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

ADVANCED **ANSWER KEY**

PAPER – 1 (Code – 11)

PHYSICS		CHEMISTRY		MATHEMATICS	
1.	BD	**18.**	ABC	**35.**	AB
2.	BCD	**19.**	ACD	**36.**	ABD
3.	CD	**20.**	ABD	**37.**	AC
4.	C	**21.**	C	**38.**	A
5.	C	**22.**	B	**39.**	A
6.	C	**23.**	B	**40.**	B
7.	B	**24.**	A	**41.**	B
8.	52	**25.**	13	**42.**	2
9.	100	**26.**	16	**43.**	98
10.	10	**27.**	900	**44.**	3480
11.	5	**28.**	5	**45.**	7
12.	10	**29.**	9	**46.**	5
13.	3	**30.**	6	**47.**	5
14.	D	**31.**	B	**48.**	B
15.	B	**32.**	B	**49.**	C
16.	B	**33.**	C	**50.**	C
17.	D	**34.**	B	**51.**	A

PART (A) : PHYSICS

1. (BD)

2. (BCD)

$$\mu\left(mg\cos\theta+\frac{mv^2}{R}\right)=mg\sin\theta$$

$$\Rightarrow \mu=\frac{mg\sin\theta}{mg\cos\theta+\frac{mv^2}{R}}$$

$$P=\bar{F}\cdot\bar{v}$$

$$=\text{Friction force}=mg\sin\theta$$

$$=-mg\sin\theta v$$

$$\omega_{mg}+\omega_f=K_f-K_i=0$$

$$\omega_f=-\omega_{mg}$$

$$=-mgR$$

$$N+\frac{mv^2}{R}=mg\cos\theta+\frac{mv^2}{R}$$

$$\mu N=mg\cos\theta-\frac{mv^2\mu}{R}$$

$$mg\sin\theta=\mu mg\cos\theta-\frac{mv^2}{R}\mu$$

3. (CD)

$$v_B=v_A\cos\theta \qquad \ell v_B=xv_A$$

$$v_B=v_A\frac{x}{\ell} \qquad \ell a_B+v_B\frac{d\ell}{dt}=xa_A+v_a\frac{dx}{dt}$$

$$\ell a_B-v_B^2=xa_A-v_A^2 \quad (a_A=0)$$

$$\ell a_B=v_B^2-v_A^2$$

$$a_B=\frac{v_B^2-v_A^2}{\ell}$$

$$a_B=\frac{\left\{\frac{3^2}{5^2}-1\right\}v_A^2}{5}$$

$$|a_B|=\frac{16}{125}v_A^2$$

4. (C)

Image in $m_1=(d_1-d)$

It will act as object for m_2

$\Rightarrow$ Distance from $m_2=2d$

$\Rightarrow$ Image in $m_2=(-d,d)$

5. (C)

$$\frac{1}{2}mv_0^2+\frac{1}{2}m\left(\frac{v_0}{2}\right)^2=mg\ell+\frac{mg\ell}{2}$$

$$\left(\frac{5}{4}\right)\left(\frac{1}{2}mv_0^2\right)=\frac{3mg\ell}{2}\Rightarrow v_0=\sqrt{\frac{12\ell g}{5}}$$

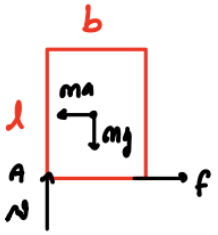
6. (C)

7. (B)

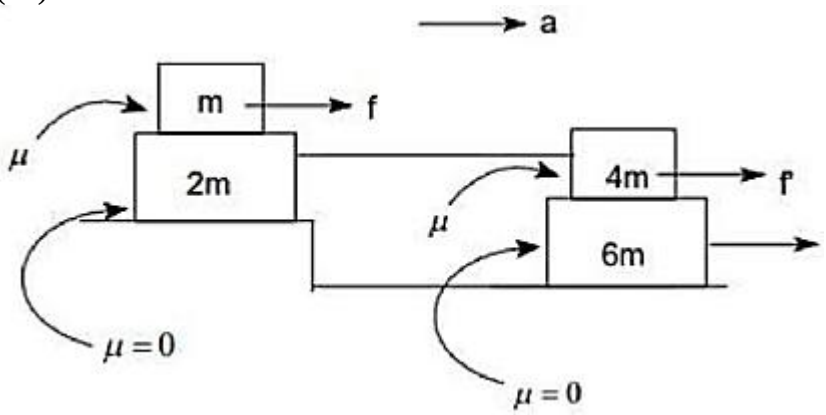
Torque below about A:

$$\frac{ma\ell}{2}=\frac{mgb}{2}$$

$$a=\frac{gb}{\ell}$$



8. (52)



