FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – IV
PAPER –1
TEST DATE: 08-02-2024

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. BC

Sol. Equation of velocity profile $v = \frac{v_o}{\sqrt{d}} y^{1/2}$

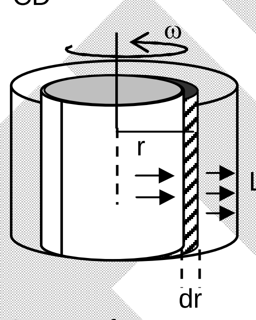
viscous force on plate $F = \eta A \frac{dv}{dy}$

y = d

shear stress = $\frac{F}{A} = \frac{\eta v_o}{2d}$

2. CD

Sol.



Lorentz force

$eE \pm e\omega rB = m\omega^2 r$

$E = \left(\frac{m\omega^2}{e} \pm \omega B\right) r = E_o r$

From gauss Law:

Electric flux $\phi = -E_o r\, 2\pi rL + E_o (r+dr) 2\pi (r+dr) L = \frac{\rho 2\pi rLdr}{\epsilon_0}$

$\rho = \frac{2\epsilon_0 m\omega}{e}\left(\omega \pm \frac{eB}{m}\right)$

3. ACD

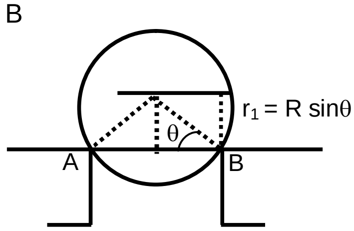
Sol. Radius $r = \frac{mv}{qB} = 5m$

Particle will move along circular path of radius 5 m in x-z plane

$T = \frac{2\pi m}{qB} = 3.14\ s.$

4. B

Sol.



$v_o = w_o R\sin\theta$

and

For second collision

$Iw_o > mv_o r_1$

$\frac{d}{2R} = \cos\theta > \sqrt{\frac{3}{5}}$

5. C

Sol. Number of α - particles $N = N_o\left(1 - e^{-\lambda\times\frac{1}{\lambda}}\right)$

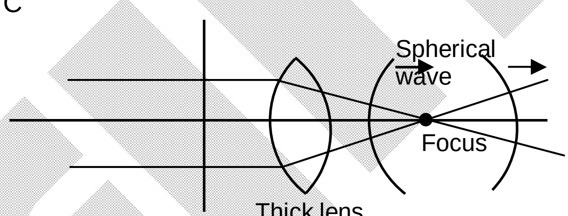
emitted in mean life time $t = \frac{1}{\lambda}$

Heat generated $= K\alpha N_0\left(1 - \frac{1}{e}\right)$

$= 1.54 \times 10^6\ J$

6. C

Sol.



7. A

Sol. From $T = \frac{2\pi}{\sqrt{GM}} r^{3/2}$

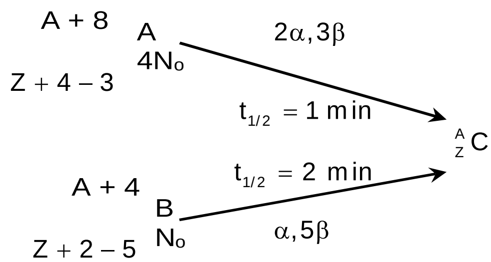
$r_1 = 10R$ and $r_2 = 40R$

Possible radius of orbits: $10R, 15R, ..., 40R$

Maximum number of orbits = $20 + 30 + 40 + ... + 80 = 350$

8. A

Sol.



$$e^{-\frac{\ln 2}{1}} \times 4 = 2^{-4}$$

$$e^{-\frac{\ln 2}{2}} \times 4 = 2^{-2}$$

$$N_A = 4N_0 e^{-\lambda_1 t} = N_B = N_0 e^{-\lambda_2 t}$$

$$4 = e^{(\ln 2)t\left(1-\frac{1}{2}\right)} = 2^{\frac{t}{2}}$$

$$t = 4 \text{ min}$$

$$\frac{N_C}{N_B} = \frac{4N_0\left(1-e^{-\lambda_1 t}\right) + No\left(1-e^{-\lambda_2 t}\right)}{No\ \ e^{-\lambda_2 t}} = 18$$

