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Set-1_Online

Aakash

Medical | IIT-JEE | Foundations

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MM : 300 AIATS For One Year JEE(Main)-2026 (XII Passed)_Test-04_Online **Time : 180 Min.**

Physics

Section-I

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

Section-II

21.	(7)	**24.**	(2)
22.	(40)	**25.**	(27)
23.	(5)		

Chemistry

Section-I

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

Section-II

46. (2)

47. (25)

48. (400)

49. (12)

50. (117)

Mathematics

Section-I

51. (1)

52. (3)

53. (1)

54. (3)

55. (1)

56. (4)

57. (3)

58. (1)

59. (3)

60. (4)

61. (2)

62. (1)

63. (3)

64. (3)

65. (3)

66. (1)

67. (4)

68. (2)

69. (3)

70. (4)

Section-II

71. (30)

72. (2)

73. (1)

74. (1)

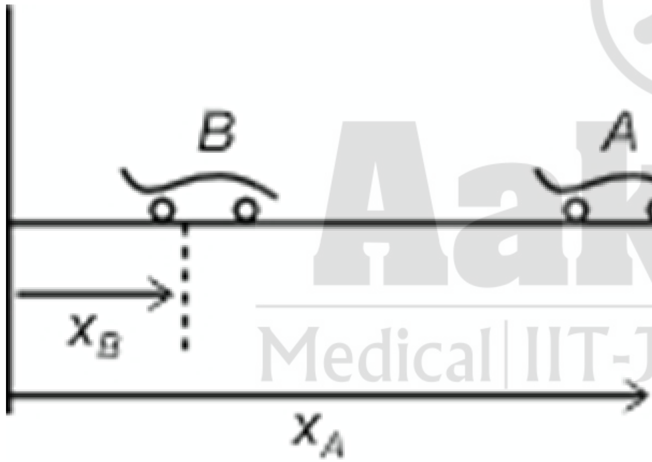
75. (20)

Hints and Solutions

Physics

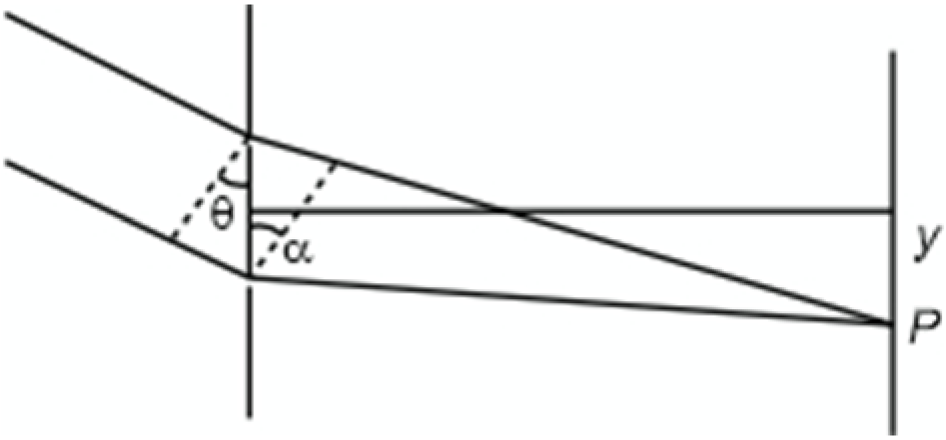
Section-I

(1) **Answer :** (3)
Hint:
For $(V_{in})_{max}$, diode will conduct
Solution:
For V_{in} minimum, $I_Z = 0$
$I_S = I_L,\ I_L = \frac{500}{500} = 100$ mA $= I_S$
$V_{min} = (R_S + R_L)\, I_L = 60$ V
For maximum V_{in}, $I_Z = 50$ mA
$I_S = (100 + 50)$ mA $= 150$ mA
$V_{max} = 50 + I_S R_S = 65$ V
So, $\frac{V_{max}}{V_{min}} = \frac{13}{12}$

(2) **Answer :** (2)
Hint:
Use concept of relative motion.
Solution:


$(V_A - V_B) \propto (x_A - x_B)$
$(V_A - V_B) = k\,(x_A - x_B)$
At $X_A - X_B = 10$, $V_A - V_B = 10$
10 = *k* 10, *k* = 1, $V_A - V_B = X_A - X_B$ …(1)
Let $X_A - X_B = y$ …(2)
$\frac{dx_A}{dt} - \frac{dx_B}{dt} = \frac{dy}{dt}$, $V_A - V_B = \frac{dy}{dt}$ …(3)
From (1), (2) and (3)
$\frac{dy}{dt} = y$
$$\int_{10}^{20} \frac{dy}{y} = \int_0^t dt$$
$t = \ln(2)$ sec

(3) **Answer :** (2)
Hint:
$\Delta\phi = 2n\pi$ for *CI*, $\Delta\phi = (2n-1)\frac{\pi}{2}$ for *DI*.
Solution:



(A) If phase difference at point *P* is zero, then $n_1 d\sin\theta = n_2 d\sin\alpha$

$\alpha = 37^{\circ}$

$\tan\alpha - \frac{y}{D}$, $y = -\frac{3}{4}$ m

(B) $\Delta x = d\sin\theta$

(C) $\Delta x = \frac{\mu_1 d\sin\theta}{\mu_2}$

$I = I_0 + I_0 + 2I_0\cos\,(\phi) = I_0$

(D) Path difference increases, as we go up.

At point *O*, $\Delta\phi$ and when it becomes 4π, there will be maximum.

Extra Δ*x* created in medium 2 must lead to $\frac{2\pi}{3}$ phase difference.

$\frac{2\pi}{\lambda} d\sin\theta_1 \cdot n_2 = \frac{2\pi}{3}$

$\sin\theta_1 = \frac{3}{25}$

$\tan\theta_1 = \frac{3}{\sqrt{616}} = \frac{y}{D}$, $y = \frac{150}{\sqrt{154}}$ cm

(4) **Answer :** (2)

Hint:

Equate potential

Solution:

Let capacitance of plate is C_1 and for conductor is C_2

After first contact

$\frac{Q-q}{q} = \frac{C_1}{C_2}$

$\frac{(q)_{\max}}{C_2} = \frac{Q}{C_1}$

$(q)_{\max} = \frac{C_2}{C_1}Q$

So, $(q)_{\max} = \frac{Qq}{Q-q}$

(5) **Answer :** (1)

Hint:

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

Solution:

Here transition is (*n* + 1) → 1

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

$$\frac{\frac{1}{\lambda} = RZ^2\left\{\frac{1}{4} - \frac{1}{9}\right\}}{\frac{1}{\lambda'} = R\left\{1 - \frac{1}{9}\right\}}$$

$\frac{5}{2} = \frac{\lambda'}{\lambda} = Z^2 \times \frac{5\times 9}{36\times 8} = \frac{5Z^2}{32}$

(6) **Answer :** (2)

Hint:

$y = A\sin\,(\omega t - kx + \phi)$

Solution:

Let equation of wave is

$y = A\sin(\omega t - kx + \phi)$

A = 12 cm, ω = 10 rad/s

at *t* = 0, *x* = 0, *y* = 0, φ = 0

$y = A\sin\left(10\pi t - \frac{\pi}{2}x + \phi\right)$

$\frac{\partial y}{\partial x} = 12\times10^{-2}\left(-\frac{\pi}{2}\right)\cos\left(100\pi t - \frac{\pi}{2}x + \phi\right)$

at t = 0, x = 0

$\frac{\partial y}{\partial x} = -12\times10^{-2}\left(\frac{\pi}{2}\right)\cos\phi\ ,\ \ \frac{\partial y}{\partial x} \to t$

