# O. P. JINDAL SCHOOL, SAVITRI NAGAR

## SAMPLE PAPER - 05

**Class: XII** **MM: 70**

**Subject: Physics** **Time: 3 Hrs**

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**General Instruction:-**

(xxv) All questions are compulsory. There are 33 questions in all.

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

(xxvii) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each. Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.

(xxviii) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

(xxix) Use of calculators is not permitted. However, you may use log tables, if necessary.

(xxx) *You may use the following physical constant where ever necessary:*

*Gravitational constant* $G = 6.6 \times 10^{-11}\ Nm^2\ kg^{-2}$

*Gas constant* $R = 8.314\ J\ mol^{-1}\ k^{-1}$

*Mass of electron* $= 9.110 \times 10^{-31}\ kg$

*Mechanical equivalent of heat* $= 4.185\ J\ cal^{-1}$

*Standard atmospheric pressure* $= 1.013 \times 10^5\ Pa$

*Absolute zero (0 K)* $= -273.15^0 C$

*Acceleration due to gravity* $= 9.8\ ms^{-2}$

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## SECTION-A

*All questions are compulsory. In case of internal choices, attempt anyone of them.*

1. If an electron is revolving in its Bohr orbit having Bohr radius of 0.529Å, then what is the radius of third orbit?

   ***Or***

   Calculate the surface area of a nucleus (assuming it to be a perfect sphere) (where, $A$ = mass number and $r_0 = 1.2 \times 10^{-15}$ m).

2. Threshold wavelength for a metal having work function $W_0$ is $\lambda$. What is the threshold wavelength for the metal having work function $2W_0$?

3. If speeds of gamma rays, X-rays and microwaves are $v_g$, $v_x$ and $v_m$ respectively, then what is the correct relationship between them?

4. At a certain place, the angle of dip is 30° and horizontal component of earth's magnetic field is 0.50 oersted. Calculate the earth's total magnetic field (in oersted).

5. The refractive index of the material of an equilateral prism is $\sqrt{3}$. Calculate the angle of incidence at minimum deviation.

*Or*

Yellow light is used in a single-slit diffraction experiment with slit width of 0.6 mm. If yellow light is replaced by X-rays, then write observation about the new pattern.

6. Assume that each atom of copper contributes one free electron. What is the average drift velocity of conduction electrons in a copper wire of cross-sectional area $10^{-7}\,m^2$ having number of free electrons per unit volume equal to $8.53 \times 10^{28}$ and carrying a current of 1.5 A?

*Or*

The storage battery of a car has an emf of 12V. If the internal resistance of the battery is 0.2 Ω, then what is the maximum current that can be drawn from the battery?

7. What is an LED? How is it biased and why?

8. To which regions of the electromagnetic spectrum, the wavelengths 2000 Å and 10000 Å belong?

9. What is the phase difference between voltage and current in a *L-C-R* series circuit at resonance?

*Or*

How can we improve the quality factor of a tuning circuit?

10. Write the dominant mechanisms for motion of charge carriers in forward and reverse biased silicon *p-n* junctions.

**For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion** (A) and the other labelled **Reason** (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.

11. **Assertion** The poles of magnet cannot be separated by breaking into two pieces.

**Reason** The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.

12. **Assertion** In a system of co-axial solenoids, it is extremely difficult to calculate the flux linkage with the outer solenoid when current flows in inner solenoid.

**Reason** The magnetic field due to the inner solenoid would vary across the length as well as cross-section of the outer solenoid (when inner solenoid is smaller in length and radius).

13. **Assertion** Diffraction determines the limitations of the concepts of light rays.

**Reason** A beam of width $a$ starts to spread out due to diffraction after it has travelled a distance $(2a^2/\lambda)$.

14. **Assertion** Nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.

**Reason** The nuclear force does not depend on the electric charge.

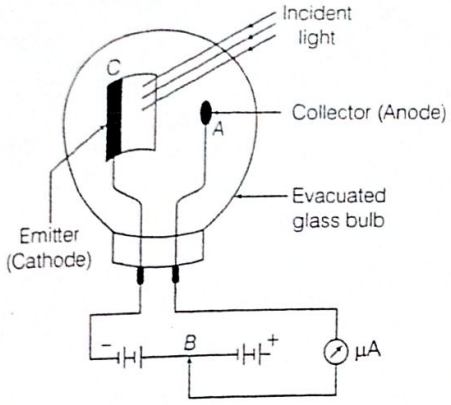
## SECTION-B

*Questions 15 and 16 are case study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.*

### Photocell

15. Photocell is a device which converts light energy into electrical energy. It is also called an electric eye.

A photocell consists of a semi-cylindrical photosensitive metal plate $C$ (emitter) and a wire loop $A$ (collector) supported in an evacuated glass or quartz bulb. When light of suitable wavelength falls on the emitter $C$, photoelectrons are emitted.




