29/03/2026

Set-1 (Online)

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Medical | IIT-JEE | Foundations

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MM : 300

AIATS For One Year JEE(Main)-2026 (SS & PS)_Test-8 & 6 (Online)

Time : 180 Min.

CHEMISTRY

Section-I

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

Section-II

21. (5)
22. (9)
23. (9)
24. (3)
25. (6)

MATHEMATICS

Section-I

26. (3)
27. (1)
28. (1)
29. (1)
30. (3)
31. (2)
32. (4)
33. (3)
34. (1)
35. (1)
36. (1)
37. (1)
38. (1)
39. (4)
40. (4)
41. (3)
42. (4)
43. (4)
44. (4)
45. (3)

Section-II

46. (86)

47. (11)

48. (36)

49. (4)

50. (1)

PHYSICS

Section-I

51. (2)

52. (4)

53. (1)

54. (4)

55. (2)

56. (3)

57. (4)

58. (3)

59. (1)

60. (3)

61. (3)

62. (2)

63. (4)

64. (1)

65. (4)

66. (2)

67. (4)

68. (3)

69. (3)

70. (1)

Section-II

71. (5)

72. (0)

73. (5)

74. (4)

75. (3)

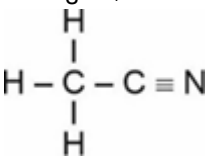
Hints and Solutions

CHEMISTRY

Section-I

(1) **Answer :** (3)
Hint:
Nitrogen can be estimated using Kjeldahl's method in aniline.
Solution:
Kjeldahl's method cannot be used for compounds which have nitrogen in the ring, an azo compound or in nitro compound. Because, they cannot be converted into ammonium sulphate by the action of sulphuric acid. Thus, among all, aniline is suitable for Kjeldahl's method.

(2) **Answer :** (4)
Hint:
Due to presence of lone pair on nitrogen, CN can also acts as nucleophile.
Solution:
In CH_3CN,



C (carbon) behave as an electrophile due to partial positive charge and nitrogen behave as a nucleophile due to presence of lone pair of electrons.

(3) **Answer :** (2)
Hint:
For non-polar molecules, van der Waals forces determines melting point and boiling point.
Solution:
Br_2 is non-polar because, both bromine atoms have the same electronegativity due to which both atom have equal charge distribution and results in a net zero dipole moment.

(4) **Answer :** (3)
Hint:
Square planar structure is possible for sp^3d^2 hybridisation having 2 lone pairs and dsp^2 hybridisation.
Solution:
PF_5 → Trigonal bipyramidal
XeF_4, $[PtCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ → Square planar
SCl_4 → See-saw
$XeOF_4$ → Square pyramidal

(5) **Answer :** (2)
Hint:
For adiabatic reversible process, PV^{γ} = constant and $TV^{\gamma-1}$ = constant
Solution:
For adiabatic reversible process,
$TV^{\gamma-1}$ = constant

$$\frac{T_2}{T_1}=\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$T_2=\left(\frac{1}{81}\right)^{1.25-1}\times 273$$

$$=\left(\frac{1}{81}\right)^{0.25}\times 273$$

$$\Rightarrow \left(\frac{1}{81}\right)^{1/4}\times 273 \Rightarrow \frac{273}{3}\Rightarrow 91\ \mathrm{K}\simeq -182^{\circ}\mathrm{C}$$

(6) **Answer :** (2)
Hint:
$eV_0=h\nu_1-\phi$
Solution:
$h\nu-h\nu_0=eV_0$
$V_0=\frac{h}{e}\nu-\frac{h}{e}\nu_0$

$$V = \frac{h}{e}\left(\nu - \nu_0\right)$$

(7) **Answer :** (4)
Hint:
Net charge on ion = Sum of oxidation number of all atoms in ion
Solution:
PO_4^{3-} ⇒ x + 4(–2) = –3
x = +5
SO_4^{2-} ⇒ x +4(–2) = –2
x = +6
$Cr_2O_7^{2-}$ ⇒ 2x + 7(–2) = –2
x = +6

(8) **Answer :** (1)
Hint:
Biuret test is helpful in testing amide linkage.
Solution:
Biuret test is given by amide linkage. It is present in proteins, polypeptides and tripeptide. It is not present in carbohydrates.

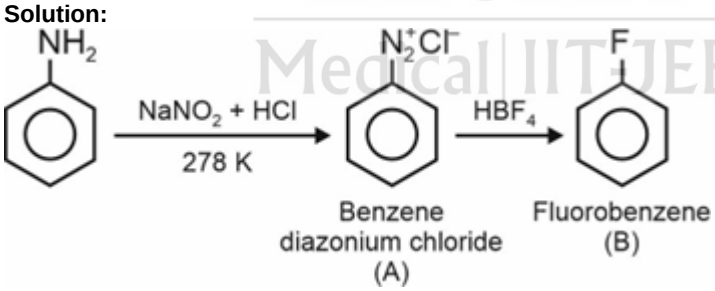
(9) **Answer :** (2)
Hint:
Use Le-Chatelier's principle.
Solution:
According to Le-Chatelier's principle, at high pressure and low temperature, the given reversible reaction will shift in forward direction to form more product.

(10) **Answer :** (4)
Hint:
i helps in determining association or dissociation of solute.
Solution:

$$i = \frac{\text{Observed colligative property}}{\text{Calculated / theoretical colligative property}}$$

$$i = \frac{\text{Normal molar mass}}{\text{Observed molar mass}}$$

(11) **Answer :** (2)
Hint:
Aniline gives benzene diazonium chloride on reaction with $NaNO_2$ + HCl (0–5°C).
Solution:



(12) **Answer :** (1)
Hint:
$q_p = q_v + \Delta n_g RT$
Solution:
$\Delta H = \Delta U + \Delta n_g RT$
$\Delta H - \Delta U = \Delta n_g RT$
$= \frac{-3 \times 8.314 \times 298}{1000}$
$= -7.43$ kJ mol^{-1}

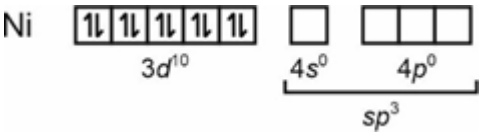
(13) **Answer :** (1)
Hint:
Halogen in aryl halide have partial double bond with carbon of ring.
Solution:
Aryl halides are less reactive towards unimolecular nucleophilic substitution reaction as compared to alkyl halides because carbocation formed will be less stable.

