**IIT – JEE: 2026 ADVANCED** | **MAJOR TEST - 3** | **DATE: 29/12/24**

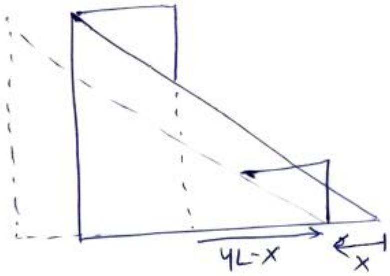
**ANSWER KEY**

# PAPER – 2 (Code – 21)

| PHYSICS | | CHEMISTRY | | MATHEMATICS | |
|---|---|---|---|---|---|
| **1.** | C | **18.** | D | **35.** | B |
| **2.** | C | **19.** | A | **36.** | C |
| **3.** | A | **20.** | D | **37.** | D |
| **4.** | B | **21.** | B | **38.** | C |
| **5.** | BC | **22.** | ABC | **39.** | ACD |
| **6.** | BC | **23.** | ABC | **40.** | ACD |
| **7.** | AB | **24.** | AC | **41.** | BCD |
| **8.** | 16 | **25.** | 4 | **42.** | 12 |
| **9.** | 25 | **26.** | 46 | **43.** | 2 |
| **10.** | 4 | **27.** | 3 | **44.** | 21 |
| **11.** | 2 | **28.** | 6 | **45.** | 4 |
| **12.** | 5 | **29.** | 11 or 12 | **46.** | 720 |
| **13.** | 5 | **30.** | 30 | **47.** | 216 |
| **14.** | 84 | **31.** | 9 | **48.** | 2 |
| **15.** | 3.6 | **32.** | 6 | **49.** | 2 |
| **16.** | 1 | **33.** | 7 | **50.** | 93 |
| **17.** | 6 | **34.** | 4 | **51.** | 53 |

## PART (A) : PHYSICS

1. (C)




$m(4L-x)+5m(-x)=0$

$\Rightarrow\ 4mL=6mx\ \Rightarrow x=\frac{2L}{3}$

2. (C)

Density = $\rho$

Mass of square = M = $\rho\left(16R^2\right)$

$\Rightarrow\ \rho=\frac{M}{16R^2}$

Mass of each disc = $\rho\pi R^2=\left(\frac{M\pi}{16}\right)$

$$\therefore\ I=\frac{M(4R)^2}{6}-4\left(\frac{M\pi}{16}\cdot\frac{R^2}{2}+\frac{M\pi}{16}\cdot\left(R\sqrt{2}\right)^2\right)$$

$$=\frac{8}{3}MR^2-4\left(\frac{M\pi R^2}{32}+\frac{M\pi R^2}{8}\right)$$

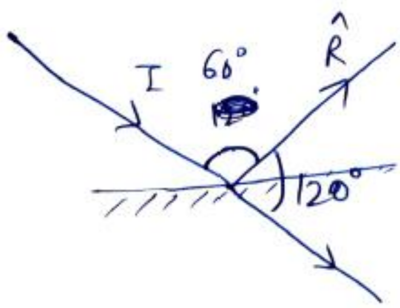
$$=\frac{8MR^2}{3}-\frac{20M\pi R^2}{32}$$

$$=MR^2\left(\frac{8}{3}-\frac{10}{16}\pi\right)$$

3. (A)

Angle between $\hat{I}$ and $\hat{R}$

$$\cos\theta=\frac{\hat{I}\cdot\hat{R}}{|\hat{I}||\hat{R}|}=\frac{\frac{1}{4}-\frac{3}{4}}{1}=-\frac{1}{2}\Rightarrow\ \theta=120^\circ$$




$\Rightarrow$ Angle of incidence $=30^\circ$

4. (B)

$$\left|\vec{v}_{rel}\right| = \sqrt{100+64-128}$$
$$= 6 \text{ m/s}$$
$$S_{rel} = 6\times 40 = 240 \text{ m}$$

5. (BC)

$$\frac{1}{2}K\left(\frac{3\ell}{2}\right)^2 = \frac{1}{2}mv^2$$
$$\Rightarrow v = \sqrt{\frac{K}{m}}\left(\frac{3\ell}{2}\right) \quad .....(1)$$