φ = π

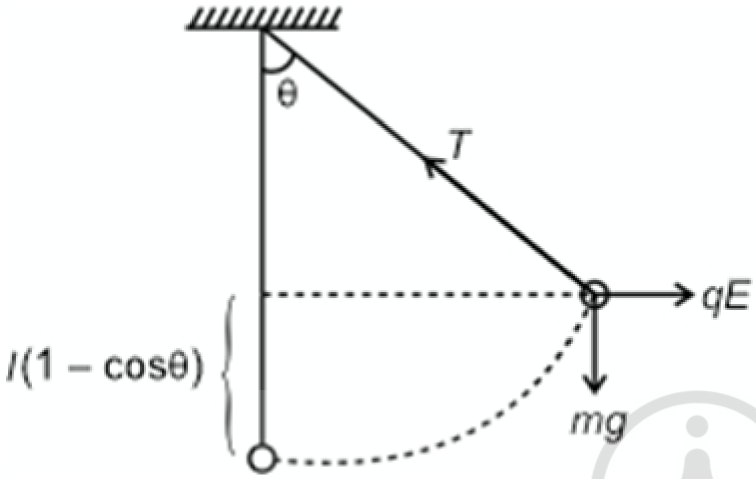
$y = 12\sin\left(\frac{\pi}{2}x - 10\pi t\right)$ cm

(7) **Answer :** (4)

Hint:

Use work energy theorem.

Solution:



$-mgl(1-\cos\theta) + qEl\sin\theta = 0$

$qE\sin\theta = mg\left(1-\cos\theta\right)$

$\tan\frac{\theta}{2} = \frac{qE}{mg}$

$\theta = 2\tan^{-1}\left(\frac{qE}{mg}\right)$

(8) **Answer :** (4)

Hint:

$H = -\frac{kA\Delta T}{l}$

Solution:

$H = -k\left(4\pi r^2\right)\frac{d\theta}{dt} = \frac{4\pi k r_1 r_2(\theta_1-\theta_2)}{r_2-r_1}$

$\int_{r_1}^{r}\frac{dr}{r} = -\frac{4k\pi}{H}\int_{\theta_1}^{\theta}d\theta$

$\theta = \theta_1 - \frac{\left(\frac{1}{r_1}-\frac{1}{r}\right)}{\left(\frac{1}{r_1}-\frac{1}{r_2}\right)} = \frac{\theta_1-\theta}{\theta_1-\theta_2}$

$\theta = \frac{2RT}{r}$

(9) **Answer :** (2)

Hint:

Conserve momentum as well as energy.

Solution:

$m(V_A)_i + 0 = m(V_A)_f + m(V_B)_f$

$(V_A)_i = (V_A)_f + (V_B)_f$ …(1)

here, $n = \frac{\frac{1}{2}m(V_A)_i^2 - \frac{1}{2}m(V_A)_f^2 - \frac{1}{2}m(V_B)_f^2}{\frac{1}{2}m(V_A)_i^2}$ …(2)

On solving

$(V_A)_f = \frac{V\pm V\sqrt{1-2n}}{2} \le V$

$(V_A)_f = \frac{V}{2}\left[1-\sqrt{1-2n}\right]$ in same direction as V

(10) **Answer :** (2)

Hint:

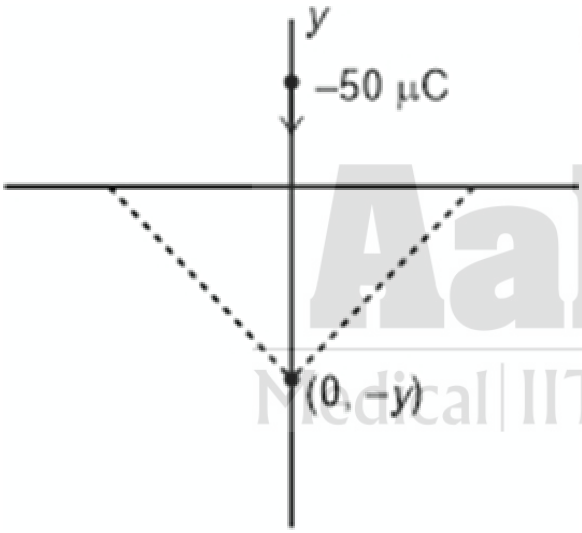
Induced field is non conservataive.

Solution:
Induced electric field is non conservative.
$\oint \vec{E} \cdot \vec{dl} \neq 0$
And net work done is found to be positive.

(11) **Answer :** (2)
Hint:
$F = \left|\frac{dV}{dx}\right| = 2\alpha x$
Solution:
Comparing $\frac{1}{2}kx^2 = \frac{1}{2}(2\alpha)x^2$
$k = 2\alpha$
$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{m}{2\alpha}}$

(12) **Answer :** (3)
Hint:
Use KVL
Solution:
Let charge on plate at any instant is $-q$.
$q + CV = -RC\frac{dv}{dt}$
⇒ $t = RC\ \log_e\left(\frac{q_0+CV}{CV}\right)$

(13) **Answer :** (3)
Hint:
Loss in K.E. = gain in P.E.
Solution:



From energy conservation,
$4 - k\frac{q^2}{5} \times 2 = \frac{-kq^2}{\sqrt{3^2+y^2}} \times 2$
$y = 6\sqrt{2}$

(14) **Answer :** (4)
Hint:
$\rho = \frac{R\pi\frac{d^2}{4}}{l}$
Solution:
LC = $\frac{0.5}{50}$ mm = 0.01 mm
$\frac{\Delta\rho}{\rho} = \frac{\Delta R}{R} + 2\frac{\Delta d}{d} + \frac{\Delta l}{l} = 2.9\%$

(15) **Answer :** (3)
Hint:
$v_B\cos\theta = u$
Solution:
Let *B* moving up with speed *v*
$u = v\cos\theta$
$\frac{du}{dt} = \frac{dv}{dt}\cos\theta - v\sin\theta \cdot \frac{d\theta}{dt}$ …(1)

$\frac{d}{dt}(l\cot\theta) = -v,\ \frac{d\theta}{dt} = \frac{v}{l}\sin^2\theta$

From (1)

$0 = a_B\cos\theta - (v\sin\theta)\left(\frac{v\sin^2\theta}{l}\right)$

$a_B = \frac{v^2\sin^3\theta}{l\cos\theta} = \frac{u^2\tan^3\theta}{l}$

$\tan\theta = \left(\frac{al}{u^2}\right)^{\frac{1}{3}}$

(16) **Answer :** (2)

Hint:

If momentum changes there would be a force.

Solution:

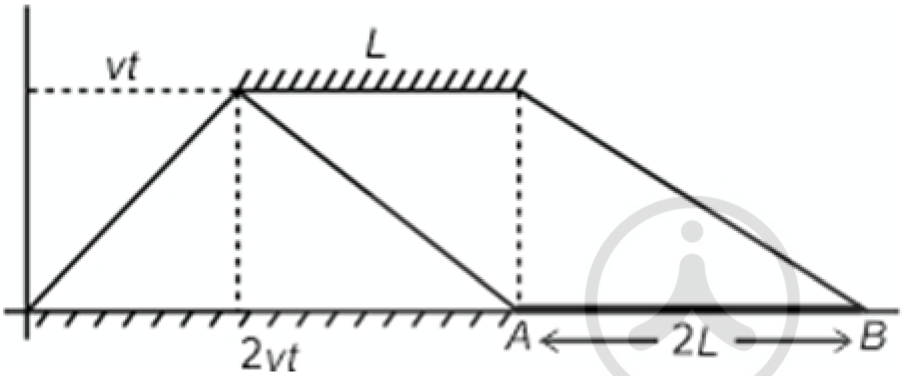
EM wave exert pressure on both surface.

