

# SCO INTERNATIONAL OLYMPIAD

## CLASS 12 PHYSICS OLYMPIAD

Official Question Paper • Set A

### Class 12 Physics SCO's official online/offline Olympiad flow.

- covers electrostatics, current electricity, magnetism, induction, AC, optics, modern physics, semiconductors and communication systems
- built for senior-secondary learners preparing for evidence-based physics reasoning and global STEM pathways
- includes objective questions, answer key and concise explanations for transparent review

Electrostatics	Current Electricity	Magnetism	EM Induction	AC
EM Waves	Ray Optics	Wave Optics	Modern Physics	Semiconductors

## Official Question Paper

Exam Name	SCO International Physics Olympiad
Class / Grade	Class 12
Paper	Set A — Rebranded Website Download
Duration	60 minutes
Question Type	Objective Type / MCQ
Total Questions	50
Recommended Marking	Q1–Q40: 1 mark each; Q41–Q50: 2 marks each; no negative marking unless separately notified
Important Instruction	Select ONE correct option for each question. Calculators are not allowed unless announced by SCO.

Student Details: Name \_\_\_\_\_ Registration ID \_\_\_\_\_ School \_\_\_\_\_

## Section A: Core Physics Concepts

**Q1.** A sinusoidal voltage  $V=200\sin 314t$  is applied to a  $10\Omega$  resistor. Find rms voltage.

1. 141.4V
2. 314.2V
3. 519.6V
4. 278.9V

**Q2.** Two moving-coil meters M1 and M2 have these particulars: M1:  $R = 10\Omega$ ,  $N = 30$ ,  $A = 3.6 \times 10^{-3} \text{ m}^2$ ,  $B = 0.25 \text{ T}$ ; M2:  $R = 14\Omega$ ,  $N = 42$ ,  $A = 1.8 \times 10^{-3} \text{ m}^2$ ,  $B = 0.50 \text{ T}$ . The spring constants are identical. What are the ratios of current sensitivity and voltage sensitivity of M2 to M1?

1. Current sensitivity = 1.4, voltage sensitivity = 1.0
2. Current sensitivity = 1.0, voltage sensitivity = 1.4
3. Current sensitivity = 0.7, voltage sensitivity = 1.0
4. Current sensitivity = 1.4, voltage sensitivity = 0.7

**Q3.** A circular coil of 20 turns and 10 cm radius is placed in a uniform magnetic field of 0.10 T normal to the plane of the coil. If the current in the coil is 5 A, cross-sectional area is and coil is made up of copper wire having free electron density about  $10^{29} \text{ m}^{-3}$ , then the average force on each electron in the coil due to magnetic field is.

1.  $2.5 \times 10^{-25} \text{ N}$
2.  $5 \times 10^{-25} \text{ N}$
3.  $4 \times 10^{-25} \text{ N}$
4.  $3 \times 10^{-25} \text{ N}$

**Q4.** A charged particle is to continue moving with constant velocity in a region of electric and magnetic fields. Which condition is NOT sufficient by itself for constant velocity?

1.  $E = 0, B \neq 0$
2.  $E \neq 0, B \neq 0$
3.  $E \neq 0, B = 0$
4.  $E = 0, B = 0$

**Q5.** The percentage increase in magnetic field B when the space within a current carrying toroid is filled with aluminium ( $\chi = 2.1 \times 10^{-5}$ ) is?

1. 0.2%
2.  $2 \times 10^{-3}\%$
3.  $2 \times 10^{-2}\%$
4.  $2 \times 10^{-4}\%$

**Q6.** A circular coil of 300 turns and diameter 14 cm carries a current of 15A. The magnitude of magnetic moment associated with the loop is?

1.  $51.7 \text{ J T}^{-1}$
2.  $69.2 \text{ J T}^{-1}$
3.  $38.6 \text{ J T}^{-1}$
4.  $19.5 \text{ J T}^{-1}$

**Q7.** The magnitude of the magnetic field at the centre of the tightly wound 150 turn coil of radius 12 cm carrying a current of 2 A is:

1. 18 G
2. 19.7 G
3. 15.7 G
4. 17.7 G

**Q8.** If the current sensitivity of a galvanometer is doubled, then its voltage sensitivity will be

1. doubled
2. halved
3. unchanged
4. four times

**Q9.** Two beams of light having intensities  $I$  and  $4I$  interfere to produce a fringe pattern on the screen. Phase difference between the beams is fraction  $\pi/2$  at point  $a$  and  $p$  at sites at  $A$  and  $B$  is

1.  $3I$
2.  $4I$
3.  $5I$
4.  $6I$

**Q10.** A radar operates at wavelength  $50.0$  cm. If the beat frequency between the transmitted signal and the signal reflected from aircraft ( $\Delta v$ ) is  $1$  kHz, then velocity of the aircraft will be