When $m'$ is dropped

$$m\sqrt{\frac{K}{m}}\left(\frac{3\ell}{2}\right) = (m+m')V \quad .....(2)$$

Also $\frac{1}{2}K\ell^2 = \frac{1}{2}(m+m')V^2$

$$V = \sqrt{\frac{K}{m+m'}}\ell \quad .....(3)$$

Substitute in (2)

$$m\sqrt{\frac{K}{m}}\left(\frac{3\ell}{2}\right) = (m+m')\sqrt{\frac{K}{m+m'}}\ell$$
$$\Rightarrow \frac{9}{4}Km = (m+m')K$$
$$\Rightarrow \frac{5Km}{4} = m'K$$
$$\Rightarrow m' = \frac{5m}{4}$$

6. (BC)

$$u_{com} = \frac{1(4)+2(0)}{1+2} = \frac{4}{3}$$
$$a_{com} = \frac{1(-g)+2(-g)}{1+2} = -g$$

7. (AB)

8. (16)

$$\tau = \mu mgR$$
$$\alpha = \frac{\tau}{I} = \frac{-\mu mgR}{\frac{2}{5}mR^2} = \frac{-5}{2}\frac{\mu g}{R}$$
$$\omega = \omega_0 + \alpha t$$
$$0 = \omega_0 + \alpha t$$
$$\Rightarrow t = \left(\frac{-\omega_0}{\alpha}\right) = \left(\frac{\omega_0 2R}{5\mu g}\right)$$
$$\Rightarrow t = \frac{40\times 2\times 1}{5\times 0.1\times 10} = 16 \text{ s}$$

9. (25)

$\because m = \frac{-1}{4}$ (-ve since length of image < length of object)

$u = (-u); \Rightarrow m = \frac{-1}{4} = \frac{-v}{(-u)} \Rightarrow V = \frac{-u}{4}$

$\frac{1}{\left(\frac{-u}{4}\right)} + \frac{1}{(-4)} = \frac{1}{-f} = \frac{-5}{4} = \frac{1}{-f}$ ......(1)

If object is moved by 5 cm

$u = -u - 5 \qquad m = \frac{-1}{2} \qquad \frac{-V}{-(u-5)} = \frac{-1}{2}$

$V = -\frac{(u-5)}{2}$

$\frac{2}{-(u-5)} + \frac{1}{-(u-5)} = \frac{1}{-f} = \frac{-3}{(4-5)} = \frac{-1}{f}$ .....(2)

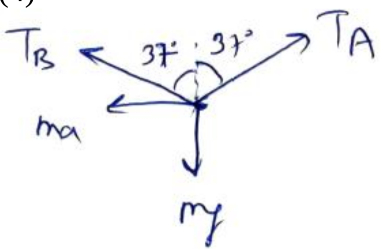
From (1) and (2)

(1) $u = 5f$

(2) $3f = u - 5$

$\Rightarrow 3f = 5f - 5 \Rightarrow 5 = 2f = f = 2.5 = 25mm$

10. (4)




$T_A = 2T_B$

$T_A \cos 37° + T_B \cos 37° = mg$

$\Rightarrow 3T_B \times \frac{4}{5} = mg \Rightarrow T_B = \frac{5mg}{12}$

$\Rightarrow T_A = \frac{5mg}{6}$

$T_A \sin 37° = T_B \sin 37° + ma$

$\Rightarrow 2T_B \times \frac{3}{5} - T_B \times \frac{3}{5} = ma$

$\Rightarrow \frac{5mg}{12} \times \frac{3}{5} = ma$

$\Rightarrow a = \frac{g}{4}$

11. (2)

Solve by similar triangle

12. (5)

Let for bouncing of the block A, the elongation in the spring is $x_1$.

$kx_1 > m_A g$ or $kx_1 > 100$

$\therefore\ x_1 > \frac{100}{150}$ or $x_1 > \frac{2}{3}$

$\therefore\ x_{1\,min} = \frac{2}{3}$

For $x_{1\,min}$, the velocity of block B will be zero.

