

ISC Solved Paper 2019

Physics

Class-XII

(Maximum Marks : 80)

(Time allowed : Three hours)

All questions are compulsory.

This question paper is divided into 4 Sections, A, B, C and D as follows:

Section A

Question number 1 is of twelve marks. All parts of this question are compulsory.

Section B

Question numbers 2 to 12 carry 2 marks each with two questions having internal choice.

Section C

Question numbers 13 to 19 carry 3 marks each with two questions having internal choice.

Section D

Question numbers 20 to 22 are long-answer type questions and carry 5 marks each. Each question has an internal choice.

The intended marks for questions are given in brackets [].

All working, including rough work, should be done on the same sheet as and adjacent to the rest of the answer.

Answers to sub parts of the same question must be given in one place only. A list of useful physical constants is given at the end of this paper.

A simple scientific calculator without a programmable memory may be used for calculations.

SECTION-A

Answer all questions.

1. A. Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below: [5×1]
- (i) A closed surface in vacuum encloses charges $-q$ and $+3q$. The total electric flux emerging out of the surface is:
- (a) Zero (b) $\frac{2q}{\epsilon_0}$
(c) $\frac{3q}{\epsilon_0}$ (d) $\frac{4q}{\epsilon_0}$
- *(ii) What is the angle of dip at a place where the horizontal component (B_H) and vertical component (B_V) of earth's magnetic field are equal:
- (a) 130° (b) 60°
(c) 45° (d) 90°
- (iii) A beam of light is incident at the polarizing angle of 35° on a certain glass plate. The refractive index of the glass plate is:
- (a) $\sin 35^\circ$ (b) $\tan 35^\circ$
(c) $\tan 55^\circ$ (d) $\sin 55^\circ$
- *(iv) In a gamma ray emission from nucleus:
- (a) only the number of protons change.
(b) the number of protons and neutrons, both change.
(c) there is no change in the number of protons and the number of neutrons.
(d) only the number of neutrons change.
- (v) The energy associated with light of which of the following colours is minimum:
- (a) violet (b) red
(c) green (d) yellow
- B. Answer the following questions briefly and to the point. [7×1]
- (i) Define equipotential surface.
- (ii) Calculate the net emf across A and B shown in Figure 1 below:

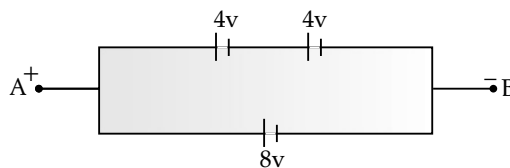


Fig. 1

- (iii) Why are the pole pieces of a horseshoe magnet in a moving coil galvanometer made cylindrical in shape?
- (iv) What is the value of power factor for a pure resistor connected to an alternating current source?
- (v) What should be the path difference between two waves reaching a point for obtaining constructive interference in Young's Double Slit experiment?
- (vi) Define critical angle for a given medium.
- (vii) Name the series in the atomic spectra of the hydrogen atom that falls in the ultra violet region.

Ans. (A) (i) (b)
 (iii) (b)
 (v) (b)

- (B) (i) Surface due to point charge wherein the electric potential remains same.
- (ii) Since $(4V + 4V = 8V)$ and $8V$ are in parallel :
 \therefore Net Emf = $8V$
- (iii) In order to attain radial magnetic field which results the strong magnetic field.
- (iv) $\cos \phi = \frac{R}{Z}$, for pure resistor, $Z = R$
 $\therefore \cos \phi = \frac{R}{R} = 1$
- (v) If x is path difference, then $x = n \lambda$, where λ is wavelength.
- (iv) It is the angle of incidence in a denser medium for which the angle of refraction is 90° in rarer medium.
- (vii) Lyman series.

SECTION-B

Answer all questions.