1.  $800$  km/hr
2.  $900$  km/hr
3.  $1000$  km/hr
4.  $1032$  km/hr

**Q11.** A spectral line of wavelength  $0.59$  mm is observed in the directions to the opposite edges of the solar disc along its equator. A difference in wavelength equal to  $(\Delta\lambda)$   $8$  picometer is observed. Period of Sun's revolution around its own axis will be about (Radius of sun =  $6.95 \times 10^8$  m)

1. 30 days
2. 24 hours
3. 25 days
4. 365 days

**Q12.** Angular width of central maximum in the Fraunhofer's diffraction pattern is measured. Slit is illuminated by the light of another wavelength, angular width decreases by  $30\%$ . Wavelength of light used is

1.  $3500 \text{ \AA}$
2.  $4200 \text{ \AA}$
3.  $4700 \text{ \AA}$
4.  $6000 \text{ \AA}$

**Q13.** A parallel beam of white light falls on a thin film whose refractive index is  $1.33$ . If angle of incidence is  $52^\circ$  then thickness of the film for the reflected light to be coloured yellow ( $\lambda = 6000 \text{ \AA}$ ) most intensively must be

1.  $14(2n + 1) \mu\text{m}$
2.  $1.4(2n + 1) \mu\text{m}$
3.  $0.14(2n + 1) \mu\text{m}$
4.  $142(2n + 1) \mu\text{m}$

**Q14.** An ammeter is obtained by shunting a  $30 \Omega$  galvanometer with a  $30 \Omega$  resistance. What additional shunt should be connected across it to double the range?

1.  $15 \Omega$
2.  $10 \Omega$
3.  $5 \Omega$
4. none of these

**Q15.** In Young's double slit experiment, using monochromatic light, fringe pattern shifts by a certain distance on the screen when a mica sheet of refractive index 1.6 and thickness 1.964 mm is introduced in the path of one of the two waves. If now mica sheet is removed and distance between slit and screen is doubled, distance between successive max. or min. remains unchanged. The wavelength of the monochromatic light used in the experiment is

1. 4000 Å
2. 5500 Å
3. 5892 Å
4. 6071 Å

**Q16.** An instrument used in electrostatics to detect the presence of electric charge on a body is called .....

1. leaf electroscope
2. compound microscope
3. telescope
4. magnetoscope

**Q17.** In Young's double slit experiment, separation between the slits is  $2 \times 10^{-3}$  m and distance of the screen from the slit is 2.5 m. Light in the range of 2000–8000 Å is allowed to fall on the slits. Wavelength in the visible region that will be present on the screen at  $10^{-3}$  m from the central maxima will be

1. 4000 Å
2. 5000 Å
3. 6000 Å
4. 8000 Å

**Q18.** Match the List I with the List II from the combinations shown

(I) Presbiopia (A) Sphero-cylindrical lens

(II) Hypermetropia (B) Convex lens of proper power may be used close to the eye

(III) Astigmatism (C) Concave lens of suitable focal length

(IV) Myopia (D) Convex spectacle lens of suitable focal length

1. I-A; II-C; III-B; IV-D
2. I-B; II-D; III-C; IV-A
3. I-D; II-B; III-A; IV-C
4. I-D; II-A; III-C; IV-B

**Q19.** If the rms current through a 6.8kΩ resistor is 8mA, the rms voltage drop across the resistor is

1. 5.44V
2. 54.4V
3. 7.07V
4. 8V

**Q20.** If the inductance of a coil is 1 henry, what is its effective inductive resistance in a D.C. circuit?

1. ∞
2. 0
3. 1 Ω
4. 2 Ω

## Section B: Application and Data-Based Reasoning

**Q21.** A sinusoidal voltage  $V=200\sin 314t$  is applied to a 10 Ω resistor. Find the frequency of the supply.

1. 40Hz
2. 50Hz
3. 60Hz

4. 80Hz

**Q22.** The p.d.  $V$  across and current  $I$  flowing through an instrument in an a.c. circuit are given by  $V = 2\cos\omega t$  V and  $I = 2\sin\omega t$  A. The power dissipated in the instrument is:

1. 0 W
2. 2.5 W
3. 1.5 W
4. 9 W

**Q23.** A cylindrical metal wire of length  $l$  and cross sections area  $S$ , has resistance  $R$ , conductance  $G$ , conductivity  $s$  and resistivity  $r$ . Which one of the following expressions for  $s$  is valid

1. fraction  $GR\rho$
2. fraction  $\rho RG$
3. fraction  $GS$
4. fraction  $RS$

**Q24.** A carbon resistor has colour strips as violet, yellow brown and golden. The resistance is

1. 641  $\Omega$
2. 741  $\Omega$
3. 704  $\Omega$
4. 407  $\Omega$

**Q25.** Two heaters designed for the same voltage  $V$  have different power ratings. When connected individually across a source of voltage  $V$ , they produce  $H$  amount of heat each in time  $t_1$  and  $t_2$  respectively. When used together across the same source, they produce  $H$  amount of heat in time  $t$

1. For series connection,  $t = t_1 + t_2$
2. For series connection,  $t = 2(t_1 + t_2)$
3. For parallel connection,  $t = 2(t_1 - t_2)$
4. For parallel connection,  $t = t_1 t_2 / [2(t_1 + t_2)]$

**Q26.** A charged body is brought near an uncharged gold leaf electroscope. What will be your observation if the body is charged?

