



Aakash

Medical | IIT-JEE | Foundations

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MM : 300

AIATS For One Year JEE(Main)-2026 (XII Passed)_Test-02_ONLINE

Time : 180 Min.

CHEMISTRY

Section-I

- | | |
|---------|---------|
| 1. (2) | 11. (3) |
| 2. (4) | 12. (3) |
| 3. (3) | 13. (3) |
| 4. (3) | 14. (3) |
| 5. (3) | 15. (1) |
| 6. (3) | 16. (3) |
| 7. (2) | 17. (2) |
| 8. (2) | 18. (4) |
| 9. (2) | 19. (1) |
| 10. (4) | 20. (1) |

Section-II

- | | |
|-----------|----------|
| 21. (8) | 24. (3) |
| 22. (95) | 25. (16) |
| 23. (134) | |

MATHEMATICS

Section-I

- | | |
|---------|---------|
| 26. (1) | 36. (4) |
| 27. (4) | 37. (1) |
| 28. (4) | 38. (3) |
| 29. (2) | 39. (1) |
| 30. (3) | 40. (2) |
| 31. (3) | 41. (2) |
| 32. (3) | 42. (1) |

33. (4)
34. (4)
35. (1)

43. (1)
44. (3)
45. (1)

Section-II

46. (10)
47. (70)
48. (9)

49. (20)
50. (13)

PHYSICS

Section-I

51. (2)
52. (2)
53. (4)
54. (4)
55. (1)
56. (4)
57. (3)
58. (1)
59. (4)
60. (2)

61. (4)
62. (2)
63. (3)
64. (1)
65. (3)
66. (4)
67. (2)
68. (1)
69. (2)
70. (4)

Section-II

71. (2)
72. (5)
73. (2)

74. (6)
75. (20)

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Hints and Solutions

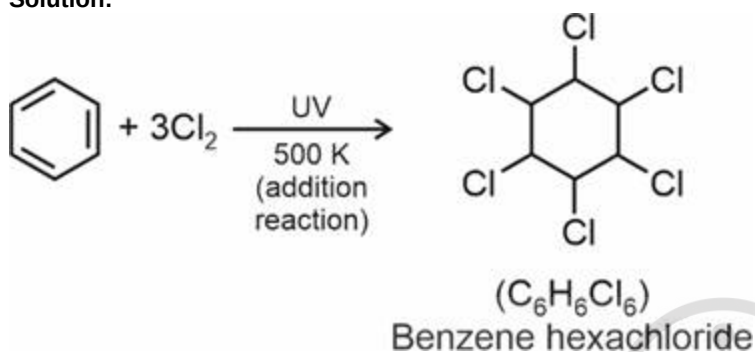
CHEMISTRY

Section-I

(1) Answer : (2)

Hint:

A is benzene hexachloride.

Solution:

(2) Answer : (4)

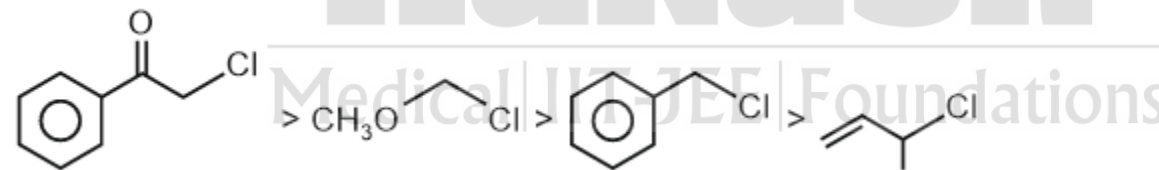
Hint:

Barfoed test is used to distinguish monosaccharides and disaccharides.

Solution:

The ninhydrin test used for the presence of proteins and amino acids, indicated by a positive result of a deep blue or purple color (known as Ruhemann's purple).

(3) Answer : (3)

Hint: S_N2 rate: $\text{CH}_3\text{X} > 1^\circ \text{RX} > 2^\circ \text{RX}$ **Solution:**

(4) Answer : (3)

Hint:

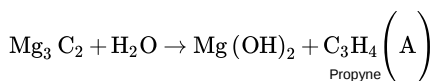
Adenine pairs with Thymine and Cytosine pairs with Guanine.

Solution:

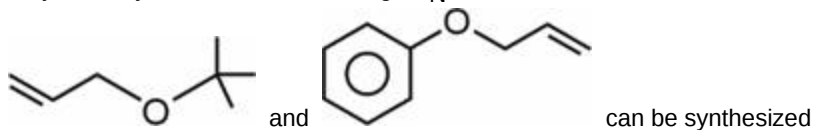
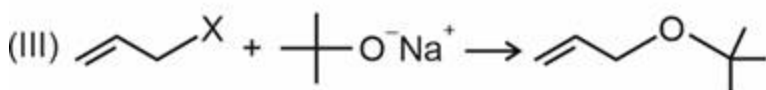
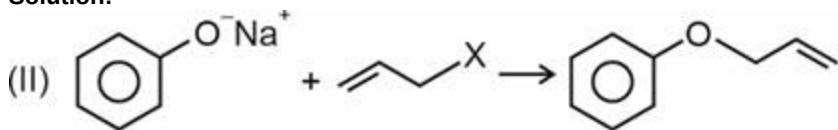
$$\frac{T}{G} = \frac{A}{C} = \frac{3}{2} = \frac{150000}{C}$$

$$C = 100000$$

(5) Answer : (3)

Hint:**Solution:**

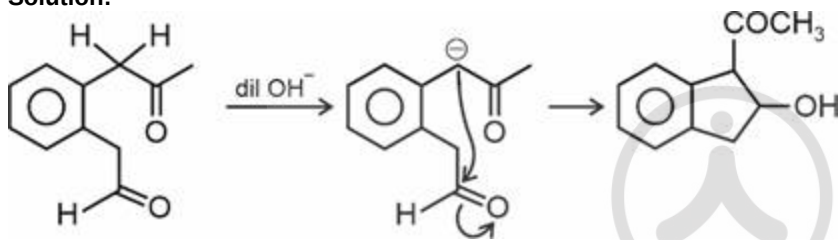
Hint:

 Vinylic or Arylic halides don't undergo S_N2 reaction under normal conditions.

Solution:


(10) Answer : (4)

Hint:

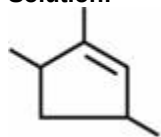
Intramolecular aldol reaction will occur.