2. In a potentiometer experiment, the balancing length with a resistance of 2Ω is found to be 100 cm , while that of an unknown resistance is 500 cm . Calculate the value of the unknown resistance. [2]

Ans. $\frac{E_1}{E_2} = \frac{IR_1}{IR_2}$, since current remains constant

$$\therefore \frac{E_1}{E_2} = \frac{R_1}{R_2} \quad (i)$$

Also $\frac{E_1}{E_2} = \frac{l_1}{l_2} \quad (ii)$

From (i) and (ii),

$$R_2 = R_1 \left(\frac{l_2}{l_1} \right) = 2\Omega \times \left(\frac{500\Omega}{100\Omega} \right)$$

$$R_2 = 10 \Omega$$

3. A rectangular loop of area 5 m^2 , has 50 turns and carries a current of 1 A . It is held in a uniform magnetic field of 0.1 T , at an angle of 30° . Calculate the torque experienced by the coil. [2]

Ans. $A = 5 \text{ m}^2, N = 50, I = 1 \text{ A}, B = 0.1 \text{ T}, \theta = 30^\circ,$
 $\tau = NIAB \sin \theta$
 $\tau = 50 \times 1 \times 5 \times 0.1 \sin 30^\circ = 12.5 \text{ N-m}$

4. (a) An electric current I flows through an infinitely long conductor as shown in Figure 2(a) below. Write an expression and direction for the magnetic field at point P.



Fig. 2(a)

OR

- (b) An electric current I flows through a circular

loop as shown in Figure 2(b) below. Write an expression and direction for the magnetic field at the centre of the loop at point P. [2]

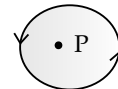


Fig. 2(b)

Ans. (a) $B = \frac{\mu_0}{4\pi} \frac{2I}{a}$, Direction \rightarrow Downward

Here all alphabets are in their usual meaning
 OR

(b) $B = \frac{\mu_0}{4\pi} \frac{2\pi I}{a}$, Direction \rightarrow Upward.

Here all alphabets are in their usual meaning

5. A transformer is used to step up an alternating emf of 200 V to 440 V . If the primary coil has 1000 turns, calculate the number of turns in the secondary coil. [2]

Ans. Given, $V_s = 440 \text{ V}, V_p = 200 \text{ V}$ and $N_p = 1000$

Since, transformer ratio = $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

$$\text{So, } N_s = N_p \left(\frac{V_s}{V_p} \right)$$

$$= 1000 \times \left(\frac{440 \text{ V}}{200 \text{ V}} \right)$$

$$N_s = 2200$$

6. State any two properties of microwaves. [2]

Ans. (i) Travel with the speed of light ($c = 3 \times 10^8 \text{ m/s}$)
 (ii) Transverse in nature ($E \perp B \perp c$).

7. Write any one use for each of the following mirrors:

- (a) Convex
- (b) Concave

[2]

- Ans. (a) Convex → as a rear view mirror.
 (b) Concave → in torch light, solar furnaces
8. The deviation produced for violet, yellow and red lights for crown glass are 3.75° , 3.25° and 2.86° respectively. Calculate the dispersive power of the crown glass. [2]

Ans. $\omega = \frac{\delta_V - \delta_R}{\delta_Y}$ [Here, all the alphabets are in their usual meanings]

$$= \frac{3.75^\circ - 2.86^\circ}{3.25^\circ}$$

$$= 0.274$$

9. (a) What is meant by mass defect?
 (b) What conclusion is drawn from Rutherford's scattering experiment of α -particles? [2]
- Ans. (a) It is the difference between the mass of the nucleons and total mass of the nucleus.
 (b) Nucleus lies at the centre of atom where whole mass is concentrated and most of the space in an atom is empty.
10. Define the following with reference to photoelectric effect:

- (a) Threshold frequency (f_0)
 (b) Stopping potential (V_s) [2]
- Ans. (a) Minimum frequency required for emission of photoelectrons from metal surface.
 (b) Negative potential applied relative to another negative plate in order to stop photoelectric current.
- *11. (a) The half-life of radium is 1550 years. Calculate its disintegration constant (λ).

