1. The force of attraction between two unit point masses separated by unit distance is numerically equal to

Sol. From Newton's law of gravitation

$F = \frac{GM_1 M_2}{r^2}$

If $M_1 = M_2 = 1$ unit of mass &

r = 1 unit of distance then

F = G = universal gravitational constant.

2. If earth shrinks to half of its present radius and the mass becomes $\left(\frac{1}{3}\right)^{rd}$ of its initial value then the duration of the day will be

Sol. As angular momentum is conserved

$I_1\omega_1 = I_2\omega_2$

$\frac{2}{5} MR^2 - \frac{2\pi}{24} = \frac{2}{5}\frac{M}{3} x \left[\frac{R}{2}\right]^2 - \frac{2\pi}{T}$

T = 2 hrs.

3. If a ring rolls along a plane surface, then linear kinetic energy / rotational kinetic energy of the ring is

Sol. Linear K.E. = $\frac{1}{2} MV^2 = \frac{1}{2} Mr^2\omega^2$

Angular K.E. = $\frac{1}{2} I\omega^2 = \frac{1}{2} Mr^2\omega^2$

Ratio = 1:1

4. The amplitude and periodic time of SHM are 5cm and 6 sec respectively. At a distance of 2.5cm from mean position the phase will be

Sol. k = a sin ωt ===> $2.5 = 5 \sin\left(\frac{2\pi}{6} - t\right)$

$\frac{2\pi t}{6} = \frac{\pi}{6}$

t = ½ sec

phase difference corresponding to 6s is 2π so phase difference corresponding to ½ s is $\frac{\pi}{6}$

5. Two wires 'A' & 'B' of the same material have radii in the ratio 2:1 and lengths in the ratio 4:1. The ratio of normal forces required to produce the same change in the length of these two wires are

Sol. $Y = \frac{F.L}{A.L}$

$F = YA\,\frac{L}{L}$

$F \,\alpha\, \frac{r^2}{L}$

$\frac{F1}{F2} = \left(\frac{r1}{r2}\right)^2 x \left(\frac{L2}{L1}\right) = \left(\frac{2}{1}\right)^2 - \left(\frac{1}{4}\right) = 1:1$

6. The increase in length on stretching a wire is 0.05%. If its poison's ratio is 0.4 then its diameter will be

Sol. Poisson's ratio $= \frac{\text{lateral strain}}{\text{longitudinal strain}}$

$= 0.4 \text{ x } \frac{0.05}{100}$

= is reduced by 0.02 %.

7. The amount of work done in increasing size of soap film 6cm x 4cm to 12cm x 8cm (surface tension 30 dyne/cm) is

Sol. Work done = change in area x T

= (96 - 24) x 2 x 30

= 4320 erg

8. A drop of water of 1mm radius splits in equal 10^6 droplets then the radius of each droplet will be

Sol. Volume of big drop = 10^6 x volume of each droplet

$\frac{4}{3}\pi R^3 = 10^6 \text{ x } \frac{4}{3}\pi R^3$

$R = 10^2 r$

$r = \frac{R}{102} = \frac{10-3}{102} = 10^{-5}$ m

9. If velocity of sound in a gas is 360 m/s and the distance between a compression and the nearest rarefaction is 1 m, then the frequency of sound is

Sol. Distance between a compression and the nearest rarefaction is $\frac{\lambda}{2}$ = 1m. Hence

$$n = \frac{V}{\lambda} = \frac{360}{2} = 180 \text{ Hz.}$$

10. The equation of a wave is represented by y = 0.01 sin 4π (100 t - x) where x & y are in meters and t in seconds. The frequency of the wave is

Sol.
$$y = 0.01 \sin 4\pi (100 t - k)$$
$$= 0.01 \sin 2\pi (200 t - 2k)$$

equation of the standard simple harmonic wave is

$$y = A\left(\sin 2\pi\right) nt - \frac{k}{\lambda}$$

comparing both equations we get

n = 200 Hz.

