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NEET 2023 SOLUTION
PHYSICS

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NEET 2023

Physics

Section – A (Compulsory)

1. In a series LCR circuit, the inductance L is 10 mH, capacitance C is 1 μF and resistance R is 100 Ω. The frequency at which resonance occurs is:

(1) 15.9 kHz (2) 1.59 rad/s
(3) 1.59 kHz (4) 15.9 rad/s

Sol:

Resonance frequency

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\times3.14\times\sqrt{10\times10^{-3}\times10^{-6}}}$$

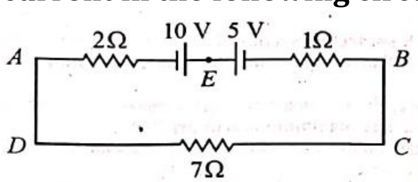
$$= \frac{1}{2\times3.14\times10^{-4}}$$

$$f_r = \frac{10\times1000}{2\times3.14}$$

$F_r = 1500$

$F_r = 1.59$ KHz

2. The magnitude and direction of the current in the following circuit is



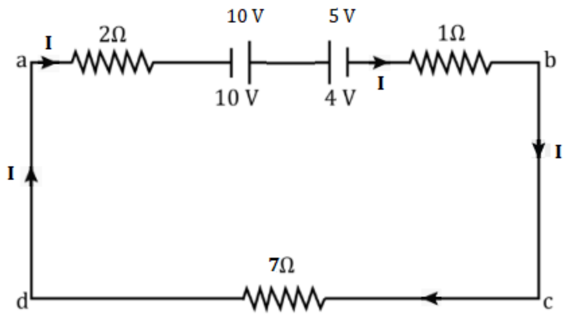
(1) 0.5 A from A to B through E

(2) $\frac{5}{9}$ A from A to B through E

(3) 1.5 A from B to A through E

(4) 0.2 A from B to A through E

Sol:



Applying KCL in loop ABCDA

– 2I + 10 – 5 – I – 7I = 0

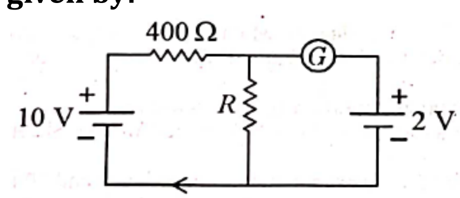
– 10I + 5 = 0

10I = 5

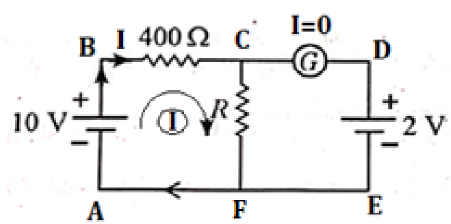
I = 0.5 A

3. If the galvanometer G does not show any deflection in the circuit shown, the value of R is given by:

(1) 50 Ω
(2) 100 Ω
(3) 400 Ω
(4) 200 Ω



Sol:



Applying KVL in loop ABCFA

+10 – 400 I – IR = 0 ... (i)

Applying KCL in loop ABCDEFA

10 – 400 I – 2 = 0

∴ 8 – 400 I = 0

∴ $I = \frac{8}{400}$

∴ $I = \frac{1}{50}$

∴ I = 0.02 A

4. The temperature of a gas is –50° C. To what temperature the gas should be heated so that the rms speed is increased by 3 times?

(1) 3295° C (2) 3097 K
(3) 223 K (4) 669°C

Sol. $T_1 = -50°C$
$= (-50 + 273)$ K
$= 223$ K
$V_2 = V_1 + 3V_1$
$V_2 = 4 V_1$

$$V_{RMS} \propto \sqrt{T}$$

$$\frac{V_2}{V_1} = \sqrt{\frac{T_2}{T_1}}$$

$$\frac{4V_1}{V_1} = \sqrt{\frac{T_2}{223}}$$

$$16 = \frac{T_2}{223}$$

$16 \times 223 = T_2$
$T_2 = 3568$ K
OR
3295°C

5. The ratio of radius of gyration of a solid sphere of mass M and radius R about its own axis to the radius of gyration of the thin hollow sphere of same mass and radius about its axis is :

(1) 5 : 3 (2) 2 : 5
(3) 5 : 2 (4) 3 : 5

Sol: Bonus

6. A Carnot engine has an efficiency of 50% when its source is at a temperature 327° C. The temperature of the sink is:

(1) 15° C (2) 100 °C
(3) 200° C (4) 27° C

Sol: Efficiency of engine

$$\eta = 1 - \frac{T_2}{T_1}$$

$$\eta = 50\% = \frac{50}{100} = 0.5$$

$T_1 = 327°C$
$T_1 = 327 + 273 = 600$ K

$$\therefore \quad \eta = 1 - \frac{T_2}{T_1}$$

$$0.5 = 1 - \frac{T_2}{600}$$

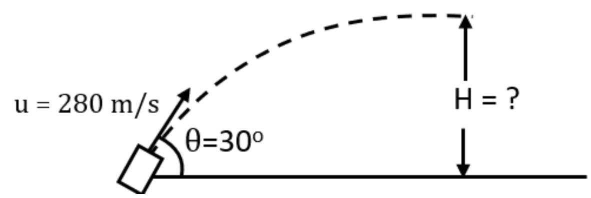
$$\frac{T_2}{600} = 1 - 0.5 = \frac{1}{2}$$

$T_2 = 300$ K
$T_2 = (300 - 273)$ °C
$\therefore$ $T_2 = 27$ °C

7. A bullet is fired from a gun at the speed of 280 ms⁻¹ in the direction 30° above the horizontal. The maximum height attained by the bullet is ($g = 9.8$ m s^{-1}, sin 30°= 0.5):

(1) 2000 m (2) 1000 m
(3) 3000 m (4) 2800 m

Sol:



Maximum Height when bullet fire in the 30° direction.

$$H = \frac{u^2 \sin^2\theta}{2g} = \frac{(280)^2 \sin^2 30}{2(9.8)}$$

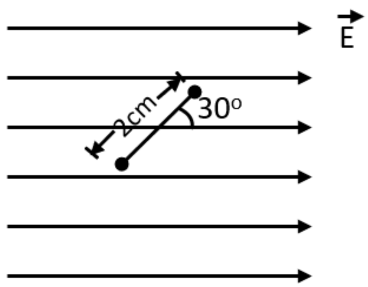
$$= \frac{280 \times 280}{2 \times 9.8} \times \left(\frac{1}{2}\right)^2$$

$$= \frac{280 \times 140}{9.8 \times 4} = \frac{9800}{9.8} = 1000 \text{ m}$$

8. An electric dipole is placed at an angle of 30° with an electric field of intensity 2×10^5 N C^{-1}. It experiences a torque equal to 4 N m. Calculate the magnitude of charge on the dipole, if the dipole length is 2 cm.