(17) **Answer :** (3)

Hint:

$v = \frac{d(s)}{dt}$

Solution:



$v_A = \frac{d}{dt}(2vt) = 2v$

$v_B = \frac{d}{dt}(2vt + 2L) = 2v$

here $v_A = v_B$

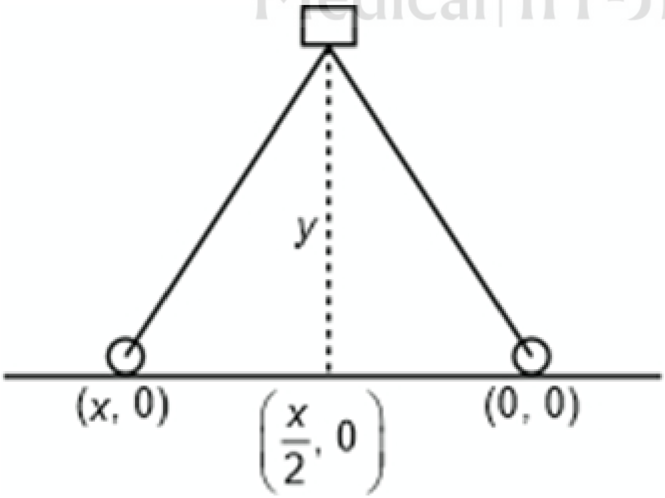
So length of spot remain same.

(18) **Answer :** (3)

Hint:

$l^2 = \left(\frac{x}{2}\right)^2 + y^2$

Solution:



$l^2 = \left(\frac{x}{2}\right)^2 + y^2$

$\frac{dy}{dt} = -\frac{x}{2\sqrt{4l^2 - x^2}} \cdot \frac{dx}{dt}$

given $-\frac{dx}{dt}$ = constant and *x* is decreasing.

Thus $v_y = \frac{dy}{dt} = \frac{\text{Decreases}}{\sqrt{\text{Increases}}}$ constant.

(19) **Answer :** (2)
Hint:
$i = \frac{1}{R}\left(\frac{d\phi}{dt}\right)$
Solution:
In larger loop, $I = \frac{E}{2\pi R\rho}$

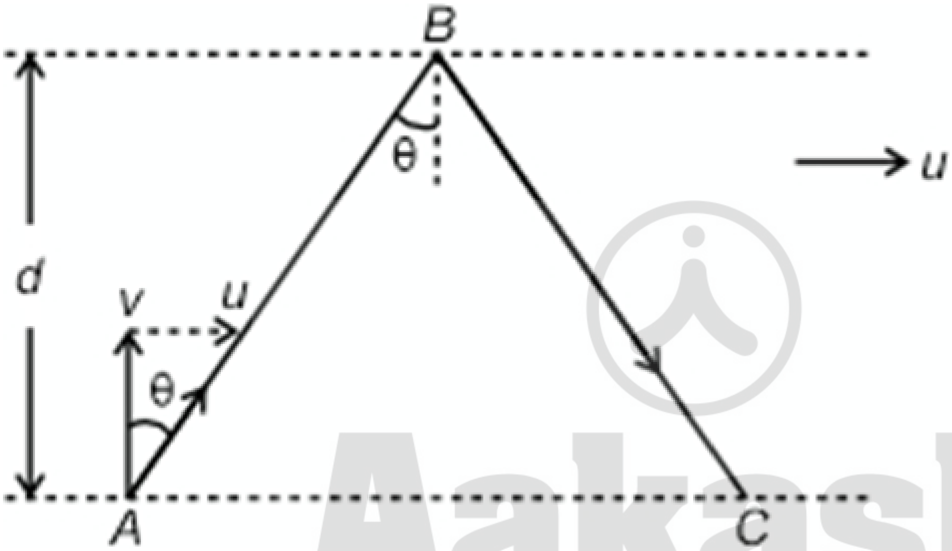
at smaller loop, $B = \frac{\mu_0 I}{2R}$

$\phi = \frac{\mu_0 I}{2R}\pi r^2$

$e = \frac{\mu_0 \pi r^2}{2R}\frac{dI}{dt} = \frac{\mu_0 r^2}{4R^2\rho}\frac{dE}{dt} = \frac{\mu_0 \beta r^2}{4R^2\rho}$

$i = \frac{\mu_0 \beta r}{8\pi\rho^2 R^2}$

(20) **Answer :** (2)
Hint:
$t = \frac{d}{v\cos\theta}$
Solution:



$t_{AB} = \frac{d}{v}$, $d = 8v$

$t_{BC} = \frac{d}{v\cos\theta}$, $d = 12v\cos\theta$

$\cos\theta = \frac{2}{3}$

$\tan\theta = \frac{u}{v} = \frac{2}{\sqrt{5}}$

Section-II

(21) **Answer :** 7
Hint:
$\frac{d\theta}{dt} = e\sigma AT^4$
Solution:
$\frac{d\theta}{dt} = \sigma AT^4$, e = 1, $\frac{d\theta}{dT} = mC$

Or $\frac{dT}{dt} = -\frac{\sigma A}{mC}T^4$, negative sign shows that temperature decreases as time increases

$\int_0^t dt = -\frac{mC}{\sigma A}\int_{T_1}^{T_2}\frac{dT}{T^4} \Rightarrow t = \frac{mC}{3\sigma A}\left(\frac{T_1^3 - T_2^3}{T_1^3 T_2^3}\right)$

here $\frac{m}{A} = \frac{r\rho}{3}$

$t = \frac{r\rho C}{9\sigma}\left(\frac{T_1^3 - T_2^3}{T_1^3 T_2^3}\right) = \frac{7r\rho C}{64\sigma T_0^3}$

(22) **Answer :** 40
Hint:
Range = $\frac{2u^2}{g}$
Solution:

Here g = 10 m/s^2

Range = 80 m = $\frac{2u^2}{g}$

$t = \frac{\text{Range}}{u} = \frac{2u}{g}$

at any instant height of balloon,

$y = -\left(\frac{dy}{dt}\right)\left(\frac{2u}{g}\right) + \frac{1}{2}g\left(\frac{2u}{g}\right)^2$

$\frac{dy}{dt} + \frac{g}{2u}y - u = 0$

$dt = \frac{dy}{u - \frac{g}{2u}y}$

$-\frac{2u}{g}\ln\left(u - \frac{g}{2u}y\right) = t + c$

at t = 0, y = 0, $c = -\frac{2u}{g}\ln(u)$

$y = \frac{2u^2}{g}\left[1 - e^{-g\frac{t}{2u}}\right] = 80\left[1 - e^{-\frac{t}{4}}\right]$

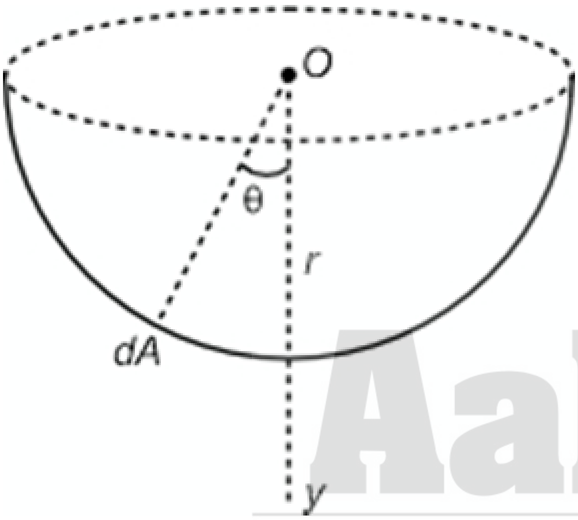
at t = 4 ln (2) = 40 m

(23) **Answer :** 5

Hint:

Energy = (I×A)

Solution:



Energy falling on area dA = $\frac{P}{4\pi r^2} \cdot dA \times 2$

$dF = \frac{PdA}{2\pi r^2 c}$

$F = \frac{P}{2\pi r^2 c} \cdot dA\cos\theta$

$= \frac{P}{2\pi r^2 c}\int dA \cdot \cos\theta = \frac{P}{2c}$

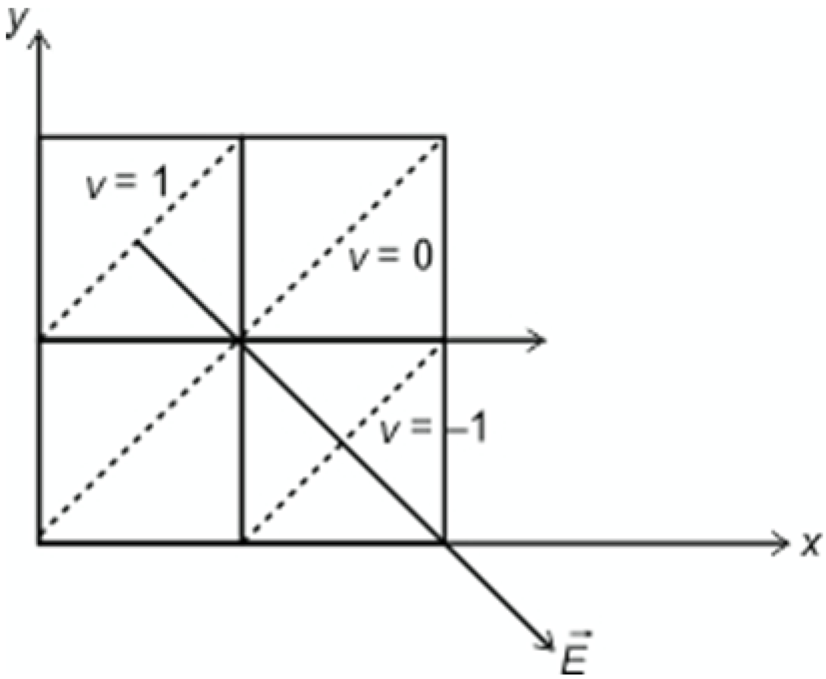
$= 5 \times 10^{-8}$ N

(24) **Answer :** 2

Hint:

$E = -\frac{dv}{dr}$

Solution:



OEH is an equipotential surface, the uniform *EF* must be perpendicular to it pointing from higher to lower potential as shown.

So, $\widehat{E}=\left(\frac{\hat{i}-\hat{j}}{\sqrt{2}}\right),\ E=\frac{v_E-v_B}{d_{CB}}=\frac{0-(-2)}{\sqrt{2}}=\sqrt{2}$

$\overrightarrow{E}=E\cdot\widehat{E}=\hat{i}-\hat{j}$

(25) **Answer :** 27
Hint:
Power = *F*×*V*
Solution:

P = *F*×*V*

In 1 sec, water coming out $\frac{dm}{dt}=\rho AV$

Again $\left(\frac{dm}{dt}\right)'=(\rho AV')=n\rho AV,\ V'=nV$

$F=\frac{dP}{dt}=\frac{d(mV)}{dt}$ = $\frac{mdV}{dt}+V\cdot\frac{dm}{dt}$, $\left\{\frac{dV}{dt}=0,\ V=\text{constant}\right\}$

$F=V\cdot\frac{dm}{dt}$

$P=FV\ \Rightarrow\ P=\rho AV^3$

For $V\rightarrow 3V_0\qquad P\rightarrow 27P_0\qquad (P\propto V^3)$

Chemistry

Section-I

(26) **Answer :** (4)
Hint:

$k=\frac{2.303}{t}\log\frac{[a_0]}{[a]}$

Solution:

	$A \longrightarrow$	$2B$	$+ C$
$t = 0$,	a_0		
$t = t$,	$a_0 - x$	$2x$	x
$t = \infty$,	0	$2a_0$	a_0

Now, $a_0 + 2x = 220$

$3a_0 = 330$

$a_0 = 110$

$x = 55$

So, now,

	$A \longrightarrow$	$2B$	$+ C$
$t = 0$,	110		
$t = t$,	55	110	55

$k = \frac{2.303}{10} \log \frac{110}{55}$

$k = 0.0693\ min^{-1}$

(27) **Answer :** (2)

Hint:

$ZnCl_2 + NaOH \rightarrow Zn\,(OH)_2$ (White ppt.)

Solution:

Metal A = Al^{3+}

Metal B = Zn^{2+}

$AlCl_3 + NH_4\,OH \rightarrow Al\,(OH)_3$

(white ppt.) → dissolves in excess NH_4OH

$ZnCl_2 + NaOH \rightarrow Zn\,(OH)_2$

(white ppt.) → dissolves in excess NaOH forming $Na_2[Zn(OH)_4]$

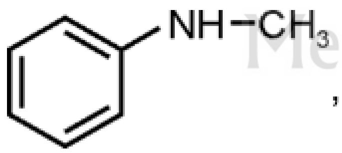
∴ Y is ⇒ $Zn(OH)_2$

(28) **Answer :** (3)

Hint:

Secondary amines gives yellow oily liquid with Nitrous acid.

Solution:



, $CH_3 - NH - CH_3$, $CH_3 - NH - CH_2CH_3$

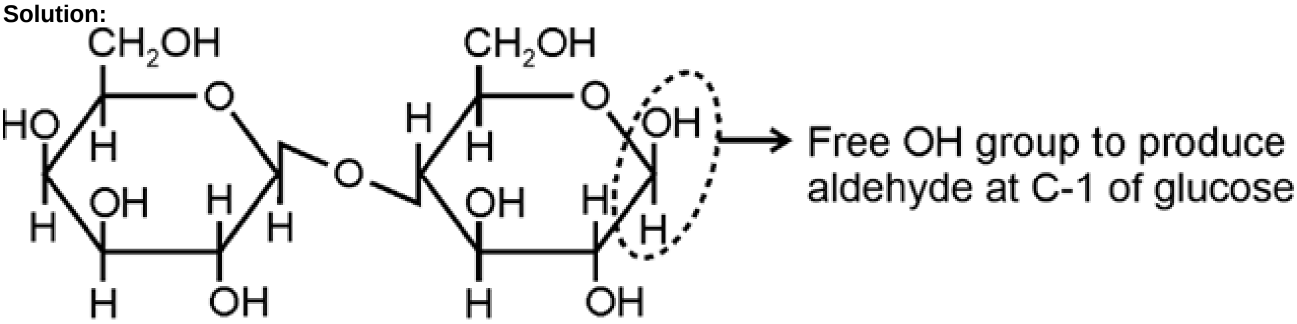
are secondary amines and forms yellow oily liquid with nitrous acid.

(29) **Answer :** (1)

Hint:

The linkage in lactose is between C-1 of galactose and C-4 of glucose unit.