1. leaves will diverge
2. leaves will converge
3. leaves will remain unaffected
4. none

**Q27.** Fill in the blank.

1 Coulomb of charge contains \_\_\_\_\_ number of electrons.

1.  $6.25 \times 10^{18}$
2.  $3.125 \times 10^{18}$
3.  $6.25 \times 10^{12}$
4.  $3.125 \times 10^{12}$

**Q28.** A plane electromagnetic wave of frequency  $\omega_0$  falls normally on the surface of a mirror approaching with a relativistic velocity  $n$ . Then frequency of the reflected wave will be ( given  $\beta = \text{fraction } \nu c$  )

1.  $(\text{fraction } 1 - \beta)(1 + \beta)\omega_0$
2.  $\text{fraction } 1 + \beta(1 - \beta)\omega_0$
3.  $\text{fraction } (1 + \beta)\omega_0(1 - \beta)$
4.  $\text{fraction } (1 - \beta)(1 + \beta)\omega_0$

**Q29.** In Young's double slit experiment the light emitted from source has  $\lambda = 6.5 \times 10^{-7}$  m and the distance between the two slits is 1 mm. Distance between the screen and slit is 1 metre. Distance between third dark and fifth bright fringe will be

1. 3.2 mm
2. 1.63 mm
3. 0.585 mm
4. 2.31 mm

**Q30.** Monochromatic light of wavelength  $5000 \text{ \AA}$  is incident on two slits separated by a distance of  $5 \times 10^{-4}$  m. Interference pattern is seen on the screen placed at a distance of 1 m from the slits. A thin glass plate of thickness  $1.5 \times 10^{-6}$  m and refractive index 1.5 is placed between one of the slits and the screen. If intensity in the absence of plate was  $I_0$  then new intensity at the centre of the screen will be

1.  $I_0$
2.  $2 I_0$
3. fraction  $I_0/2$
4. fraction  $3I_0/4$

### Section C: Conceptual and Reasoning Questions

**Q31.** The rms value of a.c. voltage with peak of 311V is

1. 220V
2. 311V
3. 180V
4. 320V

**Q32.** Two inductors of inductance  $L$  each are connected in series. Mutual inductance is ignored. What is the resultant inductance?

1. 0
2.  $L$
3.  $2L$
4.  $3L$

**Q33.** A choke is preferred to a resistance for limiting current in AC circuit because:

1. Choke is cheap
2. There is no wastage of power
3. Choke is compact in size
4. Choke is a good absorber of heat

**Q34.** The reactance of coil when used in an A.C. power supply ( 220volts, 50 cycles/sec) is 50ohms. The inductance of the coil is nearly

1. 0.16 H
2. 0.22 H
3. 2.2 H
4. 1.6 H

**Q35.** A mixer of  $100 \Omega$  resistance is connected to an A.C. source of 200 V and 50 Hz. What is the average value of the alternating potential difference over a complete cycle?

1. 308 V
2. 264 V
3. 220 V
4. 0

**Q36.** The self inductance of a coil is  $1/2$  henry. At what frequency will its inductive reactance be  $3140 \text{ m}\Omega$

1.  $100 \text{ Hz}$
2.  $10 \text{ Hz}$
3.  $1000 \text{ Hz}$
4.  $10000 \text{ Hz}$

**Q37.** An AC source is connected to a purely resistive circuit. What is true of the following

1. current leads ahead of voltage in Phase
2. current lags behind voltage in phase
3. current and voltage are in same Phase
4. any of the above may be true depending upon the value of resistance

**Q38.** A beam contains  $2 \times 10^8$  doubly charged positive ions per  $\text{cm}^3$ , all moving with speed  $10^5 \text{ m/s}$ . What is the current density?

1.  $6.4 \text{ A/m}^2$
2.  $3.2 \text{ A/m}^2$
3.  $1.6 \text{ A/m}^2$
4. None of these

**Q39.** The resistance of a wire is  $10 \Omega$ . Its length is increased by 10% by stretching. The new resistance will now be nearly

1.  $12 \Omega$
2.  $1.2 \Omega$
3.  $13 \Omega$
4.  $11 \Omega$

**Q40.** You are provided with a negatively charged gold leaf electroscope. State and explain what happens when

a glass rod rubbed with silk is rolled on the disc of electroscope

1. divergence increases
2. divergence decreases
3. divergence remains same
4. cant say

## Section D: Achievers Section

**Q41.** A gold leaf electroscope is given a positive charge so that its leaves diverge. How is the divergence of leaves affected, when:

an uncharged rod is brought near its disc

1. divergence increases
2. divergence decreases
3. divergence remains same
4. cant say