Solution:


(11) Answer : (3)

Hint:

$$\Delta H_{\text{hydrogenation}} \propto \frac{1}{\text{Stability of alkene}}$$

Solution:


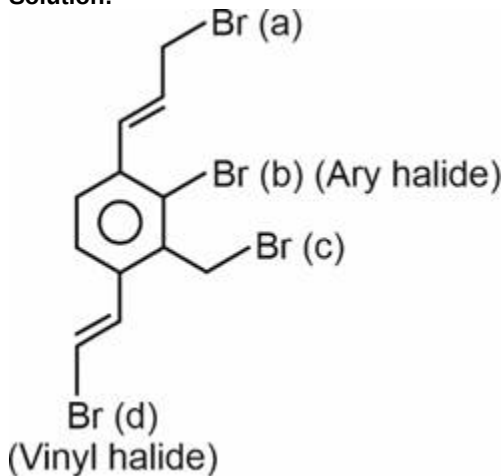
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(12) Answer : (3)

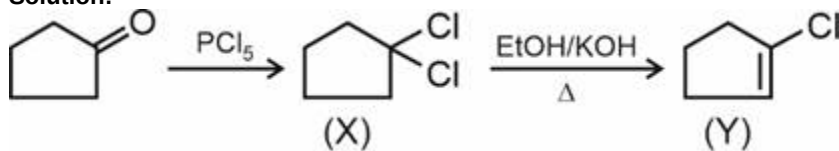
Hint:

Vinylic and Arylic halides don't undergo substitution reaction at normal condition.

Solution:


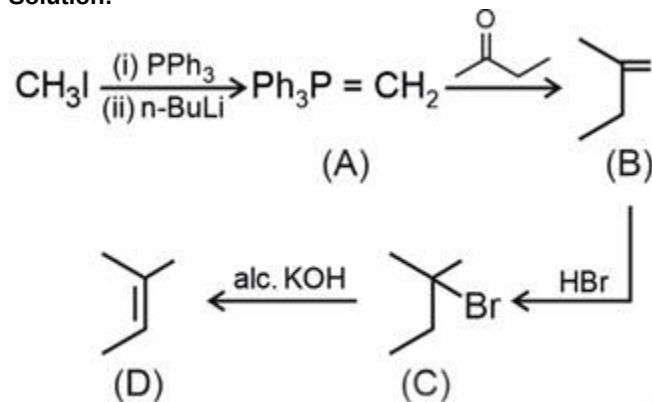
(13) Answer : (3)

Hint:
 PCl_5 on reaction with aldehyde or ketone form geminal dihalide.

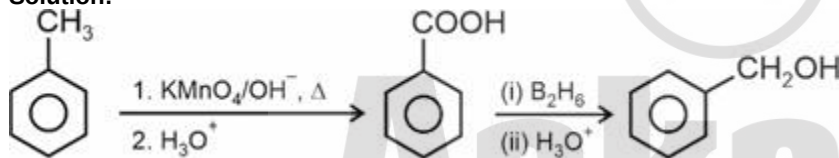
Solution:

(14) Answer : (3)

Hint:

 Alkene decolourise Br_2/CCl_4 solution.

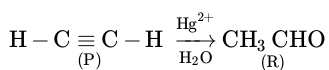
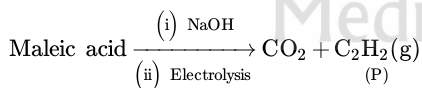
Solution:

(15) Answer : (1)

Hint:
 B_2H_6 reduces carboxylic acid to alcohol.

Solution:

(16) Answer : (3)

Hint:

Kolbe's electrolysis process

Solution:

 CH_3CHO does not give Victor Meyer test.

(17) Answer : (2)

Hint:

Carbylamine test is for primary amines.

Solution:

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

(18) Answer : (4)

Hint:

Azulene is highly polar

Solution:

Azulene



• Highly polar

- Exist in solid state
- Isomer of naphthalene.
- ∴ Direction of dipole moment is from 7 membered ring to 5 membered ring.

(19) Answer : (1)

Hint:

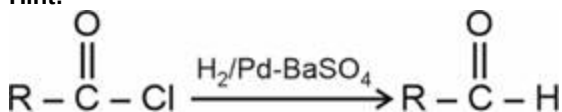
Test of sulphur has $[\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$ as complex, which is violet color.

Solution:

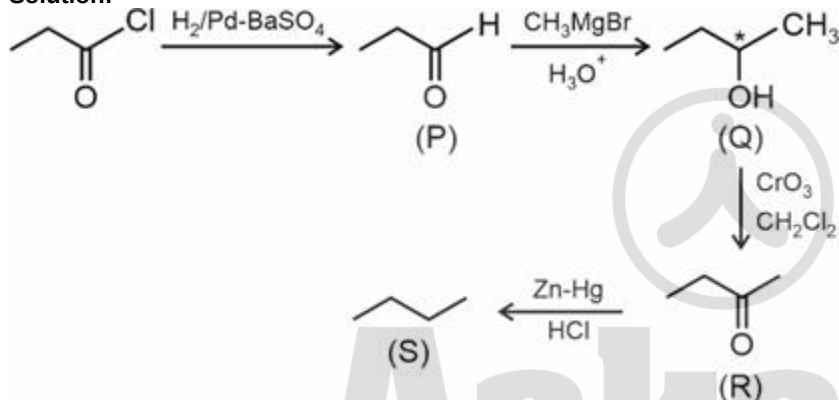
- Test of P $\Rightarrow (\text{NH}_4)_3\text{PO}_4 \cdot 12\text{MoO}_3$ (yellow)
- Test of S $\Rightarrow [\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$ (violet)
- Test of N $\Rightarrow \text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \cdot x\text{H}_2\text{O}$ (Prussian blue)
- Test of N and S $\Rightarrow [\text{Fe}(\text{SCN})_3]^{2+}$ (Blood red)

(20) Answer : (1)

Hint:



Solution:



- R is ketone can't undergo Cannizzaro's reaction.
- S is butane, a saturated hydrocarbon.