Thus, the photoelectric current sets up in the photoelectric cell corresponding to incident light, it provides the information about the objects as has been seen by our eye in the presence of light.

(i) All photons present in a light beam of single frequency incident on the emitter $C$ have
(a) same frequency but different momentum
(b) same momentum but different frequency
(c) different frequency and momentum
(d) same frequency and momentum

(ii) Photocell is based on photoelectric effect that gave evidence that light in interaction with matter,
(a) is converted into particles of same size
(b) is converted into particles of same energy
(c) is converted into mass following $E = mc^2$
(d) behaves as if it was made of packets of energy, each of energy $hv$

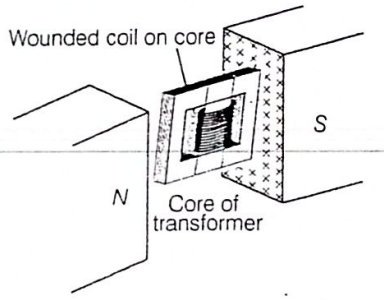
(iii) When intensity of a light beam incident on emitter $C$ is increased , then
(a) energy of photons present increases
(b) momentum of photons present increases
(c) wavelength of photons present increases
(d) number of photons crossing a unit area per second increases

(iv) A photocell cannot be used
(a) for reproduction of sound in motion pictures
(b) in burglar alarms
(c) as a fire alarm
(d) to illuminate a room

(v) Monochromatic light of frequency $6.0 \times 10^{14}$ Hz is incident on photocell that is used in metro stations.. The energy of a photon in the light beam is
(a) $5 \times 10^{-15}$ J (b) $3.98 \times 10^{-19}$ J
(c) $2.54 \times 10^{-14}$ J (d) $5.16 \times 10^{-14}$ J

## Eddy Current

**16.** Coil is wound over metallic core is helpful in reducing eddy currents in the metallic cores of transformers, electric motors, induction furnaces and other such devices (as shown below). Eddy current are undesirable since they heat up the core and dissipate electrical energy in the form of heat. These currents are minimised by using laminations of metal to make a metal core.




(i) How are eddy currents minimised to make a metal core of transformer on which coils are wound?
(a) By using laminations of metal
(b) By using solid metallic core
(c) Both (a) and (b)
(d) Neither (a) nor (b)

(ii) The plane of the laminations must be arranged parallel to the magnetic field, so that they cut across the
(a) keep on sliding
(b) keep on rotating
(c) cut across the induced eddy currents
(d) Both (a) and (b)

(iii) Induction furnace is used to produce
(a) low temperature to melt the metal
(b) high temperature to melt the metal
(c) constant low temperature 20°C
(d) high pressure

(iv) Induction furnace can be utilised to prepare
(a) alloys, by melting the constituent metals
(b) metal, by mixing electrons, protons, neutrons
(c) Both (a) and (b)
(d) Neither (a) nor (b)

(v) When a high frequency alternating current is passed through a coil which surrounds the metal to be melted. Then,
(a) the metal freezes
(b) coil rotates with frequency $\omega$
(c) the metal melts
(d) None of the above

## SECTION-C

*All questions are compulsory. In case of internal choices, attempt anyone.*

**17.** Show that the total induced charge simply depends upon the change in the magnetic flux and is independent of the time rate of change of flux.

**18.** A pure germanium plate of area $3.5 \times 10^{-4}$ m$^2$ and of thickness $1.5 \times 10^{-3}$ m is connected across a battery of potential 5 V. Find the amount of current produced at room temperature in the germanium sample. Given that, the concentration of carriers in germanium at room temperature is $1.6 \times 10^{6}$ m$^3$. The mobilities of electrons and holes are $0.4$ m$^2$ V$^{-1}$ s$^{-1}$ and $0.2$ m$^2$ V$^{-1}$ s$^{-1}$, respectively.