**Q42.** An ebonite rod rubbed with fur and a glass rod rubbed with silk cloth are brought nearer to each other. Then:

1. They will attract each other
2. They will repel each other
3. Nothing will happen to them
4. They will get heated up.

**Q43.** You are provided with a negatively charged gold leaf electroscope. State and explain what happens when an ebonite rod rubbed with fur is brought near the disc of electroscope

1. divergence increases
2. divergence decreases
3. divergence remains same
4. cant say

**Q44.** A positively charged body has deficiency of .....

1. electrons
2. protons
3. neutrons
4. holes

**Q45.** A body can be negatively charged by

1. Giving excess of electrons to it
2. Removing some electrons from it
3. Giving some protons to it
4. Removing some neutrons from it

**Q46.** Near and far points of human eye are

1. 25 cm and infinite
2. 50 cm and 100 cm
3. 25 cm and 50 cm
4. 0 cm and 25 cm

**Q47.** A defective eye cannot see close objects clearly because their image is formed

1. On the eye lens
2. Between eye lens and retina
3. On the retina
4. Beyond retina

**Q48.** Retina of eye acts like ..... of camera

1. Shutter
2. Film
3. Lens
4. None of these

**Q49.** A person can see things most clearly at a distance of 10 cm. What focal length of spectacles is needed to enable clear vision of objects at 30 cm?

1. 15 cm (concave)
2. 15 cm (convex)
3. 10 cm
4. 0

**Q50.** An astronaut looks down at Earth from a space shuttle at an altitude of 400 km. If the pupil diameter is 5 mm and visible light has wavelength 500 nm, approximately what linear size can be resolved?

1. 0.5 m
2. 5 m
3. 50 m
4. 500 m

## Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	1	2	1	3	2	4	3	5	2
6	2	7	3	8	3	9	2	10	2
11	3	12	2	13	3	14	1	15	3
16	1	17	1	18	3	19	2	20	2
21	2	22	1	23	1	24	2	25	1
26	1	27	1	28	3	29	2	30	1
31	1	32	3	33	2	34	1	35	4
36	3	37	3	38	1	39	1	40	2
41	2	42	1	43	1	44	1	45	1
46	1	47	4	48	2	49	1	50	3

## Detailed Answer Explanations

### Q1. Answer: 1. 141.4V

General sinusoidal voltage variation is given by:

$$V = V_0 \sin(\omega t)$$

Here, in this equation  $V_0$  is peak voltage.

So, on comparing both equation we get:

$$V_0 = 200V, \omega = 314$$

Relation between rms voltage and peak voltage is:

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}} = \frac{200}{\sqrt{2}} = 141.4V$$

### Q2. Answer: 1. Current sensitivity = 1.4, voltage sensitivity = 1.0

Current sensitivity is proportional to  $NBA/k$ . So  $(M_2/M_1) = (42 \times 0.50 \times 1.8)/(30 \times 0.25 \times 3.6) = 1.4$ . Voltage sensitivity is current sensitivity divided by resistance, so  $(M_2/M_1) = 1.4 \times (10/14) = 1.0$ .

### Q3. Answer: 2. $5 \times 10^{-25}N$

Number of turns on the circular coil,  $n = 20$

Radius of the coil,  $r = 10\text{cm} = 0.1\text{m}$

Magnetic field strength,  $B = 0.10\text{T}$

Current in the coil,  $I = 5.0\text{A}$

The total torque on the coil is zero because the field is uniform.

Cross-sectional area of copper coil,  $A = 10^{-5}\text{m}^2$

Number of free electrons per cubic meter in copper,  $N = 10^{29}/\text{m}^3$

Charge on the electron,  $e = 1.6 \times 10^{-19}\text{C}$

Magnetic force,  $F = Bev_d$

Where,

$v_d$  = Drift velocity of electrons

$$v_d = \frac{INeA}{B}$$

$$F = \frac{BeINeA}{B} = \frac{BINA}{B} = \frac{0.1 \times 5 \times 10^{29} \times 10^{-5}}{0.1} = 5 \times 10^{-25}\text{N}$$

Hence, the average force on each electron is  $5 \times 10^{-25}\text{N}$ .

### Q4. Answer: 3. $E \neq 0, B = 0$

If  $E \neq 0$  and  $B = 0$ , the particle experiences an electric force  $qE$  and accelerates. Hence this condition is not sufficient for constant velocity.

### Q5. Answer: 2. $2 \times 10^{-3}\%$

Given:

The susceptibility of the aluminium is  $2.1 \times 10^{-5}$ .