9. B

Sol. Using Barnaul's Equation- $\frac{P}{\rho}\ln P + \frac{v^2}{2} + gh = \text{Constant}$,

Eq. of continuity - $\rho A v =$ constant and

Ideal gas eq.- $P = \rho\left(\frac{R}{M}\right)T$

We get $v_1 = 4 \times 11$

$v_2 = 5 \times 70$

$\frac{\rho_1}{\rho_2} = 2$

Mass flow rate = $\rho_1 A_1 v_1 = 1 \times 40$

10. D

Sol. $\frac{1}{V}\left(\frac{dV}{dT}\right) = \frac{m}{T}$ where m = $\tan\theta$

$$TV^{-\frac{1}{m}} = \text{constant}$$

$$PV^{\left(1-\frac{1}{m}\right)} = \text{constant}$$

$$W = -\frac{nR\Delta T}{1-\frac{1}{m}-1} = nmR\Delta T$$

$$\Delta U = \frac{n\ f\ R\Delta T}{2}$$

$$C = \frac{\left(1-\frac{1}{m}-\frac{5}{3}\right)R}{\left(1-\frac{1}{m}-1\right)\left(\frac{5}{3}-1\right)} = \frac{\frac{1}{m}+\frac{2}{3}}{\frac{1}{m}\times\frac{2}{3}}R$$

$= \frac{(3+2m)}{2}R$

molar heat capacity = nC=$(3+2m)R$

11. C

Sol. Terminal velocity $\propto r^2$

density h = $\frac{v^2}{2g}$, $h \propto r^4$

Rate of production of heat = $F_v v \propto r^5$

SECTION – B

12. 3

Sol. K = K(about vertical axis from O) + K(about horizontal axis OA)

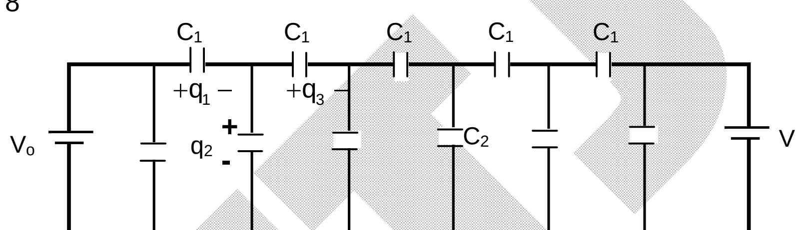
$= \frac{1}{2}\left(\frac{2}{5}mR^2 + m4R^2\right)\frac{v^2}{4R^2} + \frac{1}{2}\frac{2}{5}mR^2\frac{v^2}{R^2}$

$= \left(\frac{11}{20} + \frac{1}{5}\right)mv^2$

$= \frac{3}{4}mv^2$

13. 8

Sol.



$q_1 = q_2 + q_3$

$C_1(v_o - v_o r) = C_2(v_0 r) + C_1(v_0 r - v_0 r^2)$

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

$V = v_0 3^{-5}$

14. 1

Sol. $2\mu t = n\lambda \Rightarrow t_{min} = \frac{\lambda}{2\mu} = \frac{1}{5}\mu m$

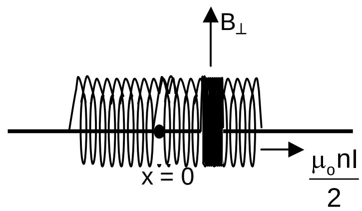
15. 8

Sol. $Q = 4 \times 7.1 - 2 \times 1.1 - 2 \times 1.1 = 24$ MeV

So, $\frac{Q}{3} = 8$MeV

16. 2

Sol.



$F = \int I 2\pi R B_\perp n dx$ ....(1)

From conservation of magnetic flux

$\int B_\perp 2\pi R dx = \frac{\mu_o n I A}{2}$ ....(2)

From (1) and (2)

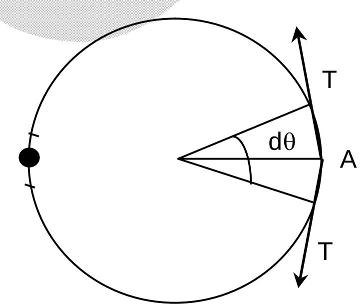
$F = \frac{\mu_o n^2 I^2 A}{2} = 2K\frac{x}{2}$ (where x is compression)

$x = \frac{\mu_o n^2 I^2 A}{2K}$

17. 7

Sol. Tensile stress at O be zero.