(14) **Answer :** (2)
Hint:

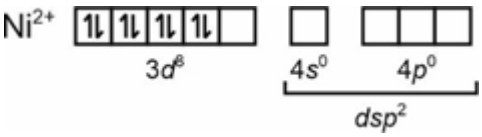
Species having 0 unpaired electrons are diamagnetic.

Solution:

$Ni(CO)_4$ has $3d^8 4s^2$ configuration (ground state)



Hybridisation of Ni atom in $Ni(CO)_4$ is sp^3.



Hybridisation of Ni^{2+} in $[Ni(CN)_4]^{2-}$ is dsp^2.

(15) Answer : (3)

Hint:

If $\Delta G < 0$, process is spontaneous.

Solution:

ΔH	ΔS	ΔG = ΔH – TΔS	Remarks
(–)	(+)	(–) always	Spontaneous
(+)	(+)	(–) high temperature	Spontaneous
(+)	(+)	(+) low temperature	Non-spontaneous
(–)	(–)	(–) low temperature	Spontaneous
(–)	(–)	(+) high temperature	Non-Spontaneous

(16) Answer : (1)

Hint:

Oxoacid of phosphorus.

Solution:

Hypophosphorus acid → H_3PO_2

Orthophosphorus acid → H_3PO_3

Pyrophosphorus acid → $H_4P_2O_5$

Pyrophosphoric acid → $H_4P_2O_7$

Metaphosphoric acid → $(HPO_3)_n$

(17) Answer : (2)

Hint:

Optical isomerism is shown by $[M(AA)_3]$, $[M(AA)_2a_2]$ and $[M(AA)a_2b_2]$

Solution:

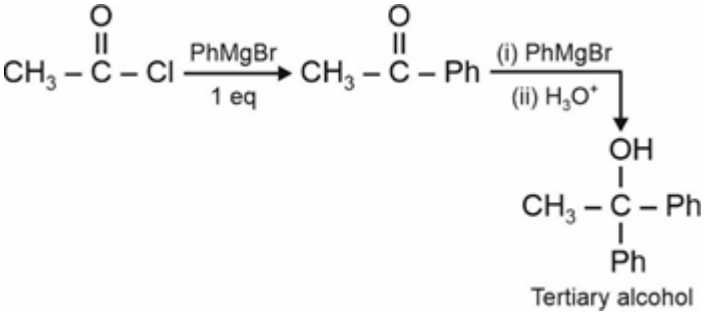
$[MA_3B_3]$ type complexes do not show optical isomerism.

(18) Answer : (1)

Hint:

PhMgBr show nucleophilic addition elimination reaction with acyl halides.

Solution:

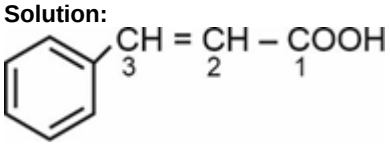


(19) Answer : (3)

Hint:

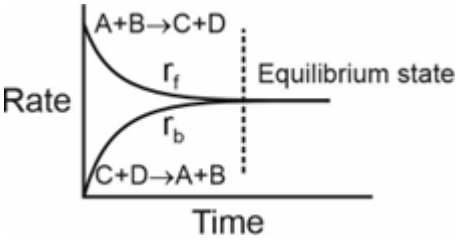
Functional group is part of parent chain.

Solution:



3-Phenyl prop-2-enoic acid (IUPAC name)
Cinnamic acid (Common name)

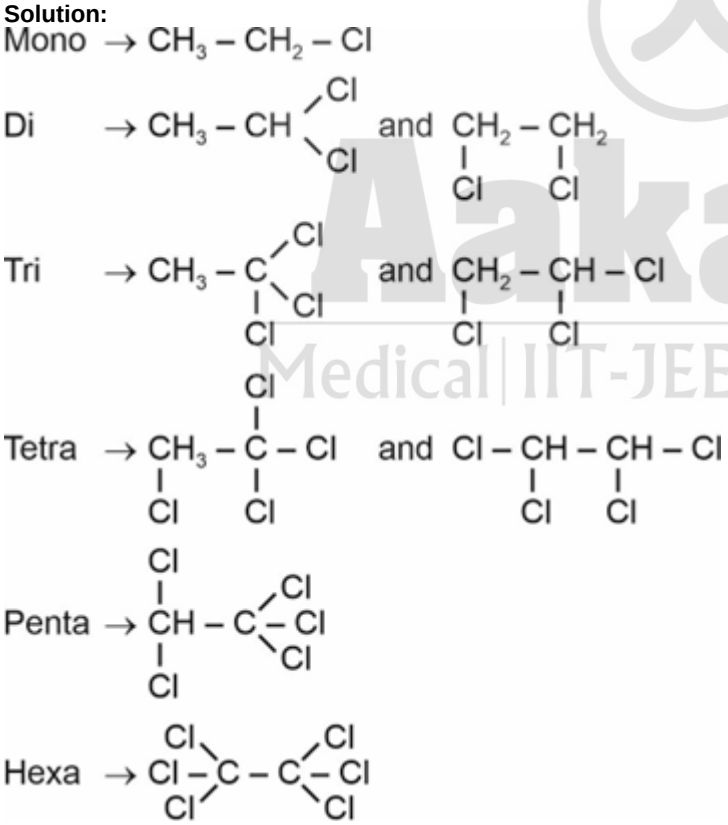
(20) **Answer :** (2)
Hint:
At equilibrium, $r_f = r_b$
Solution:
A + B ⇌ C + D



Section-II

(21) **Answer :** 5
Hint:
Species having vacant orbital acts as Lewis acid.
Solution:
BF_3, $AlCl_3$, Fe^{3+}, CH_3CO^+ and $[CH_2 – CH = CH_2]^+$ are Lewis acids.
NH_3, SO_4^{2-} , NO_3^- are Lewis bases.