The magnetic field in the absence of the aluminium:

$$B_0 = \mu_0 H$$

Whereas the magnetic field in the presence of aluminium is:

$$B = \mu_0(1 + X_m)H$$

Therefore, the change in the magnetic field is given by:

$$B - B_0 = \mu_0 X_m H$$

So, The percentage increase in the magnetic field is :  
 $\% B = \frac{\mu_{0x_m} \mu_{0H}}{\mu_{0H}} \times 100\%$   
 $\begin{array}{l} \% B = x_m \times 100\% \Rightarrow 2.1 \times 10^{-3}\% \end{array}$

**Q6. Answer: 2. 69.2J T<sup>-1</sup>**

Given,  
 $D = 14\text{cm}$   
 $r = \frac{14}{2} = 7\text{cm} = 0.07\text{m}$   
 $N = 300$   
 $I = 15\text{A}$   
 The magnitude of the magnetic moment associate with the loop is  
 $\begin{array}{l} M = NIA = NI\pi r^2 = 300 \times 15 \times 3.14 \times 0.07 \times 0.07\text{m} = 69.2\text{Am}^2 \end{array}$   
 The correct option is B.

**Q7. Answer: 3. 15.7 G**

Given  
 $\begin{array}{l} N = 150 \\ I = 24\text{r} = 12\text{cm} = 0.12\text{m} \end{array}$   
 The magnitude of the magnetic field at the center is  
 $B = \frac{\mu_0 NI}{2r}$   
 $B = \frac{4\pi \times 10^{-7} \times 150 \times 22 \times 0.12}{2}$   
 $B = \frac{2 \times 600 \times 3.14 \times 10^{-7}}{2} = 70.24$   
 $\begin{array}{l} B = 15.7 \times 10^{-4}\text{T} = 15.7\text{G} \end{array}$

**Q8. Answer: 3. unchanged**

Current sensitivity of galvanometer is deflection per unit current i.e  
 $\frac{\phi}{I} = \frac{NABk}{R}$ .....(i)  
 Similarly voltage sensitivity is deflection per unit voltage  
 i.e.  $\frac{\phi}{V} = \frac{NABk}{R} \frac{1}{IV} = \frac{NABk}{R} \frac{1}{IR}$ .....(ii)  
 From (i) and (ii)  
 Voltage sensitivity = current sensitivity X  $\frac{1}{R}$   
 Now if current sensitivity is doubled, then the resistance in the circuit will also be doubled since it is proportional to the length of the wire, then voltage sensitivity  
 $= (2 \times \text{current sensitivity}) \times \frac{1}{2R} = \text{current sensitivity} \times \frac{1}{R}$   
 $= (\text{current sensitivity}) \times \frac{1}{R}$   
 Hence, voltage sensitivity will remain unchanged.

**Q9. Answer: 2. 4 I**

Given  $I_1 = I, I_2 = 4I; \theta_1 = \frac{\pi}{2}$  and  $\theta_2 = \pi$   
 $I_A = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \theta_1$   
 $I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \frac{\pi}{2} = I_1 + I_2 = 5I$   
 $I_B = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \theta_2$   
 $= I_1 + I_2 + 2\sqrt{I_1 I_2} \cos \pi = I$   
 therefore  $I_A - I_B = 5I - I = 4I$

**Q10. Answer: 2. 900 km/hr**

when source is fixed and observer is moving towards it  
 $v' = \frac{c + ac}{c}$   
 when source is moving towards observer at rest  
 $= c \left[ 1 + \frac{ac}{c} \right] \left( 1 - \frac{ac}{c} \right)^{-1} v \approx \left( 1 + \frac{2ac}{c} \right) v$   
 therefore  $\Delta v = v' - v = \frac{2av}{c} = \frac{2a\lambda}{c}$   
 therefore  $a = \lambda \frac{\Delta v}{2} = \frac{0.5 \times 1000}{2} = 250 \text{ms}^{-1}$   
 $= 900 \text{km/hr}$

**Q11. Answer: 3. 25 days**

$\frac{\Delta \lambda}{\lambda} = \frac{v}{c}$  or  $\Delta \lambda = \frac{\lambda}{c} \Delta v$   
 Change in wavelength for two edges =  $\pm \Delta \lambda$   
 Total change,  $\Delta \lambda = 2 \Delta \lambda$   
 $= 2 \frac{\lambda}{c} \Delta v$  or  $v = \frac{c}{2\lambda} \Delta \lambda$   
 and  $T = \frac{2\pi Rv}{c} = 2\pi R \frac{\Delta \lambda}{2\lambda} = \frac{4\pi R \Delta \lambda}{\lambda c}$   
 $= \frac{4 \times 3.14 \times 6.95 \times 10^8 \times 0.59 \times 10^{-6}}{3 \times 10^8 \times 3 \times 10^8} = 12 \times 86400 \text{days}$   
 $24.8 \text{days} \approx 25 \text{days}$

**Q12. Answer: 2. 4200 Å**

For first diffraction min.  $d \sin \theta = \lambda$   
 and if angle is small,  $\sin \theta = \theta$   
 $d\theta = \lambda$   
 i.e. Half angular width,  $\theta = \frac{\lambda}{d}$   
 Full angular width  $w = 2\theta = \frac{2\lambda}{d}$   
 Also  $w' = \frac{2\lambda}{d}$   
 therefore  $\frac{\lambda}{\lambda'} = \frac{w}{w'}$  or  $\lambda' = \lambda \frac{w}{w'}$   
 $= 6000 \times 0.7 = 4200 \text{ Å}$