11. A certain quantity of water cools from 70^0c to 60^0c in the first 5 minutes and to 54^0c in the next 5 minutes. The temperature of the surroundings is

Sol. By Newton's law of cooling

$$\frac{\theta 2 - \theta 1}{t} = k\left(\frac{\theta 1 + \theta 2}{2} - \theta_0\right) \quad \ldots\ldots\ldots 1.$$

$$\frac{70 - 60}{5} = k (65 - \theta_0) \quad \ldots\ldots\ldots 2.$$

$$\frac{60 - 54}{5} = k (57 - \theta_0) \quad \ldots\ldots\ldots 3.$$

Dividing eq^n 1 by eq^n 2

$$\frac{5}{3} = \frac{65 - \theta 0}{57 - \theta 0}$$

$$\theta_0 = 45^0 \text{ c}$$

12. An ideal black body emits radiations at the rate of 5.67 watt/cm^2. Its temperature will be (take T = 5.67 x 10^{-8} W/m^2k^4)

Sol.
$$E = \sigma T^4$$
$$T = \left(\frac{E}{\sigma}\right)^{1/4}$$
$$= \left(\frac{5.67 \text{ x } 10^4}{5.67 \text{ x } 10^{-8}}\right) \qquad = 10^3 \text{ k}$$

13. The straight line distance travelled by a molecule with uniform velocity between two successive collisions is called as Free Path.

14. dyne / cm^2 is NOT a unit of Strain

15. The equation of state of some gases can be expressed as $\left(p + \frac{a}{v2}\right)(v - b) = RT$. Here p is pressure, v is the volume, T is the absolute temperature and a, b & R are constants. The dimensions of 'a' are

Sol. By principle of dimensional homogeneity

$$\left(\frac{a}{V^2}\right) = \left(P\right)$$
$$[a] = [p]\,[v^2]$$
$$= [M^1L^{-1}T^{-2}]\,[L^6]$$
$$= [M^1L^5T^{-2}]$$

16. Four electric charges A, B, C, D are arranged as shown. The electric force will be least between charges

Sol. $F \,\alpha\, \frac{q_1 q_2}{r^2}$ ……… colum's law

$$F_{AB} \,\alpha\, \frac{8}{x2}$$

$$F_{AD} \,\alpha\, \frac{8}{y2}$$

$F_{BD} \ \alpha \ \frac{16}{x^2+y^2}$

$F_{AC} \ \alpha \ \frac{4}{x^2+y^2}$

Therefore from all equations the electric force will be least between A and C.

17. A wire of resistance R is cut into n equal parts. These parts are then connected in parallel. The equivalent resistance of the combination will be

Sol. Resistance of each part will be R/n such 'n' parts are joined in parallel.

So, $R_{eq} = \frac{R}{n^2}$

18. A convex lens of focal length 40 cm is in contact with a concave lens of focal length 25 cm. The power of the combination is

Sol. $P = p_1 + p_2 = \frac{1}{f1\ (m)} + \frac{1}{f2\ (m)}$

$= \frac{1}{0.4} + \frac{1}{-0.25}$ (focal length of concave lens –ve)

$= \frac{1}{0.4} - \frac{1}{0.25} = -1.5\ D$

19. Which of the following sets have different dimensions ?

Sol. Dipole moment, Electric flux, Electric field

20. Between the plates of a parallel plate condenser, a plate of thickness 't_1' and dielectric constant K_1 is placed. In the rest of space, there is another plate of thickness 't_2' and dielectric constant K_2. The potential difference across the condenser will be

Sol. $V = V_1 + V_2 = E_1t_1 + E_2t_2$

$= \frac{\sigma}{K_1 \epsilon_0} t_1 + \frac{\sigma}{K_2 \epsilon_0} t_2$

$= \frac{\sigma}{\epsilon_0}\left(\frac{t_1}{K_1} + \frac{t_2}{K_2}\right)$

$= \frac{Q}{A\epsilon_0}\left(\frac{t_1}{K_1} + \frac{t_2}{K_2}\right)$ ($\sigma = Q/A$)

21. The resistance of the four arms P, Q, R and S in a wheat stone's Bridge are 10 ohm, 30 ohm, 30 ohm and 90 ohm respectively. The e.m.f. and internal resistance of the cell are 7 volt and 5 ohm respectively. If the galvanometer resistance is 50 ohm, the current drawn from the cell will be

Sol. For a balanced wheatstone's network $\frac{P}{Q} = \frac{R}{S}$,

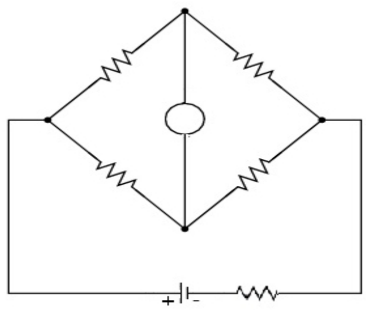
As the bridge is balanced, no current will flow through galvanometer.