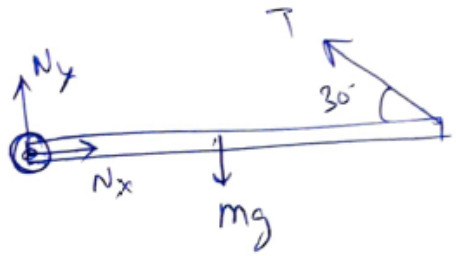
$$F=(13m)a\Rightarrow a=\frac{F}{13m}$$

$$f=ma=\frac{F}{13}\le\mu mg$$

Also, $f'=(7m)a=\frac{7F}{13}\le 4\mu mg$

$$\Rightarrow F\le\frac{52\mu mg}{7}$$

9. (100)



Torque below about hinge

$$mg\times\frac{\ell}{2}=T\cos 60^\circ\times\ell$$

$$\Rightarrow T=mg$$

Vertical force below

$$T\cos 60^\circ+\mu_y=mg$$

$\Rightarrow \mu_y = \dfrac{mg}{2}$

Horizontal force below

$N_x = T\cos 30° = \dfrac{mg\sqrt{3}}{2}$

$F = \sqrt{N_x^2 + N_y^2} = mg\sqrt{\dfrac{1}{4}+\dfrac{3}{4}} = mg = 100\ N$

10. (10)

At t = 0

$f = +1m, \qquad u = -9m$

$\dfrac{1}{v}+\dfrac{1}{(-9)} = \dfrac{1}{1} \Rightarrow \dfrac{1}{v} = 1+\dfrac{1}{9} = \dfrac{10}{9} \Rightarrow v = \dfrac{9}{10}$

At t = 1s

$f = 1m \qquad u = -4m$

$\dfrac{1}{v}+\dfrac{1}{(-4)} = \dfrac{1}{1} \Rightarrow \dfrac{1}{v} = \dfrac{1}{1}+\dfrac{1}{4} = \dfrac{5}{4} = v = \dfrac{4}{5}$

Distance moved $= \dfrac{9}{10}-\dfrac{4}{5} = \left(\dfrac{1}{10}\right)$

Time = 1s

$< v >= \dfrac{1/10}{1} = \dfrac{1}{10} m/s = 10\ cm/s$

11. (5)

$$X_{COM} = \frac{M(0)+\left(\frac{-M}{4}\right)\left(\frac{R}{2}\right)+\frac{M}{4}\left(\frac{3R}{2}\right)}{M}$$

$$= \frac{-R}{8}+\frac{3R}{8} = \frac{R}{4}$$

$$= 5\,cm$$

12. (10)

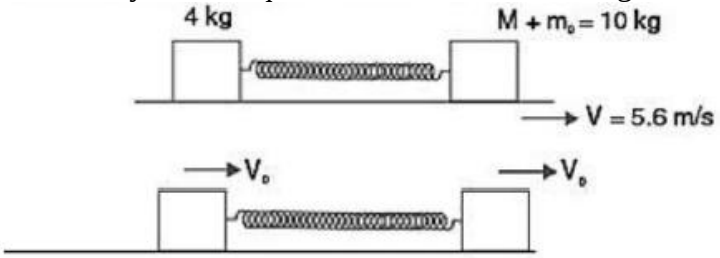
After collision velocity of $(M + m_0)$ system is given by momentum conservation.

$(M+m)V = m_0 u$

$10V = 0.14 \times 400$

V = 5.6 m/s

Now the system is equivalent to that shown in figure below.