According to conservation principle of mechanical energy,

$U_i + K_i = U_f + K_f$

$\frac{1}{2}kx_0^2 + \frac{1}{2}mv_{0\,min}^2 = mg\left(x_0 + x_{1\,min}\right) + \frac{1}{2}kx_{1\,min}^2$

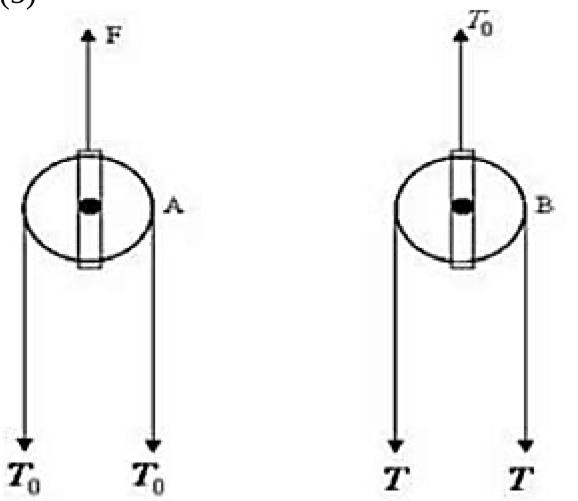
Here, $x_0 = \frac{mg}{k}$

By putting the value,

$v_{0\,min} = \frac{20}{\sqrt{15}}\ m/s$

$\therefore\ n = 5$

13. (5)




Let $T_0 =$ tension in the string passing over A

T = tension in the string passing over B

$2T_0 = F$ and $2T = T_0$

$\Rightarrow\ T = \frac{F}{4}$

When F = 600 N

As T < Mg and T > mg, M will remain stationary on the floor,

Whereas m will move.

Acceleration of m,

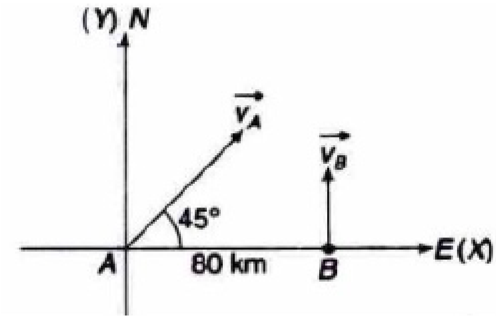
$a = \frac{T - mg}{m} = \frac{150 - 100}{10} = 5\ m/s^2$

14. (84)

15. (3.6)

**Solution for Que. No. 14 & 15**

Let east be our x directions and north be y direction




$\vec{v}_A = 16\sqrt{2}\cos 45°\hat{i} + 16\sqrt{2}\sin 45°\hat{j}$

$= (16\hat{i} + 16\hat{j})\text{kmh}^{-1}$

$\vec{v}_B = 4\hat{j}\,\text{kmh}^{-1}$

Velocity of A as observed by B is

$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$

$= 16\hat{i} + 12\hat{j}$

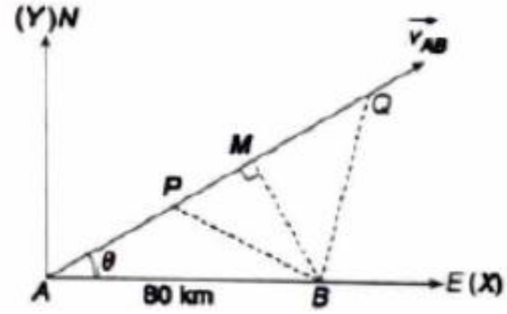
$v_{AB} = \sqrt{16^2 + 12^2} = 20\ \text{kmh}^{-1}$

Direction of $\vec{v}_{AB}$ makes an angle $\theta$ with East where

$\tan\theta = \left(\frac{3}{4}\right)$

$\Rightarrow\ \theta = 37°$

An observer in ship B finds that A is moving at 20 $\text{kmh}^{-1}$ in a direction of $37°\text{N}$ of east




BM is perpendicular to the line representing $\vec{v}_{AB}$ BM is smallest separation between the two ships.