(1) 6 mC (2) 4 mC
(3) 2 mC (4) 8 mC

Sol:



Torque due to electric field

$\tau = PE \sin\theta$

Electric dipole moment

$P = (q \times 2\ell)$

$\therefore$ $4 = P \times 2 \times 10^5 \times \sin 30°$

$4 = P \times 2 \times 10^5 \times \frac{1}{2}$

$\therefore$ $P = 4 \times 10^{-5}$

$\therefore$ $q \times (2\ell) = 4 \times 10^{-5}$

$q \times 2 \times 10^{-2} = 4 \times 10^{-5}$

$q = 2 \times 10^{-3}$ C

$\therefore$ Correct option : 2 mC

9. Given below are two statements:

Statement I: Photovoltaic devices can convert optical radiation into electricity.

Statement II: Zener diode is designed to operate under reverse bias in breakdown region.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both **Statement I** and **Statement II** are incorrect.

(2) **Statement I** is correct but **Statement II** is incorrect.

(3) **Statement I** is incorrect but **Statement II** is correct

(4) Both **Statement I** and **Statement II** are correct.

Sol:

Statement I: Photovoltaic devices can Converts optical signal into electrical signal.

Statement II: Zener diode generally operate in reverse biased condition. Therefore breakdown occurs.

Both statement I & II are correct.

10. The errors in the measurement which arise due to unpredictable fluctuations in temperature and voltage supply are:

(1) Personal errors
(2) Least count errors
(3) Random errors
(4) Instrumental errors

Sol:

Random error arise due to random and unpredictable variations in experimental conditions.

Ex. Pressure, Temperature voltage supply.

11. The ratio of frequencies of fundamental harmonic produced by an open pipe to that of closed pipe having the same length is:

(1) 2:1 (2) 1:3
(3) 3:1 (4) 1:2

Sol:

Length is same, $L_0 = L_C = L$

Fundamental freq. of Open pipe

'n_0' = $\frac{V}{4L}$

Fundamental freq. of Closed pipe

'n_C' = $\frac{V}{4L}$

$\therefore$ $\frac{n_0}{n_C} = \frac{V/2L}{V/4L} = \frac{4L}{2L}$

$n_0 : n_c = 2 : 1$

12. The net magnetic flux through any closed surface is :

(1) Positive (2) Infinity

(3) Negative (4) Zero

Sol:

Net Magnetic flux through a closed surface is given by Gauss Law.

$\phi = \int B \cdot dA$

According to this Law, the surface Integral of the magnetic flux intensity over closed surface is ZERO.

$\int B \cdot dA = 0$

13. The work functions of Caesium (Cs), Potassium (K) and Sodium (Na) are 2.14 eV. 2.30 eV and 2.75 eV respectively. If incident electromagnetic radiation has an incident energy of 2.20 eV, which of these photosensitive surfaces may emit photoelectrons?

(1) Both Na and K (2) K only

(3) Na only (4) Cs only

Sol:

Work function (ϕ_0)

$\phi_{0\,CS} = 2.14$ eV

$\phi_{0\,K} = 2.30$ eV

$\phi_{0\,Na} = 2.75$ eV

Energy of Photon $\phi_0 = h\nu = 2.20$eV

For Photo emission, Photon energy must be greater than work function of photosensitive surfaces.

$\phi_0 > \phi_{0\,(cs)}$

$\phi_0 < \phi_{0\,(K)}$

$\phi_0 < \phi_{0\,(Na)}$

∴ Incident photon Energy is greater than work function of Cs only.

∴ Photo emission occurs only for Caesium surface.

14. The minimum wavelength of X-rays produced by an electron accelerated through a potential difference of V volts is proportional to:

(1) $\frac{1}{V}$ (2) $\frac{1}{\sqrt{V}}$

(3) V^2 (4) $\sqrt{V}$

Sol:

Energy in terms of wavelength

$$E = \frac{hc}{\lambda}$$

$$eV = \frac{hc}{\lambda}$$

$$\lambda \propto \frac{1}{V}$$

15. A 12 V, 60 W lamp is connected to the secondary of a step down transformer, whose primary is connected to ac mains of 220 V. Assuming the transformer to be ideal, what is the current in the primary winding?

(1) 2.7 A (2) 3.7 A

(3) 0.37 A (4) 0.27 A

Sol :

P → primary s → secondary

$V_s = 12$ V

$P_s = 60$ W

$V_p = 220$ W

Transformer is Ideal

$P_{in} = P_{out}$

$V_P i_P = P_S$

$220 \times i_P = 60$

∴ $$i_p = \frac{6}{22} = \frac{3}{11} = 0.27A$$

16. Light travels a distance x in time t_1 in air and 10x in time t_2 in another denser medium. What is the critical angle for this medium?