Extension is maximum when both blocks have same velocity

$(4+10)V_0 = 10 \times 5.6 \Rightarrow V_0 = 4\,m/s$

Energy conservation

$\dfrac{1}{2}Kx^2 + \dfrac{1}{2}(14)V_0^2 = \dfrac{1}{2} \times 10 \times 5.6^2$

$$\Rightarrow \frac{1}{2}\times(8960)\times x^2+\frac{1}{2}\times 14\times 4^2=\frac{1}{2}\times 10\times(5.6)^2$$

Solving x = 0.1 m

13. (3)

If volume = constant $\Rightarrow$ mass = constant

$$I=\frac{mL^2}{12}+\frac{mR^2}{4}=\frac{mL^2}{12}+\frac{mV}{\pi L^4}$$

$$\frac{dI}{dL}=\frac{m}{12}(2L)+\frac{mV}{4\pi}\left(\frac{-1}{L^2}=0\right)$$

$$\Rightarrow \frac{L}{6}=\frac{V}{4\pi L^2}$$

$$\Rightarrow L=\sqrt[3]{\frac{6B}{\pi 4}}$$

$$V=\pi R^2 L$$

$$R^2=\frac{V}{\pi L}$$

$$L=\sqrt[3]{\frac{6V}{4\pi}};\qquad R=\sqrt{\frac{V}{\pi L}}$$

$$R\sqrt{L}=\sqrt{\frac{V}{\pi}}$$

$$L^3=\frac{6V}{4\pi} \qquad .....(1)$$

$$R^2L=\frac{V}{\pi} \qquad .....(2)$$

$$(1)/(2)$$

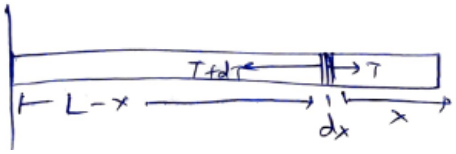
$$\frac{L^2}{R^2}=\frac{6}{4}\Rightarrow \frac{L}{R}=\sqrt{\frac{3}{2}}$$

14. (D)

$$F_x=-\frac{\partial U}{\partial x};\ F_y=-\frac{\partial U}{\partial z};\ F_z=-\frac{\partial U}{\partial z}$$

Check for all.

15. (B)



$$dT=\left(dm/\omega^2(L-x\right)$$

$$\int_0^T dT=\int_0^x \frac{M}{L}dx\,\omega^2(L-x)$$

$$T=\frac{m}{L}\omega^2\left(Lx-\frac{x^2}{2}\right)$$

At R; $x = \frac{L}{4} \Rightarrow T = \frac{m}{L}\omega^2\left(\frac{L^2}{4} - \frac{L^2}{32}\right) = \frac{m\omega^2}{L}\left(\frac{7L^2}{32}\right)$

Similarly substitute for all.

16. (B)

$v = 6t - \frac{3t^2}{2}$

$v = 3t\left(2 - \frac{t}{2}\right)$

$v = 0$ at $t = 0$, $t = 4$

$\boxed{\begin{array}{l} v > 0 \text{ at } t < 4 \\ v < 0 \text{ at } t > 4 \end{array}}$

$a = 6 - 3t$

$\boxed{\begin{array}{l} a > 0 \text{ at } t < 2 \\ a < 0 \text{ at } t > 2 \end{array}}$

$\boxed{\begin{array}{l} x = 0 \\ \text{at } t = 0, 6 \end{array}}$

$\boxed{\begin{array}{l} v = 0 \\ \text{at } t = 0, 4 \end{array}}$

17. (D)

PART (B) : CHEMISTRY

18. (ABC)

$X(s) \rightleftharpoons Y(g) + 2Z(g)$

e $\quad P_1 \quad 2P_1$

$P_{tot} = 3P_1 \quad K_{p_1} = 4P_1^3$

$V(s) \rightleftharpoons W(g) + 2Z(g)$

e $\quad 2P_1 \quad 4P_1$

$P_{tot} = 6P_1 \quad K_{p_2} = 32P_1^3$

(A) $K_{p_2} = 8K_{p_1}$ (True)

e $\quad X(s) \rightleftharpoons Y(g) + 2Z(g)$
$\quad\quad\quad\quad x \quad\quad 2x+2y$

e $\quad V(s) \rightleftharpoons W(g) + 2Z(g)$
$\quad\quad\quad\quad y \quad\quad 2x+2y$

$4(x+y)^3 = 36P_1^3$

$x + y = 9^{1/3} P_1$

$x = \frac{P_1}{3 \times 3\sqrt{3}}$

$y = \frac{8P_1}{3 \times 3\sqrt{3}}$

So (ABC)

19. (ACD)

20. (ABD)

$E_{4S} < E_{3d}$.