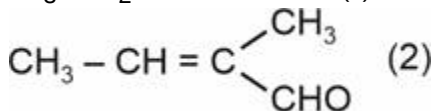
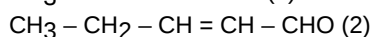
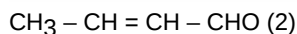
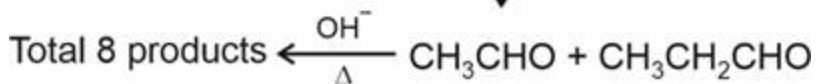
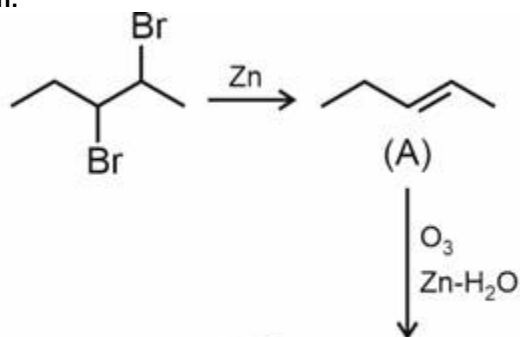
Section-II
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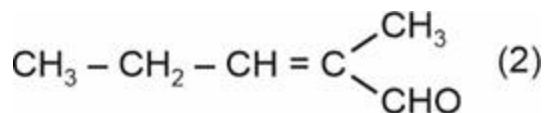
(21) Answer : 8

Hint:

Dehalogenation will occur.

Solution:





(22) Answer : 95

Hint:

$$\Delta G^\circ = -RT \ln K_{eq}$$

Solution:

$$K_{eq} > 1 \Rightarrow \Delta G^\circ < 0$$

$$\Rightarrow -1722.66 = -2 \times 298 \times \ln K_{eq}$$

$$K_{eq} = 18 = \frac{[B]}{[A]}$$

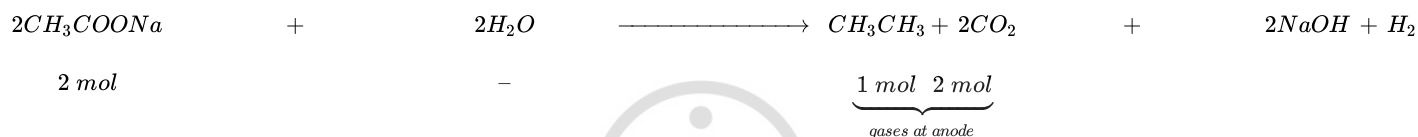
$$\therefore \% = \frac{[B]}{[A]+[B]} = \frac{18}{19} \times 100 = 95\%$$

(23) Answer : 134

Hint:

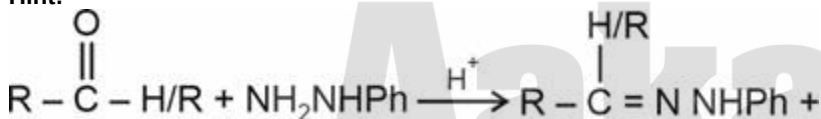
Ethane and CO_2 gas is released at anode during Kolbe's electrolysis of sodium acetate.

Solution:

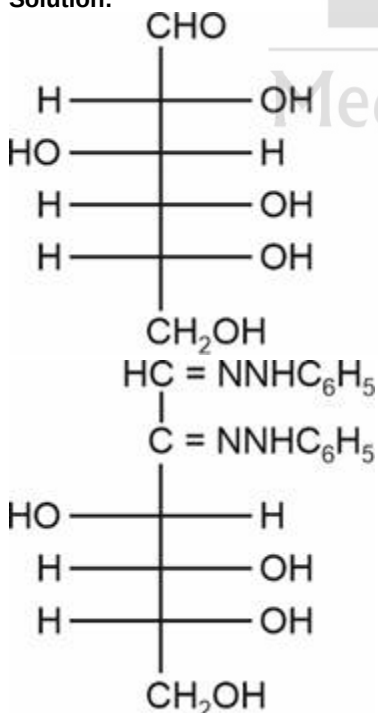
Moles of CH_3COONa taken = 4 mol \therefore mol of gases released = 6 mol \therefore Volume of gas = $6 \times 22.4 \text{ L} = 134.4 \text{ L}$

(24) Answer : 3

Hint:



Solution:

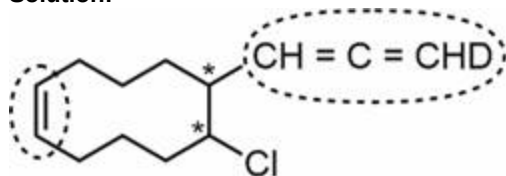


(25) Answer : 16

Hint:

Allene show optical isomer here

Solution:



$$n = 4$$

$$2^4 = 16$$

MATHEMATICS

Section-I

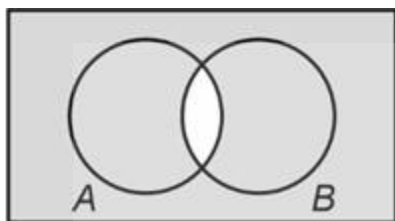
(26) Answer : (1)

Hint:

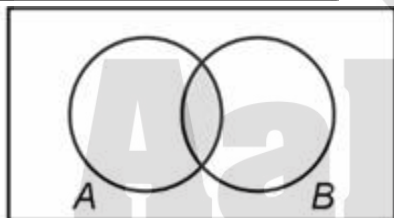
Use Venn diagram

Solution:

$$(A \cap B)^c =$$



$$A - (A \cap B)^c =$$



$$= A \cap B^c$$

(27) Answer : (4)

Hint:

$$\text{Period of } \sin 3x = \frac{2\pi}{3}$$

Solution:

$$\text{Period of } 2\{x\} = 1$$

$$\text{Period of } \sin 3x = \frac{2\pi}{3}$$

$$\text{LCM of } 1 \text{ and } \frac{2\pi}{3} = \frac{\text{LCM of } (1, 2\pi)}{\text{HCF of } (1, 3)}$$

LCM of $(1, 2\pi)$ does not exist

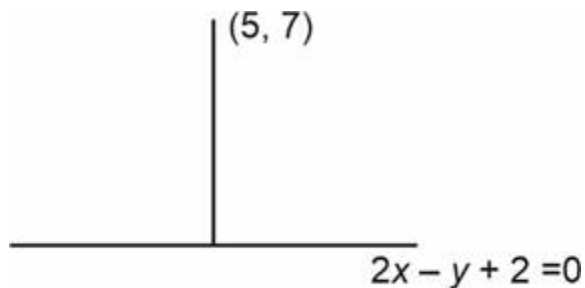
$\Rightarrow f(x)$ is non-periodic

(28) Answer : (4)

Hint:

$$\frac{x-5}{2} = \frac{y-7}{-1} = \frac{-2(10-7+2)}{4+1}$$

Solution:



• (x_1, y_1)

$$\frac{x-5}{2} = \frac{y-7}{-1} = \frac{-2(10-7+2)}{5}$$

$$\frac{x-5}{2} = -2 \text{ and } \frac{y-7}{-1} = -2$$

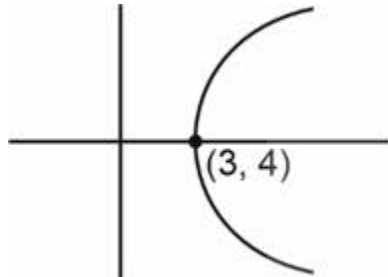
$$x = 1, y = 9$$

(29) Answer : (2)

Hint:

Length of latus rectum is $4a$.