**Q13. Answer: 3. 0.14 (2n + 1) μm**

$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{0.7881}{1.33} = 0.6$   
 $\cos r = \sqrt{1 - \sin^2 r} = \sqrt{1 - (0.6)^2} = 0.8$   
 For constructive interference on reflection  
 $2\mu t \cos r = (2n + 1)\frac{\lambda}{2}$   
 $\Rightarrow t = \frac{(2n + 1)\lambda}{4\mu \cos r} = \frac{(2n + 1) \times 0.64 \times 1.33 \times 0.8}{4}$   
 $= 0.14(2n + 1) \mu\text{m}$

**Q14. Answer: 1. 15 Ω**

For ammeter,  $S = \frac{I_g}{I - I_g} \times G$   
 $\Rightarrow \frac{S}{G} = \left( \frac{I}{I_g} - 1 \right) \Rightarrow I = 2I_g$   
 New range is doubled, i.e.  $4I_g$   
 Now shunt required,  $S = \frac{I_g}{4I_g - I_g} \times G = 10\Omega$   
 This can be obtained by shunting the earlier shunt of  $30 \Omega$  with an additional shunt of  $15\Omega$ .

**Q15. Answer: 3. 5892 Å**

$\frac{x}{D} = (u - 1)t$  or  $x = (u - 1)tD$   
 when distance between screen and slit is doubled, then fringe width  $\propto D$   
 As  $\propto D$   
 therefore  $\frac{2\lambda D}{D} = \frac{(u - 1)tD}{D}$   
 or  $\lambda = \frac{(u - 1)t}{2} = \frac{(1.6 - 1) \times 1.964 \times 10^{-6}}{2}$   
 $= 0.5892 \times 10^{-6} \text{ m} = 5892 \text{ Å}$

**Q16. Answer: 1. leaf electroscope**

An instrument used in electrostatics to detect the presence of electric charge on a body is called gold leaf electroscope.  
 A gold-leaf electroscope, which is an instrument for detecting electric charge. The electroscope is first discharged, and a charged object is then brought close to the instrument's top terminal. Induction causes a separation of the charges inside the electroscope's metal rod, so that the top terminal gains a net charge of opposite polarity to that of the object, while the gold leaves gain a charge of the same polarity. Since both leaves have the same charge, they repel each other and spread apart. The electroscope has not acquired a net charge: the charge within it has merely been redistributed, so if the charged object were to be moved away from the electroscope the leaves will come together again.

**Q17. Answer: 1. 4000 Å**

$\Delta x = \frac{x}{D} = \frac{10^{-3} \times 2 \times 10^{-2}}{32.5} = 8000 \text{ Å}$   
 For bright line  $8000 = n_1 \lambda_1 = n_2 \lambda_2 = n_3 \lambda_3$   
 If  $n_1 = 2 \Rightarrow \lambda_1 = 4000 \text{ Å}$   
 i.e., second bright line for visible region is present.

**Q18. Answer: 3. I-D; II-B; III-A; IV-C**

I-D; II-B; III-A; IV-C

**Q19. Answer: 2. 54.4V**

Rms current  $I_{\text{rms}} = 8\text{mA}$   
 Resistance of resistor =  $R = 6.8\text{k}\Omega$   
 Thus rms voltage  $V_{\text{rms}} = I_{\text{rms}}R$   
 therefore  $V_{\text{rms}} = (8 \times 10^{-3}) \times (6.8 \times 10^3) \Rightarrow V_{\text{rms}} = 54.4\text{V}$

**Q20. Answer: 2. 0**

$X_L = \omega L$   
 In DC,  $\omega = 0$   
 Therefore, effective inductive resistance is  
 $X_L = 0$

**Q21. Answer: 2. 50Hz**

General sinusoidal voltage variation is given by:  
 $V = V_0 \sin(\omega t)$   
 On comparing both equation we get:  
 $\omega = 314 = 2\pi f \Rightarrow f = \frac{314}{2\pi} = 50 \text{ Hz}$

**Q22. Answer: 1. 0 W**

Given,  
 $V = 2 \cos \omega t$   
 $i = 9 \sin \omega t$   
 $\cos \phi = 0$  therefore  $P = 0$   
 therefore option A is correct.

**Q23. Answer: 1. fraction  $\frac{G}{R\rho}$**

Conductivity  $\sigma = \frac{1}{\rho}$  .....(i)  
 and conductance  $G = \frac{1}{R}$   
 $\Rightarrow GR = \frac{1}{\rho R}$  .....(ii)  
 From equation (i) and (ii)  $\sigma = \frac{G}{R\rho}$

**Q24. Answer: 2. 741  $\Omega$**

Using standard colour codes  
 Violet = 7, yellow = 4, brown = 1 and gold = 5 % (tolerance)  
 So  $R = 74 \times 10^1 \pm 5\% = 740 \pm 5\%$   
 So its value will be nearest to 741  $\Omega$ .