Solution:



β-D-Galactose β-D-Glucose

Lactose

(30) **Answer :** (2)

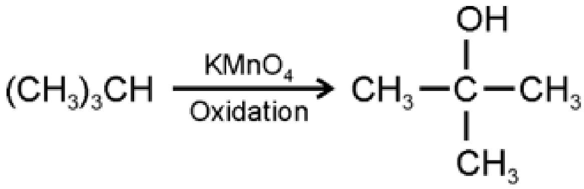
Hint:

$CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3} HCHO$ (gives Cannizaro reaction)

Solution:

$CH_4 + O_2 \xrightarrow{Cu/523\ K/100\ atm} CH_3OH$ (known as wood spirit)

$CH_3CH_3 + O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn} CH_3COOH$ (substrate for Hell-Volhard-Zelinsky reaction)



(gives instant turbidity with anhy. $ZnCl_2$/HCl)

(31) Answer : (3)

Hint:

Highest enthalpy of atomisation is of vanadium.

Solution:

Enthalpy of atomisation (kJ/mol)

Ti → 473

V → 515

Cr → 397

Mn → 281

V has highest value

V ⇒ [Ar] $4s^2 3d^3$ electronic configuration

(n – 1)d, ns electrons = 5

(32) Answer : (2)

Hint:

XeF_2 has 2 bond pairs and 3 lone pairs.

Solution:

PCl_3 → 2 lone pairs and 3 bond pairs

NH_3 → 1 lone pair and 3 bond pairs

SF_4 → 1 lone pair and 4 bond pairs

(33) Answer : (1)

Hint:

Electrical conductance also known as metallic conductance increases with decrease of temperature.

Solution:

The conductance of electricity by ions present in the solution is called electrolytic or ionic conductance.

It increases with increase of temperature.

(34) Answer : (4)

Hint:

P_{O_2} = Mole fraction of O_2 × Total pressure

Solution:

$$P_{O_2} = \frac{\frac{28}{32}}{\frac{28}{32}+\frac{70}{28}+\frac{2}{40}} \times 1.25 = \frac{0.875}{3.425} \times 1.25 = 0.3193$$

$$P_{N_2} = \frac{\frac{70}{28}}{\frac{28}{32}+\frac{70}{28}+\frac{2}{40}} \times 1.25 = \frac{2.5}{3.425} \times 1.25 = 0.9124$$

$$P_{Ar} = \frac{\frac{2}{40}}{\frac{28}{32}+\frac{70}{28}+\frac{2}{40}} \times 1.25 = \frac{0.05}{3.425} \times 1.25 = 0.0182$$

$$\frac{P_{N_2}}{P_{O_2}} = \frac{0.9124}{0.3193} = 2.857 = 2.86$$

$$\frac{P_{O_2}}{P_{Ar}} = \frac{0.3193}{0.0182} = 17.54$$

Or simply,

$$\frac{(\text{Partial pressure})_X}{(\text{Partial pressure})_Y} = \frac{(\text{Mole})_X}{(\text{Mole})_Y}$$

(35) Answer : (1)

Hint:

The graph that shows exponential growth and exponential decay is the correct graph for 1^{st} order kinetics.

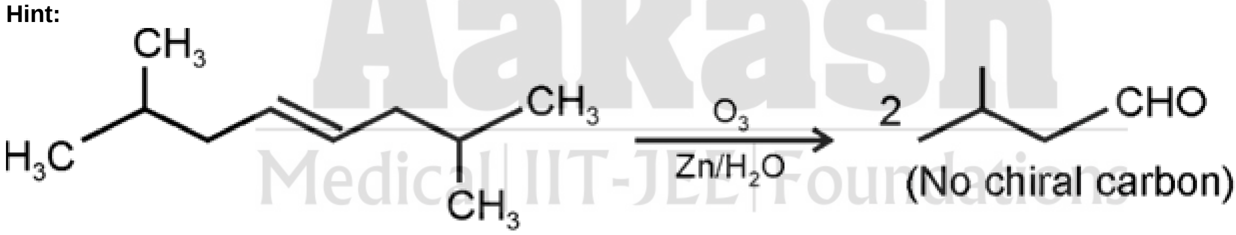
Solution:

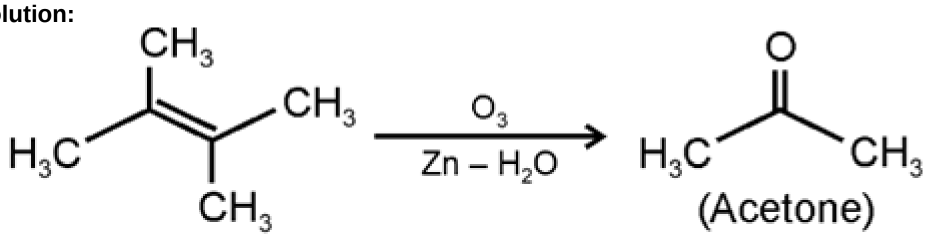
Before Antivirus
· Exponential growth
· First order growth
$I = I_0 e^{kt}\ (k > 0)$
· Graph : Upward curve
After Antivirus :
· Exponential decay
· First order decay
$I = I_0 e^{-kt}\ (k > 0)$
· Graph : Downward curve

(36) **Answer :** (3)
Hint:
P^+ ⇒ In^+ ⇒ Reducing, because it tends to loose e^-.
Solution:
Q^{3+} ⇒ Tl^{3+} ⇒ Oxidising, because it tends to gain e^- as Tl^+ more stable than Tl^{3+}.

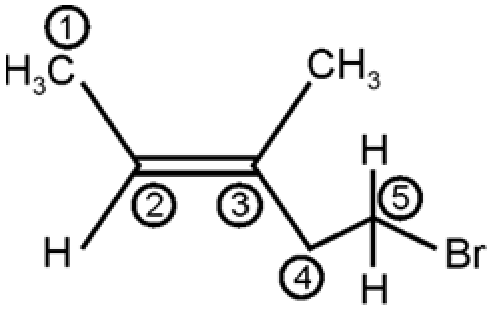
(37) **Answer :** (1)
Hint:
Cr has highest second enthalpy of ionization among 3d series. Fe has +1 oxidation state in brown ring complex.
Solution:
CrO_3 is ⇒ Acidic oxide

(38) **Answer :** (1)
Hint:
$$\underset{20^\circ C}{H_2O(l)} \xrightarrow{(1)} \underset{0^\circ C}{H_2O(l)} \underset{(2)}{\rightleftharpoons} \underset{0^\circ C}{H_2O(s)} \xrightarrow{(3)} \underset{-20^\circ C}{H_2O(s)}$$
Solution:
(1) → –y × 20
(2) → –x × 1000
(3) → –z × 20
ΔH_{net} = –y × 20 + (–x × 1000) + (–z × 20)
= –20(y + 50x + z)

(39) **Answer :** (1)
Hint:


Solution:


2, 3-dimethyl but-2-ene

(40) **Answer :** (2)
Hint:


Solution:

5-Bromo-3-methylpent-2-ene is the correct IUPAC name.

(41) **Answer :** (1)
Hint:
Oxygen of ether can also form H-bond with water just like alcohols.
Solution:
Both statements are correct.

(42) **Answer :** (1)
Hint:
3Cl has more –I effect than $–NO_2$ followed by –CN than –Ph group.
Solution:
The correct order of acidic strength is A > D > E > B > C.

(43) **Answer :** (4)
Hint:
The black body emits and absorbs radiations of all frequencies.
Solution:
Intensity depends upon temperature for a black body.

(44) **Answer :** (1)
Hint:
A ⇒ $[Co(NH_3)_5Br]SO_4$ and B ⇒ $[Co(NH_3)_5SO_4]Br$
Solution:
A + $BaCl_2$ ⇒ $BaSO_4$ (white ppt.)
B + $AgNO_3$ ⇒ AgBr (yellow ppt.)