Solution:



$$4x - 3y + 5 = 0$$

$$a = \left| \frac{12-12+5}{\sqrt{3^2+4^2}} \right| = 1$$

Length of latus rectum is $4 \times 1 = 4$

(30) Answer : (3)

Hint:

$h'(x) = f(x)$ [some positive quantity]

Solution:

$$h'(x) = f(x) - 2f(x)f'(x) + 3(f(x))^2 f'(x)$$

$$= f(x) [1 - 2f(x) + 3(f(x))^2]$$

A quadratic equation in $f(x)$ with $D < 0$

$h'(x) = f(x)$ [some positive quantity]

When $f(x) \uparrow \Rightarrow h(x) \uparrow$

$f(x) \downarrow \Rightarrow h(x) \downarrow$

(31) Answer : (3)

Hint:

$$f(|x|) = x^2 - 3, -3 \leq x \leq 3$$

Solution:

$$f(|x|) = x^2 - 3, -3 \leq x \leq 3$$

$$|f(x)| = \begin{cases} 3 & , & -3 \leq x < 0 \\ 3 - x^2 & , & 0 \leq x < \sqrt{3} \\ x^2 - 3 & , & \sqrt{3} \leq x \leq 3 \end{cases}$$

$$h(x) = \begin{cases} x^2 & , & -3 \leq x < 0 \\ 0 & , & 0 \leq x < \sqrt{3} \\ 2(x^2 - 3) & , & \sqrt{3} \leq x \leq 3 \end{cases} \quad h'(x) = \begin{cases} 2x & , & -3 \leq x < 0 \\ 0 & , & 0 \leq x < \sqrt{3} \\ 4x & , & \sqrt{3} \leq x \leq 3 \end{cases}$$

(32) Answer : (3)

Hint:

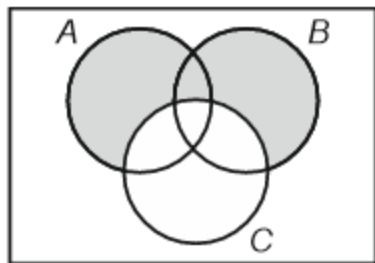
Use Venn diagram

Solution:

$n(A)$ = Number of 3-digit numbers that are divisible by 3.

$n(B)$ = Number of 3-digit numbers that are divisible by 5.

$n(C)$ = Number of 3-digit numbers that are divisible by 11.



$$n(A) = 300$$

$$n(B) = 180$$

$$n(C) = 81$$

$$n(A \cap B) = 60$$

$$n(B \cap C) = 17$$

$$n(A \cap C) = 27$$

$$n(A \cap B \cap C) = 6$$

$$\text{Required number} = 300 + 180 - 60 - 17 - 27 + 6 = 382$$

(33) Answer : (4)

Hint:

$$t = \lim_{x \rightarrow 0} \frac{5x + 8 \sin x}{x}$$

Solution:

$$t = \lim_{x \rightarrow 0} \frac{5x + 8 \sin x}{x}$$

$$= \lim_{x \rightarrow 0} \frac{5x}{x} + \frac{8 \sin x}{x}$$

$$= 5 + 8$$

$$t = 13$$

(34) Answer : (4)

Hint:

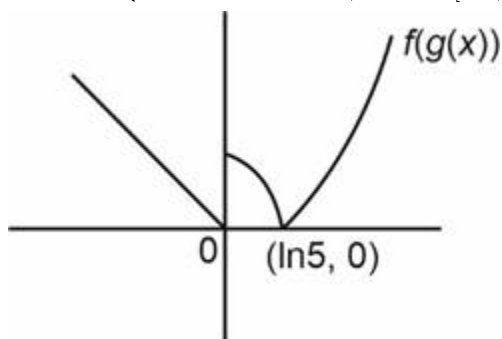
$$f(x) = \begin{cases} 5 - x & , \quad x < 5 \\ x - 5 & , \quad x \geq 5 \end{cases}$$

Solution:

$$f(x) = \begin{cases} 5 - x & , \quad x < 5 \\ x - 5 & , \quad x \geq 5 \end{cases}$$

$$g(x) = \begin{cases} e^x & , \quad x \geq 0 \\ x + 5 & , \quad x \leq 0 \end{cases}$$

$$f(g(x)) = \begin{cases} 5 - e^x & , \quad x \in [0, \ln 5) \\ -x & , \quad x < 0 \\ e^x - 5 & , \quad [\ln 5, \infty] \end{cases}$$



(35) Answer : (1)

Hint:

$$\frac{2b^2}{a_1} = 2$$

Solution:

$$(x+1)^2 + (3y+3)^2 = P+10$$

$$\frac{(x+1)^2}{P+10} + \frac{(y+1)^2}{9} = 1$$

$$\frac{2b^2}{a} = 2$$

$$2 \left(\frac{P+10}{9} \right) = \sqrt{P+10} \cdot 2$$

$$\Rightarrow P = 71$$

$$a = 2 \times 9 = 18$$

$$b = 2 \times 3$$

$$\Rightarrow a + b = 24$$

(36) Answer : (4)

Hint:

$$f(x) = \begin{cases} x & , \quad x \in (0, \frac{\pi}{4}) \\ \frac{\pi}{2} - x & , \quad x \in (\frac{\pi}{4}, \frac{\pi}{2}) \end{cases}$$

Solution:

$$f(x) = \begin{cases} x & , \quad x \in (0, \frac{\pi}{4}) \\ \frac{\pi}{2} - x & , \quad x \in (\frac{\pi}{4}, \frac{\pi}{2}) \end{cases}$$

$$g(x) = \begin{cases} \frac{\pi}{2} - x & , \quad x \in (0, \frac{\pi}{4}) \\ x & , \quad x \in (\frac{\pi}{4}, \frac{\pi}{2}) \end{cases}$$

$$f(x) + g(x) = \frac{\pi}{2}, x \in (0, \frac{\pi}{2})$$

(37) Answer : (1)

Hint:

Length of the focal chord is $4a \operatorname{cosec}^2 \theta$.