(22) **Answer :** 9
Hint:
Chloroderivative are obtained by photochlorination.
Solution:



(23) **Answer :** 9
Hint:
Number of g eq electrolysed = Number of Faraday of charge passed
Solution:
3 L of 0.5 M KCr_2O_7 solution will contain 1.5 moles of $K_2Cr_2O_7$.

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow Cr^{3+} + 7H_2O$$

1 mole of $Cr_2O_7^{2-}$ requires 6 Faraday of electricity.

∴ 1.5 mole of $Cr_2O_7^{2-}$ will require 6 × 1.5 ⇒ 9 F

(24) **Answer :** 3
Hint:
Covalent chlorides are sparingly soluble.
Solution:
All the chloride compounds are water soluble except AgCl, Hg_2Cl_2 and $PbCl_2$.

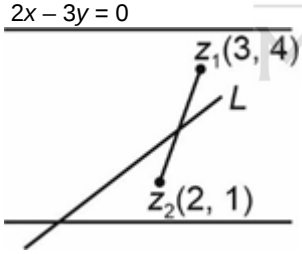
(25) **Answer :** 6
Hint:
Line of Balmer series will not be observed.
Solution:
5 → 4, 5 → 3, 6 → 1, 4 → 3, 4 → 1, 3 → 1

MATHEMATICS

Section-I

(26) **Answer :** (3)
Hint:
$^nC_r = \frac{n}{r} \times {}^{n-1}C_{r-1}$
Solution:
$S = \frac{^{120}C_{30}}{120} + \frac{^{119}C_{30}}{119} + \frac{^{118}C_{30}}{118} + ... + \frac{^{60}C_{30}}{60}$
$\because \ ^nC_r = \frac{n}{r} \times {}^{n-1}C_{r-1}$
So, $^nC_{30} = \frac{n}{30} \times {}^{n-1}C_{29}$
$S = \frac{1}{30}(^{119}C_{29} + {}^{118}C_{29} + {}^{117}C_{29} + ... + {}^{59}C_{29})$
$\because \sum_{k=r}^{n} {}^kC_r = {}^{n+1}C_{r+1}$
$\therefore \ S = \frac{1}{30}(^{120}C_{30} - {}^{59}C_{30})$

(27) **Answer :** (1)
Hint:
$z = x + iy$
Solution:
Clearly $2(z+\bar{z}) + 3(z-\bar{z})i = 0$
$2x - 3y = 0$



z lies on intersection of L and line joining z_1 and z_2
i.e., $y - 1 = 3(x - 2)$
i.e., $3x - y = 5$ and $2x - 3y = 0$
$\therefore \ x = \frac{15}{7}, \ y = \frac{45}{7} - 5 = \frac{10}{7}$
$\therefore \ z = x + iy = \frac{15}{7} + \frac{10i}{7}$

(28) **Answer :** (1)
Hint:
$f'' = \begin{cases} P^2xe^{Px} + 2Pe^{Px}; & x \le 0 \\ 2P - 6x; & x > 0 \end{cases}$
Solution:
$f'' = \begin{cases} P^2xe^{Px} + 2Pe^{Px}; & x \le 0 \\ 2P - 6x; & x > 0 \end{cases}$
$f'(x)$ increasing if $(Px + 2)Pe^{Px} \ge 0$
and $2P - 6x \ge 0$
$2 + Px \ge 0 \ \Rightarrow x \ge \frac{-2}{P} \Rightarrow x \in \left[\frac{-2}{P}, \ 0\right]$

or $x \le \frac{P}{3} \Rightarrow x \in \left[0, \frac{P}{3}\right]$

$\therefore$ On comparing, $\left(\frac{\lambda}{P}, \frac{P}{\mu}\right) = \left[\frac{-2}{P}, \frac{P}{3}\right]$

$\Rightarrow \lambda = -2, \mu = 3$

(29) Answer : (1)

Hint:

$d\left(\frac{x}{y}\right) = \frac{ydx - xdy}{y^2}$

Solution:

$x\left(y^2 \cdot e^{xy} + e^{\frac{x}{y}}\right)dy = y\left(e^{\frac{x}{y}} - y^2 \cdot e^{xy}\right)dx$

$\Rightarrow y^2\left(xdy + ydx\right)e^{xy} = e^{\frac{x}{y}}\left(ydx - xdy\right)$

$\Rightarrow e^{xy}d(xy) = e^{\frac{x}{y}}\left(\frac{ydx - xdy}{y^2}\right) = e^{\frac{x}{y}}d\left(\frac{x}{y}\right)$

$\Rightarrow e^{xy} = e^{\frac{x}{y}} + c$

(30) Answer : (3)

Hint:

$P(A) = \frac{5}{36}, P(B) = \frac{4}{36}$

Solution:

$P(A) = \frac{5}{36}, P(B) = \frac{4}{36}$

$\because$ Equal throws are disregarded.

$P(B) = \frac{31}{36} \cdot \frac{1}{9} + \frac{31}{36} \cdot \frac{8}{9} \cdot \frac{31}{36} \cdot \frac{1}{9} + \left(\frac{31}{36}\right)^3\left(\frac{8}{9}\right)^2 \cdot \frac{1}{9} + \ldots$

$\Rightarrow P(B) = \frac{31}{76}$

(31) Answer : (2)

Hint:

Let $z = \frac{x^2+x+1}{x^2+x}$

Solution:

$y = \log_3(x^4 + x^2 + 1) - \log_3(x^4 - x^3 + 2x^2 - x + 1)$

$y = \log_3 \frac{x^4+x^2+1}{x^4-x^3+2x^2-x+1}$

$= \log_3 \frac{(x^2+x+1)(x^2-x+1)}{(x^2+1)(x^2-x+1)}$

$= \log_3 \frac{x^2+x+1}{x^2+1}$

Let $z = \frac{x^2+x+1}{x^2+1}$

$\Rightarrow (z-1)x^2 - x + (z-1) = 0$

As $x \in R$, so $D \ge 0$

$1 - 4(z-1)(z-1) \ge 0$

$\Rightarrow (z-1)^2 \le \frac{1}{4}$

$\Rightarrow \frac{1}{2} \le z \le \frac{3}{2}$

$y_{\min} = \log_3\left(\frac{1}{2}\right), y_{\max} = \log_3\frac{3}{2}$

$\therefore y_{\min} + y_{\max} = \log_3\left(\frac{1}{2}\right) + \log_3\left(\frac{3}{2}\right)$