(45) **Answer :** (4)
Hint:
pH = 2 ⇒ $[H^+]$ ⇒ 10^{-2} ⇒ 0.01
Solution:
New concentration ⇒ $\frac{0.01}{2}$
⇒ 0.005
pH = –log 0.005 ⇒ 2.3

Section-II

(46) **Answer :** 2
Hint:
CN^-, $C_2O_4^{2-}$ ⇒ Strong field ligand.
Solution:
$[Fe(CN)_6]^{4-} \Rightarrow Fe^{2+} \Rightarrow d^6 \Rightarrow t_{2g}^6 e_g^0$ ⇒ 0 unpaired e^- ⇒ d^2sp^3 hybridisation
$[Fe(H_2O)_6]^{2+} \Rightarrow Fe^{2+} \Rightarrow d^6 \Rightarrow t_{2g}^4 e_g^2$ ⇒ 4 unpaired e^- ⇒ sp^3d^2 hybridisation
$[Mn(CN)_6]^{4-} \Rightarrow Mn^{2+} \Rightarrow d^5 \Rightarrow t_{2g}^5 e_g^0$ ⇒ 1 unpaired e^- ⇒ d^2sp^3 hybridisation
$[Co(C_2O_4)_3]^{3-} \Rightarrow Co^{3+} \Rightarrow d^6 \Rightarrow t_{2g}^6 e_g^0$ ⇒ 0 unpaired e^- ⇒ d^2sp^3 hybridisation
$[FeF_6]^{3-} \Rightarrow Fe^{3+} \Rightarrow d^5 \Rightarrow t_{2g}^3 e_g^2$ ⇒ 5 unpaired e^- ⇒ sp^3d^2 hybridisation
$[Ni(H_2O)_6]^{2+} \Rightarrow Ni^{2+} \Rightarrow d^8 \Rightarrow t_{2g}^6 e_g^2$ ⇒ 2 unpaired e^- ⇒ sp^3d^2 hybridisation
$[Fe(CN)_6]^{4-}$ and $[Co(C_2O_4)_3]^{3-}$ are diamagnetic and d^2sp^3 hybridised.

(47) **Answer :** 25
Hint:

MX_2	$\longrightarrow$	M^{2+}	+	$2X^-$
1		–		–
$1-\alpha$		α		2α

Solution:
i = 1 – α + α + 2α
i = 1 + 2α
1.5 = 1 + 2α
$\alpha = \frac{0.5}{2} = 0.25$
$\boxed{\%\alpha = 25}$

(48) **Answer :** 400

Hint:
Galvanic cell established after passage of current.
$\mathrm{Cu}\left|\mathrm{Cu}^{2+}\right|\left|\mathrm{Ag}^{+}\right|\mathrm{Ag}$
Solution:
2 F deposits 2 equi of Cu^{2+} ⇒ 1 mol
Initial moles of Cu^{2+} = 1 × 2 M ⇒ 2 moles
Final moles ⇒ 2 moles – 1 mol ⇒ 1 mole
$\left[\mathrm{Cu}^{2+}\right]_{\text{final}}=\frac{1}{1}=1\text{ M}$

Similarly, 0.2 Faraday deposits ⇒ 0.2 eq. Ag^{+} ⇒ 0.2 mol
Initial moles ⇒ 0.3 × 1 ⇒ 0.3 mol
Final moles ⇒ 0.3 – 0.2 ⇒ 0.1 mol
$\left[\mathrm{Ag}^{+}\right]_{\text{final}}=\frac{0.1}{1\text{ L}}=0.1\text{ M}$

Now, $\mathrm{E}_{\text{cell}}=\mathrm{E}^{\circ}_{\text{cell}}-\frac{0.06}{2}\log\frac{\left[\mathrm{Cu}^{2+}\right]}{\left[\mathrm{Ag}^{+}\right]^{2}}$
Putting values,
$$\mathrm{E}_{\text{cell}}=\left[0.80-0.34\right]-\frac{0.06}{2}\log\frac{1\text{ M}}{(0.1\text{ M})^{2}}$$
$\boxed{\mathrm{E}_{\text{cell}}=400\text{ mV}}$

(49) **Answer :** 12
Hint:

% of C = $\dfrac{\frac{\text{Molecular weight }(\mathrm{C})}{\text{Molecular weight }(\mathrm{CO_2})}\times\text{Weight of }CO_2}{\text{Weight of organic compound}}\times 100$

Solution:

% of C = $\dfrac{\frac{12}{44}\times 110}{250}\times 100=\frac{12\times 10}{4\times 250}\times 100=12$

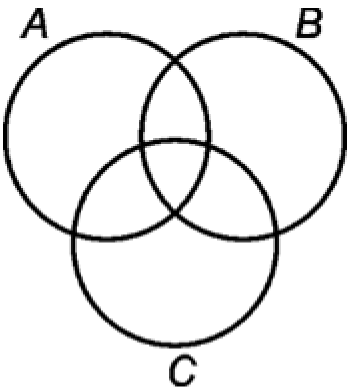
∴ $\boxed{\%\text{ of C} = 12\%}$

(50) **Answer :** 117
Hint:
The molecular formula of triiodothyronine is $C_{15}H_{12}I_3NO_4$.
Solution:
Molecular weight = 15 × 12 + 12 × 1 + 127 × 3 + 14 × 1 + 4 × 16
Molecular weight = 651
Weight of 3 iodine atoms = 381
∴ % of iodine = $\frac{381}{651}\times 100$ = 58.52%
2x = 117.04

Mathematics

Section-I

(51) **Answer :** (1)
Hint:
Venn diagram.
Solution:



$n(C-B)=34$, $n(C-A)=35$
$n(A\cap B\cap C)=1$
$\therefore\ n(C-B)+n(C-A)+n(A\cap B\cap C)=70$

(52) Answer : (3)
Hint:
Put $f'(x)=0$
Solution:
We have
$f(x)=\frac{x^2-3x+2}{x^2+2x-3}=\frac{(x-2)(x-1)}{(x+3)(x-1)}$ = $1-\frac{5}{x+3}$, $x\neq 1$, –3
⇒ $f'(x)=\frac{5}{(x+3)^2}$
⇒ $f'(x)>0\ \forall$ x $\in D_f$
⇒ $f(x)$ is increasing in its domain.

(53) Answer : (1)
Hint:
Let $\frac{x-1}{x+2}=t$ ⇒ $\frac{3}{(x+2)^2}dx=dt$
Solution:
$$I=\int\frac{dx}{(x-1)^{3/4}(x+2)^{5/4}}=\int\frac{dx}{(x+2)^2\left(\frac{x-1}{x+2}\right)^{3/4}}$$
Let $\frac{x-1}{x+2}=t$ ⇒ $\frac{3}{(x+2)^2}dx=dt$
$$\therefore\ I=\int\frac{dt}{3t^{3/4}}=\frac{1}{3}\int t^{-3/4}dt$$
= $\frac{1}{3}\frac{t^{1/4}}{\frac{1}{4}}+C$
= $\frac{4}{3}\left(\frac{x-1}{x+2}\right)^{1/4}+C$