Thus equivalent resistance is

$$R_{eq} = \frac{(10+30)\,(30+90)}{(10+30+30+90)}$$

$$= \frac{40 \text{ x } 120}{160}$$

$$= 30 \text{ Ohm}$$



Reffective = 30 + 5 = 35 Ohm.

$$\text{Now } I = \frac{V}{Reff} = \frac{7}{35} = \frac{1}{5} = 0.2 \text{ A}$$

22. The maximum K.E. of protons in a cyclotron of radius 0.4 m in a magnetic field of 0.5 T is (M_p = 1.67 x 10^{-27} kg, charge on proton = 1.6 x 10^{-19} C)

Sol. $$K.E. = \frac{q^2B^2R^2}{2M_P} = \frac{(1.6 \text{ x } 10^{-19})^2\,(0.5)^2\,(4 \text{ x } 10^{-1})^2}{2 \text{ x } 1.67 \text{ x } 10^{-27}}$$

$$= 3.06 \text{ x } 10^{-13} \text{ J}$$

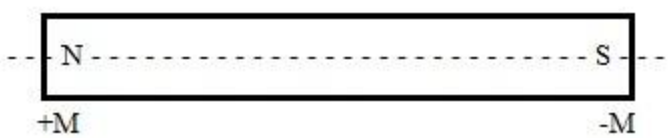
$$= \frac{3.06 \text{ x } 10^{-13}}{1.6 \text{ x } 10^{-19}} \text{ eV}$$

$$= 1.9 \text{ x } 10^{6} \text{ eV}$$

$$= 1.9 \text{ MeV}$$

23. A magnet of magnetic moment M and pole strength 'm' is divided in two equal parts along its axis, then magnetic moment of each part will be

Sol.



New Length $L^1 = L$

New pole strength $M^1 = M/2$

New Magnitude dipole moment $M^1 = 2 M^1 L$
$= 2 M/2 L$
$= M/2$

24. A simple pendulum has time period T_1. The point of suspension is now moved upward according to the relation $y = kt^2$ ($k = 1 m/s^2$), where y is the vertical displacement. The time period now becomes T_2. The ratio $\frac{T12}{T22}$ is (take $g = 10\ m/s^2$)

Sol. $Y = kt^2 \Rightarrow \frac{dy}{dt} = 2kt$

$= \frac{d^2y}{dt^2} = 2k$

$= a_y = 2\ m/s^2$ ……… (k = 1)

$T_1 = 2\pi\sqrt{\frac{l}{g}}$, $T_2 = 2\pi\sqrt{\frac{l}{g+a_y}}$

$\frac{T_1^{\,2}}{T_2^{\,2}} = \frac{g+a_y}{g} = \frac{10+2}{10} = \frac{12}{10} = \frac{6}{5}$

25. Two capacitors C_1 & C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero, then

Sol. The potential on each of them can be zero, if

$q_{net} = 0$

$\therefore q_1 \pm q_2 = 0$

$\therefore C_1V_1 \pm C_2V_2 = 0$

$\therefore 120\ C_1 \pm 200\ C_2 = 0$

$\therefore 3\ C_1 \pm 5\ C_2 = 0$

26. In the young's double slit experiment using a monochromatic light of wavelength λ, the path difference (in terms of integer n) corresponding to any point having half the peak intensity is

Sol. $I = I_{max} . \cos^2\frac{\theta}{2}$ ……… 1

Given $I = \frac{I_{max}}{2}$ ……… 2

From 1 & 2

$\theta = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \ldots\ldots\ldots$

path difference, $\Delta x = \left(\frac{\lambda}{2\pi}\right)\theta$

$$\Delta x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4} \ldots\ldots\ldots \left(\frac{2n+1}{4}\right)\lambda$$

27. Range of frequencies allowed for commercial FM radio broadcast is
    88 to 108 MHz

Sol. Explanation not required.