(1) $\sin^{-1}\left(\frac{10t_2}{t_1}\right)$ (2) $\sin^{-1}\left(\frac{t_1}{10t_2}\right)$

(3) $\sin^{-1}\left(\frac{10t_1}{t_2}\right)$ (4) $\sin^{-1}\left(\frac{t_2}{t_1}\right)$

Sol:

$V_1 = \frac{x}{t_1}$ medium 1 (air)

$V_2 = \frac{10x}{t_2}$ medium 2 (Denser)

$i_c = \sin^{-1}\left(\frac{1}{{}^1\mu_2}\right) = \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$

$\mu = \frac{C}{V}$ $\therefore \mu \propto \frac{1}{V}$

$\therefore$ $i_C = \sin^{-1}\left(\frac{V_2}{V_1}\right)$

$i_c = \sin^{-1}\left[\frac{10x/t_2}{x/t_1}\right]$

$i_c = \sin^{-1}\left(\frac{10t_1}{t_2}\right)$

17. A metal wire has mass (0.4 ± 0.002) g, radius (0.3 ± 0.001) mm and length (5 ± 0.02) cm. The maximum possible percentage error in the measurement of density will nearly be:

(1) 1.3% (2) 1.6%
(3) 1.4% (4) 1.2%

Sol: M = (0.4 ± 0.002) gm

r = (0.3 ± 0.001) mm

ℓ = (5 ± 0.02) cm

Density of wire $\rho = \frac{\text{Mass}}{\text{volume}}$

$\rho = \frac{M}{\pi r^2 \ell}$

$\therefore$ % error in density is

$\%\rho = \%M + 2\%r + \%\ell$

$\%\rho = \frac{0.002}{0.4}\times 100 + 2\times\frac{0.001}{0.3}\times 100 + \frac{0.02}{5}\times 100$

$= 0.5 \times 0.66 + 0.4$

$\%\rho = 1.56\%$

18. For Young's double slit experiment, two statements are given below:

Statement I: If screen is moved away from the plane of slits, angular separation of the fringes remains constant.

Statement II: If the monochromatic source is replaced by another monochromatic source of larger wavelength, the angular separation of fringes decreases.

In the light of the above statements, choose the correct answer from the options given below :

(1) Both **Statement I** and **Statement II** are false.

(2) **Statement I** is true but **Statement II** is false.

(3) **Statement I** is false but **Statement II** is true.

(4) Both **Statement I** and **Statement II** are true.

Sol:

In YDSE, Angular width 'θ'

$\theta = \frac{\lambda}{d}$

Angular width depends on,

(i) directly proportional to λ

(ii) Inversely proportional to slit separation.

θ is independent of distance between slit 4 screen.

$\theta \times \lambda \Rightarrow \therefore \lambda\uparrow\uparrow \rightarrow \theta\uparrow\uparrow$

Statement I is True but

Statement II is false

19. The half life of a radioactive substance is 20 minutes. In how much time, the activity of substance drops to $\left(\frac{1}{16}\right)^{th}$ of its initial value?

(1) 40 minutes (2) 60 minutes
(3) 80 minutes (4) 20 minutes

Sol :

No. of half life (n)

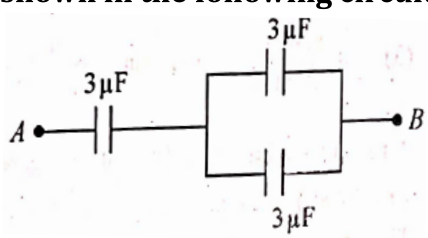
$$\left(\frac{1}{16}\right)=\left(\frac{1}{2}\right)^4=\left(\frac{1}{2}\right)^n$$

$\therefore$ n = 4

$\therefore$ Time taken by substance to drop to $\left(\frac{1}{16}\right)^{th}$ of initial

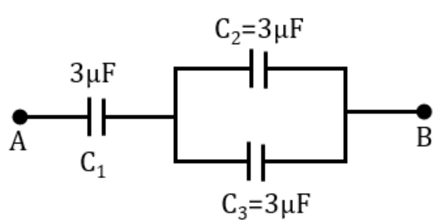
T = 20 × 4 = 80 min

20. The equivalent capacitance of the system shown in the following circuit is :



(1) 3 μF (2) 6 μF
(3) 9 μF (4) 2 μF

Sol :



C_2 and C_3 are connected in parallel

$\therefore$ $C_{eq_1} = C_2 + C_3$

$= 3 + 3$

$C_{eq_1} = 6\ \mu F$

Now C_1 and C_{eq_1} becomes in series,

$$\therefore \quad C_{eq} = \frac{C_1 + C_{eq_1}}{C_1 + C_{eq_1}}$$

$$= \frac{3\times6}{3+6} = \frac{18}{9}$$

$C_{eq} = 2\ \mu F$

21. Resistance of a carbon resistor determined from colour codes is (22000 ± 5%) Ω. The colour of third band must be :

(1) Green (2) Orange
(3) Yellow (4) Red

Sol :

R = (22000 ± 5%) Ω

$R = (22\times10^3 \pm 5\%)\Omega$

1st Band (Red) → 2

2nd Band (Red) → 2

3rd band (Orange) → 3

4th band (Gold) → 10^3

22. An ac source is connected to a capacitor C. Due to decrease in its operating frequency:

(1) displacement current increases.
(2) displacement current decreases.
(3) capacitive reactance remains constant
(4) capacitive reactance decreases.

Sol:

Current through capacitor ∝ Impedance

$I \propto X_c$

$$X_c = \frac{1}{\omega c}$$

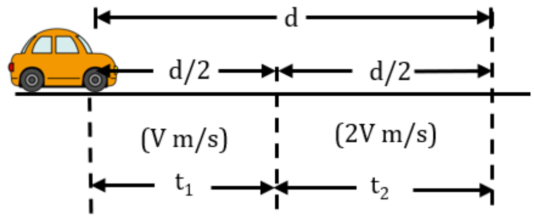
$$I \propto X_c = \frac{1}{2\pi fc}$$

$f\downarrow \rightarrow I\downarrow$

23. A vehicle travels half the distance with speed υ and the remaining distance with speed 2υ. Its average speed is:

(1) $\frac{2\upsilon}{3}$ (2) $\frac{4\upsilon}{3}$
(3) $\frac{3\upsilon}{4}$ (4) $\frac{\upsilon}{3}$

Sol:



$$V_{avg}=\frac{d_1+d_2}{t_1+t_2}$$

$$=\frac{\frac{d}{2}+\frac{d}{2}}{\left(\frac{d}{2v}\right)+\left(\frac{d}{4v}\right)}\qquad \left\{\begin{array}{l} t_1=\frac{d/2}{v}=\frac{d}{2v} \\ t_2=\frac{d/2}{2v}=\frac{d}{4v}\end{array}\right\}$$

$$=\frac{d}{\left(\frac{3d}{4v}\right)}$$

$$V_{avg}=\frac{4}{3}V$$

24. The amount of energy required to form a soap bubble of radius 2 cm from a soap solution is nearly : (surface tension of soap solution = 0.03 N m^{-1})

(1) 5.06×10^{-4} J (2) 3.01×10^{-4} J

(3) 50.1×10^{-4} J (4) 30.16×10^{-4} J

Sol: Bubble → Double

Energy required to form soap bubble

E = 2 × T dA

dA = surface area of bubble = $4\pi r^2$

$E = 2 \times 0.03 \times 4 \times 3.142 \times (2 \times 10^{-2})^2$

$= 0.03 \times 8 \times 3.142 \times 4 \times 10^{-4}$

$= 0.03 \times 100.54 \times 10^{-4} = 3.01 \times 10^{-4}$ J

25. The venturi-meter works on:

(1) Bernoulli's principle

(2) The principle of parallel axes

(3) The principle of perpendicular axes

(4) Huygen's principle

Sol :

Venture-meter works on Bernoullis principle, Which express that the distinction in pressure made over the hindrance gives the proportion of the liquid stream rate.