(54) Answer : (3)
Hint:
Vieta's formula
Solution:
α, β, γ are the roots of $x^3-x^2-1=0$
$\alpha+\beta+\gamma=1$
$\alpha\beta+\beta\gamma+\gamma\alpha=0$
$\alpha\beta\gamma=1$
$\alpha^2+\beta^2+\gamma^2=1$
Also, $\beta^3=\beta^2+1$, $\gamma^4=\gamma^3+\gamma=\gamma^2+\gamma+1$
Now, $\alpha^2+\beta^3+\gamma^4=\alpha^2+\beta^2+1+\gamma^2+\gamma+1=3+\gamma$
Let $3+\gamma=x$ ⇒ $\gamma=x-3$, then $f(\gamma)=0$
Replace x by x – 3
⇒ $x^3-10x^2+33x-37=0$

(55) Answer : (1)
Hint:
$\frac{\Sigma x_i}{6}=2$ and $\frac{\Sigma x_i^2}{6}-2^2=23$
Solution:

$\frac{\Sigma x_i}{6}=2$ and $\frac{\Sigma x_i^2}{6}-2^2=23$

$\therefore\ \frac{-3+4+7-6+\alpha+\beta}{6}=2$

α + β = 10

$\frac{9+16+49+36+\alpha^2+\beta^2}{6}-4=23$

$\alpha^2+\beta^2=52$

$\alpha^2+(10-\alpha)^2=52$

$\alpha^2-10\alpha+24=0$

$(\alpha-4)(\alpha-6)=0$

α = 4, 6

When α = 4, β = 6

α = 6, β = 4

M.D = $\frac{\Sigma|x_i-\bar{x}|}{6}=\frac{13}{3}$

(56) **Answer :** (4)

Hint:

$\frac{x+6}{3}=\frac{y}{2}=\frac{z+1}{1}=\lambda$

$\frac{x-7}{4}=\frac{y-9}{3}=\frac{z-4}{2}=\mu$

Solution:

Any point on the given lines $\frac{x+6}{3}=\frac{y}{2}=\frac{z+1}{1}=\lambda$, $\frac{x-7}{4}=\frac{y-9}{3}=\frac{z-4}{2}=\mu$ can be taken as (3λ – 6, 2λ, λ – 1) and (7 + 4μ, 9 + 3μ, 4 + 2μ)

For their point of intersection, we have

$3\lambda-6=4\mu-7$

$3\lambda-4\mu=-1$ …(1)

$2\lambda=3\mu+9$

$2\lambda-3\mu=9$ …(2)

$\lambda-1=2\mu+4$

$\lambda-2\mu=5$ …(3)

λ = 3, μ = –1

∴ Point of intersection is (3, 6, 2)

$\therefore\ d=\sqrt{(7-3)^2+(8-6)^2+(9-2)^2}$

$=\sqrt{16+4+49}$

$=\sqrt{69}$

$\therefore\ d^2+5=69+5=74$

(57) **Answer :** (3)

Hint:

Let $\cos^{-1}\frac{1}{\sqrt{5}}=\theta$

Solution:

Let $\cos^{-1}\frac{1}{\sqrt{5}}=\theta$

$\therefore\ \cos\theta=\frac{1}{\sqrt{5}}$

$\sin\theta=\frac{2}{\sqrt{5}}$

$\sin 2\theta=2\times\frac{2}{\sqrt{5}}\times\frac{1}{\sqrt{5}}=\frac{4}{5}$

$\therefore\ \alpha=\tan\left(\frac{5\pi}{16}\times\frac{4}{5}\right)=\tan\frac{\pi}{4}=1$

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

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

$=\cos\left(2\cos^{-1}\frac{3}{5}\right)$

$=\cos 2\alpha \qquad \left\{\because\ \alpha=\cos^{-1}\frac{3}{5}\ \Rightarrow\ \cos\alpha=\frac{3}{5}\right\}$

$=2\cos^2\alpha-1$

$=2\times\frac{9}{25}-1=\frac{18-25}{25}=-\frac{7}{25}$

$\alpha+\beta=1-\frac{7}{25}=\frac{18}{25}$, $\alpha\beta=\frac{-7}{25}$

∴ Equation is $x^2-(\alpha+\beta)x+\alpha\beta=0$

$x^2-\frac{18}{25}x-\frac{7}{25}=0$

$25x^2 - 18x - 7 = 0$

(58) **Answer :** (1)
Hint:
$B = A(B - I)$
Solution:
$AB = A + B$
$B = AB - A$
$= A(B - I)$
$|B| = |A|\,|B - I| = 0$

(59) **Answer :** (3)
Hint:
Bayes theorem
Solution:
E_1 = Event of both getting correct answer
E_2 = Event of both getting wrong answer
E = Event of both obtaining same answer
$P(E_1) = \frac{1}{4} \times \frac{1}{6} = \frac{1}{24}$
$P(E_2) = \left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{6}\right) = \frac{3}{4} \times \frac{5}{6} = \frac{5}{8}$
$P\left(\frac{E}{E_1}\right) = 1,\ P\left(\frac{E}{E_2}\right) = \frac{1}{15}$
$P\left(\frac{E_1}{E}\right) = \frac{1 \times \frac{1}{24}}{1 \times \frac{1}{24} + \frac{5}{8} \times \frac{1}{15}} = \frac{\frac{1}{24}}{\frac{1}{24} + \frac{1}{24}} = \frac{1}{2}$
$\therefore\ |a+b| = |1+2| = 3$

(60) **Answer :** (4)
Hint:
Property of reflexive, symmetric and transitive
Solution:
In set of integers Z, 0 doesn't divide 0, so R is not reflexive
$2R4$ but $4 \not{R}\, 2$ so R is not symmetric
aRb, $bRc \Rightarrow a$ divides b, b divides c
$\Rightarrow\ b \neq 0,\ b = pa,\ c = qb$
$\Rightarrow\ c = (pq)a,\ pq \in Z$
$\Rightarrow a$ divides c
$\Rightarrow aRc$
$\therefore R$ is transitive

(61) **Answer :** (2)
Hint:
$\frac{5^{200}}{8} = \frac{(1+24)^{100}}{8}$
Solution:
$\frac{5^{200}}{8} = \frac{(1+24)^{100}}{8}$
$\therefore\ \left\{\frac{5^{200}}{8}\right\} = \frac{1}{8}$

(62) **Answer :** (1)
Hint:
Let the first term be a
$x = a + (m-1)\,d$
$y = a + (n-1)\,d$
Solution:
Let the first term be a
$x = a + (m-1)\,d$
$y = a + (n-1)\,d$
$s = \frac{m+n}{2}\,[2a + (m+n-1)\,d]$
$x + y = 2a + (m+n-2)\,d$ and $x - y = (m-n)\,d$
$\Rightarrow\ d = \frac{x-y}{m-n}$
$\Rightarrow\ x + y = 2a + (m+n-1)\,d - \left(\frac{x+y}{m-n}\right)$
$s = \frac{m+n}{2}\left[x + y + \frac{x-y}{m-n}\right]$

(63) **Answer :** (3)

Hint:
General form of circle is $z\bar{z}+\alpha\bar{z}+\overline{\alpha}z+\beta=0$
Solution:
$z\bar{z}+\alpha\bar{z}+\overline{\alpha}z+\beta=0$
$z\bar{z}+2z+2\bar{z}-5=0$
$z_0=-2,\ r=\sqrt{4+5}$
$r = 3$
$|z + 2| = 3$

(64) Answer : (3)
Hint:
Let P be $\left(\frac{3}{2}+\frac{3}{2}t^2,\ 3t\right)$
Solution:
$y^2=6\left(x-\frac{3}{2}\right)$
Equation of directrix $x = 0$
Let P be $\left(\frac{3}{2}+\frac{3}{2}t^2,\ 3t\right)$
∴ Coordinate of M are (0, 3t)
$\therefore\ MS=\sqrt{9+9t^2}$
$MP=\frac{3}{2}+\frac{3t^2}{2}$
$\therefore\ 9+9t^2=\left(\frac{3}{2}+\frac{3}{2}t^2\right)^2=\frac{9}{4}\left(1+t^2\right)^2$
$\therefore\ 4=1+t^2$
⇒ Length of side = 6