28. The current gain α of transistor is 0.95. The change in collector current corresponding to a change of 0.4 mA in the base current in a common emitter arrangement is

Sol. $\alpha = \frac{\Delta I_C}{\Delta I_E}, \ \beta = \frac{\Delta I_C}{\Delta I_B}$

$\beta = \frac{\alpha}{1-\alpha} = \frac{0.95}{1-0.95} = 19$

$\therefore \Delta I_C = \beta . \Delta I_B = 19 \times 0.4 = 7.6$ mA

29. If the speed of light was 50 % of the present value, then percentage decrease in the energy released will be

Sol. $E = mc^2$

$E1 = m\left(\frac{c}{2}\right)^2$ (C1 = C/2)

$= \frac{mc^2}{4}$

$= \frac{E}{4}$

Percentage decrease $= \frac{E - E^1}{4} \times 100$

$= \frac{E - E/4}{4} \times 100$

$= \frac{3}{4} \times 100 = 75$ %

30. The kinetic energy of photoelectrons emitted from a metal are k_1 and k_2, when it is irradiated with light of wavelength λ_1 and λ_2 respectively. The work function of metal is

Sol. K.E. = $\frac{nc}{\lambda} - \phi$

$\frac{nc}{\lambda_1} - \phi = k_1$ ……… 1

$nc - \phi \lambda_1 = k_1 \lambda_1$

$\frac{nc}{\lambda_2} - \phi = k_2$ ……… 2

$nc - \phi \lambda_2 = k_2 \lambda_2$

From eq^n 1 & 2

$(\lambda_2 - \lambda_1)\ \phi = k_1\lambda_1 - k_2\lambda_2$

$$\phi = \frac{k_1\lambda_1 - k_2\lambda_2}{\lambda_2 - \lambda_1}$$

31. Which of the following statement is not true

The majority carriers in n - type semiconductors are electrons.

Sol. Explanation not required.

32. The circuit which accepts only current at the resonant frequency and reject the current of other frequencies. The circuit is

Acceptor circuit

Sol. Explanation not required.

33. A radioactive nucleus undergoes a series of decay according to the scheme

$$X \xrightarrow{\alpha} X_1 \xrightarrow{\beta} X_2 \xrightarrow{\alpha} X_3 \xrightarrow{\gamma} X_4$$

If the mass number and atomic number of X are 180 and 70 respectively, then what are these numbers for X_4

172 and 69

Sol. i) Emission of α particles mass no decreases by 4 and atomic no decreases by 2.

ii) Emission of β particles mass no remains same but atomic no increases by 1.

iii) Emission of γ particles remains same.

34. The path length of oscillation of simple pendulum of length 1 meter is 16 cm. Its maximum velocity is (g = π^2m/s^2)
is

Sol. Path length $= 16\ cm$

$\therefore$ Amplitude $a = 8\ cm$

Period $T = 2\pi\sqrt{\frac{l}{g}}$

$= 2\pi\sqrt{\frac{1}{\pi^2}}$

$= 2\pi \times \frac{1}{\pi} = 2s$

Maximum velocity $V_{max} = a\omega$

$= a \times \frac{2\pi}{T}$

$= 8 \times \frac{2\pi}{2}$

$= 8\pi\ cm/s$

35. A circular coil carrying current I has radius R & magnetic field at the centre is B. At what distance from the centre along the axis of the same coil, the magnetic field will be B/8 ?

Sol. $B = \frac{\mu_0 nIa^2}{(a^2+x^2)^{3/2}} = \frac{\mu_0 nIa^2}{a^3} = \frac{\mu_0 nI}{a}$

$\frac{B}{8} = \frac{\mu_0 nIa^2}{(a^2+x^2)^{3/2}}$

$\frac{\mu_0 nI}{8a} = \frac{8 \times \mu_0 nIa^2}{(a^2+x^2)^{3/2}}$

$\frac{1}{8a^3} = \frac{1}{(a^2+x^2)^{3/2}}$

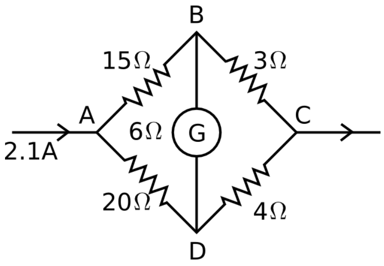
$\frac{1}{2a} = \frac{1}{(a^2+x^2)/2}$

$4a^2 = a^2 + x^2$

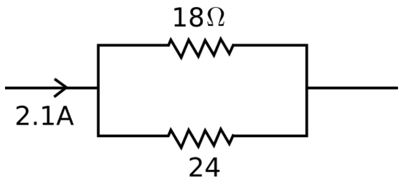
$x^2 = 3a^2$

$x = \sqrt{3}$

36. In the following network, the current flowing through $15\ \Omega$ resistance is



Sol.