Tensile at A



$T\, d\theta = (\lambda R d\theta)\omega^2(2R)$

$T = \frac{m}{2\pi R}2R^2\omega^2$

$T = \frac{7m\omega^2 R}{22}$

Tensile stress at A.. $T_A = \frac{7m\omega^2 R}{22a_o}$

$T_A - T_o = \frac{7m\omega^2 R}{22a_o}$

Chemistry

PART – II

SECTION – A

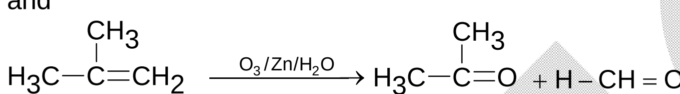
18. BC
Sol. Fact.

19. BC
Sol. Since H atoms are very small, so steric hindrance between them in eclipsed as well as staggered conformation is nearly same. So, torsional strain (i.e. repulsion between electron cloud of C–H bonds) and interaction between σ C–H (bonding) and σ^* C–H (antibonding) becomes main factors.

20. ABC
Sol. Alkene which on reductive ozonolysis given only ethanol is 2-butene.
So, other isomers of this alkene are

$$H_3C-CH_2-CH=CH_2 \xrightarrow{O_3/Zn/H_2O} H_3C-CH_2-CH=O+H-CH=O$$

and



Hence, (A), (B) and (C) is correct answer.

21. D
Sol. $\Delta U < 0$
For an isothermal process $\Delta T = 0$ so $\Delta U = 0$

22. A
Sol. $AgNO_3 + HCl \rightarrow AgCl + HNO_3$

λ_m^o AgCl = $(133\times10^{-4}+426\times10^{-4}-421\times10^{-4})Sm^2mol^{-1}$

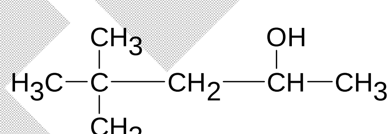
= $(138\times10^{-4})Sm^2mol^{-1}$

For AgCl $\lambda_m = \lambda_m^o$

λ_m AgCl(pure) = $(2.68\times10^{-4} - 0.86\times10^{-4})\ Sm^{-1} = 1.82\times10^{-4}\ Sm^{-1}$

$\lambda_m = \frac{\kappa\times1000}{C}$, here C = solubility

Ksp (AgCl) = C^2

23. B
Sol. (A) is 

24. C
Sol. Fact.

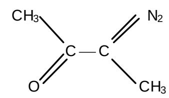
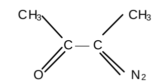
25. A
Sol. Factual.

26. B

Sol. (P) $Br - CH_2 - CH_2 - CH_2 - \underset{\underset{O}{||}}{C} - CH_3 \xrightarrow[THF]{Mg} BrMg - (CH_2)_3 - \underset{\underset{O}{||}}{C} - CH_3$

Intramolecular reaction makes cyclic compounds while Intermolecular reaction will go for polymerisation. Hence intramolecular cyclisation makes less decrease in entropy than intermolecular reaction.

(Q) Five membered ring formation takes place faster than six membered ring.

(R) The conformation  will not convert in to $O = C = \underset{\underset{CH_3}{|}}{C} - CH_3$ but 

can form this because migration of methyl group will not become possible in first conformation.

(S) Six membered ring is thermodynamically more stable than five membered ring.

27. C

Sol. Factual.

28. A

Sol. (P) → (2), (4)

$Bi^{3+} + H_2O \rightarrow (BiO)^+ + 2H+$

(Q) → (2)

$NaAlO_2 + H_2O \rightarrow Al(OH)_3 + NaOH$

(R) → (3)

$SiO_4^{4-} + 2H+ \rightarrow Si_2O_7^{6-} + H_2O$

(S) → (2), (3)

$Na_2B_4O_7 \xrightarrow{HCl} H_3BO_3$

$Na_2B_4O_7 \xrightarrow{H_2O} H_3BO_3$

SECTION – B

29. 4

Sol. Weaker acid have strong conjugate base.