Balmer of H lies in visible range

Li^{2+} is single e^- species. so no shielding.

So (ABD)

21. (C)

In P $[H^+] = 0.1$

in Q $[H^+] = \frac{50 \times 0.1 - 25 \times 0.1}{75}$

$= \frac{1}{30}$.

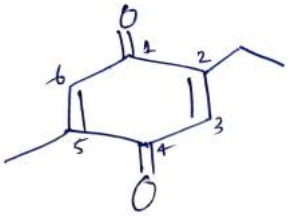
In R $[H^+] = \frac{2.5}{100} = \frac{1}{40}$

In S $[H^+] = \frac{2.5 + 2.5}{150} = \frac{1}{30}$

In T $[OH^-] = \frac{50 - 5}{200} = \frac{1}{40}$

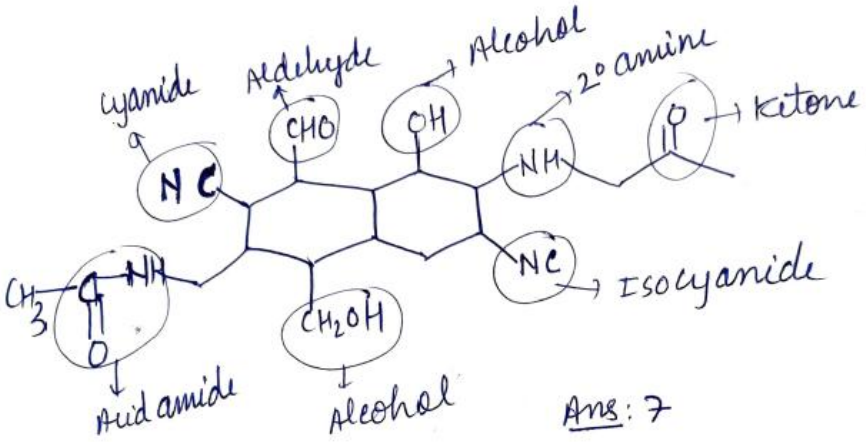
$\Rightarrow$ (C)

22. (B)



2-Ethyl-5-methyl cyclohexa-2,5-diene-1,4-dione

23. (B)



Ans: 7

24. (A)

$NO_2-CH_2-COOH > NC-CH_2-COOH > F-CH_2-COOH > Cl-CH_2COOH$

(Due to $-I$ Power $-NO_2 > -CN > -F > -Cl$)

25. (13)

26. (16)

$$\Delta S_{sys} = 10 \times R \times \ln \frac{2}{1}$$

$$= 7R = 56$$

$$\Delta S_{surr} = \frac{-1\left(\frac{nRT}{7} - \frac{nRT}{2}\right)}{T}$$

$$= -\frac{10 \times R}{2} = -5R = -40$$

$$\Delta S_{univ} = 16$$

27. (900)

$$Q = -\Delta U$$

$$n C_{process} \Delta T = -n C_V \Delta T$$

$$C_{process} = -1.5R = C_V + \frac{R}{1-m}$$

$$\frac{R}{1-m} = -3R \Rightarrow \frac{1}{1-m} = -3$$

$$1 - m = -\frac{1}{3} \Rightarrow m = \frac{4}{3}$$

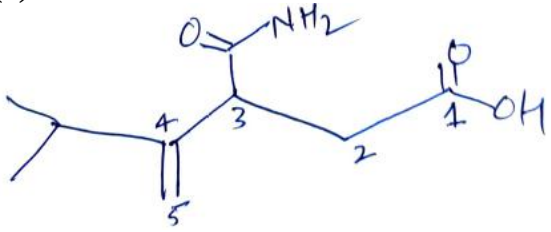
$$T_f = T_i \left(\frac{V_i}{V_f}\right)^{m-1} = 300 \times \frac{1}{2} = 150$$

$$\Delta U = 1 \times 1.5R \times (-150) = -225R$$

$$Q = 225R.$$

$$W = \Delta U - Q = -450R = -900 \text{ cal}.$$

28. (5)



29. (9)

Bicyclo [3.3.3] undecane

$B_1 + B_2 + B_3 = 3 + 3 + 3 = 9$

30. (6)

NO_2-CH_2-COOH

$(CH_3)_2CH-COOH$

CH_3-COOH

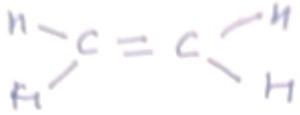
$HCOOH$

$NC-CH_2-COOH$

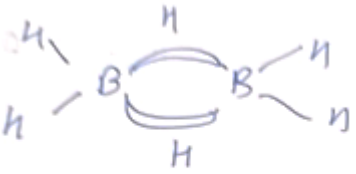
$(NO_2)_2CH-COOH$

due to acid anion stability

31. (B)



(I) → Q, R



(II) → P, R, T.