26. In hydrogen spectrum, the shortest wavelength in the Balmer series is λ. The shortest wavelength in the Bracket series is :

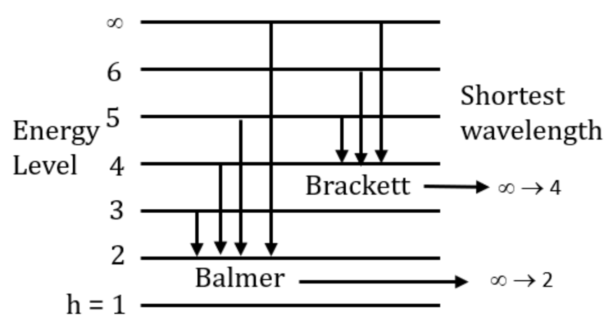
(1) 4λ (2) 9λ

(3) 16λ (4) 2λ

Sol :

H-spectrum wavelength,

$$\frac{1}{\lambda}=R\left(\frac{1}{p^2}-\frac{1}{n^2}\right)$$



Balmer series

$$\frac{1}{\lambda_B}=R\left(\frac{1}{(2)^2}-\frac{1}{(\infty)^2}\right)$$

$$\frac{1}{\lambda_B}=R\left(\frac{1}{4}\right) \qquad \ldots.(1)$$

Brackett series

$$\frac{1}{\lambda_{BR}}=R\left(\frac{1}{(4)^2}-\frac{1}{(\infty)^2}\right)$$

$$\frac{1}{\lambda_{BR}}=R\left(\frac{1}{(16)}\right) \qquad \ldots.(2)$$

From equation (1) & (2)

$$\therefore \quad \frac{\frac{1}{\lambda_B}}{\frac{1}{\lambda_{BR}}}=\frac{R\left(\frac{1}{4}\right)}{R\left(\frac{1}{16}\right)}=4$$

$$\frac{\lambda_{BR}}{\lambda_B}=\frac{\lambda_{BR}}{\lambda}=4$$

$\therefore \quad \lambda_{BR} = 4\lambda$

27. The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm, potential energy stored in it will be:

(1) 4U (2) 8U
(3) 16U (4) 2U

Sol :

Change in length : x_1 = 2cm, x_2 = 8 cm
P.E. stored in the spring is,

$$U = \frac{1}{2}Kx^2$$

$$\therefore \quad \frac{U_2}{U_1} = \frac{\frac{1}{2}Kx_2^2}{\frac{1}{2}Kx_1^2}$$

$$\frac{U_2}{U_1} = \left(\frac{x_2}{x_1}\right)^2 = \left(\frac{8}{2}\right)^2 = (4)^2$$

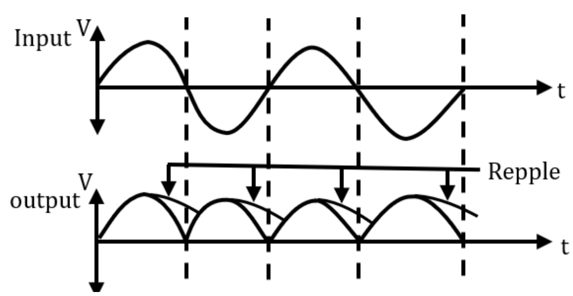
$$\frac{U_2}{U_1} = 16 \rightarrow U_2 = 16\ U$$

28. A full wave rectifier circuit consists of two p-n junction diodes, a centre-tapped transformer, capacitor and a load resistance. Which of these components remove the ac ripple from the rectified output?

(1) p-n junction diodes
(2) Capacitor
(3) Load resistance
(4) A centre-tapped transformer

Sol:

Full wave rectification



The ripple can be removed by connecting CAPACITOR in parallel to the load which convert the ripple voltage into a smoother DC voltage.

29. The magnetic energy stored in an inductor of inductance 4 μH carrying a current of 2 A is:

(1) 4 mJ (2) 8 mJ
(3) 8 μJ (4) 4 μJ

Sol:

Magnetic energy stored in Inductor is

$$U = \frac{1}{2}L\,i^2$$

$$= \frac{1}{2}4 \times 10^{-6} \times (2)^2$$

$= 8 \times 10^{-6}$ J

U = 8 μJ

30. If $\oint_s \vec{E}\cdot\vec{dS} = 0$ over a surface, then :

(1) the magnitude of electric field on the surface is constant.
(2) all the charges must necessarily be inside the surface.
(3) the electric field inside the surface is necessarily uniform.
(4) the number of flux lines entering the surface must be equal to the number of flux lines leaving it.