$= \log_3\frac{3}{4} = 1 - \log_3 4$

$\therefore m^2 + n^2 = 1 + 16 = 17$

(32) Answer : (4)

Hint:

$-1 \le \frac{10x+6}{3} \le 1$

Solution:

$4x^2 + 11x + 6 > 0, -1 \le 4x + 3 \le 1$

and $-1 \le \frac{10x+6}{3} \le 1$

$(4x+3)(x+2) > 0, \ -1 \le x \le \frac{-1}{2}$

and $\frac{-9}{10} \le x \le \frac{-3}{10}$

$x < -2$ or $x > \frac{-3}{4}$

Common values are $x \in \left(\frac{-3}{4}, \frac{-1}{2}\right]$

(33) Answer : (3)

Hint:

$\frac{dy}{dx} + \frac{e^x}{e^x-4}y = \frac{3x^2+2x}{e^x-4}$

Solution:

$e^x G\left(x\right) = \int_3^x \left(3t^2 + 2t + 4G'\left(t\right)\right) dt$

Let $y = G(x)$

$\frac{dy}{dx} + \frac{e^x}{e^x-4}y = \frac{3x^2+2x}{e^x-4}$

IF = $e^x - 4$

Solution $y(e^x - 4) = \int (3x^2 + 2x)\, dx + c$

$\Rightarrow y(e^x - 4) = x^3 + x^2 + c$

$G(3) = 0 \Rightarrow y(3) = 0$, $c = -36$

$\therefore\ G(x) = \frac{x^3+x^2-36}{e^x-4}$

(34) Answer : (1)

Hint:

Number of choices for $L_1 = 3$, $L_2 = 4$, $L_3 = 3$

Solution:

Number of choices for $L_1 = 3$

After placing L_1, 4 envelops remain

Choices for $L_2 = 4$

Similarly, choices for $L_3 = 3$

$\therefore$ Total ways = $3 \times 4 \times 3 = 36$

(35) Answer : (1)

Hint:

Practical problem of union and intersection of two sets.

Solution:

Let A = Families own a car

B = Families own a scooter

C = Families own a bicycle

$\therefore n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(A \cap C) + n(A \cap B \cap C)$

$= 65 + 70 + 45 - 40 - 30 - 35 + x$

$= 75 + x$

N(neither) $= 100 - (75 + x) = 25 - x$

$\therefore 0 < 25 - x < 25$ but for bicycle $45 - 65 + x \geq 0$ it means $25 \geq x \geq 20$

(36) Answer : (1)

Hint:

Different types of relation.

Solution:

$1 + a \cdot a = 1 + a^2 > 0\ a \in R$

$\therefore (a, a) \in S$, $\therefore S$ is reflexive

Next, $(a, b) \in S \Rightarrow 1 + ab > 0$

$\Rightarrow 1 + ba > 0 \Rightarrow (b, a) \in S$

$\therefore S$ is symmetric.

Next, $(a, b) \in S$ and $(b, c) \in S$, does not imply then $(a, c) \in S$, for example

$(2,\ 1) \in S,\ \left(1,\ -\frac{1}{2}\right) \in S$ but $\left(2,\ -\frac{1}{2}\right) \notin S$

$\therefore S$ is not transitive.

(37) Answer : (1)

Hint:

Let $\frac{x-5}{x+2} = t^7$

Solution:

$I = \int \frac{dx}{(x+2)^{8/7}(x-5)^{6/7}}$

$\Rightarrow \int \frac{dx}{(x+2)^2\left(\frac{x-5}{x+2}\right)^{6/7}}$

Let $\frac{x-5}{x+2}=t^7$

Differentiable on both sides, we get

$\left(\frac{(x+2)-(x-5)}{(x+2)^2}\right)dx=7t^6dt$

$\Rightarrow \quad \frac{7}{(x+2)^2}dx=7t^6dt$

Hence, $I=\int t^{-6}\cdot t^6dt=t+c=\left(\frac{x-5}{x+2}\right)^{1/7}+c$

(38) Answer : (1)

Hint:

Property of determinant.

Solution:

$$\sum_{r=1}^{n}D_r=\begin{vmatrix}\sum_{r=1}^{n}2^{r-1} & 2\sum_{r=1}^{n}3^{r-1} & 4\sum_{r=1}^{n}5^{r-1}\\ \alpha & \beta & \gamma\\ 2^n-1 & 3^n-1 & 5^n-1\end{vmatrix}$$

$$=\begin{vmatrix}2^n-1 & 3^n-1 & 5^n-1\\ \alpha & \beta & \gamma\\ 2^n-1 & 3^n-1 & 5^n-1\end{vmatrix}=0$$

(39) Answer : (4)

Hint:

$\bar{x}=\frac{\Sigma x_i f_i}{\Sigma f_i}$

Solution:

x_i	0	2	2^2	...	2^n
f_i	${}^nC_0$	${}^nC_1$	${}^nC_2$		${}^nC_n$

$\frac{0\times{}^nC_0+2\times{}^nC_1+2^2\times{}^nC_2\ldots 2^n\times{}^nC_n}{{}^nC_0+{}^nC_1+{}^nC_2\ldots{}^nC_n}$

$=\frac{3^n-1}{2^n}=\frac{242}{2^n}$

$\Rightarrow 3^n=3^5$

$\Rightarrow n=5$

(40) Answer : (4)

Hint:

Linear differential equation.