30. 2

Sol.

 and 

31. 3

Sol. Total weight = 19.6 gm

(a) 2.8 g of molecules, density = 0.75 g /litre

Volume = $\frac{\text{mass}}{\text{density}} = \frac{2.8}{0.75}$

1 mole $\longrightarrow$ 22.4 litres at N.T.P

$\longrightarrow \frac{2.8}{0.75}$ litres at N.T.P

Moles = $\frac{2.8}{0.75} \times \frac{1}{22.4}$

Molecules = $\frac{2.8}{0.75}\times\frac{6}{22.4}\times10^{23}=1\times10^{23}$

(b) 11.2 g of molecules, density = 3 g /litre molecules = 1×10^{23}

(c) 5.6 g of molecules, density = 1.5 g/ litre molecules = 1×10^{23}

Total no of molecules = 3×10^{23}

= 10^{-23} N = 3

32. 6

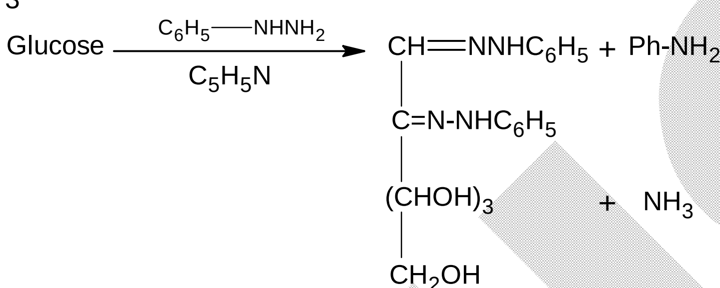
Sol. Cinnabar → HgS, Wolframite →$FeWO_4$, Solder → 50% Pb and 50% Sn, Sindoor → Pb_3O_4, Pattinson's process-desilverisation of lead, Bronze does not contain Lead, Calcium plumbate → $CaPbO_2$

33. 4

Sol. Pb^{2+}, Cu^{2+}, Cr^{3+}, Zn^{2+}

34. 3

Sol.



Mathematics

PART – III

SECTION – A

35. ABC

Sol. $I_1 = \int_0^{\pi/2} \cos\left(\pi\cos^2 x\right)dx = \int_0^{\pi/2} \cos\left(\pi\sin^2 x\right)dx$

$2I_2 = \int_0^{\pi/2} 2\cos\left(\frac{\pi}{2}\right)\cos\left(\frac{\pi}{2}\cos 2x\right) = 0$

$I_1 = 0$

$I_2 = \int_0^{\pi/2} \cos\left(\pi\left(1-\cos 2x\right)\right)dx = -\int_0^{\pi/2} \cos\left(\pi\cos 2x\right)dx$

$= -\frac{1}{2}\int_0^{\pi} \cos\left(\pi\cos t\right)dt$ put $2x = t$

$= -I_3$

$\Rightarrow I_2 + I_3 = 0$

36. BD

Sol. The line y = mx + c makes a chord of length $2\sqrt{\frac{a^2\left(1+m^2\right)-c^2}{1+m^2}}$ from circle $x^2 + y^2 = a^2$

37. ABD

Sol. $y = \log_7\left(\log_7 x\right) \Rightarrow \frac{dy}{dx} = \frac{1}{x\log e^x \log_e 7}$

38. B

Sol. $\because$ $2\cos\theta_1 = \frac{8}{5} \Rightarrow \cos\theta_1 = \frac{4}{5} \Rightarrow \tan\frac{\theta_1}{2} = \sqrt{\frac{1-\frac{4}{5}}{1+\frac{4}{5}}} = \frac{1}{3}$ and $e = \frac{1}{2}$

$\therefore$ $\tan\frac{\theta_2}{2} \times \frac{1}{3} = \frac{-\frac{1}{2}}{\frac{3}{2}}$

$\frac{\theta_2}{2} = \frac{3\pi}{4} \Rightarrow \theta_2 = \frac{3\pi}{2}$

$\therefore$ $B = \left(0,-\sqrt{3}\right) \Rightarrow AB = 2 + 2 - \frac{1}{2} \times \frac{8}{5} = 4 - \frac{4}{5} = \frac{16}{5}$