Solution:

$$y^2 = 12x + 2y + 23$$

$$y^2 - 2y + 1 = 12(x+2)$$

$$(y-1)^2 = 12(x+2)$$

Vertex : $(-2, 1)$

$$a = 3$$

Focus : $(1, 1)$

Let equation of focal chord of the parabola is $\frac{x}{p} + \frac{y}{q} = 1$

$$\frac{x}{p} + \frac{y}{2} = 1$$

It passes through focus

$$\frac{1}{p} + \frac{1}{2} = 1$$

$$p = 2$$

Equation of focal chord is

$$x + y = 2 \Rightarrow m = -1 \Rightarrow \theta = \frac{3\pi}{4}$$

Length of focal chord is $4a \operatorname{cosec}^2 \theta$

$$= 4(3) \operatorname{cosec}^2 \left(\frac{3\pi}{4} \right)$$

$$= 12 \times 2$$

$$= 24$$

(38) Answer : (3)

Hint:

Take $f(x) = x^{1/x}$

Solution:

Take $f(x) = x^{1/x}$

$$\ln(f(x)) = \frac{1}{x} \ln x$$

$$\frac{1}{f(x)} f'(x) = -\frac{1}{x^2} \ln x + \frac{1}{x^2}$$



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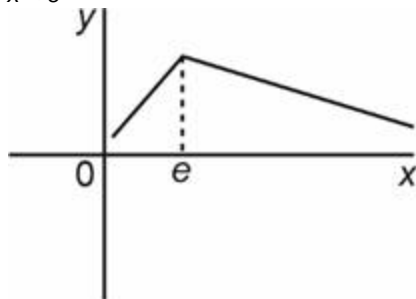
$$f'(x) = x^{1/x} \left(\frac{1-\ln x}{x^2} \right)$$

$$f'(x) > 0$$

$$\Rightarrow 1 - \ln x > 0$$

$$\ln x < 1$$

$$x < e$$



$$e^{1/e} > \pi^{1/\pi}$$

$$e^\pi > \pi^e$$

$$17^{18} > 18^{17}$$

$$20^{21} > 21^{20}$$

$$(\sqrt{3})^{\sqrt{2}} > (\sqrt{2})^{\sqrt{3}}$$

(39) Answer : (1)

Hint:

Foci is $(\pm 5, 0)$

Solution:

$$\frac{x^2}{36} + \frac{y^2}{11} = 1$$

$$e^2 = 1 - \frac{11}{36} = \frac{25}{36}$$

$$\Rightarrow e = \frac{5}{6}$$

Foci of ellipse is $(\pm ae, 0) = (\pm 5, 0)$

$$\text{Hyperbola be } = \frac{x^2}{\frac{100}{16}} - \frac{y^2}{\frac{P}{16}} = 1$$

$$a = \frac{10}{4} = \frac{5}{2}$$

$$b^2 = \frac{P}{16}$$

$$ae_H = 5$$

$$\frac{5}{2} \cdot e_H = 5$$

$$e_H = 2$$

$$4 = 1 + \frac{\frac{P}{16}}{\frac{100}{16}}$$

$$3 = \frac{P}{100}$$

$$\Rightarrow P = 300$$

$$\text{Length of latus rectum} = \frac{2 \times 300}{16 \cdot \frac{5}{2}} = 15$$

(40) Answer : (2)

Hint:

Let $x = n$ be any integer (except 0)

Solution:

Let $x = n$ be any integer (except 0)

$$\text{Then } \lim_{x \rightarrow n^-} 2n^3 e^n (\cos(\pi(2n-1))) = -2n^3 e^n$$

$$\lim_{x \rightarrow n^+} 2n^3 e^n (\cos(\pi(n+n))) = 2n^3 e^n$$

LHL \neq RHL

But $f(x)$ is continuous at $x = 0$

(41) Answer : (2)

Hint:



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Eccentricity of rectangular hyperbola is $\sqrt{2}$

Solution:

$$3x^2 - 3y^2 - 18x + 12y + 2 = 0$$

$$\Rightarrow 3(x^2 - 6x) - 3(y^2 - 4y) + 2 = 0$$

$$\Rightarrow 3(x^2 - 6x + 9) - 3(y^2 - 4y + 4) = 13$$

$$\Rightarrow \frac{(x-3)^2}{\frac{13}{3}} - \frac{(y-2)^2}{\frac{13}{3}} = 1$$

Eccentricity of rectangular hyperbola is $\sqrt{2}$.

(42) Answer : (1)

Hint:

$$\cos^{-1}\left(\frac{3}{5}\right) = \tan^{-1}\left(\frac{4}{3}\right)$$

Solution:

$$\operatorname{cosec}\left[2\cot^{-1}(7) + \cos^{-1}\left(\frac{3}{5}\right)\right]$$

$$= \operatorname{cosec}\left[2\tan^{-1}\left(\frac{1}{7}\right) + \tan^{-1}\left(\frac{4}{3}\right)\right]$$

$$= \operatorname{cosec}\left[\tan^{-1}\left(\frac{\frac{2}{7}}{1 - \frac{1}{49}}\right) + \tan^{-1}\left(\frac{4}{3}\right)\right]$$

$$= \operatorname{cosec}\left[\tan^{-1}\left(\frac{7}{24}\right) + \tan^{-1}\left(\frac{4}{3}\right)\right]$$

$$= \operatorname{cosec}\left[\tan^{-1}\left(\frac{\frac{7}{24} + \frac{4}{3}}{1 - \frac{7}{24} \times \frac{4}{3}}\right)\right]$$

$$= \operatorname{cosec}\left[\tan^{-1}\left(\frac{117}{44}\right)\right]$$

$$= \frac{125}{117}$$

(43) Answer : (1)

Hint:

Multiply and divide by 7^x

Solution:

Multiply and divide by 7^x

$$\lim_{x \rightarrow 2} \frac{7^{2x} - 56 \cdot 7^x + 343}{7^{x/2} - 7}$$

$$\lim_{x \rightarrow 2} \frac{(7^x - 49)(7^x - 7)}{(7^{x/2} - 7)}$$

$$\lim_{x \rightarrow 2} \frac{(7^{x/2} - 7)(7^{x/2} + 7)(7^x - 7)}{(7^{x/2} - 7)}$$

$$= (7 + 7)(7^2 - 7)$$

$$= 14 \cdot 42$$

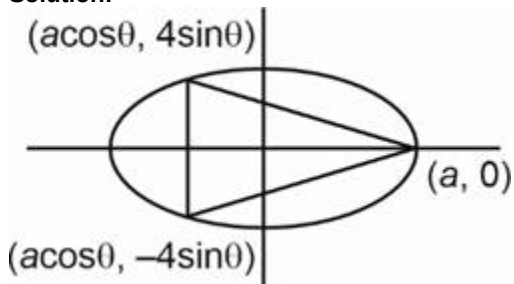
$$= 588$$

(44) Answer : (3)