OR

*(b) Copy and complete, the following table for a radioactive element whose half-life is 10 minutes. Assume that you have 30 g of this element at $t = 0$.

t (minute)	0	20	30
Amount of radioactive element left in gm	30	—	—

12. Define frequency modulation and state any one advantage of frequency modulation (FM) over amplitude modulation (AM).

SECTION-C

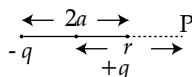
Answer all questions.

13. Obtain an expression for electric potential 'V' at a point in an end-on position i.e., axial position of an electric dipole. [3]
- Ans. Consider an electric dipole of charges $\pm q$ having separation '2a' as shown in diagram. Let 'p' be the point on its axial position at distance 'r' from its midpoint.

$$V_1 \text{ (due to } -q) = \frac{1}{4\pi\epsilon_0} \frac{(-q)}{r+a}$$

$$V_2 \text{ (due to } +q) = \frac{1}{4\pi\epsilon_0} \frac{(+q)}{r-a}$$

$$\text{Net } V = V_1 + V_2 = \frac{q}{4\pi\epsilon_0} \left\{ \frac{1}{r-a} - \frac{1}{r+a} \right\}$$



$$= \frac{q}{4\pi\epsilon_0} \left\{ \frac{r+a - r-a}{r^2 - a^2} \right\}$$

$$= \frac{q(2a)}{4\pi\epsilon_0 (r^2 - a^2)}$$

or
$$V = \frac{1}{4\pi\epsilon_0} \cdot \frac{p}{r^2 - a^2} \quad \{\because p = q(2a)\}$$

14. Three capacitors of capacitance $C_1 = 3 \mu\text{F}$, $C_2 = 6 \mu\text{F}$ and $C_3 = 10 \mu\text{F}$, are connected to a 10 V battery as shown in Figure 3 below:

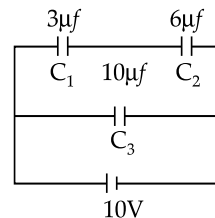


Fig. 3

Calculate:

- (a) Equivalent capacitance.
 (b) Electrostatic potential energy stored in the system.

Ans. Given : $C_1 = 3 \mu\text{F}$, $C_2 = 6 \mu\text{F}$, $C_3 = 10 \mu\text{F}$ and battery potential $E = V = 10\text{V}$

- (a) Since C_1 & C_2 are in series, so their equivalent capacitance C'

$$\frac{1}{C'} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{3\mu\text{F}} + \frac{1}{6\mu\text{F}}$$

or, $C' = 2 \mu\text{F}$

Again, $C' \parallel C_3$, So their equivalent capacitance C is given as

$$C = C' + C_3 = 2 \mu\text{F} + 10 \mu\text{F}$$

$$= 12 \mu\text{F}$$

- (b) Now, the stored electrostatic potential energy

$$(U) = \frac{1}{2} CV^2$$

$$= \frac{1}{2} \times 12\mu\text{F} \times (10\text{V})^2$$

$$= 600\mu\text{J} = 6.0 \times 10^{-4} \text{ J}$$

15. (a) Obtain the balancing condition for the Wheatstone bridge arrangement as shown in Figure 4 below:

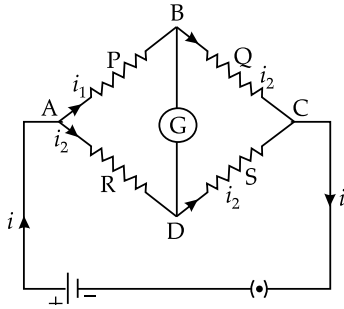


Fig. 4

OR

- (b) Draw a labelled circuit diagram of a potentiometer to measure the internal resistance 'r' of a cell. Write the working formula (derivation is not required). [3]

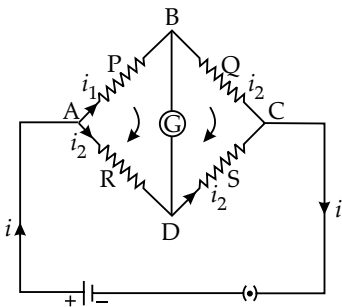
Ans. (a) The potential at B is equal to potential at D. So, no current flows through the galvanometer. This is called balanced condition of Wheatstone's bridge.