*Or*

Three photodiodes $D_1$, $D_2$ and $D_3$ are made of semiconductors having band-gaps of 2.5 eV, 2 eV and 3 eV, respectively. Which ones will be able to detect light of wavelength 6000 Å?

**19.** In Bohr's atomic model, an electron is revolving in $n = 3$ level. Calculate the speed and time period of revolution of electron.

*Or*

(i) On bombarding $U^{235}$ by slow neutron, 200 MeV energy is released. If the power output of atomic reactor is 1.6 MW, determine the rate of fission.

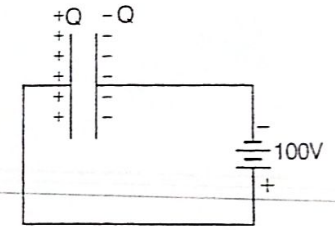
(ii) What is the ratio of mass of daughter nucleus to mass of parent nucleus in any fission process?

**20.** Derive an expression for angle of dip, if $B_H$ and $B_V$ are horizontal and vertical component of resultant earth's magnetic field. Also, support your answer with figure depicting three magnetic elements of earth.

**21.** If a charged spherical conductor of radius 10 cm has potential $V$ at a point distant 5 cm from its centre, then find the potential at a point distant 15 cm from the centre.

*Or*

A 900 pF capacitor is charged by 100 V battery in the given figure. How much electrostatic energy and charge are stored by the capacitor ?




**22.** A long train is moving with uniform speed from North to South.
(i) Will any induced emf appear across the ends of its axle?
(ii) Will the answer be affected, if the train moves from East to West?

**23.** Give the limitations of Bohr's theory of hydrogen atom.

**24.** Write the characteristic properties of photons.

**25.** (i) Is the ratio of frequencies of ultraviolet rays and infrared rays in glass more than, less than or equal to 1?
(ii) What type of electromagnetic waves are used at metro stations to detect metal or explosive material?

## SECTION-D

*All questions are compulsory. In case of internal choices, attempt anyone.*

**26.** A ray of light is incident on the face of prism ($\mu = 1.5$) at an angle of 60°. The refracting angle of the prism is also 60°. Determine

(i) angle of emergence

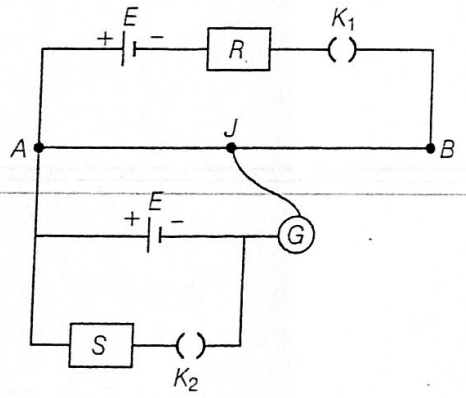
(ii) and angle of deviation.

Given, $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right) = 35°16'$,

$\sin 24°44' = 0.42$

and $\sin^{-1}(0.63) = 39°$

**27.** Two students $X$ and $Y$ perform an experiment on potentiometer as shown in the circuit diagram, keeping other things unchanged, (i) $X$ increases the value of $R$ (ii) $Y$ decreases the value of resistance $S$ in the set-up.




How would these changes effect the position of null point in each case and why?

**28.** (i) Two slits in Young's double slit experiments have width in ratio 1 : 25. Determine the ratio of intensity at the maxima and minima in the interference pattern.

(ii) In the Young's double slit experiment, using a monochromatic light of wavelength $\lambda$. Determine the path difference (in terms of integer $n$) corresponding to any point having half the peak intensity.

***Or***

A short object of length $L$ is placed along the principal axis of a concave mirror away from focus. The object distance is $u$. If the mirror has a focal length $f$, what will be the length of the image? You may take $L << |v - f|$.

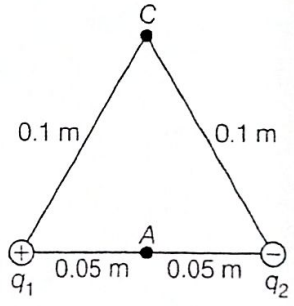
**29.** An air capacitor has a capacitance of 2 μF, which becomes 12 μF when a dielectric medium is filled in the space between the plates. Find

(i) dielectric constant of that material.

(ii) induced charge on the dielectric due to polarisation when a charge of 6 μC is given to the positive plate of the capacitor.