Hint:

$$\text{Length of latus rectum} = \frac{2b^2}{a}$$

Solution:



$$A = \frac{1}{2} \times 8 \sin \theta \times a(1 - \cos \theta)$$

$$A = 4a \sin \theta (1 - \cos \theta)$$



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$$\frac{dA}{d\theta} = 4a[\cos\theta - \cos^2\theta + \sin^2\theta] \quad \frac{dA}{d\theta} = 4a(1 + \cos\theta - 2\cos^2\theta)$$

$$\frac{dA}{d\theta} = 0$$

$$\Rightarrow 1 + \cos\theta - 2\cos^2\theta = 0$$

$$\cos\theta = 1 \text{ or } \cos\theta = -\frac{1}{2}$$

$$\Rightarrow \theta = \frac{2\pi}{3}$$

$$\frac{d^2A}{d\theta^2} = 4a[-\sin\theta + \sin 2\theta] < 0 \text{ for } \theta = \frac{2\pi}{3}$$

$$A_{\max} = 4a \sin\left(\frac{2\pi}{3}\right) \left[1 - \cos\left(\frac{2\pi}{3}\right)\right]$$

$$= 4a \cdot \frac{\sqrt{3}}{2} \left[1 + \frac{1}{2}\right] = 15\sqrt{3}$$

$$= 3\sqrt{3}a = 15\sqrt{3}$$

$$\Rightarrow a = 5$$

$$\text{Length of latus rectum} = \frac{2 \times 16}{5} = \frac{32}{5}$$

(45) Answer : (1)

Hint:

$$-1 < \frac{\cos 7}{-7} < 0$$

Solution:

$$\lim_{x \rightarrow 0} \left[\frac{\cos(x-6)}{|x-6|} \right]$$

$$\text{LHL} = \lim_{h \rightarrow 0^-} \left[\frac{\cos(h-6)}{|h-6|} \right] = \left[\frac{\cos(-7)}{(-7)} \right]$$

$$= \left[\frac{-\cos 7}{7} \right]$$

$$\because \cos 7 > 0$$

$$-1 < \frac{\cos 7}{-7} < 0$$

$$\Rightarrow \text{LHL} = -1$$

$$\text{RHL} = \lim_{h \rightarrow 0^+} \left[\frac{\cos(h-6)}{(h-6)} \right] = \left[\frac{\cos 6}{-6} \right]$$

$$\text{RHL} = -1$$

Value at $x = 0$

$$\left[\frac{\cos 6}{-6} \right] = -1$$

$$\Rightarrow \lim_{x \rightarrow 0} \left[\frac{\cos(x-6)}{(x-6)} \right] = -1$$



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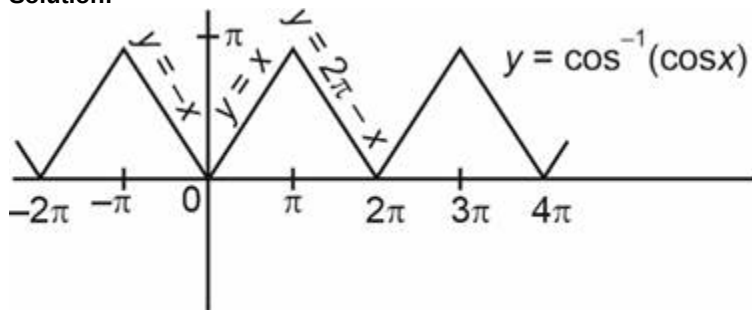
Section-II

(46) Answer : 10

Hint:

$$\cos^{-1}(\cos 10) = 4\pi - 10$$

Solution:



$$\cos^{-1}(\cos 10) = 4\pi - 10$$

$$4\pi - \cos^{-1}(\cos 10) = 10$$

(47) Answer : 70

Hint:

$$4 - 2a + b = 0$$

Solution:

$$4 - 2a + b = 0$$

Apply L-hospital rule here,

$$\lim_{x \rightarrow 2} 2x - a = -3$$

$$4 - a = -3$$

$$a = 7$$

$$\Rightarrow 4 - 2(7) + b = 0$$

$$b = 10$$

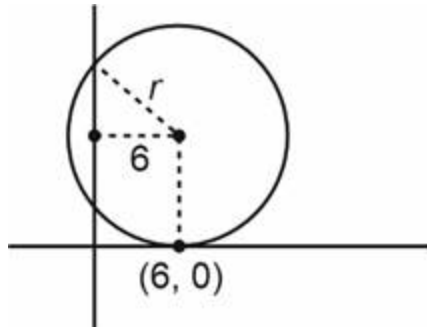
$$\Rightarrow a \cdot b = 70$$

(48) **Answer :** 9

Hint:

$$r = \{6^2 + (3\sqrt{5})^2\}$$

Solution:



$$r = \sqrt{6^2 + (3\sqrt{5})^2}$$

$$r = \sqrt{36 + 45} = 9$$

(49) **Answer :** 20

Hint:

$$L_1 \parallel L_2$$

Solution:

Distance between L_1 and L_2 is

$$L_1 : 2x + 4y + 10 = 0$$

$$L_2 : 2x + 4y + p = 0$$

$$\left| \frac{10-p}{2\sqrt{5}} \right| = \frac{1}{\sqrt{5}}$$

$$\Rightarrow |10 - p| = 2$$

$$10 - p = \pm 2$$

$$p = 8, 12$$

(50) **Answer :** 13

Hint:

For reflexive, we need to add

(1, 1), (2, 2), (3, 3), (4, 4)

Solution:

For reflexive, we need to add

(1, 1), (2, 2), (3, 3), (4, 4)

For symmetric, we need to add

(2, 1), (3, 2), (4, 3)

So, we have

(1, 1), (2, 2), (3, 3), (4, 4)

(1, 2), (2, 1)

(2, 3), (3, 2)

(3, 4), (4, 3)

$1R2$ and $2R3$ so $1R3$ and $3R1$

$2R3$ and $3R4$ so $2R4$ and $4R2$

$1R3$ and $3R4$ so $1R4$ and $4R1$

So 13 elements must be added



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PHYSICS

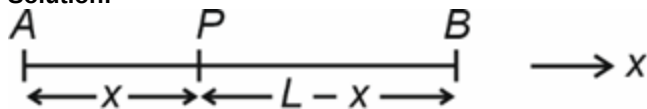
Section-I

(51) Answer : (2)