$$I_1 + I_2 = 2.1A$$
$$18I_1 = 24I_2$$
$$3I_1 = 4I_2 = 4(2.1 - I_1)$$
$$7I_1 = 8.4 - 4I_1$$
$$7I_1 = 8.4$$
$$I_1 = \frac{8.4}{7} = 1.2A$$

37. In amplitude modulation

Sol. In amplitude modulation amplitude of the carrier wave changes according to information signal.

38. If $M_2 =$ magnetization of a paramagnetic sample, $B =$ external magnetic field, $T =$ absolute temperature, $C =$ curie constant then according to Curie's law in magnetism, the correct realtion is

Sol. $M_z = \dfrac{M_{ext}}{V}$

$M_z = \dfrac{CB}{T}$ ..... (Paranmagnetic)

where, $C = C$ Curie constant.

39. An electron of stationary hydrogen atom jumps from 4^{th} energy level to ground level. The velocity that the photon acquired as result of electron transition will be
($h =$ Planck's constant, $R =$ Rydberg's constant, $m =$ mass of photon)

Sol.
$$\frac{1}{\lambda} = R\left(\frac{1}{P^2} - \frac{1}{n^2}\right]$$
$$\frac{1}{\lambda} = R\left[\frac{1}{1} - \frac{1}{16}\right]$$
$$\frac{1}{\lambda} = \frac{15-R}{16}$$
$$\lambda = \frac{16}{15R}$$
$$P = \frac{h}{\lambda}$$
$$mv = \frac{h}{\lambda}$$
$$V = \frac{h}{m\lambda} = \frac{15hR}{m16}$$
$$V = \frac{15\,hR}{16\,m}$$

40. For a particle performing linear S.H.M., its average speed over one oscillation is
($a =$ amplitude of S.H.M., $n =$ frequency of oscillation)

Sol. Distance travelled in one oscillation is $4a$ and time is period is T velocity $= \frac{4a}{T} = 4\ an$

41. In a capillary tube having area of cross-section $'A'$, water rises to a height $'h'$. If cross-sectional area is reduced to $'\frac{A}{9}'$, the rise of water in the capillary tube is

Sol. $rh =$ constant

$r_1h_1 = r_2h_2$	$A_1 = \pi r_1^2$
$\frac{r_1}{r_2} = \frac{h_2}{h_1}$	$A_2 = \pi r_2^2$
$3 = \frac{h_2}{h_1} = \frac{h_2}{h_1}$	$\frac{\pi r_1^2}{9} = \pi r_2^2$
$h_2 = 3h_1 = 3h$	$\frac{r_1^2}{r_2^2} = 9 \Rightarrow \frac{r_1}{r_2} = 3$

42. A string is vibrating in its fifth overtone between two rigid supports $2.4\ m$ apar. The distance between successive node and antinode is

Sol. Fifth overtone

$$2.4 = 6n$$
$$A = 0.4m$$
$$\frac{\lambda}{2} = 0.4$$
$$\lambda = 0.8$$
$$\frac{\lambda}{4} = \frac{0.8}{4}$$
$$= 0.2$$

43. The moment of inertia of a ring about an axis passing through the centre and perpendicular to its plane is $'I'$. It is rotating with angular velocity $'\omega'$. Another identical ring is gently placed on it so that their centres coincide. If both the rings are rotating about the same axis then loss in kinetic energy is

Sol. $$I_1\omega_1 = I_2\omega_2$$
$$I\omega = 2I\omega_1$$
$$\omega_1 = \frac{\omega}{2}$$
$$\text{New } KE = \frac{1}{2}I\omega^2$$
$$= \frac{1}{2}2I\left(\frac{\omega}{2}\right)^2$$
$$= \frac{I\omega^2}{4}[$$

Change in $KE = \frac{1}{2}I\omega^2 - \frac{I\omega^2}{4} = \frac{I\omega^2}{4}$

44. When source of sound moves towards a stationary observer, the wavelength of sound received by him

Sol. $$n_a = n\left[\frac{v \pm v_0}{v \mp v_s}\right]$$
$$v_0 = 0$$
$$n_a = n\left[\frac{v}{v - v_s}\right]$$

So frequency increase, wavelength decreases.