Sol : Net magnetic flux through a closed surface is given by gauss law

$$\oint_s \vec{E}\cdot\vec{ds} = 0 = \frac{q_{in}}{\epsilon_0} = \phi$$

$\therefore$ $q_{in} = 0$

Flux $\phi = 0$

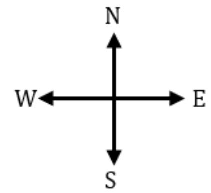
Incoming flux = Outgoing flux

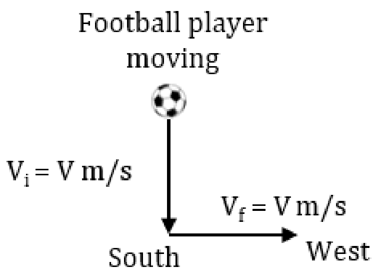
31. A football player is moving southward and suddenly turns eastward with the same speed to avoid an opponent. The force that acts on the player while turning is:

(1) along northward
(2) along north-east
(3) along south-west
(4) along eastward

Sol :

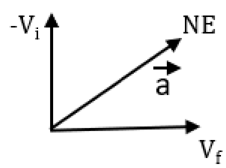
Direction :





$\vec{a} = \Delta\vec{v}$

$\vec{a} = \vec{v_f} - \vec{v_i}$



∴ Force acting along North-east direction while turning southward to east ward

32. Let a wire be suspended from the ceiling (rigid support) and stretched by a weight W attached at its free end. The longitudinal stress at any point of cross-sectional area of the wire is:

(1) W/A (2) W/2A

(3) Zero (4) 2W/A

Sol:

$$\text{Longitudinal stress} = \frac{\text{Tension}}{\text{Area}}$$

$$\therefore \quad \text{Stress} = \frac{\text{Weight}}{\text{Area}} = \frac{W}{A}$$

33. The angular acceleration of a body, moving along the circumference of a circle, is:

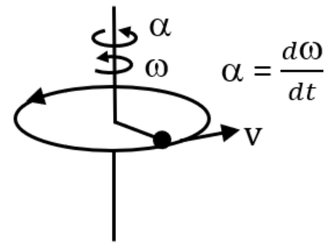
(1) along the radius towards the centre

(2) along the tangent to its position

(3) along the axis of rotation

(4) along the radius, away from centre

Sol :



34. In a plane electromagnetic wave travelling in free space, the electric field component oscillates sinusoidally at a frequency of 2.0 × 10^{10} Hz and amplitude 48 Vm^{-1}. Then the amplitude of oscillating magnetic field is: (Speed of light in free space = 3 × 10^8 m s^{-1})

(1) 1.6×10^{-8} T (2) 1.6×10^{-7} T

(3) 1.6×10^{-6} T (4) 1.6×10^{-9} T

Sol:

$E_0 = c\,B_0$

$$B_0 = \frac{E_0}{c} = \frac{48}{3 \times 10^8}$$

$B_0 = 16 \times 10^{-8}$

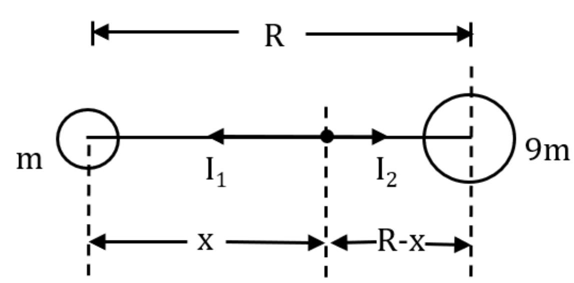
$B_0 = 1.6 \times 10^{-7}$ T

35. Two bodies of mass m and 9m are placed at a distance R. The gravitational potential on the line joining the bodies where the gravitational field equals zero, will be (G = gravitational constant)

(1) $-\frac{12Gm}{R}$ (2) $-\frac{16Gm}{R}$

(3) $-\frac{20Gm}{R}$ (4) $-\frac{8Gm}{R}$

Sol:



Gravitational field equals to Zero.

$I_1 - I_1 = 0$

$I_1 = I_2$

$\frac{GM}{x^2} = \frac{G(9M)}{(R-x)^2}$

$(R-x)^2 = 9x^2$

$(R-x)^2 = (3x)^2$

$R - x = 3x$

$R = 4x$

$x = \frac{R}{4}$

Now,

$V = -\frac{GM}{x} - \frac{G(9M)}{R-x}$

$= \frac{-GM}{R/4} - \frac{9GM}{R-R/4} f$

$= \frac{-GM}{R} = \left(\frac{1}{(1/4)} + \frac{9}{(3/4)}\right)$

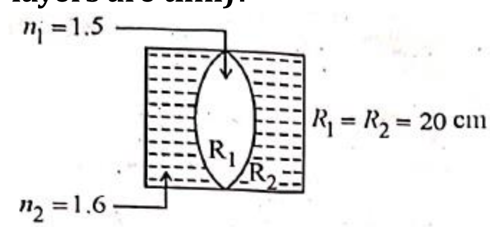
$= \frac{-GM}{R}(4+12)$

$= \quad -\frac{GM}{R}(16)$

$V = -\frac{16GM}{R}$

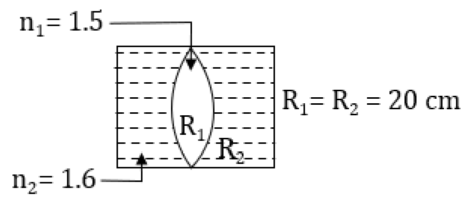
Section – B (Attempt Any 10)

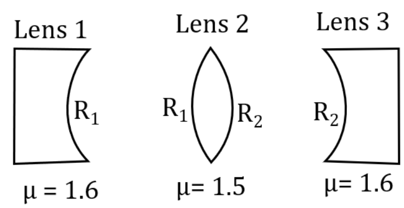
36. In the figure shown here, what is the equivalent focal length of the combination of lenses (Assume that all layers are thin)?



(1) −40 cm
(2) −100 cm
(3) −50 cm
(4) 40 cm

Sol.