In closed circuit ABDA

$$\begin{aligned} i_1 P - i_2 R &= 0 \\ i_1 P &= i_2 R \end{aligned} \quad \dots(1)$$

In closed mesh BCDB.

$$\begin{aligned} i_1 Q - i_2 S &= 0 \\ i_1 Q &= i_2 S \end{aligned} \quad \dots(2)$$



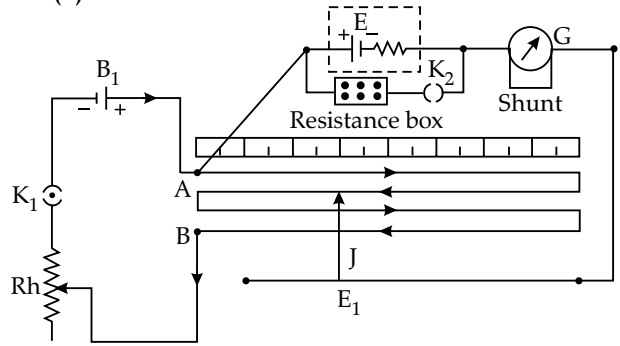
Divide Equation (1) by equation (2)

$$\frac{i_1 P}{i_1 Q} = \frac{i_2 R}{i_2 S}$$

We get, $\frac{P}{Q} = \frac{R}{S}$

OR

- (b)



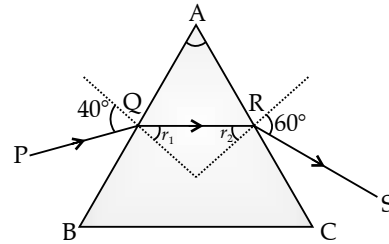
$$\text{Working Formula } r = R \left(\frac{l_1}{l_2} - 1 \right)$$

16. (a) A ray of light is incident on a prism whose refractive index is 1.52 at an angle of 40° . If the angle of emergence is 60° , calculate the angle of the prism. [3]

OR

- (b) Calculate the focal length of a convex lens whose radii of curvature of two surfaces is 10 cm and 15 cm respectively and its refractive index is 1.5. [3]

Ans. (a)



$$n = 1.52$$

Since, $n = \frac{\sin i}{\sin r_1}$

$$\sin r_1 = \frac{\sin 40^\circ}{1.52} = 0.4228$$

or

$$r_1 = 25^\circ$$

Also, $n = \frac{\sin e}{\sin r_2}$

$$\sin r_2 = \frac{\sin 60^\circ}{1.52} = 0.5697$$

$$r_2 = 34.7^\circ$$

$$\text{Angle of prism (A)} = r_1 + r_2 = 59.7^\circ$$

OR

- (b) Using Len's Maker's formula $\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$

$$\frac{1}{f} = (1.5 - 1) \left(\frac{1}{10} - \frac{1}{-15} \right)$$

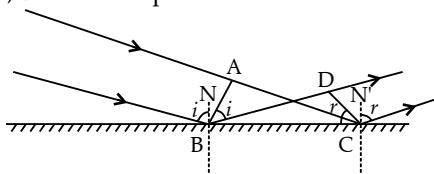
$$\frac{1}{f} = 0.5 \left\{ \frac{25}{10 \times 15} \right\}$$

$$f = \frac{10 \times 15}{0.5 \times 25} = 12 \text{ cm}$$

17. Derive the law of reflection using Huygen's Wave Theory. [3]

Ans. AB and CD are wave-fronts. Time taken by light to travel from B to D is equal to time taken by it from C to A.