III → T

IV → R, S, T.

32. (B)

XeF_6 $\sigma = 6$, $lp = 1$

capped octahedron.

III → P

XeO_3F_2 5σ, 3π.

⇒ trigonal bipyramid

IV → Q.

XeO_4 4σ, 4π.

⇒ tetrahedron

I → R

XeO_6^{4-} 6σ, ~~2~~π. ⇒ octahedron

II → S.

XeO_2F_2 $\sigma = 4$, ~~A~~$= 2$, $lp = 1$.

33. (C)

N_2^+ → 13e⁻

NO → 15e⁻ I → R, T

NF^{2-} → 18e⁻

II → P, T.

O_2 → bo = 1

$CO \rightarrow 14e^-$ III $\rightarrow$ Q., T.

$CN^- \rightarrow 14e^-$

$C_2 \rightarrow 12e^-$ IV $\rightarrow$ S T.

$CN^+ \rightarrow 12e^-$

34. (B)

(I) $P(V-b) = RT$ (RT)

(II) $\left(P + \frac{a}{V^2}\right)(V) = RT$ (Q.)

(III) $PV = RT$ (S)

(IV) $\left(P + \frac{a}{V^2}\right)(V-b) = RT$ (P)

PART (C) : MATHEMATICS

35. (AB)

36. (ABD)

$f(1) = \max\{1+\sin 1, 1, 1-\cos 1\} = 1+\sin 1$

$g(f(0)) = g(1) = \max\{1, |1-1|\} = 1$

$f(g(0)) = f(1) = 1+\sin 1$

$g(f(1)) = g(1+\sin 1) = \max\{1, |1+\sin 1-1|\} = 1$

37. (AC)

(A) $f(x) - \ln\left(\tan \pi[x] + \left|x^2+2x-3\right|\right)$

$\therefore \quad [x] \in I \Rightarrow \tan \pi[x] = 0$, and $\left|x^2+2x-3\right| = \left|(x+1)^2 - 2\right| \in [0, \infty)$

So, $f(x) \in R \Rightarrow f(x)$ is surjective.

(B) $g(x) = \frac{x^2+2x-3}{x-1}, x \neq 1$

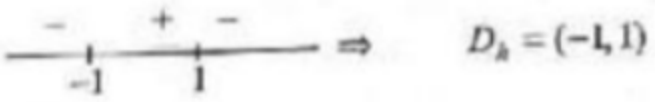
$g(x) = \frac{(x-1)(x+3)}{(x-1)}, x \neq 1$

$g(x) = x+3 \quad \therefore g(x) \neq 4 \quad (\because x \neq 1)$

So, range of g(x) is R – {4}

$\Rightarrow$ g(x) is not surjective.

(C) $h(x) = \ln\left(\frac{1-x}{1+x}\right), \frac{1-x}{1+x} > 0$



$\Rightarrow \quad D_h = (-1, 1)$

$\because \quad \dfrac{1-x}{1+x}$ take all value between $(0, \infty)$

So, range of $h(x) = R$

$\Rightarrow$ h(x) is surjective.

(D) $k(x)\sqrt{[x]+[-x]+1}+\sqrt{\{x\}+\{-x\}+1}$

Domain of k(x) is R

$x \notin I \Rightarrow [x]+[-x]=-1$ and $\{x\}+\{-x\}=1$

$\Rightarrow \quad k(x)=2$

$x \notin I \Rightarrow [x]+[-x]=-1$ and $\{x\}+\{-x\}=1$

$\Rightarrow \quad k(x)=2$

So, range of $k(x)=\{\sqrt{2}, 2\}$

So, k(x) is not surjective.