***Or***

Two point charges $q_1$ and $q_2$ of $+10^{-8}$ C and $-10^{-8}$ C, respectively are placed 0.1 m apart.




Then, find the magnitudes of electric fields at $A$ and $C$.

**30.** Give the $V$-$I$ characteristics of the following

(i) $p$-$n$ junction diode

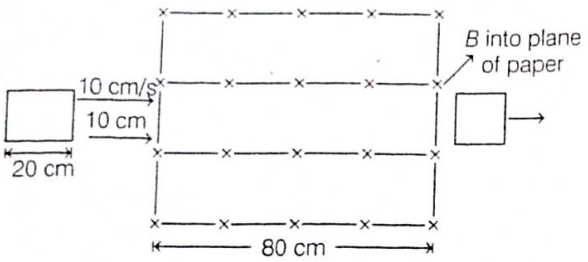
(ii) Light emitting diode

(iii) solar cell

## SECTION-E

*All questions are compulsory. In case of internal choices, attempt anyone.*

**31.** Define mutual inductance of a pair of coils and write on which factors does it depend. A square loop of 20 cm is initially kept 30 cm away from a region of uniform magnetic field of 0.1 T as shown in figure.




It is then moved towards the right with a velocity of 10 $cm^{-1}$ till it goes out of the field. Plot a graph showing the variation of

(i) magnetic flux ($\phi$) through the loop with time ($t$)

(ii) induced emf ($e$) in the loop with time ($t$)

(iii) induced current in the loop, if it has resistance of 0.1 Ω.

***Or***

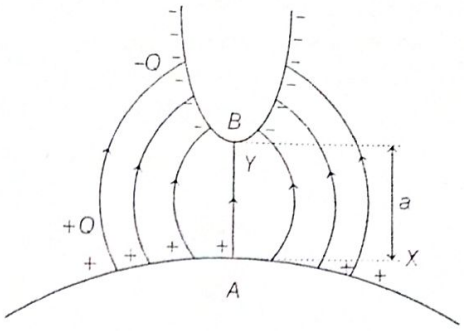
(i) A 10V, 650Hz, source is connected to a series combination of $R = 100\Omega$, $C = 10\mu F$ and $L = 0.15H$.

Find out the time in which the resistance will get heated by 10°C, if the thermal capacity of the resistance = 20J/°C.

(ii) Obtain the resonant frequency and quality factor of a series $L$-$C$-$R$ circuit with $L = 4$ H, $C = 64\,\mu F$ and $R = 20\Omega$.

**32.** (i) Two conductors carrying equal and opposite charges create a non-uniform field as shown in the figure given below.

What will be the capacity of this capacitor, if the field along $Y$-axis varies as $E = \frac{Q}{\varepsilon_0 A}[1 + BY^2]$, where $B$ is a constant?




(ii) (a) An electrostatic field line is a continuous curve, i.e. it cannot have sudden breaks. Why is it so?

(b) Explain, why two field lines never cross one another.

***Or***

A non-conducting disc of radius $r$ and uniform positive surface charge density $\sigma$ is placed on the ground with its axis along $Z$-axis. A particle of mass $m$ and positive charge $q$ is dropped along the axis of the disc, from a height $H$ with zero initial velocity. The particle has $q/m = 4\varepsilon_0 g / \sigma$.

(i) Find the value of $H$, if the particle just reaches the disc.

(ii) Draw the graph of its potential energy as a function of its height and find its equilibrium position from the centre of the disc.

**33.** (i) In a Young's double slit experiment, the two slits are kept 2mm apart and the screen is positioned 140 cm away from the plane of the slits. The slits are illuminated with light of wavelength 600 nm. Find the distance of the third bright fringe, from the central maximum, in the interference pattern obtained on the screen.

(ii) If the wavelength of the incident light were changed to 480 nm, then find out the shift in the position of third bright fringe from the central maximum.

(iii) In a single-slit diffraction pattern observed on a screen placed at $D$ metre distance from the slit of width $d$ metre find the ratio of the width of the central

maximum to the width of other secondary maximum.

***Or***

(i) A beam of light converges to a point *P*. Now, a lens is placed on the path of the convergent beam 12 cm apart from *P*. At what point does the beam converge, if the lens is

(a) a convex lens of focal length 20 cm

(b) and a concave lens of focal length 16 cm?

(ii) Find the position of the image formed by the lens combination given in the following figure.