(65) Answer : (3)
Hint:
$g(y)=e^y$
Solution:
$f(x)\,g(y)+f'(x)\,g(y)=g'(y)$
$(f(x)+f'(x))\,g(y)=g'(y)$
$f(x)+f'(x)=\frac{g'(y)}{g(y)}$ = constant
⇒ $g(y)=e^y$
$\frac{g'(y)}{g(y)}=k$
$\int\frac{dg}{g}=\int k\,dy$
$\ln|g(y)| = ky+c_1$
$g(y)=ce^{ky}$
$g(0) = 1$
∴ $c = 1$
$g(y)=e^{ky}$
$g'(y)=ke^{ky}$
$g'(0)=1$
⇒ $k = 1$
$\therefore\ g(y)=e^y$
$f(x)+f'(x)=k=1$
$f'(x)=1-f(x)$
$\int\frac{df}{1-f}=\int dx$
$-\ln|1-f(x)| = x+c_1$
$\ln|1-f(x)| = -x-c_1$
$f(x)=1-c_2e^{-x}$
$f'(x)=c_2e^{-x}$
$f'(0)=-5$
⇒ $c_2=-5$
$f(x)=1+5e^{-x}$

(66) Answer : (1)
Hint:
$\sin\theta<\frac{1}{2}$

Solution:

$2\sin^2\theta - 5\sin\theta + 2 > 0$

$\sin\theta < \frac{1}{2} \qquad (\because\ -1 \le \sin\theta \le 1)$

$\theta \in \left(0,\ \frac{\pi}{6}\right) \cup \left(\frac{5\pi}{6},\ 2\pi\right)$

(67) **Answer :** (4)

Hint:

Use concept of combination.

Solution:

Number of ways to choose positions for even digits = ${}^6C_3 = \frac{6!}{3!3!} = 20$

The remaining 3 positions will be occupied by the odd digits.

Once the positions are chosen, then even digits (2, 4, 6) must be placed in increasing order.

There is only 1 way to arrange them in increasing order.

Similarly, the odd digits (1, 3, 5) must be placed in decreasing order.

There is only one way to arrange them in decreasing order.

∴ Total number of ways = ${}^6C_3 \times 1 \times 1$ = 20

(68) **Answer :** (2)

Hint:

Use expansion of ln(1 + 6x) and ln(1 + λx)

Solution:

$\lim\limits_{x\to 0} \frac{\ln\ (1+6x) - \ln\ (1+\lambda x)}{x} = 12$

Using expansion

$\lim\limits_{x\to 0} \frac{(6x+.....)-(\lambda x+.....)}{x} = 12$

$6 - \lambda = 12$

$\lambda = -6$

∴ Absolute value of λ is 6

(69) **Answer :** (3)

Hint:

$\tan 15^\circ = \left|\frac{m_2 - m_1}{1+m_1 m_2}\right| \qquad \{m_2$ is slope of $L_2\}$

Solution:

Slope of $L_1 = m_1 = \tan 45^\circ = 1$

$\tan 15^\circ = \left|\frac{m_2 - m_1}{1+m_1 m_2}\right| \qquad \{m_2$ is slope of $L_2\}$

$2 - \sqrt{3} = \left|\frac{m_2 - 1}{1+m_2}\right|$

Case I :

$\frac{m_2-1}{1+m_2} = 2 - \sqrt{3}$

$m_2 = \sqrt{3}$

Case II :

$\frac{m_2-1}{1+m_2} = -(2-\sqrt{3})$

$m_2 = \frac{1}{\sqrt{3}}$

∴ Equation of L_2 is $y - 0 = \sqrt{3}(x+1)$

$y = \sqrt{3}(x+1)$

or $y - 0 = \frac{1}{\sqrt{3}}(x+1)$

$\sqrt{3}y = x + 1$

(70) **Answer :** (4)

Hint:

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

Solution:

$f(x) = x^2 + 9$, $g(x) = \frac{x}{x-9}$

$a^2 = fog(10) = f\left(\frac{10}{10-9}\right) = f(10) = 109$

$b^2 = gof(3) = g(18) = \frac{18}{9} = 2$

∴ Ellipse is $\frac{x^2}{109} + \frac{y^2}{2} = 1$

$e^2 = 1 - \frac{2}{109} = \frac{107}{109}$

$l = \frac{2b^2}{a} = \frac{2\times 2}{\sqrt{109}} = \frac{4}{\sqrt{109}}$

$\therefore\ 8e^2 + l^2 = 8 \times \frac{107}{109} + \frac{16}{109} = 8$

Section-II

(71) Answer : 30

Hint:

$\Sigma x_i = 15 \times 12$ and $\frac{\Sigma x_i^2}{15} - 12^2 = 14$

Solution:

$\Sigma x_i = 15 \times 12$ and $\frac{\Sigma x_i^2}{15} - 12^2 = 14$

$\Sigma y_i = 15 \times 14$ and $\frac{\Sigma y_i^2}{15} - 14^2 = \sigma^2$

Now, $13 = \frac{(14+144)\times 15 + (\sigma^2 + 196)\times 15}{30} - 13^2$

⇒ $3\sigma^2 = 30$

(72) Answer : 2

Hint:

$T_{r+1} = {}^{1000}C_r \cdot (2)^{\frac{1000-r}{3}} \cdot (5)^{\frac{r}{6}}$

Solution:

$T_{r+1} = {}^{1000}C_r \cdot (2)^{\frac{1000-r}{3}} \cdot (5)^{\frac{r}{6}}$

For the term to be rational, r is multiple of 6 and 1000 – r is multiple of 3.

But, $\frac{1000-r}{3} = \frac{1000}{3} - \frac{6k}{3} = \frac{1000}{3} - 2k$ which cannot be multiple of 3.

∴ Number of irrational terms = 1001

(73) Answer : 1

Hint:

$\vec{p} \cdot \vec{q} = 0$

Solution:

$(\vec{p} \times \vec{q} + \vec{p}) \times \vec{p} = \vec{q}$

$(\vec{p} \times \vec{q}) \times \vec{p} = \vec{q}$

⇒ $\vec{p} \cdot \vec{q} = 0$

$\therefore\ [\vec{p}\ \vec{q}\ \vec{r}] = \vec{p} \cdot (\vec{q} \times \vec{r}) = \vec{p} \cdot (\vec{q} \times (\vec{p} \times \vec{q} + \vec{p}))$

$= (\vec{q}^{\,2}) \cdot (\vec{p}^{\,2}) = 1$

(74) Answer : 1

Hint:

$g(y) = y + \sin y$

Solution:

$f(x) = x + \sin x$

If x, y lies on $f(x)$ then $(-y, -x)$ lines on $g(x)$

⇒ $x = g(y)$, where $g(y) = y + \sin y$

Area = $(2\pi)(2\pi) - \int_0^{2\pi} (y + \sin y)\, dy = 2\pi^2$

(75) Answer : 20

Hint:

Radical axis : $-2ax + a^2 + 2by - b^2 = 20$

Solution:

Radical axis : $-2ax + a^2 + 2by - b^2 = 20$

which passes through $(0, b)$

$\therefore\ a^2 + 2b^2 - b^2 = 20$

⇒ $a^2 + b^2 = 20$