39. D

Sol. $\because$ Image of $(2,1)$ in $2x - y + 1 = 0$ is

$\frac{x-2}{2} = \frac{y-1}{-1} = \frac{-2\left(4-1+1\right)}{4+1} = \frac{-8}{5}$

$\Rightarrow$ $x = 2 - \frac{16}{5} = \frac{-6}{5}$, $y = \frac{8}{5} + 1 = \frac{13}{5}$

$\therefore$ Slope of directrix $= \dfrac{\frac{13}{5}-3}{\frac{-6}{5}-1} = \dfrac{-\frac{2}{5}}{-\frac{11}{5}} = \dfrac{2}{11}$

$\therefore$ Equation of axis,

$y-1=\dfrac{-11}{2}(x-2)$

$\Rightarrow$ $2y-2=-11x+22 \quad \Rightarrow \quad 11x+2y=24$

40. D

Sol. $\because$ $(\vec{a}\times\vec{b})\cdot\left[(\vec{a}.\vec{c})\vec{b}-(\vec{a}.\vec{b})\vec{c}\right]=0-(\vec{a}.\vec{b})\left[\vec{a}\times\vec{b}\times\vec{c}\right]$

$=-\dfrac{1}{2}\times\dfrac{1}{\sqrt{2}}$

41. D

Sol. $\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \Rightarrow$ Sum of diagonal

$=\sum a^2$ (all 9 terms of element)

$a^2+b^2+c^2+d^2+e^2+f^2+g^2+h^2+i^2=7$

(5 zero) 1 of them 2, 3 of them 1 $\Rightarrow 7 = {}^9C_4\dfrac{4!}{3!}$

(2 zero) 7 of them 1 $\Rightarrow 7 = {}^9C_7\dfrac{7!}{7!}$

42. C

Sol. AEEI $\rightarrow$ 4V, DRJLNG $\rightarrow$ 6C (V – vowels, C – consonants)

–xx – xx – xx –

$N=\dfrac{4!}{2!}\times 6! = 12\times 720 = 2^6\times 3^3\times 5^1$

43. A

Sol. 3x + y – z = 0

$x-\dfrac{py}{4}+z=0$

$2x-y+2z=q$

Eqn. (2)$\times$(2) – eqn. (3)

$\Rightarrow$ $\left(1-\dfrac{p}{2}\right)y=4-q$

For unique solution, $p\neq 2, q\in N \Rightarrow$ Number of ordered pairs (p, q) in [1, 10] are 90.

For infinite solution, p = 2 and q = 4 $\Rightarrow$ exactly one ordered pair.

For no solution, p = 2 and $q\neq 4 \Rightarrow$ Number of ordered pairs (p, q) in [1, 10] are 9.

44. D

Sol. (P) $\displaystyle\int_1^3 g(x)dx+\int_3^1 g^{-1}(x)dx=0$

(Q) $f(x)\big|_{max} = f(\pi) = \dfrac{5+3}{3-1} = 4$

(R) $f'(x) = 3x^2 + 2px + q \begin{smallmatrix} \nearrow 1 \\ \searrow 3 \end{smallmatrix}$

$\dfrac{q}{3} = 3 \Rightarrow q = p$

$\dfrac{-2p}{3} = 4 \Rightarrow p = -6$

$\Rightarrow p + q = 3$

(S) $L = \displaystyle\int_0^1 \frac{dx}{(1+x)(2+x)}$

$= \displaystyle\int_0^1 \left(\frac{1}{1+x} - \frac{1}{2+x}\right)dx = \left(\ln\left|\frac{1+x}{2+x}\right|\right)_0^1$

$\Rightarrow \ln\left(\dfrac{2}{3}\right) - \ln\left(\dfrac{1}{2}\right)$

$\Rightarrow \ln\left(\dfrac{4}{3}\right) \equiv \ln\left(\dfrac{a}{b}\right)$

$\therefore |a-b| = 1$

45. A

Sol. (P) Tangent to hyperbola having slope m is

$y = mx \pm \sqrt{9m^2 - 25}$

Putting m = 2, we get $y = 2x \pm \sqrt{11}$.