Hint:

$$\omega = \frac{2\pi}{T}$$

Solution:



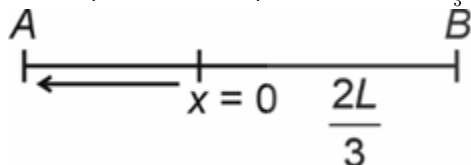
At P

$$F = \left(\frac{6mg}{L}\right)(-x) + \frac{3mg}{L}(L-x) = \frac{3mg}{L}(L-3x)$$

$$F = -\frac{3mg}{L}(3x-L)$$

$$a = -\frac{3g}{L}(3x-L) = -\frac{3g}{L}3\left(x - \frac{L}{3}\right)$$

$$\Rightarrow \omega^2 = \frac{9g}{L} \quad T = \frac{2\pi}{3} \sqrt{\frac{L}{g}}$$

 At $t = 0$ particle at A displacement $= x = \frac{L}{3}$ from mean position


$$\sqrt{3gL} = \omega \sqrt{A^2 - \frac{L^2}{9}}$$

$$\Rightarrow \frac{3gL}{\omega^2} = A^2 - \frac{L^2}{9}$$

$$\frac{3L^2}{9} = A^2 - \frac{L^2}{9}$$

$$\Rightarrow A = \frac{2L}{3}$$

From A to B

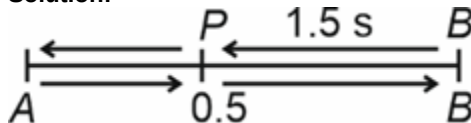
$$t = \frac{T}{12} + \frac{T}{4} = \frac{T}{3} = \frac{2\pi}{9} \sqrt{\frac{L}{g}}$$

(52) Answer : (2)

Hint:

Phasor diagram

Solution:



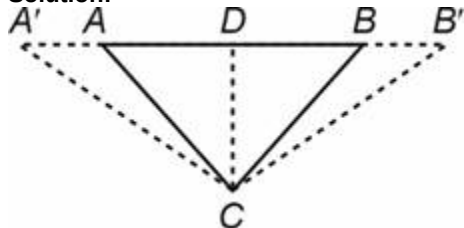
$$T = 2 \text{ s}$$

(53) Answer : (4)

Hint:

$$\Delta l = l \propto \Delta T$$

Solution:



$$DC^2 = l_2^2 - \left(\frac{l_1}{2}\right)^2$$

$$DC^2 = [l_2(1 + \alpha_2 \Delta T)]^2 - \left[\left(\frac{l_1}{2}\right)(1 + \alpha_1 \Delta T)\right]^2$$

$$\simeq l_2^2 - \frac{l_1^2}{4} + l_2^2 2\alpha_2 \Delta T - \left(\frac{l_1^2}{4}\right) 2\alpha_1 \Delta T$$

$$\Rightarrow \left(\frac{l_2}{l_1}\right)^2 = \frac{\alpha_1}{4\alpha_2}$$

$$\Rightarrow \frac{l_2}{l_1} = \frac{1}{2} \sqrt{\frac{\alpha_1}{\alpha_2}}$$

(54) Answer : (4)

Hint:

$$\Delta l = l \alpha \Delta T$$

Solution:

$$AP = l_1, PB = L - l_1$$

Friction on AP will be upward = f_1

Friction on PB will be downward = f_2

$$f_1 - f_2 = mg \sin \theta$$

$$\mu \frac{m}{L} g \cos \theta [(l_1) - (L - l_1)] = mg \sin \theta$$

$$\Rightarrow \mu = \frac{L}{2} \left(1 + \frac{\tan \theta}{\mu}\right) = \frac{31}{32} L$$

(55) Answer : (1)

Hint:

$$PV = nRT$$

Solution:

$$PV = nRT \Rightarrow PV = \frac{m}{M} RT$$

$$\Rightarrow MV = \frac{mRT}{P}$$

$$\Rightarrow M_A V_A = M_B V_B$$

$$\Rightarrow M_A l_1 = M_B l_2$$

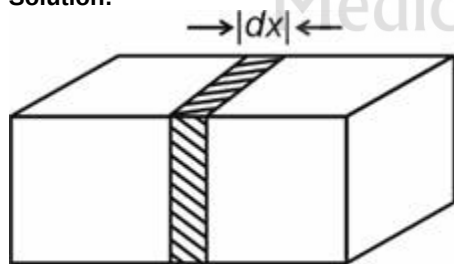
$$\Rightarrow \frac{l_1}{l_2} = \frac{M_B}{M_A} = \frac{28}{32} = \frac{7}{8}$$

(56) Answer : (4)

Hint:

$$n = \frac{PV}{RT}$$

Solution:



$$T_{(x)} = T_0 \left(1 + \frac{x}{L}\right)$$

$$n = \frac{PV}{RT}$$

$$dn = \frac{PA dx}{RT_{(x)}}$$

$$\int dn = \frac{PA}{RT_0} \int_0^L \frac{dx}{\left(1 + \frac{x}{L}\right)}$$

$$\Rightarrow n = \frac{PAL}{RT_0} \ln 2$$

(57) Answer : (3)

Hint:

$$Y = 3\alpha$$

Solution:

$$\begin{aligned}
 V &= L^3 \\
 \Delta V &= V(3\alpha)\Delta T \\
 \frac{\Delta V}{V} &= 3\alpha\Delta T \\
 MS\Delta T &= Q \\
 VdS\Delta T &= Q \\
 \Rightarrow Q &= VdS\frac{\Delta V}{V \times 3\alpha} = \frac{dSL^3}{100}
 \end{aligned}$$

(58) Answer : (1)

Hint:

Ideal gas equation

Solution:

$$PV = nRT$$

(59) Answer : (4)

Hint:

$$Q = nC_p \Delta T$$

Solution:

For steam from $100^\circ - 120^\circ$

$$\begin{aligned}
 Q_T &= (1 \times \frac{1}{2} \times 10) + (1 \times 80) + (1 \times 1 \times 100) + (1 \times 540) \\
 &= 725
 \end{aligned}$$

(60) Answer : (2)

Hint:

$$PV^n = \text{constant} \Rightarrow n = -1$$

Solution:

$$PV^{-1} = k$$

$$x = -1$$

$$nC\Delta T = \frac{P_2V_2 - P_1V_1}{1-x} + \frac{P_2V_2 - P_1V_1}{y-1}$$

$$nR\Delta T = \left[\frac{1}{2} + \frac{5}{2} \right]$$

$$= n3R\Delta T$$

(61) Answer : (4)