Also, medium is same so velocity will remain same. Now, Distance = speed \times time.



i.e, $BD = v \times t$

$AC = v \times t$ { $\therefore t$ is also same. }

So, $BD = AC$ (i)

In ΔABC , $\sin i = \frac{AC}{BC}$

or $AC = BC \sin i$... (ii)

In ΔDCB , $\sin r = \frac{BD}{BC}$

or $BD = BC \sin r$... (iii)

From (i), (ii) and (iii)

$$BC \sin i = BC \sin r$$

$$\sin i = \sin r$$

or $\angle i = \angle r$

18. State any two Bohr's postulates and write the energy value of the ground state of the hydrogen atom. [3]

Ans. (i) Acc. to Bohr's Quantisation condition,

$$L = n \frac{h}{2\pi}$$

where $L \rightarrow$ angular momentum,

$h \rightarrow$ Planck's constant

$n \rightarrow$ Principle Quantum Number.

(ii) According to Bohr's frequency condition, the energy radiated is given by, $\Delta E = E_i - E_f = h\nu$

where $\nu =$ frequency.

(iii) Energy at ground state; $E = -13.6 \text{ eV}$

19. With reference to semi-conductors answer the following: [3]

(i) What is the change in the resistance of the semi-conductor with increase in temperature?

(ii) Name the majority charge carriers in n - type semi-conductor.

(iii) What is meant by doping?

Ans. (i) With increase in temperature, resistance decreases

(ii) free - electrons

(iii) It is the process of deliberate addition of impurities to a pure - semiconductor to increase its conductivity.

SECTION-D

Answer all questions.

20. (a) (i) An alternating emf of 200 V, 50 Hz is applied to an L-R circuit, having a resistance R of 10 Ω and an inductance L of 0.05 H connected in series. Calculate:

(1) Impedance.

(2) Current flowing in the circuit.

(ii) Draw a labelled graph showing the variation of inductive reactance (X_L) versus frequency (f).

OR

(b) (i) An a.c. source of emf $\varepsilon = 200 \sin \omega t$ is connected to a resistor of 50 Ω .

Calculate:

(1) Average current (I_{avg}).

(2) Root mean square (rms) value of emf.

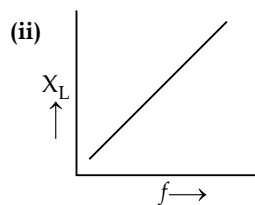
(ii) State any two characteristics of resonance in an LCR series circuit. [5]

Ans. (a) (i) Given $E = 200 \text{ V}$, $f = 50 \text{ Hz}$, $R = 10 \Omega$,
 $L = 0.05 \text{ H}$

$$X_L = \omega L = 2\pi fL = 2\pi \times 50 \times 0.05 = 15.7 \Omega$$

(1) Impedance $Z = \sqrt{R^2 + X_L^2} = \sqrt{10^2 + (15.7)^2} = 18.62 \Omega$

(2) Circuit current $I = \frac{E}{Z} = \frac{200}{18.62} = 10.74 \text{ A}$



OR

(b) (i) $E_0 = 200 \text{ V}$, $R = 50 \Omega$

$$I_0 = \frac{E_0}{R} = \frac{200}{50} = 4 \text{ A}$$

(1) Average current $I_{av} = \frac{2}{\pi} \times 4 = \frac{8}{\pi} = 2.546 \text{ A}$