**Q25. Answer: 1. For series connection,  $t = t_1 + t_2$**

$H = \frac{V^2 R_1 t_1}{2} = \frac{V^2 R_2 t_2}{2}$  ... (i)  
 $H = \frac{V^2 (R_1 + R_2) t}{2}$  for series ... (ii)  
 $H = \frac{V^2 R_1 t_1}{2} + \frac{V^2 R_2 t_2}{2}$  for parallel ... (iii)  
 $t_1 + t_2 = t$  from (i) and (ii),  $t = \frac{t_1 t_2 t_1 + t_2}{t_1 + t_2}$  from (i) and (iii)

**Q26. Answer: 1. leaves will diverge**

The electroscope is charged with a known charge, say with negative charge, by touching a negatively charged rod to the metal disc of the electroscope. The leaves of the electroscope open up, that is diverge. Now when the body to be tested is touched with the metal disc, the leaves either diverge more or collapse based on the nature of the body that is tested.  
 Therefore, the process of bringing a charged body near the uncharged electroscope is called as charging of the electroscope and the leaves of the electroscope diverge.  
 Hence, the leaves diverge in this case

**Q27. Answer: 1.  $6.25 \times 10^{18}$**

As charge is quantized  
 Total charges  $Q = ne$   
 $1 \text{ coulomb} = ne \Rightarrow n = \frac{1}{e} = \frac{1}{1.6 \times 10^{-19}}$   
 $n = 6.25 \times 10^{18}$

**Q28. Answer: 3. fraction  $(1 + \beta) \omega_0 (1 - \beta)$**

Frequency of Em waves going towards the approaching mirror,  $\omega' = \frac{c + v}{c} \omega_0$   
 Frequency of waves reflected from mirror and moving towards source,  
 or  
 $\omega'' = \frac{c - v}{c} \omega'$   
 $\omega'' = \frac{c - v}{c} \left( \frac{c + v}{c} \omega_0 \right) = \left( \frac{c^2 - v^2}{c^2} \right) \omega_0$  where  $\beta = \frac{v}{c}$

**Q29. Answer: 2. 1.63 mm**

$x_5 = \frac{\lambda D}{d} = \frac{56.5 \times 10^{-7} \times 110^{-3}}{0.1} = 32.5 \times 10^{-4} \text{ m}$   
 $x_3 = \frac{(2n - 1)\lambda D}{2d} = \frac{56.3 \times 10^{-7} \times 12 \times 10^{-3}}{0.1} = 16.25 \times 10^{-4} \text{ m}$   
 therefore  $x_5 - x_3 \approx 1.63 \text{ mm}$ .

**Q30. Answer: 1.  $I_0$**

$$\text{fraction } x dD = (\mu - 1) t$$

$$\text{or } x = \text{fraction } (\mu - 1) D t d = \text{fraction } (1.5 - 1) \times 1.5 \times 10^{-6} \times 15 \times 10^{-4}$$

$$= 1.5 \times 10^{-3} \text{ m}$$

**Q31. Answer: 1. 220V**

Peak value of a.c. voltage  $V_o = 311$  volts  
 The rms value of voltage  $V_{\text{rms}} = \text{fraction } V_o \sqrt{2}$   
 therefore  $V_{\text{rms}} = \text{fraction } 311 \sqrt{2} = \text{fraction } 311 \times 1.414 = 220$  volts

**Q32. Answer: 3. 2L**

When the two inductors are connected in series to one another, they are simply been added up and the direction of the magnetic flux does not have any affect on the net inductance of the two inductors.

$$\text{beginarray} L' = L_1 + L_2 L' = L + LL' = 2L \text{endarray}$$

So option C is correct.

**Q33. Answer: 2. There is no wastage of power**

In an AC circuit, the coil of high inductance and negligible resistance used to control current, is called the choke coil. Power factor of choke is very small. The power absorbed by the coil is very small. The only loss of energy is due to hysteresis in the iron core, which is much less than the loss of energy in the resistance that can also reduce the current if placed instead of the choke coil. Hence, option B is correct.

**Q34. Answer: 1. 0.16 H**

Given :  $f = 50$  cycles/sec  
 Reactance  $X_L = 50\Omega$   
 Inductance of the coil  $L = \text{fraction } X_L \omega = \text{fraction } 50 \times 2\pi \times 50 = 0.16$  H

**Q35. Answer: 4. 0**

We need to find the average potential difference across the mixer. Here by average we mean average over a long period of time. As we know in one complete cycle, average voltage across the mixer is zero. ( In one complete cycle current changes the direction and net voltage across a resistor is zero). So when in one complete cycle voltage drop across the resistor is zero, then the average voltage drop across the resistor (mixer) is zero.