Solution:

$\frac{dy}{dx}+\frac{xy}{x^2-1}=\frac{x^3+4}{\sqrt{1-x^2}}$

IF = $e^{\int\frac{x}{x^2-1}dx}=e^{\frac{1}{2}\ln|x^2-1|}=\sqrt{1-x^2}$ ($\because x\in(-1,1)$)

$\therefore$ Solution is $y\sqrt{1-x^2}=\int(x^3+x)\,dx+c$

$y\sqrt{1-x^2}=\frac{x^4}{4}+\frac{x^2}{2}+c$

$f(0)=0\Rightarrow c=0$

$\therefore \quad y=\frac{x^4+2x^2}{4\sqrt{1-x^2}}$

$$I=2\int_{-1/2}^{1/2}f(x)\,dx=\int_{0}^{1/2}\frac{x^4+2x^2}{\sqrt{1-x^2}}$$

Let $x=\sin\theta$, $dx=\cos\theta\,d\theta$

$\therefore \quad I=\int_{0}^{\pi/6}(\sin^4\theta+2\sin^2\theta)\,d\theta$

$= \int_0^{\pi/6} \left[\frac{3-4\ \cos 2\theta+\cos 4\theta}{8}+1-\cos 2\theta\right] d\theta$

$I = \int_0^{\pi/6} \left(\frac{3-4\ \cos 2\theta+\cos 4\theta+8-8\ \cos 2\theta}{8}\right) d\theta$

$= \int_0^{\pi/6} \frac{11-12\ \cos 2\theta+\cos 4\theta}{8} d\theta$

$= \left[\frac{11}{8}\theta - \frac{12}{8}\times\frac{1}{2}\sin 2\theta + \frac{1}{4\times 8}\sin\theta\right]_0^{\pi/6}$

$= \frac{11}{8}\times\frac{\pi}{6} - \frac{3}{4}\cdot\frac{\sqrt{3}}{2} + \frac{1}{4\times 8}\cdot\frac{\sqrt{3}}{2}$

$= \frac{11}{48} - \frac{23\sqrt{3}}{64}$

(41) Answer : (3)

Hint:

Length of latus rectum ($a < b$) = $\frac{2a^2}{b}$

Solution:

$e^2 = 1 - \frac{a^2}{b^2}$

$\Rightarrow \frac{4}{5} = 1 - \frac{a^2}{a^2+4}$

$\Rightarrow a^2 = 1$

Hence, the ellipse = $\frac{x^2}{1} + \frac{y^2}{5} = 1$

and latus rectum = $\frac{2a^2}{b} = \frac{2}{\sqrt{5}}$

(42) Answer : (4)

Hint:

Concept of limit.

Solution:

$\lim_{x\to\frac{1}{\sqrt{2}}} \frac{\sin(\cos^{-1}x)-x}{1-\frac{\sqrt{1-x^2}}{x}}$

$= \lim_{x\to\frac{1}{\sqrt{2}}} \frac{\sqrt{1-x^2}-x}{1-\left(\frac{\sqrt{1-x^2}}{x}\right)}$

$= \lim_{x\to\frac{1}{\sqrt{2}}} (-x) = \frac{-1}{\sqrt{2}}$

(43) Answer : (4)

Hint:

The coefficient of $(xy)^{n_1} y^{n_2} (zy)^{n_3}$ in $(xy + y + yz)^{15}$ is $\frac{\lfloor 15}{\lfloor n_1 \lfloor n_2 \lfloor n_3}$, where $n_1 + n_2 + n_3 = 15$

Solution:

The coefficient of $(xy)^{n_1} y^{n_2} (zy)^{n_3}$ in $(xy + y + yz)^{15}$ is $\frac{\lfloor 15}{\lfloor n_1 \lfloor n_2 \lfloor n_3}$, where $n_1 + n_2 + n_3 = 15$

Put, $n_1 = 4$, $n_2 = 5$, $n_3 = 6$

$\Rightarrow$ Coefficient of $x^4 y^{15} z^6$ in $(xy + y + yz)^{15}$ is $\frac{\lfloor 15}{\lfloor 4 \lfloor 5 \lfloor 6}$.

(44) Answer : (4)

Hint:

Centre $(-g, -f)$

Solution:

Given circle : $x^2 + y^2 - 4gx + 8y + 15c = 0$

Passes through $(4, -2)$

$16g - 15c = 4$ …(i)

Centre $(2g, -4)$ lies on given line.

So, $2g + 6c = 5$ …(ii)

On solving (i) and (ii),

$c = \frac{4}{7}$ and $g = \frac{11}{14}$

Equation of circle $x^2 + y^2 - \frac{22}{7}x + 8y + \frac{60}{7} = 0$

$\therefore$ *y*-intercept = $2\sqrt{f^2 - c} = 4\sqrt{\frac{13}{7}}$ units

(45) Answer : (3)

Hint:

Median = $l + \frac{\frac{N}{2} - cf}{f} \times h$

Solution:

Median = $l + \frac{\frac{N}{2} - cf}{f} \times h$

Median class is 10–15

l = 10, h = 5, f = 10, $cf = a + b$

$N = a + b + 10 + 8 + 6 = a + b + 24$

$\therefore \ 12 = 10 + \frac{\frac{a+b+24}{2} - (a+b)}{10} \times 5$

$\Rightarrow a + b = 16$ ...(i)

$\bar{x} = \frac{\Sigma f_i x_i}{\Sigma f_i}$

$13 = \frac{2.5a + 7.5b + 10(12.5) + 8(17.5) + 6(22.5)}{a+b+24}$

$\Rightarrow 10.5a + 5.5b = 88$ ...(ii)

From (i) and (ii),

$a = 0, b = 16$

$\therefore (a - b)^2 = 256$

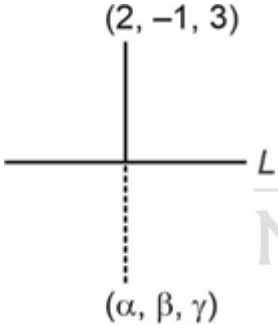
Section-II

(46) Answer : 86

Hint:

Image of (2, –1, 3) w.r.t. line.