$f_1 = \frac{-R}{\mu - 1} = \frac{-20}{1.6-1} = \frac{-20}{0.6}$

$f_1 = \frac{-100}{3}$cm

$f_2 = \frac{R}{2(\mu-1)}$

$= \frac{20}{2(1.5-1)}$

$= \frac{20}{2 \times 0.5}$

$F_2 = 20$ cm

$f_3 = \frac{-R}{\mu - 1}$

$= \frac{-20}{1.6-1} = \frac{-20}{0.6}$

$f_3 = \frac{-100}{3}$cm

$\therefore \quad \frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}$

$$\frac{1}{f}=\frac{1}{-100/3}+\frac{1}{20}+\frac{1}{-100/3}$$

$$=\frac{-3}{100}+\frac{1}{20}\times\frac{5}{5}-\frac{3}{100}$$

$$=\frac{-3+5-3}{100}$$

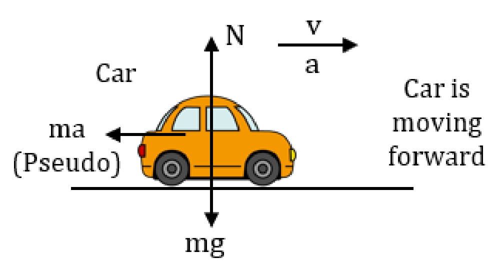
$$\frac{1}{f}=-\frac{1}{100}$$

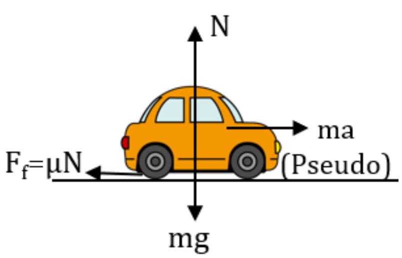
F = –100 cm

37. Calculate the maximum acceleration of a moving car so that a body lying on the floor of the car remains stationary. The coefficient of static friction between the body and the floor is 0.15 ($g = 10\ m\ s^{-2}$).

(1) $150\ m\ s^{-2}$ (2) $1.5\ m\ s^{-2}$
(3) $50\ m\ s^{-2}$ (4) $1.2\ m\ s^{-2}$

Sol:





To stop the car

$F_{net} = 0$

$F_f - ma = 0$

$\mu mg - ma = 0$

$\mu g - a = 0$

$a = \mu g$

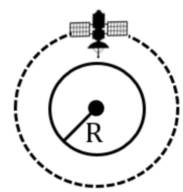
$= 0.15\ (10)$

$a = 1.5\ m/s^2$

38. A satellite is orbiting just above the surface of the earth with period T. If d is the density of the earth and G is the universal constant of gravitation, the quantity $\frac{3\pi}{Gd}$ represents:

(1) T^2 (2) T^3
(3) $\sqrt{T}$ (4) T

Sol:



Time period of satellite orbiting just above the surface of earth.

$\therefore \quad r = R + h \approx R$ .... (Neglect height)

$$T=2\pi\sqrt{\frac{r^3}{GM}}$$

$$T=2\pi\sqrt{\frac{R^3}{GM}} \qquad r = R$$

$$\rho=\frac{M}{V}=\frac{M}{\frac{4}{3}\pi R^3}$$

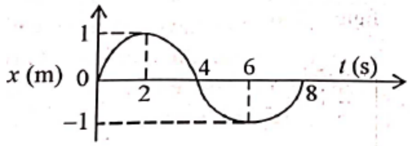
$$\therefore \quad M=\frac{4}{3}\pi R^3\rho$$

$$\therefore \quad T=2\pi\sqrt{\frac{R^3}{G\left(\frac{4}{3}\pi R^3\rho\right)}}$$

$$T=\sqrt{\frac{\pi^2\times 3}{G\pi\rho}}=\sqrt{\frac{3\pi}{G\rho}}$$

$$T^2=\frac{3\pi}{G\rho}$$

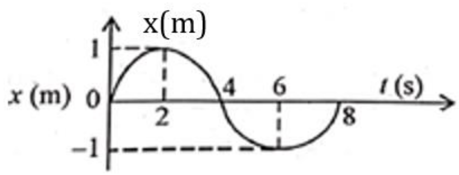
39. The x-t graph of a particle performing simple harmonic motion is shown in the figure. The acceleration of the particle at t = 2 s is:



(1) $-\frac{\pi^2}{8} ms^{-2}$ (2) $\frac{\pi^2}{16} ms^{-2}$

(3) $-\frac{\pi^2}{16} ms^{-2}$ (4) $\frac{\pi^2}{8} ms^{-2}$

Sol :



A = 1m, T = 8 sec

Acceleration

$a = -\omega^2 x$

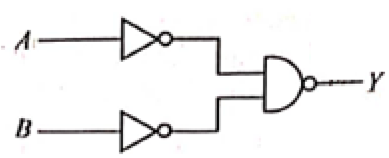
at t = 2s, x = A

$a = -\omega^2 A$

$= -\left(\frac{2\pi}{T}\right)^2 A = -\frac{4\pi^2}{(8)^2}\cdot 1 = -\frac{4\pi^2}{64}$

$a = \frac{-\pi^2}{16} ms^{-1}$

40. For the following logic circuit, the truth table is:



(1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(2)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

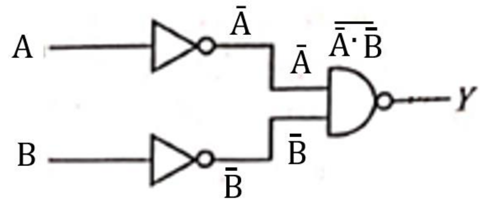
(3)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

(4)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Sol :



A	B	$\bar{A}$	$\bar{B}$	$\bar{A}\cdot\bar{B}$	$y = \overline{\bar{A}\cdot\bar{B}}$ = A + B
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

41. A horizontal bridge is built across a river. A student standing on the bridge throws a small ball vertically upwards with a velocity 4 m s^{-1}. The ball strikes the water surface after 4 s. The height of bridge above water surface is (Take g = 10 m s^{-2}):

(1) 60 m (2) 64 m

(3) 68 m (4) 56 m

Sol:

Diagram I:

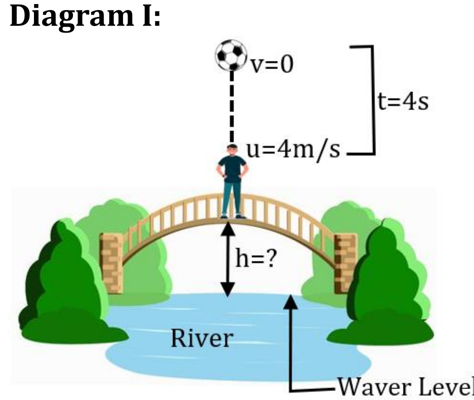
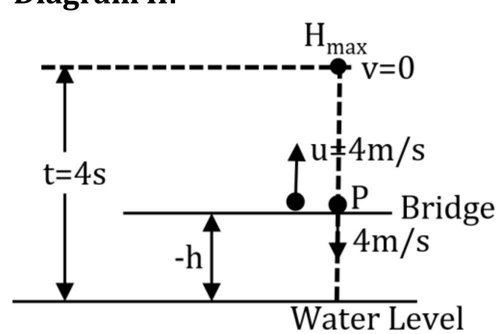


Diagram II:



At point P, initial speed of ball is 4 m/s in upward direction. After returning speed will be same at point P. in down ward direction [Because of acceleration due to gravity].