**Q36. Answer: 3. 1000Hz**

We know that,  
 $\text{beginarray} \omega X_L = \omega L \omega = \text{fraction } X_L \omega = 6280 \text{endarray}$   
 $\text{beginarray} f = \text{fraction } \omega \times 2\pi = 1000 \text{ Hz} \text{endarray}$

**Q37. Answer: 3. current and voltage are in same Phase**

In a pure ohmic AC resistance, the current and voltage are in phase as there is no phase difference between them, The current flowing through the resistance is directly proportional to the voltage across it with this linear relationship in an AC circuit being called impedance.

**Q38. Answer: 1. 6.4 A/m<sup>2</sup>**

$$J = nqv = n(ze)v = \text{fraction } 2 \times 10^{18} \times 2 \times 1.6 \times 10^{-19} \times 10^5 (10^{-2})^3 = 6.4$$

$$\frac{\text{A}}{\text{m}^2}$$

**Q39. Answer: 1. 12 Ω**

Since  
 $R \propto \frac{l}{A}$   
 $\Rightarrow$  If length is increased by 10% resistance is increases by almost 20%  
 Hence new resistance  
 $R'$   
 $= 10 + 20\% \text{ of } 10 = 10 + \text{fraction } 20 \times 10 = 12\Omega$

**Q40. Answer: 2. divergence decreases**

On rubbing a glass rod with silk, the electrons from the glass rod get transferred to the silk. The silk now has an excess of electrons and so is negatively-charged. On the other hand, the glass rod is deficient in electrons and

hence is positively charged. In the above case, the silk undergoes negative electrification. When the positively charged glass rod is touched on the disc of a negatively charged gold leaf electroscope, the divergence between the gold leaves decreases as unlike charges attract each other. Hence, the divergence decreases as the glass rod rubbed with silk is rolled on the disc of electroscope

**Q41. Answer: 2. divergence decreases**

When uncharged rod is touched on the disc of a positively charged gold leaf electroscope, the divergence between the gold leaves decreases as unlike charges attract each other. It is to be noted that a charged body can also attract an uncharged body, so repulsion is the sure test to determine whether the body is charged or not. Therefore, when the uncharged rod is rolled on the disc of the positively charged gold leaf electroscope, the electrons from the electroscope are transferred to the rod and hence, the rod becomes negatively charged. Now the unlike charges attract each other and the divergence decreases.

**Q42. Answer: 1. They will attract each other**

The phenomena of charging due to rubbing are called Triboelectric effect. When an ebonite rod is rubbed with fur the rod gets negatively charged because the friction between the fur and the rod makes the ebonite rod to gain an electron from the fur. This is because electrons in fur are less tightly bound than the electrons in the ebonite rod. When you are rubbing the glass rod with the silk cloth, electrons are stripped away from the atoms in the glass and transferred to the silk cloth. This leaves the glass rod with more positive than negative charge, so you get a net positive charge. Hence, ebonite rod and glass rod will attract each other.

**Q43. Answer: 1. divergence increases**

On rubbing an ebonite rod with fur, the electrons from the fur get transferred to the ebonite rod. The fur now has a deficiency of electrons and so is positively charged. On the other hand, the ebonite rod has an excess of electrons and hence is negatively charged. In the above case, the fur undergoes positive electrification. Now, when the negatively charged ebonite rod is touched on the disc of a negatively charged gold leaf electroscope, the divergence between the gold leaves increases as like charges repel each other. Hence, the divergence increases when an ebonite rod rubbed with fur is brought near the disc of negatively charged electroscope.

**Q44. Answer: 1. electrons**

Normally a body is neutral having equal number of positively charged protons and negatively charged electrons. When some electrons are taken out of the body, positive charge becomes more than negative charge in body and hence the body as a whole become positively charged. Hence a positively charged body has deficiency of electrons.

**Q45. Answer: 1. Giving excess of electrons to it**

Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field. There are two types of electric charges: positive and negative. Positively charged substances are repelled from other positively charged substances, but attracted to negatively charged substances; negatively charged substances are repelled from negative and attracted to positive. An object is negatively charged if it gains excess of electrons, and is otherwise positively charged if loses excess of electrons or uncharged. Hence, A body can be negatively charged by Giving excess of electrons to it.

**Q46. Answer: 1. 25**

cm

and infinite

25

cm

and infinite

**Q47. Answer: 4. Beyond retina**

Beyond retina

**Q48. Answer: 2. Film**

Film

**Q49. Answer: 1. 15 cm (concave)**

The corrective lens must form the image of an object at 30 cm at the person's near point of 10 cm. Using the lens formula gives a negative focal length of about 15 cm, so a concave lens is required.

**Q50. Answer: 3. 50 m**

Using the diffraction limit  $\theta \approx 1.22\lambda/D$ , the minimum resolvable size is  $s \approx h\theta = 4 \times 10^5 \times 1.22 \times 5 \times 10^{-7} / 5 \times 10^{-3} \approx 49$  m, approximately 50 m.

End of Question Paper