Solution:



$L : \frac{x-1}{1} = \frac{y+2}{-1} = \frac{z-2}{2} = \lambda$

General point = (λ + 1, –λ – 2, 2λ + 2)

$\Rightarrow \ \lambda = \frac{1}{3}$

$(\alpha, \ \beta, \ \gamma) = \left(\frac{2}{3}, \ \frac{-11}{3}, \ \frac{7}{3}\right)$

$k^2 = \frac{782}{9}$

(47) Answer : 11

Hint:

Sum of roots = $\frac{-b}{a}$

Product of roots = $\frac{c}{a}$

Solution:

If sin ϕ and cos ϕ are roots of $4x^2 - 2x + k = 0$, then

$\sin\phi + \cos\phi = \frac{1}{2}$ ...(i)

$\sin\phi\cos\phi = \frac{k}{4}$ ...(ii)

$(\sin\phi + \cos\phi)^2 = \sin^2\phi + 2\sin\phi\cos\phi + \cos^2\phi$

$\frac{1}{4} = 1 + \frac{k}{2} \ \Rightarrow \ k = \frac{-3}{2}$

$\therefore \ \sin\phi\cos\phi = \frac{-3}{8}$

Also, $\sin^3\phi + \cos^3\phi$

$= (\sin\phi + \cos\phi)^3 - 3\sin\phi\cos\phi(\sin\phi + \cos\phi)$

$= \frac{1}{8} - 3\left(\frac{-3}{8}\right)\left(\frac{1}{2}\right) = \frac{11}{16}$

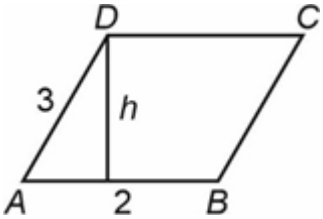
$\therefore 16(\sin^3\phi + \cos^3\phi) = 11$

(48) **Answer :** 36

Hint:

$\tan\theta = \frac{m_1 - m_2}{1 + m_1 m_2}$

Solution:



$x - 3y + 6 = 0$

$m_1 = \frac{1}{3}$

$x + 2 - 5 = 0$

$m_2 = \frac{-1}{2}$

$\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right| = \left|\frac{\frac{1}{3} + \frac{1}{2}}{1 - \frac{1}{6}}\right| = 1$

$\therefore \sin\theta = \frac{1}{\sqrt{2}}$

$\frac{h}{3} = \sin\frac{\pi}{4} \Rightarrow h = \frac{3}{\sqrt{2}}$

$K = \frac{3}{\sqrt{2}} \cdot 2 = 3\sqrt{2}$

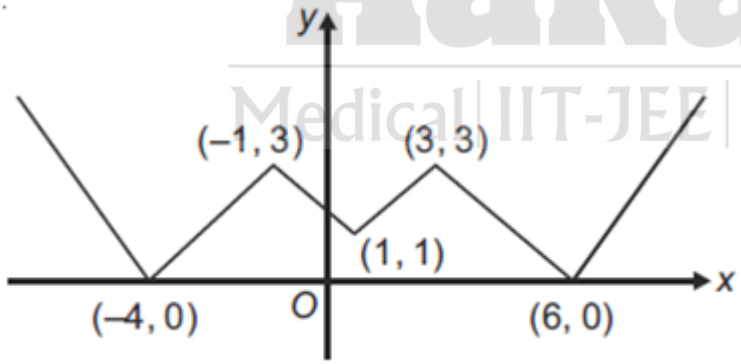
$\Rightarrow 2K^2 = 36$

(49) **Answer :** 4

Hint:

Draw graph

Solution:



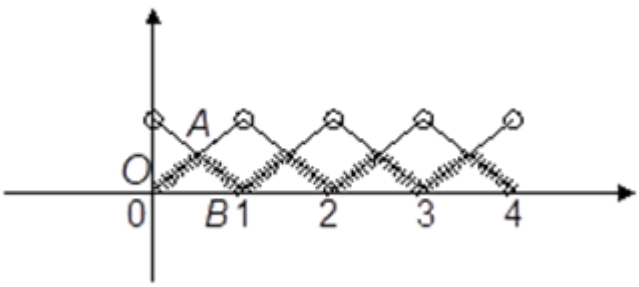
$x = 0, 1, 3, 6$ are points of extremum.

(50) **Answer :** 1

Hint:

Area under curve.

Solution:



Required area = 4(ar ΔOAB) = $4\left(\frac{1}{2}\cdot 1\cdot\frac{1}{2}\right) = 1$

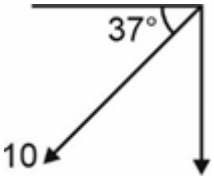
PHYSICS

Section-I

(51) Answer : (2)
Hint:
$\frac{dv}{v} = -\alpha dt + \frac{dv_0}{v_0}$
Solution:
$v = v_0 e^{-\alpha t}$
$\frac{dv}{v} = -\alpha dt + \frac{dv_0}{v_0}$
$\frac{dv}{v} \times 100 = -\alpha t \frac{dt}{t} \times 100 + \frac{dv_0}{v_0} \times 100$
= 0.1 × 5 × 2 + 1
$\frac{dv}{v} \times 100 = 2\%$

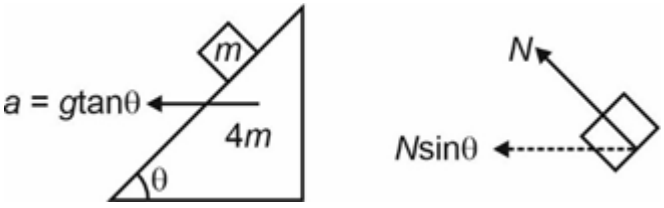
(52) Answer : (4)
Hint:
$T = \frac{2u \sin(\alpha \pm \beta)}{g \cos \beta}$
Solution:
$T_1 = \frac{2u \sin(\alpha - \beta)}{g \cos \beta}; \; T_2 = \frac{2u \sin(\alpha + \beta)}{g \cos \beta}$
$\frac{T_1}{T_2} = \frac{\sin \alpha \cos \beta - \cos \alpha \sin \beta}{\sin \alpha \cos \beta + \cos \alpha \sin \beta}$
$= \frac{\tan \alpha - \tan \beta}{\tan \alpha + \tan \beta} = \frac{1}{2}$

(53) Answer : (1)
Hint:
$\vec{v}_{RP} = \vec{v}_R - \vec{v}_P$
Solution:



Velocity of person = $-8\hat{i} - 6\hat{j}$
$\vec{v}_{RG} = 12\hat{i} - 6\hat{j}$
New velocity of person = $-16\hat{i} - 12\hat{j}$
$\vec{v}_{RP} = 28\hat{i} + 6\hat{j}$
$= \sqrt{28^2 + 6^2} = \sqrt{820} = 2\sqrt{205}$

