10^{-7}T$, perpendicularly outward to the plane of paper

viii) A square wire of side 3cm is placed 25cm away from a concave mirror of focal length 10cm. what is the area enclosed by the image of the wire?

a) $2cm^2$ b) $4cm^2$ c) $6cm^2$ d) $8cm^2$

Ans: b) $4cm^2$

ix) An illuminated object and a screen are placed 90cm apart. What is the focal length and nature of the lens required to produce a clear image on the screen, twice the size of the object?

a) 20cm, convex b) 30cm, convex c) 45cm, convex d) 45cm, concave

Ans: a) 20cm, convex

x) A double slit experiment is performed with sodium light of wavelength 589.3 nm and the interference pattern is observed on a screen 100 cm away. The tenth bright fringe has its centre at a distance of **12 mm** from the central maxima. What will be the separation between the slits.

a) 2.45mm b) 0.245mm c) 4.9 mm d) 0.49 mm

Ans: d) 0.49 mm

xi) If the kinetic energy of a free electron doubles, its de-Broglie wavelength changes by the factor

a) $\frac{1}{2}$ b) $\frac{1}{\sqrt{2}}$ c) 2 d) $\sqrt{2}$

Ans: b) $\frac{1}{\sqrt{2}}$

xii) Select the incorrect option for the photo electric effect –

a) Kinetic energy of the photo electrons is independent of the intensity of incident light.

b) Stopping potential depends upon the intensity of the incident light.

c) Photo current increases with increase in intensity of incident light.

d) Stopping potential increases with increase in frequency of the incident radiation.

Ans: b) Stopping potential depends upon the intensity of the incident light.

xiii) Chose the correct option for a p-n junction.

a) Width of the depletion region increases with increase in forward bias.
b) The small amount of current in reverse bias condition(before break down), is caused by minority carriers.
c) At unbiased condition the electric field in the depletion region is directed from 'p' side to 'n' side.
d) None of these.

Ans: b) he small amount of current in reverse bias condition(before break down), is caused by minority carriers.

xiv) The output of a two input digital device is given as $\overline{Y} = \bar{A} + \bar{B}$. It will behave as a

a) NOT gate b)NOR gate c) AND gate d) OR gate

Ans: c) AND gate

Section – II

Group – A

2. Answer the following question in brief. (Alternatives are to be noted) **1x4=4**

i) What is Stoke's line? Ans: Refer to text book.

ii) **What is the use of transducer in communication system?**
Ans: Transducer is an electrical device which converts the variation of any physical quantity (e.g. sound, temperature, pressure, force, displacement etc) into corresponding variation in the electrical signal. For example microphone, coverts sound wave to corresponding electrical signal.

iii) **The conductivity of semi conductor increases with increase in temperature – why?**
Ans: If the temperature is increased, then the electrons acquire thermal energy and can overcome the forbidden energy gap to attain the energy of conduction band, hence become available for the conduction and thereby increase the conductivity.

iv) **Why does the mass number of an atom not change, after emitting a β particle?**
Ans: A β particle is generated, when a neutron is converted into a proton and an electron.

$$n_0^1 \rightarrow p_1^1 + e_{-1}^0$$

The β particle is emitted from the nucleus. As one neutron is converted into a proton, so the mass number remains the same and the atomic number increases by 1 .

Or

How does the capacitance of a parallel plate capacitor get modified if a conducting slab (of thickness less than plate separation) is introduced in between the plates?
Ans: The capacitance increases as a conducting slab is introduced.

Capacitance without conducting slab, is $= \frac{\epsilon_0 A}{d}$

Capacitance with conducting slab (of thickness 't'), is $= \frac{\epsilon_0 A}{d-t}$