Hint:

Energy conservation

Solution:

$$dQ = dW = -\mu mgx = (dm)L$$

$$\Rightarrow \frac{dQ}{dt} = -\mu mgv = \left(\frac{dm}{dt} \right) L$$

$$a = \frac{-\mu mg}{m} = -\mu g$$

$$v = v_0 - \mu gt$$

$$\Rightarrow \mu mg(v_0 - \mu gt) = \left(\frac{dm}{dt} \right) L$$

$$\Rightarrow -\int_0^1 \frac{\mu g}{L}(v_0 - \mu gt) dt = \int_{M_0}^M \frac{dm}{m}$$

$$M = M_0 e^{-\frac{\mu g}{L}} \left(v_0 - \frac{\mu g}{2} \right) = M_0 e^{-\frac{(\mu g)^2}{L}}$$

(62) Answer : (2)

Hint:

Mechanical energy conservation

Solution:

$$mg(h+x) = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$$

(63) Answer : (3)

Hint:

$z = z_0 \sin(\omega t \pm kx)$ is general equation of wave

Solution:

$$z = 10^{-2} \sin 10\pi t - \frac{2\pi}{\lambda} \underbrace{(x\hat{i} + y\hat{j} + z\hat{k})}_{\left(\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j} \right)}$$



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$$\vec{k} = \frac{2\pi}{\lambda} \left(\frac{\hat{i}}{2} + \frac{\sqrt{3}}{2} \hat{j} \right)$$

Direction of propagation = \hat{k}

$$= \frac{\hat{i}}{2} + \frac{\sqrt{3}}{2} \hat{j}$$

$$A = 10^{-2} \text{ m} = 1 \text{ cm}$$

$$\frac{2\pi}{\lambda} = 2\pi \Rightarrow \lambda = 1 \text{ m}$$

$$w = \frac{k}{v} \Rightarrow v = \frac{k}{w}$$

$$\Rightarrow \frac{2\pi}{10\pi} = \frac{1}{5} \text{ m/s} = 0.2 \text{ m/s}$$

(64) Answer : (1)

Hint:

$$P = \frac{1}{2} \mu \omega^2 A^2 v$$

Solution:

$$P = \frac{1}{2} \mu v A^2 \omega^2 = \frac{2\pi^2 A^2}{\lambda^2} \sqrt{\frac{T^3}{\mu}}$$

$$A = 10 \times 10^{-3}$$

$$\lambda = \frac{1}{2} \text{ m}$$

$$T = 500 \text{ N}$$

$$\mu = 0.8 \text{ kg/m}$$

$$P = 98.7 \text{ W}$$

(65) Answer : (3)

Hint:

Even harmonic doesn't exist.

Solution:

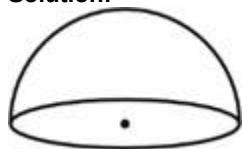
$$N = 8$$

(66) Answer : (4)

Hint:

$$V = \frac{Kq}{r} \text{ (potential due to a point charge)}$$

Solution:



$$\frac{kq}{r} = \frac{9 \times 10^9 \times 5 \times 10^{-9}}{1}$$

$$\Rightarrow 45 \text{ volt}$$

(67) Answer : (2)

Hint:

$$\oint \vec{E} \cdot d\vec{S} = \frac{q}{\epsilon_0}$$

Solution:

$$\vec{E} = \frac{4\pi a \vec{r}}{r^3}$$

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

Comparing \vec{E} with $\frac{KQ\vec{r}}{r^3}$ (due to point charge)

$$\Rightarrow KQ = 4\pi a$$

$$\Rightarrow Q = (4\pi a)4\pi\epsilon_0 \text{ placed at origin}$$

$$\text{Flux } (\phi) = \frac{Q}{\epsilon_0} = 16\pi^2 a$$

(68) Answer : (1)

Hint:

Force on negative charge is towards high potential.

Solution:

Negative charge moves from lower potential to higher potential.

(69) Answer : (2)



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Hint:

Coulomb's law can be derived from Gauss law.

Solution:

Conceptual.

(70) Answer : (4)
Hint:

Energy conservation

Solution:

$$W = H + \Delta U$$

$$\Delta U = 0$$

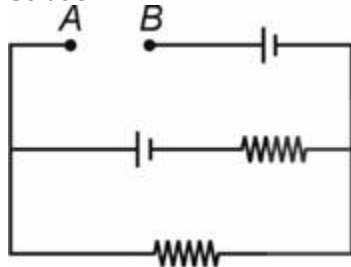
$$W = 4$$

$$Q = CV = 20 \mu\text{C}$$

$$W = Q(10 \text{ V}) = 20 \mu\text{C} \times 10 \text{ V} = 200 \mu\text{J}$$

Section-II
(71) Answer : 2
Hint:

Maximum power transfer theorem.

Solution:


For maximum power

 R_{eq} across AB must be equal to R

$$R_{eq} = \frac{3 \times 6}{3+6} = 2 \Omega = R$$

(72) Answer : 5
Hint:

No current through ammeter.

Solution:

If current through Ammeter = 0

$$\text{Then current in circuit} = \frac{14}{2+R}$$

$$\text{Voltage across } R = R \left(\frac{14}{2+R} \right) = 10 \text{ V}$$

$$\Rightarrow R = 5 \Omega$$

(73) Answer : 2
Hint:

Isobaric process

Solution:

$$\frac{V}{T} = \text{Constant} \Rightarrow P = \text{Constant}$$

$$W = \int P_0 dV = 2P_0V_0$$

$$W = 2RT_0$$

(74) Answer : 6
Hint:

$$V = iR$$

Solution:

$$R_{AB} = 100 \Omega$$

$$R_{AP} = 72 \Omega$$

$$I = \frac{E}{r_1 + 100 + 50} \dots (i)$$

$$-72I - \frac{\epsilon}{2} - Ir_1 + \epsilon = 0 \dots (ii)$$

From (i) and (ii)

$$r_1 = 6 \Omega$$

(75) Answer : 20

Hint:

$$\tau = I\alpha$$

Solution:

$$\tau = I\alpha = MB$$

$$i\pi r^2 B = \frac{mr^2}{2}\alpha$$

$$\alpha = \frac{2iB\pi}{m}$$

$$= \frac{2 \times 2 \times 10\pi}{2} = 20\pi \text{ rad/s}^2$$



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