(54) Answer : (4)
Hint:
$a = g\tan\theta$
Solution:



$N \sin\theta = ma$
$N \sin\theta = mg \tan\theta$
$N = \frac{mg}{\cos\theta}$

(55) Answer : (2)
Hint:
Work energy theorem.
Solution:
$P \rightarrow R$:

$\frac{1}{2}m(4)^2 - \frac{1}{2}m(6)^2 = \omega_f + (\omega_E)_{PR}$ ...(i)

R → *Q* :

$\frac{1}{2}mv^2 - \frac{1}{2}m(4)^2 = \omega_f + (\omega_E)_{RQ}$ ...(ii)

$\omega_{E_{PR}} = -(\omega_E)_{RQ}$

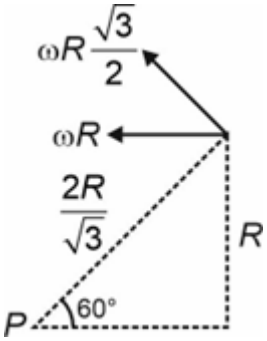
v = 2 m/s

(56) Answer : (3)

Hint:

$\omega = \frac{d\theta}{dt}$

Solution:



$\omega_P = \frac{\omega R\frac{\sqrt{3}}{2}}{\frac{2R}{\sqrt{3}}} = \frac{3}{4}\omega$

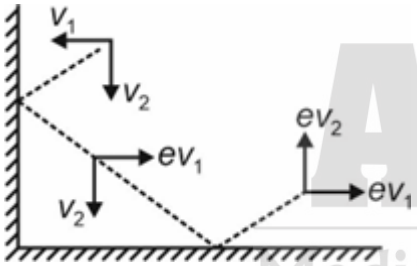
ω_P = 6 rad/s

(57) Answer : (4)

Hint:

$e = \frac{v_{sep}}{v_{app}}$

Solution:



$\vec{v}_f = -e\vec{v}_i$

$\vec{v}_f = -\frac{1}{3}(\hat{i} + 3\hat{j})$

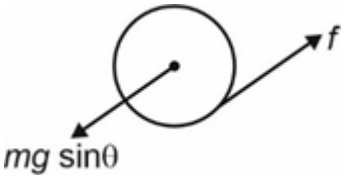
Speed = $\frac{\sqrt{10}}{3}$

(58) Answer : (3)

Hint:

Pure rolling

Solution:



f = *mg*sinθ

a = α*R*

$f = \frac{mR^2}{2}\alpha$

$\frac{ma}{2} = mg\sin\theta$

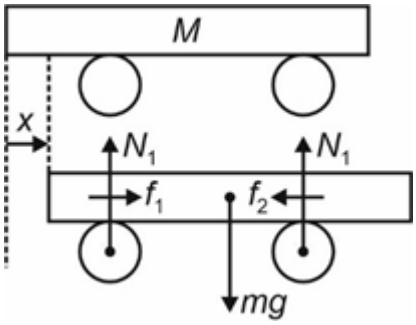
a = 2*g*sinθ

(59) Answer : (1)

Hint:

$N_1 + N_2 = mg$

Solution:



$N_1 = mg\left(\frac{1}{2} + \frac{x}{d}\right)$

$N_2 = mg\left(\frac{1}{2} - \frac{x}{d}\right)$

$F = f_2 - f_1 = \frac{2\mu mgx}{d}$

$\omega = \sqrt{\frac{2\mu g}{d}}$

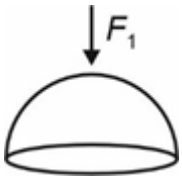
(60) **Answer :** (3)

Hint:

$\rho gR \cdot \pi R^2 - F_1 = \frac{2}{3}\rho\pi R^3$

Solution:

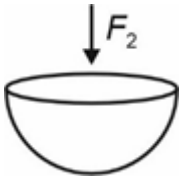
F_1 : Force on upper half



$\rho gR \cdot \pi R^2 - F_1 = \frac{2}{3}\rho\pi R^3$

$F_1 = \frac{1}{3}\rho\pi R^3$

F_2 : Force on lower half



$F_2 - \rho gR \cdot \pi R^2 = \frac{2}{3}\rho\pi R^3$

$F_2 = \frac{5}{3}\rho\pi R^3$

(61) **Answer :** (3)

Hint:

$F = \eta A\frac{dv}{dz} = mg\sin\theta$

Solution:

$F = \eta A\frac{dv}{dz} = mg\sin\theta$

$0.2 \times 4 \times \frac{15}{h} = 10 \times 10 \times \frac{1}{2}$

$\frac{12}{h} = 50$

$h = \frac{12}{500} = 0.24\ mm$

(62) **Answer :** (2)

Hint:

$dQ = dU + dW$

Solution:

$dU = Q + 3(PdV + VdP)$

$dQ = dU + PdV = 0$

$-PdV = 3PdV + 3VdP$

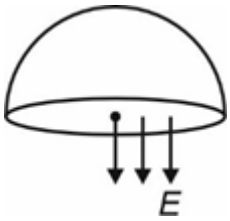
$-4PdV = 3VdP$

$\frac{dP}{dV} = \frac{-4}{3}\left(\frac{P}{V}\right)$

$Y = \frac{4}{3}$

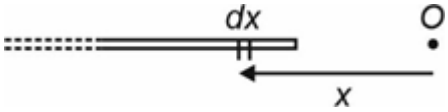
(63) **Answer :** (4)

Hint:
Equipotential surface
Solution:



$V_P = V_O$

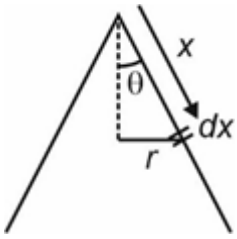
(64) Answer : (1)
Hint:
$E = \frac{kq}{r^2}$
Solution:



$$dE = \int_R^\infty \frac{k\lambda dx}{x^2} = \frac{k\lambda}{R} = \frac{\lambda}{4\pi\varepsilon_0 R}$$

$$E_0 = \sqrt{\left(\frac{\lambda}{4\pi\varepsilon_0 R}\right)^2 + \left(\frac{\lambda}{2\pi\varepsilon_0 R}\right)^2} = \frac{\lambda}{4\pi\varepsilon_0 R}\sqrt{5}$$