45. Heat energy is incident on the surface at the rate of $1000 J/min$. If coefficient of absorption is 0.8 and coefficient of reflection is 0.1 then heat energy transmitted by the surface in 5 minutes is

Sol. $Q_i = 1000 J/m$

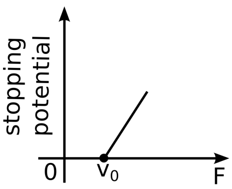
$1 = r + a + t$

$t = 1 - 0.1 - 0.8 = 0.1$

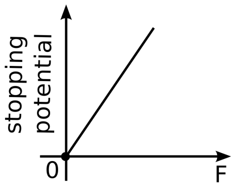
$Q_t = 0.1 \times 1000 \times 5$

$= 500 J$

46. Following graphs show the variation of stopping potential correspondig to the frequency of incident radiation (F) for a given metal. The correct variation is shown in graph ($v_0 =$ Threshold frequency)



(1)



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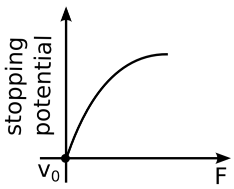

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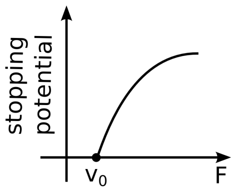
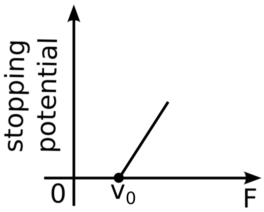


(4)

Sol.

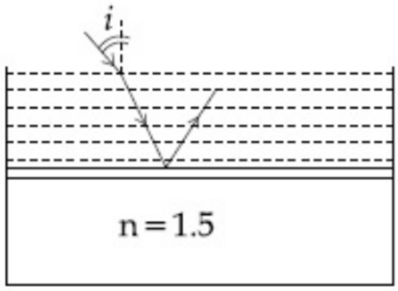


47. A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is :

Sol. $\frac{\Delta l}{l} = 0.5\% \quad \Rightarrow \frac{\Delta A}{A} = -0.5\%$

$R = \frac{\rho l}{A} \quad \therefore \frac{\Delta R}{R} = \frac{\Delta l}{l} - \frac{\Delta A}{A} = 1\%$

48. Consider a tank made of glass (refractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ. A student finds that, irrespective of what the incident angle i (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass inerface is never completely polarized. For this to happen, the minimum value of μ is :



Sol. Taking the angle of incidence 90^o,

$$(1)\sin 90^o = \mu \sin\theta = 1.5 \sin\alpha \quad \Rightarrow \sin\theta = \frac{1}{\mu}$$

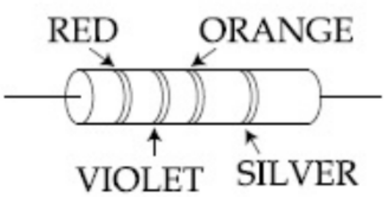
$$\mu \tan\theta = 1.5 \Rightarrow \tan\theta = \frac{1.5}{\mu}$$

$$\sin\theta = \frac{3}{9+4\mu^2} = \frac{1}{\mu} \quad \therefore \mu = \frac{3}{\sqrt{5}}$$

49. A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. the coercivity of the bar magnet is :

Sol. Coercivity $H = \frac{B}{\mu_0} = \frac{\mu_0 n_i}{\mu_0} = n_i = \frac{(100)(5.2)}{(0.2)} = 2600 A/m.$

50. A resistance is shown in the figure. Its value and tolerance are given respectively by :



Sol. Red = 2

Violet = 7

Orange = 3

Silver = 10%

$\therefore R = 27 \times 10^3 \pm 10\%$