$\therefore \quad s = ut + \frac{1}{2}at^2$

$-h = 4(4) + \frac{1}{2}(-10)(4)^2$

$-h = 16 - \frac{10}{2} \times 16$

$-h = 16 - 80$

$-h = -64$

$h = 64$ m

42. Two thin lenses are of same focal lengths (f), but one is convex and the other one is concave. When they are placed in contact with each other, the equivalent focal length of the combination will be:

(1) f/4 (2) f/2

(3) Infinite (4) Zero

Sol:

combined focal length

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

$\frac{1}{f_{eq}} = \frac{1}{f} + \frac{1}{(-f)}$

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

$\frac{1}{f_{eq}} = 0$

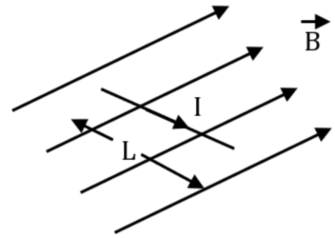
$f_{eq} = \frac{1}{0} = \infty$

43. A wire carrying a current I along the positive x-axis has length L. It is kept in a magnetic field $\vec{B} = (2\hat{i} + 3\hat{j} - 4\hat{k})T$. The magnitude of the magnetic force acting on the wire is:

(1) $\sqrt{5}$IL (2) 5 IL

(3) $\sqrt{3}$IL (4) 3 IL

Sol :



Force Acting on current carrying wire

$\vec{F} = i(\vec{\ell} \times \vec{B})$

$= I(L\hat{i} \times (2\hat{i} \times 3\hat{j} - 4\hat{k}))$

$= IL(\hat{i} \times (2\hat{i} + 3\hat{j} - 4\hat{k}))$

$= IL[2(\hat{i} \times \hat{i}) + 3(\hat{i} \times \hat{j}) - 4(\hat{i} \times \hat{k})]$

$= IL[2(0) + 3\hat{k} - 4(-\hat{j})]$

$\vec{F} = IL(4\hat{j} \times 3\hat{k})$

$|\vec{F}| = IL\sqrt{(4)^2 + (3)^2} = IL\sqrt{16 + 9}$

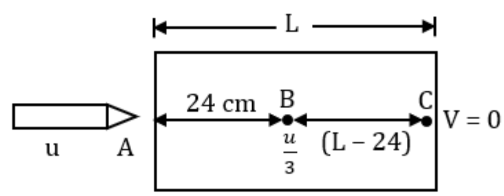
F = 5IL

44. A bullet from a gun is fired on a rectangular wooden block with velocity u. When bullet travels 24 cm through the block along its length horizontally, velocity of bullet becomes $\frac{u}{3}$. Then it further penetrates into the block in the same direction before coming to rest exactly at the other end of the block. The total length of the block is:

(1) 24 cm (2) 28 cm

(3) 30 cm (4) 27 cm

Sol :



From A to B

u = u m/s., $v = \left(\frac{u}{3}\right)$ m/s.

$\therefore \quad v^2 = u^2 + 2as$

$$\left(\frac{u}{3}\right)^2 = u^2 - 2\times a\times 24$$

$$\frac{u^2}{9} - u^2 = -48a$$

$$-\frac{8u^2}{9} = -48a$$

$$\frac{u^2}{54} = a$$

From A to C

$u = \left(\frac{u}{3}\right)$ m/s. v = 0 m/s.

$\therefore \quad v^2 = u^2 + 2as$

$$0 = u^2 - 2\times\left(\frac{u^2}{54}\right)\times L$$

$$u^2 = \frac{u^2}{27}\times L$$

L = 27 cm.

45. The resistance of platinum wire at 0°C is 2Ω and 6.8Ω at 80°C. The temperature coefficient of resistance of the wire is:

(1) $3 \times 10^{-3}\ °C^{-1}$ (2) $3 \times 10^{-2}\ °C^{-1}$

(3) $3 \times 10^{-1}\ °C^{-1}$ (4) $3 \times 10^{-4}\ °C^{-1}$

Sol:

Platinum wire :	R	T
	2Ω	0°C
	6.8 Ω	80°C

ΔT = 80

Variation of Resistance

$R = R_0(1 + \propto \Delta T)$

$6.8 = 2(1 + \propto(80))$

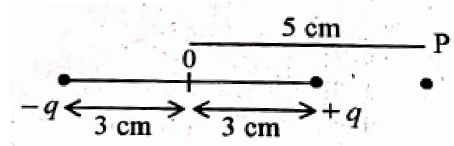
$3.4 = 1 + 80\propto$

$80\propto = 2.4$

$$\propto = \frac{2.4}{80} = \frac{0.24}{8}$$

$\propto = 0.03/°C$

46. An electric dipole is placed as shown in the figure.

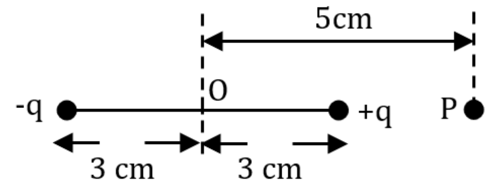


The electric potential (in 10^2 V) at point P due to the dipole is (ϵ_0 = permittivity of free space and $\frac{1}{4\pi\epsilon_0} = K$

(1) $\left(\frac{5}{8}\right)qK$ (2) $\left(\frac{8}{5}\right)qK$

(3) $\left(\frac{8}{3}\right)qK$ (4) $\left(\frac{3}{8}\right)qK$

Sol :