$\text{BM} = 80\sin\theta = 80 \times \frac{3}{5} = 48\ \text{km}$

When ship A is at P (in RF of B) such that BP = 60 km the two ships start communicating and that stop communicating as soon as A cross point Q such that BQ = 60 km.

$\text{PM} = \sqrt{60^2 - 48^2} = 36\ \text{km}$

Similarly, MQ = 36 km

$\text{AM} = 80\cos\theta = 80 \times \frac{4}{5} = 64\ \text{km}$

$\therefore\ \text{AP} = 80\cos\theta - 36 = 80 \times \frac{4}{5} - 36 = 64 - 36 = 28\ \text{km}$

14. Time after which both can start communicating is the time when A reaches P (in RF of B)

$= \frac{28}{20} = \left(\frac{28}{20} \times 60\right) = \text{min} = (28 \times 3)\,\text{min} = 84\ \text{min}$

16. (1)

$$\frac{1}{2}\times100\times(0.1)^2\times2=\frac{1}{2}mv^2$$

$$\Rightarrow\ 1=\frac{1}{2}mv^2$$

$$\Rightarrow\ 1=\frac{1}{2}\times2v^2$$

$$\Rightarrow\ v=1\,m/s$$

17. (6)

$$\mu mgx=1$$

$$\mu(20)\times0.3=1$$

$$\mu=\frac{1}{6}$$

## PART (B) : CHEMISTRY

18. (D)

A) $Fe^{3+} \rightarrow 4s^0\ 3d^5$
$Co^{3+} \rightarrow 4s^0\ 3d^6$
] unpaired $e^-$ greater in $Fe^{3+}$

B) $Ti^{3+} \rightarrow 4s^0\ 3d^1$
$Cr^{+} \rightarrow 4s^0\ 3d^5$
$Sc^{2+} \rightarrow 4s^0\ 3d^1$
] all paramagnetic

C) $Mg \rightarrow 3s^2$  $n+l+m = 3+0+0 = 3$

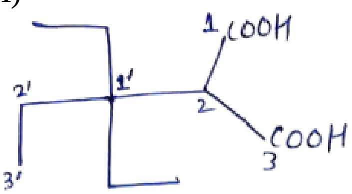
D) $Cl \rightarrow (1s^2)(2s^2 2p^6)(3s^2 3p^5)$

$\sigma$ ~~$Z_{eff}$~~ $= 2\times1 + 8\times0.85 + 6\times0.35$

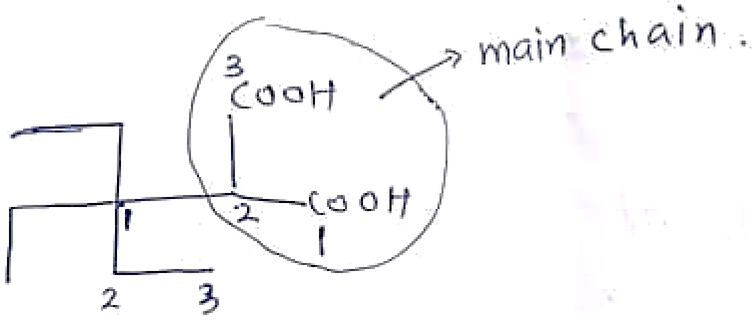
$\sigma = 2 + 6.8 + 2.1 = 10.9$

$Z_{eff} = 17 - 10.9 = 6.1$

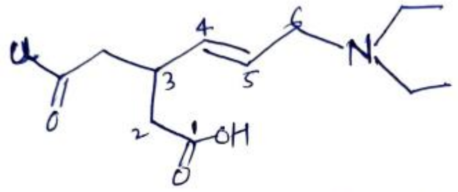
19. (A)