(Q) Equation of pair of asymptotes to hyperbola is

$\dfrac{x^2}{9} \pm \dfrac{y^2}{25} = 0$ or $5x \pm 3y = 0$

(R) Normal to hyperbola having slope m is

$y = mx \pm \dfrac{(a^2+b^2)m}{\sqrt{a^2 - b^2m^2}}$

For given hyperbola, it is $y = mx \pm \dfrac{34m}{\sqrt{9-25m^2}}$

Putting $m = \dfrac{1}{2}$, we get

$y = \dfrac{1}{2}x \pm \dfrac{17}{\sqrt{9-\dfrac{25}{4}}} \Rightarrow 2y = x \pm \dfrac{68}{\sqrt{11}}$

(S) Foci of hyperbola are $\left(\pm\sqrt{34},\ 0\right)$

So, line $y = x - \sqrt{34}$ is focal chord.

SECTION – B

46. 3

Sol. $\because$ $f'(x) = b^2 + (a-1)b + 2 - (\sin^2 x + \cos^4 x) \geq 0$

$(f'(x))_{min} = b^2 + (a-1)b + 1 \geq 0$

$\therefore$ $(a-1)^2 - 4 < 0$

$\Rightarrow$ $a \in (-1, 3)$

$a = 0$ or 1 or 2

$0 + 1 + 2 = 3$

47. 4

Sol. $I = \int_1^2 \frac{x^3 - 3x^2}{\ln(x-1)}$ and $J = \int_2^3 \frac{3x-5}{\ln(x-2)}$

$\Rightarrow$ $J = \int_1^2 \frac{3x-2}{\ln(x-1)}$

$J + I = \int_1^2 \frac{x^3 - 3x^2 + 3x - 2}{\ln(x-1)} = \int_1^2 \frac{(x-1)^3 - 1}{\ln(x-1)} dx$

$= \int_1^2 \frac{(x-1)^3 - 1}{\ln(x-1)} dx = \int_1^2 \frac{x^3 - 1}{\ln x} dx = \ln 4$

$\therefore$ $e^{\ln 4} = 4$

48. 2

Sol. $\overrightarrow{OA} = a\hat{i} + b\hat{j} + c\hat{k}$ and $a^2 + b^2 + c^2 = 4$

$\Rightarrow$ $AB = \left(25 - 24\cos^2 \frac{\theta}{2}\right)$

$\therefore$ $|QD| = \frac{2}{5}\cos\frac{\theta}{2}$

$\Rightarrow$ $25|QD| = 2$

49. 4

Sol. $\frac{3x^2 + 1}{\sqrt{x^4 + x^2}} = \frac{3x^2 + 1}{x\sqrt{x^2 + 1}} = \frac{x^2 + 1 + 2x^2}{x\sqrt{x^2 + 1}}$

$= \frac{\sqrt{x^2 + 1}}{x} + \frac{2x}{\sqrt{x^2 + 1}} \geq 2\sqrt{2}$

$f(x) = 2\sqrt{2}$

$\therefore$ $x^2 + 1 = 2x^2$

$x^2 = 1$

$x = \pm 1 \quad x = 1$

$\int_0^{\sqrt{2}} \frac{(3x^2 + 1)dx}{\sqrt{x^4 + x^2}} \geq 2\sqrt{2} \times \sqrt{2} = 4$

50. 3

Sol. $\because$ $\left|adj(A)\right| = |A|^{n-1}$

$\Rightarrow$ $\left|adj(adj(A))\right| = \left|adj(A)\right|^{n-1} = |A|^{(n-1)^2}$

$\Rightarrow$ $\left|adj(adj(adj(A)))\right| = |A|^{(n-1)^2}$

$\Rightarrow$ $(n-1)^2 = 4$

$n-1=2$

$n=3$

51. 2

Sol. Given $a_{11} = b_{11}, a_{22} = b_{22}, a_{12} = -b_{12}, a_{21} = -b_{21}$ and AB = BA = I

$\Rightarrow$ $A = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{11} \end{pmatrix}$ and $|A| = 1$

$\therefore$ $a_{11}^2 - a_{12}a_{21} = 1$

$a_{12}a_{21} = a_{11}^2 - 1$

$\Rightarrow$ a_{12} or $a_{21} = (a_{11} - 1)$ or $(a_{11} + 1)$

$\Rightarrow$ $|a_{12} - a_{21}| = 2$