(65) Answer : (4)
Hint:
$v = \frac{kq}{r}$
Solution:



$\tan\theta = \frac{3}{4}$

$dv = \frac{k\omega 2\pi r dx}{x}$

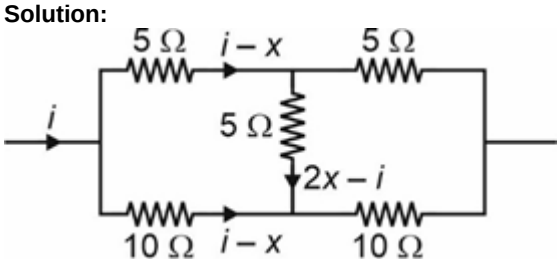
$= \frac{1}{4\pi\varepsilon_0}\frac{\sigma 2\pi\cdot x\cdot\frac{3}{5}dx}{x}$

$= \frac{\sigma}{2\pi\varepsilon_0}\frac{3}{5}\cdot\pi\int_0^l dx$

$= \frac{3\sigma}{10\pi\varepsilon_0}\cdot\frac{3}{5}\cdot l\frac{R}{R}$

$= \frac{3Q}{10\pi\varepsilon_0 R}$

(66) Answer : (2)
Hint:
Use KCL and KVL.
Solution:



$21 - 10(i - x) - 5x = 0$
$10(i - x) - 5(2x - i) - 5x = 0$
$x = \frac{3}{5}i$

$\frac{v}{i} = 7\ \Omega$

$i = \frac{21}{7} = 3\ \text{A}$

(67) Answer : (4)

Hint:

Magnetic field lines density is higher at *A*.

Solution:

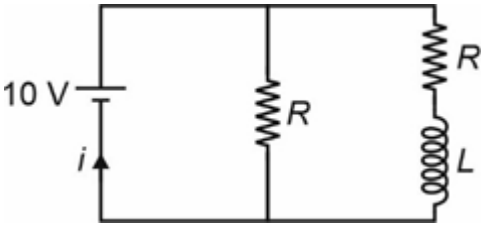
Magnetic field lines density is higher at *A*.

(68) Answer : (3)

Hint:

$i = \frac{\varepsilon}{R} + \frac{\varepsilon}{R}(1 - e^{-\frac{t}{L}R})$

Solution:



$i = \frac{\varepsilon}{R} + \frac{\varepsilon}{R}(1 - e^{-\frac{t}{L}R}) = 5 + 5(1 - e^{2})$

$i = 5(2 - e^{-2})$

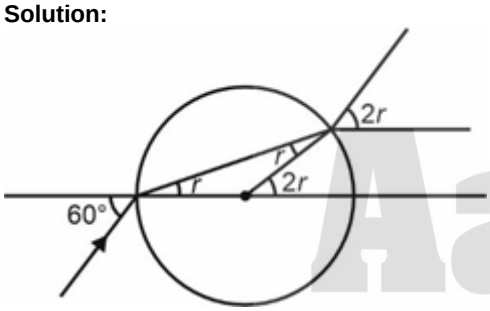
$P = 10 \times 5(2 - e^{-2}) = 50(2 - e^{-2})$

(69) Answer : (3)

Hint:

$\mu \sin r = 1 \sin 2r$

Solution:



$1 \sin 60° = \mu \sin r$

$\mu \sin r = 1 \sin 2r$

$\sin 2r = \sin 60°$

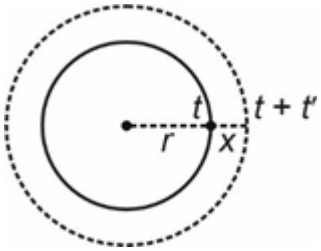
$\mu = \sqrt{3}$

(70) Answer : (1)

Hint:

$P \cdot \frac{x}{c} = N \cdot \frac{hc}{\lambda}$

Solution:



$t' = \frac{x}{c}$

$P \cdot \frac{x}{c} = N \cdot \frac{hc}{\lambda}$

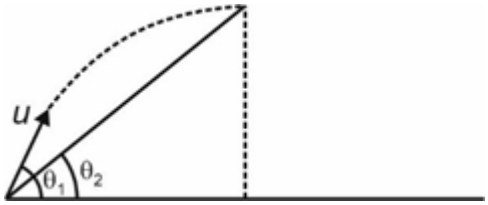
Section-II

(71) Answer : 5

Hint:

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

Solution:



$\frac{u\sin\theta_1 t_0-\frac{1}{2}gt_0^2}{u\cos\theta_1 t_0}=\tan(\theta_2)$

$u=\frac{gt\cos\theta_2}{2\sin(\theta_1-\theta_2)}$

(72) **Answer :** 0
Hint:
Net force is zero.
Solution:
There is no tendency of slipping.
So, friction is zero.

(73) **Answer :** 5
Hint:
$mgx+\frac{1}{2}k(x_0^2-(2x+x_0)^2)=0$
Solution:
Let *x* is displacement of block.
$mgx+\frac{1}{2}k(x_0^2-(2x+x_0)^2)=0$
$x=\frac{mg}{2k}-x_0=\frac{mg}{4k}=\frac{20}{400}=\frac{1}{20}\ \mathrm{m}=50\ \mathrm{cm}$

(74) **Answer :** 4
Hint:
$P=\frac{I}{2C}$
Solution:
$P=\frac{I}{2C}$
$P=\frac{I}{2C}$
$P=\frac{E_0}{2\pi R^2 C}$

(75) **Answer :** 3
Hint:
$\Delta x = d\sin\theta$
Solution:
$\Delta x=d\sin\theta=\frac{d\cdot d}{2D}=\frac{d^2}{2D}$
$\frac{d^2}{2D}=\frac{3\lambda}{2}$
$\lambda=\frac{d^2}{3D}=\frac{3\times3\times10^{-6}}{3\times1}=3\ \mu\mathrm{m}$