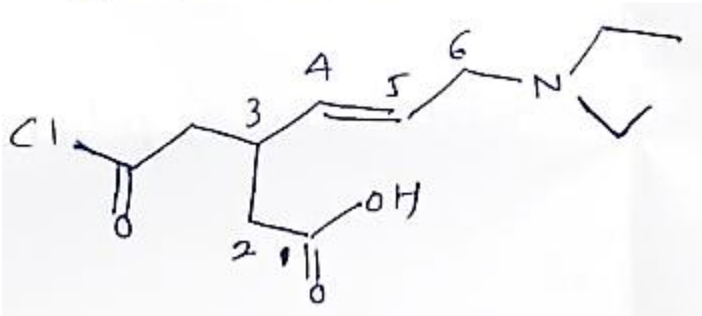

2-(1', 1'-Diethyl propyl) propane-1, 3-dioic acid




20. (D)



3-chloro carbonyl methyl-6-(N, N-diethyl amino) hex-4-en-1-oic acid



21. (B)

$$N_2O_4 \rightleftharpoons 2NO_2$$

$$K_p = \frac{4\alpha^2}{1-\alpha^2}P$$

$$\frac{4(0.4)^2}{1-(0.4)^2}P_1 = \frac{4(0.5)^2}{1-(0.5)^2}P_2$$

$$\frac{P_1}{P_2} = \left(\frac{0.5}{0.4}\right)^2 \times \frac{1-(0.4)^2}{1-(0.5)^2}$$

$$= \frac{25}{16} \times \frac{84}{75} = \frac{7}{4}$$

22. (ABC)

π bond between C & S ⇒ nodal plane is xy

⇒ π bond is formed by overlap of $p_z$ orbitals

⇒ π bond between C & N is due to overlap of $p_y$ orbitals

⇒ π-backbond of N – Si will be by $p_z - d_{xz}$

⇒ max 4 atoms can lie in a plane

23. (ABC)

24. (AC)

$\Delta S_{vap}$ at 350 = $\frac{35000}{350}$ = 100 J/K-mole.

As P↑, $\Delta S_{vap}$ ↓

⇒ (AC)

25. (4)

$\mu = [n(n+2)]^{1/2} = 2.83 \Rightarrow n = 2.$

$N_2$ $\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^2$ (n = 0)

$O_2$ $\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \sigma_{2p_z}^2, \pi_{2p_x}^2 = \pi_{2p_y}^2, \pi_{2p_x}^{*1} = \pi_{2p_y}^{*1}$

(n = 2)

$C_2^{2+}$, $B_2$ $\sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2},\ \pi_{2p_x}^1 = \pi_{2p_y}^1$ $(n=2)$

$C_2$ $\sigma_{1s}^2\ \sigma_{1s}^{*2},\ \sigma_{2s}^2,\ \sigma_{2s}^{*2},\ \pi_{2p_x}^2 = \pi_{2p_y}^2$ $(n=0)$

$N_2^{2-}$ $\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^2, \pi_{2p_x}^{*1} = \pi_{2p_y}^{*1}$ $(n=2)$

$F_2$ $\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \sigma_{2p_z}^2, \pi_{2p_x}^2 = \pi_{2p_y}^2, \pi_{2p_x}^{*2} = \pi_{2p_y}^{*2}$ $(n=0)$

$O_2^-$ $\sigma_{1s}^2\ \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \sigma_{2p_z}^2, \pi_{2p_x}^2 = \pi_{2p_y}^2, \pi_{2p_x}^{*2} = \pi_{2p_y}^{*1}$ $(n=1)$

$Li_2^{+}$ $\sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^1$ $(n=1)$

$B_2^-$ $\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}\ \pi_{2p_x}^2 = \pi_{2p_y}^1$ $(n=1)$

26. (46)

$A^{4+} + e^- \longrightarrow A^{3+}$ $\quad -23x$ ①

$A^{2+} \longrightarrow A^{3+} + e^-$ $\quad 15x$ ②

$A^{2+} + e^- \longrightarrow A^+$ $\quad -8x$ ③

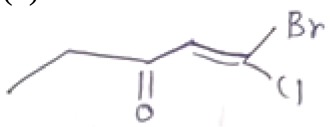
② − ① − ③

$A^+ \longrightarrow A^{4+} + 3e^-$ $\quad 15x + 8x + 23x$

$= 46x$

27. (3)