38. (A)

$$\left(4\sin^2 x+\frac{1}{\sin^2 x}\right)+\left(\tan^2 x+\frac{1}{\tan^2 x}\right)=6$$

$$=\left(2\sin x-\frac{1}{\sin x}\right)^2+\left(\tan x-\frac{1}{\tan x}\right)^2+4+2=6$$

For solution to lie exists

$$2\sin x-\frac{1}{\sin x}=0 \text{ and } \tan x-\frac{1}{\tan x}=0$$

39. (A)

$$16\left(\sin^5 x+\cos^5 x\right)-11(\sin x+\cos x)=0$$

$$\Rightarrow \quad (\sin x+\cos x)\left\{16\left(\sin^4 x-\sin^3 x\cos x+\sin^2 x\cos^2 x-\sin x\cos^3 x+\cos^4 x\right)-11\right\}=0$$

$$\Rightarrow \quad (\sin x+\cos x)\left\{16\left(1-\sin^2 x\cos^2 x-\sin x\cos x\right)-11\right\}=0$$

$$\Rightarrow \quad (\sin x+\cos x)(4\sin x\cos x-1)(4\sin x\cos x+5)=0$$

As $4\sin x\cos x+5\neq 0$, we have

The required values are

$$\frac{\pi}{12}, \frac{5\pi}{12}, \frac{9\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}, \frac{21\pi}{12}$$

They are 6 solutions on $[0, 2\pi]$

40. (B)

$$P=\frac{49}{100}$$

41. (B)

No's divisible by 3 = 300, No's divisible by 4 = 225

No's divisible by 12 = 75, No's divisible by 48 = 18

Total no's = 300 + 225 – 75 – 18,

Total no's = 432

42. (2)

43. (98)

A	B	C	
1	1	3	${}^2C_1.{}^3C_1.{}^4C_3 = 24$
1	2	2	${}^2C_1.{}^3C_2.{}^4C_2 = 36$
1	3	1	${}^2C_1.{}^3C_3.{}^4C_1 = 8$
2	1	2	${}^2C_2.{}^3C_1.{}^4C_2 = 18$
2	2	1	${}^2C_2.{}^3C_2.{}^4C_1 = 12$
			98

44. (3480)

$x_1 + x_2 + x_3 + x_4 = 16, 17, 18, 19, 20$

${}^{20}C_4 - {}^{15}C_4 = 3480$

45. (7)

46. (5)

Let $y = \dfrac{ax^2 + 3x - 4}{3x - 4x^2 + a}$

$x^2(a + 4y) + 3(1 - y)x - (4 + ay) = 0$

If $x \in R, D \geq 0$

$\Rightarrow 9(1-y)^2 + 4(a + 4y)(4 + ay) \geq 0 \Rightarrow (9 + 16a)y^2 + (4a^2 + 46)y + (9 + 16a) \geq 0$

For all $y \in R, (9 + 16a) > 0$ & $D \leq 0$

$\Rightarrow (4a^2 + 46)^2 - 4(9 + 16a)(9 + 16a) \leq 0 \Rightarrow 4(a^2 - 8a + 7)(a^2 + 8a + 16) \leq 0$

$\Rightarrow a^2 - 8a + 7 \leq 0 \quad \Rightarrow \quad 1 \leq a \leq 7$

$9 + 16a > 0 \,\&\, 1 \leq a \leq 7$

Taking intersection, $a \in [1, 7]$

Now, checking the boundary values of a

For a = 1

$y = \dfrac{x^2 + 3x - 4}{3x - 4x^2 + 1} = -\dfrac{(x-1)(x+4)}{(x-1)(4x+1)}$

$\because x \neq 1 \Rightarrow y \neq -1$

$\Rightarrow a = 1$ is not possible.

If a = 7

$y = \dfrac{7x^2 + 3x - 4}{3x - 4x^2 + 7} = \dfrac{(7x-4)(x+1)}{(7-4x)(x+1)}$ $\qquad \because x \neq -1 \Rightarrow y \neq -1$

So y will assume all real values for some real values of x.

So, $a \in (1, 7)$

47. (5)

48. (B)

$P(x)=(x-1)(x-2)(x-3)(x-4)+x^3+1$

$=x^4-9x^3+35x^2-50x+25$

$a=9,\ b=35,\ c=50,\ d=25$

49. (C)

$a=3, b=2, c=1, d=2$

50. (C)

51. (A)