(2) $E_{rms} = \frac{E_0}{\sqrt{2}} = \frac{200}{\sqrt{2}} = 141.42 \text{ V}$

(ii) (a) $X_L = X_C$

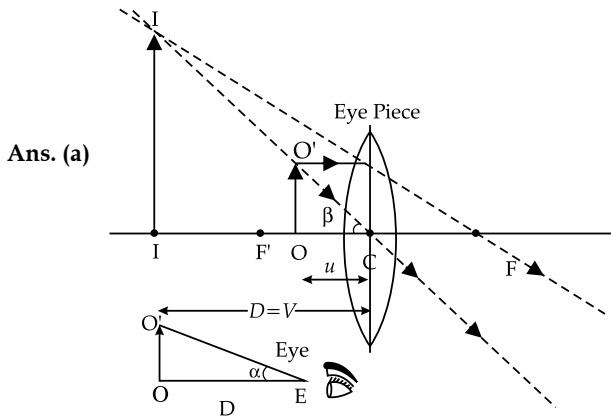
(b) $Z_{min} = R$

21. (a) Draw a neat labelled ray diagram showing the formation of an image at the least distance of distinct vision D by a simple microscope.

When the final image is at D, derive an expression for its magnifying power at D.

OR

- (b) Draw a neat labelled diagram of Young's Double Slit experiment. Show that $\beta = \frac{\lambda D}{d}$, where the terms have their usual meaning (either for bright or dark fringe). [5]



$$\tan \beta = (OO'/OC), \tan \alpha = (OO'/OE)$$

$$M = \beta/\alpha = (OO'/OC)/(OO'/OE) = (OE/OC) = (IC/OC) = v/u$$

Now apply lens formula,

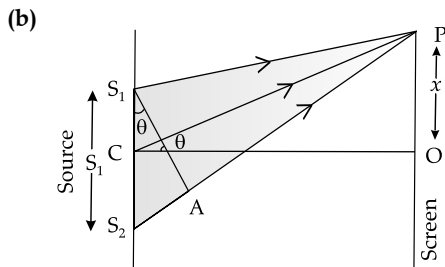
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{v}{v} - \frac{v}{u} = \frac{v}{f}$$

$$1 - M = \frac{D}{f} \quad \left[\because M = \frac{v}{u} \right]$$

$$\therefore M = 1 + \frac{D}{f}$$

OR



From the constructed diagram,

$$\text{Path difference} = S_2P - S_1P = S_2P - AP$$

$$[\because S_1P \approx AP]$$

$$= S_2A$$

$$\text{In } \Delta S_1AS_2, \sin \theta = \frac{S_2A}{S_1S_2} \quad \dots(i)$$

$$\text{In } \Delta POC, \tan \theta = \frac{OP}{CO} \quad \dots(ii)$$

If θ is small, from eq (i) and (ii),

$$\frac{S_2A}{S_1S_2} = \frac{OP}{CO}$$

$$\frac{S_2A}{d} = \frac{x}{D}$$

$$\text{or } S_2A = \frac{xd}{D}$$

At constructive interference (bright fringe),

$$\frac{xd}{D} = n\lambda$$

$$\text{or, for } n^{\text{th}} \text{ fringe } x_n = \frac{nD\lambda}{d}$$

$$\text{or, for } (n+1)^{\text{th}} \text{ fringe } x_{n+1} = \frac{(n+1)D\lambda}{d}$$

$$\text{Fringe width, } \beta = x_{n+1} - x_n$$

$$\beta = \frac{(n+1)D\lambda}{d} - \frac{nD\lambda}{d} = \frac{\lambda D}{d}$$

- *22. (a) * (i) Draw a labelled circuit diagram of a half wave rectifier and give its output waveform.

- * (ii) Draw a symbol for NOR gate and write its truth table.

OR

- * (b) (i) Draw, a neat circuit diagram to study the input and output characteristics of a common emitter transistor.

- * (ii) Draw the symbol for AND gate and write its truth table.

Useful Constants and Relations:

1.	Charge on electron	(e)	$1.6 \times 10^{-19} \text{C}$
2.	Planck's constant	(h)	$6.6 \times 10^{-34} \text{Js}$
3.	Speed of light in vacuum	(c)	$3 \times 10^8 \text{ms}^{-1}$