28. (6)



1-bromo-1-chloropent-1-en-3-one

$P_1$ $P_2$ $P_3$ $P_4$

29. (11 or 12)

) $2\pi r = 5\lambda$

$\Rightarrow n = 5$

photon of $2^{nd}$ highest energy from de-excitation from $5^{th}$ orbit is

$4 \rightarrow 1$

$4 \rightarrow 1$ of H will correspond to $3 \rightarrow 12$ of $Li^{2+}$

30. (30)

$$Br_2(l) + Cl_2(g) \rightleftharpoons 2BrCl.$$

| | | | |
|---|---|---|---|
| i | | 1 | 0 |
| e | | $1-x$ | $2x$ |

$2x$ moles $\Rightarrow$ 0.1 atm.

$$\frac{(0.1)^2}{P_{Cl_2}} = 1 \Rightarrow P_{Cl_2} = 0.01$$

$$\Rightarrow n_{Cl_2} \text{ at eq} = \frac{2x}{10} = 1 - x.$$

$$x = \frac{1}{1.2}$$

$$n_{Br_2} \text{ needed} = \frac{1}{1.2} + \frac{2}{1.2} = \frac{30}{12}$$

31. (9)

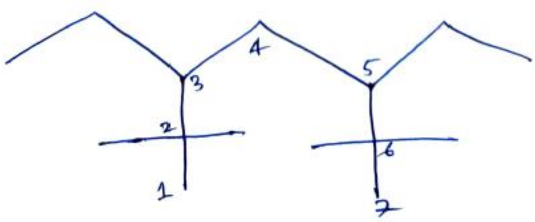
a, c, d, e, f, g, h, (i), j

Correct

32. (6)

c, d, f, h, (i), (j) true

33. (7)




34. (4)

## PART (C) : MATHEMATICS

35. (B)

For $C_1 P(h)=\frac{2}{3}$, for $C_2 P(h)=\frac{1}{3}$, given roots of the equation $x^2-\alpha x+\beta=0$ equal real roots

$\Rightarrow \quad \alpha^2=4\beta$

$\alpha=2$ and $\beta=1$ $\qquad\qquad$ $\alpha=\beta=0$

So required probability $=\left(\frac{2}{3}\right)^2\cdot {}^2C_1\cdot\frac{1}{3}\cdot\frac{2}{3}+\left(\frac{1}{3}\right)^2\left(\frac{2}{3}\right)^2=\frac{16}{81}+\frac{4}{81}=\frac{20}{81}$

36. (C)

$$\left(x^2+\frac{1}{x^2}\right)+2a\left(x+\frac{1}{x}\right)+1=0$$

$\Rightarrow \quad \left(x+\frac{1}{x}\right)^2+2a\left(x+\frac{1}{x}\right)-1=0$

$\Rightarrow \quad t^2+2at-1=0$

Where $t=x+(1/x)$. Now,

$$\left(x+\frac{1}{x}\right)\ge 2 \text{ or } \left(x+\frac{1}{x}\right)\le -2$$

$\therefore \quad t\ge 2$ or $t\le -2$

Now, Eq. (1) will have at least two positive roots, when at least one root of Eq. (2) will be greater then 2. From Eq. (2),

$$D=4a^2-4(-1)=4\left(1+\alpha^2\right)>0, \forall x\in R \qquad \text{….. (3)}$$

Let the roots of Eq. (2) be $\alpha,\beta$. If $\alpha,\beta\le 2$, then

$\Rightarrow \quad f(2)\ge 0$ and $\frac{-B}{2A}<2$

$\Rightarrow \quad 4+4a-1\ge 0$ and $-\frac{2a}{2}<2$

$\Rightarrow \quad a\ge -\frac{3}{4}$ and $a>-2$

$\Rightarrow \quad a\ge -\frac{3}{4}$

Therefore, at least one root will be greater than 2. Then,

$$a<-\frac{3}{4} \qquad \text{….. (4)}$$

Combining (3) and (4), we get

Hence, at least one root will be positive if $a\in\left[-\infty,-\left(\frac{3}{4}\right)\right]$.