Electric potential at point P is

$$V = \frac{KP}{r^2 - \ell^2}$$

$$= \frac{K(q\times 2\times \ell)}{(5)^2 - (3)^2}\ \{p = q \times (2\ell)\}$$

$$= \frac{kq(2\times 3)}{25-9} = \frac{6kq}{16}$$

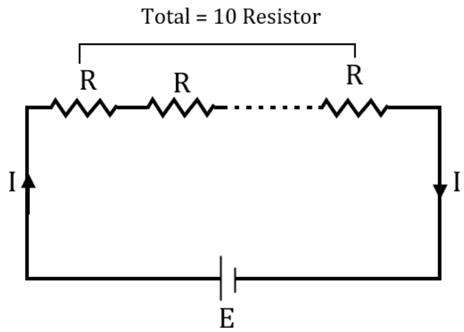
$$V = \frac{3kq}{8}$$

47. 10 resistors, each of resistance R are connected in series to a battery of emf E and negligible internal resistance. Then those are connected in parallel to the same battery, the current is increased n times. The value of n is:

(1) 100 (2) 1
(3) 1000 (4) 10

Sol:

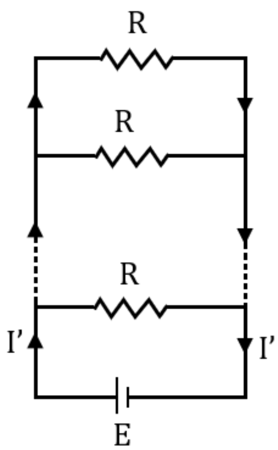
1.



$\therefore$ $R_{eq} = nR = 10\,R\,\Omega$

$\therefore$ $I = \dfrac{E}{R_{eq}} = \dfrac{E}{10R}$

2.



$R'_{eq} = \dfrac{R}{n} = \dfrac{R}{10}\Omega$

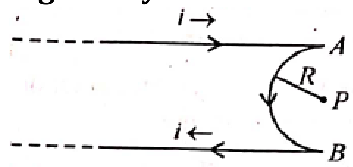
$I' = \dfrac{E}{R'_{eq}} = \dfrac{E}{R/10} = \dfrac{10E}{R}$

$\therefore$ $\dfrac{I'}{I} = \dfrac{10E/R}{E/10R} = 100$

$\dfrac{nI}{I} = 100$

$n = 100$

48. A very long conducting wire is bent in a semi-circular shape from A to B as shown in figure. The magnetic field at point P for steady current configuration is given by:



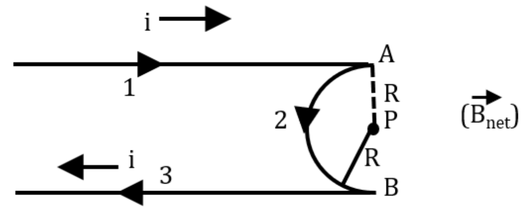
(1) $\dfrac{\mu_0 i}{4R}$ pointed away from the page

(2) $\dfrac{\mu_0 i}{4R}\left[1-\dfrac{2}{\pi}\right]$ pointed away from page

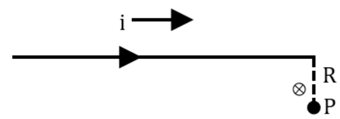
(3) $\dfrac{\mu_0 i}{4R}\left[1-\dfrac{2}{\pi}\right]$ pointed into the page

(4) $\dfrac{\mu_0 i}{4R}$ pointed into the page

Sol :

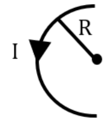


1. Magnetic field at point 'P' due to semi-infinite wire 1



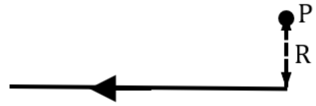
$\vec{B}_{semi\infty 1} = \dfrac{\mu_0 I}{4\pi R}\otimes$

2. Magnetic field at point 'P' due to semi-circular wire 2



$\vec{B}_{semi0} = \dfrac{\mu_0 I}{4R}\odot$

3. Magnetic field at point 'P' due to semi-infinite wire 3



$$\vec{B}_{semi\infty 2} = \frac{\mu_0 I}{4\pi R} \otimes$$

Net magnetic field at point P

$$\vec{B}_{net} = \vec{B}_{semi\infty 1} + \vec{B}_{semi0} + \vec{B}_{semi\infty 2}$$

$$= -\frac{\mu_0 I}{4\pi R}\frac{\mu_0 I}{4R} - \frac{\mu_0 I}{4R}$$

$$= \frac{\mu_0 I}{4R}\left(-\frac{1}{\pi} + 1 - \frac{1}{\pi}\right)$$

$$\overrightarrow{B_{net}} = \frac{\mu_0 I}{4R}\left(1 - \frac{2}{\pi}\right) \qquad \left\{\frac{2}{\pi} < 1\right\}$$

Sign convention :
$\otimes \rightarrow -ve$
$\odot \rightarrow +ve$

∴ net magnetic field will be directed into the plane.

49. The radius of inner most orbit of hydrogen atom is 5.3 × 10⁻¹¹ m. What is the radius of third allowed orbit of hydrogen atom?

(1) 1.06 Å (2) 1.59 Å
(3) 4.77 Å (4) 0.53 Å

Sol:

Radius of orbit

$r \propto n^2$

∴ $\frac{r_2}{r_1} = \left(\frac{n_2}{n_1}\right)^3$

$\frac{r_2}{r_1} = \left(\frac{3}{1}\right)^2$

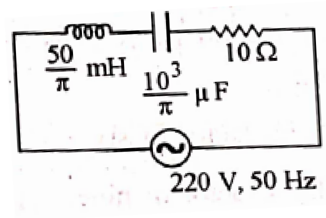
$r_2 = 9r_1$

$r_2 = 9 \times 5.3 \times 10^{-11}$

$r_2 = 47.7 \times 10^{-11}$

$r_2 = 4.77$ Å

50. The net impedance of circuit (as shown in figure) will be :



(1) 15 Ω (2) $5\sqrt{5}$ Ω
(3) 25 Ω (4) $5\sqrt{2}$ Ω

Sol:

R = 10Ω

Capacitive Reactance

$$X_c = \frac{1}{2\pi fc}$$

$$= \frac{1}{2\pi \times 50 \times \frac{10^3}{\pi} \times 10^{-6}}$$

$X_C = 10\Omega$

Inductive Reactance,

$X_L = 2\pi fL$

$X_L = 2\pi \times 50 \times \frac{50}{\pi} \times 10^{-3}$

$X_L = 5\Omega$

Impedance of circuit

$$z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{(10)^2 + (10-5)^2}$$

$$= \sqrt{100+25}$$

$$z = 5\sqrt{5}$$

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