37. (D)

$1440=2^5.3^2.5^1$

No. of divisors $=(5+1).(2+1).(1+1)=36$

Product of divisors = 1.2.3.480.720.1440

Here all the 36 divisors are written in the increasing order. They can be clubbed into 18 pairs, as shown below.

(1.1440). (2.720).(3.480) …….. etc.

$\therefore$ Product of divisors $=(1440)^{18}=2^{90}.3^{36}.5^{18}=(2^3.3)^{30}.3^6.5^{18}=24^{30}.3^6$

Which is divisible by $24^x$

$\therefore$ maximum value of x = 30

38. (C)

Total number of 6 digit natural number formed (zero can be in 1st place) having exactly three odd digit and three even digit equal to ${}^6C_3 5^6$

Total number of 5 digit natural number formed (zero can be in first place) having exactly 3 odd digit and 2 even digit equals to ${}^5C_3\, 5^5$

Total number of 6 digit natural number (zero cannot be in 1st place) having exactly three odd digit and three odd digit and three even digits equals to

${}^6C_3 5^6 - {}^5C_3 5^5 = (100-10)5^5 = 281250$

39. (ACD)

40. (ACD)

41. (BCD)

42. (12)

Use $D \ge 0, -6 < \frac{-b}{2a} < 1$ and $f(-6) > 0, f(1) > 0$

43. (2)

General term is

$$T_r = \frac{r+2}{r(r+1)2^{r+1}}$$
$$= \frac{1}{r\cdot 2^r} - \frac{1}{(r+1)\cdot 2^{r+1}}$$

44. (21)

There are $\binom{40}{2} = 780$ total pairings of teams, and thus $2^{780}$ possible outcomes. In order for no two teams to win the same number of games, they must each win a different number of games. Since the minimum and maximum possible number of games won are 0 and 39 respectively, and there are 40 teams in total, each team corresponds uniquely with some k, with $0 \le k \le 39$, where k represents the number of games the team won. With this in mind, we see that there are a total of 40! Outcomes in which no two teams win the same number of games. Further, note that these are all the valid combinations, as the team with 1 win must beat the team with 0 wins, the team with 2 wins must beat the teams with 1 and 0 wins, and so on; thus, this uniquely defines a combination.

The desired probability is this $\frac{40!}{2^{780}}$.

45. (4)

$$\frac{-\cos 4x}{2} = \frac{1}{2}$$
$$\cos 4x = -1$$
$$4x = \pi, 3\pi$$

$x = \frac{\pi}{4}, \frac{3\pi}{4}$

2 solutions.

46. (720)

$4 \times \left( {}^5C_2 \times {}^4C_2 \times {}^3C_2 \right)$

47. (216)

Toys in group 1 1 2 $\rightarrow \frac{4!}{1!1!2!2!} \times 3! = 36$

Marbles $O \quad O \quad \not{O} \quad \not{O} = {}^4C_2 = 6$

$\Rightarrow$ Total ways = 36 × 6 = 216

48. (2)

$\frac{1}{3}\left[\frac{1}{5} + \frac{1}{9} + \frac{1}{14} + \frac{1}{20} + \frac{1}{27} + ..........\infty\right]$

$= \frac{2}{3}\left[\frac{1}{2\times5} + \frac{1}{3\times6} + \frac{1}{4\times7} + \frac{1}{5\times8} + \frac{1}{6\times9}.......\infty\right] = \frac{13}{54}$

49. (2)

$$\sum_{n=2}^{\infty} \frac{U_{n+1} - U_{n-1}}{U_{n-1} - U_{n+1}} = \sum_{n=2}^{\infty} \frac{1}{U_{n-1}} - \frac{1}{U_{n+1}}$$

$$= \frac{1}{U_1} + \frac{1}{U_2} = 2$$

50. (93)

Number of functions $= 3^5 - \left[ {}^3C_1 + {}^3C_2 \left(2^5 - 2\right)\right]$

51. (53)

$D(6) =$ dearrangement of 6 objects = 265

Required number of functions $= \frac{D_6}{5} = \frac{265}{5} = 53$